

# CONTACT IMAGE SENSOR (CIS) KD series for Web Surface Inspection

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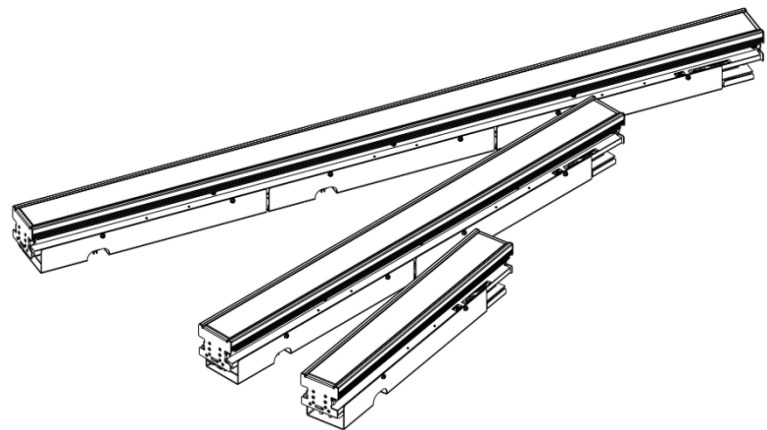
KD6R367CX2, KD6R587CX2, KD6R807CX2

KD6R367CX2-NL, KD6R587CX2-NL, KD6R807CX2-NL

## User's Manual

TM-XN192C

Aug 21th 2025



Design and specification are subject to change without notice.

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# Chapter 1 : Notice

## 1-1 RESTRICTION FOR USE

Thank you very much for purchasing Mitsubishi Electric Contact Image Sensor (CIS). This document contains information that introduces how to use this product appropriately and safely. Read through this document carefully before starting to use this product in your equipment or system.



This product is designed for the purpose of being used in general industries. Do not use this product for specific and particular applications (aerospace application, combustive equipment, transportation equipment, life-support system, safety device, etc.) where special quality and reliability are required and failure or malfunction could directly threaten people's lives, or do harm to the human body. Do not use for applications other than the purpose of being used in general industries intended by Mitsubishi Electric. If you plan to use such particular applications, contact our sales department personnel before doing so. If you have been using it for applications other than the general industries intended by Mitsubishi Electric without consulting our sales department personnel, Mitsubishi Electric SHALL HAVE NO RESPONSIBILITY OR LIABILITY (INCLUDING, BUT NOT LIMITED TO ANY AND ALL RESPONSIBILITY OR LIABILITY BASED ON CONTRACT, WARRANTY, TORT, PRODUCT LIABILITY) FOR ANY INJURY OR DEATH TO PERSONS OR LOSS OR DAMAGE TO PROPERTY CAUSED BY the PRODUCT.



Determine the applicability of this product to your equipment or devices through an appropriate analysis or evaluation by the designer of such equipment or devices, or personnel related to the specification. Such designers or personnel shall warrant the performance and safety of your equipment or devices such as dust-proof, water-proof, EMC and EMI, by themselves.



Design, specification and the contents of this document are subject to change without notice.

## 1-2 PRECAUTIONS

**Be aware of the following warnings and cautions to use this product appropriately and safely.**

### ■ Indications and definitions

|                                                                                                  |                                                                                                                      |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|  <b>Warning</b> | This indicates that improper use of this product may result in a hazard such as death or catastrophic bodily injury. |
|  <b>Caution</b> | This indicates that improper use of this product may result in a hazard such as a bodily injury or property damage.  |

### ■ Indications and definitions

|                                                                                     |                                                                |                                                                                       |                                                                                                    |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
|   | This indicates the Warning or Caution described above.         |   | This indicates a prohibited action such as an operation in a place where this product may get wet. |
|  | This indicates the prohibited action that must not be handled. |  | This indicates the prohibition of the disassembly of this product.                                 |
|  | This indicates the mandatory action that must be carried out.  |  | This indicates the possibility of the injury under the specific situation                          |

## 1-2 PRECAUTIONS

|                                                                                     |                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | Warning                                                                                                                                                                                                                                                            |
|    | <p><b><u>Do not operate this product in a place where it is explosive, combustible or inflammable.</u></b><br/>Operating in a place having propane gas, gasoline or flammable gas may cause a fire and/or an explosion.</p>                                        |
|    | <p><b><u>Use power supply having protection against overload.</u></b><br/><u>This product may be able to flow large current due to short circuit fault.</u></p>                                                                                                    |
|    | <p><b><u>Stop operation when you find any abnormalities or defects.</u></b><br/>Otherwise, a fire or an electric shock may occur.</p>                                                                                                                              |
|    | <p><b><u>Do not repair, disassemble and/or modify by yourself.</u></b><br/>Otherwise, a fire, defect, or an electric shock may occur. If you need to repair this product, you must contact the agency who sold you this product.</p>                               |
|    | <p><b><u>Do not get this product wet. Handle this product with water-proofing.</u></b><br/>Otherwise, a defect or an electric shock may occur. This product is designated for indoor use. This product is designed as a line-scan module embedded in a system.</p> |
|  | <p><b><u>Do not operate this product outdoors.</u></b><br/>This product is designed as a line-scan module embedded in a system. This product is designated for indoor use.</p>                                                                                     |
|  | <p><b><u>Do not put anything on this product.</u></b><br/>Otherwise, a fire or electrical shock may occur because of the things or materials in this product.</p>                                                                                                  |

## 1-2 PRECAUTIONS

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Warning                                                                                                                                                                                                                                                                                                                                        |
|  | <p><b><u>Do not put this product on an unstable surface, slanting and/or vibrating.</u></b><br/>Otherwise, drop and/or fail of this product may cause injury.</p>                                                                                                                                                                              |
|  | <p><b><u>Do not look at the internal illumination directly.</u></b><br/>This product (not included -NL series) comprises a bright illumination.</p>                                                                                                                                                                                            |
|  | <p><b><u>Avoid the damage that ESD can cause. Never expose the internal electronics to a potentially hazardous environment. Do not handle this product with an insulation sheet or on wooden desk. In addition, do not cover this product with any materials having an electrostatic discharge.</u></b> Doing so may cause serious damage.</p> |

## 1-2 PRECAUTIONS

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <h3>Caution</h3>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|    | <p><b><u>Do not store this product in the following places.</u></b></p> <ul style="list-style-type: none"> <li>● In a vibrating or precarious place</li> <li>● In a humid, smoky, vaporized or dusty place</li> <li>● In a slanting place</li> <li>● In a place exposed by direct sun light</li> <li>● In a temperature varying place</li> <li>● Near anything generating heat (eg. A stove, heater, etc)</li> <li>● In a corrosive gas atmosphere (CL<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, NO<sub>x</sub> etc.)</li> </ul> |
|    | <p><b><u>Care should always be exercised when handling and operating this product with your equipment or device.</u></b></p> <ul style="list-style-type: none"> <li>● Do not drop or damage this product.</li> <li>● Do not put things on this product.</li> <li>● No food or drink beside this product.</li> <li>● Do not put any materials or liquids on this product.</li> <li>● Avoid any ingress of materials, metals or smoke into this product and its connector.</li> </ul>                                                                 |
|    | <p><b><u>Use the specified power cable connector and CoaXPress™ cable.</u></b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|  | <p><b><u>Power OFF when you insert or remove cables.</u></b><br/>Otherwise, an electric shock or a malfunction may occur.</p>                                                                                                                                                                                                                                                                                                                                                                                                                       |

## 1-2 PRECAUTIONS

|                                                                                     |                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <b>Caution</b>                                                                                                                                                                                                                                                                    |
|    | <p><b><u>Keep this product clean. And do not touch the glass surface of this product.</u></b><br/>           Otherwise, a defect or a failure may occur. When you need to clean this product, you must clean the glass surface of this product with a soft cloth and IPA etc.</p> |
|    | <p><b><u>Put cables in a fixed position appropriately while operating.</u></b><br/>           Otherwise, a connection failure and damage may occur.</p>                                                                                                                           |
|    | <p><b><u>Do not use or operate this product in a slanting or unstable place</u></b></p>                                                                                                                                                                                           |
|    | <p><b><u>Do not use or operate this product in a humid, smoky, vaporized or dusty place.</u></b></p>                                                                                                                                                                              |
|   | <p><b><u>Do not disassemble the side-bracket for mechanical mounting to your equipment or device.</u></b><br/>           Otherwise, an ingress of materials and dust, or a defect or a malfunction may occur.</p>                                                                 |
|  | <p><b><u>Be cautious of your cloths and arms for not to be caught by the sheet metal attached to the edge of the glass side.</u></b> It may cause injury.</p>                                                                                                                     |

## 1-2 PRECAUTIONS



### Caution ( Disclaimer)

Mitsubishi Electric assumes no responsibility and no liability for any damages resulting from a fire, earthquake or any other act of God, acts by third parties, misoperation by the user intentionally or accidentally, or used under extreme operating conditions.

Mitsubishi Electric assumes no responsibility and no liability for any damages resulting from indirect, additional or consequential damages, including but not limited to loss of expected income and suspension of business activities.

Mitsubishi Electric assumes no responsibility and no liability for any damages resulting from an unintended use as stipulated in Manual and Datasheet of this product.

Mitsubishi Electric assumes no responsibility and no liability for any damages resulting from improper handling, use or repair by any party other than Mitsubishi Electric.

Mitsubishi Electric warrants this product in conformity with the specification specified only in the Datasheet and the Manual of this product.

Mitsubishi Electric's total liability shall not exceed the purchase price of this product.

## 1-2 PRECAUTIONS



### Handling precautions

Handle this product carefully. Do not drop, shock, vibrate this product.

Do not operate not in compliance with the conditions defined in the Datasheet and the Manual of this product.

Keep this product cool with the appropriate thermal management referred to in “k Handling precautions” to reduce the variation of illumination and dark output on this product.

This product is designed as an embedded line camera module. Determine the applicability of this product to your equipment or devices through the appropriate analysis or evaluation by the designer of such equipment or devices, or personnel related to the specification. Such designers or personnel shall warrant the performance and safety of your equipment or devices such as dust-proofing, water-proofing, EMC and EMI, by themselves.

### 1-3-1 CE Mark compatibility conditions

This product is designed to comply with EMC Directive 2014/30/EC of EU legislation.

In order to make this product CE mark compliant, use this product under the following conditions.

- ① Length of 24V power supply cables has to be 5m or shorter. Attach ferrite cores recommended in the following pages with the power supply cables in order to reduce noise emission. The details of the ferrite cores are explained in the following pages.
- ② Prepare your power supply dedicated for this product, and supply 24V power to this product.

Moreover, this product is designed as an embedded module. When this product shall be installed to the other equipment, the equipment has to be compliant with the necessary regulation and directives.

This product is complied with the following EMC directives and standards.

|                      |                                                                              |
|----------------------|------------------------------------------------------------------------------|
| EMC directives       | 2014/30/EC                                                                   |
| Applicable standards | Immunity EN 61000-6-2:2005 / AC:2005<br>Emission EN 61000-6-4:2007 / A1:2011 |

Category of ISM equipment by EN55011: Comply with Group 1, Class A test standard  
Class A equipment is regulated to be used under industrial environment. It could be potentially difficult to assure the electromagnetic compatibility under other environment. Refer to EN55011 standards for further details.

## 1-3-1 Conditions - CE mark certification

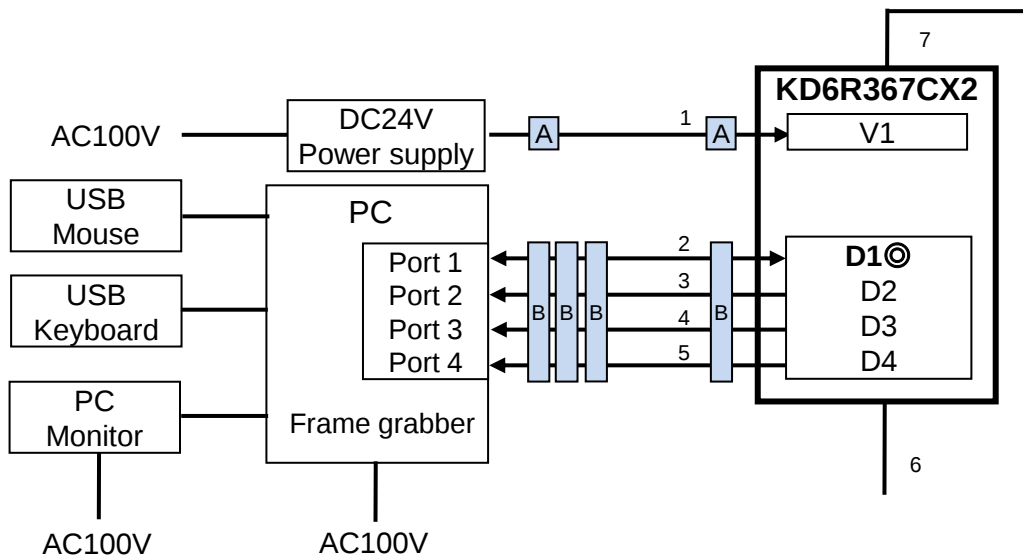
### 1. KD6R367CX2 (L1 type)

Recommended ferrite cores are shown below.

- Ferrite core A: RFC-H13, (1 turn) (KITAGAWA INDUSTRIES)
- Ferrite core B: RFC-20, (1 turn) (KITAGAWA INDUSTRIES)

Attach ferrite cores as described in below.

- Cable between V1 connector and 24V power supply: Two Ferrite cores A.
- Cables between Connector D1, D2, D3, and D4, and Frame grabber:  
Four Ferrite cores B



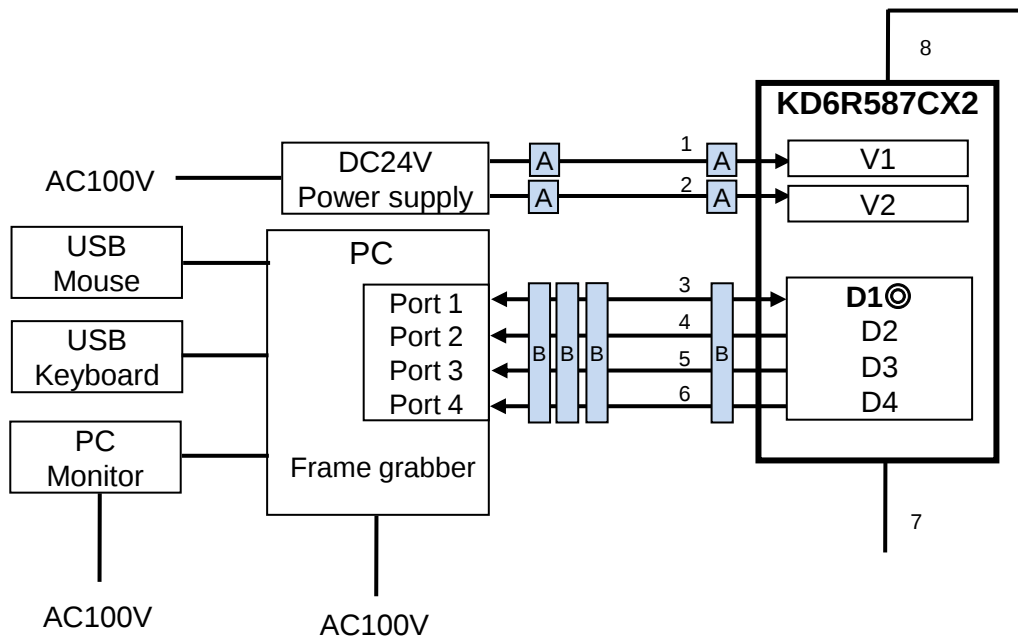
| No. | Items       | Cable length, shielding |
|-----|-------------|-------------------------|
| 1   | DC24V cable | 5m, shielded            |
| 2   | Coax cable  | 3m, shielded            |
| 3   | Coax cable  | 3m, shielded            |
| 4   | Coax cable  | 3m, shielded            |
| 5   | Coax cable  | 3m, shielded            |
| 6   | Earth cable | 2m                      |
| 7   | Earth cable | 2m                      |

## 1-3-1 Conditions - CE mark certification

### 2. KD6R587CX2 (L2 type)

Attach ferrite cores as described below.

- Cables between V1/V2 connectors and 24V power supply  
: Two Ferrite cores A each
- Cables between Connector D1 to D4, and Frame grabber  
: Four Ferrite cores B



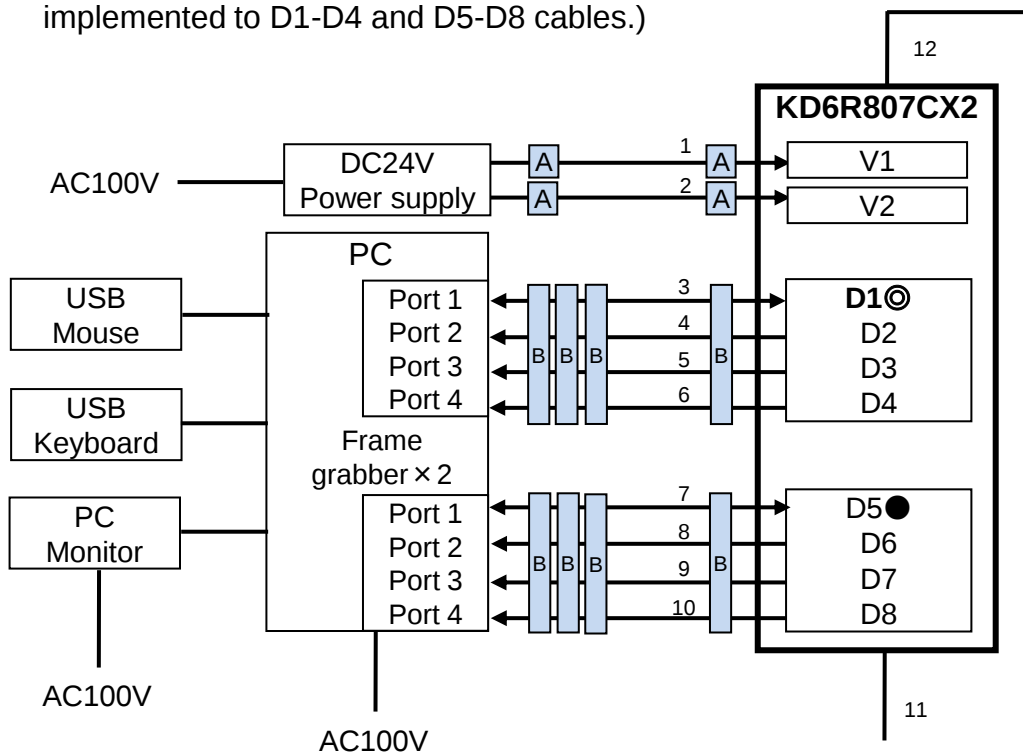
| No. | Items       | Cable length, shield |
|-----|-------------|----------------------|
| 1   | DC24V cable | 5m, shielded         |
| 2   | DC24V cable | 5m, shielded         |
| 3   | Coax cable  | 3m, shielded         |
| 4   | Coax cable  | 3m, shielded         |
| 5   | Coax cable  | 3m, shielded         |
| 6   | Coax cable  | 3m, shielded         |
| 7   | Earth cable | 2m                   |
| 8   | Earth cable | 2m                   |

## 1-3-1 Conditions - CE mark certification

### 3. KD6R807CX2 (L3 type)

Attach ferrite cores as described below.

- Cables between V1/V2 connectors and 24V power supply  
: Two Ferrite cores A each
- Cables between Connector D1 to D8, and Frame grabber  
: Eight Ferrite cores B (Four ferrite cores should be implemented to D1-D4 and D5-D8 cables.)



| No. | Items       | Cable length, shielding |
|-----|-------------|-------------------------|
| 1   | DC24V cable | 5m, shielded            |
| 2   | DC24V cable | 5m, shielded            |
| 3   | Coax cable  | 3m, shielded            |
| 4   | Coax cable  | 3m, shielded            |
| 5   | Coax cable  | 3m, shielded            |
| 6   | Coax cable  | 3m, shielded            |
| 7   | Coax cable  | 3m, shielded            |
| 8   | Coax cable  | 3m, shielded            |
| 9   | Coax cable  | 3m, shielded            |
| 10  | Coax cable  | 3m, shielded            |
| 11  | Earth cable | 2m                      |
| 12  | Earth cable | 2m                      |

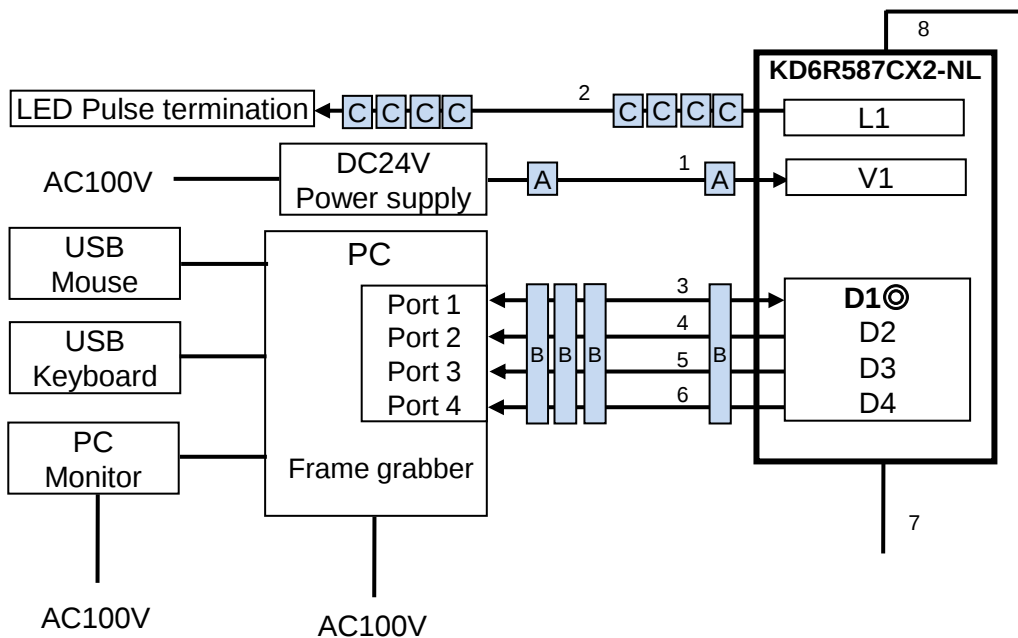


## 1-3-1 Conditions - CE mark certification

### 5. KD6R587CX2-NL (L2 type)

Attach ferrite cores as described below.

