User's Manual

Line Scan Camera

Model:RMSL8K76CP/RMSL6K76CP/RMSL4K76CP

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

*Group 1 contains all ISM (Industrial, Scientific and medical) equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the Equipment itself.

*Class A equipment is equipment suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

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 4.11 pixel correction function. Please refer to 4.11 pixel correction function for details.
- 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.
- 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.
- 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 an embedded memory.
- When using external trigger, change the setting with the trigger packet supplied beforehand from the frame grabber 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 eapired 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

- 7µm 8192/6144/4096 pixels monochrome
- Maximum line rate is 76.923KHz
- Flat-field correction – minimizes lens vignetting, non-uniform lighting and sensor FPN and PRNU
- Compatible with CoaXPress IF Ver1.1.1
- Cable length about 100m at CXP-3(3.125Gbps)X1 or X2
  CXP-5(5.000Gbps)X1 or X2 is about 40m

∗ Set to CXP-3X1 at factory mode.

∗ Operating power supply can be a single external power supply 12V to 15V or PoCXP

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
- This camera utilizes an Intelligent Transportation System
- Outdoor surveillance

  Wide dynamic range prevents the camera from saturation caused by direct rays and specular refection rays.

An example of Visual Inspection of PCBs is shown below.

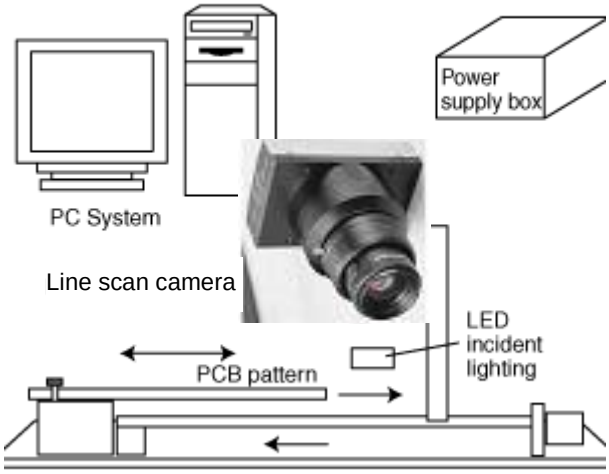


Figure 1-2-1 Visual Inspection of PCBs

Applicable Work

COB, BGA and MCM printed circuit boards

Performance

1. Maximum board size: 100mm×200mm
2. Resolution: 10μm
3. Inspection time: less than 30 seconds

Unit Configuration

1. Camera: Line scan camera
2. Controller: Dedicated software for PC system
3. Size: L930 x D500 x H500 (mm)

Applicable Fields

Inspection of patterns on film PCBs

1.3 Image Sensor

The camera uses a CMOS sensor with a maximum line rate of 76.923KHz to acquire high responsivity and superior quality images.

The pixels are 7μmx7μm.

RMSL8K76CP outputs 8192 pixels, RMSL6K76CP outputs 6144 pixels and RMSL4K76CP outputs 4096 pixels data on the CoaXPress interface.

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		
	RMSL8K76CP	RMSL6K76CP	RMSL4K76CP
Number of Pixels	8192	6144	4096
Pixel Size HxV (μm)	7x7		
Sensor Length (mm)	57.344	43.008	28.672
Spectral Responsivity (nm)	400 -1000 (Peak : 625, See Figure 1-4-1)		
Maximum Line Rate (kHz) / (μs)	76.923 / 13.00 (See Table 1-4-3)		
Saturation Exposure (lx･s) (typically)	0.071[Minimum Gain, Pixel Correction Initial Value, Daylight Fluorescent Light]		
Responsivity (typically) [Minimum Gain, Pixel Correction Initial Value, Daylight Fluorescent Light] Visible Area (400~700nm)	100(V/[lx･s]) Analog 5V Conversion Sensitivity		
Gain Adjustable Range *Analog Amplifier +Digital	Analog Amplifier： x 1 to x 10 (8 Steps) Digital： x 1 to x 2 (512 Steps)		
Offset Adjustable Range *Digital	Digital：-127～127 (0.5DN/STEP:8bit) -127～12 7(2.0DN/STEP:10bit)		
FPN (Fixed Pattern Noise)	Typically 5DN (without correction, at minimum gain) 2DN (with correction, at minimum gain)		
PRNU(Photo Response Non Uniformity)	Typically 20DN (without correction, at minimum gain) 4DN (with correction, at minimum gain)		
Random Noise	Typically 20DN (peak value at minimum gain)		
Video output	CoaXPress		

Connectors	CXP1 / CXP2	75Ω DIN 1.0/2.3 type		
	Power Supply	Hirose: HR10G（6Pin）		
Lens Mount		M72x0. 75 Screw	Nikon F Mount	
Operating Temperature (˚C) No Condensation		0 to 50		
Power Supply Voltage (V)		DC12~15[±5%]		
Consumption Current (mA) (typically)		750	650	550
Size W x H x D (mm)		80x120x71.2	80x120x85.9	
Mass (g) (Camera only)		610	600	600
Additional Functions		1 Shading Correction 2 Gain/Offset/Video Output(8bit/10bit) Adjustable 3 Test Pattern Output On/Off 4 Programmable Exposure Control 5 Scan Direction Switching 6 Display of Internal Temperature of Camera		

*1) DN : Digital Number (10-bit : 0 -1023)

*2) Measurements were made at room temperature.

Table 1-4-2 CoaXPress IF Specifications

CoaXPress interface specifications	
Ver.	1.1.1 *1
Bit Rate	3.125 or 5.000 (CXP-3 or CXP-5)
Discovery Rate	3.125 (CXP-3)
Number of Connections	1 or 2（cable）
Power Over CoaXPress （PoCXP）	Only for connector CXP 1 side
Pixel Format	Mono8 or Mono10 （black and white 8bit ・10bit）
Image Type	Rectangular
Low Speed connection Trigger (Trigger packet)	frame grabber（Host） → camera（Device） jitter ±8ns・Min. pulse width 2.9us ＊2

* 1 Please use the frame grabber board for CoaXPress Ver1.1.1.
Indicator status (refer to P.24) is different from CoaXPress Ver1.0.
* 2 Jitter and minimum pulse width also depend on the frame grabber board.

Table 1-4-3 CxpLinkConfiguration and maximum line rate and maximum cable length

CxpLink Configuration	Maximum Line Rate (kHz)			Cable length (m)
	RMSL8K76CP	RMSL6K76CP	RMSL4K76CP	
CXP-3X1(Factory set.)	25.000	33.333	50.000	100
CXP-5X1	38.461	50.000	76.923	40
CXP-3X2	50.000	66.666	76.923	100
CXP-5X2	76.923	76.923		40

＊CxpLinkConfiguration is set to CXP-3X1 when loading the factory - shipped setting value in the memory. It is necessary to reconfigure CxpLink Configuration and store it in memory according to the maximum line rate to be used. (Refer to 4.2.7.1 CXP link setting and 4.2.6 User Set Control)
Maximum cable length is approximate.

The quantum efficiency is shown below.

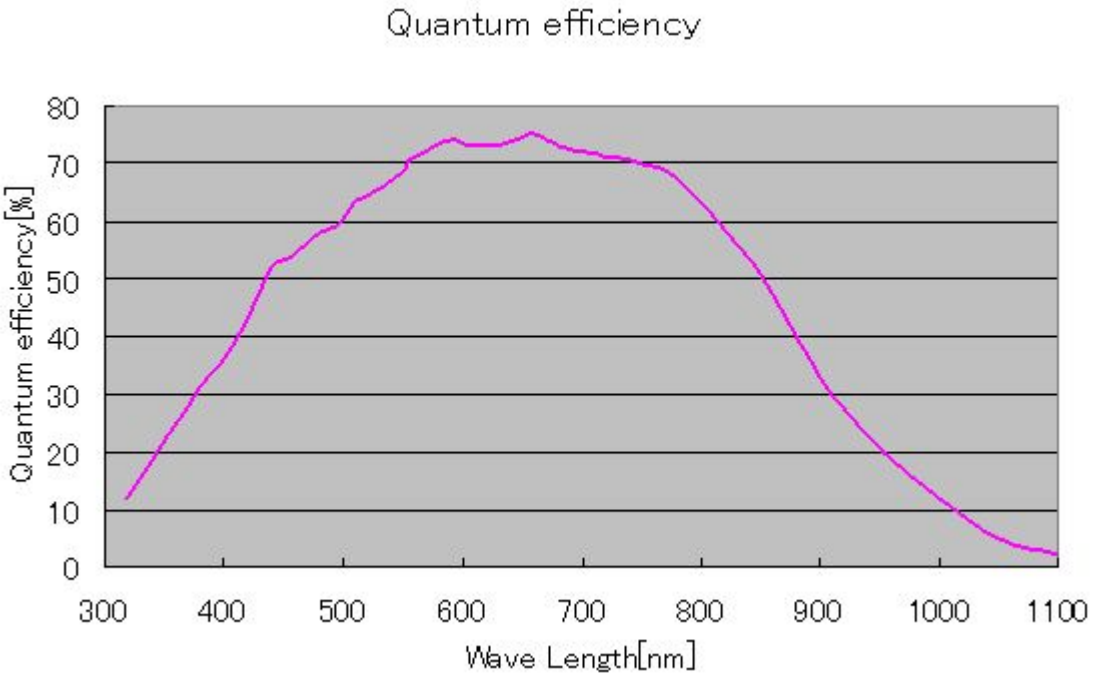


Figure 1-4-1 Quantum efficiency

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.
An optional mounting base (sold separately) is available.

2.2 Fixing the Camera

- Use the M4 screw holes (4 on the front, 8 on the side) to set the camera.
- Or use the 1/4"-20UNC screw hole for a tripod (1 place at bottom).
- ◆ If using the front panel M4 mounting holes (4 places at front, 8 places at side), the screw length for fixing the camera at the front should be less than 8mm, and less than 6mm for 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.

