User's Manual

Line Scan Camera

Type: RMSL8K100CL

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 2014/30/EU, based on the following specifications applied:
EU Harmonised Standards
EN55032:2015/A11:2020 Class A
EN55011:2016/A11:2020 Group1 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.
- 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 lost by using Setting Pixel Correction. Please refer to White Pixel Correction Data Save.
- Do not use the ultraviolet rays and the X-rays wavelength as the lighting source because a characteristic of the image sensor may deteriorate.
- Note that when the image sensor is exposed to excessive quantities of light, blooming may occur, because this product does not have a special Anti-Blooming function.
- Avoid exposing the image sensor under excessive light quantity for a long period.
- 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.
- 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.
- The signal ground (SG) and the frame ground (FG) are connected inside the camera unit. Design the system configuration so that a loop will not be formed by the ground potential differential.
- Do not disconnect the camera while rewriting the embedded memory.
- When you change exposure mode that is set at NEDfactory, input control signal (CC1) from the capture board.

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.

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1 Product Outline

1.1 Features

- High speed readout (100KHz @10taps, Mono8, 85MHz, 8192 pixels)
- High resolution (8,192 pixels)
- Easy control of gain/ offset/ video output with external software.
- Easy connection with a variety of frame grabber boards via Camera Link interface
- Single power source DC 12V to 24V for operation
- PRNU / Shading correcting function

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
- Visual inspection of printed circuit boards
- This camera utilizes an Intelligent Transportation System
- Outdoor surveillance

An example of Visual Inspection is shown below.

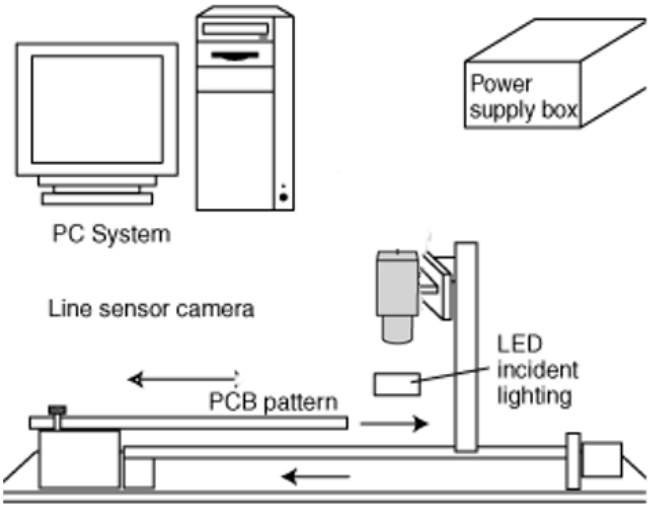


Figure 1-2-1 Visual Inspection of PCBs

1.3 Image Sensor

The camera adopts a monochromatic CMOS sensor with 8,192 pixels to acquire high responsivity and superior quality images.

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 line rate, unless otherwise specified.

Table 1-4-1 Performance Specifications

Items		Specifications
Number of Pixels		8,192
Pixel Size H x V(μm）		7x7
Sensor Length（mm）		57.344
Clock frequency of Camera Link(MHz)		40,70,80,85
Max line Rate (kHz) Min line Period(μs)		100 @10taps, Mono8, 85MHz, 8192 pixels 10
Saturation Exposure (lx･s) (typically) [Minimum Gain]		0.067
Responsivity (V/ [lx･s]) (typically) [Minimum Gain]		82 @Analog 5V Conversion Sensitivity
Gain Adjustable Range *Analog Amplifier +Digital		Analog Amplifier：x1,x2,x4,x8,x10,x18 Digital ：x1 to x2（512 Steps）
Digital Offset Adjustable Range (DN)		-64 to 64 (513 Steps) @Mono8 -256 to 256 (513 Steps) @Mono10
Camera Link Configuration		Base, Medium, Full, Eighty Bit
Control Input		CC1：External Trigger Signal CC2,3,4：Not in use
Connectors	Data/Controller	3M：SDR26[Mini Camera Link] x 2
	Power Supply	Hirose: HR10G (6-Pin)
Lens Mount		M72x0.75
Operating Temperature (˚C) (No Condensation)		0 to 50(internal temperature is below +75 °C)
Power Supply Voltage (V)		DC12 to 24 [+/-5%]
Consumption Current (mA) (typically)		780 @DC12V
Size W x H x D (mm)		80 x 100 x 37.7
Mass (g) (Camera only)		450
Additional Functions		1 Shading Correction 2 Gamma Correction 3 Pixel Selection (ROI) 4 Binning

Notes：Measurements were made at room temperarure, daylight fluorescent light, a visible range and initial setting value of pixel correction in factory shipment.

The spectral responsivity is shown below.

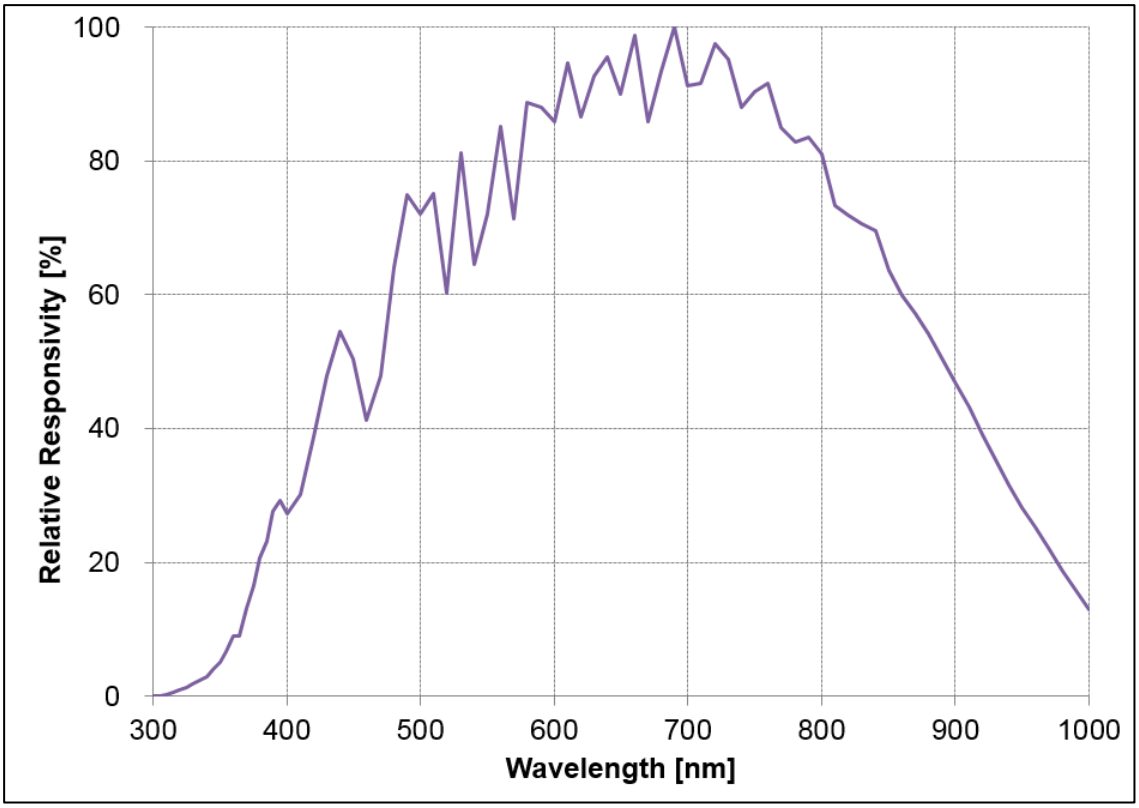


Figure 1-4-1 Spectral Responsivity

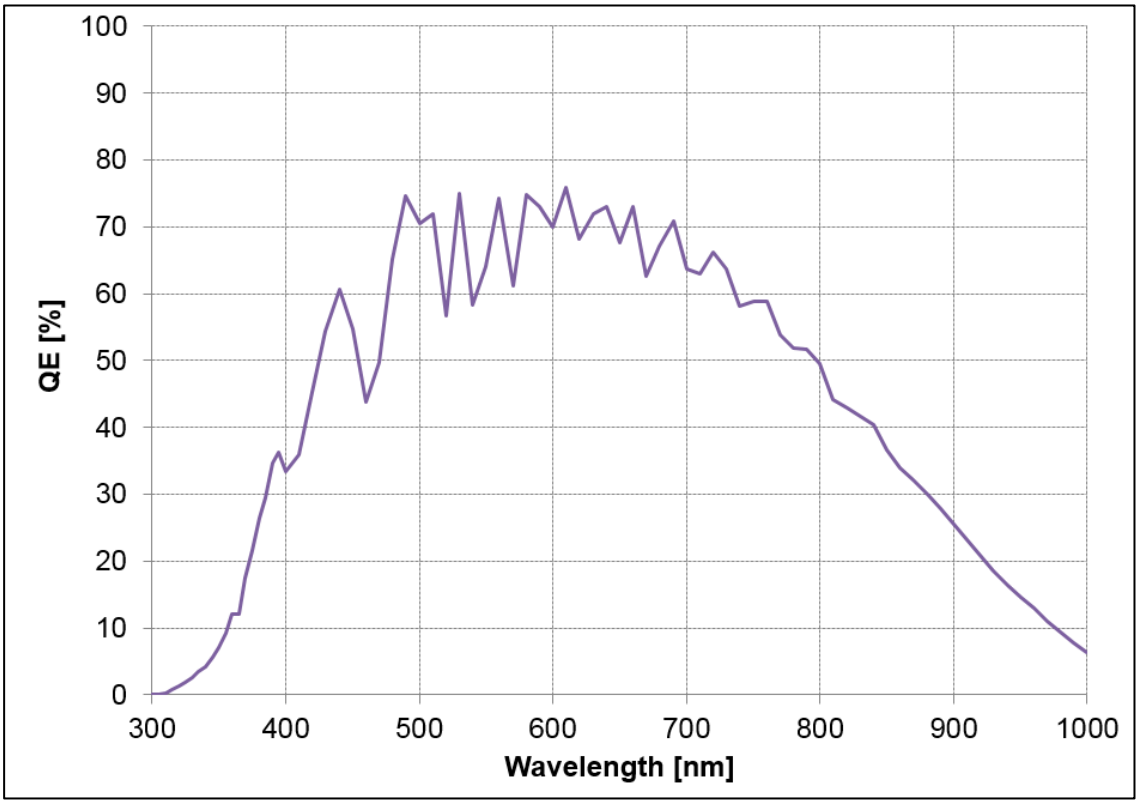


Figure 1-4-2 Quantum Efficiency

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.

Use the camera mounting bracket with excellent heat radiation property to radiate the heat of the camera from camera front panel to the camera mounting bracket.

2.2 Fixing the Camera

- Use the M4 screw holes (4 places at the front, 8 places at the side) to fix the camera.
- Or use the 1/4"-20UNC screw hole for a tripod (1 place at the side).
- If using the front panel M4 mounting holes, 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 provide an adjustment mechanism yourself as necessary.

2.3 Dimensions of Camera

The dimensions of the camera is shown below.

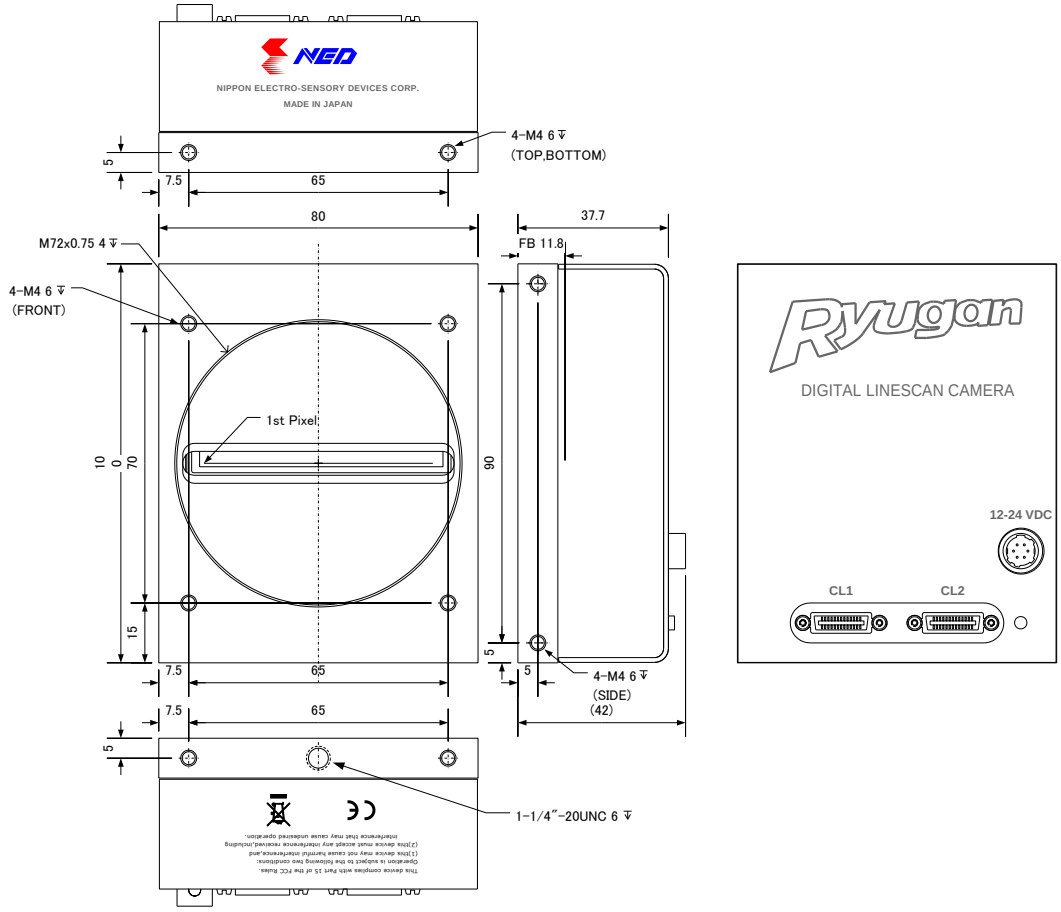


Figure 2-3-1 Dimensions of the Camera

2.4 Optical Interface

For RMSL8K100CL, M72 × 0.75 screw mount is available.The amount and wavelengths of light required to capture useful images depend on the intended use. Factors include the physical properties, speed, the object's spectral characteristics, exposure time, the light source characteristics, the specifications of the acquisition system and so on. The exposure amount (exposure time x light amount) is the most important factor in getting desirable images. Please determine the exposure amount after studying what is most important to your system.

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

- LED light sources are relatively inexpensive, provide a uniform field and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity.
- Halogen light sources generally provide very little blue 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.

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

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

3. Hardware

3.1 Camera Connection

Use the camera in the following way:

(1) Camera Link cables must be used to connect the camera unit with the frame grabber board.

Notes:

・Camera Link Full Configuration cables must be used to connect the camera unit with the frame grabber board.Use two cables of the same length and the same manufacturer.

・In case 2Tap output selected use only one cable(Camera Link Base/Medium or Full) and Connect the cable to CL1 connector. (CL2 connector is not used)

・In case asymmetric Camera Link Full Configuration cables are used, connect the camera with the connector labeled as ”Camera side”.

(2) Connect the camera with the designated power supply. Use the designated power cable to connect the camera with the power source for the camera. Insert the plug end of the cable into the camera. Attach the opposite end (loose wires) to the power unit. Other than those above, a personal computer, a frame grabber board, a compatible lens, a lens mount, a light source and an encoder are necessary, depending on the situation.