- Cables between V1 connectors and 24V power supply  
: Two Ferrite cores A
- Cables between Connector D1 to D4, and Frame grabber  
: Four Ferrite cores B
- Cable between L1 connector and LED Pulse termination:  
Eight Ferrite cores C.



| No. | Items                    | Cable length, shield |
|-----|--------------------------|----------------------|
| 1   | DC24V cable              | 5m, shielded         |
| 2   | LED control signal cable | 5m, shielded         |
| 3   | Coax cable               | 3m, shielded         |
| 4   | Coax cable               | 3m, shielded         |
| 5   | Coax cable               | 3m, shielded         |
| 6   | Coax cable               | 3m, shielded         |
| 7   | Earth cable              | 2m                   |
| 8   | Earth cable              | 2m                   |

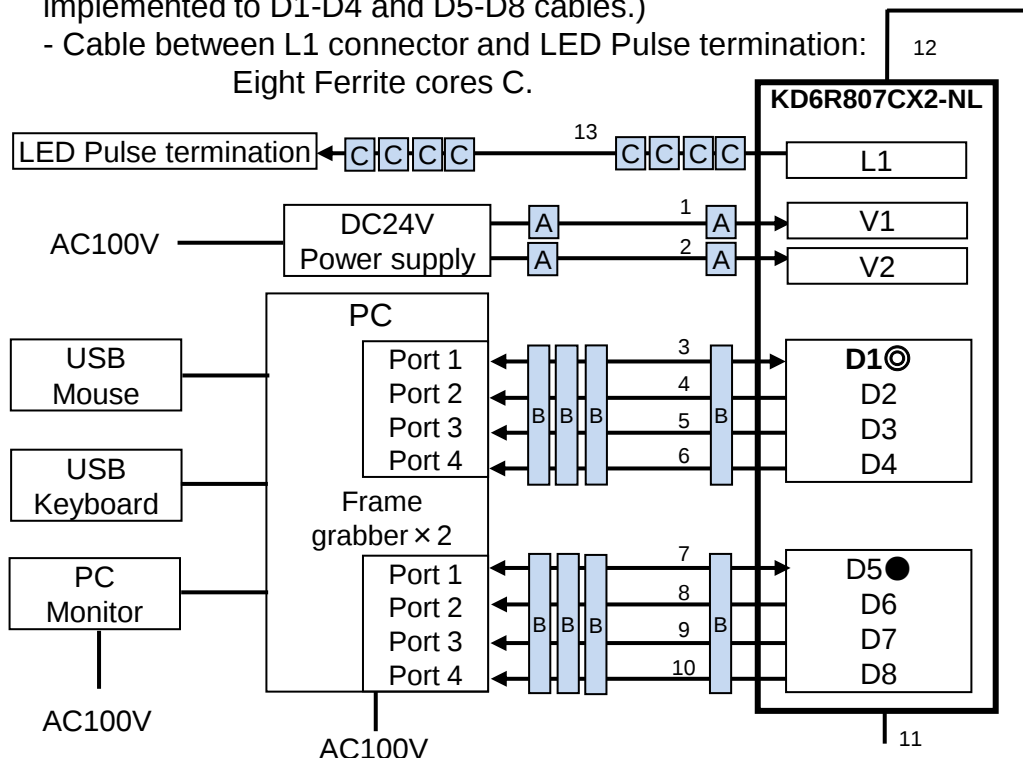
# 1-3 CE marking

## 1-3-1 Conditions - CE mark certification

### 6. KD6R807CX2-NL (L3 type)

Attach ferrite cores as described below.

- Cables between V1/V2 connectors and 24V power supply  
: Two Ferrite cores A each
- Cables between Connector D1 to D8, and Frame grabber  
: Eight Ferrite cores B (Four ferrite cores should be implemented to D1-D4 and D5-D8 cables.)
- Cable between L1 connector and LED Pulse termination:  
Eight Ferrite cores C.



| No. | Items                    | Cable length, shielding |
|-----|--------------------------|-------------------------|
| 1   | DC24V cable              | 5m, shielded            |
| 2   | DC24V cable              | 5m, shielded            |
| 3   | Coax cable               | 3m, shielded            |
| 4   | Coax cable               | 3m, shielded            |
| 5   | Coax cable               | 3m, shielded            |
| 6   | Coax cable               | 3m, shielded            |
| 7   | Coax cable               | 3m, shielded            |
| 8   | Coax cable               | 3m, shielded            |
| 9   | Coax cable               | 3m, shielded            |
| 10  | Coax cable               | 3m, shielded            |
| 11  | Earth cable              | 2m                      |
| 12  | Earth cable              | 2m                      |
| 13  | LED control signal cable | 5m, shielded            |

## 1-4 WARRANTY

### 1-4-1 Warranty

Mitsubishi Electric warrants this product in conformity with the specification specified only in Datasheet and Manual of this product within Warranty period.

(Mitsubishi Electric does not warrant any devices, equipments, and systems, which comprise this product.)

### 1-4-2 Warranty period

1 year from the ex-factory date.

### 1-4-3 Contents of warranty

If any product failure or defect which is recognized to happen under Mitsubishi Electric's responsibility is found within the warranty period, any repair services at Mitsubishi Electric's own expense or replacements with the same product under the scope of product specification shall be provided.

### 1-4-4 Out of Warranty

Notwithstanding above, this product shall not be warranted in the following circumstances.

- In case of out of warranty period.
- In case of improper handling, use or repair by any other party than Mitsubishi Electric.
- In case of improper conditions that are not stipulated in the data sheet or the manual.
- In case of a malfunction due to improper use.

The cost of repair or replacement shall be charged to the customer who requested to repair the Out of Warranty product. Also, Mitsubishi Electric shall not be liable to any indirect damages, consequential damages, etc. related to the product.

### 1-5-1 Repair method

Your sole remedy shall be repair or replacement of this product (Contact Image Sensor), provided that the defective product is returned to our factory and analyzed by Mitsubishi Electric.

When you return this product (Contact Image Sensor) to Mitsubishi Electric, return it according to the packing specification of the shipment and use our packing materials (refer to 2-6 Packaging). If you cannot use our packing materials, this product should be protected by more than triple bubble wrap and be put it on suitable case.

Notwithstanding above, depending on circumstances of the discontinuity of material procurement and facility etc, repair of this product may not be available. In that case, such request is handled as an upgrade or repair into other equivalent products.

### 1-5-2 Request of repair

If you need to return this product for Repair, you must contact the agency who sold you this product. Do not return your product to Mitsubishi Electric without prior authorization. The shipment cost to return this product shall be borne by sending party.

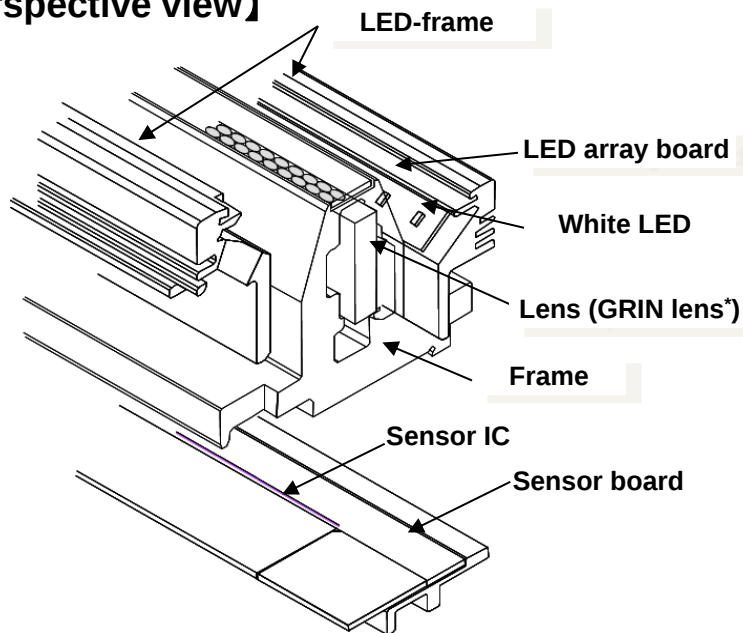
### 1-5-3 Repair period

This product would be repaired for 1 year after the final production of this product, provided that Mitsubishi Electric would be able to maintain production equipment or tools and procure the necessary materials for the repair. The prior announcement of the discontinuation of this product will be announced through the agency who sold you this product, or through our website.

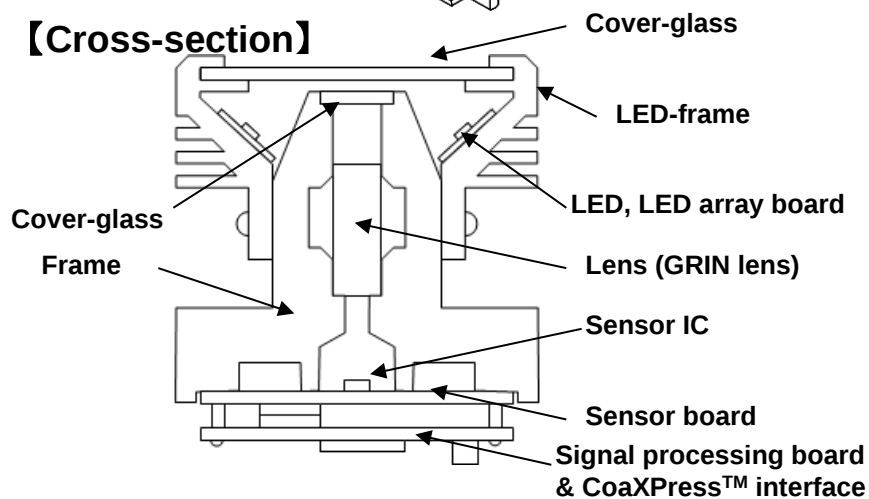
# Chapter 2 : Overview

## 2-1 What's Contact Image Sensor

### 【Perspective view】



### 【Cross-section】



This product (CIS : Contact Image Sensor) is a scanning device that comprises several key-components in below;

- Sensor IC array in the length as same as scan width.
- Rod lens array in the length as same as scan width.
- Illumination in the length as same as scan width.  
(-NL series does not have illumination.)

\* **GRIN lens** : Gradient Index lens

The features of CIS can be compared to line camera as follows;

|                             | CIS                                      | Optical reduction system                 |
|-----------------------------|------------------------------------------|------------------------------------------|
| ① Resolution                | Fixed                                    | Flexible                                 |
| ② Depth of focus            | Shallow<br>( $\pm 0.5 \sim 2\text{mm}$ ) | Deep<br>( $\sim 4\text{mm}$ )            |
| ③ Distortion                | Small                                    | Large                                    |
| ④ Light path                | Short (10~50mm)                          | Long( $\sim 200\text{mm}$ )              |
| ⑤ Requested light intensity | Small                                    | Large                                    |
| ⑥ Power consumption         | Small                                    | Large                                    |
| ⑦ light-sensitive element   | CMOS / CCD                               | CMOS / CCD                               |
| ⑧ Impacting and vibration   | Strong                                   | Weak                                     |
| ⑨ Setup adjustment          | Easy                                     | Need to be adjusted with lens precisely. |
| ⑩ Outline                   | Compact                                  | Large                                    |

## 2-2 Principal technology of CIS

### 【How to acquire reflective light】

Chart

Picture

Fig.1

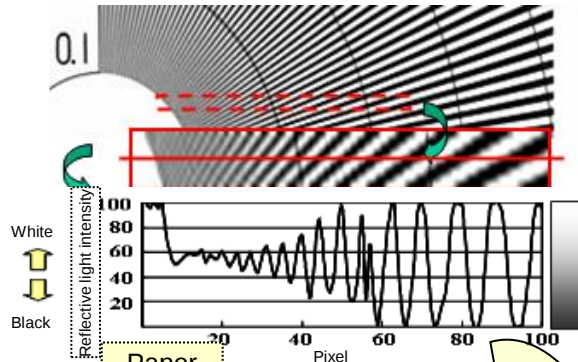


Fig.2

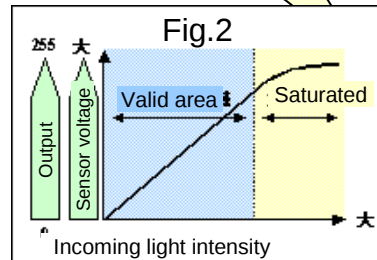
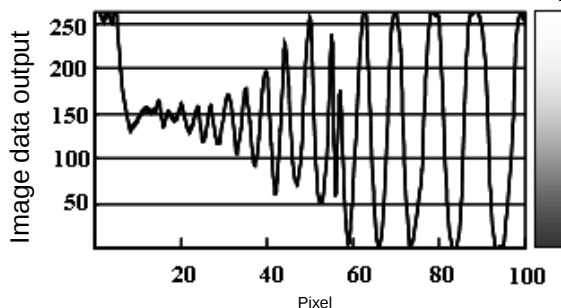


Fig.3

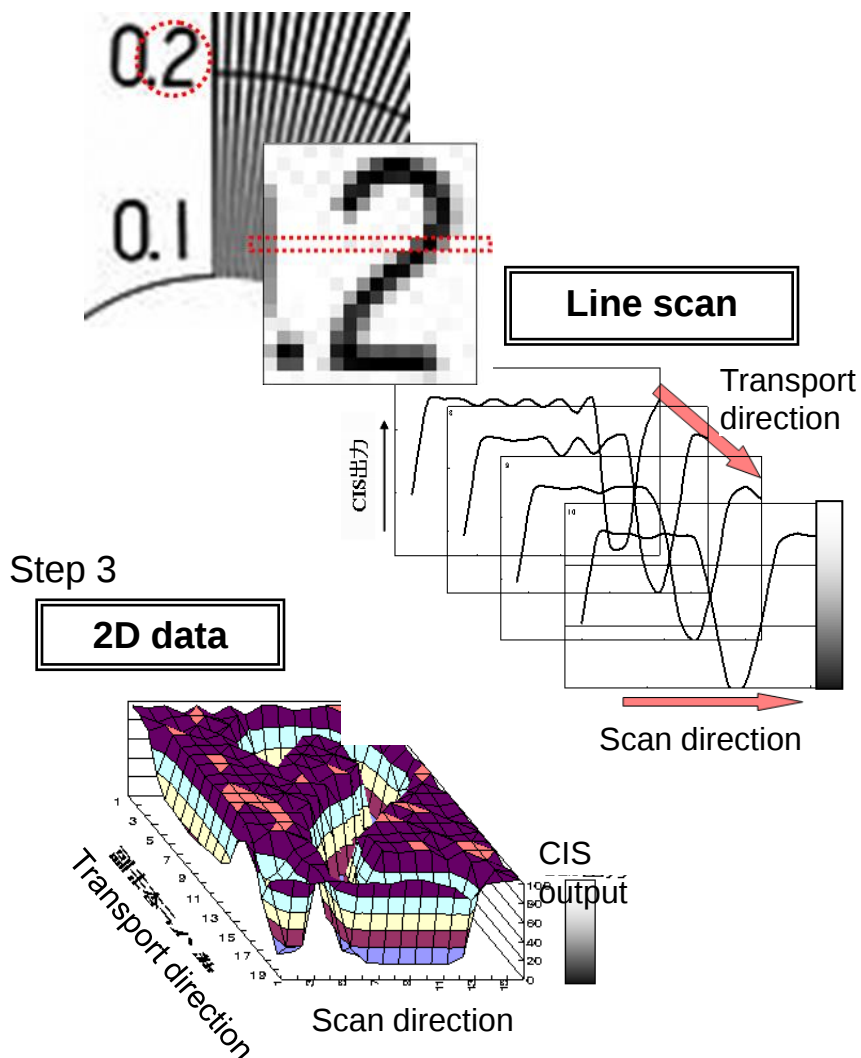


This clause explains how to acquire the raw information of the light and convert into electrical signal information.

- When scanning a surface of the object, the illumination on this product irradiates the object.
- The object reflects the light. Generally the illuminated black object reflects weaker reflective light. On the other hand, the illuminated white object reflects stronger one.
- Refer to the drawing on left side (Fig.1). The black and white charts have a correlation with the reflected light intensity.
- The strong and weak reflective light arrives at the surface of Sensor ICs (photo-diodes) through lens.
- As described in the drawing on the left side (Fig.3), Sensor ICs correspondingly converts the strong and weak light into the large and small electrical signal based on the converting property of Sensor ICs as described on the drawing on left side (Fig.2).
- Sensor ICs are arranged in an array and detect the optical information corresponding to that position.

## 2-2 Principal technology of CIS

### Objective information



This product captures 2-d image by scanning one line repeatedly and continuously.

- Acquiring a data of one line in scan direction.
- Relative transport in transport direction between the object and this product can accumulate 2 dimensional data.

Refer to left side of the drawings.

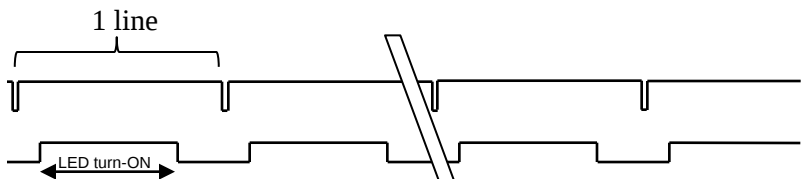
### 【Example of scanning “2”】

- Step 1: Sensor IC reads one line in red point-line area. The size of the line in transport direction is based on the size of pixel.
- Step 2: The scanning line is transported in transport direction.
- Step 3: Repeating Step 1 and 2 generates 2D image data. (The height of the 2D-data means the strength of CIS output.)

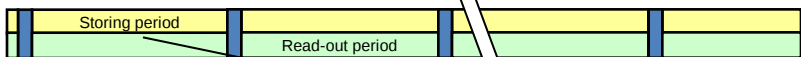
## 2-2 Principal technology of CIS

### 【Data output timing】

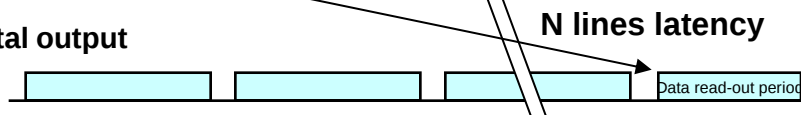
#### Line frequency



#### Internal read-out period



#### Digital output



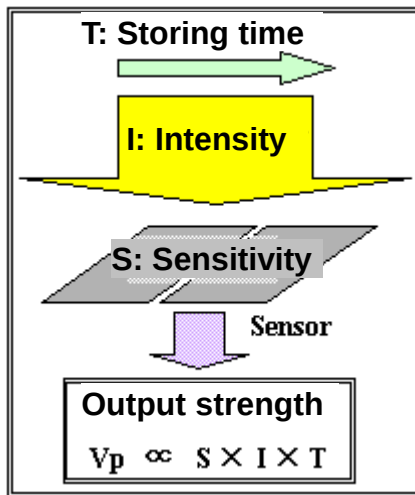
### 【Data output timing】

There is a latency to read-out a line data. The N-line latency is designated from a timing of LED turn-ON as described on the left drawing.

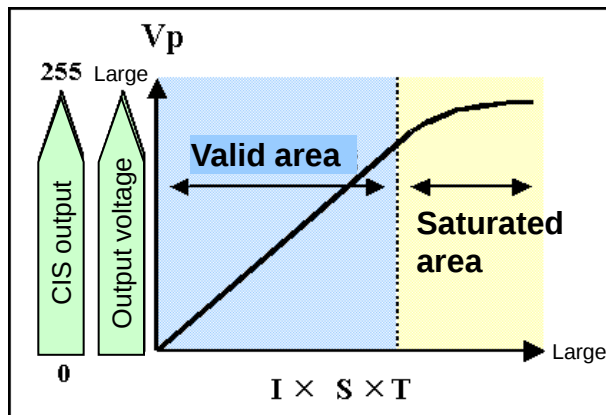
- 1) Sensor ICs converts the light information into the electrical signal (1 line)
- 2) Period to read out the analog data of sensor pixels (1 line)
- 3) Period to convert the analog data into digital data and rearrange the data position of each pixel in scanning direction (1 line)
- 4) Period to process internal image processing (3 to 10 lines)

## 2-2 Principal technology of CIS

### 【Strength of Sensor IC output】



### 【Property of Sensor IC】



### 【CIS output】

CIS output ( $V_p$ ) is defined below;

- Light intensity : I
- Sensor IC Sensitivity : S
- Storing time (illuminated time to Sensor IC ) : T

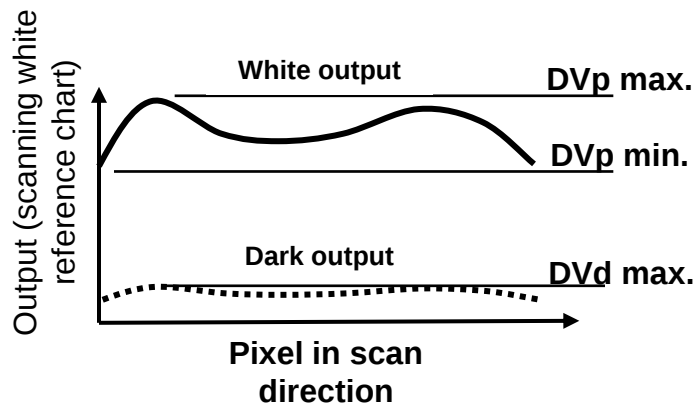
$$V_p = k \times I \times S \times T$$

(k: coefficient)

### 【Remark】

- 1) To keep a quality of the image,  $V_p$  is an important factor so that Light intensity (I) and Storing time (T) have to be adjusted appropriately.
- 2) If the intensity of the light source becomes too strong, CIS output becomes saturated. In order to avoid such saturation of the output, adjust the illumination's intensity (LED-duty) appropriately.