M72 × 0.75 screw mount

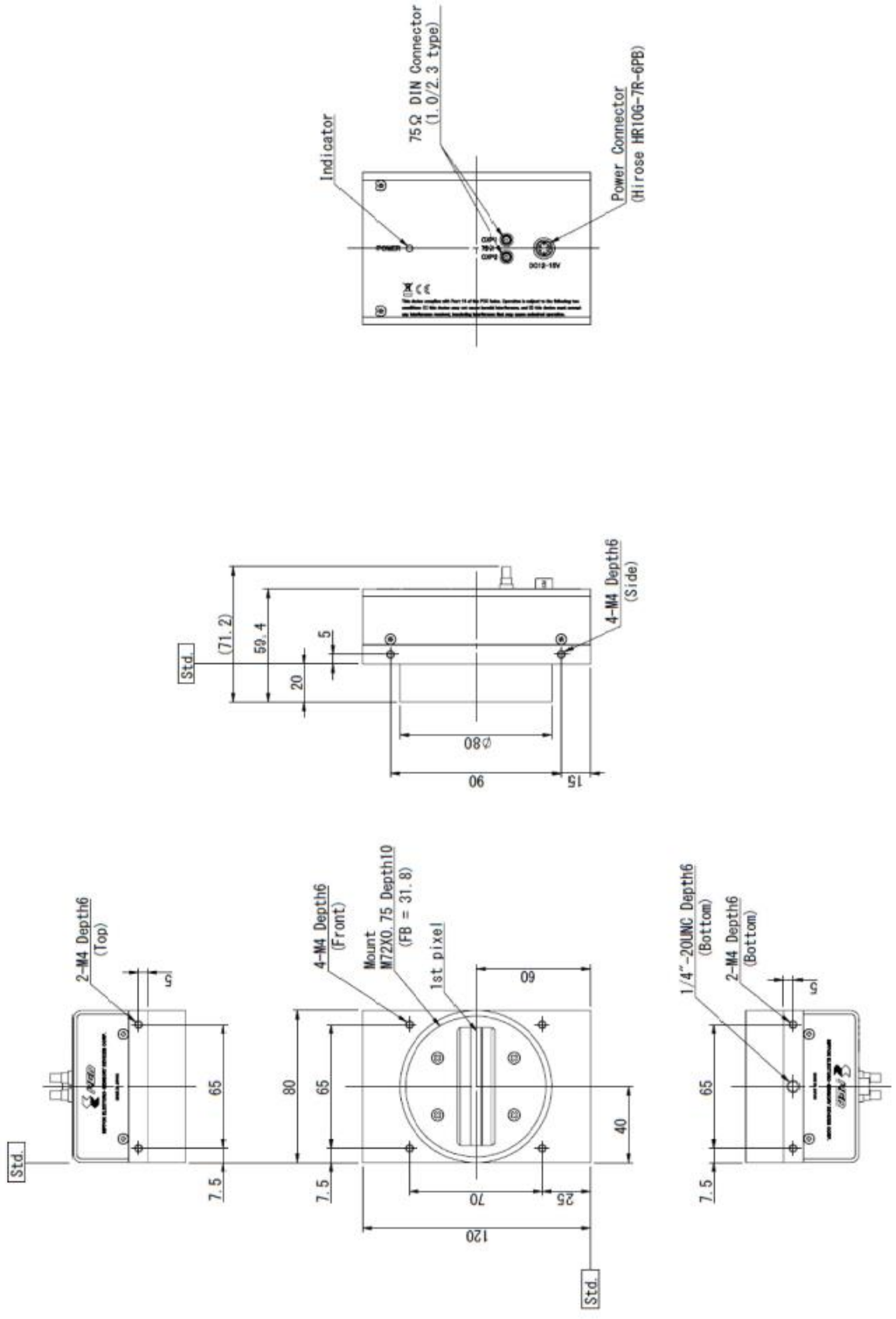


Figure 2-2-1 Dimensions of the RMSL8K76CP

Nikon F Mount

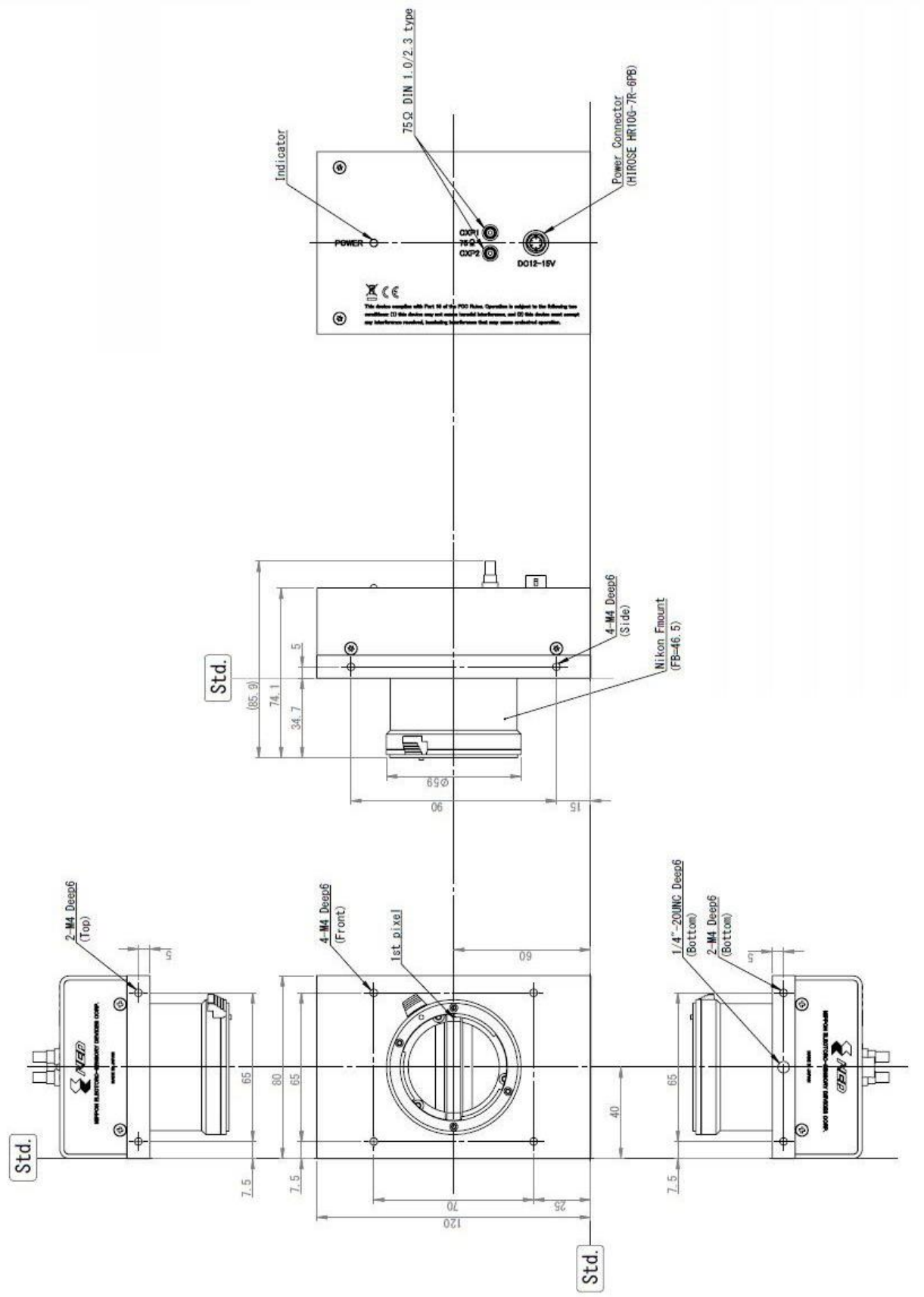


Figure 2-2-2 Dimensions of the RMSL6K76CP

Nikon F Mount

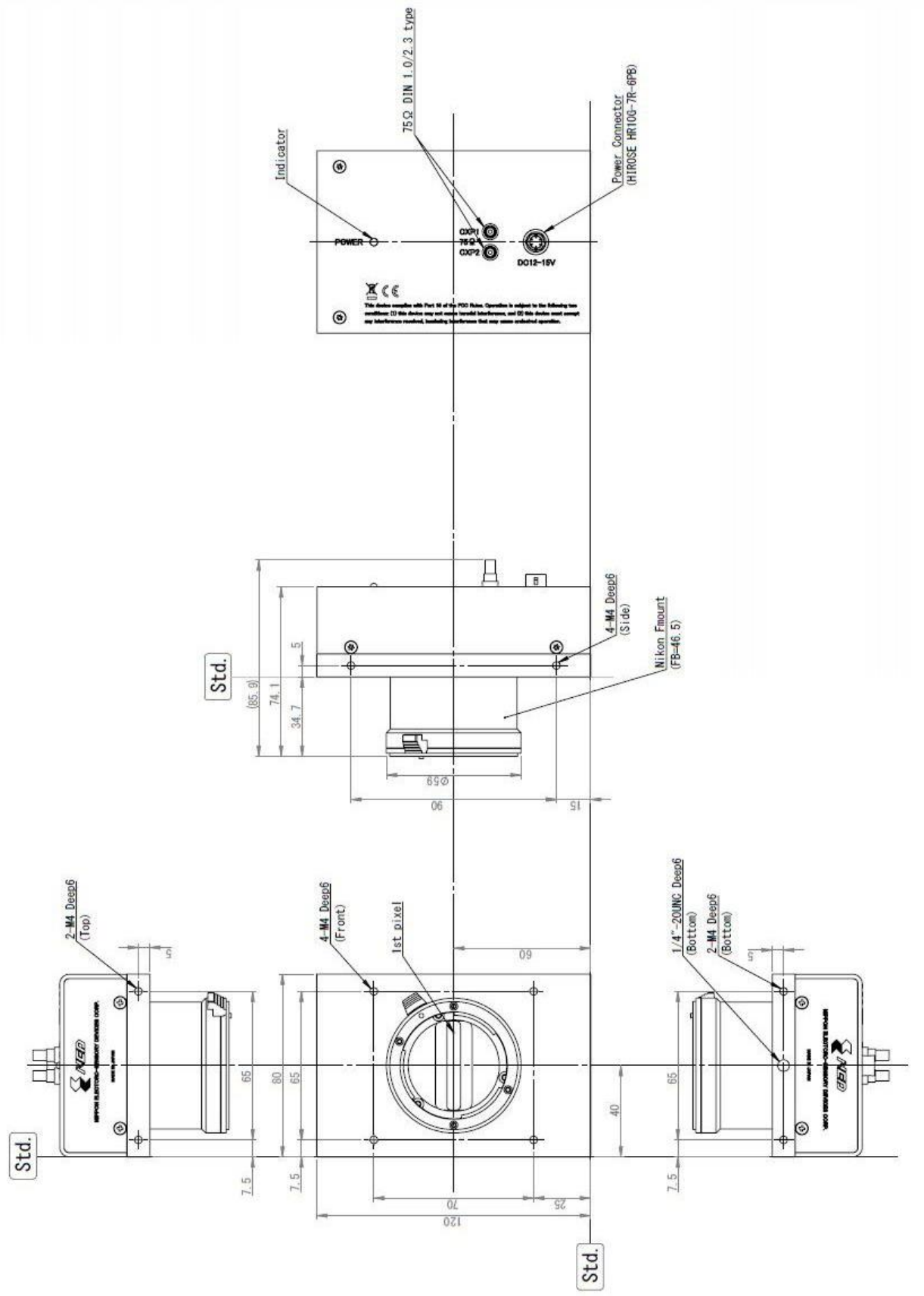


Figure 2-2-3 Dimensions of the RMSL4K76CP

2.3 Optical Interface

For RMSL8K76CP, M72×0.75 screw mount is used.

For RMSL6K76CP, RMSL4K76CP, Nikon F mount is used.

The amount and wavelengths of light required to capture useful images depend on the intended use. Factors include the property, speed, the objects 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) Please connect the camera and frame grabber board with CoaXPress cable (standard certified product).

◆ To connect the camera and frame grabber board, use CoaXPress cable (standard certified product). Please use the necessary number (one or two) of CoaXPress cables corresponding to the speed (CXP-3 or CXP-5) set to the camera (CxpLink Configuration).

Also, when using two CoaXPress cables, please use CoaXPress cable of the same manufacturer and the same length.

There are two types of CoaXPress cable connectors: BNC and DIN.

Please select according to the camera and frame grabber board.

(2) Connect to the power supply. (When PoCXP is not used)

To connect the camera and camera power supply, use the power cable. Connect the plug side of the power cable to the camera and connect the unprocessed side to the camera power supply.

In addition to this, you need a personal computer, frame grabber board, imaging lens, lens mount, light source, encoder, etc. Please select the one suitable for your purpose and set it appropriately.

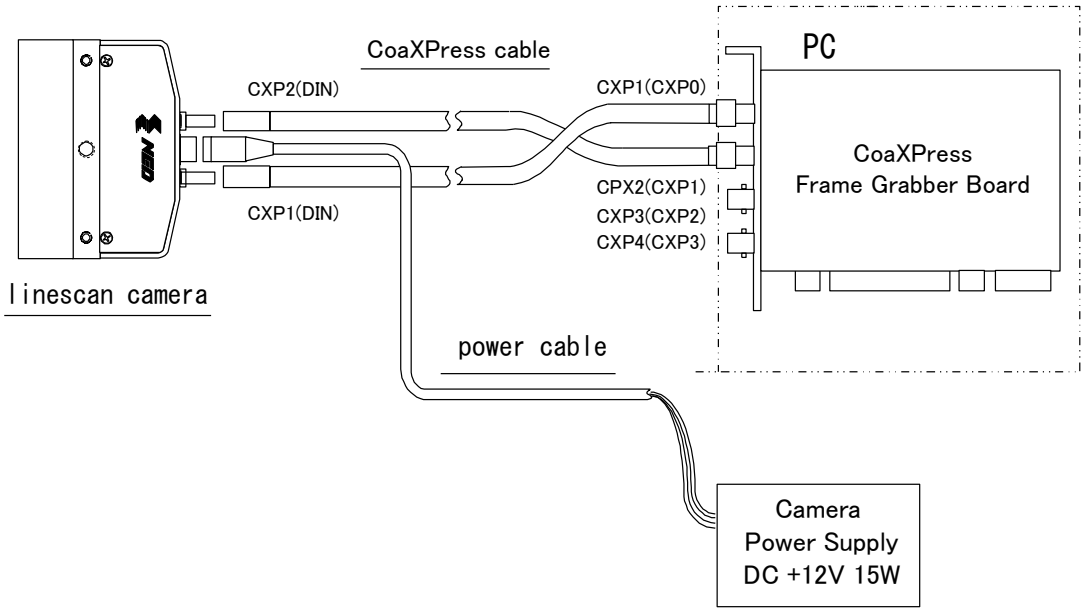


Figure 3-1-1 Connections between Camera and Frame Grabber Board and Power Supply

＜Note : Choosing a suitable CoaXPress cable＞

Please use a 75Ω coaxial cable with a BNC connector according to the CoaXPress standard. The maximum cable length is not prescribed by the standard. The maximum cable length to be able to transfer data depends on factors such as attenuation, diameter and manufacturer.