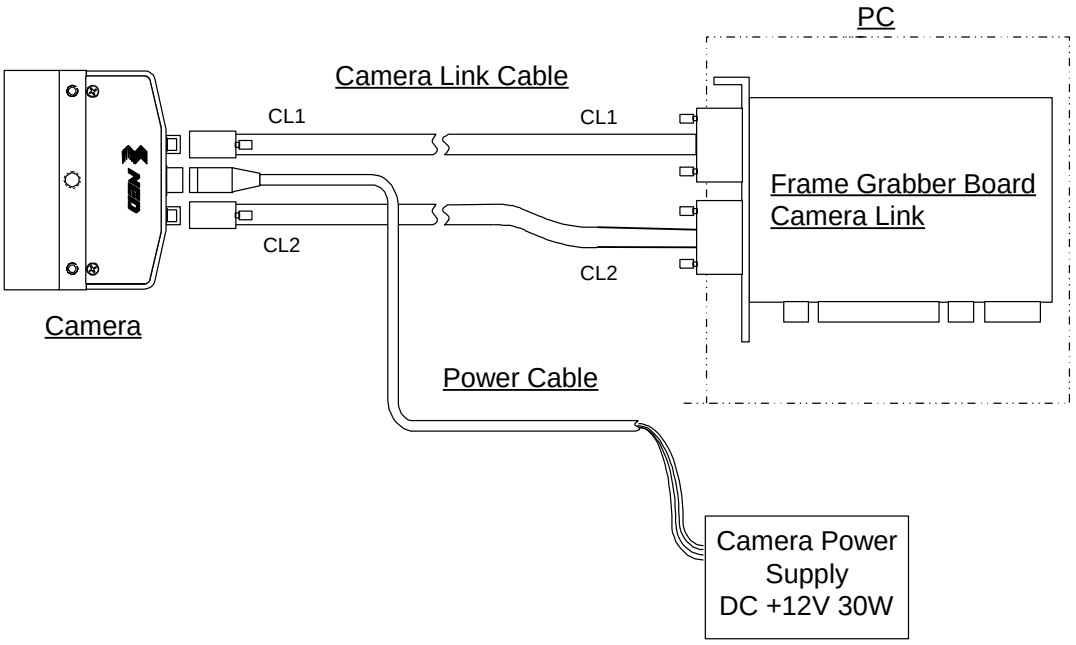


Figure 3-1-1 Connections between Camera and Frame Grabber Board and Power Supply

Notes:

・There are two connectors available for the Camera Link Medium or Full Configuration board. Always check the frame grabber board specifications before making connections.

<Notes: 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 connectors and the LED indicator are as follows.

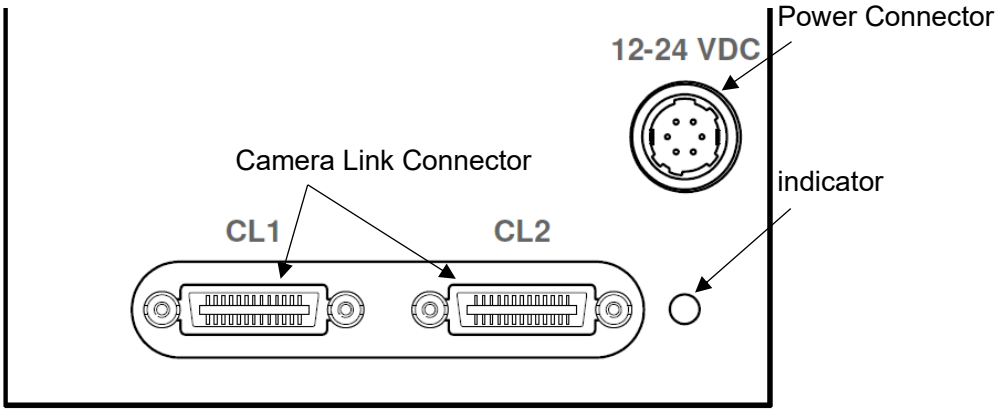


Figure 3-2-1 Input / Output Connectors and Power connector

3.3 Connectors･Pin Assignments･Cables

This camera adopts Base～Eighty Bit Configuration of Camera Link interface standards. The figure shown below shows the interface for the camera and a typical implementation for the frame grabber interface.

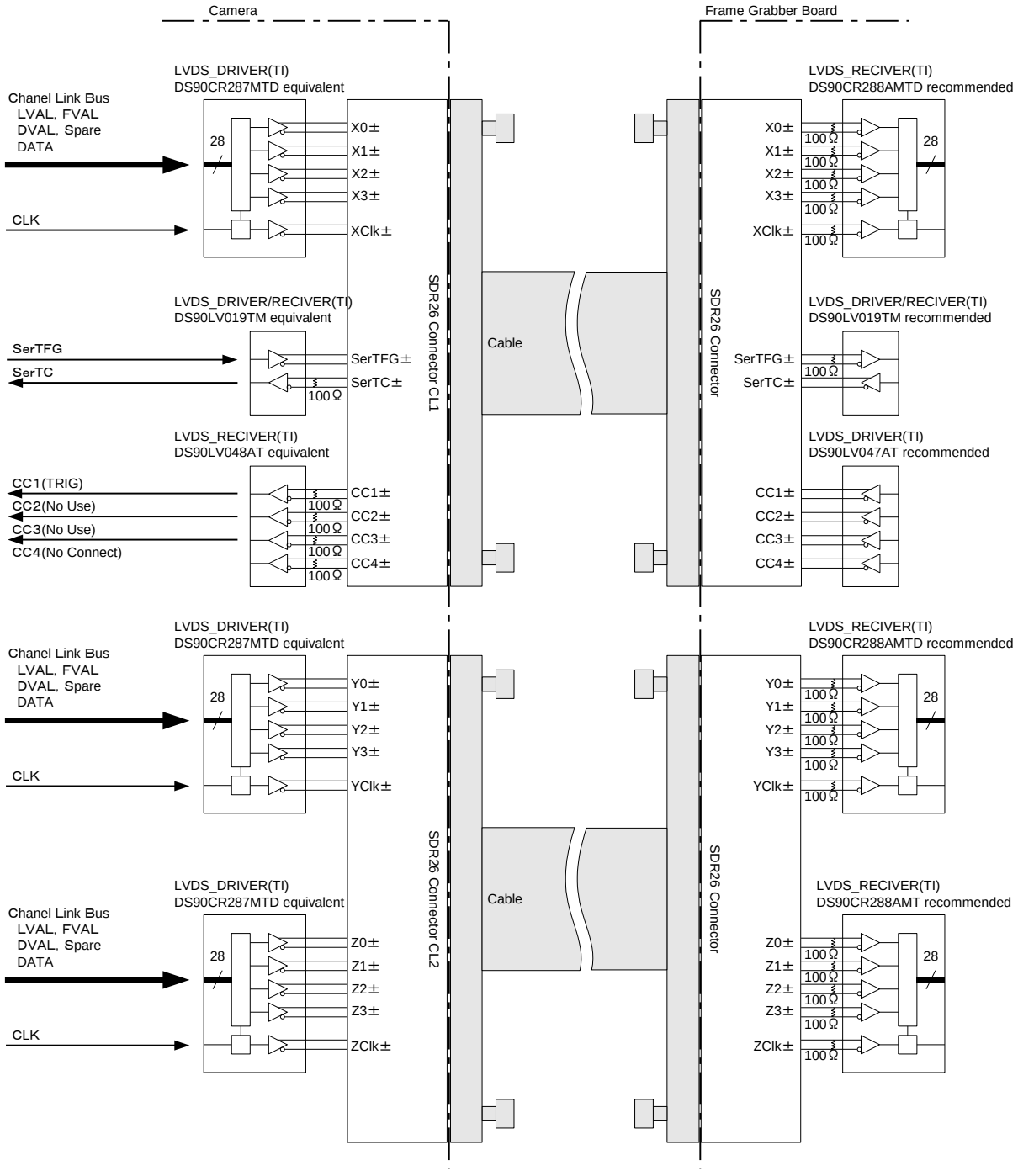


Figure 3-3-1 Camera / Frame Grabber Interface（Base, Medium, and Full）

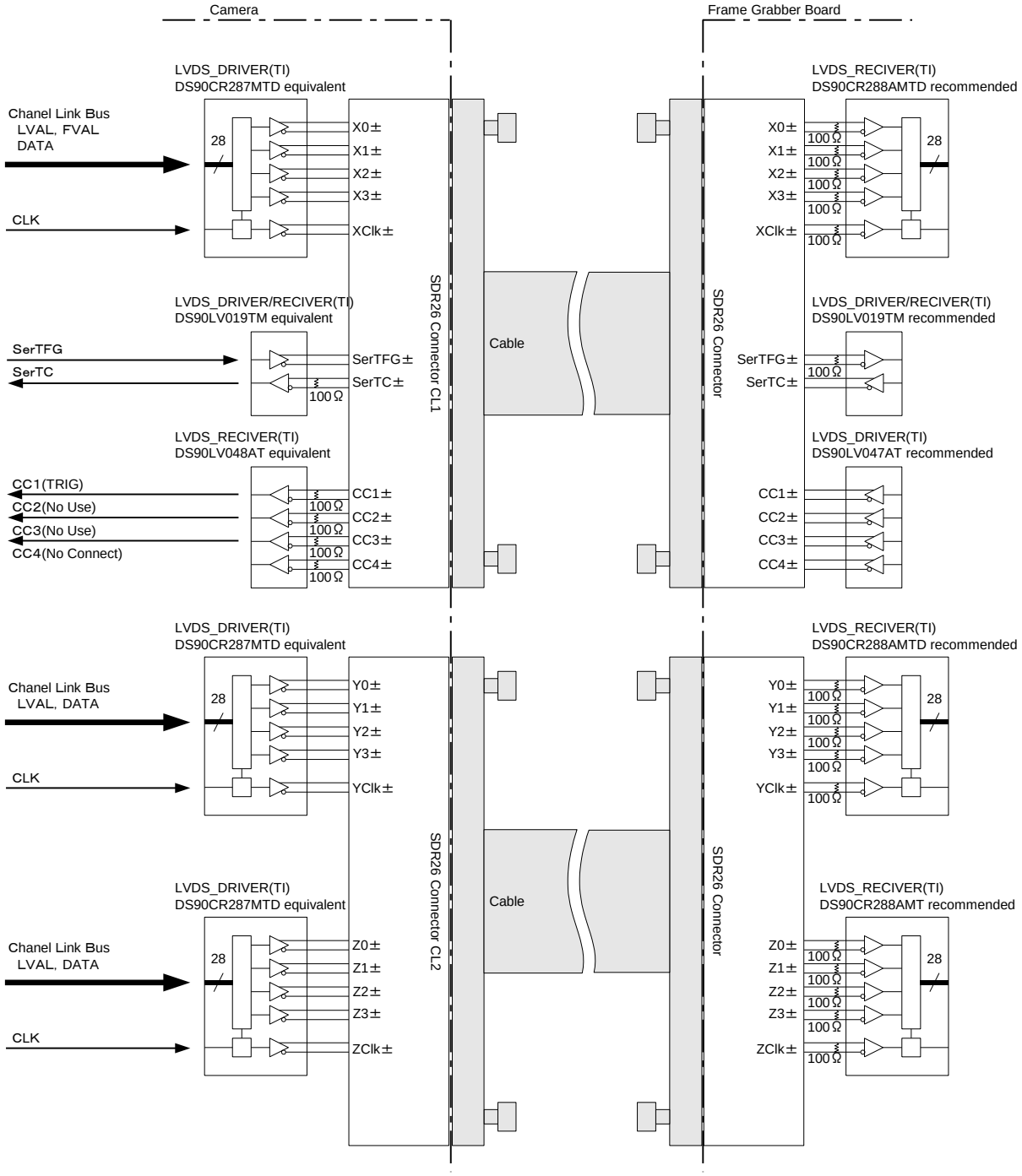


Figure 3-3-2 Camera / Frame Grabber Interface（Eighty Bit）

The table below shows the Camera Link port assignments.

Table 3-3-1 Camera Link Output bit assignments

	Number of Connector	Number of Chip	Number of Signal	Mono			
				Base～Full		Eighty Bit	
				Mono8/2,4,8taps	Mono10/2,4taps	Mono10/8taps	Mono8/10taps
Base	1	1 (X)	0	M1.0	M1.0	M1.2	M1.0
			1	M1.1	M1.1	M1.3	M1.1
			2	M1.2	M1.2	M1.4	M1.2
			3	M1.3	M1.3	M1.5	M1.3
			4	M1.4	M1.4	M1.6	M1.4
			6	M1.5	M1.5	M1.7	M1.6
			27	M1.6	M1.6	M1.8	M4.1
			5	M1.7	M1.7	M1.9	M1.5
			7	M2.0	M1.8	M2.2	M1.7
			8	M2.1	M1.9	M2.3	M2.0
			9	M2.2	Not Used	M2.4	M2.1
			12	M2.3	Not Used	M2.5	M2.4
			13	M2.4	M2.8	M2.6	M2.5
			14	M2.5	M2.9	M2.7	M2.6
			10	M2.6	Not Used	M2.8	M2.2
			11	M2.7	Not Used	M2.9	M2.3
			15	M3.0	M2.0	M3.2	M2.7
			18	M3.1	M2.1	M3.3	M3.2
			19	M3.2	M2.2	M3.4	M3.3
			20	M3.3	M2.3	M3.5	M3.4
			21	M3.4	M2.4	M3.6	M3.5
			22	M3.5	M2.5	M3.7	M3.6
			16	M3.6	M2.6	M3.8	M3.0
			17	M3.7	M2.7	M3.9	M3.1
			24	LVAL	LVAL	LVAL	LVAL
			25	FVAL(GND)	FVAL(GND)	FVAL(GND)	FVAL(GND)
			26	DVAL	DVAL	M1.0	M4.0
			23	Spare	Spare	M1.1	M3.7

Medium	2	2 (Y)	0	M4.0	M4.0	M4.2	M4.2
			1	M4.1	M4.1	M4.3	M4.3
			2	M4.2	M4.2	M4.4	M4.4
			3	M4.3	M4.3	M4.5	M4.5
			4	M4.4	M4.4	M4.6	M4.6
			6	M4.5	M4.5	M4.7	M5.0
			27	M4.6	M4.6	M4.8	LVAL
			5	M4.7	M4.7	M4.9	M4.7
			7	M5.0	M3.0	M5.2	M5.1
			8	M5.1	M3.1	M5.3	M5.2
			9	M5.2	M3.2	M5.4	M5.3
			12	M5.3	M3.3	M5.5	M5.6
			13	M5.4	M3.4	M5.6	M5.7
			14	M5.5	M3.5	M5.7	M6.0
			10	M5.6	M3.6	M5.8	M5.4
			11	M5.7	M3.7	M5.9	M5.5
			15	M6.0	M3.8	M6.2	M6.1
			18	M6.1	M3.9	M6.3	M6.4
			19	M6.2	Not Used	M6.4	M6.5
			20	M6.3	Not Used	M6.5	M6.6
			21	M6.4	M4.8	M6.6	M6.7
			22	M6.5	M4.9	M6.7	M7.0
			16	M6.6	Not Used	M6.8	M6.2
			17	M6.7	Not Used	M6.9	M6.3
			24	LVAL	LVAL	LVAL	M7.2
			25	FVAL	FVAL	M2.0	M7.3
			26	DVAL	DVAL	M2.1	M7.4
			23	Spare	Spare	M3.0	M7.1

Full	2	3 (Z)	0	M7.0	Not Used	M7.2	M7.5
			1	M7.1	Not Used	M7.3	M7.6
			2	M7.2	Not Used	M7.4	M7.7
			3	M7.3	Not Used	M7.5	M8.0
			4	M7.4	Not Used	M7.6	M8.1
			6	M7.5	Not Used	M7.7	M8.3
			27	M7.6	Not Used	M7.8	LVAL
			5	M7.7	Not Used	M7.9	M8.2
			7	M8.0	Not Used	M8.2	M8.4
			8	M8.1	Not Used	M8.3	M8.5
			9	M8.2	Not Used	M8.4	M8.6
			12	M8.3	Not Used	M8.5	M9.1
			13	M8.4	Not Used	M8.6	M9.2
			14	M8.5	Not Used	M8.7	M9.3
			10	M8.6	Not Used	M8.8	M8.7
			11	M8.7	Not Used	M8.9	M9.0
			15	Not Used	Not Used	M3.1	M9.4
			18	Not Used	Not Used	M4.0	M9.7
			19	Not Used	Not Used	M4.1	M10.0
			20	Not Used	Not Used	M5.0	M10.1
			21	Not Used	Not Used	M5.1	M10.2
			22	Not Used	Not Used	M6.0	M10.3
			16	Not Used	Not Used	M6.1	M9.5
			17	Not Used	Not Used	M7.0	M9.6
			24	LVAL	LVAL	LVAL	M10.5
			25	FVAL	FVAL	M7.1	M10.6
			26	DVAL	DVAL	M8.0	M10.7
			23	Spare	Spare	M8.1	M10.4

Notes:

1) Set the LVDS, Channel Link receiver side to 100-ohm termination.