### 【White output and Dark output uniformity】



### 【Definition of CIS output】

This product comprises CMOS sensor IC which each pixel has each DC offset and variation of sensitivity. And the variation of lens and light intensity also affect the CIS output. CIS output is defined in below.

#### 1. Dark output uniformity

Dark output uniformity is an output uniformity when the illumination is turned OFF.

Dark output is defined as maximum value DVd max.

#### 2. White output uniformity

White output after Dark correction (DVEp) means white output value after subtracting dark output from sensor output pixel by pixel .

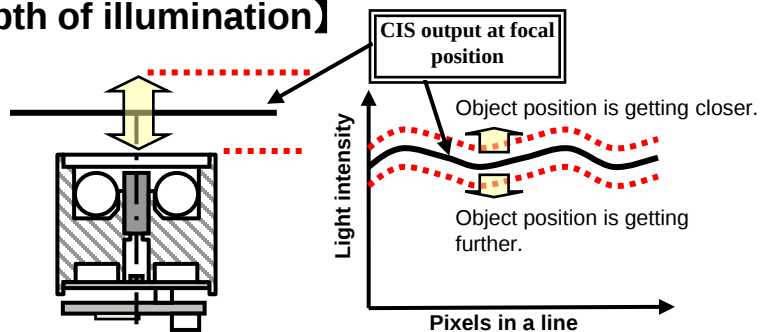
White output uniformity (UEp) indicates the output variation when this product is scanning white reference chart.

White output uniformity is calculated as follows;

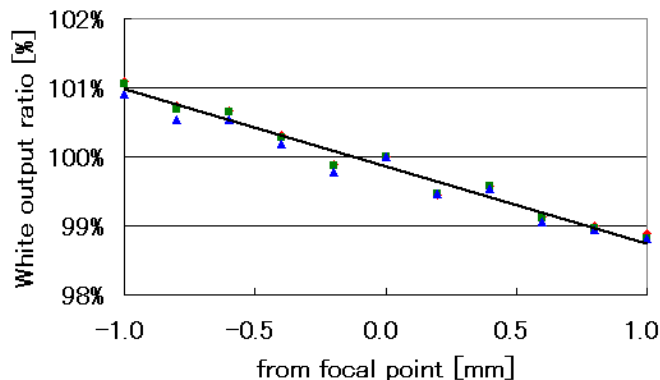
$$UEp = ( DVEp \text{ max.} - DVEp \text{ min.} ) / DVEp \text{ max.}$$

## 2-3 Definition

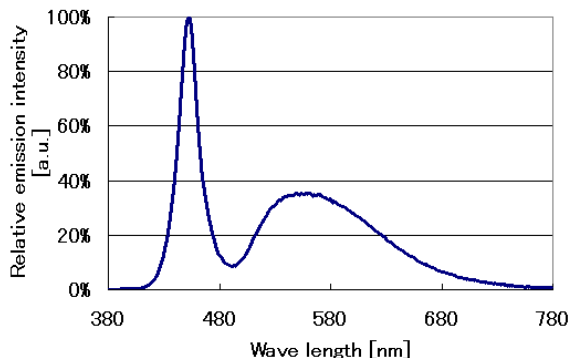
### 【Depth of illumination】



### 【DOI of KD series】



### 【Spectrum of illumination】



### 【Definition of CIS output】

#### 3. Light intensity

This indicates a strength or intensity of the light on a surface of the object. As described on the left, CIS output  $V_p$  is controlled by “Light intensity (I)” \* “Storing time (T)”. Therefore, in order to increase scanning speed, Light intensity is needed to be increased.

#### 4. DOI : Depth of Illumination

DOI is shown in the figure on the left. This figure explains the variation of illumination intensity due to the changes of the object position on the lens optical axis. If a position of the object is set close to the illumination system, the CIS output becomes large. If another position of the object is set away from the illumination system, the CIS output becomes lower.

Larger variation of DOI provides more difficulty to recognize if the output variation is caused by variation of the reflectance of the object or by the change of the position of the object.

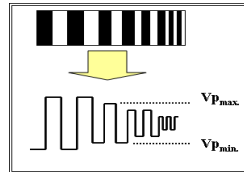
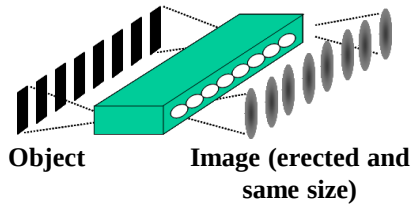
#### 5. Spectrum of illumination

This product comprises white LED array as a built-in illumination. Refer to the spectrum of illumination on the left.

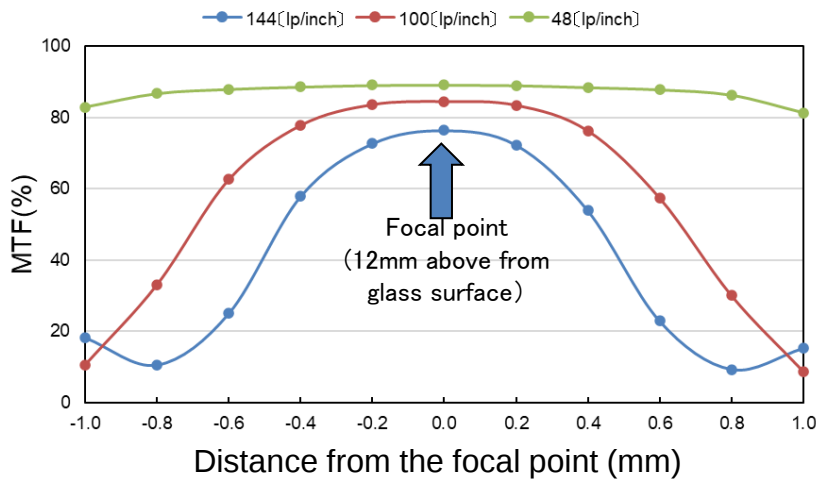
## 2-3 Definition

### 【Depth of Focus】

Definition of resolution



### Depth of Focus (KD6R367CX2)



### Scan images



### 【Definition of CIS output】

#### 6. DOF : Depth of Focus

Depth of Focus indicates a change of a focus performance on various positions of the object from focal position on a lens-axis.

Generally, the resolution becomes lower or defocused when the scanning position is moved away from a focal point.

The resolution is defined as MTF (Modulation Transfer Function) value.

The MTF value is calculated by the following formula when scanning a reference chart having a respective width and pitch of the white and black areas.

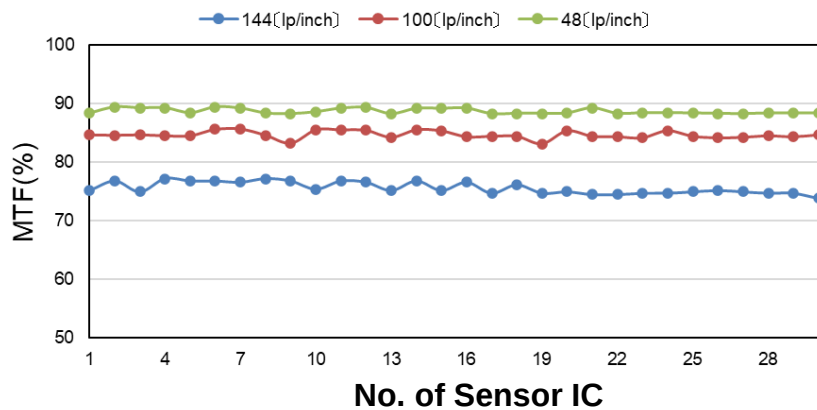
$$MTF = \frac{V_{pmax.} - V_{pmin.}}{V_{pmax.} + V_{pmin.}} \times 100 (\%)$$

•lp/inch: lp/inch explains the resolution. The resolution is defined by reading the black and white same-width stripes. This pair of the same-width black and white stripe is called as “line pair” (lp), and the “lp/inch “ shows how many “lp”s are printed in 1 inch.

For example, “144 lp/inch chart” means that 144 pairs of black and white stripes are printed in 1 inch on the chart. And the calculation of the resolution is  $25.4 (\text{mm}) / 288 (\text{stripes}) = 88.19$ , which is about  $88\mu\text{m}$  width strips are printed.

## 2-3 Definition

### 【MTF variation of scan direction】



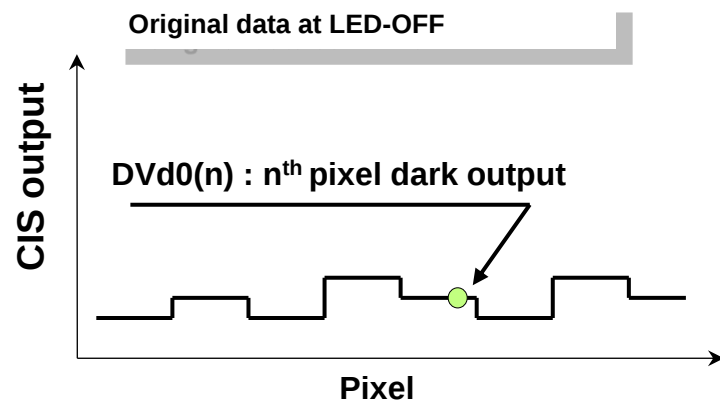
**Variation of MTF value (KD6R367CX2 : L1)**

The graph on the left shows a property of resolution uniformity in the scanning direction of KD6R367CX2. Each dot on this Graph shows MTF value of each sensor chip in a CIS.

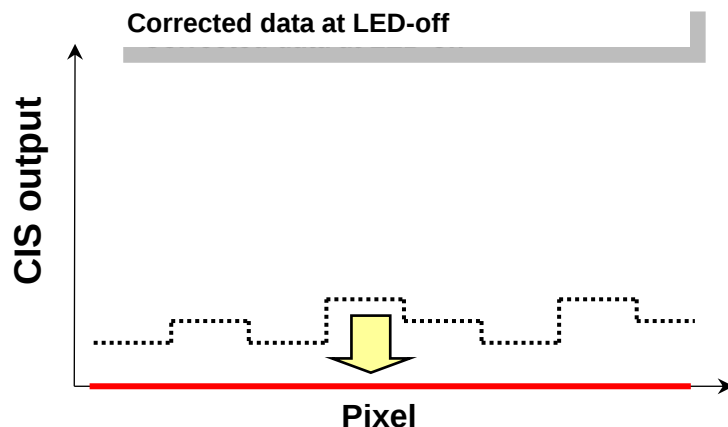
#### 1. MTF value variation in the scanning direction

The graph on the upper left shows an example of MTF values of each sensor ICs. This shows that this CIS has uniform resolution in whole scanning width.

### 【Dark correction】



$$DVp(n) = DVp(n) - Dvd0(n)$$



### 【CIS output and signal processing function】

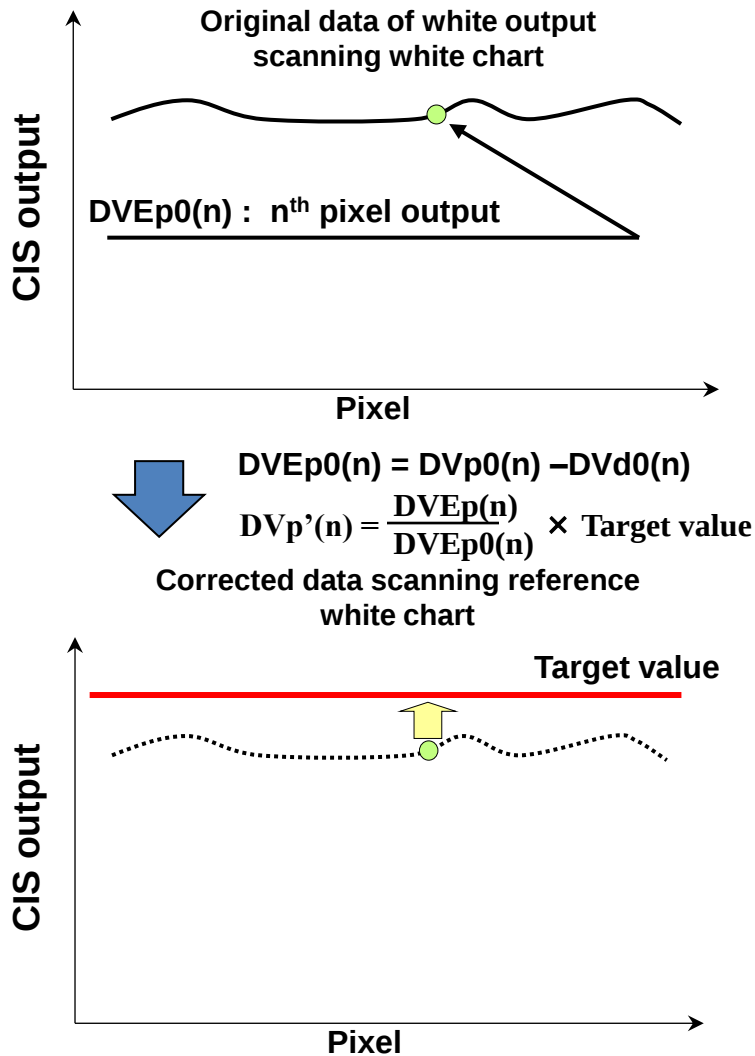
This product is equipped with correction functions of the pixel unit. These functions correct the variations due to DC offset and the sensitivity variation of each pixel of the CMOS sensor, the lens, and the illuminations, and enable this product to provide good images.

#### 1. Dark correction

This is a function that corrects DC-offset on each pixel into zero. This function subtracts the pixel dark-correction data (Dvd0 (n)) from the original pixel dark output data (Dvp (n)) pixel by pixel.

Dark-correction data (Dvd0 (n)) is generated by averaging 32 lines of the data to minimize the effect of noise on each pixel in the condition of turning off the illumination. Using Dark correction on CIS output allows this product to provide the only dynamic range responding the incoming light.

### 【White correction】



### 【 CIS output and signal processing function 】 2. White correction

CIS output corrected by Dark correction is affected by the sensitivity of the CMOS sensor, the imaging efficiency of the lens, and the illumination intensity. White correction enables this product to correct these variations and to provide a uniform output, when a uniform-reflectance chart is scanned.

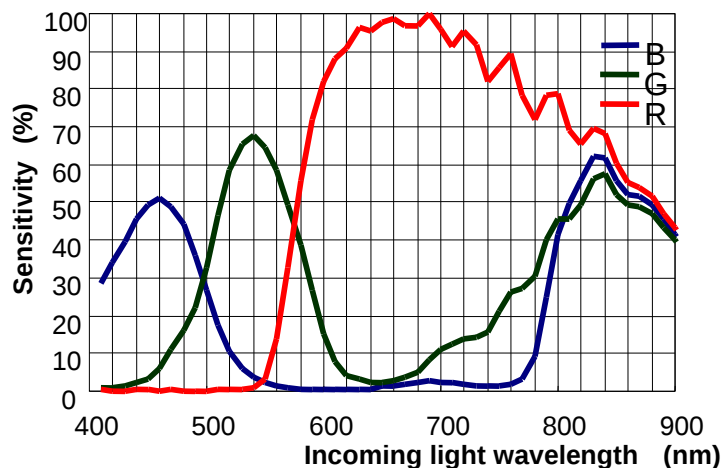
White correction corrects the white output (DVEp (n)) acquired in an actual scanning operation by using the white correction data (DVEp0(n)) acquired in scanning another object having an uniform reflectance. CIS output corrected by White correction, DVp'(n) is calculated by the following formula.

$$DVp'(n) = \frac{DVEp(n)}{DVEp0(n)} \times \text{Target value}$$

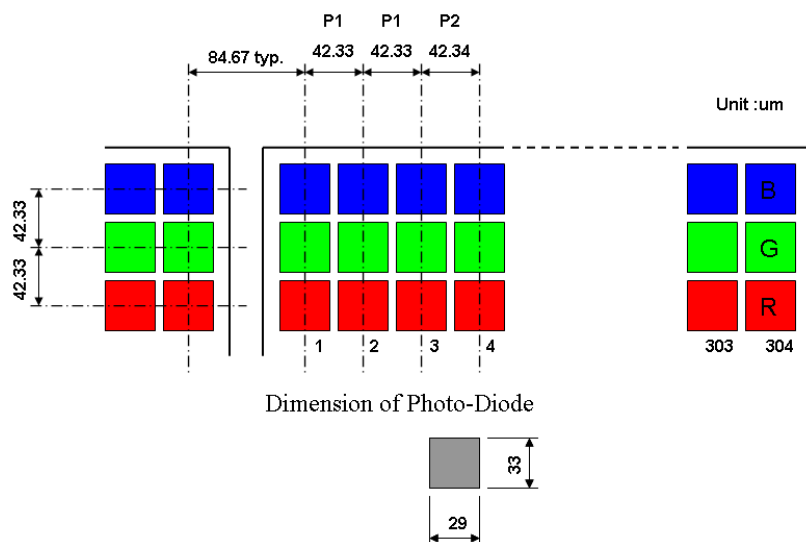
Target value can be set by register value. There are several methods to create White correction data. Refer to Function specification for further detailed information.

## 2-4 Features of scanning pixels

### 【Sensor IC spectral sensitivity】



### 【Pixel alignment of Sensor ICs】



### 【Sensor IC spectral sensitivity】

This product comprises a color trilinear sensor ICs that feature Filter-on-Chip technology. The Sensor IC's spectral sensitivity is described on the left.

### 【Pixel alignment of Sensor ICs】

The plural Sensor ICs are assembled in a line on a sensor board in this product. The numbers of 288 pixels x 3 color Sensor ICs for each length are as follows;

367 mm size : 30 chips

587 mm size : 48 chips

807 mm size : 66 chips

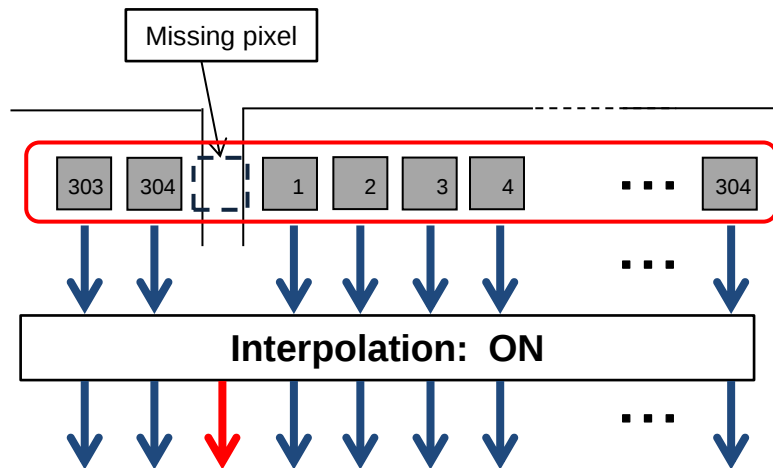
Because keeping enough dicing area at the edge of Sensor ICs is necessary, the resolution between the neighboring pixels of neighboring Sensor ICs is not 600 dpi, and is designated to be 300 dpi ( $84\mu\text{m}$ ) pitch and controlled to be placed within  $\pm 15\mu\text{m}$  tolerance.

Therefore, the pixel pitch between the neighboring sensor ICs is arranged in 300dpi pitch, and doesn't output a pixel data between sensor ICs, which is called "missing pixel".

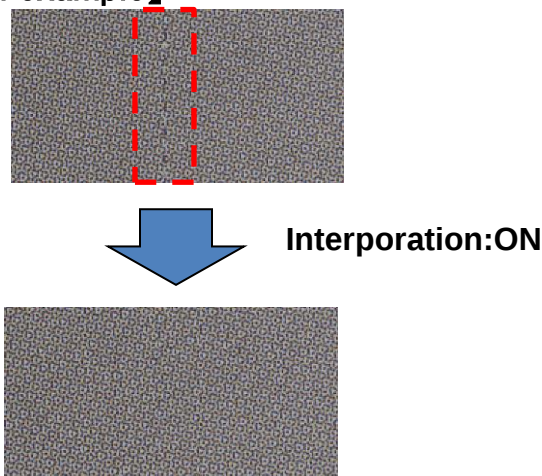
Additionally, a function of Interpolation that can insert a pixel data created by neighboring pixels data for each gap between neighboring Sensor ICs is available on this product.

## 2-5 Interpolation function

### 【Conceptual Diagram of Interpolation】



### 【Interpolation example】



### 【Interpolation function】

This product has a Sensor IC array having a reduction of a resolution at the gap between sensor ICs. This is a function to compensate a reduction of the resolution between neighboring Sensor ICs.

### 【Technology of Interpolation】

To get the most expected Interpolation data, the resolution of the gaps between neighboring Sensor ICs are designated to be 300dpi and precisely controlled by the tolerance of  $\pm 15\mu\text{m}$  in X/Y direction.

- The missing pixel data can be generally interpolated by generating the data of missing pixel based on Filter Interpolation.
- If the image data is cyclic, the missing pixel data may need to be interpolated by generating the data of missing pixel based on "Average keeping interpolation". Refer to the following patent publication for further detail.