Therefore, please be sure to use CoaXPress cable certified as standard.

Refer to JIIA (http://jiia.org/cxp/) for more information about standard approved cables.

As specifications for each manufacturer differs, please contact the cable manufacturer directly for details.

Please note that operation can not be guaranteed with coaxial cables other than standard certified products and self-made cables.

3.2 Input / Output Connectors and Indicator

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

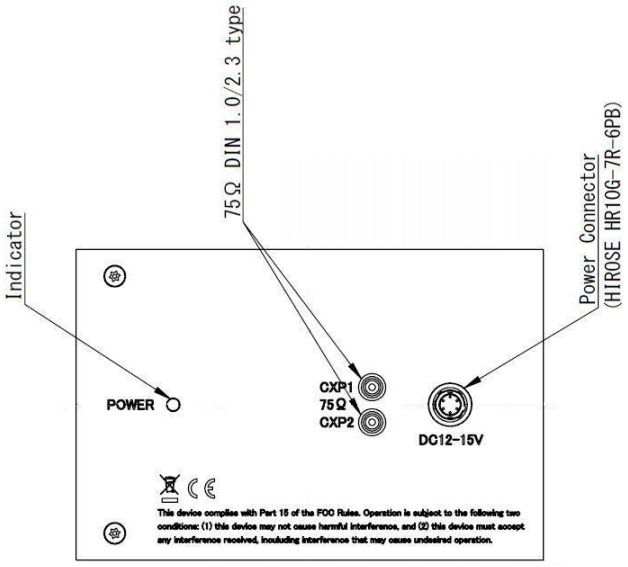


Figure 3-2-1 Input/Output Connectors and Indicator

3.3 Connectors･Pin Assignments

This camera uses 6-pin round shape push-pull lock type connector for the Power Supply. Acceptable Cable (Acceptable plug): DGPSH -10 (HIROSE : HR10G-7P-6S)

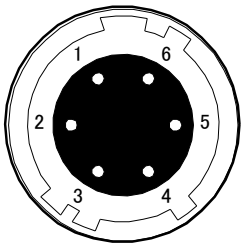


Figure 3-3-1 Power Supply Connector (HIROSE: HR10G-7R-6PB)

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

No	NAME	Colour of Cable
1	DC12 –15V	White
2	DC12 –15V	Red
3	DC12 –15V	―
4	GND	Green
5	GND	Black
6	GND	―

Note:

The cable colour in the table describes the compatible cable DGPSH-10.

3.4 Power Supply

This camera can supply two kinds of power from the power connector and from the CXP 1 connector (PoCXP).

For safety, please remove the power connector for PoCXP of the frame grabber board when using the power connector.

3.4.1 How to supply from power connector

A single DC voltage (DC +12V to +15V) must be supplied to the power connector.

DC + 12 to + 15 V When the power is supplied, the indicator (orange LED) lights up, after a few seconds it turns steady green and the camera enters the operating state.

Notes:

1) When selecting a power source, choose one with the capacity to allow for inrush current. (RMSL8K76CP is 15W, RMSL6K76CP is 12W and RMSL4K76CP is 10W or more is recommended)
2) Insert the cable plug securely until it locks into position. This is to prevent the connector from coming loose during power transmission.
3) 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.
4) 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.
5) 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.
6) It is recommended that the shield processing of the power cable to be connected with GND on the power supply side.

3.4.2 How to supply from the CXP 1 connector (PoCXP)

Connect the power connector for PoCXP on the frame grabber board.

The type of power connector varies depending on the frame grabber manufacturer. For details of connector type, supply voltage, etc., refer to the frame grabber board instruction manual.

When the PC power supply is turned on, power is supplied via the CoaXPress cable.

Notes:

1) Do not supply power (DC +12V to +15V) to the camera power connector.

3.5 LED Indicator Status

The status of the indicator varies depending on CoaXPress's Ver. This camera is CoaXPress Ver1.1.1.

Table 3-5-1 Indicator status

LED Indicator Status	CoaXPress Ver.	
	1.1.1 (New)	1.0 (Old)
Camera Power Supply is off	LED off	
Camera Booting Up (Power On)	Lights orange	
Device Discovery	Lights orange for 0.5s	
Line rate > ~1.6s *1	Blinks orange	
Low Speed Link disconnected (Cable disconnected)	Blinks red	Lights red
Unable to process commands (System crash) *2	Lights red	Blinks red
Transmitting image packets (Acquisition Start =1)	Blinks green	Lights green
Not transmitting image packets (Acquisition Stop =1)	Lights green	Blinks green

*1 When the line rate is close to 1.6s, the LED may flash orange and green alternately.

*2 Turn on the camera power supply again.

4 Camera Control

The camera can be controlled by the frame grabber board through the camera's control registers. The camera supports GenICam, and so can be easily controlled by a GenICam-compatible frame grabber. The camera control software which came with your frame grabber should be used for camera control.

Once the camera settings have been made and saved, the camera will operate without further setting.

4.1 Flow of Camera Control

4.1.1 GenICam overview

- The camera control register information is saved inside the camera (XML file).
- The frame grabber board reads the XML file during Discovery, and acquires the register information.
- Camera control is enabled after Discovery.

Please check your frame grabber's manual for how to perform device discovery.

4.1.2 Camera Control registers

Various settings (features) of this camera correspond to GenICam SFNC 2.3. Please set with the software attached to the frame grabber board.

The commands used in this camera are as shown in Table 4-1-2-1.

Table 4-1-2-1 List of Camera Control Registers

Features Name	R/W	VAL < factory settings >	Control Description
Category : Device Information			
Device User ID	R/W	(ASCII code) <0x00>	User define ASCII code. ASCII code is up to 15 characters. The last of ASCII code is "NULL(0x00)".
DeviceTemperatureSelector	RW	Mainboard / Subboard	Select temperature measurement location Mainboard : Surrounding of FPGA Subboard : Internal of FPGA
DeviceTemperature	R		Display the temperature inside (℃) Mainboard : MAX75 ℃ Subboard : MAX90 ℃

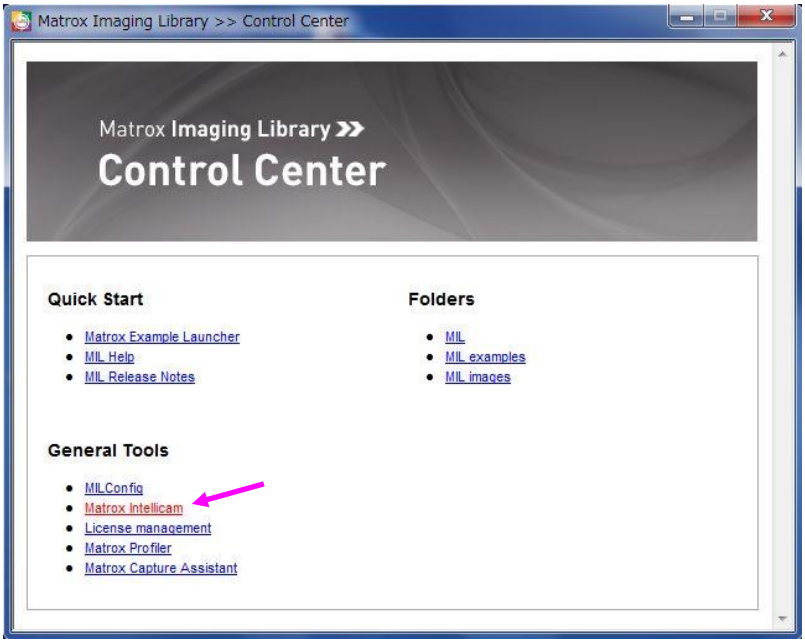
Category : Image Format Control			
ReverseX	RW	True / False <False>	True : Reverse False : Forward
PixelFormat	RW	Mono8 / Mono10 <Mono8>	Mono8 : mono8bit Mono10 : mono10bit
TestPattern	RW	Off / GreyHorizontalRamp <Off>	Off : off GreyHorizontalRamp : on
Category :Acquisition Control			
AcquisitionLineRate	RW	300～76923 <8183>	Hz(unit)
TriggerSelector	RW	ExposureStart	No need to change setting
TriggerMode	RW	Off / On <Off>	Off : External trigger disabled On : External trigger enabled
ExposureMode	RW	Timed / TriggerWidth <Timed>	Timed : ExposureTime value TriggerWidth : External trigger "H" time
ExposureTime	RW	1.0～3331.0 <120.0>	Unit : μsec 0.2 / step
Category : Analog Control			
NED_AnalogGain	RW	x100～x1000 <x100>	x1 / x2 / x3 / x4 / x5 / x6 / x8 / x10
GainSelector	RW	All	No need to change setting
Gain	RW	1.000000～2.000000 <1.000000>	x1～x2 0.001957 / step
BlackLevelSelector	RW	All	No need to change setting
BlackLevel	RW	-127～127 <0>	-63...63(0.5DN/step at 8bit) -254...254(2DN/step at 10bit)
Gamma	RW	0.250～4.000 <1.000>	γ value 0.01 / step

Category : User Set Control			
UserSetSelector	RW	Default/UserSet1	
UserSetLoad	W		
UserSetSave	W	W	
Category : Transport Layer Control – CoaXPress			
CxpLinkConfiguration	RW	CXP3_X1/ CXP5_X1/ CXP3_X2/ CXP5_X2 (exclude RMSL4K76CP) <CXP3_X1>	Transfer speed and Number of cables
Category : NED additional feautures			
NED_FFCMode	RW	Disable/ Factory white/ User white/ User black+Factory white/ User black+User white <Factory white>	Factory black Factory black + Factory white Factory black + User white User black + Factory white User black + User white
NED_PRNUTarget	RW	1～1023 <800>	Pixel Correction Target Value （10bit DN）
NED_PRNUCalibration	W		Store pixel correction data in memory (White)
NED_FPNCalibration	W		Store pixel correction data in memory (Black)

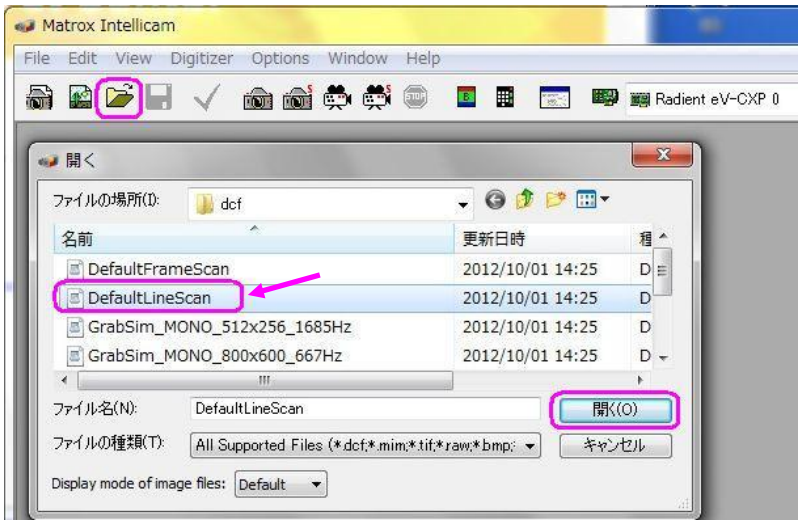
4.2 Details on register system

This explanation uses the Matrox Radient eV-CXP as an example.