2) With the driver side of LVDS, even if not used, do not make it open but set the logic to H or L.

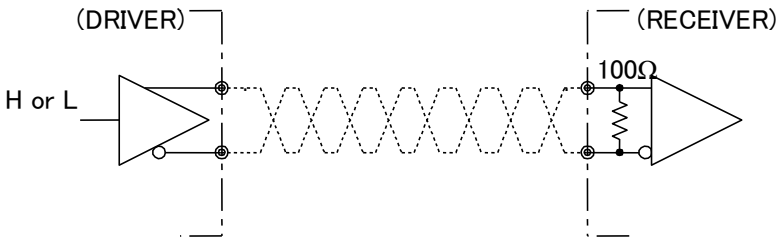


Figure 3-3-3 Circuit of LVDS

The camera has 26-pin SDR connectors (0.8mm pitch) for control signals of Camera Link, data signals and serial communications.

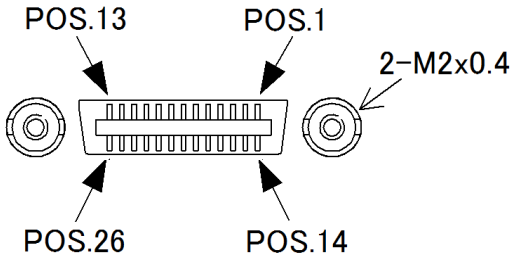


Figure 3-3-4 Mini Camera Link Connector

Table 3-3-2 Camera Link Connector (26-pin SDR 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
0	CC2+	23	CC2-	In
11	CC3-	24	CC3+	In
12	CC4+	25	CC4-	In
13	Inner Shield	26	Inner Shield	

CL2(Medium, Full or Eighty Bit Configuration)

No	Name	No	Name	I/O
1	Inner Shield	14	Inner Shield	
2	Y0-	15	Y0+	Out
3	Y1-	16	Y1+	Out
4	Y2-	17	Y2+	Out
5	Yclk-	18	Yclk+	Out
6	Y3-	19	Y3+	Out
7	100Ωterminated	20	100Ωterminated	
8	Z0-	21	Z0+	Out
9	Z1-	22	Z1+	Out
10	Z2-	23	Z2+	Out
11	Zclk-	24	Zclk+	Out
12	Z3-	25	Z3+	Out
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)
  Y0+,Y0-･･･Y3+,Y3-: Data output (Channel Link)
  Yclk+, Yclk-: Clock output for above data output synchronization (Channel Link)
  Z0+,Z0-･･･Z3+,Z3-: Data output (Channel Link)
  Zclk+, Zclk -: 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: SDR-MDR：1MF26-L560-00C-xxx by or equivalent
  3M: SDR-SDR：1SF26-L120-00C-xxx 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).

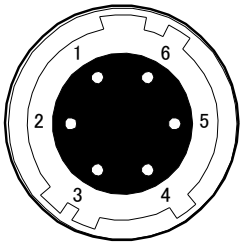


Figure 3-3-5 Power Supply Connector (HIROSE: HR10G-7R-6PB)

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

No	Name	Colour of Cable "DGPSH-10"
1	DC12 to 24V	White
2	DC12 to 24V	Red
3	DC12 to 24V	
4	GND	Green
5	GND	Black
6	GND	

Notes: The applicable cable "DGPSH-10" is a 4-core cable.

3.4 Power Supply

The camera requires a single power supply (DC+12 to +24V). The indicator (LED) blinks orange when power is supplied. After a short period, it changes to a solid green light, indicating that the camera is operational.

Notes:

1) When selecting a power source, choose one with the capacity to allow for inrush current. (30W or more recommended)
2) When the power supply starts up, the required voltage must be increased monotonously within 500ms.
3) Insert the cable plug securely until it locks into position. This is to prevent the connector from coming loose during power transmission.
4) Take the necessary countermeasures in the electric supply line for lightning surge protection, if the camera is used in the area where lightning strikes often occur.
5) Do not share the power supply and ground connection with the apparatus such as the inverter-controlled motor units or other devices that generate noise interference to avoid the failure and malfunction of the camera. Place the camera far away from the apparatus generating noise. Do not arrange the signal cables and the power supply cable for camera adjacently.
6) If the lamp fails to illuminate even after power is switched on, turn off power immediately. Inspect wiring. Check the voltage and capacity of the supplied power source.
7) It is recommended that the shield processing of the power cable to be connected with GND on

the power supply side.

4 Camera Control

The camera can be controlled directly by commands through the serial communication. The attached camera control software can also be used for camera control. 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 S1 CMD CR
- Format S2 CMD ☐ VAL 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), numerical values only

4.1.3 Camera Sending Message (PC Receiving Message)

- Format R1 >R CR >[SB] CR EOT
- Format R2 (for “sta” command) >R CR >[MEM] CR >[SB] CR EOT

  >: Results start text (0x3E)
  R**:** Camera receives command analyzed results
  [SB]**:** Camera receives command send back
  [MEM]**:** Memory data readout value
  CR**:** Separated text (0 x 0D)
  EOT**:** Send command all text end text (0 x 04)

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 When the control character exceeds 254 characters
VAL ERR!	Parameter accepted was outside of specified
MEM ERR!	Camera memory error
TRG ERR!	When the scanning interval becomes more than a few seconds when arbitrary pixel correction data is acquired.

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 [Factory Settings]	Control Description
Operation Status Readout	Sta		Readout the current camera settings
Readout Internal Temperature	temp		Displays internal PCB temperature
Analog Gain	gax	0/1/2/3/4/5 [1]	x1/x2/x4/x8/x10/x18 (Recommended Value x1 to x8)
Digital Gain	gdx	0 to 511 [0]	x1...x2(x0.003906/step)
Digital Offset	odx	-256 to 256 [0]	-64 to +64DN (0.25DN/step @Mono8) -256 to +256DN (1.0DN/step @Mono10)
Noise reduction Type	nrt	0/1 [0]	1x3 Weighted average filter/ 1x3 Median filter
Noise reduction	nr	0/1 [0]	OFF/ON
Gamma Correction setting	gamma	250 to 4000 [1000]	γ0.25 to 4.00
Trigger Mode	inm	0/1/2 [0]	Free Run/Ext Edge/Ext Level
Line Rate	prd	500 to 100000 [10000]	500 to 100,000Hz(100ns/step)
Programmable Exposure Time	expo	3600 to 1998000 [98000]	3,600 to 1,998,000ns(100ns/step)
ROI range	roi_range		Readout ROI setting region
ROI Pixel Number	width	256 to 8192 [8192]	256 to 8,192 pixels (16/step @binning 1)
ROI Pixel Offset	offx	0 to 7936 [0]	0 to 7,936 pixels (16/step @binning 1)
Horizontal Binning Mode	bhm	0/1 [0]	Addition/ Addition Average
Horizontal Binning Pixel Number	bh	1/2 [1]	1(OFF)/2 pixels
Scanning Direction	rev	0/1 [0]	Forward/Reverse
Pixel Format	pxf	0/1 [0]	Mono8/Mono10
Test Pattern	tpn	0/1/2 [0]	OFF/Horizontal Ramp/ Horizontal Vertical Ramp
Clock Frequency of Camera Link	clkcl	85/80/70/40 [85]	85/80/70/40MHz
Output Tap Pattern (Geometry)	tapg	0/1/2/3 [2]	GenIcam 1X2/1X4/1X8/1X10

Pixel Correction Setting	ffcm	0/1/2/3/4 [0]	Factory correction data / User arbitrary correction data1 / User arbitrary correction data2 / User arbitrary correction data3 / User arbitrary correction data4
Pixel Correction Data Save [gray]	wht		Arbitrary user's correction data Is acquired and stored in the memory.
Pixel Correction Data Save [dark]	blk		Arbitrary user's correction data Is acquired and stored in the memory.
Pixel Correction target level1	ffct1	1 to 1023 [768]	1 to 1,023DN(@Mono10)
Pixel Correction target level2	ffct2	1 to 1023 [768]	1 to 1,023DN(@Mono10)
Pixel Correction target level3	ffct3	1 to 1023 [768]	1 to 1,023DN(@Mono10)
Pixel Correction target level4	ffct4	1 to 1023 [768]	1 to 1,023DN(@Mono10)
Pixel correction gray data at factory copy to selected memory	ffccpyw	0/1/2/3/4	Factory/user1/user2/user3/user4
Pixel correction dark data at factory copy to selected memory	ffccpyb	0/1/2/3/4	Factory/user1/user2/user3/user4
Select parameter table	ussel	0/1/2/3/4 [1]	Factory/user1/user2/user3/user4
Memory Load	rfd		Readout setup data in memory
Memory Save	sav		Store present setup data in memory
Memory Initializing	rst		Reset to factory settings
Set the default parameter table when power up	usdef	0/1/2/3/4 [1]	Factory/user1/user2/user3/user4
Transmission Speed Setting	sbaud	9600/ 115200	9,600(initial) /115,200bps

4.2 Details on Commands

4.2.1 Setting Analog Gain

Sets analog gain.

- Format：S2, R1
- CMD： gax
- VAL： 0(x1),1(x2),2(x4),3(x8),4(x10),5(x18)

<Example> Setting Analog Gain 4(x10)

Send： gax □ 4 CR

Receive：>OK CR >gax 4 CR EOT

4.2.2 Setting Digital Gain

Sets the camera digital gain.

- Format：S2, R1
- CMD： gdx
- VAL： 0(x1) to 511(x2)

<Example> Setting Digital Gain 256 (1+256/511) =x1. 50

Send： gdx □ 256 CR

Receive：>OK CR >gdx 256 CR EOT

4.2.3 Setting Digital Offset

Sets digital offset.

- Format：S2, R1
- CMD： odx
- VAL： -256 to 256(DN @Mono10)

<Example> Setting Digital Offset to +20DN @Mono10(+5DN @Mono8)

Send： odx □ 20 CR

Receive：>OK CR >odx 20 CR EOT

4.2.4 Setting Noise Reduction Type

Set Noise Reduction Type

- Format：S2, R1
- CMD： nrt
- VAL： 0(1x3 Weighted average filter), 1(1x3 Median filter)

<Example> Setting Noize Reduction 1x3 Median filter

Send： nrt □ 1 CR

Receive：>OK CR >nrt 1 CR EOT

4.2.5 Setting Noise Reduction

Set Noize Reduction

- Format：S2, R1
- CMD： nr
- VAL： 0(Off),1(On)

<Example> Setting Noise Reduction On

Send： nrt □ 1 CR

Receive：>OK CR >nrt 1 CR EOT

Notes:

The noise can be reduced by setting noise reduction ‘ON’, but the resolution may be decreased. Please test by yourself whether the defect can be detected or not.

4.2.6 Setting Gamma correction

Sets the gamma correction value.

- Format：S2, R1
- CMD： gamma
- VAL： 250(γ0.25)～4000(γ4.00)

<Example> Setting the gamma correction coefficient: 0.45

Send： gamma □ 450 CR

Receive：>OK CR >gamma 450 CR EOT

Notes：

1/1,000 of VAL becomes the coefficient.

4.2.7 Setting Exposure Mode

Sets the exposure mode.

- Format：S2, R1
- CMD： inm
- VAL： 0(Free run),1(Ext Edge),2(Ext Level)

<Example> Setting the exposure mode to Ext Edge

Send： inm □ 1 CR

Receive：>OK CR >inm 1 CR EOT

4.2.8 Setting Line Rate

Sets the Line Rate.

- Format：S2, R1
- CMD： prd
- VAL： 500 to 100000(Hz)

<Example> Setting line rate 40KHz

Send： prd □ 40000 CR

Receive：>OK CR >prd 40000 CR EOT

Table 4-2-8 Maximum Line Rate (Typical value)

GenICam Tap Geometry			
1x2	1x4	1x8	1x10
20,703Hz	41,322Hz	81,967Hz	100,000Hz

*) Clock frequency:85MHz

*) ROI Pixel Number:8,192pixels

*) Horizontal Binning Pixel Number:1

*) Exposure time：≦ Line period (1/Line-Rate)-2μs

Notes：

1) This can be operated at the setting of Free Run mode
2) The relation between the line rate and the exposure time is as follows. Line period (reciprocal number of the line rate) > Exposure time + 2μs. If the inequality mentioned as above is not met when you attempt to set the line rate, the camera coordinates the exposure time automatically to meet the above inequality. The coordinated exposure time can be obtained by the present value acquisition command.
3) If the inequality mentioned as above is not met when you attempt to set the exposure time the camera coordinates the line rate automatically to meet the above inequality. The coordinated line rate can be obtained by the present value acquisition command.

4.2.9 Setting Exposure Time

Sets the exposure time. Only operates at Free Run/Ext Edge.

- Format：S2, R1
- CMD： expo
- VAL： 3600 to 1998000(nS)

<Example> Setting exposure time 100μs

Send： expo □ 100000 CR

Receive：>OK CR >expo 100000 CR EOT

Notes：

1) This can be operated at the settings of Free Run mode and Ext Edge mode.
2) Set the value by 100nS unit. Less than 100ns is cut off automatically at the time. when you attempt to set the value with less than 100nS. The value without less than 100nS of the exposure time can be obtained by the present value acquisition command.
3) The relation between the line rate and the exposure time is as follows. Line period (reciprocal number of the line rate) > Exposure time + 2μs. If the inequality mentioned as above is not met when you attempt to set the line rate, the camera coordinates the exposure time automatically to meet the above inequality. The coordinated exposure time can be obtained by the present value acquisition command.
4) If the inequality mentioned as above is not met when you attempt to set the line rate the camera coordinates the exposure time automatically to meet the above inequality. The coordinated exposure time can be obtained by the present value acquisition command.

4.2.10 Readout ROI setting region

Readout the ROI setting region.

- Format：S1, R2
- CMD： roi_range

<Example>Pixel Number of reading start position minmum value.：offx.min
Pixel Number of reading start position maximun value：offx.max
Pixel Number of reading start position minimum units：offx.inc
Readout ROI Pixel Numbers minimum value：width.min
Readout ROI Pixel Numbers maximum value：width.max
Readout ROI Pixel Numbers minimum units：width.inc

Send： roi_range CR

Receive：>OK CR >offx.min= 0 CR >off.max= 7936 CR >offx.inc= 16 CR
>width.min= 256 CR >width.max 8192 CR > width.inc= 16 CR
>roi_range CR EOT

4.2.11 Readout ROI Pixel Numbers

Sets the quantity of the readout pixels as ROI (Region of Interest) of the output signal of the camera.

- Format：S2, R1
- CMD： width
- VAL： 256 to 8192(pixels)

<Example> In case setting the ROI readout pixel numbers to 2048 pixels

Send： width □ 2048 CR

Receive：>OK CR >width 2048 CR EOT

Notes：

1) In case Horizontal Binning Pixel Number is 1,set this number as the multiple of 16.Moreover {(ROI Pixel Offset) + (ROI Pixel Number)} should below 8,192.
2) In case Horizontal Binning Pixel Number is 2,set this number as the multiple of 8.Moreover {(ROI Pixel Offset) + (ROI Pixel Number)} should below 4,096.
3) In case Horizontal Binning Pixel Number is 2, the readout value of (ROI Pixel Offset) and(ROI Pixel Number) using command “sta” are 1/2.

4.2.12 Pixel Number of reading start position

Sets the pixel number of the reading start position of the output signal of the camera.

- Format：S2, R1
- CMD： offx
- VAL： 0 to 7936(pixels)

<Example> Setting the pixel number of the reading start position :512 as 512-pixel

Send： offx □ 512 CR

Receive：>OK CR >offx 512 CR EOT

Notes：

1) When the value of the pixel number of reading start position is 0, the reading begins with the first pixel.
2) In case Horizontal Binning Pixel Number is 1,set this number as the multiple of 16.Moreover {(ROI Pixel Offset) + (ROI Pixel Number)} should below 8,192.
3) In case Horizontal Binning Pixel Number is 2,set this number as the multiple of 8.Moreover {(ROI Pixel Offset) + (ROI Pixel Number)} should below 4,096.
4) In case Horizontal Binning Pixel Number is 2, the readout value of (ROI Pixel Offset) and(ROI Pixel Number) using command “sta” are 1/2.

4.2.13 Pixel Binning Mode

Sets the pixel binning mode of the output signal of the camera.