### Japanese Related Patent No.:

- (1) 3767593
- (2) 3810404
- (3) 4199784
- (4) 4772754

## 2-6 Specification

| Item                            | Unit         | L1:KD6R367CX2<br>L2:KD6R587CX2<br>L3:KD6R807CX2                                                                                                                                   | L1:KD6R367CX2-NL<br>L2:KD6R587CX2-NL<br>L3:KD6R807CX2-NL                                                                                                                          |
|---------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scanning width                  | mm           | 367.0 / 587.2 / 807.4                                                                                                                                                             | 367.0 / 587.2 / 807.4                                                                                                                                                             |
| # of Valid pixels               | pixel        | 8,640 / 13,824 / 19,008<br>× R/G/B 3 lines (color)                                                                                                                                | 8,640 / 13,824 / 19,008<br>× R/G/B 3 lines (color)                                                                                                                                |
| Resolution                      | dpi          | 600                                                                                                                                                                               | 600                                                                                                                                                                               |
| Line scan frequency<br>(*1)     | kHz          | External sync.: 50.6 max<br>Internal sync.: 55 max                                                                                                                                | External sync.: 50.6 max<br>Internal sync.: 55 max                                                                                                                                |
| I/F Format                      | —            | CoaXPress™ Rev1.1 compliant                                                                                                                                                       | CoaXPress™ Rev1.1 compliant                                                                                                                                                       |
| Output format                   | —            | Refer to the next page                                                                                                                                                            | Refer to the next page                                                                                                                                                            |
| Data output rate                | Gbps /<br>ch | 6.25 max (*2)                                                                                                                                                                     | 6.25 max (*2)                                                                                                                                                                     |
| Additional Signal<br>Processing | —            | <ul style="list-style-type: none"> <li>- White / Dark Correction function</li> <li>- Programmable Gain Amplifier</li> <li>- Interpolation</li> <li>- γ correction etc.</li> </ul> | <ul style="list-style-type: none"> <li>- White / Dark Correction function</li> <li>- Programmable Gain Amplifier</li> <li>- Interpolation</li> <li>- γ correction etc.</li> </ul> |
| illumination                    | —            | White-LED Array                                                                                                                                                                   | none                                                                                                                                                                              |
| Focal point                     | mm           | 52<br>from reference holes at both sides of CIS                                                                                                                                   | 51.4<br>from reference holes at both sides of CIS                                                                                                                                 |
| Outline<br>(L × W × H)          | mm           | 434.1 / 654.1 / 874.1 X 64 X (143)                                                                                                                                                | 434.1 / 654.1 / 874.1 X 64 X (138)                                                                                                                                                |
| Weight                          | kg           | 2.9 / 4.2 / 5.5                                                                                                                                                                   | 2.2 / 3.1 / 4.2                                                                                                                                                                   |

(\*1) 600dpi, refer to the next page (\*2) CXP-6 standard

## 2-6 Specification

### Output format and Scan rate

- Output channel: CXP Single, Quad, Dual switchable
- Bit rate: CXP-6 / 5 / 3 (6.25 / 5 / 3.125 Gbps/ch )
- Image format: 24bit color, 30bit color, 8bit mono, 10bit mono switchable
- Line frequency is changed by the output format of data, output resolution, and sync mode.

#### KD6R367/807CX2, KD6R367/807CX2-NL

| Resolution | Max. Line frequency [KHz] |             |            |           |                |             |            |           |
|------------|---------------------------|-------------|------------|-----------|----------------|-------------|------------|-----------|
|            | External sync.            |             |            |           | Internal sync. |             |            |           |
|            | 30bit color               | 24bit color | 10bit mono | 8bit mono | 30bit color    | 24bit color | 10bit mono | 8bit mono |
| 600dpi     | 50.6                      | 55          |            |           |                |             |            |           |
| 300dpi     | 80.9                      | 91.8        | 96.2       |           |                |             |            |           |
| 200dpi     | 100.9                     | 112         | 130.6      |           |                |             |            |           |
| 150dpi     | 115.2                     | 125.9       | 159.1      |           |                |             |            |           |

#### KD6R587CX2, KD6R587CX2-NL

| Resolution | Max. Line frequency [KHz]       |                |               |              |
|------------|---------------------------------|----------------|---------------|--------------|
|            | External sync. / Internal sync. |                |               |              |
|            | 30bit<br>color                  | 24bit<br>color | 10bit<br>mono | 8bit<br>mono |
| 600dpi     | 44.2                            | 55             |               |              |
| 300dpi     | 88.7                            | 96.2           |               |              |
| 200dpi     | 130.6                           |                |               |              |
| 150dpi     | 159.1                           |                |               |              |

### 【Serial Numbers】

This product have the serial numbers shown in the table below.

Please check the serial numbers label affixed to CIS.

1. The serial numbers YYMM is determined by the manufacturing date.

YY: Year of manufacture, MM: Month of manufacture (Example: Manufactured in February 2024, YYMM=2402.)

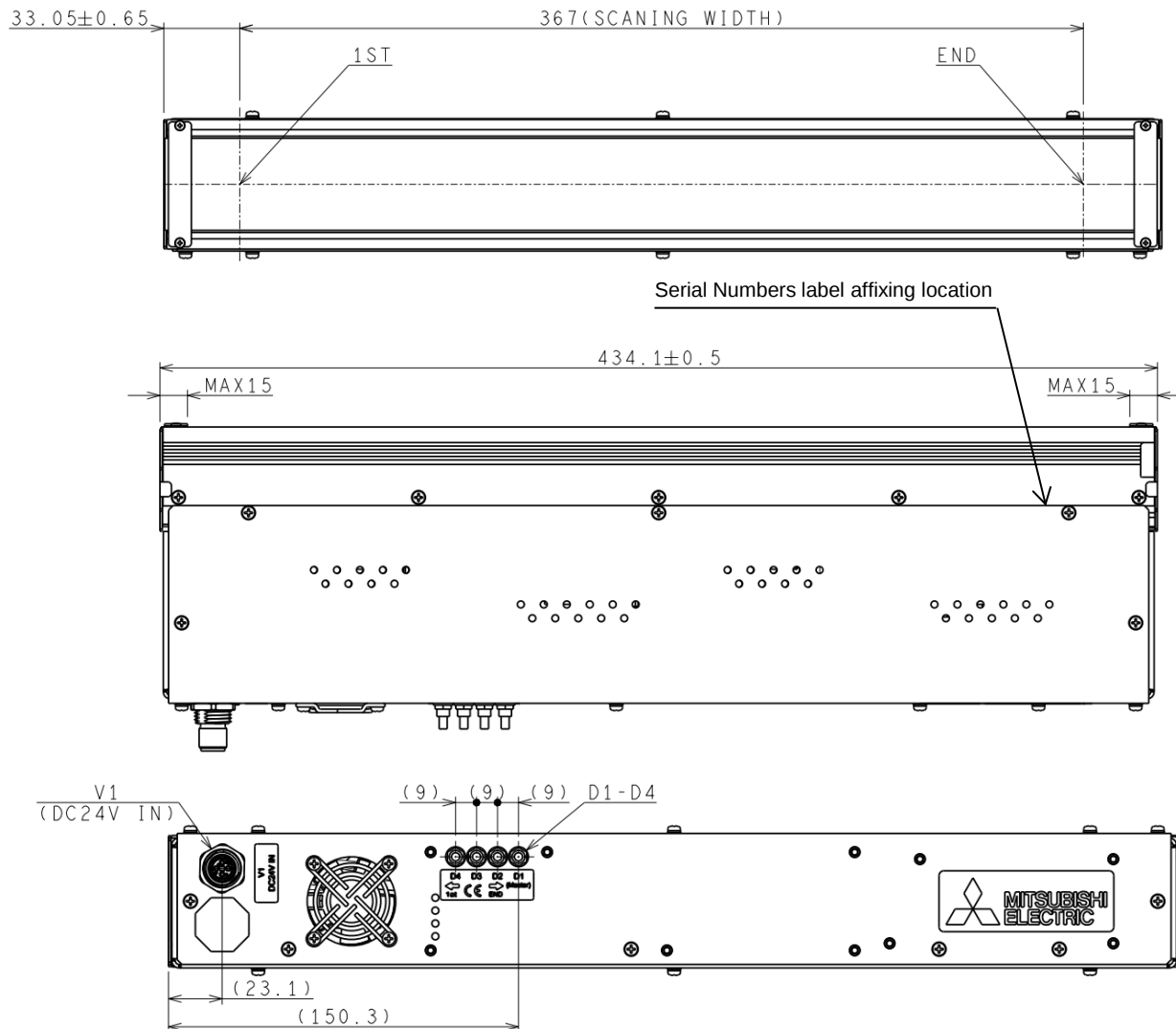
2. The Serial numbers after YYMM, the numbers 60/61/62 of each serial number,

indicate the model code. (60 : KD6R367CX2, 61 : KD6R587CX2, 62 : KD6R807CX2, 63 : KD6R367CX2-NL, 64 : KD6R587CX2-NL, 65 : KD6R807CX2-NL)

Refer to the outline drawings on the following pages for the location of the serial number label.