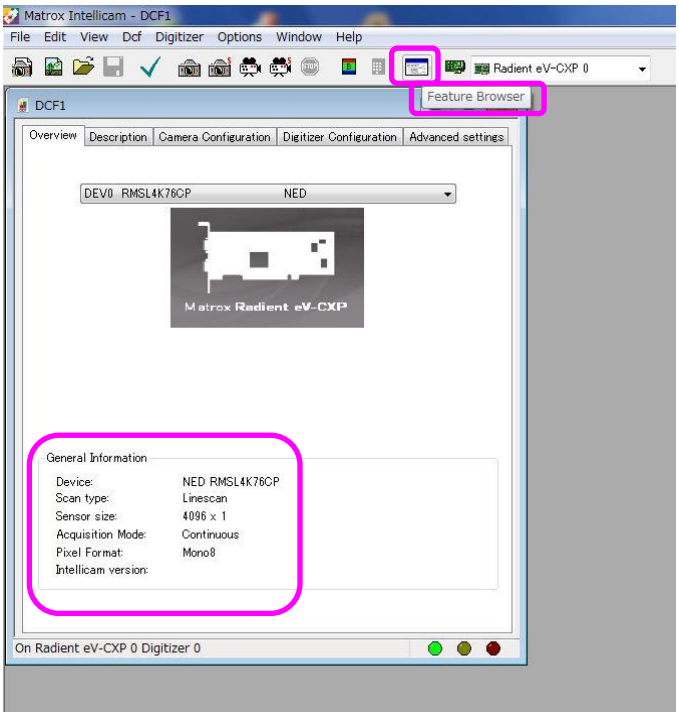
1. Open Intellicam from the Matrox Imaging Library



2. From the Intellicam “File/Open” Menu, open “DefaultLineScan”

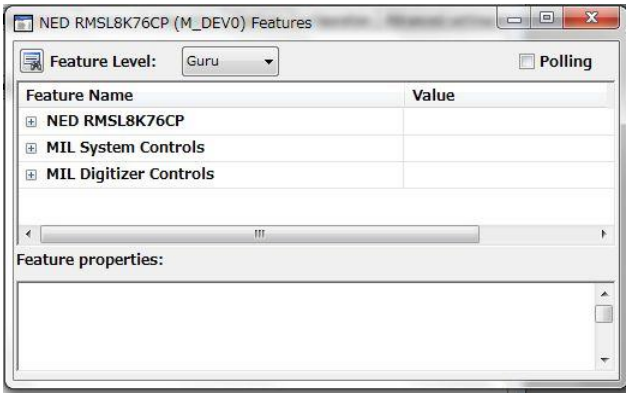


3. If the contents of the DCF file are displayed, then discovery has been performed successfully.



4. Open "Feature Browser" from the Intellicam menu.

5. Control the camera from the Features box.

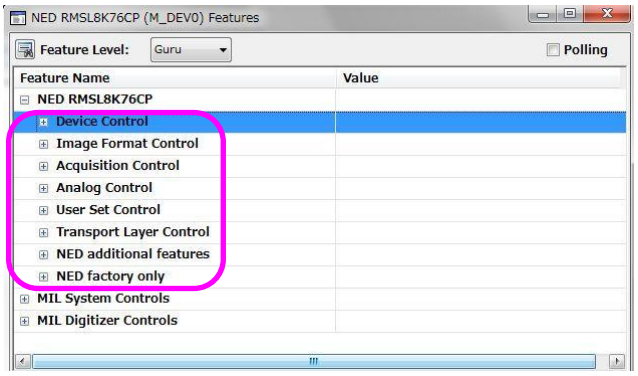


◆ In the case of the Matrox Radient eV-CXP, the list of registers is displayed in the window. Change the settings via the dropdown list or spinners.

4.2.1 Category

The camera control register has the following eight categories.

1.Device Control (Device temperature)
2.Image Format Control (Related images)
3.Acquisition Control (Related Exposure / trigger)
4.Analog Control (Related Gain・Offset)
5.User Set Control (Loading and saving camera setting values)
6.Transport Layer Control (Related CoaXPress IF)
7.NED additional features (Related Pixel Correction)
8.NED factory only (Not Used)



4.2.2 Device Control

4.2.2.1 Setting of camera temperature selection

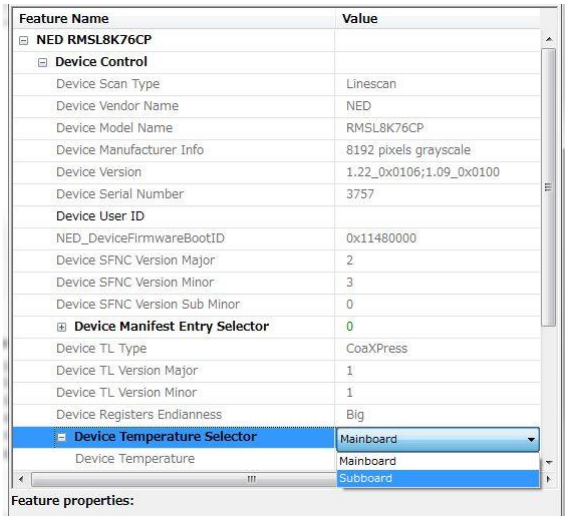
Select the location of the camera internal temperature to be displayed on DeviceTemperature.

・Register name DeviceTemperatureSelector

・VAL Mainboard / Subboard

(Example)

DeviceTemperatureSelector : Subboard



4.2.2.2 Camera temperature indication

Displays the camera internal temperature selected by DeviceTemperatureSelector.

・Register name DeviceTemperature

・Load value (℃)

(Example)

DeviceTemperatureSelector : Subboard

DeviceTemperature : 53.100

∗Mainboard should be used in an environment such as below 75℃, Subboard below 90℃.

4.2.3 Image Format Control

4.2.3.1 Setting Pixel Readout Direction

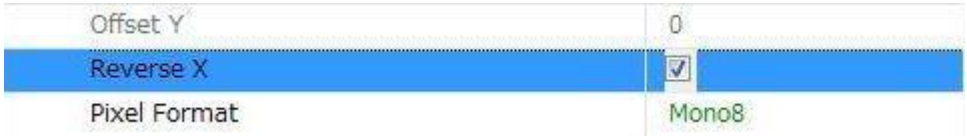
Sets the pixel readout direction.

・Register name ReverseX

・VAL clear the check box(Forward) / check box (Reverse)

(Example)

Reverse : check box (Reverse)



4.2.3.2 Setting PixelFormat

Switch between monochrome 8 bit / monochrome 10 bit.

・Register name Pixel Format

・VAL Mono8 / Mono10 (monochrome 8-bit/10-bit switching)

(Example)

Pixel Format : Mono8 (monochrome 8-bit)

4.2.3.3 Generating Test Pattern

Generates test pattern.

・Register name TestPattern

・VAL Off / GreyHorizontalRamp

(Example)

TestPattern : GreyHorizontalRamp

4.2.4 Acquisition Control

4.2.4.1 Setting Line Rate

Sets the Line Rate.

・Register name AcquisitionLineRate

・VAL 500～76923（Hz）

(Example)

AcquisitionLineRate : 25000（Sets the line rate to 25000 Hz）

＊The line rate (1 / AcquisitionLineRate) setting is 0.200us steps.

If the value of (1 / AcquisitionLineRate) can not be divided by 200 ns, the actual setting value will be different.

Ex)

· When set to 15000 Hz, the actual set value is 15015Hz.

· When set to 30000 Hz, the actual setting value is 30120Hz.

If the setting value of AcquisitionLineRate is increased, the value of ExposureTime may be automatically changed.

The values are generally set according to the following formula.

ExposureTime ＜＝ （1 / AcquisitionLineRate）- 2.2 us

4.2.4.2 Trigger type selection

Sets the trigger type of the camera.

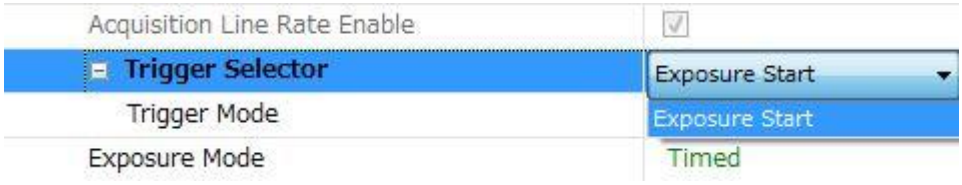
Only ExposureStart (exposure start trigger) can be selected.

・Register name TriggerSelector

・VAL ExposureStart

(Example)

TriggerSelector : ExposureStart



4.2.4.3 Setting of external trigger permission

Sets enable / disable of external trigger.

Enable (On) when using external trigger.

・Register name TriggerMode

・VAL Off / On（Disable / Enable）

(Example)

TriggerMode : On

＊When this setting is enabled, it is necessary to supply a trigger packet from the frame grabber board to the camera.

For details on how to supply the trigger packet, refer to the manual of each frame grabber board.

4.2.4.4 Setting ExposureMode

Sets the exposure mode when the camera's external trigger enable setting (TriggerMode) is enabled (On).

・Register name ExposureMode

・VAL Timed（Exposure time is set value of Exposure Time）

TriggerWidth（Exposure time is the "H"time of the ext. trigger pulse）

(Example)

ExposureMode : Timed

4.2.4.5 Setting ExposureTime

Sets the exposure time.

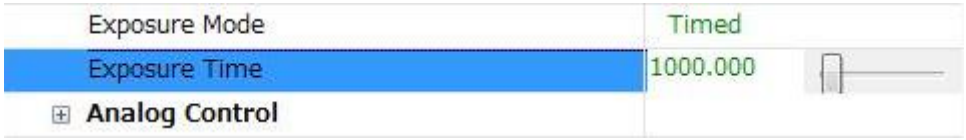
It is valid when TriggerMode is invalid (Off) or TriggerMode is enabled (On) and ExposureMode is Timed.

・Register name ExposureTime

・VAL 1.000～3331.000（0.200us step）

(Example)

ExposureTime : 1000.000



* If increasing the ExposureTime setting, the value of AcquisitionLineRate may be changed automatically.

The values are generally set according to the following formula.

AcquisitionLineRate ＜＝ 1 / （ExposureTime ＋ 2.2）us

4.2.5 Analog Control

4.2.5.1 Setting Analog Gain

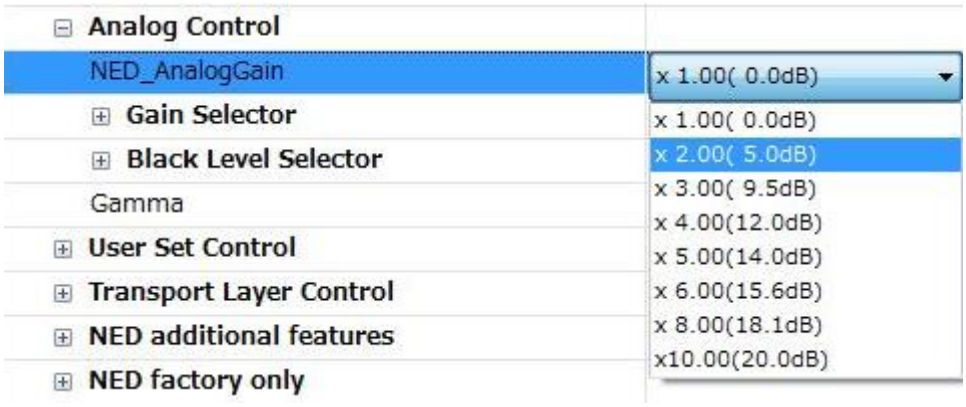
Sets analog gain in 8 steps between x1 and x10.