- Format：S2, R1
- CMD： bhm
- VAL： 1(Addition), 2(Addition average)

<Example> Setting the pixel binning mode Additon

Send： bhm □ 1 CR

Receive：>OK CR >bhm 1 CR EOT

4.2.14 Horizontal Pixel Binning

Sets the number of horizontal pixel binning of the output signal of the camera.

- Format：S2, R1
- CMD： bh
- VAL： 1, 2(pixels)

<Example>

Send： bh □ 2 CR

Receive：>OK CR >bh 2 CR EOT

4.2.15 Setting Scanning Direction

Switches scanning direction.

- Format：S2, R1
- CMD： rev
- VAL： 0(Forward),1(Reverse)

<Example> Reverse output

Send： rev □ 1 CR

Receive：>OK CR >rev 1 CR EOT

4.2.16 Pixel Format

Sets the pixel format of the output signal of the camera.

- Format：S2, R1
- CMD： pxf
- VAL： 0(Mono8),1(Mono10)

<Example> Setting the pixel format: 1[Mono] as Monochrome 10bits

Send： pxf □ 1 CR

Receive：>OK CR >pxf 1 CR EOT

Notes：

When “Output Tap Pattern (Geometry)” is set to “GenIcam 1X10” , “Pixel Format Mono10” cannot be set.

4.2.17 Test Pattern Display

Switches the test pattern displays.

- Format：S2, R1
- CMD： tpn
- VAL： 0(OFF), 1(Horizontal ramp pattern), 2(Horizontal & Vertical ramp patten)

<Example> Setting the Horizontal ramp test pattern

Send： tpn □ 1 CR

Receive：>OK CR >tpn 1 CR EOT

4.2.18 Clock Frequency of Camera Link

Sets the clock frequency of the output signal of the camera.

- Format：S2, R1
- CMD： clkcl
- VAL： 85,80,70,40(MHz)

<Example> Setting the clock frequency:40 as 40MHz

Send： clkcl □ 40 CR

Receive：>OK CR >clkcl 40 CR EOT

4.2.19 Output Tap Pattern (Geometry)

Sets the tap pattern (geometry) of the output signal of the camera.

- Format：S2, R1
- CMD： tapg
- VAL： 0(1X2),1(1X4),2(1X8),3(1X10)

<Example> Setting the tap:1[GenIcam 1X4] as 1 zone in X with 4taps

Send： tapg □ 1 CR

Receive：>OK CR >tapg 1 CR EOT

Table 4-2-19-1 Camera Link Configuration

Camera Link Configuration	GenICam Tap Geometry			
	1x2	1x4	1x8	1x10
Base (Mono8)	○			
Base (Mono10)	○			
Medium (Mono8)		○		
Medium (Mono10)		○		
Full (Mono8)			○	
Eighty Bit (Mono8)				○
Eighty Bit (Mono10)			○	

Notes：

When “Pixel Format Mono10” is selected, “Output Tap Pattern (Geometry) GenIcam 1X10” , cannot be set.

4.2.20 Setting Pixel Correction mode

Sets pixel correction mode.

- Format：S2, R1
- CMD： ffcm
- VAL： 0(Factory correction data),1 to 4(User arbitrary correction data1 to 4)

<Example> User arbitrary correction data1

Send： ffcm □ 1 CR

Receive：>OK CR >ffcm 1 CR EOT

4.2.21 Pixel Correction Data Acquisition (illuminating)

Acquires the pixel correction data (in illumination) of the user arbitrary and saves it in flash memory. This can be saved by one each by each step of the analog gain.

- Format：S1, R1
- CMD： wht

<Example>

Send： wht CR

Receive：>OK CR >wht CR EOT

4.2.22 Pixel Correction Data Acquisition (illuminating)

Acquires the pixel correction data (in dark) of the user arbitrary and saves it in flash memory. This can be saved by one each by each step of the analog gain.

- Format：S1, R1
- CMD： blk

<Example>

Send： blk CR

Receive：>OK CR >blk CR EOT

4.2.23 Pixel Correction Target Level

Set the pixel correction target level (10bit output equivalent value) for every user memory.

- Format：S2, R1
- CMD： ffct1, ffct2, ffct3, ffct4
- VAL： 1～1023(DN @Mono10)

<Example> Setting the User arbitrary correction target for user1 level 900DN @Mono10

Send： ffct1 □ 900 CR

Receive：>OK CR >ffct 900 CR EOT

4.2.24 Copy the Pixel correction gray data at factory to selected user memory

Copy the pixel correction gray data of selected gax at factory to any user memory.

- Format：S2, R1
- CMD： ffccpyw
- VAL： 1(user1), 2(user2), 3(user3), 4(user4)

<Example> Copy the pixel correction gray data at factory to user1

Send： ffccpyw □ 1 CR

Receive：>OK CR >ffccpyw 1 CR EOT

4.2.25 Copy the Pixel correction dark data at factory to selected user memory

Copy the pixel correction dark data of selected gax at factory to any user memory.

- Format：S2, R1
- CMD： ffccpyb
- VAL： 1(user1), 2(user2), 3(user3), 4(user4)

<Example> Copy the pixel correction dark data at factory to user1

Send： ffccpyb □ 1 CR

Receive：>OK CR >ffccpyb 1 CR EOT

4.2.26 Select parameter table

Select the parameter table.

- Format：S2, R1
- CMD： ussel
- VAL： 0(factory),1(user1), 2(user2), 3(user3), 4(user4)

<Example> Select the parameter table 2(user2).

Send： ussel □ 2 CR

Receive：>OK CR >ussel 2 CR EOT

4.2.27 Memory Load (Readout the Camera setting from the flash memory)

Reads out the camera settings from the flash memory.

- Format：S1, R2
- CMD： rfd

<Example>

Send： rfd CR

Receive：>OK CR >Model=RMSL8K100CL CR <Ver.=0.40_0x3050 CR
>Serial=2307006 CR >UserSet=1 CR >UserSetStartUp=1 CR
>offx.min= 0 CR >offx.max= 7936 CR >offx.inc= 16 CR
>width.min= 256 CR >width.max= 8192 CR >width.inc= 16 CR
>gax 1 CR >gdx 0 CR >odx 0 CR >gamma 1000 CR >inm 0 CR
>prd 10000 CR >expo 98000 CR >width 8192 CR >offx 0 CR
>bhm 0 CR >bh 1 CR >rev 0 CR >pxf 0 CR >tpn 0 CR >tapg 2 CR
>ffcm 0 CR >ffct1 768 CR >ffct2 768 CR >ffct3 768 CR >ffct4 768 CR
>nr 0 CR >nrt 0 CR >clkcl 85 CR >logmode 1 CR
>rfd CR EOT

4.2.28 Memory Save

Save the current settings to the selected parameter table (1 to 4) of internal flash memory.

- Format：S1, R1
- CMD： sav

<Example>

Send： sav CR

Receive：>OK CR >sav CR EOT

Notes：

It is not allowed to save to the parameter table0(factory).

4.2.29 Memory Initializing (Initializing Camera Settings)

Resets the flash memory to the factory default.

- Format：S1, R2
- CMD： rst

<Example>

Send： rst CR

Receive：>OK CR >Model=RMSL8K100CL CR <Ver.=0.40_0x3050 CR
>Serial=2307006 CR >UserSet=1 CR >UserSetStartUp=1 CR
>offx.min= 0 CR >offx.max= 7936 CR >offx.inc= 16 CR
>width.min= 256 CR >width.max= 8192 CR >width.inc= 16 CR
>gax 1 CR >gdx 0 CR >odx 0 CR >gamma 1000 CR >inm 0 CR
>prd 10000 CR >expo 98000 CR >width 8192 CR >offx 0 CR
>bhm 0 CR >bh 1 CR >rev 0 CR >pxf 0 CR >tpn 0 CR >tapg 2 CR
>ffcm 0 CR >ffct1 768 CR >ffct2 768 CR >ffct3 768 CR >ffct4 768 CR
>nr 0 CR >nrt 0 CR >clkcl 85 CR >logmode 1 CR
>rst CR EOT

4.2.30 Set the default parameter table when power up

- Format：S2, R1
- CMD： usdef
- VAL： 0(factory),1(user1),2(user2),3(user3),4(user4)

<Example>Set the default parameter table when power up to 3(user3).

Send： usdef □ 3 CR

Receive：>OK CR > usdef 3 CR EOT

Notes：

When change this parameter, the settings are saved to internal flash memory.

4.2.31 Setting Transmission speed

Sets the serial Transmission speed (baud rate)

- Format：S2, R1
- CMD： sbaud
- VAL： 9600,115200(bps)

<Example> Sets to 115,200bps

Send： sbaud 115200 CR

Receive：>OK CR > sbaud 115200 CR EOT

Notes：

1) The initial setting at startup is 9,600.

2) The software of the PC must be changed at the same time when the above setting is changed.

4.2.32 Returning the Camera Settings to the its original status

Returns the current camera settings.

- Format：S1, R2
- CMD： sta

<Example>

Send： sta CR

Receive：>OK CR >Model=RMSL8K100CL CR <Ver.=0.40_0x3050 CR
>Serial=2307006 CR >UserSet=1 CR >UserSetStartUp=1 CR
>offx.min= 0 CR >offx.max= 7936 CR >offx.inc= 16 CR
>width.min= 256 CR >width.max= 8192 CR >width.inc= 16 CR
>gax 1 CR >gdx 0 CR >odx 0 CR >gamma 1000 CR >inm 0 CR
>prd 10000 CR >expo 98000 CR >width 8192 CR >offx 0 CR
>bhm 0 CR >bh 1 CR >rev 0 CR >pxf 0 CR >tpn 0 CR >tapg 2 CR
>ffcm 0 CR >ffct1 768 CR >ffct2 768 CR >ffct3 768 CR >ffct4 768 CR
>nr 0 CR >nrt 0 CR >clkcl 85 CR >logmode 1 CR
>sta CR EOT

4.2.33 Readout Camera Internal PCB Temperature

Reads out the camera’s internal PCB temperature

- Format：S1, R1
- CMD： temp

<Example>

Send： temp CR

Receive：>OK CR >Temp = 51.1 CR >temp CR EOT

Notes：

Temperatures will be expressed in degrees centigrade (Celsius).

4.3 Digital Processing flow in FPGA

The digital processing flow in FPGA is shown below.

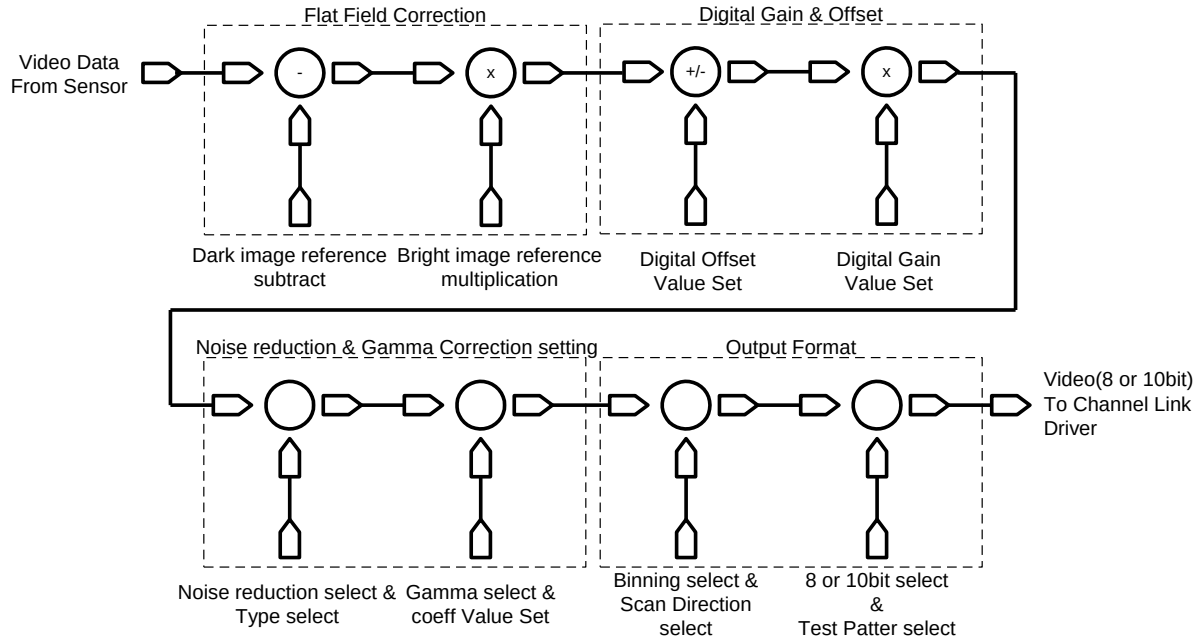


Figure 4-3-1 FPGA Processing Block Diagram

4.4 Startup

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

After those sequences, the camera is ready to get images and output data.

The startup procedure is as follows:

(1) The camera hardware initializes. The indicator (LED orange) lights.

(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. The colour of the indicator (LED) turns into green from orange.

4.5 Setting Gain

Gain can be adjusted by setting analog gain (6 steps, x1~x18) or digital gain (512 steps, x1~x2). In both cases, increasing the gain setting increases the slope of the camera's response curve, so that the output saturates at a lower level of light. Conversely, with less light, a higher output can be obtained; that is to say, the cameras sensitivity has been increased. The command "gax" is used for analog gain setting and the command "gdx" is used for digital gain setting.

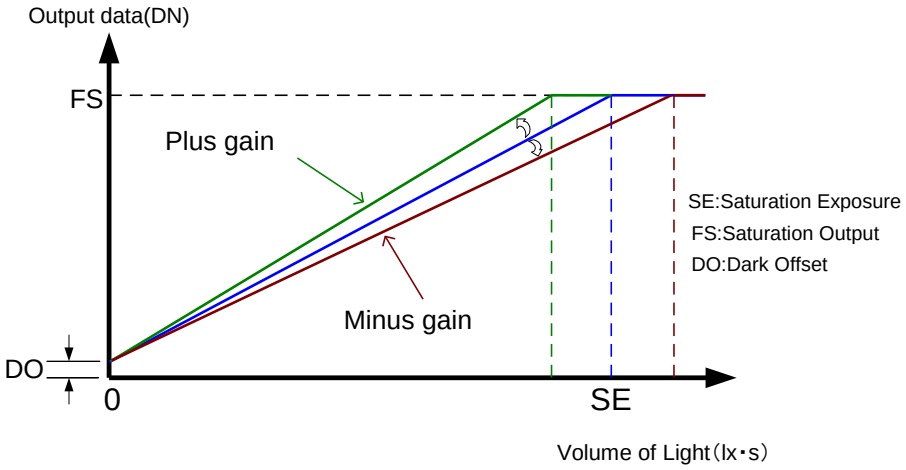


Figure 4-5-1 Gain Adjustment

Gain-Sensitivity at digital gain x1, pixel correction: default, factory white correction data is shown below.

Table 4-5-1 Gain-Sensitivity

gax	Analog gain	Sensitivity V/(lx · s)
0	x1(0dB)	82
1	x2(6dB)	164
2	x4(12dB)	328
3	x8(18.1dB)	656
4	x10(20dB)	820
5	x18(25.1dB)	1476

The magnification calculating formulas of the digital gain are as follows.

Digital gain magnification：DGAIN = 1 + VAL / 511

Digital gain setting value：VAL = (DGAIN -1) x 511

Notes:

1) Gain and noise values are proportionally related. Adjust amount of gain in accordance with the requirements of your camera system.
2) We recommend using gain from x1 to x8.
3) See 4.2.1 and 4.2.2 for the information of Commands.

4.6 Setting Offset

The digital offset can be set in the ranges from -64 to +64(DN) @Mono8 or from -256 to +256(DN) @Mono10, using the command “odx”.