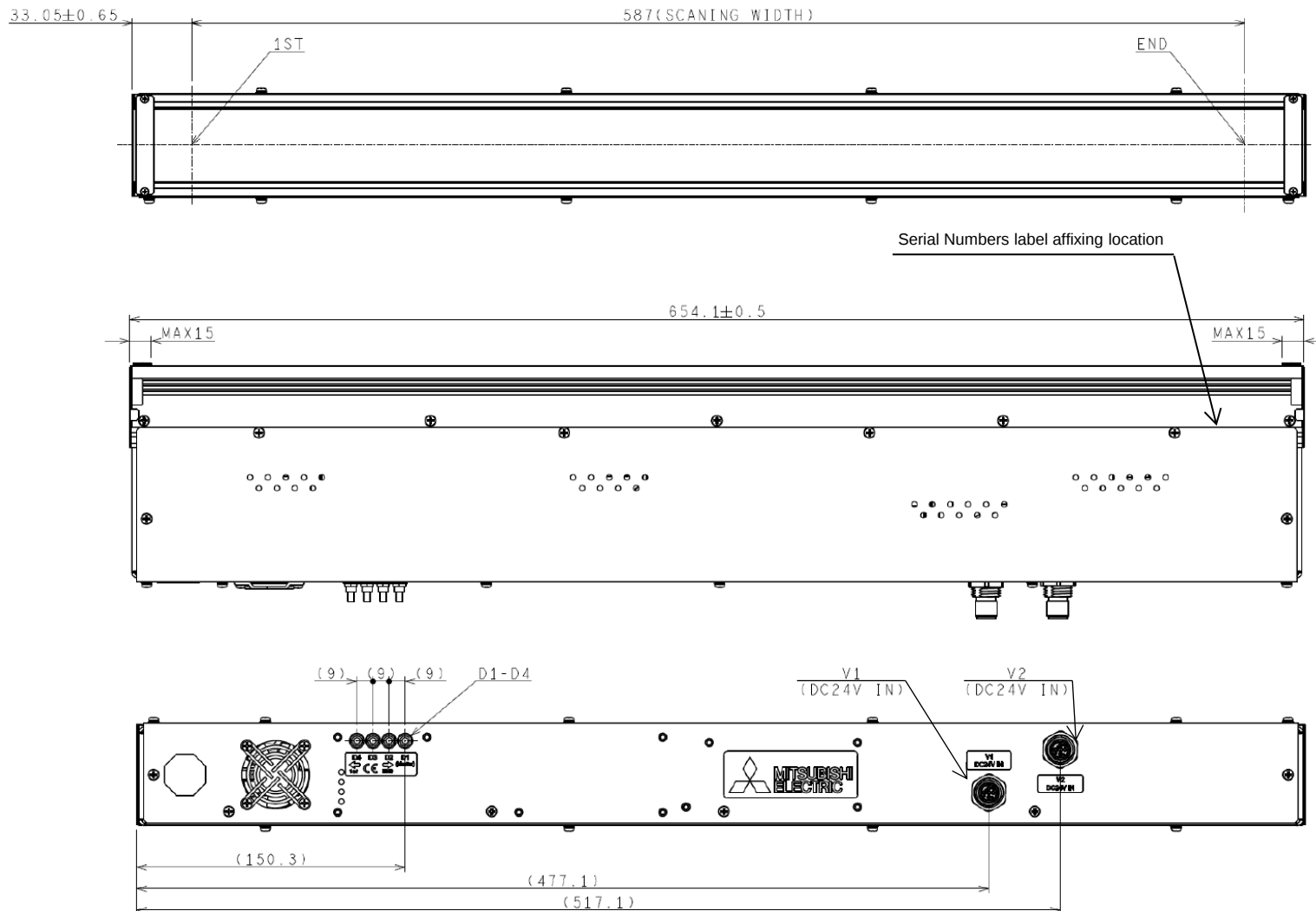
## 2-6 Specification

### 【 L1 type:KD6R367CX2 Outline】



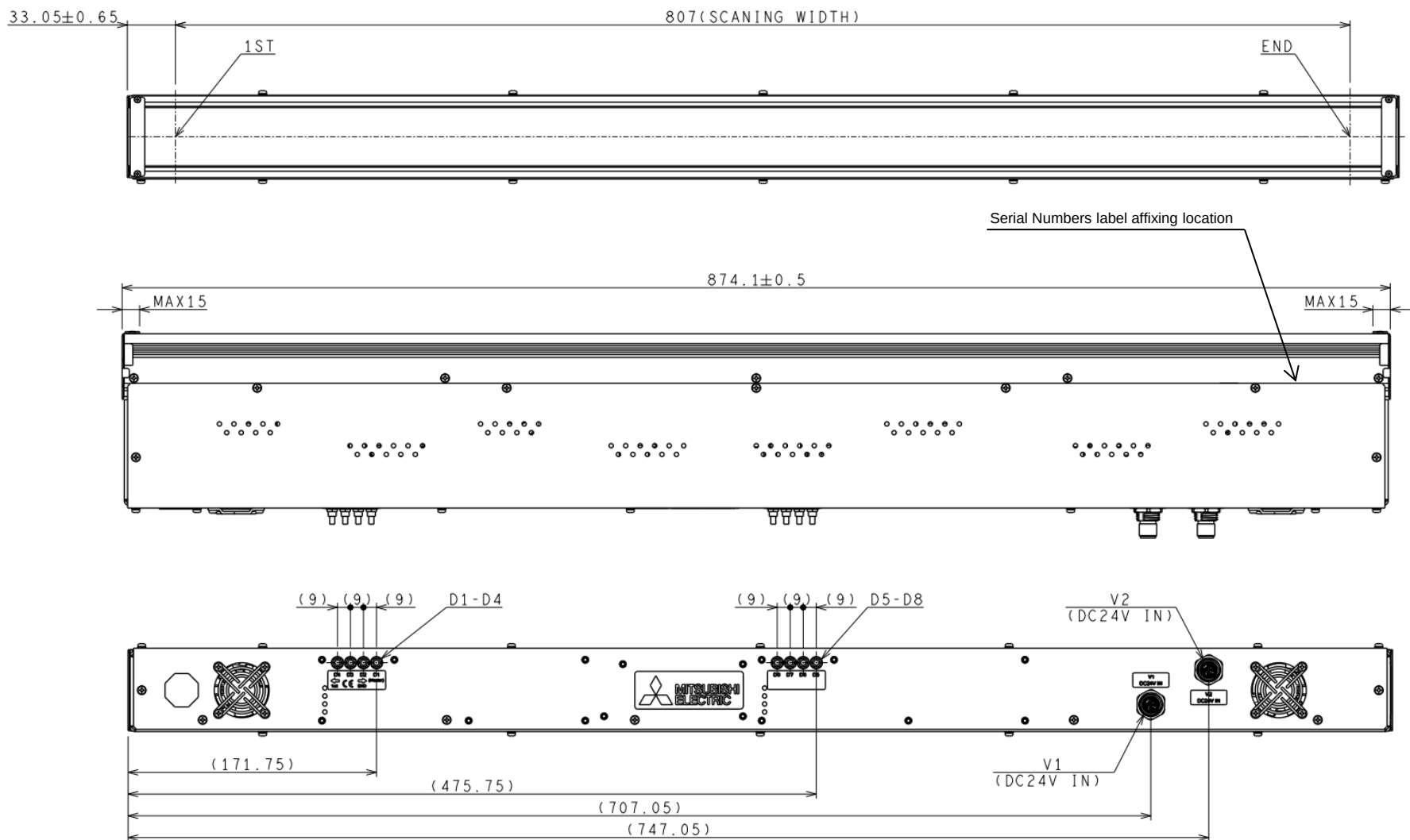
## 2-6 Specification

### 【 L2 type: KD6R587CX2 Outline】



## 2-6 Specification

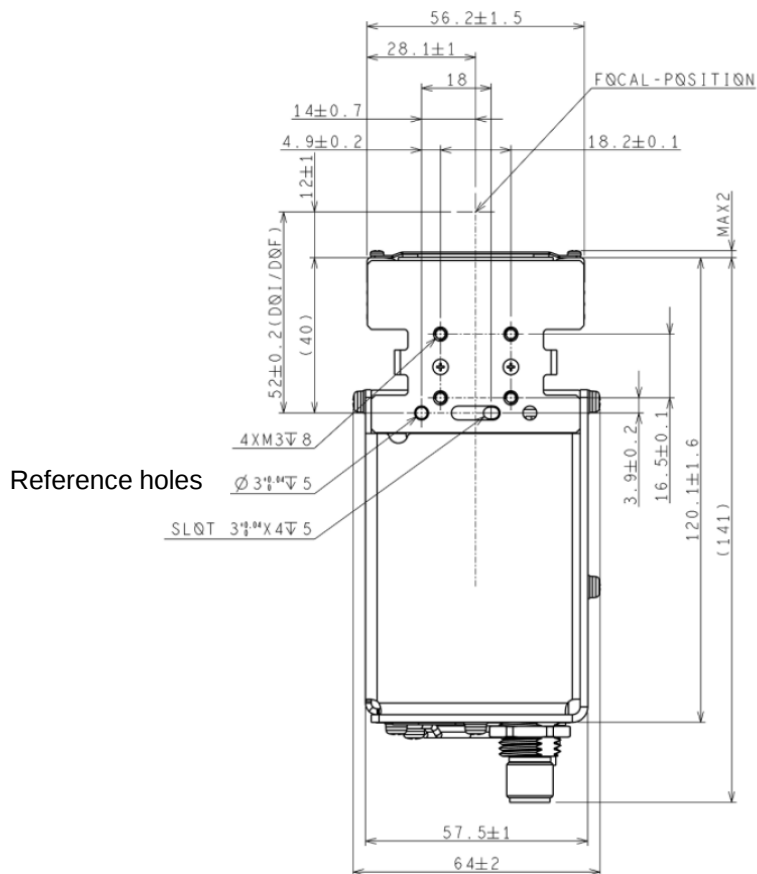
### 【 L3 type:KD6R807CX2 Outline】



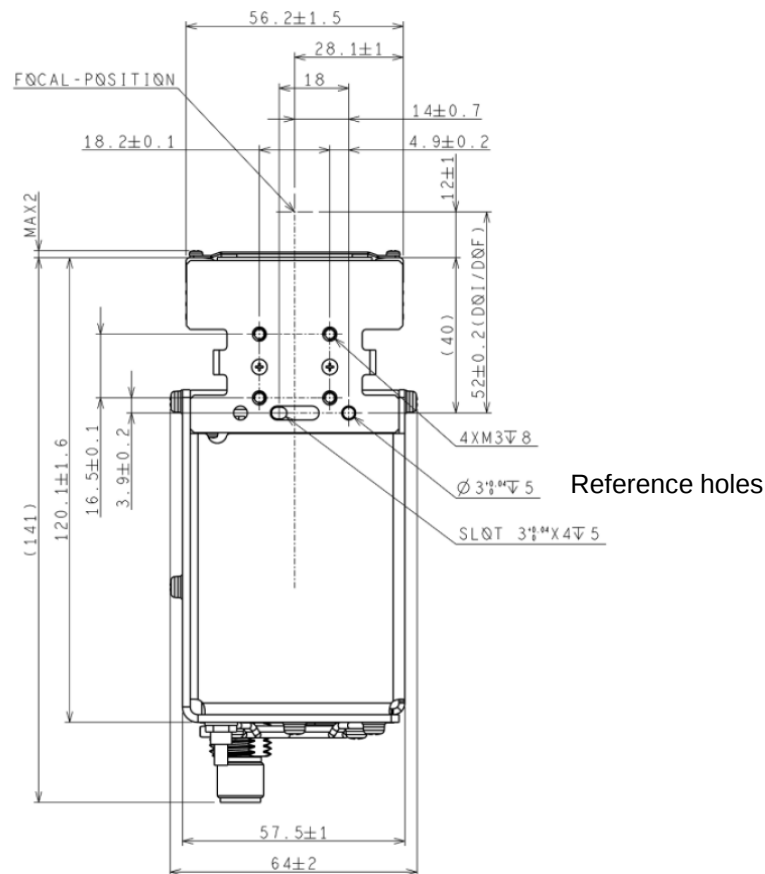
## 2-6 Specification

【 L1/L2/L3 : KD6R367/587/807CX2 side view (common) 】

**1st-side Bracket**



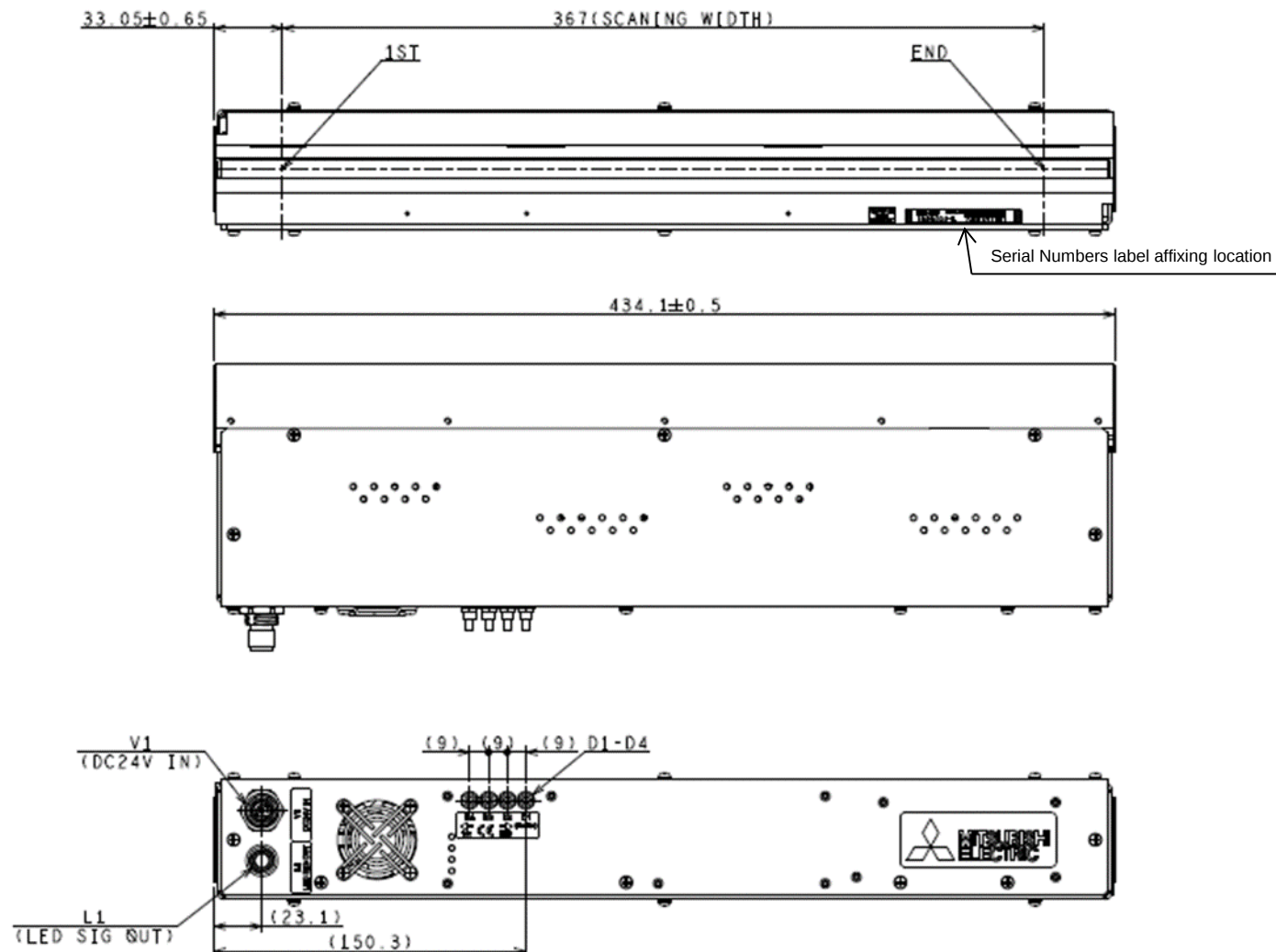
**end-side Bracket**



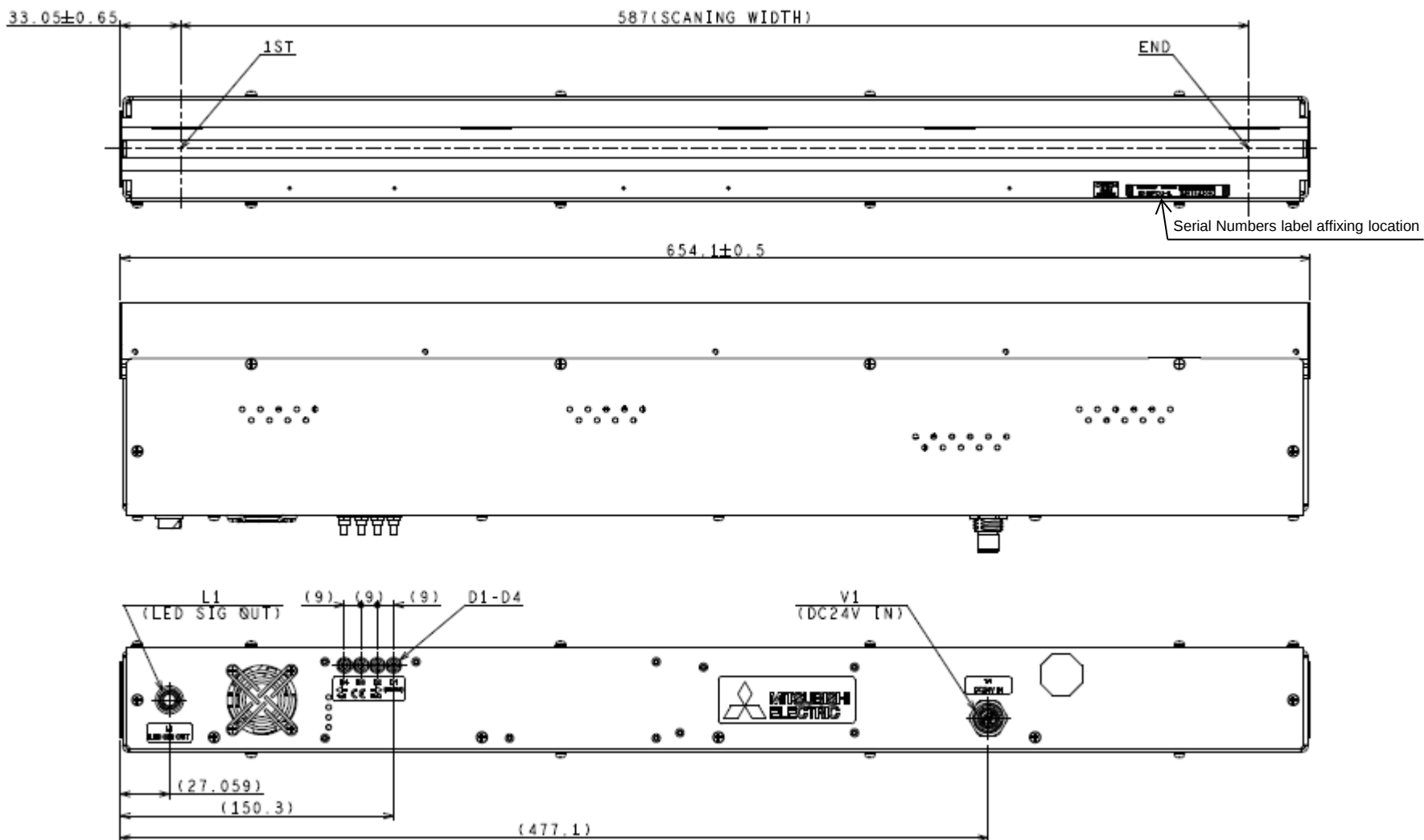
To install this CIS to your system (equipment), Position of CIS should be determined by two reference holes on the both sides of it. Then it should be fixed by 8pcs of M3 screws.

## 2-6 Specification

### 【 L1 type:KD6R367CX2-NL Outline】

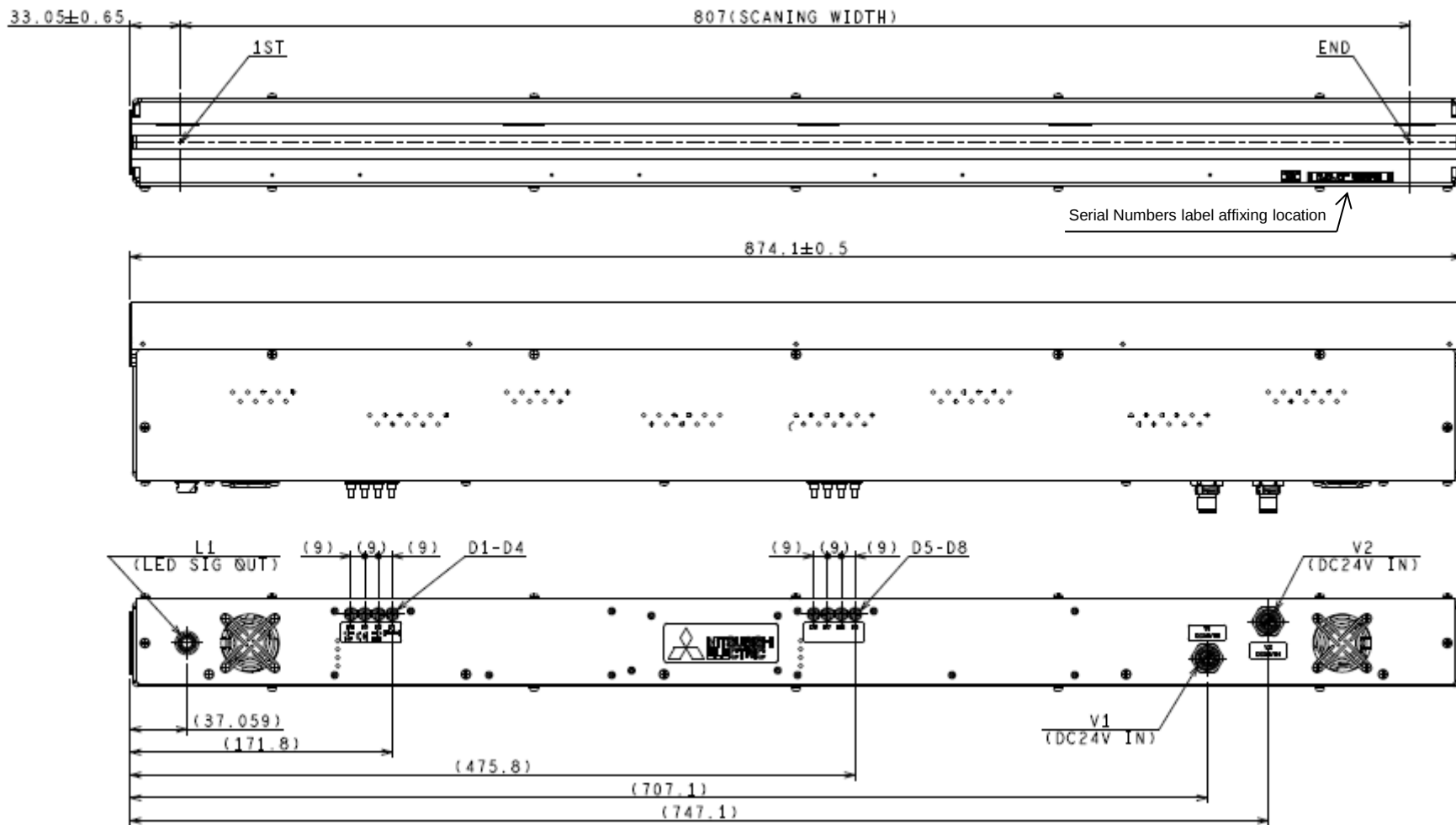


【 L2 type:KD6R587CX2-NL Outline】



## 2-6 Specification

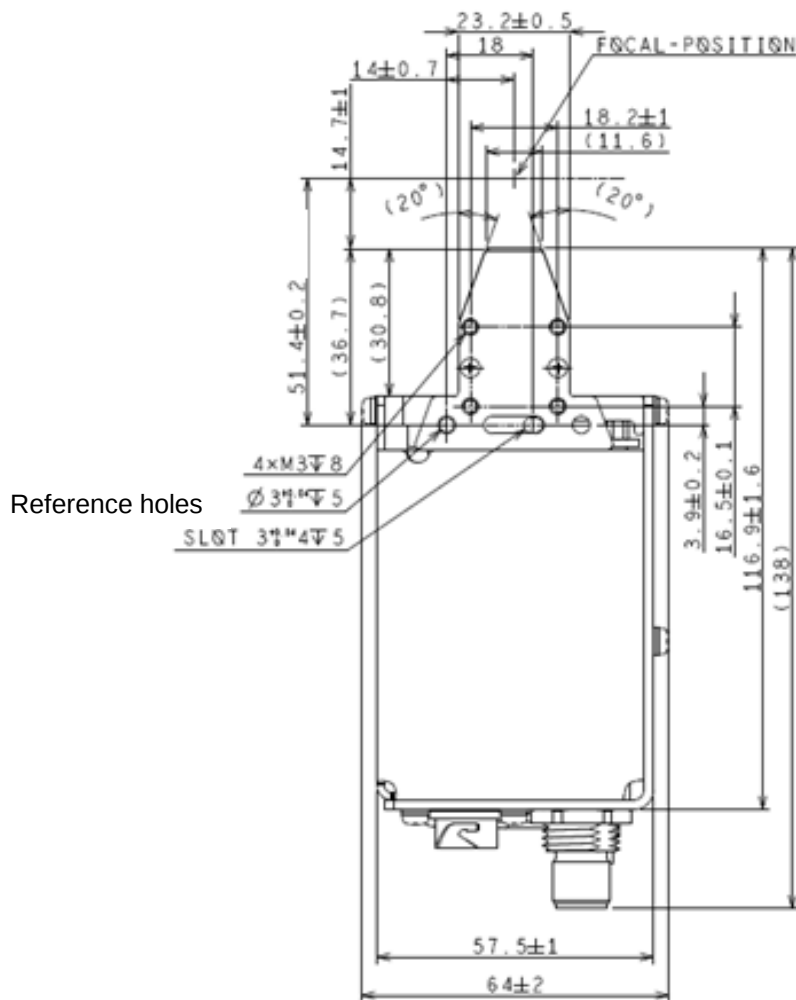
### 【 L3 type: KD6R807CX2-NL Outline】



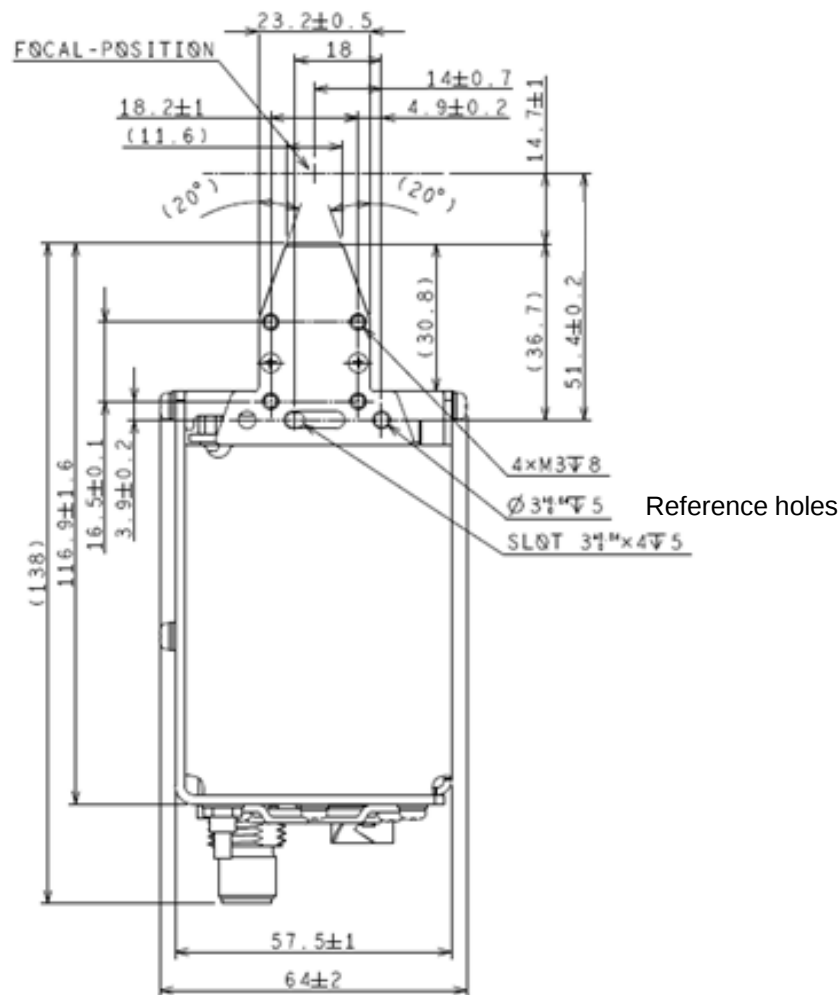
## 2-6 Specification

【 L1/L2/L3 : KD6R367/587/807CX2-NL side view (common) 】

1st-side Bracket



end-side Bracket

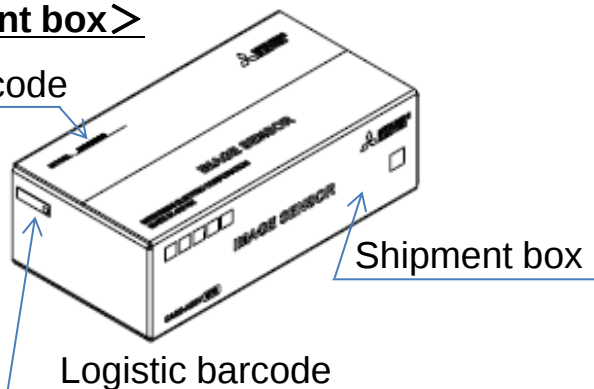


## 2-7 Packaging

### 【 L1 (KD6R367CX2, KD6R367CX2-NL) Packaging 】

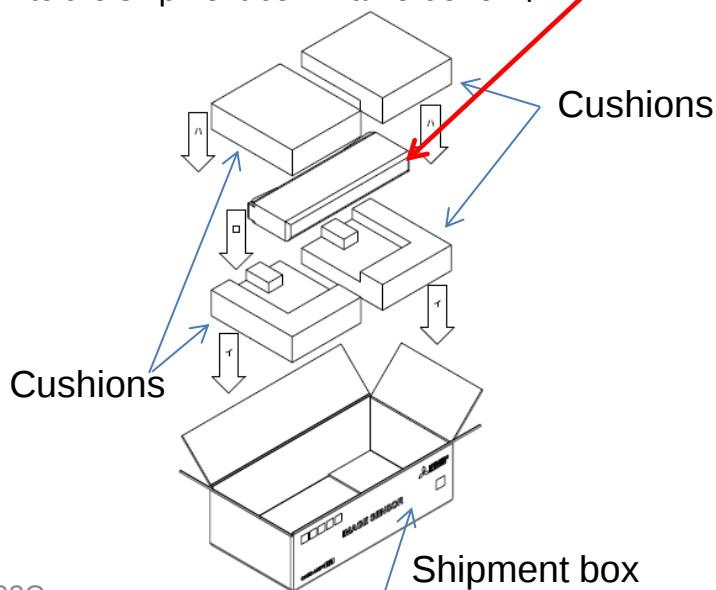
#### <Shipment box>

Product barcode



③

Pack CIS (②) is wrapped by an electrostatic sheet and cushions into the shipment box in an order of イ→□→ハ.

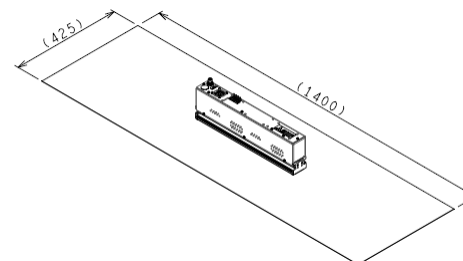


② CIS wrapped by the electrostatic sheet



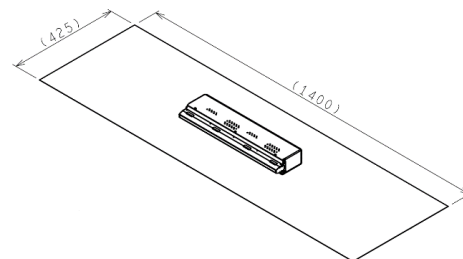
①-A (KD6R367CX2)

CIS of which glass surface facing downside is put on the electrostatic sheet.



①-B (KD6R367CX2-NL)

CIS of which glass surface facing sideways is put on the electrostatic sheet.

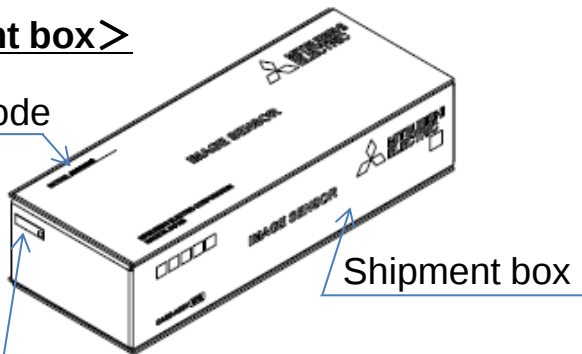


## 2-7 Packaging

### 【 L2/L3 (KD6R587/807CX2, KD6R587/807CX2-NL) Packaging 】

#### <Shipment box>

Product barcode

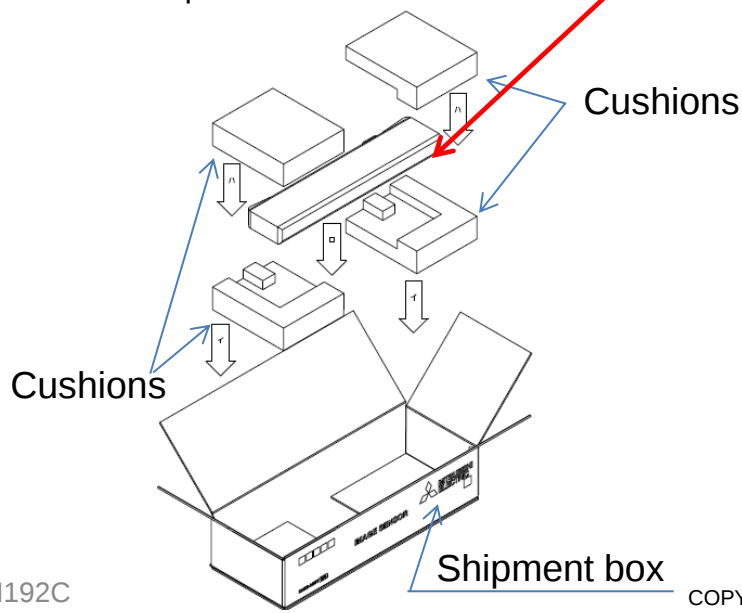


Logistic barcode

Shipment box

③

Pack CIS(②) is wrapped by an electrostatic sheet and cushions into the shipment box in an order of イ→ロ→ハ.