・Register name NED_AnalogGain

・VAL × 1.00 ~ × 10.00

(Example) × 2.00

Analog Gain : Setting analog gain (x2.00)



4.2.5.2 Gain type selection

It can only select All (all pixels).

・Register name GainSelector

・VAL All

(Example)

GainSelector : All

4.2.5.3 Setting Digital Gain

Sets digital gain in 512 steps between x1 and x2

Digital Gain : 1023 / (1023 – VAL)

・Register name Digital Gain

・VAL 0 (×1)~511 (×2)

(Example)

Digital Gain: 255 (Setting digital gain (1023/(1023-255)=x1.327)

4.2.5.4 Select offset type

It can only select All (all pixels).

・Register name BlackLevelSelector

・VAL All

(Example)

BlackLevelSelector : All

4.2.5.5 Setting Digital Offset

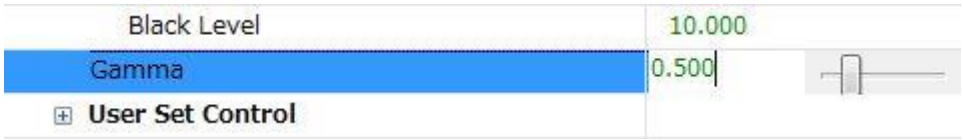
Sets the digital offset of the camera.
-63 to +63DN (8 bits) / -254 to +254DN (10 bits) can be set in 512 steps.

・Register name　　BlackLevel
・VAL　　-127～127（1step）
(Example)
BlackLevel :10

4.2.5.6 Setting Gamma correction

Set camera gamma correction.

・Register name　　Gamma
・VAL　　0.250～4.000（0.001step）
(Example)
Gain : 0.500



4.2.6 User Set Control

4.2.6.1 Memory selection setting

Select and set the memory where the camera settings are saved.

・Register name UserSetSelector

・VAL Default / UserSet1（Factory setting / user setting）

(Example)

UserSetSelector : Default

4.2.6.2 Memory load (Read camera settings from flash memory)

Load the setting of the camera selected by UserSetSelector and reflect it on the camera.

・Register name UserSetLoad

・VAL Execute()

(Example)

UserSetSelector : Default（Select factory default settings）

UserSetLoad : Execute() （Load factory default settings）

4.2.6.3 Save memory (Save camera settings to flash memory)

Save the setting value of the current camera in the user setting memory.

・Register name UserSetSave

・VAL Execute()

(Example)

UserSetSelector : UserSet1（Select user setting）

UserSetSave : Execute() （Save to user settings）

4.2.7 Transport Layer Control – CoaXPress

4.2.7.1 CXP link setting

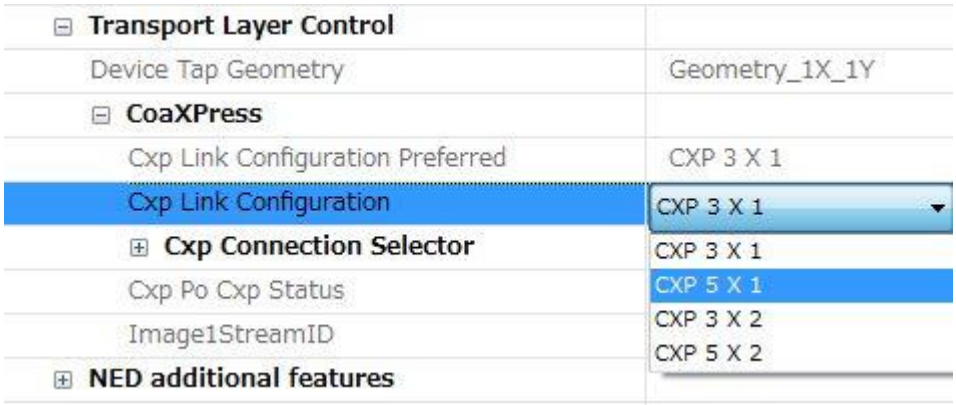
Set the transfer speed of the CoaXPress IF and the number of cables.

・Register name CxpLinkConfiguration

・VAL CXP3_X1（Factory mode）
CXP5_X1
CXP3_X2
CXP5_X2（RMSL4K76CP cannot be selected）

(Example)

CxpLinkConfiguration : CXP5_X1



＊When maximum line rate (76.923 KHz) is required, please set as follows.

RMSL8K76CXP ： CXP5_X2

RMSL6K76CXP ： CXP5_X2

RMSL4K76CXP ： CXP5_X1 or CXP3_X2

For details on the relation between CxpLink Configuration and maximum line rate, refer to page 13.

4.2.8 NED additional features

4.2.8.1 Setting Pixel Correction

Sets pixel correction.

- Register name NED_FFCMode
- VAL Disable (Factory black correction)
  Factory white (Factory black and white correction)
  User white (Factory black and user white correction)
  User black and Factory white (User black and factory white correction)
  User black and User white (User black and user white correction)

(Example)

NED_FFCMode : User white

4.2.8.2 Setting Pixel Correction Target Value

White Pixel Correction Sets the target value when capturing data.
Normally, use the factory default setting (800).

- Register name NED_PRNUTarget
- VAL 0 to 1023 (Setting correction level: 10-bit)

(Example)

NED_PRNUTarget :800

4.2.8.3 Saving White Pixel Correction Data

Acquires current white pixel correction data and saves it in the flash memory. One set of correction data can be saved for each step of analog gain.

- Register name NED_PRNUCalibration
  VAL Execute()

(Example)

NED_PRNUCalibration : Execute()

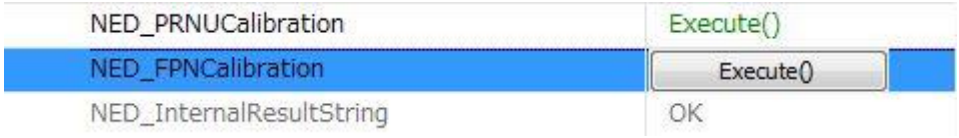
4.2.8.4 Saving Black Pixel Correction Data

Acquires current black pixel correction data and saves it in the flash memory. One set of correction data can be saved for each step of analog gain.

- Register name NED_FPNCalibration
  VAL Execute()

(Example)

NED_FPNCalibration : Execute()



4.3 Digital Processing flow in FPGA

The digital processing flow in FPGA is shown below.

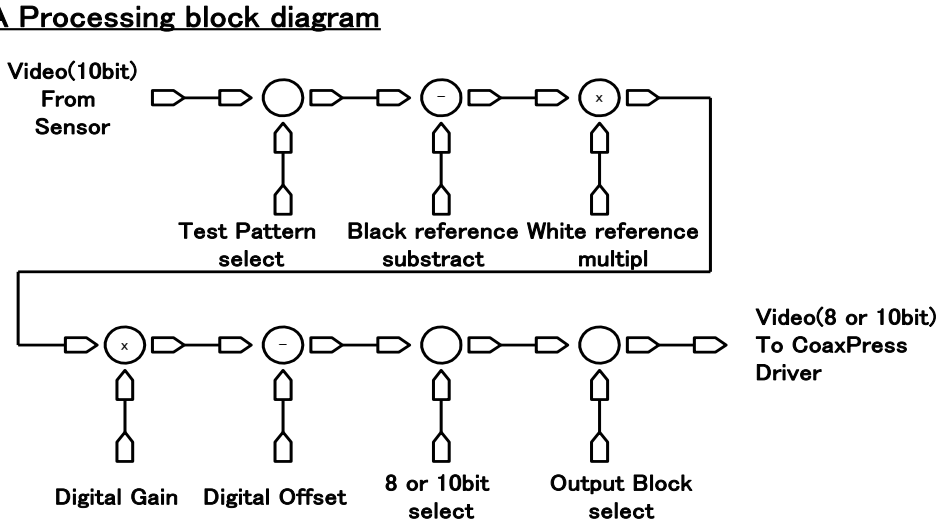


Figure 4-3-1 FPGA Processing Block Diagram

4.4 Startup

After turning on, the camera run a startup procedure before it starts getting images and outputting data. It takes about ten 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 those sequences, the camera is ready to get images and output data.

In order to output camera control and images, it is necessary to perform device discovery from the grabber board.

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 .

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

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

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

Registers for rewriting the memory are as follows.

- UserSetSave
- NED_PRNUCalibration
- NED_FPNCalibration

◆ To change the external trigger permission setting from the factory setting, please execute with the trigger packet supplied from the frame grabber board side. If you do not supply or supply a trigger packet outside the specification range, you can not capture images or change camera settings. For the input conditions of the trigger packet (external trigger), refer to sections 4.8.2 and 4.8.3.

Table 4-5-1 External trigger enable setting and trigger packet

External trigger enable setting (TriggerMode)	Trigger packet (External trigger)
Off（Factory setting）	No supply required
On	No supply required

4.6 XML file

The XML file is a file saved in the camera which contains the register information described in chapter 4.

According to the CoaXPress specification, when “Device Discovery” is performed from the camera control software supplied with the frame grabber, this file is read out, and the camera control registers are displayed in the camera control software (in the case of some manufacturers, they may not be displayed)

◆ However, if the frame grabber does not support GenICam, this function is not available.

4.7 Video Output Format

The camera outputs 8-bit or 10-bit black and white digital data through Coax Press IF.

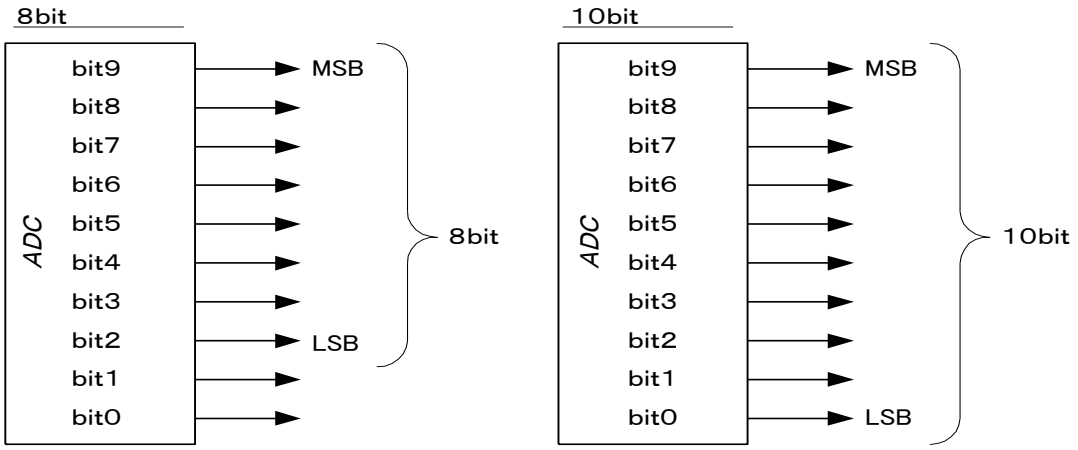


Figure 4-7-1 Pin Assignments of Digital Data

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

.

4.8 Exposure Mode and Timing Chart

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

4.8.1 Free Run Exposure Mode (When external trigger permission is invalid)

The free-run exposure mode is the mode when external trigger permission is invalid (Triggermode: off).

Set the camera camera control register with the AciliationLineRate and the Programmable exposure time (ExposureTime), respectively. Settable line rate and programmable exposure time are as follows.

Table 4-8-1-1 Programmable Exposure Time

1/scan	Line Rate(Hz)	300～76923
p	Programmable exposure time (us)	1.000～3331.000 ＊

＊The programmable exposure time is 0.200us steps.

The relationship between programmable exposure time (us) and line rate (Hz) is as follows.

Programmable exposure time (p) ≤ (1 / line rate) - 2.2 us

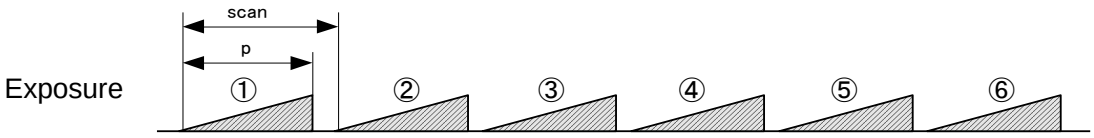


Figure 4-8-1-1 Free Run Exposure Mode

4.8.2 External Trigger (Timed) Exposure Mode

External trigger (Timed) exposure mode is the mode when the external trigger enable is enabled (Triggermode: on) and the exposure mode is Timed (Exposure Mode: Timed).