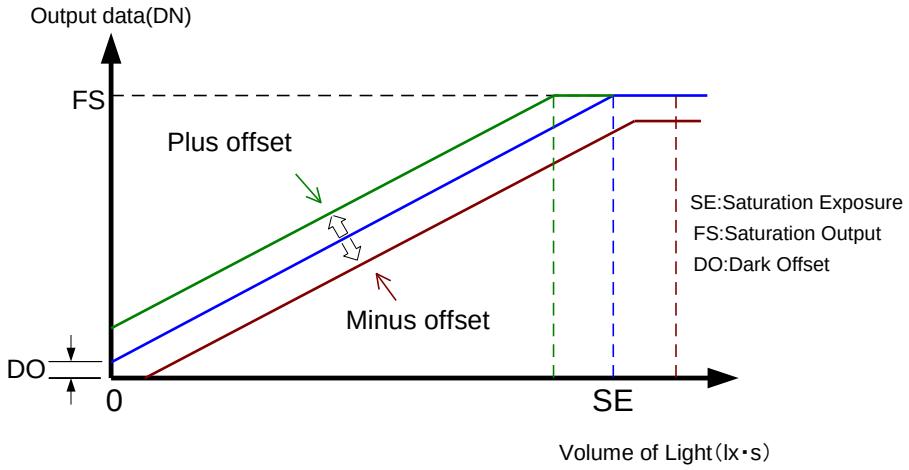


Figure 4-6-1 Offset Adjustment

Notes:

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

2) The gradients of lines do not change.

3) See 4.2.3 for the information of Command.

4.7 Noise reduction

The random noise of image data can be reduced by setting noise reduction to ON.

Command “nr” is used to ON/OFF this function.

Noise reduction type of 1x3 Weighted average filter or 1x3 Median filter can be selected by using command “nrt”.

Notes：

1) The noise can be reduced by setting noise reduction ‘ON’, but the resolution may be decreased. Please test by yourself whether the defect can be detected or not.
2) The detail of these commands please refer chapter4.2.4 and 4.2.5.

4.8 Gamma Correction Setting

The gamma correction coefficient can be set in the range of 0.45 to 4.00 using the command “gamma”. The relation between Input and Output should be calculated to the following formula.

$$Vo = Vmax \times \left(\frac{Vi}{Vmax}\right)^{\gamma}$$

Vo: Output data
Vi: Input data
Vmax: 255(@Mono8) or 1023(@Mono10)
γ : correction coefficient

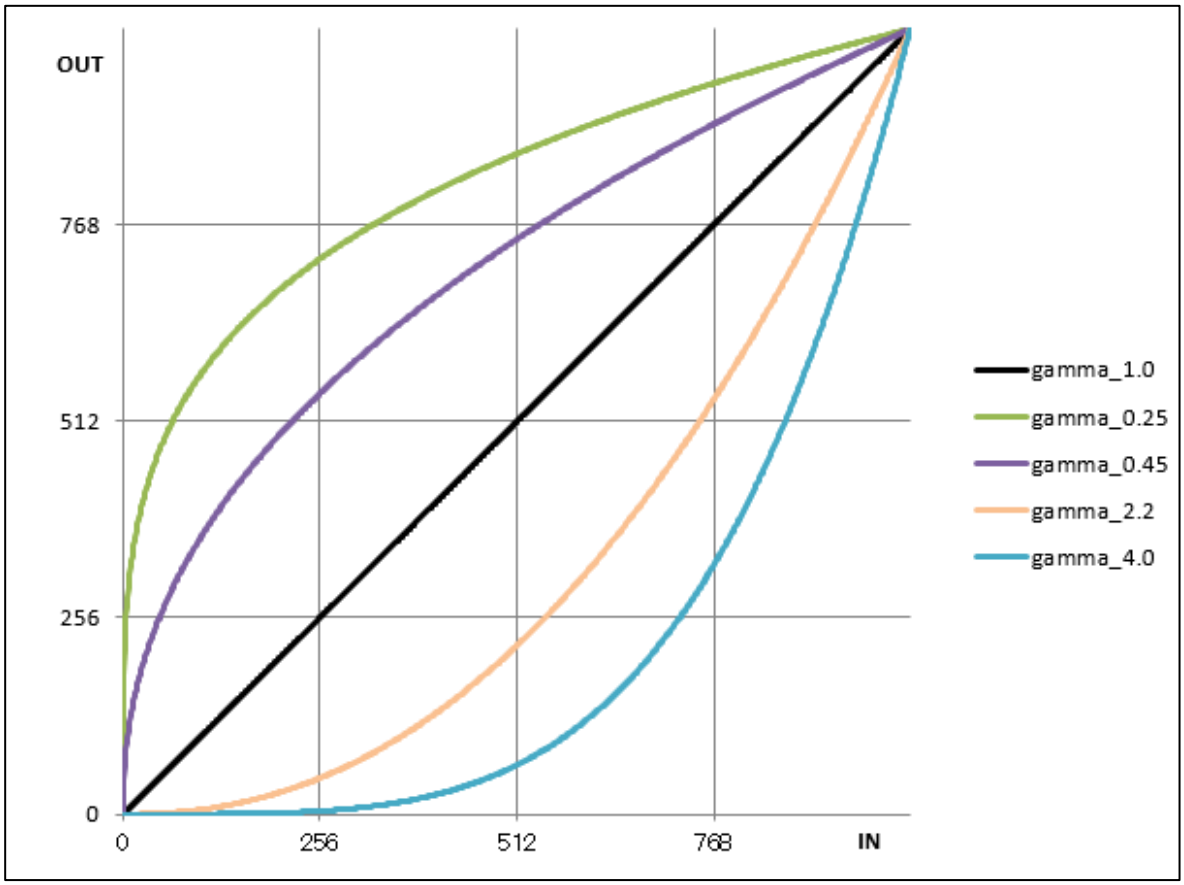


Figure 4-8-1 Gamma Correction Characteristics

Notes :

See 4.2.6 for the information of Command.

4.9 Exposure Mode and Timing Chart

The mode for the free run exposure, the external trigger exposure (Trigger edge) or the external trigger exposure (Trigger level) can be selected using the command "inm".

Table 4-9-1 Exposure Mode

Mode	Control Input of CameraLink (CC1)
Free Run Exposure Mode (Programming time setting)	Not use
External Trigger Exposure Mode (Trigger Edge)	External trigger (CC1) from FrameGraber is required
External Trigger Exposure Mode (Trigger Level)	External trigger (CC1) from FrameGraber is required

Notes：

1)When changing the factory setting exposuremode, be sure to send the control input signal(CC1). If you do not send CC1 or if the sending control input signals are out of the designated range, you cannot get images and cannot change the settings. See 4.9.2 and 4.9.3.

2) See 4.2.7 for the information of Command

4.9.1 Free Run Exposure Mode (Programming time setting)

In free-run exposure mode, the exposure time and the scan rate are determined by the settings made through serial communication. The exposure and the readout repeat themselves in the scan period which is determined by the scan rate. The exposure time is set by the command “expo” and the scan rate is set by the command “prd”. The range of programmable exposure time and the timing chart of the exposure and the readout are shown below.

Table 4-9-1-1 Programmable Exposure Time

Item	symbol	Time (μs)
Line period [Line rate =1/S]	S	10.0 to 2000.0 (*1) (*2) [100,000 to 500Hz]
Programmable exposure time	P	3.6 to 1998 (*1)
Readout time	R	0.15 to 102.4 (*2) (*3)

*1) S≧P+2μs *2) S≧R+6/Ck *3) R＝Pn/Tn/Ck

(Pn: Pixel number, Tn: Tap number, Ck: Clock frequency of Camera Link [MHz])

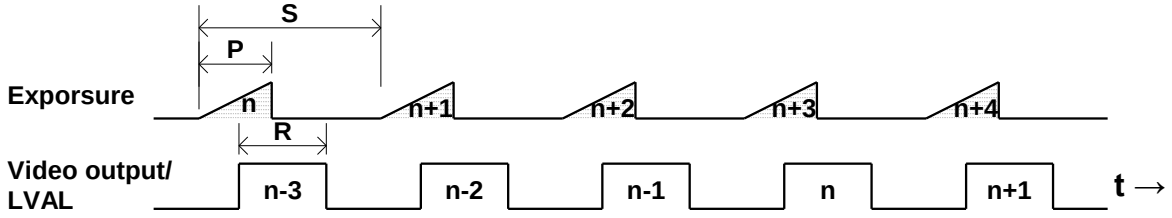


Figure 4-9-1-1 Free Run Exposure Mode

Notes:

See 4.2.7, 4.2.8 and 4.2.9 for the information of Command.

4.9.2 External Trigger Exposure Mode (Trigger Edge)

In external trigger exposure mode (Trigger Edge), the exposure time is determined by the setting through the 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 (CC1). The exposure time is set by the command “expo”.

The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

Table 4-9-2-1 Programmable Exposure Time

Item	symbol	Time (μs)
Trigger pulse H time	T1	≧0.1
Trigger pulse L time	T2	≧0.1
Trigger pulse cycle (Line period)	T3	≧10.0 (*1,*2)
Programmable exposure time	P	3.6 to 1,998 (*1)
Readout time	R	0.15 to 102.4 (*2, *3)

*1) T3≧P+2μs *2) T3≧R+6/Ck *3) R＝Pn/Tn/Ck

(Pn: Pixel number, Tn: Tap number, Ck: Clock frequency of Camera Link [MHz])

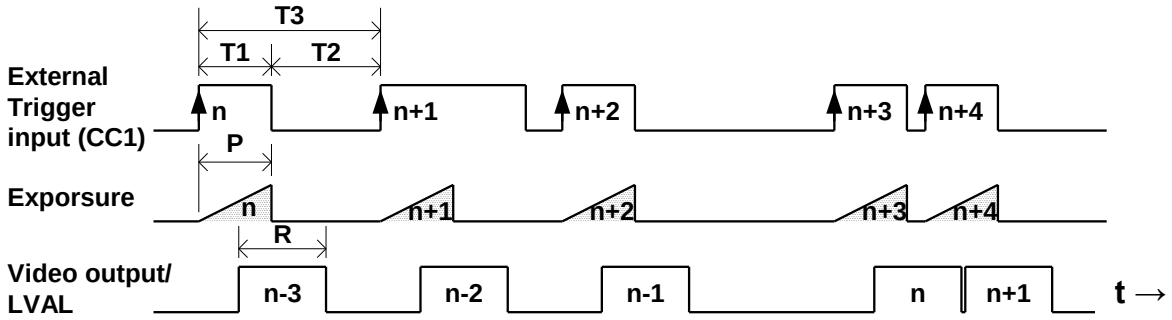


Figure 4-9-2-1 External Trigger (Trigger Edge) Exposure Mode

Notes:

See 4.2.7 for the information of Command.

4.9.3 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(CC1). The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

Table 4-9-3-1 Exposure Time (Trigger Level)

Item	Symbol	Time (μs)
Trigger pulse H time (Exposure Time)	T1	≧3.6
Trigger pulse L time	T2	≧2
Trigger pulse cycle (Lien period)	T3r/T3f	≧10.0 (*1)
Exposure delay time	T4	3.533
Readout time	R	0.15～102.4 (*1,*2)

*1) T3≧R+6/Ck *2) R=Pn/Tn/Ck

(Pn: Pixel number, Tn: Tap number, Ck: Clock frequency of Camera Link [MHz])

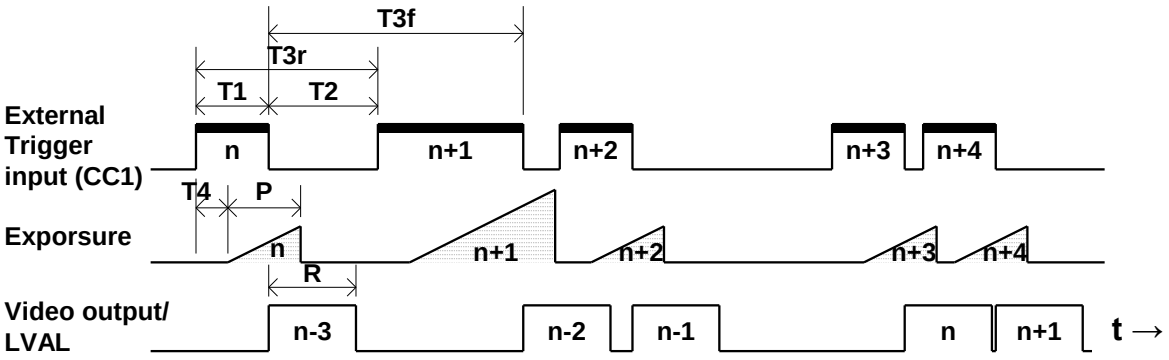


Figure 4-9-3-1 External Trigger (Trigger Level) Exposure Mode

Notes:

See 4.2.7 for the information of Command.

4.10 Video Output Format

4.10.1 Pixel Selection (ROI)

The regions for ROI (Region of Interest) and ROI-offset are shown below. The quantity of the readout pixels as ROI and the pixel number of the reading start position can be set. The quantity of the readout pixels can be set by the command “width”: 256 to 8192 The pixel number of the reading start position can be set by the command “offx”: 0 to 7936.

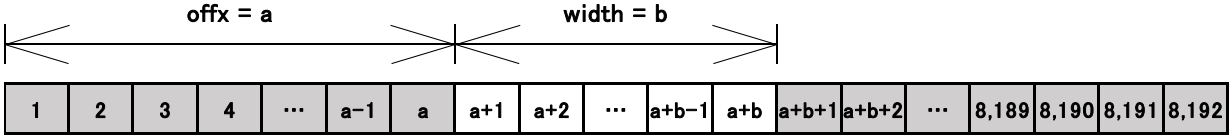


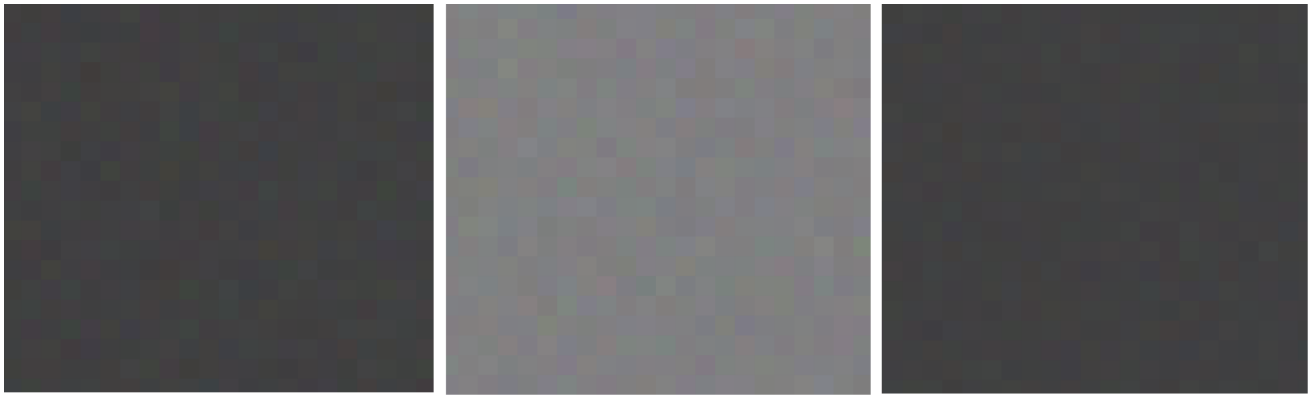
Fig. 4-10-1-1 ROI width and offset

Notes：

1) This selection affects the line rate. (See 4.9.1, 4.9.2 and 4.9.3)
2) See 4.2.10, 4.2.11 and 4.2.12 for the information of Commands.

4.10.2 Horizontal Pixel Binning

The horizontal pixel data (one pixel of +2 pixel, three pixel of +4 pixel ...8,191 pixel +8,192 pixel) can be calculated on the addition or addition average and can be output. The number of horizontal pixel binning can be set by the command “bh”. The horizontal pixel binning mode can be set by the command “bhm”.



Off On (Addition) On (Addition Average)

Fig. 4-10-2-1 Horizontal pixel binning image

Notes：

1) The sensitivity doubles and the noise are increased √2 times by the binning addition mode.
2) The sensitivity is the same and the noise reduces in 1/ √2 by the binning addition average mode.
3) The resolution (the number of the output pixels) becomes 1/2 by the binning addition average mode.
4) This selection affects the line rate. (See 4.9.1, 4.9.2 and 4.9.3)
5) See 4.2.13 and 4.2.14 for the information of Commands.

4.10.3 Camera Scan Readout Direction Setting

The camera scan readout direction can be changed from forward to reverse, or vice versa using the command “rev”. The correlation between the camera scan readout direction and web (object movement) direction is shown below.