Cushions

Cushions

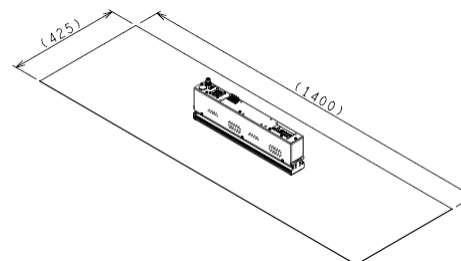
Shipment box

② CIS wrapped by the electrostatic sheet



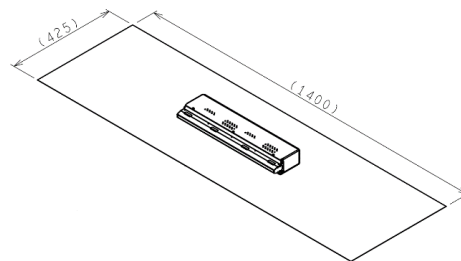
①-A (KD6R587/807CX2)

CIS of which glass surface facing downside is put on the electrostatic sheet.



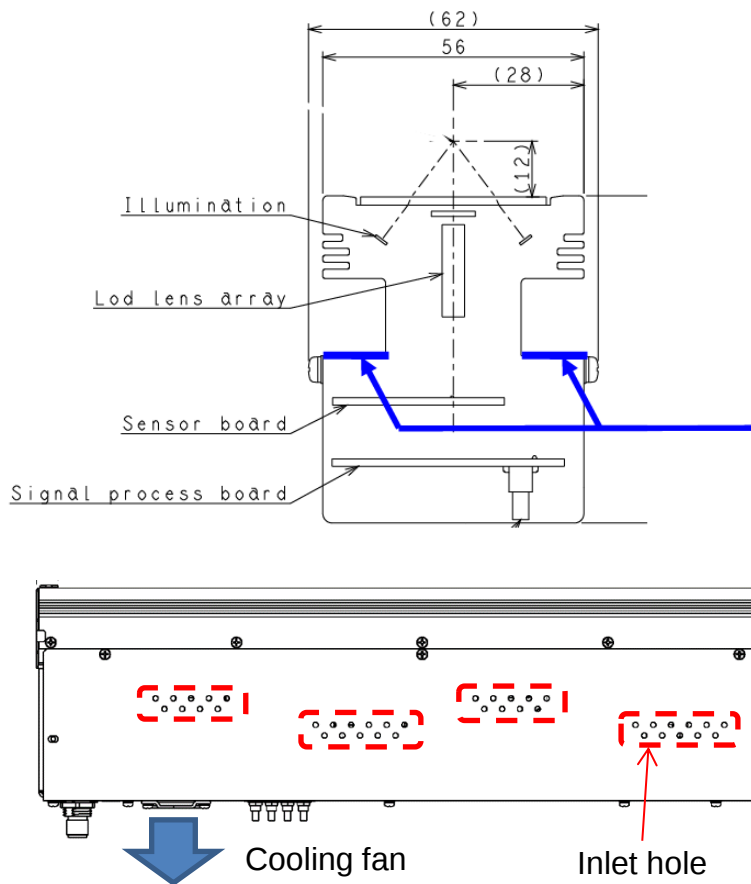
①-B (KD6R587/807CX2-NL)

CIS of which glass surface facing sideways is put on the electrostatic sheet.



## 2-8 Handling precautions

### 2-8-1 Thermal management



### 【Thermal management】

This product can be operated under an environmental temperature ( $T_a$ ) between  $+5$  and  $+50^{\circ}\text{C}$  of, under natural air cooling circumstance.

In other circumstance that the product temperature may be raised by the incoming heat from the peripheral devices and/or the connecting part, check the case temperature  $T_w$  (refer left diagram), and control the temperature  $T_w$  to be between  $+5$  and  $+70^{\circ}\text{C}$ .

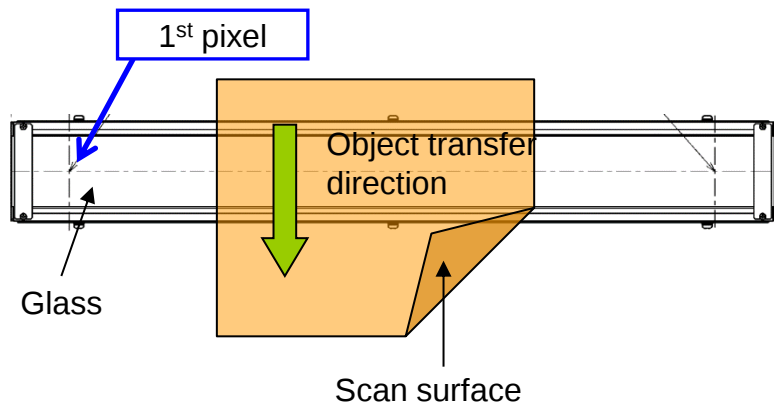
### 【Precaution on the inlet hole】

The air flow taken in through inlet holes and vented out through cooling fan enables this product cooled down. Therefore, when installing the product to your system, do not to block the inlet holes and the cooling fan.

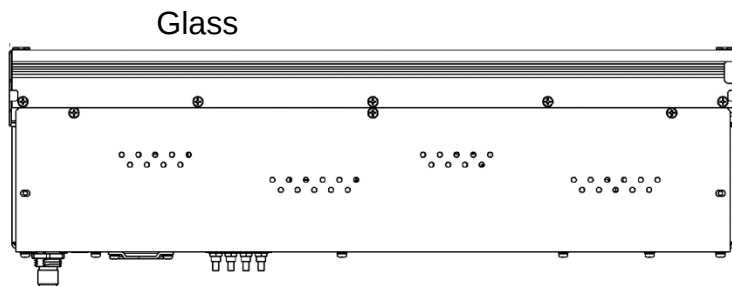
# Chapter 3 : Installation

## 3-1 Installation

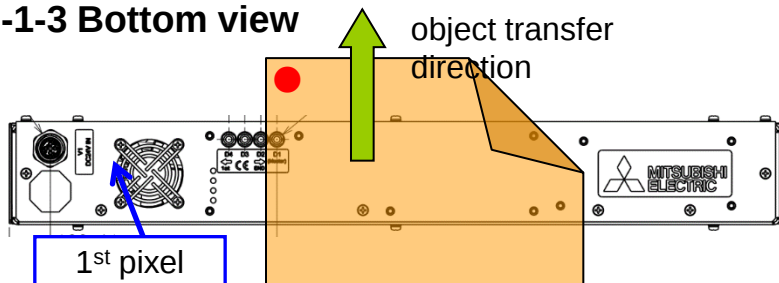
### 3-1-1 Top view



### 3-1-2 Side view



### 3-1-3 Bottom view



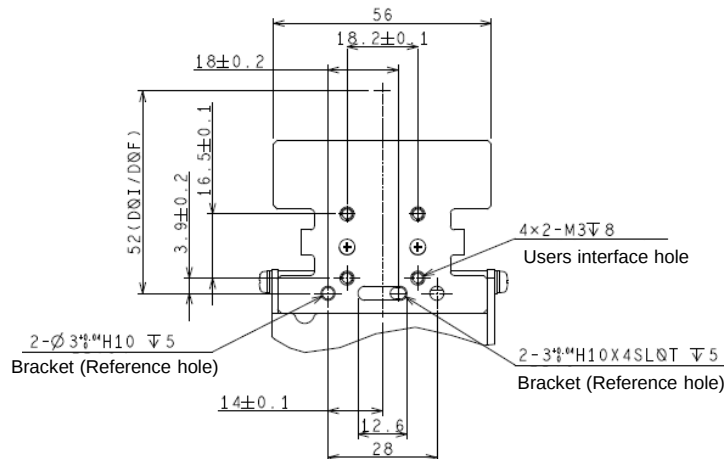
### 【Remarks】 Where to place the media

- ① Set the object in front of the glass surface of CIS.
- ② Set the object as shown in left diagram.  
Set the left side (● mark) of the object at Bottom view close to the 1<sup>st</sup> pixel position.
- ③ Transfer the object to the direction as shown in figure 3-1-1.

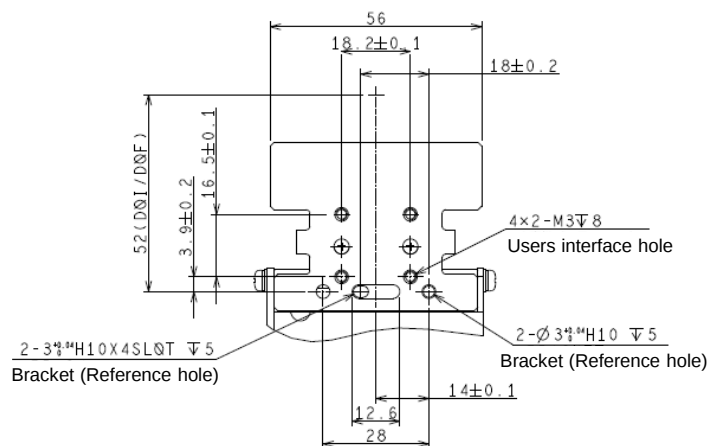
## 3-1 Installation

### 3-1-3 Both side view

#### 1st-side Bracket



#### End-side Bracket

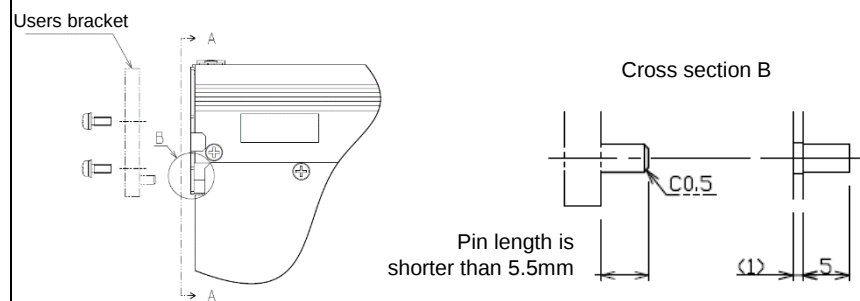


### **[Remark] How to install CIS into your device**

- 1) Attach CIS to your system at the both end sides of CIS by M3 screws . Focal point is defined the position from the guide holes at the end of CIS .
- 2) There is the focal point of CIS from the guide holes .
- 3) For a reference, the working distance of the built-in illumination type CIS is  $12 \pm 1$  mm.
- 4) There are 4 screw holes (M3) each end side of CIS (total 8 screw holes). Use guide holes to make sure the CIS is on the right position.
- 5) A chassis of CIS is made of aluminum. When tightening a screw, be careful about thread damage of screw hole.

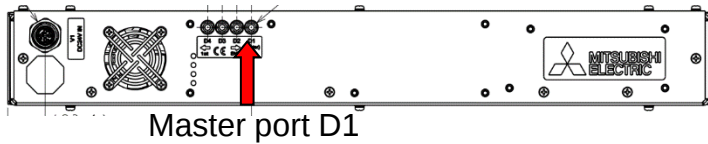
| Material of screw           | Tightening force [N·cm] |
|-----------------------------|-------------------------|
| Iron (strength ranking 4.6) | $72 \pm 7$              |
| Stainless (SUS 304)         | $63 \pm 6$              |
| Brass (C3601BD)             | $42 \pm 4$              |

- 6) Shorter than 5.5mm is recommended for a length of the pin for guide holes.

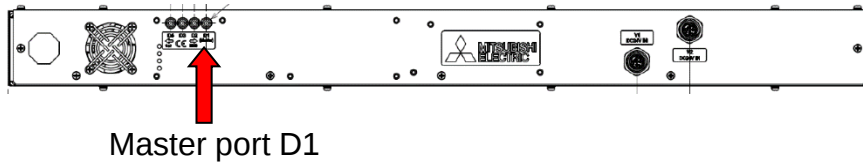


### 3-1-4 Bottom view

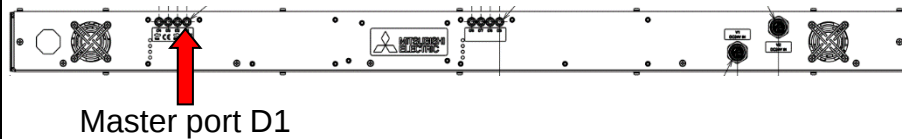
L1(KD6R367CX2 / CX2-NL)



L2(KD6R587CX2 / CX2-NL)



L3(KD6R807CX2 / CX2-NL)



### 【Interface of connectors】

- ① Connectors are located on the bottom side of this CIS .
- ② Connector No. is indicated on the cover .
- ③ Each connector is listed in the following table.

| Item                         | No.     | Model |    |    |
|------------------------------|---------|-------|----|----|
|                              |         | L1    | L2 | L3 |
| Power supply for CIS (+24V ) | V1      | ○     | ○  | ○  |
|                              | V2      | ×     | ○  | ○  |
| CoaXPress™ connectors        | Masters | D1    | ◎  | ◎  |
|                              |         | D2    | ○  | ○  |
|                              |         | D3    | ○  | ○  |
|                              |         | D4    | ○  | ○  |
|                              | Slaves  | D5    | ×  | ×  |
|                              |         | D6    | ×  | ×  |
|                              |         | D7    | ×  | ×  |
|                              |         | D8    | ×  | ×  |

\*◎ : Master port

\*● : Slave port

## 3-2 Preparation

### 3-2-1 Preparation by users

Items shown in the following table have to be prepared by the users (details are shown from the next pages).

#### 【 Remarks 】

The cable and connector which is indicated by (\*) is enclosed into evaluation kit of this sensor.

However, those items are NOT INCLUDED in this product. These items should be prepared separately by the user.

| Parts<br>No | Items                                   | Quantity      |    |    |                  |    |    |
|-------------|-----------------------------------------|---------------|----|----|------------------|----|----|
|             |                                         | KD-CX2 series |    |    | KD-CX2-NL series |    |    |
|             |                                         | L1            | L2 | L3 | L1               | L2 | L3 |
| ①           | DC24V power cable and connector (*)     | 1             | 2  | 2  | 1                | 1  | 2  |
| ②           | CoaXPress™ cable                        | 4             | 4  | 8  | 4                | 4  | 8  |
| ③           | Frame Grabber board                     | 1             | 1  | 2  | 1                | 1  | 2  |
| ④           | DC24V power                             | 1             |    |    | 1                |    |    |
| ⑤           | External illumination control cable (*) |               |    |    | 1                |    |    |

## 3-2 Preparation

### 3-2-1 Preparation by users

#### ① DC5V power cable

Following cable and connector are recommended.

Cable : CVV-S-1.25SQ-4-15(**Fujikura dia cable**)

Connector : SACC-M12FST-4PL-CM SH (**Phoenix Contact**)

V1/V2 connector for power supply is

**SACC-DSI-M12MST-4CON-M16/0,5(Phoenix Contact)**



Pin assignment of V1/V2 connector is shown below.

| V1,V2  |          |     |                                                                         |
|--------|----------|-----|-------------------------------------------------------------------------|
| Pin No | name     | I/O | remark                                                                  |
| 1      | LED_CONT | I   | OPEN: LED OFF<br>GND: LED ON                                            |
| 2      | Enable   | I   | GND or OPEN: Normal operation<br>GND or OPEN after +24V applied: Reboot |
| 3      | +24V     | I   | VDD                                                                     |
| 4      | GND      | I   | GND                                                                     |

Please twist wires for pin no.3(+24V) and no.4(GND) when it will be assembled.

#### 【Remarks】

If standard cable will be used as power supply cable for this sensor, please make sure the pin assignment and wire gauge(conductor size of wire). Cable resistance 65mΩ or less between the power supply and CIS is recommended.

(Cable standard AWG16: approx. 5m, AWG14: approx. 7.8m)

【Reference】

## 3-2 Preparation

### 3-2-1 Preparation by users

#### ② CoaXPress™ cable

CIS (This product) has DIN1.0 / 2.3 connectors.



Check the connectors of Grabber board (DIN1.0 / 2.3 or BNC) and prepare the connectable cables.



#### ③ Frame grabber board

Prepare Frame Grabber board (or PC with Grabber board installed) supporting CoaXPress™.

#### 【Remarks】

CIS does not support PoCXP. Set the Frame Grabber board settings as NOT to supply +24V power to the CoaXPress™ cable.

#### ④ DC24V power

Supply more than the current capacity listed in below.

| No. | Configuration    | Current capacity (A) |    |    |
|-----|------------------|----------------------|----|----|
|     |                  | L1                   | L2 | L3 |
| 1   | KD-CX2 series    | 10                   | 10 | 15 |
| 2   | KD-CX2-NL series | 5                    | 5  | 10 |

## 3-2 Preparation

### 3-2-1 Preparation by users

#### ⑤ External illumination control cable

Non-illumination type CIS (CX-NL series) outputs a trigger signal from connector L1, that is used to synchronize the exposure timing of this product with an external illumination. When using this trigger signal for the external illumination control, prepare the cable to connect with the external illumination.

The following connectors are used for connection:  
Cable side connector: LF10WBP-4S (HRS)

CIS connector has LF10WBR-4P(HRS).

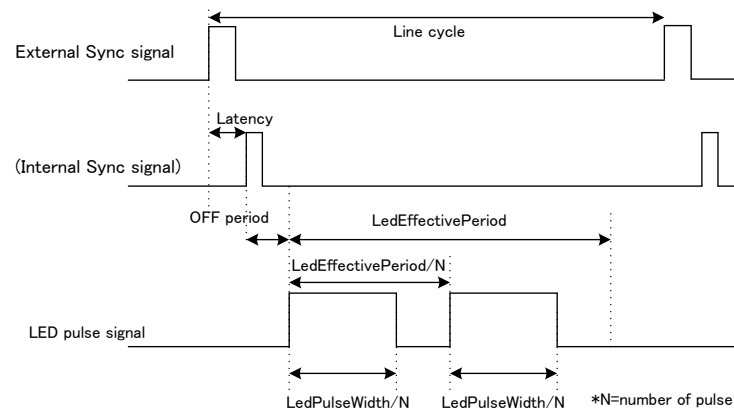


Pin assignment of CIS connectors is shown below.

| Non-illumination CIS(KD-CX2-NL series) |             |     |         |
|----------------------------------------|-------------|-----|---------|
| Pin No                                 | Name        | I/O | Remarks |
| 1                                      | OUT PULSE_B | O   |         |
| 2                                      | NC          | –   |         |
| 3                                      | OUT PULSE_A | O   |         |
| 4                                      | GND         | –   | GND     |

#### 【Reference】

#### Illumination trigger signal timing chart



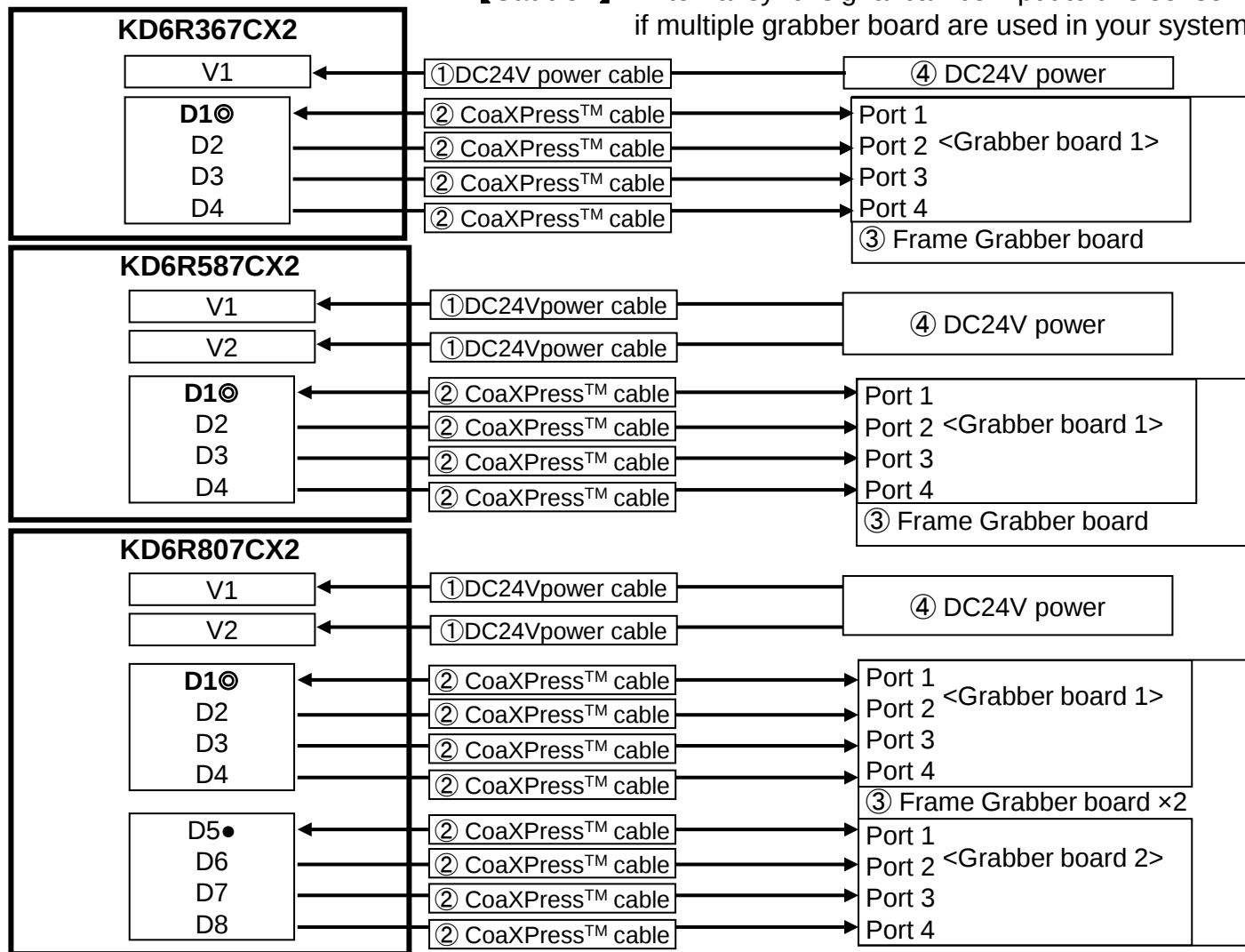
## 3-3 Connections

### 3-3-1 Connections

#### 1) KD-CX2 series

**【Caution】** Common GND should be shared with all power source if electric power will be supplied from multiple power source.