The line cycle is set by the cycle of the external trigger, and exposure start is set by the rising edge of the external trigger. Set the exposure time to the programmable exposure time (ExposureTime). The settable line cycle and programmable exposure time are as follows.

Table 4-8-2-1 External Trigger (Timed) Exposure Time

a	Trigger pulse Htime (us)	≧2.9
b	Trigger pulse Ltime (us)	≧2.9
c	Trigger pulse cycle (us)	≧13.00
p	Programmable exposure time (us)	1.000～3331.000 ＊

＊The programmable exposure time is 0.200us steps.

The relationship between programmable exposure time (us) and line period (us) is as follows.

Programmable exposure time (p) ≦ line cycle (c) - 2.2us

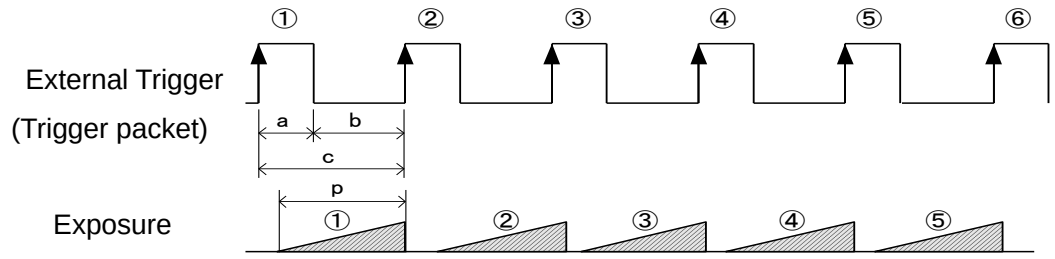


Figure 4-8-2-1 External Trigger (Timed) Exposure Mode

4.8.3 External Trigger (TriggerWidth) Exposure Mode

External trigger (TriggerWidth) exposure mode is when the external trigger enable is enabled (Triggermode: on) and the exposure mode is TriggerWidth (ExposureMode: TriggerWidth).

The line cycle is set by the cycle of the external trigger, and the exposure time is set by the high time of the external trigger. The settable line cycle and exposure time are as follows.

Table 4-8-3-1 External Trigger (TriggerWidth) Exposure Time

a	Trigger pulse Htime (us)	≧10.1
b	Trigger pulse Ltime (us)	≧2.9
c	Trigger pulse cycle (us)	≧13.00

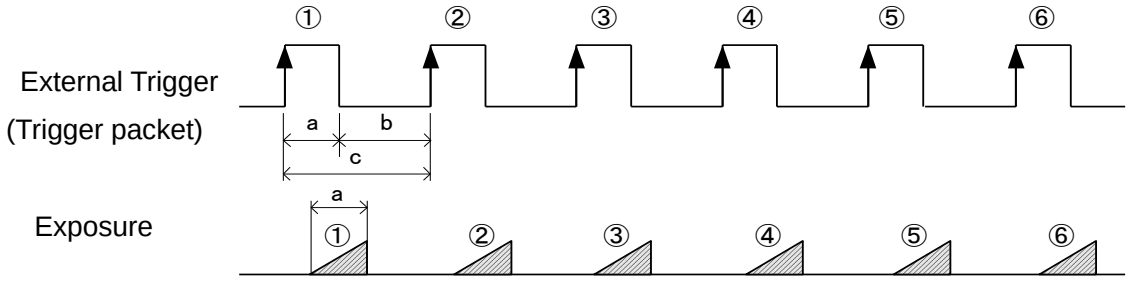


Figure 4-8-3-1 External Trigger (TriggerWidth) Exposure Mode

4.9 Setting Offset

In the diagram below, the horizontal axis indicates the volume of light and 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 for the saturation current, or the amount of exposure when the output saturates.

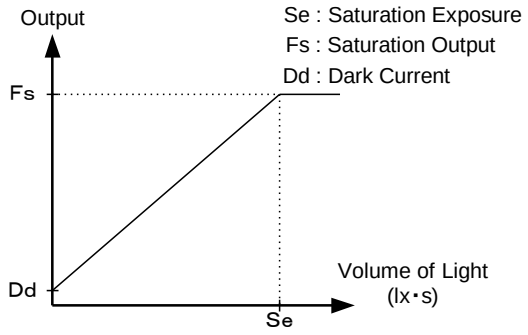


Figure 4-9-1 Saturation Exposure and Dark Current Output

By setting the offset, you can set the Y-intercept arbitrarily. DF shows the digital offset value. The gradients of lines do not change.

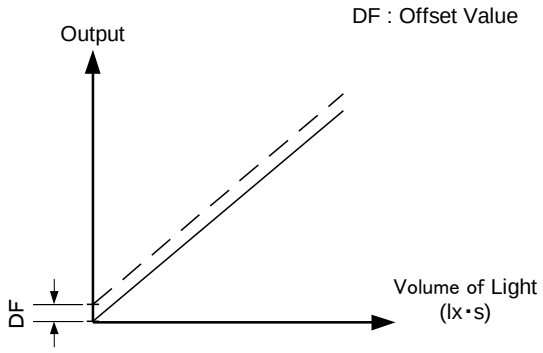


Figure 4-9-2 Offset Adjustment

◆ Adjust gain and offset to meet your system’s requirements.

4.10 Setting Gain

The camera can adjust the analog gain (x1 to X10.0 in 8 steps) and the digital gain. As the diagram below indicates, increasing the gain setting increases the slope 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.

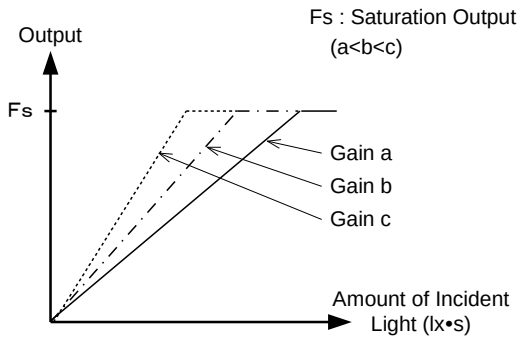


Figure 4-10-1 PGA Gain Adjustment

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

Gain-Sensitivity is shown below.

Table 4-10-1 Gain-Sensitivity

	Analog Amplifier		Sensitivity (V/lx□s)
0	x1.00	0.0dB	100
1	x2.00	6.0dB	200
2	x3.00	9.5dB	300
3	x4.00	12.0dB	400
4	x5.00	14.0dB	500
5	x6.00	15.6dB	600
6	x8.00	18.1dB	800
7	x10.00	20.0dB	1000

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

4.11 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.

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 (10-bit digital)
Vin :Input data (digital) Vout :Output data (digital)
The corrected data is expressed in the following equation.
Vout=(Vin-Cal_bl)xTarget_val/(Cal_wh-Cal_bl)

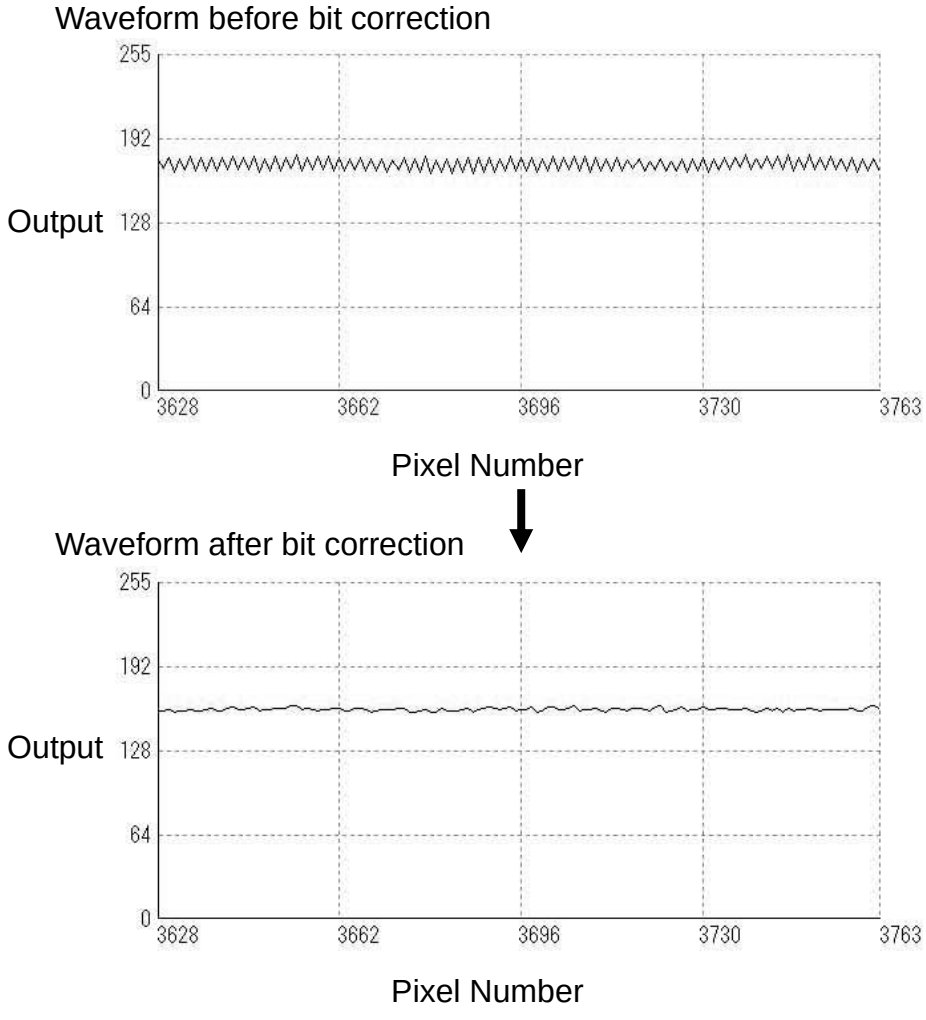


Figure 4-11-1 Waveform before and after bit correction

4.11.1 Pixel (bit) correction related register

There are the following four types of registers related to pixel correction.

◆ Setting Pixel Correction

Sets pixel correction.

・Register name NED_FFCMode

・VAL Disable (Factory black correction)
Factory white (Factory black and white correction)
User white (Factory black and user white correction)
User black and Factory white (User black and factory white correction)
User black and User white (User black and user white correction)

◆ Setting Pixel Correction Target Value

White Pixel Correction Sets the target value when capturing data.

Normally, factory shipping setting (800) is used as it is but please change accordingly.

・Register name NED_PRNUTarget

・VAL 1～1023（1DNstep）

◆ Saving White Pixel Correction Data

Acquires current white pixel correction data and saves it in the flash memory.

One set of correction data can be saved for each step of analog gain.

・ Register name NED_PRNUCalibration
VAL Execute()

◆ Saving Black Pixel Correction Data

Acquires current black pixel correction data and saves it in the flash memory.

One set of correction data can be saved for each step of analog gain.

・ Register name NED_FPNCalibration
VAL Execute()

4.11.2 White pixel · Black pixel correction data acquisition condition

◆ When acquiring white pixel correction data

Remove the lens cap to make the subject white uniform. Any white correction data can be acquired with this. When the lens is attached, the shading of the lens and the light source are corrected at the same time, but since the shading of the subject is directly reflected, shift the focus.

◆ When capturing black pixel correction data

Please attach the lens cap and shade the light.

4.12 Test Pattern

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

The test pattern of the RMSL8K76CP is below.