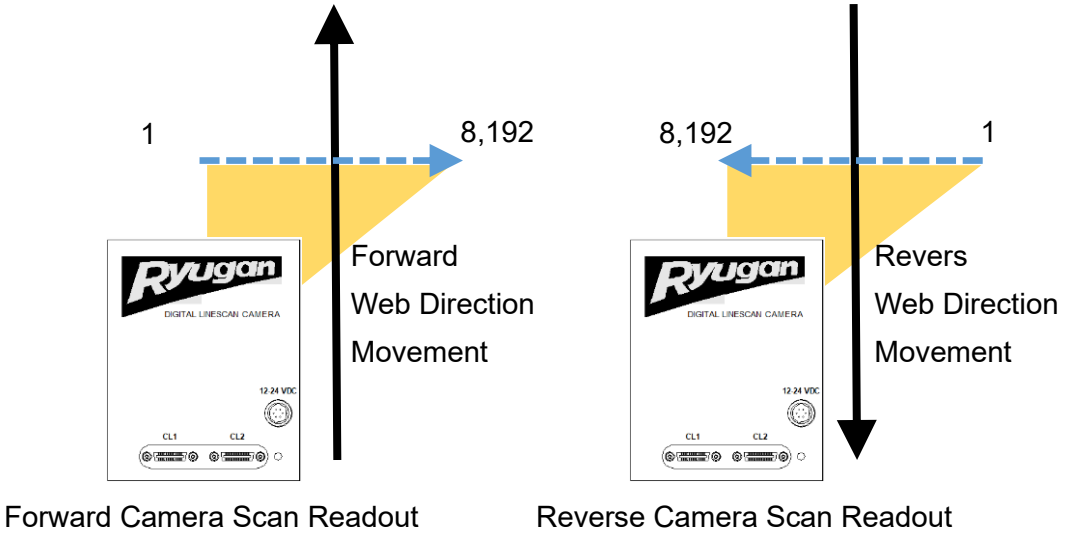


Figure 4-10-3-1 Correlation of Camera Scan Readout Direction and Object Movement Direction

Note：

1) See 4.2.15 for the information of Commands.

4.10.4 Pixel Format

The camera outputs 8-bit (Mono8) or 10-bit (Mono10) digital data. This can be set using the command ”pxf“.

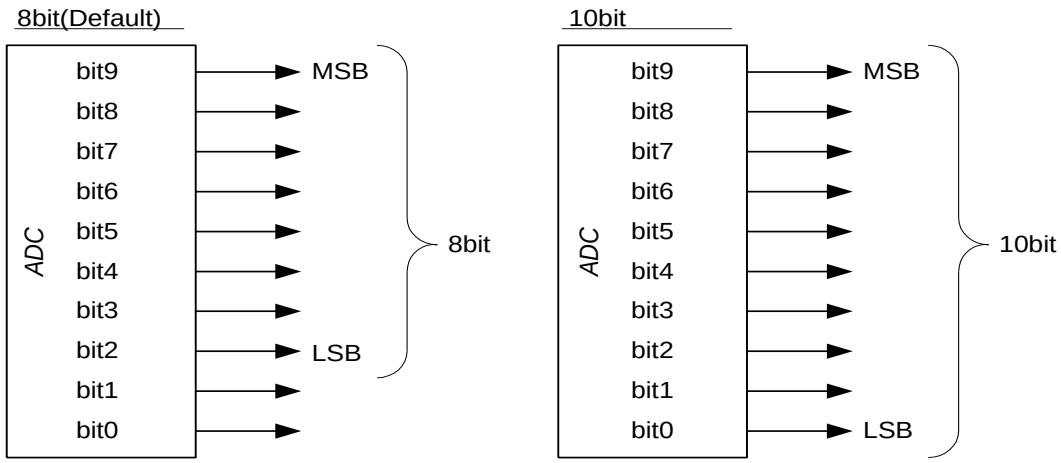


Figure 4-10-4-1 Assignments of Digital Data

Notes：

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

2) See 4.2.16 for the information of Command.

4.10.5 Test Pattern

Two types of test pattern outputs are available. Use them to check if your system is properly acquiring camera data.

Figure 4-10-5-1 Image of the horizontal ramp pattern on Mono8

Where pixel 0 has the value 0DN, the value increases by 1DN each pixel, up to 255DN, then the pattern repeats.

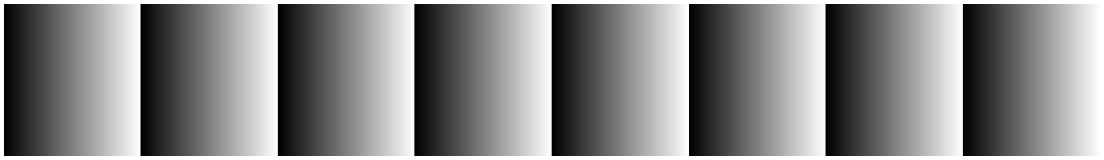


Figure 4-10-5-2 Image of the horizontal ramp pattern on Mono10

Where pixel 0 has the value 0DN, the value increases by 1DN each pixel, up to 1023DN, then the pattern repeats.

Figure 4-10-5-3 Image of the XY (horizontal vertical) ramp pattern on Mono8

The value increases by 1DN each pixel, up to 255DN in both X-direction and Y-direction, the pattern repeats.

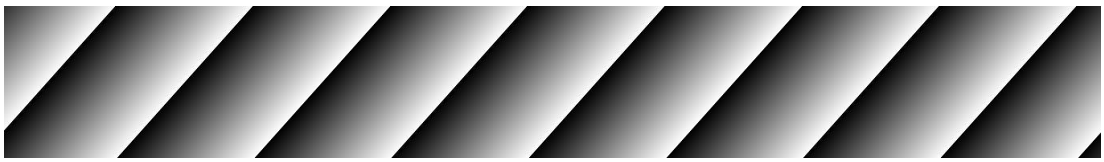


Figure 4-10-5-4 Image of the XY (horizontal vertical) ramp pattern on Mono10

The value increases by 1DN each pixel, up to 1023DN in both X-direction and Y-direction, the pattern repeats.

Notes：

See 4.2.17 for the information of Command.

4.11 Video Output Format

4.11.1 Clock Frequency of Camera Link

The clock frequency, 85MHz, 80MHz, 70MHz or 40MHz can be set using the command ”clkcl“.

Notes：

1) This selection affects the line rate. (See 4.9.1, 4.9.2 and 4.9.3)

2) This selection affects the cable length of Camera Link(See 3.1）

3) When you want to change the clock frequency, please stop capturing images.

4) See 4.2.18 for the information of Command.

4.11.2 Tap Geometry

The tap geometry, GenICam 1X2, 1X4, 1X8, 1X10 can be selected using the command “tapg”.

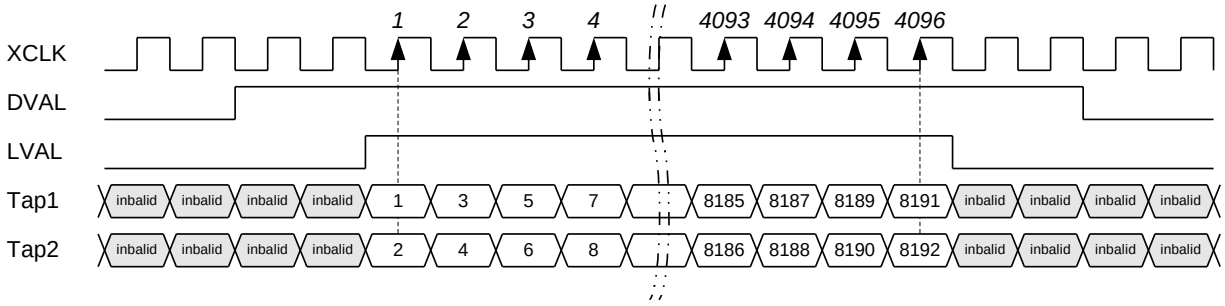


Figure 4-11-2-1 Video Output Phase of the Camera: GenICam 1x2(1zone in X with 2taps)

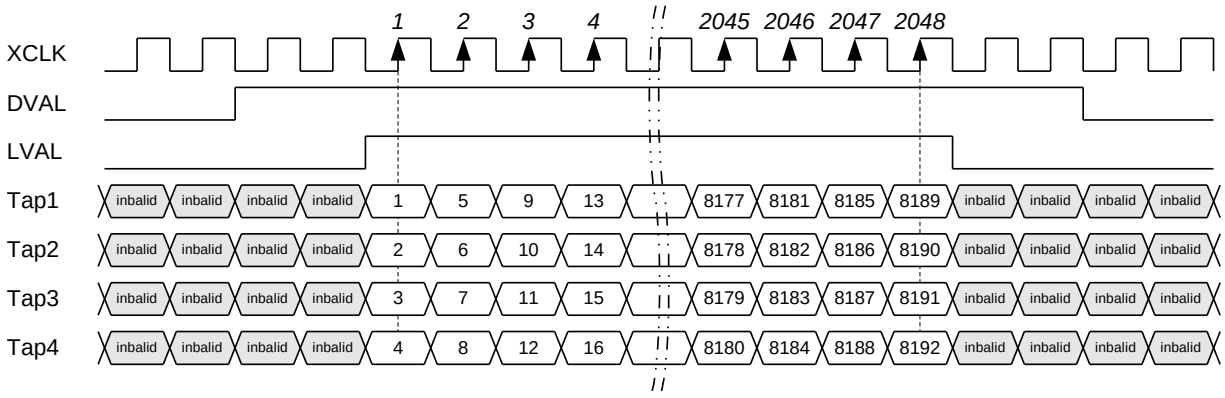


Figure 4-11-2-2 Video Output Phase of the Camera: GenICam 1x4(1zone in X with 4taps)

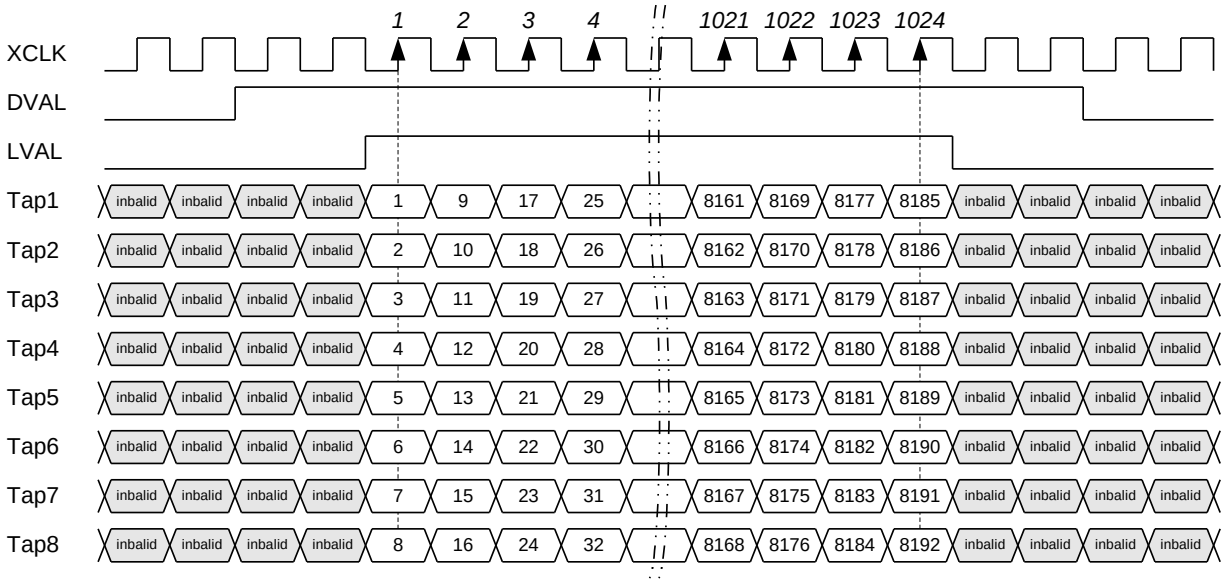


Figure 4-11-2-3 Video Output Phase of the Camera: GenICam 1x8(1zone in X with 8taps)

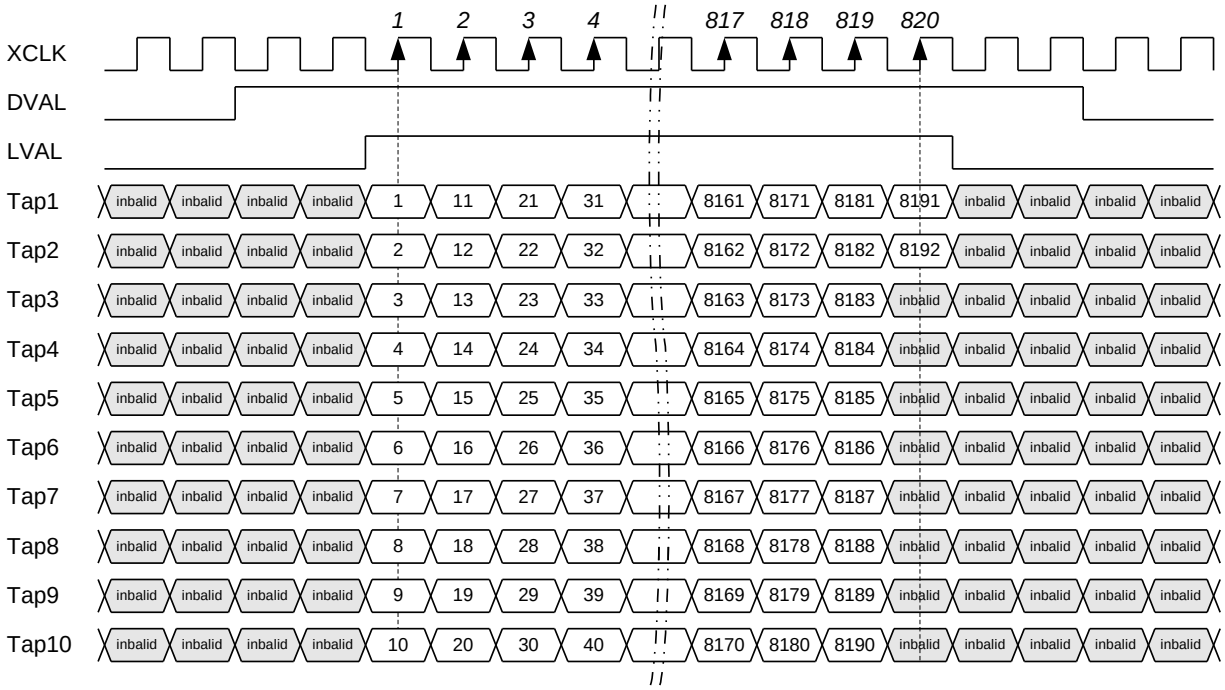


Figure 4-11-2-4 Video Output Phase of the Camera: GenICam 1x10(1zone in X with 10taps)

Notes：

1) This selection affects the scan rate. (See 4.9.1, 4.9.2 and 4.9.3)
2) See 4.2.19 for the information of Command.
3) FVAL = 0 (low level) fixed
4) In case you choose GenICam 1x8(1zone in X with 8taps) please confirm that the pixel format is match to the FrameGraber settings.

4.12 Pixel Correction

Generally speaking, image sensors (CCD, CMOS and so on) have fixed pattern noise and photo response non-uniformity. Lens shadings and light sources also can cause non-uniformity. The camera is set to the optimal correction before shipping in order to provide images of high grade. The camera also has the function of user white correction to cope with lens shading and non-uniform illumination.

Output should be calculated to the following formula.

$$Vo = (Vi - bl) \times \frac{Tv}{wh - bl}$$

Vo: Output data (After correction)
Vi: Input data (Before correction)
Bl: Output data of each pixel in perfect dark (factory correction or user arbitrary correction)
Wh: Output data of each pixel in uniform illumination (factory correction) or when viewing a subject for correction (user arbitrary correction)
Tv: Target value for user correction (10-bit output conversion value) The corrected data is expressed in the following equation.