**【Caution】** External sync. signal can be input to this sensor from master port if multiple grabber board are used in your system.



\* ◎ : Master port

\* ● : Slave port

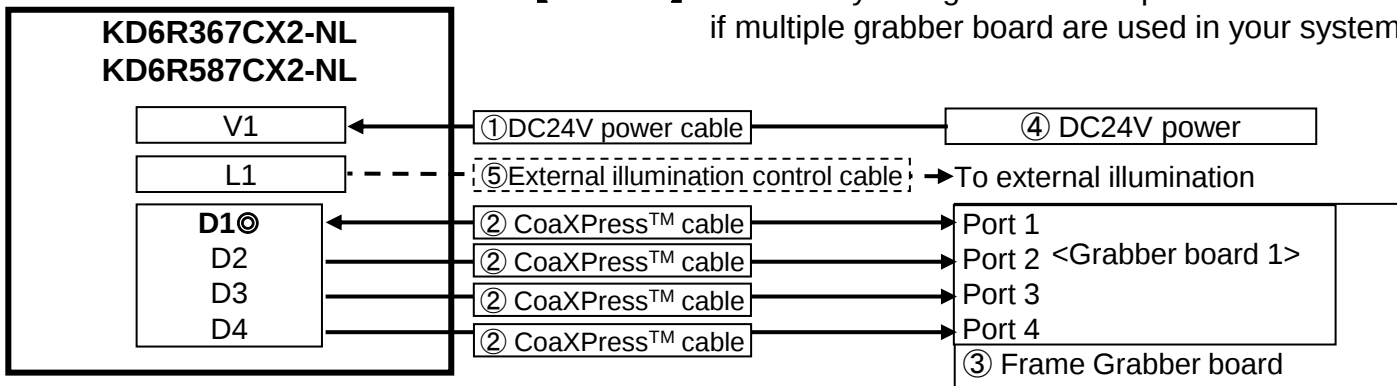
## 3-3 Connections

### 3-3-1 Connections

#### 2) KD-CX2-NL series

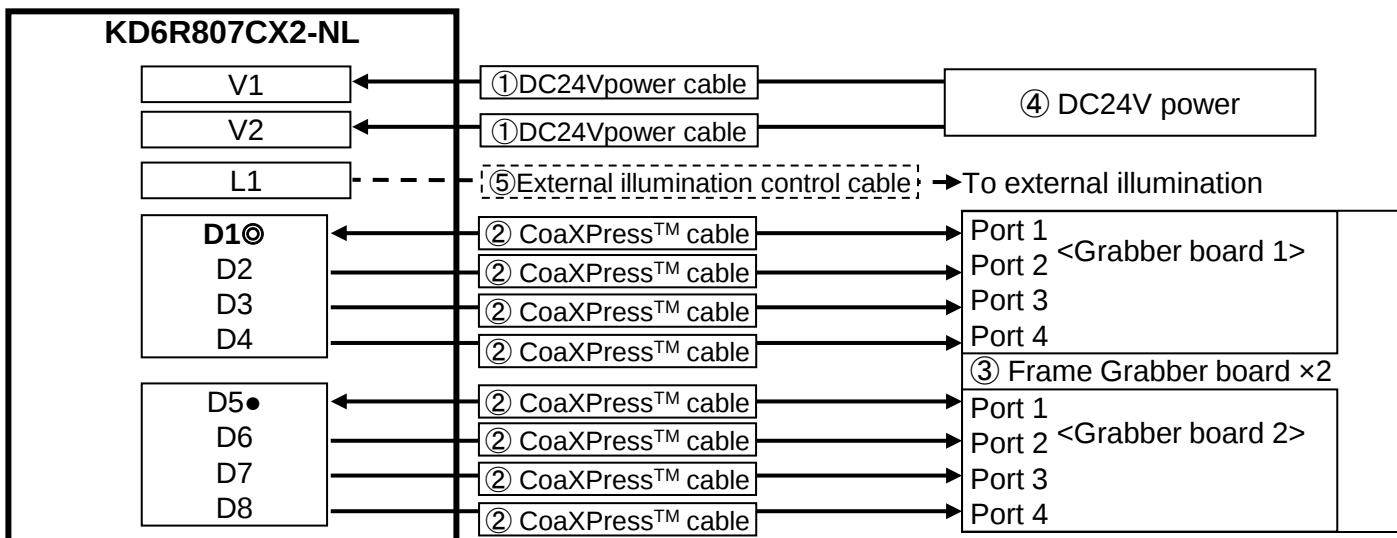
**【Caution】** Common GND should be shared with all power source if electric power will be supplied from multiple power source.

**【Caution】** External sync. signal can be input to this sensor from master port if multiple grabber board are used in your system.



\* ◎ : Master port

\* ● : Slave port



## 3-3 Connections

### 3-3-2 DC24V cable connection

(This cable is not included in the CIS product)

1) Connect ① DC24V power cable to CIS connectors **V1/V2**.



| Type                    | No. | Model |    |    |
|-------------------------|-----|-------|----|----|
|                         |     | L1    | L2 | L3 |
| Power for<br>CIS (+24V) | V1  | ○     | ○  | ○  |
|                         | V2  | ×     | ○  | ○  |

2) **SACC-DSI-M12MST-4CON-M16/0,5 (Phoenix Contact)** is used as power supply connector of this sensor. Please connect the connector of cable side to the connector of sensor side.

#### 【Remarks】

1) CIS does not support hot-swapping.  
Make sure to power off CIS before connecting / removing cables from the sensor. Otherwise, it will be damaged.

## 3-3 Connections

### 3-3-3 CoaXPress™ connectors

(This cable is not included in the CIS product)

1) Connect CoaXPress™ cable to **D1 to D8**.

\* CIS has DIN 1.0/2.3 connectors



| Type                  | No. | Model |    |    |
|-----------------------|-----|-------|----|----|
|                       |     | L1    | L2 | L3 |
| CoaXPress™ connectors | D1  | ⊙     | ⊙  | ⊙  |
|                       | D2  | ○     | ○  | ○  |
|                       | D3  | ○     | ○  | ○  |
|                       | D4  | ○     | ○  | ○  |
|                       | D5  | ×     | ×  | ●  |
|                       | D6  | ×     | ×  | ○  |
|                       | D7  | ×     | ×  | ○  |
|                       | D8  | ×     | ×  | ○  |

\*⊙: Master port

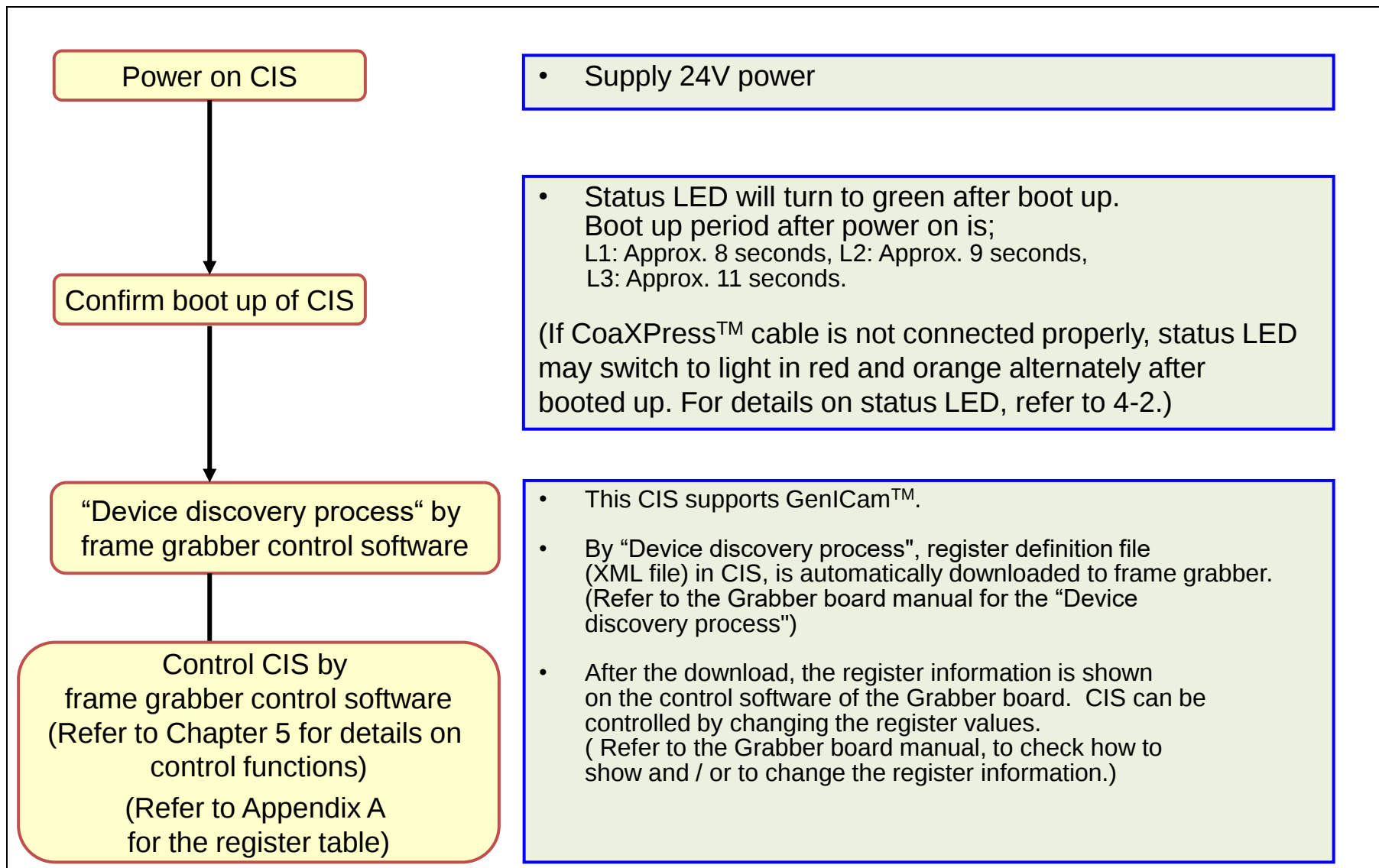
\*●: Slave port

### 【Remarks】

- 1) When you use several Grabber boards, the external sync signal can be provided only through Master port (D1). Also communication control for the main functions can be set only through Master port. (D1) Remark when changing Grabber board settings.
- 2) CIS does not support PoCXP. Set the Frame Grabber board settings NOT to supply +24V power over the CoaXPress™ cable.

# Chapter 4 : How to control CIS

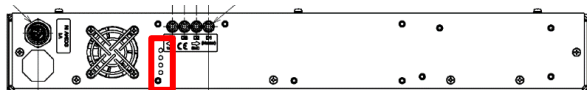
## 4-1 Startup procedure



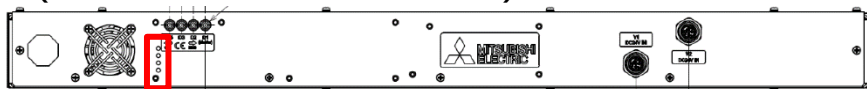
## 4-2 Status LED

### 4-2-1 Status LED

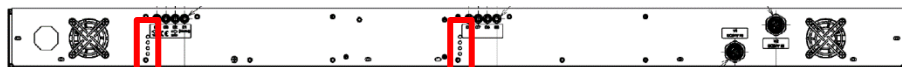
L1(KD6R367CX2 / CX2-NL)



L2(KD6R587CX2 / CX2-NL)



L3(KD6R807CX2 / CX2-NL)



| LED status                                                                          |                                   | CIS Status                               |
|-------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------|
|    | LED off                           | No power                                 |
|    | Orange<br>Rapid blink             | Detecting link                           |
|  | Red and orange<br>alternate blink | CXP link<br>establishing                 |
|  | Green<br>LED on                   | Link established,<br>no stream transfer  |
|  | Green Rapid<br>blink              | Link established,<br>transferring stream |
|  | Red 0.5 sec.<br>LED blink         | CRC error                                |

### 【Status LED】

Status LED is located on the back of CIS.

Status LED shows the status of communication status and CIS.

### 【Communication status of CoaXPress™】

Each LED shows the communication status of CoaXPress™ connectors.

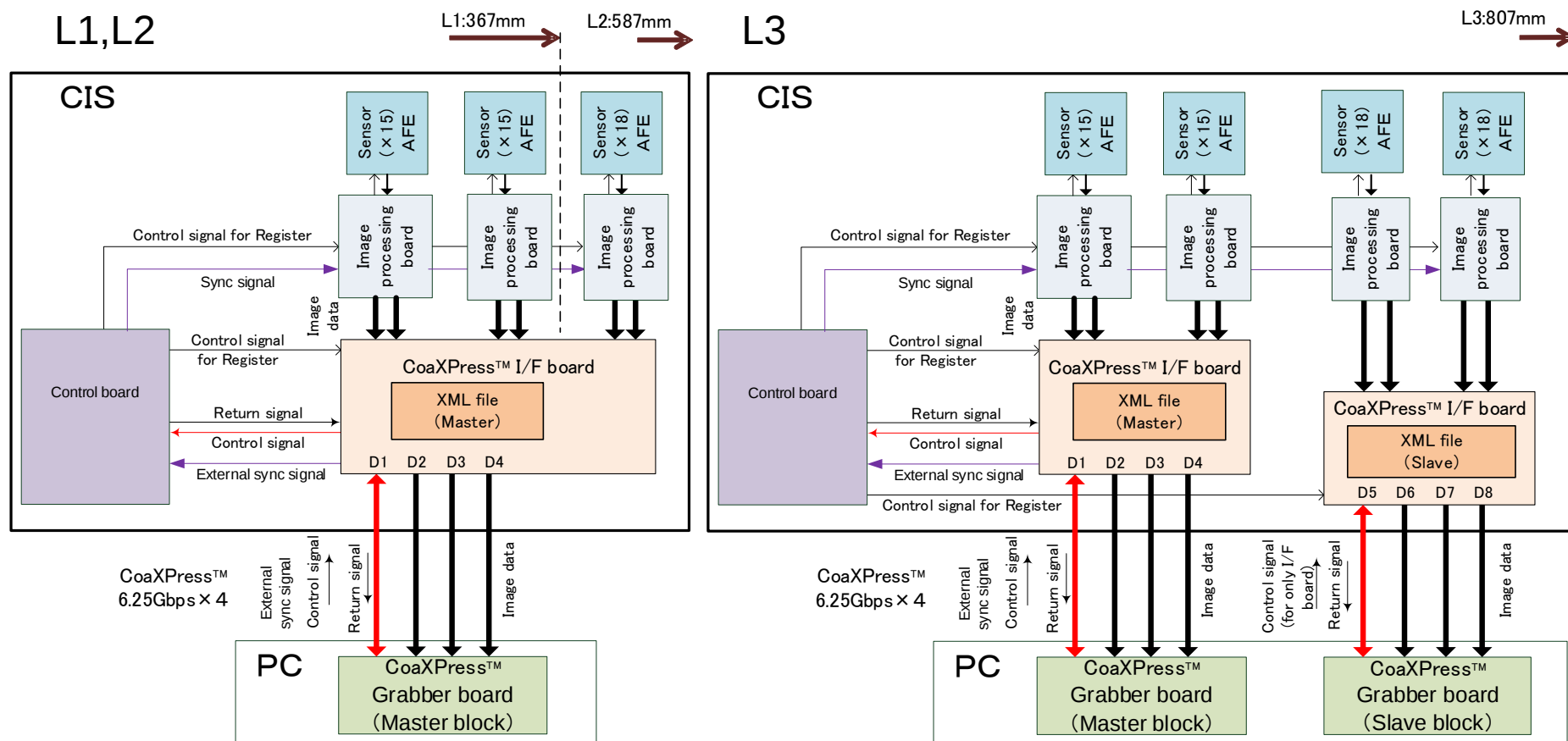
### 【Status of CIS】

Combination of the 4 status LED shows the status of CIS.

| LED status                                                                            |                                          | CIS Status                                          |
|---------------------------------------------------------------------------------------|------------------------------------------|-----------------------------------------------------|
|    | Ch1 to 4: Red LED on                     | FPGA abnormal<br>temperature of I/F board           |
|    | Ch1 to 4: Orange LED on                  | System boot<br>(FPGA configuration<br>of I/F board) |
|   | Ch1 to 3: OFF<br>Ch4: Orange LED on      | System boot<br>(FPGA reset status<br>of I/F board)  |
|  | Ch1 to 2: OFF<br>Ch3 to 4: Orange LED on | System boot<br>(Setting CLK Gen<br>of I/F board)    |
|  | Ch1: OFF<br>Ch2 to 4: Orange LED on      | System boot<br>(CIS booting up)                     |

## 4-3 Communication control (overview)

### 4-3-1 Communication control block diagram



## 4-3 Communication control (overview)

### 4-3-1 Communication control block diagram

#### 【Communication control】

L3 types have two signal blocks for CoaXPress™, and the 1<sup>st</sup> signal block (Connector D1 to D4) is the Master block. Main functions of the CIS can be controlled through the D1 of Master block.

In case of using of the external sync mode, input trigger signal to the 1<sup>st</sup> Master port (D1). (No input required for the internal sync. mode.)

Slave block (Connector D5 to D8) is mainly used only to change settings related to link control of CoaXPress™. When you change a part of register values in Master block, you need to change the part of register values in Slave block. (Register information used for the Slave system is stored on the CIS as XML file for the Slave)

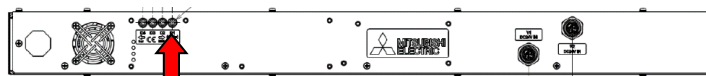
#### 【Master port connectors】

L1(KD6R367CX2)



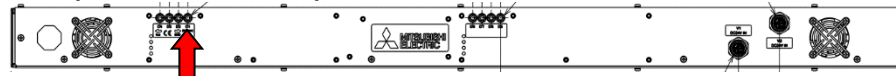
D1 Master port

L2(KD6R587CX2)



D1 Master port

L3(KD6R807CX2)



D1 Master port

#### 【Line sync signal】

##### 1. External sync. mode

External sync signal, input through communication port, is distributed to the other block inside CIS. The line data from each block is synchronized at line scan basis.

##### 2. Internal sync mode

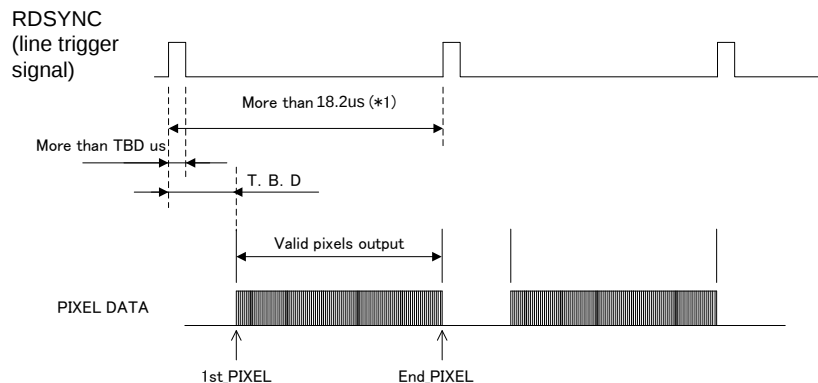
Sync signal created inside CIS is distributed to the other block inside CIS. The line data from each block is synchronized at line scan basis.

#### 【Remarks】

- 1) CIS can be controlled only through Master port. (Signal through the other ports will not be reflected to CIS)
- 2) Confirm where to be connected from your Grabber board.

## 4-4 Sync signal timing (External sync mode)

### 4-4-1 Sync. signal timing



\*1 18.2 usec is the min. scan period for all models at 600 dpi output. Each min. scan period in different output modes is different.

### 【External sync. mode】

\*The initial setting of this product is internal sync. mode.

- 1) To operate CIS at external sync. mode, line trigger signal (RDSYNC at left diagram) has to be input through the 1<sup>st</sup> block, Master port (D1).
- 2) For scan operation, the scan cycle is decided by RDSYNC startup timing.  
Secure "H" term (more than 3.8us) of RDSYNC.
- 3) If you input the sync. signal created by an encoder on the object conveyer through the Grabber boards, the scan timing of this product can be synchronized with the motion of the object.