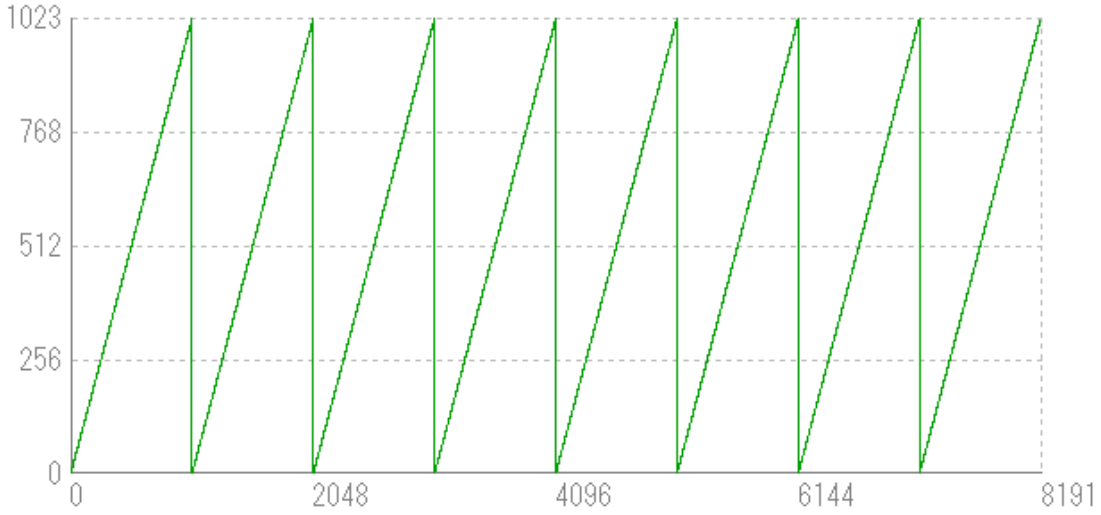


Figure 4-12-1 Test Pattern of RMSL8K76CP

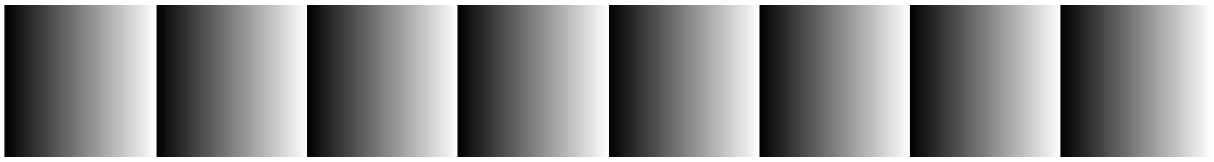


Figure 4-12-2 Test Image of RMSL8K76CP

The test pattern is a ramp from 0 to 1023DN in 10-bit mode, and then it repeats itself from 0 again 8 times.
The test pattern is a ramp from 0 to 255DN in 8-bit mode, and then it repeats itself from 0 again 32 times.

The test pattern of the RMSL6K76CP is below.

Figure 4-12-3 Test Pattern of RMSL6K76CP

Figure 4-12-4 Test Image of RMSL6K76CP

The test pattern is a ramp from 0 to 1023DN, 0 to 511 in 10-bit mode, and then it repeats itself from 0 again 4 times.
The test pattern is a ramp from 0 to 255DN in 8-bit mode, and then it repeats itself from 0 again 24times.

The test pattern of the RMSL4K76CP is below.

Figure 4-12-5 Test Pattern of RMSL4K76CP

Figure 4-12-6 Test Image of RMSL4K76CP

The test pattern is a ramp from 0 to 1023DN in 10-bit mode, and then it repeats itself from 0 again 4 times.
The test pattern is a ramp from 0 to 255DN in 8-bit mode, and then it repeats itself from 0 again 16 times.

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

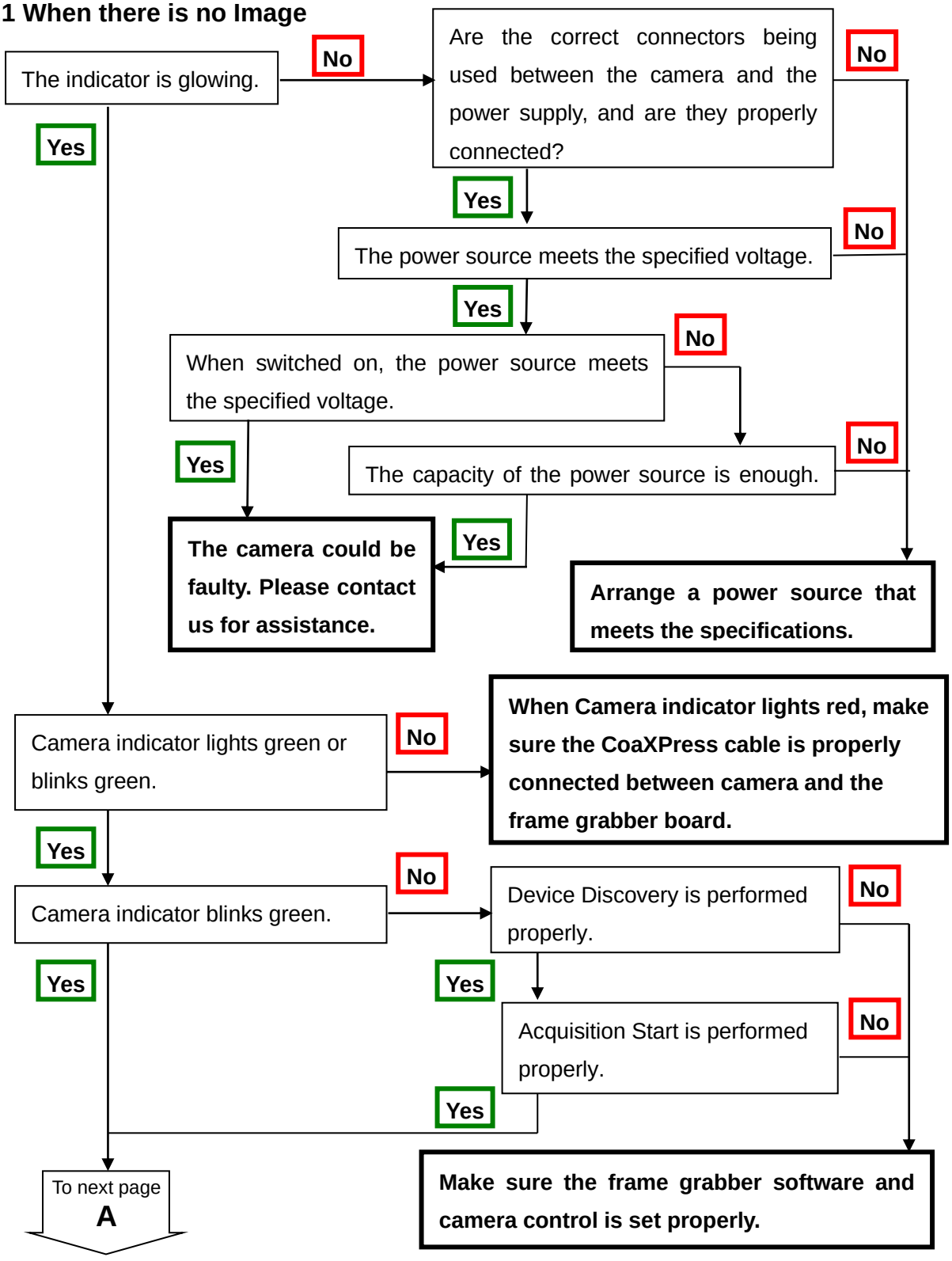
Dust: Can usually be removed by blowing the window surface using a compressed air blower.

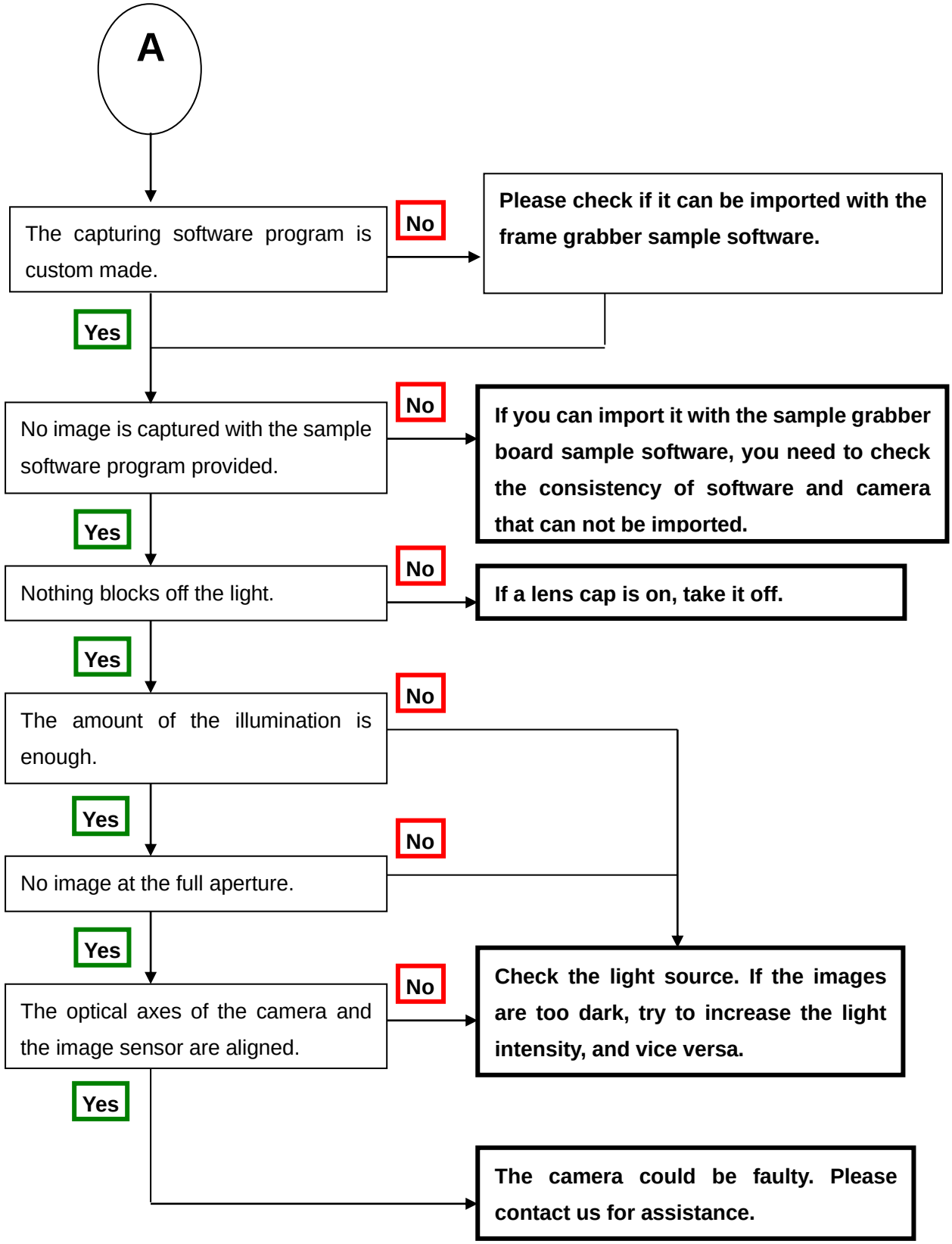
Oil: Wipe the window with a lint-free cloth wiper moistened with ethyl alcohol carefully and slowly.