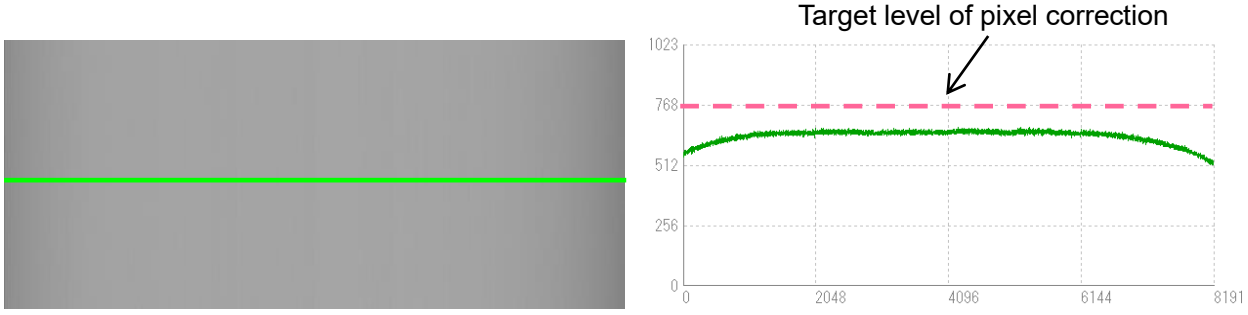


Image “before” user arbitrary pixel is corrected. Luminance Profile of left image

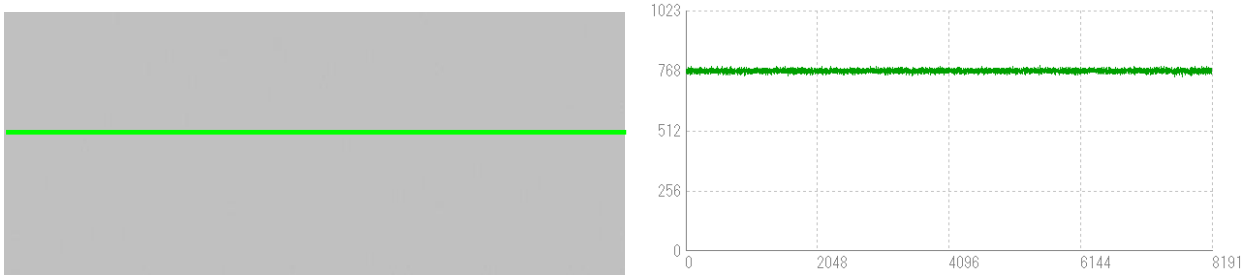


Image “after” user arbitrary pixel is corrected. Luminance Profile of left image

Figure 4-12-1 Waveform before and after bit correction

4.12.1 Operating Procedure

Put on a lens cap etc. to darken the camera view. Now we can acquire User Arbitrary Correction Data (dark). Send the command “blk CR” via the COM port. The camera should return “>OK” “>blk”. Now the User Arbitrary Correction Data (dark) has been written to the camera’s flash memory.

Next, remove the lens cap so that light enters the camera. Place a uniformly white object fully in the camera view. Now we can acquire User Arbitrary Correction Data (gray). When this is done with the lens attached, lens and illumination shading will also be corrected at the same time. However, dark and light details of the white object will be picked out, so the lens should be defocused. Next, send the command “wht CR” over the COM port. The camera should return “>OK” “>wht”. Now the User Arbitrary Correction Data (gray) has been written to the camera’s flash memory.

When the target level for pixel correction is set to 900 for example, follow the steps below.

Send the command “ffct 900 CR” via the COM port.

Make sure that the camera return “＞OK CR ＞ffct 900 CR EOT”.

Now the target level for pixel correction has been set.

This pixel correction data can be replaced by User Arbitrary Correction Data as the following steps.

Send the command “ffcm 1 CR” via COM port.

Make sure that the camera return “＞OK CR ＞ffcm 1 CR EOT”.

Now the pixel correction data has been replaced by User Arbitrary Correction Data.

Notes:

1) For “Val” above, substitute the target value, 0~1023 (10-bit output conversion value).
2) The pixel correction target value should be set slightly higher than the obtained image brightness in order to attain the full range of output.
3) The processing for acquiring correction data takes some time. It depends on line rate.
4) See 4.2.20, 4.2.21, 4.2.22, 4.2.23, 4.2.24 and 4.2.25 for the information of Commands.

4.13 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, blk)
- Select parameter table (ussel)
- Set the default parameter table when power up (usdef)

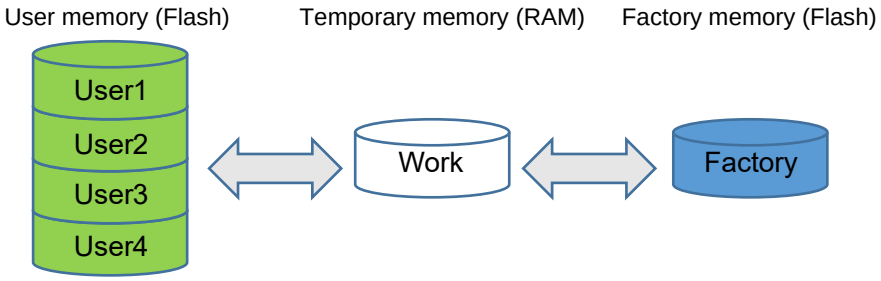


Figure 4-5-1 memory configuration in the camera

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) It is not allowed to save to the parameter table0(factory).
6) See 4.2.26, 4.2.27, 4.2.28, 4.2.29 and 4.2.30 for the information of Commands.

4.14 Serial Communication Settings

Serial communication is performed through the Camera Link Interface

Table 4-14-1 shows serial communication settings.

Table 4-14-1 Communication Settings

Parameter Items	Setup Value
Communication Speed (Baud rate)	9,600bps
Data Length	8bit
Parity Bit	None
Stop bit	1bit
Flow Control	None

Notes:

1) Communication Speed can be changed to 115,200.

2) See 4.2.31 for the information of Commands.

5 Sensor Handling Instructions

5.1 Electrostatic Discharge and the Sensor

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

5.2 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.

5.3 Cleaning the Sensor Window

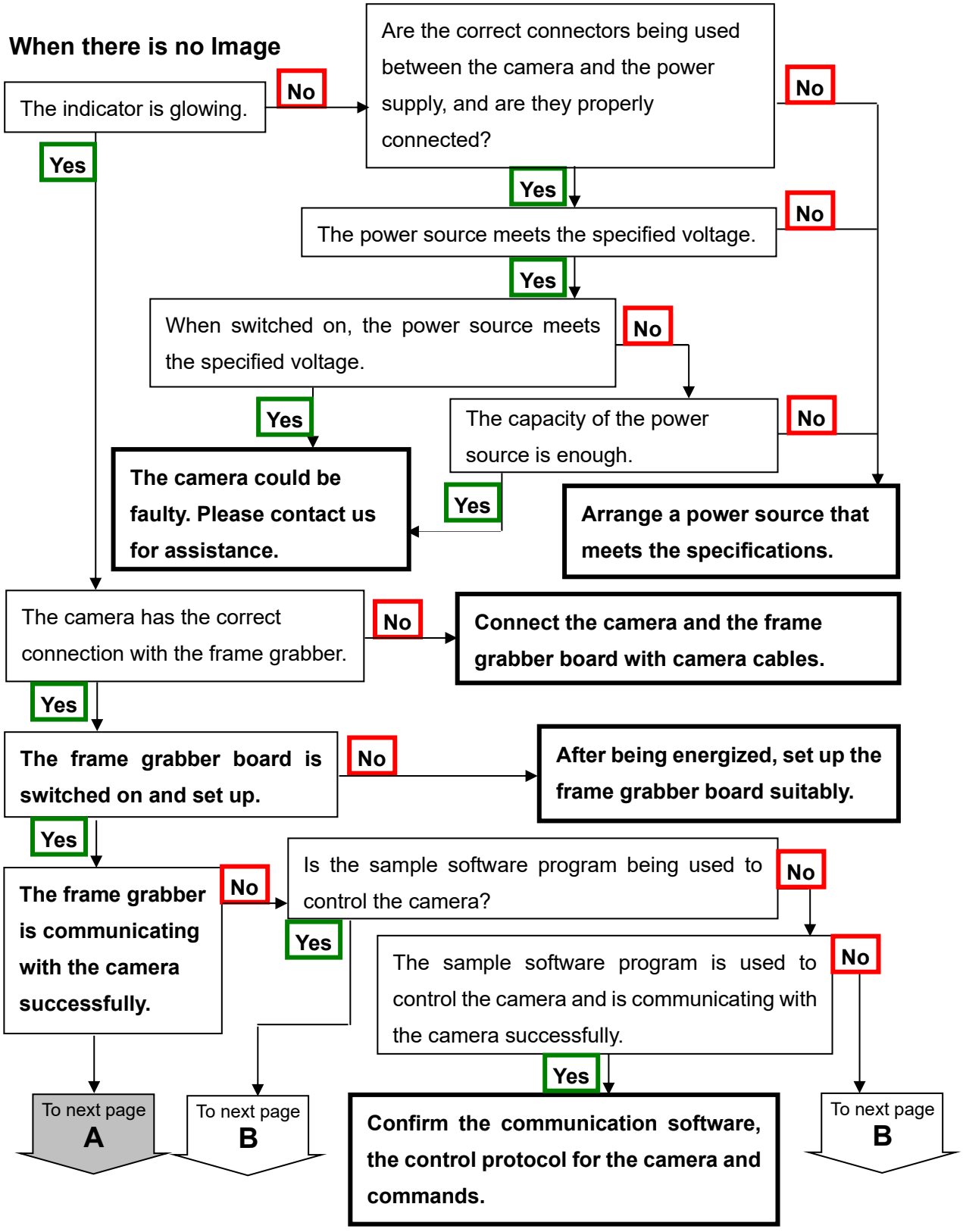
Dust: Can usually be removed by blowing the window surface using a compressed air blower.

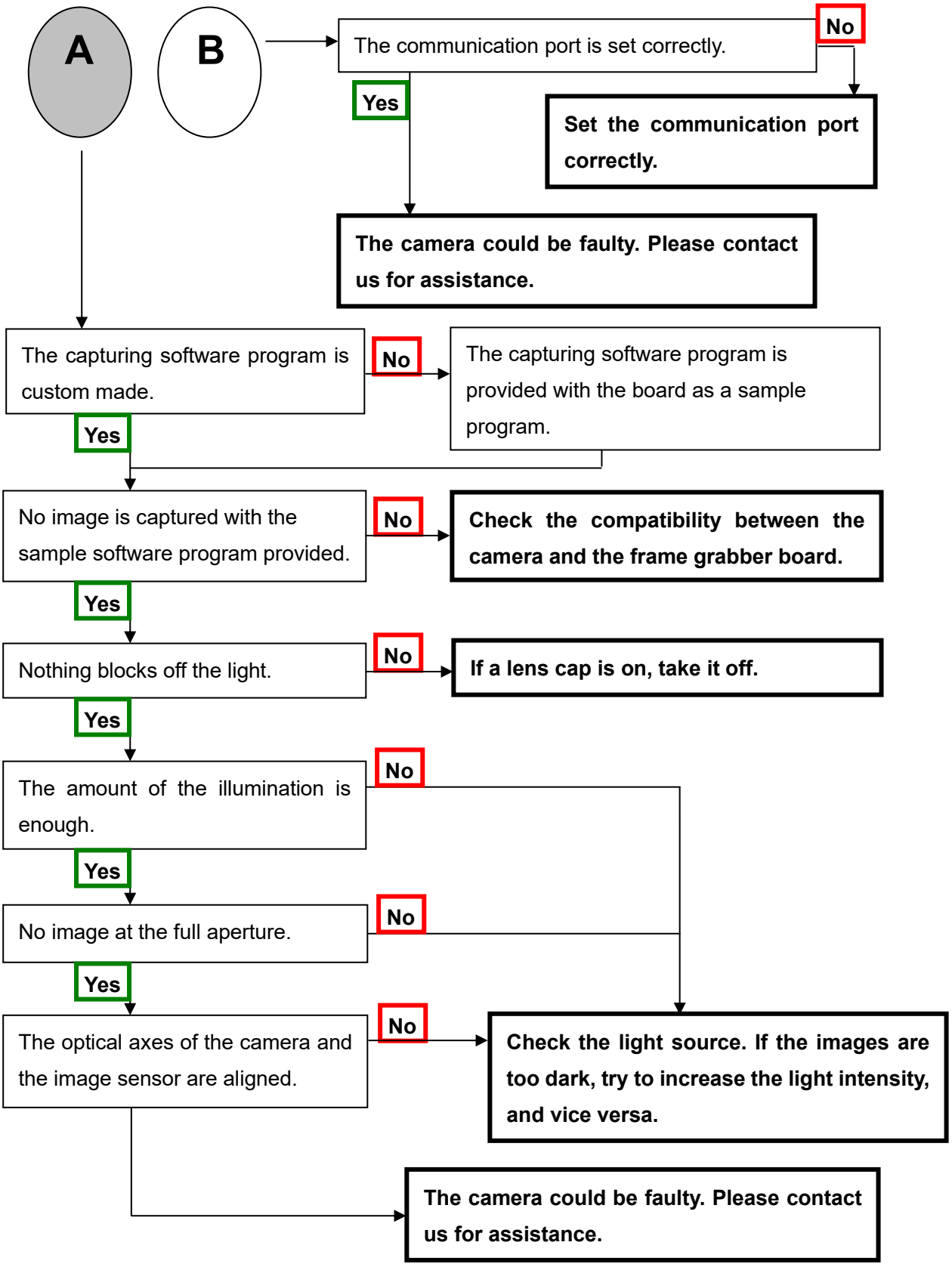
Oil: Wipe the window with a lint-free cloth wiper moistened with ethyl alcohol carefully and slowly.

6 Troubleshooting

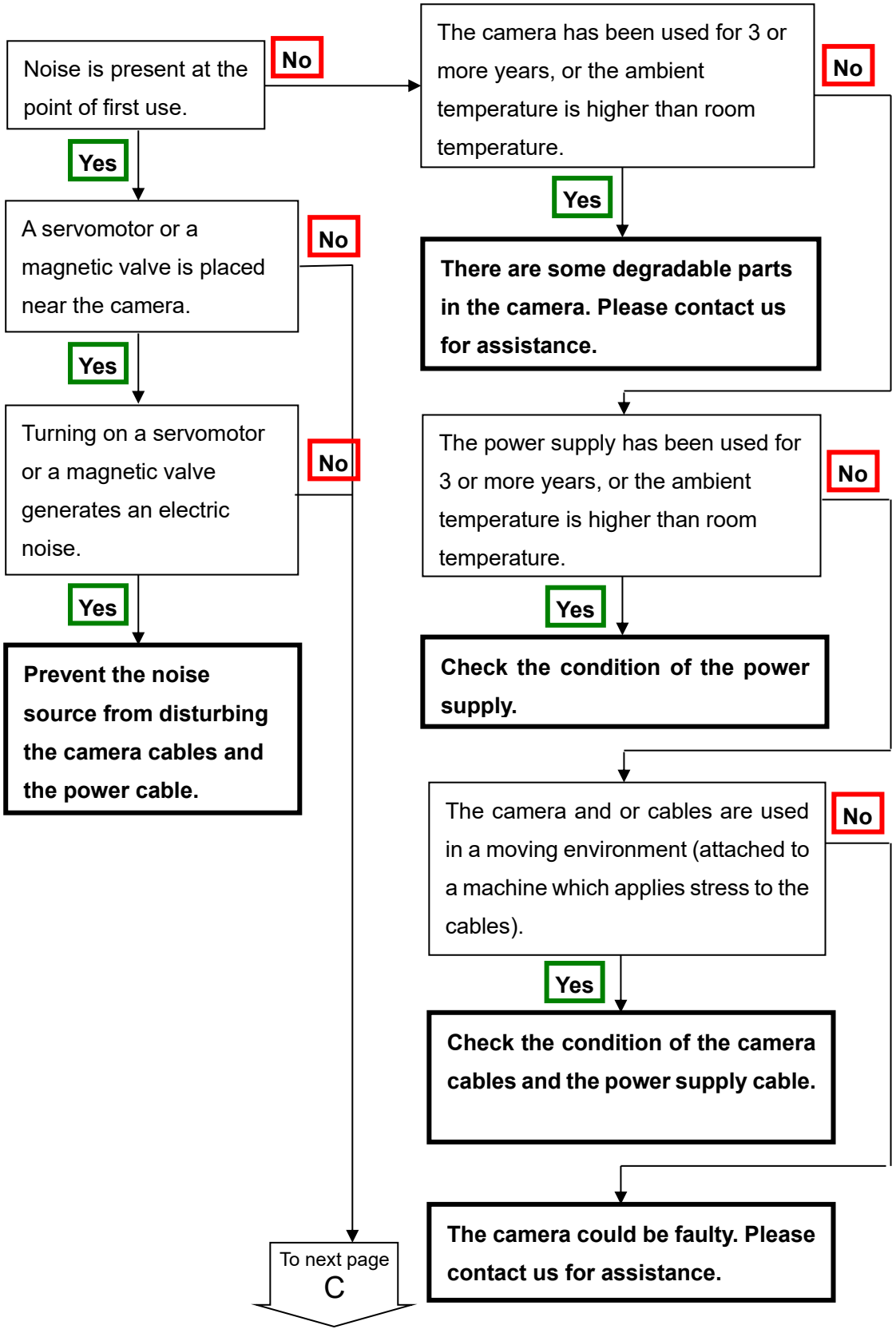
The following pages contain several troubleshooting charts that can help you find the cause of problems users sometimes encounter.