6 Troubleshooting

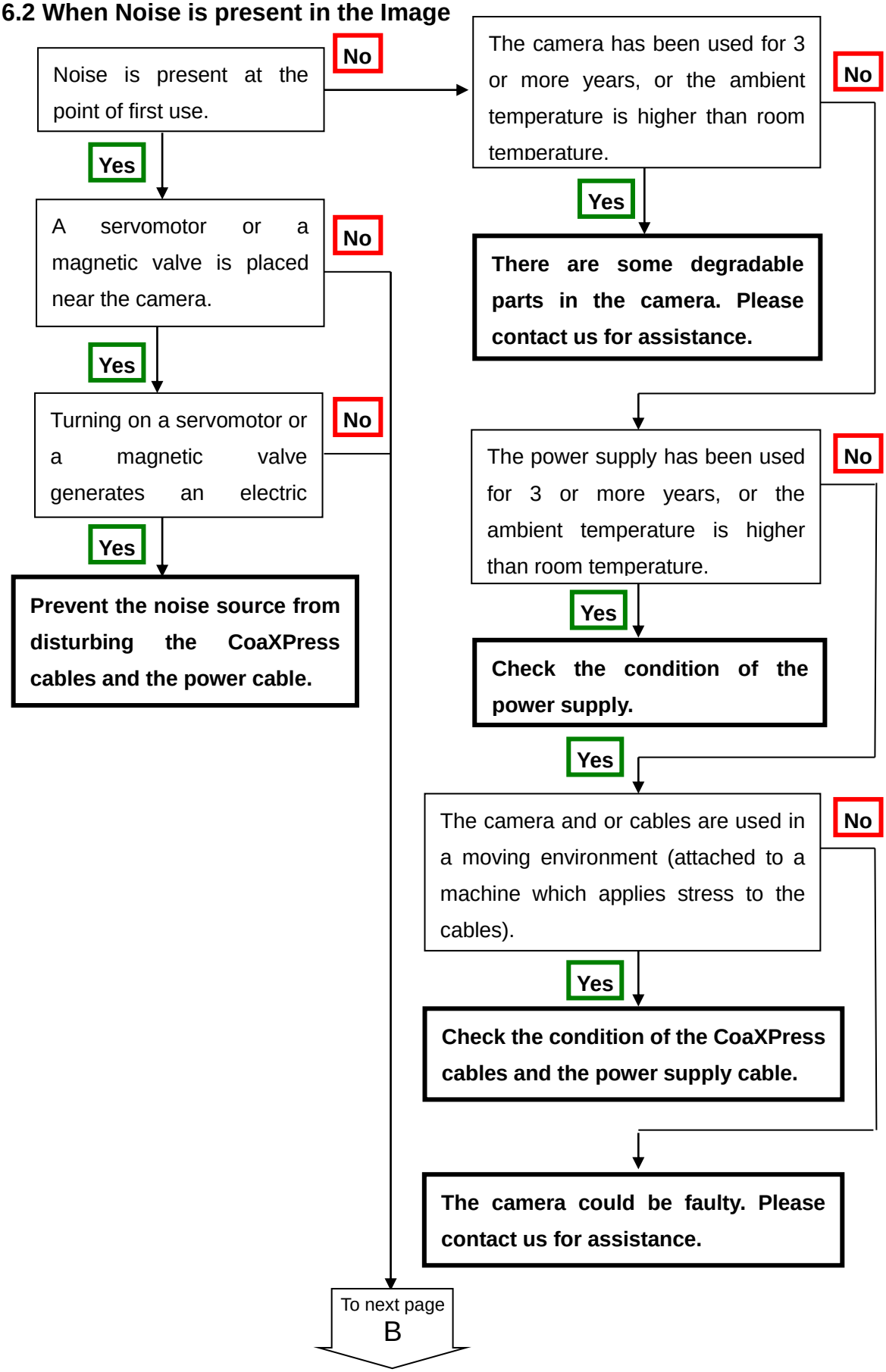
The following pages contain several troubleshooting charts that can help you find the cause of problems user sometimes encounter.

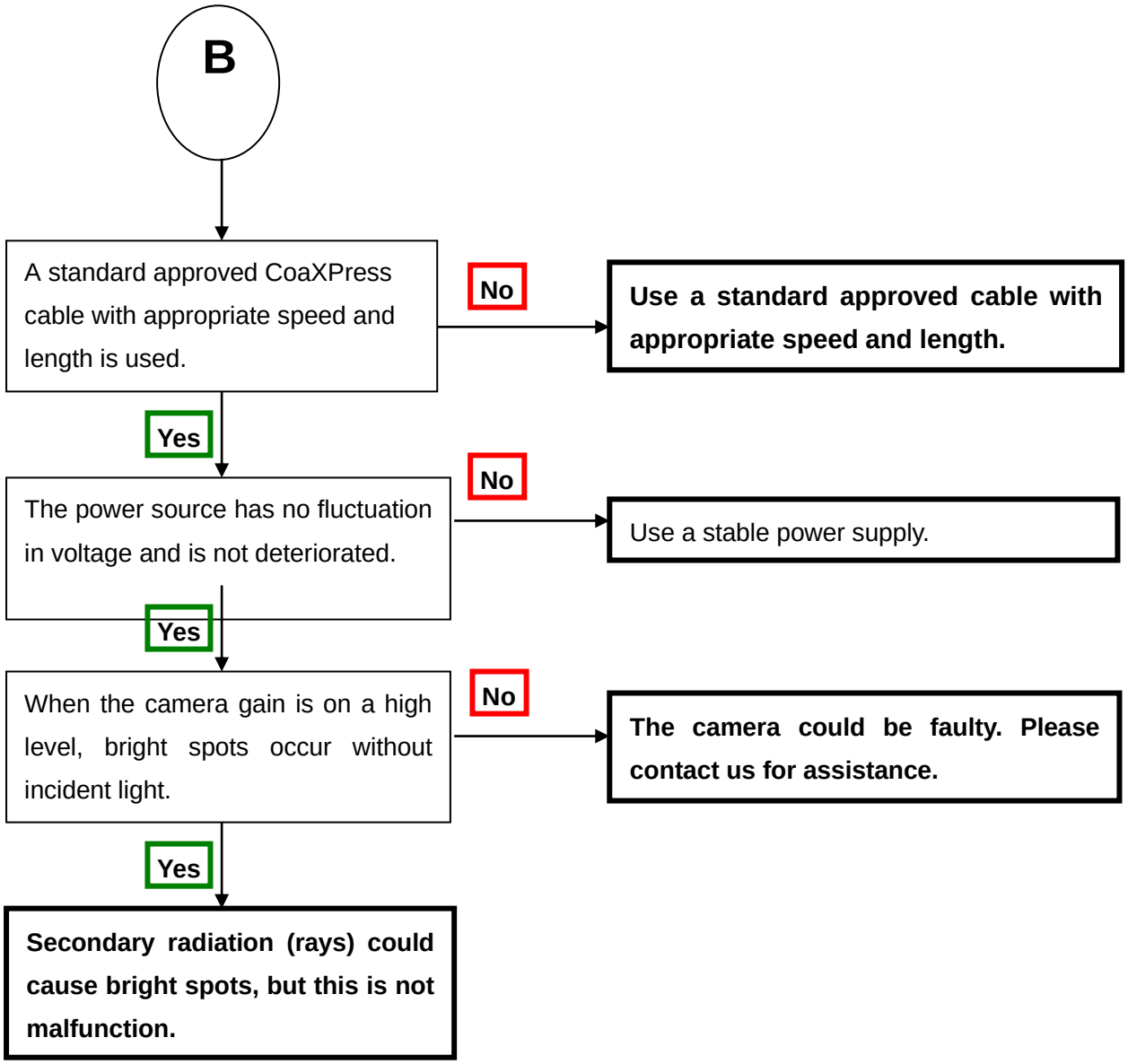
6.1 When there is no Image



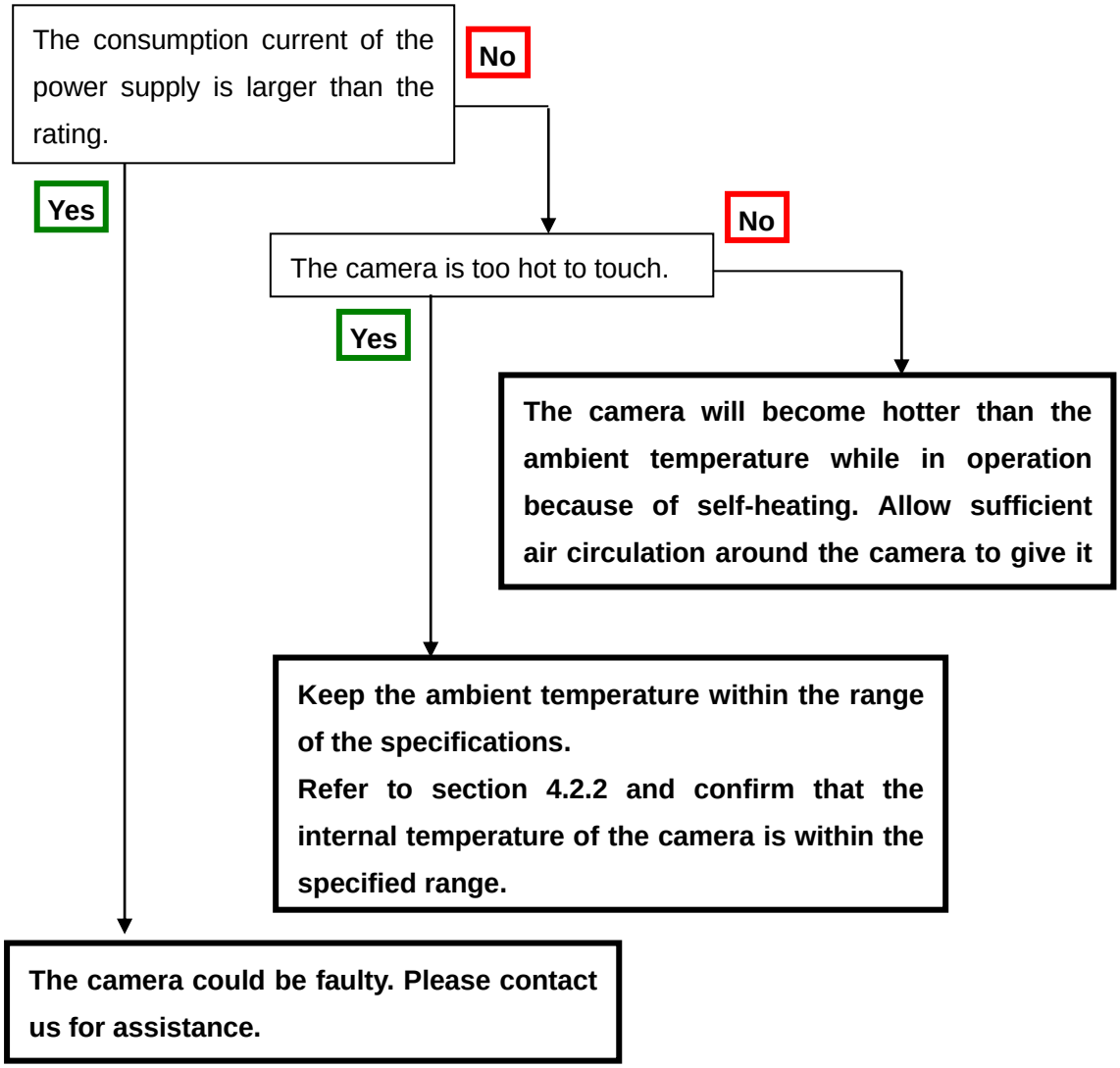

A
The capturing software program is custom made.
No
Please check if it can be imported with the frame grabber sample software.
Yes
No image is captured with the sample software program provided.
No
If you can import it with the sample grabber board sample software, you need to check the consistency of software and camera that can not be imported.
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.
Yes
The camera could be faulty. Please contact us for assistance.

6.2 When Noise is present in the Image




B
A standard approved CoaXPress cable with appropriate speed and length is used.
No
Use a standard approved cable with appropriate speed and length.
Yes
The power source has no fluctuation in voltage and is not deteriorated.
No
Use a stable power supply.
Yes
When the camera gain is on a high level, bright spots occur without incident light.
No
The camera could be faulty. Please contact us for assistance.
Yes
Secondary radiation (rays) could cause bright spots, but this is not malfunction.

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

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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

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

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

E-Mail
sales@ned-sensor.com

7.3 Product Support

7.3.1 Warranty card (attach a separate)

Read carefully the Warranty card, please trasure 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.

Revision History

Revision Number	Date	Changes
01	May 24, 2018	Initial release
02	Feb. 06, 2020	Figure 2-2-1 Dimensions of the RMSL8K76CP change