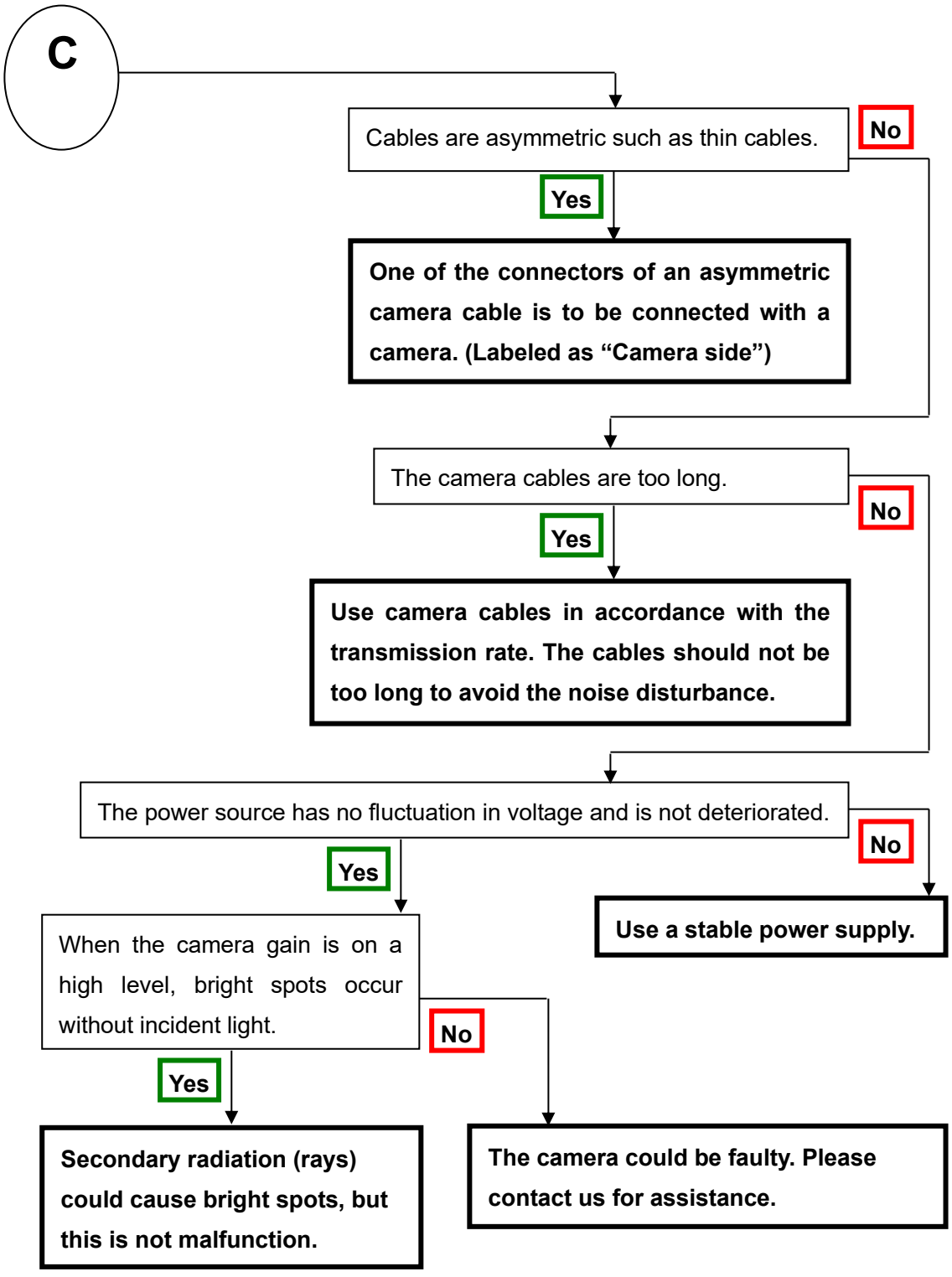
6.1 When there is no Image



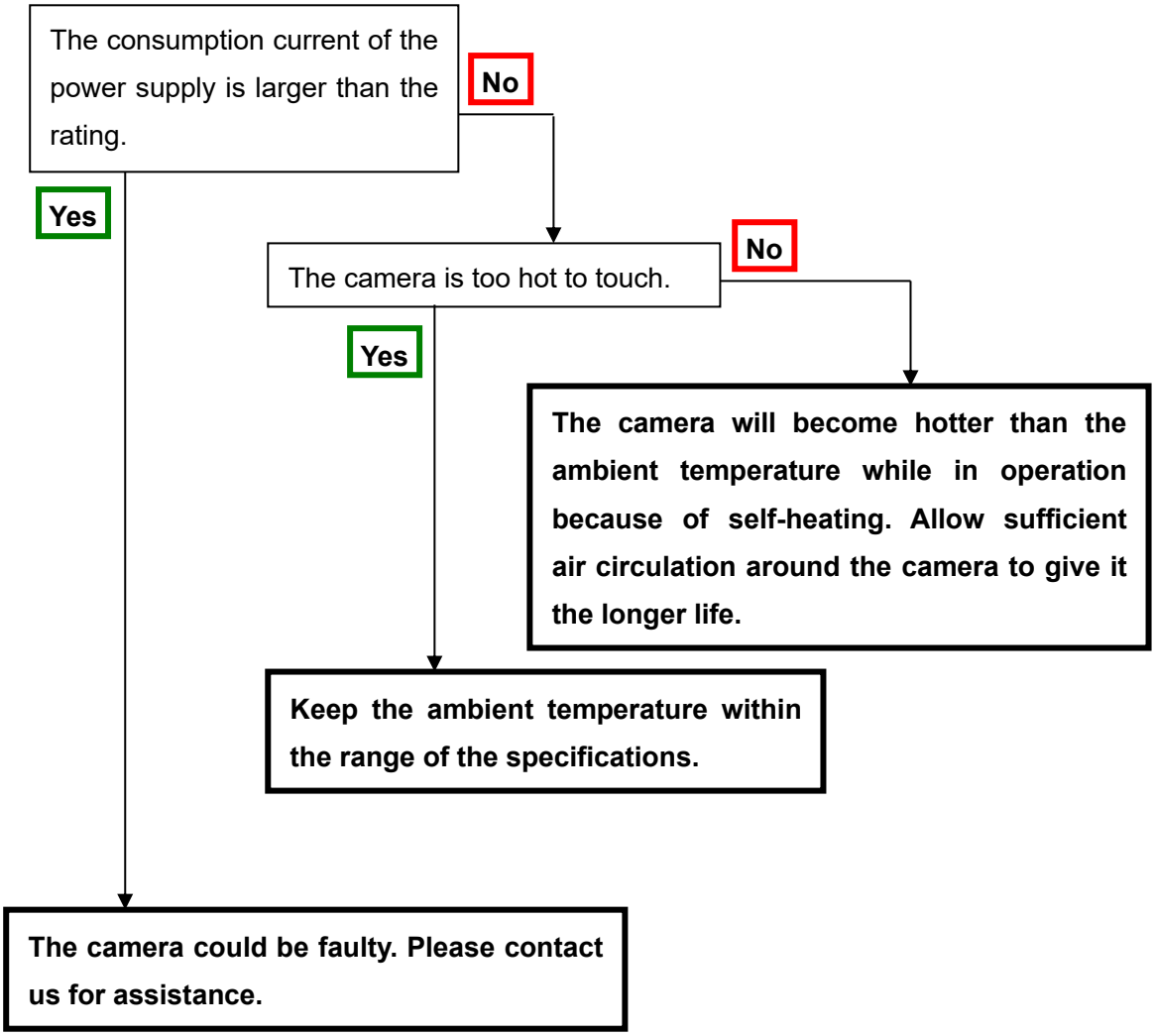

A
B
The communication port is set correctly.
No
Yes
Set the communication port correctly.
The camera could be faulty. Please contact us for assistance.
The capturing software program is custom made.
No
The capturing software program is provided with the board as a sample program.
Yes
No image is captured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

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

6.3 When the Camera becomes hot



7 Others

7.1 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.

7.2 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

Jiburaruta Seimei 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

URL

http://www.ned-sensor.com

E-Mail

mailto:sales@ned-sensor.com

7.3 Product Support

7.3.1 Warranty card (attach a separate)

Read carefully the Warranty card, please treasure it.

7.3.2 When you need to repair

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. 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 4.2.32 "Reading Operational Status"). 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.

The example of the camera status.
When the command "sta" is sent, the current camera settings are returned.

```
sta
>OK
>Model=RMSL8K100CL
>Ver.=0.40_0x3050
>Serial=2307006
>UserSet=1
>UserSetStartUp=1
    .
    .
    .
>gax 3
>gdx 22
>odx 10
>gamma 1000
>inm 0
>prd 100000
    .
    .
    .
>logmode 1
>sta
```

8 Appendix (How to use the measurement function)

8.1 Overview

This camera can measure the line period of external trigger, and that of output signal, and exposure time.

8.2 Measurement Commands

The table below shows the list of Measurement Commands.

Control Item	CMD	Control Description
Initialization	msrst	Reset the measurement value.
Readout Measurement Value	msdump	Acquire the Measurement value.

The Measurement items and initial values are shown below.

msLineRate: Average line frequency / 800(Hz)
msLineRateMax: Maximum line frequency / 100(Hz)
msLineRateMin: Minimum line frequency / 15,000,000(Hz)
msCC1Freq: Average CC1 frequency / 800(Hz)
msCC1FreqMax: Maximum CC1 frequency / 100(Hz)
msCC1FreqMin: Minimum CC1 frequency / 15,000,000(Hz)
msCC1High: Average CC1 trigger pulse high time / 1,250,500(nsec)
msCC1HighMax: Maximum CC1 trigger pulse high time / 66(nsec)
msCC1HighMin: Minimum CC1 trigger pulse high time / 10,000,000(nsec)
msExpo: Average exposure time / 1,253,533(nsec)
msExpoMax: Maximum exposure time / 3,600(nsec)
msExpoMin: Minimum exposure time / 10,003,533(nsec)

8.3 Command Details

8.3.1 initialization

Reset the measurement value.

・Format CMD CR

・CMD msrst

(Example)

msrst
>OK
>msrst

8.3.2 Readout Measurement Value

Acquire the measurement value.

・Format CMD CR

・CMD msdump

(Example)

msdump
>OK
>msLineRate=5311
>msLineRateMax=5312
>msLineRateMin=5311
>msCC1Freq=10624
>msCC1FreqMax=10624
>msCC1FreqMin=10623
>msCC1High=47058
>msCC1HighMax=47066
>msCC1HighMin=47058
>msExpo=172600
>msExpoMax=172600
>msExpoMin=172600
>msdump

8.4 Details of measurement functions

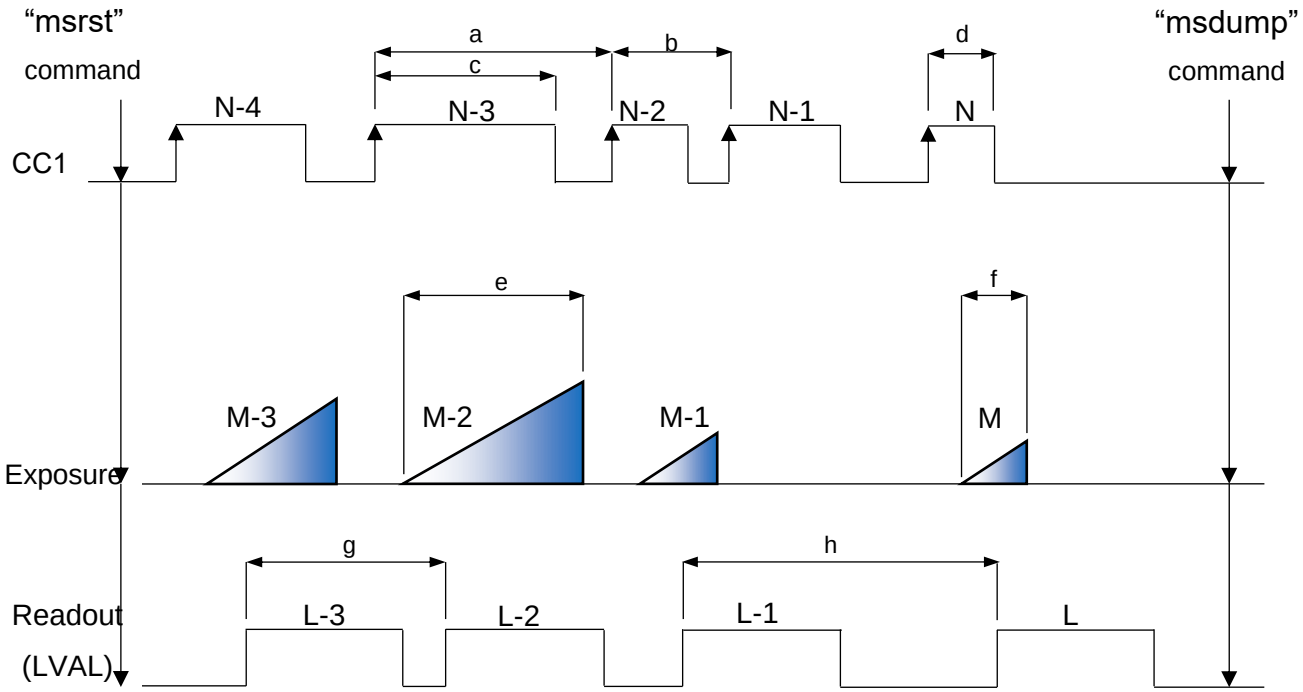


Figure 8-4 Example Maximum/ Minimum value

a: Minimum CC1 frequency (Hz) msCC1FreqMin
b: Maximum CC1 frequency (Hz) msCC1FreqMax
c: Maximum CC1 trigger pulse high time (nsec) msCC1HighMax
d: Minimum CC1 trigger pulse high time (nsec) msCC1HighMin
e: Maximum exposure time (nsec) msExpoMax
f: Minimum exposure time (nsec) msExpoMin
g: Maximum line rate (Hz) msLineRateMax
h: Maximum line rate (Hz) msLineRateMin

Each average value is calculated from the values of the latest 8 lines before receiving msdump command. CC1 uses data from N-7 to N, exposure time from M-7 to M, and line rate from L-7 to L. Therefore, the value is invalid until 8 lines are input after reset.

Notes:

If the measurement signal does not change, such as the case the CC1 signal is not input from the outside after resetting, it will remain at the initial value (maximum value < minimum value).

CC1 frequency and line rate, and CC1 high time and exposure time may not match perfectly due to measurement error.

Example-1

(If there are missing lines in the image)

There are two possibilities. One is such case the external trigger period is shorter than the shortest scan cycle and the trigger cancel function is activated, and the other is the case the external trigger signal is missing.

If trigger cancellation occurs continuously, the average CC1 frequency will be twice the average line rate. Also, when cancellation occurs intermittently, it can be judged by comparing the maximum value of the CC1 frequency and the maximum value of the line rate, measured until line missing occurs after resetting the measurement value. When CC1 frequency maximum value > line rate maximum value, trigger cancellation has occurred.

If the external trigger signal is missing, the CC1 frequency maximum and minimum values will differ when measuring until line missing occurs after resetting the measured value.

Example-2

(Even though the exposure time is controlled by an external trigger, the expected image brightness is not achieved. For example, the exposure setting of the camera is intended to operate at external level, but is incorrectly set to external edge.)

After resetting the measurement value, compare the HI period of CC1 with the exposure time, and if they are different, the exposure control setting may be wrong. If the values are the same, check the waveform of the input trigger signal.

Revision History

Revision Number	Date	Changes
01	Nov. 06, 2023	Initial release
02		
03		
04		