### 【Remarks】

- 1) Input/set the longer sync. signal cycle than the line cycle.  
Improper image data is output if the sync signal cycle is shorter than necessary line cycle.
- 2) Do not use TBD lines just after sync. signal input.  
(Invalid data is output due to the internal line delay)

# Chapter 5 Getting started

## 5-1 Initial settings

### 5-1-1 Initial settings

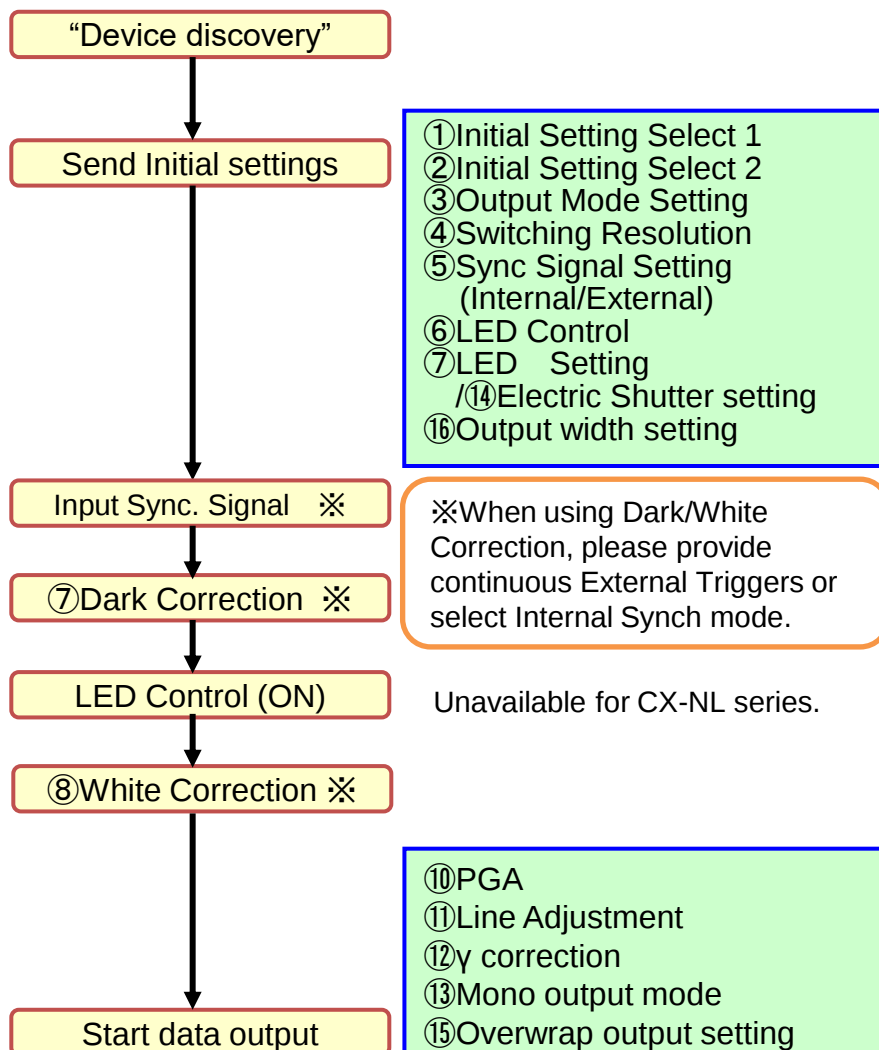
| Items                                         | Initial settings                                                                         |
|-----------------------------------------------|------------------------------------------------------------------------------------------|
| <b>Output format</b>                          | 24bit RGB<br>CXP6-Quad                                                                   |
| <b>Output resolution</b>                      | 600dpi<br>Interpolation OFF                                                              |
| <b>Synchronization signal setting</b>         | Internal synchronization mode                                                            |
| <b>Dark Correction</b>                        | OFF                                                                                      |
| <b>LED Control</b><br>※Unavailable for CX2-NL | ON<br>Duty period: 14.0us                                                                |
| <b>White Correction</b>                       | OFF                                                                                      |
| <b>PGA</b>                                    | Not used (1 time)                                                                        |
| <b>Line adjustment</b>                        | ON<br>Resolution in transport direction: 600dpi<br>Transport direction: Original (B→G→R) |
| <b>γ correction</b>                           | OFF                                                                                      |
| <b>Overwrap output</b>                        | OFF                                                                                      |
| <b>Mono mode</b>                              | OFF. Color output                                                                        |

### [CIS initial settings]

- 1) Initial settings of this product are described on the left table, when you power on the product without any uses after the shipment from our factory.
- 2) Refer to the following pages about any respective settings for your applications.

## 5-2 Procedure of function settings

### 5-2-1 Procedure of function settings



### [Procedure of function settings]

- 1) This product contains several image processing function that can be controlled over CoaXPress™ I/F.
- 2) Procedure of several function settings is described on the left chart. Change each respective settings for your applications.
  - ① Initial Setting Select 1
  - ② Initial Setting Select 2
  - ③ Output Mode Setting
  - ④ Switching Resolution
  - ⑤ Sync Signal Setting (Internal/External)
  - ⑥ LED Control
  - ⑦ LED Setting ⑭Electric Shutter Setting
  - ⑧ Dark Correction
  - ⑨ White Correction
  - ⑩ PGA
  - ⑪ Line Adjustment
  - ⑫ γ Correction
  - ⑬ Mono output mode
  - ⑮ Overlap Output
  - ⑯ Output width setting

- 3) Control several functions (such as White and Dark Corrections) while monitoring a time-dependent output-change in a continuous operation.

#### [Remark]

- 1) When using Dark/White Correction, provide continuous External Triggers or select Internal Sync. mode.
- 2) Generate your Dark/White Correction data every time when you scan your object.

## 5-2 Setting①: Initial setting select 1

| Address | Register name                   | R/W | Val    | Result                                                                                                              | Initial |
|---------|---------------------------------|-----|--------|---------------------------------------------------------------------------------------------------------------------|---------|
| 7200    | UserSet_1_Save                  | R/W | 1      | Save CIS settings to User Setting 1 on Flush Memory.                                                                | -       |
| 7204    | UserSet_2_Save                  | R/W | 1      | Save CIS settings to User Setting 2 on Flush Memory.                                                                | -       |
| 7208    | UserSet_3_Save                  | R/W | 1      | Save CIS settings to User Setting 3 on Flush Memory.                                                                | -       |
| 720C    | UserSet_1_Load                  | R/W | 1      | Read out CIS settings on User Setting 1.                                                                            | -       |
| 7210    | UserSet_2_Load                  | R/W | 1      | Read out CIS settings on User Setting 2.                                                                            | -       |
| 7214    | UserSet_3_Load                  | R/W | 1      | Read out CIS settings on User Setting 3.                                                                            | -       |
| 7218    | UserSet_Load_Factory<br>Defalut | R/W | 1      | Read out CIS settings on Factory Setting (Initial Setting).                                                         | -       |
| 7240    | UserSet_BootSet_select          | R/W | 0 to 3 | Select a setting to boot after power-ON.<br>0:Factory Setting, 1:User Setting 1, 2:User Setting 2, 3:User setting 3 | 0       |

### 5-2-2 Initial Setting Select 1

#### [Function]

Save and read CIS Initial Setting

After power ON, this product boots an Initial Setting which is selected by the value of "UserSet\_BootSet\_select".

By running a function of "UserSet\_#\_Save", the active CIS settings can be saved or stored on a Flush Memory on this product. (For example, values of CIS Setting, White/Dark Correction, and γ Correction.)

You can save 3 different User Settings (from 1 to 3).  
By running a function of "UserSet\_#\_Load", this product booth the selected User Setting.

#### [Remark]

1) Any setting of communication over CoaXPress™ cannot be saved or stored. The initial value at the following register is always a fixed value after power ON.

| Register name | Initial |
|---------------|---------|
| LinkConfig    | CXP6_4  |

2) Never turn off the product while UserSet\_#\_Save is running. This product may be not able to operate normally due to break setting data for saving.

when this product detect to break the user setting data automatically, factory setting is loaded instead of user setting data when turn on this product.)

## 5-2 Setting②: Initial setting select 2

| Address | Register name      | R/W | Parameter Data | Function                                                       | Initial |
|---------|--------------------|-----|----------------|----------------------------------------------------------------|---------|
| 7248    | UserSet_Use_600dpi | R/W | 0 to 1         | Correction data for 600dpi resolution<br>0: Disable / 1:Enable | 1       |
| 724C    | UserSet_Use_300dpi | R/W | 0 to 1         | Correction data for 300dpi resolution<br>0: Disable / 1:Enable | 0       |
| 7250    | UserSet_Use_200dpi | R/W | 0 to 1         | Correction data for 200dpi resolution<br>0: Disable / 1:Enable | 0       |
| 7254    | UserSet_Use_150dpi | R/W | 0 to 1         | Correction data for 150dpi resolution<br>0: Disable / 1:Enable | 0       |

### 5-2-3 Initial Setting Select-2

#### [Function]

Save and read CIS correction data when changing resolution

If changing the resolution, please execute this command prior to save white/dark correction data to flash memory in CIS.

When saving correction data if changing the resolution, please send this command to suitable address (resolution you want to use) and changing the value (Parameter Data=1:Activate) prior to execute UserSet\_#\_Save.

Correction data for 600dpi can be saved in initial setting.

※ Dark/White correction data is hold in this product every resolution. However saving and reading action from/to flash memory in CIS is valid only the resolution which is enabled by this command.

#### [Remark]

- 1) Due to all correction data is saved / read, the startup is slow, therefore it is recommended to set the unused resolution setting to "Parameter Data=0".
- 2) When executing UserSet\_#\_Save, the correction data of the resolution set to disable is reset.
- 3) The setting of this command is also valid after turn off CIS and correction data is reflected when turn on CIS.

## 5-2 Setting③: Output mode setting

| Address | Register name | R/W | Val                                                                                                     | Result                                                                                                                                                                                                                                                                                                           | Initial |
|---------|---------------|-----|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 6010    | PixelFormat   | R/W | 0x0401,<br>0x0402,<br>0x0101,<br>0x0102                                                                 | Switch image output format<br>0x0401:24bit RGB color , 0x0402:30bit RGB color<br>0x0101:8bit mono, 0x0102:10bit mono                                                                                                                                                                                             | 0x0401  |
| 4014    | LinkConfig    | R/W | 0x40048,<br>0x40040,<br>0x40038,<br>0x20048,<br>0x20040,<br>0x20038,<br>0x10048,<br>0x10040,<br>0x10038 | Set bit-rate of output data and number of output channel<br>0x40048:CXP6_X4,0x40040:CXP5_X4,0x40038:CXP3_X4<br>0x20048:CXP6_X2,0x20040:CXP5_X2,0x20038:CXP3_X2<br>0x10048:CXP6_X1,0x10040:CXP5_X1,0x10038:CXP3_X1<br><br>※CXP6=6.25 ,CXP5=5 ,CXP3=3.125 [Gbps/ch]<br>X1=Single(1ch) ,X2=Dual (2ch) ,X4=Quad(4ch) | 0x40048 |

### 5-2-4 Output Mode Setting

#### [Function]

Switch image output format, and select among “24bit color”, “30bit color”, “8bit mono”, and “10bit mono”

Switch bit-rate of output data and number of output channel

Bit-rate: CXP6 ,CXP5 , CXP3

CXP6=6.25 ,CXP5=5 ,CXP3=3.125 [Gbps/ch]

Number of output channel: Single(1ch), Dual (2ch), Quad (4ch)

1) Output mode is complied with CoaXPress™ .

#### [Remark]

- 1) The frame grabber you use needs to be capable of the Output Format you select on this product.
- 2) When changing “PixelFormat” and “LinkConfig”, please change the settings to all of CXP signal channels including slave channel.
- 3) The setting of “LinkConfig” after power ON always becomes “CXP6\_X4”.
- 4) Because “Output Mode Setting” interacts with Line Frequency and number of output pixel, please set this setting based on your calculation for each setting.

## 5-2 Setting④: Switching resolution

| Address | Register name     | R/W | Val    | Result                                                                                                                                                                                                                     | Initial |
|---------|-------------------|-----|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 70B0    | ResolutionSetting | R/W | 0 to 4 | Set Resolution and Interpolation On/Off<br>0: 600dpi, Interpolation ON<br>1: 600dpi, Interpolation OFF<br>2: 300dpi mode<br>3: 200dpi mode<br>4: 150dpi mode ※Interpolation is not supported on 300,200, and 150dpi modes. | 1       |

### 5-2-5 Switching Resolution in scan direction

#### 1) 600dpi, Interpolation ON



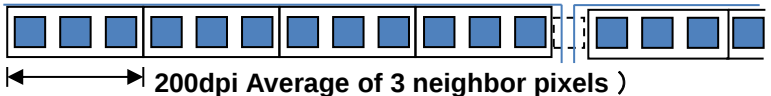
#### 2) 600dpi, Interpolation OFF



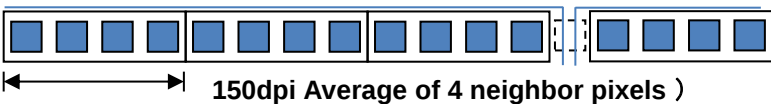
#### 3) 300dpi mode



#### 4) 200dpi mode



#### 5) 150dpi mode



#### [Function]

Change Resolution of image output, and switch Interpolation ON/OFF

Switching resolution is a function which is processed on each sensor IC by averaging analogue signals from neighboring pixels.  
For more details about Interpolation, refer to Chapter 2-5.

#### [Remark]

- 1) When you switch the resolution lower, control the relative transport speed to your object according to the resolution you select.
- 2) Interpolation function estimates and creates a pixel data of a missing pixel or gap between Sensor ICs, while monitoring output information of neighboring pixels. Thus, it doesn't indicate any actual scanned data. Determine an applicability of this function to your equipment or devices through an appropriate analysis or evaluation by the designer of such equipment.

## 5-2 Setting⑤: Sync signal setting

| Address | Register name     | R/W | Val              | Result                                                                                                                      | Initial |
|---------|-------------------|-----|------------------|-----------------------------------------------------------------------------------------------------------------------------|---------|
| 6028    | TriggerMode       | R/W | 0 or 1           | Set Sync Signal input source<br>0: Internal Sync mode<br>1: External Sync mode                                              | 0       |
| 7000    | LinePeriodCounter | R/W | 0<br>To<br>65535 | Set Line Frequency (Internal Sync mode)<br>$\text{Line Frequency(} \mu\text{sec)} = \frac{(\text{Register value}) + 1}{35}$ | 692     |

### 5-2-6 Sync Signal Setting

#### [Function]

Select a Sync Signal input source.

Select External Sync mode and provide sync signals to CIS, when your object transport speed is changeable. (For more details, please refer to Chapter 4-3.)

Select Internal Sync mode and control line frequency, when your object transport speed is fixed. You can change line frequency max. 1,872  $\mu\text{sec/line}$ .

#### [Remark]

- 1) When using External Sync mode, provide sync signals which have scanning frequency corresponding to your transport speed of the object you scan or CIS.

## 5-2 Setting⑥: LED control

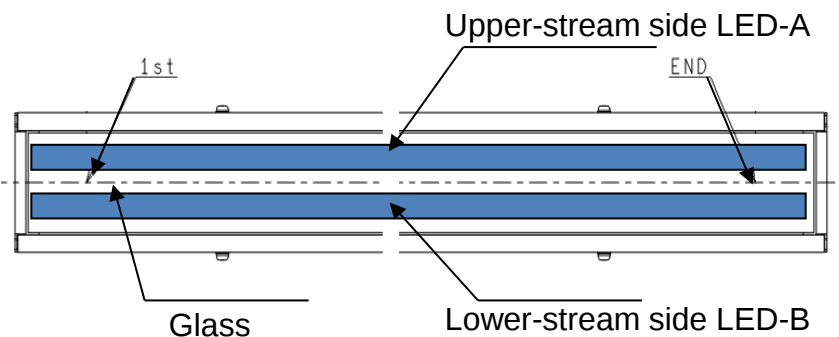
※On CX-NL series, LED Control functions as External LED pulse signal control.

| Address | Register name | R/W | Val    | Result                                                                                                                                                                                         | Initial |
|---------|---------------|-----|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7010    | LedSelector   | R/W | 0 to 3 | LED lighting control<br>0: OFF<br>1: Upper-stream side LED-A, one side lighting ON<br>2: Lower-stream side LED-B, one side lighting ON<br>3: Both Upper-stream LED-A and Lower-stream LED-B ON | 3       |

### 5-2-7 LED Control

#### [Function]

This function controls LED lighting.



#### [Remark]

- 1) Sequential multiple different LED lightings (both External LED and built-in LED) are not supported by this product. In this case, White Correction cannot be operated, too. When you select one of the LED control modes, you can save White Correction data and run White Correction.
- 2) As LED Control function, CX2-NL series outputs External LED pulse signal over External Connector L1.

## 5-2 Setting⑦: LED setting

| Address | Register name      | R/W | Val        | Result                                                                                                                    | Initial |
|---------|--------------------|-----|------------|---------------------------------------------------------------------------------------------------------------------------|---------|
| 7014    | LedPulseDivision   | R/W | 0 to 3     | Set LED Pulse division<br>0:OFF, 1: 2 pulses, 2: 4 pulses, 3: 8 pulses                                                    | 0       |
| 7018    | LedPulseWidthA     | R/W | 0 to 65535 | Upper-stream LED-A lighting period or pulse width<br>$\text{Lighting period (usec)} = \frac{(\text{Register value})}{35}$ | 450     |
| 701C    | LedPulseWidthB     | R/W | 0 to 65535 | Lower-stream LED-B lighting period or pulse width                                                                         | 450     |
| 7020    | LedEffectivePeriod | R/W | 0 to 65535 | Set LED Effective Period<br>$\text{LED Effective Period(usec)} = \frac{(\text{Register value})}{35}$                      | 692     |

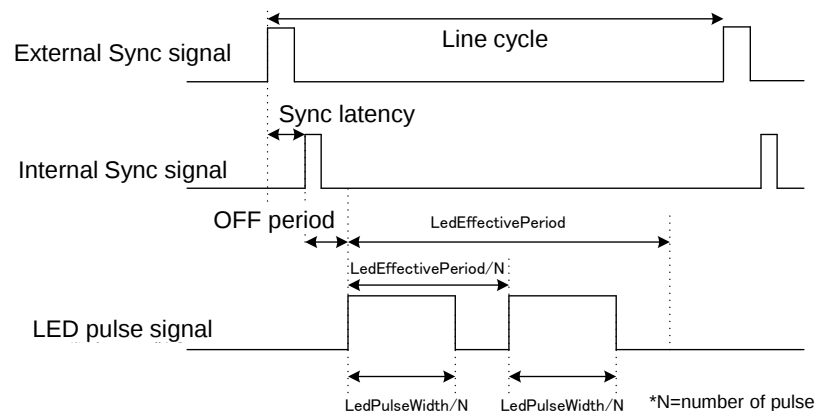
### 5-2-8 LED Control

#### [Function]

Intensity of Built-in LED can be controlled. The built-in LED is operated by pulse control. By changing the pulse width of LED lighting, you can adjust the intensity of the LED. The intensity of both Upper-stream side LED-A and Lower-stream side LED-B can be controlled independently. You can also change the number of pulses (or divisions) within 1 line cycle of LED lighting.

#### [Remark]

- 1) Maximum LED Pulse Width is equivalent to the setting value of LED Effective Period. If you set LED Pulse Width longer than LED Effective Period, the LED is NOT turned ON after the end of LED Effective Period.
- 2) Include an appropriate margin of line frequency variation when you set LED Effective Period.
- 3) If you set LED Effective Period longer than Line Cycle, the next sync signal or reset initialize the next timing of LED Effective Period.



## 5-2 Setting⑧: Dark correction

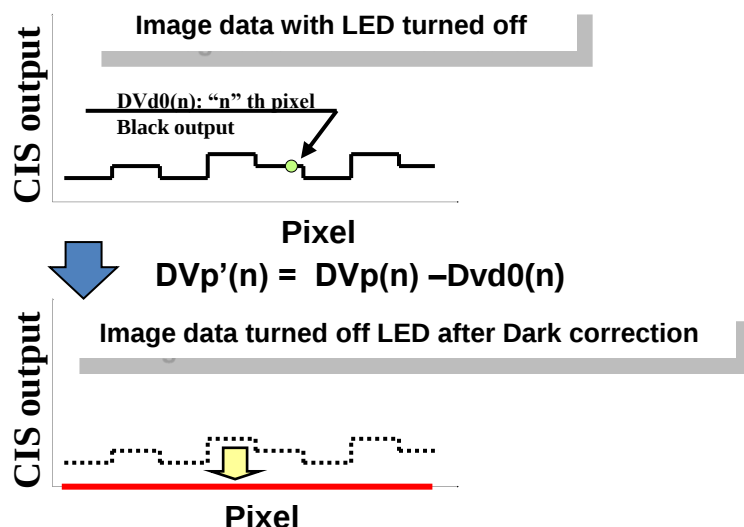
※When operating Dark/White correction, input external sync. signal continuously, or conduct with internal sync. mode.

| Address | Register name         | R/W | Val    | Result                                        | Initial |
|---------|-----------------------|-----|--------|-----------------------------------------------|---------|
| 7050    | DarkCorrectionEnable  | R/W | 0 or 1 | Dark correction On/Off setting<br>0:OFF /1:ON | 0       |
| 7054    | DarkCorrectionExecute | R/W | 1      | Generate Dark Correction Data                 | -       |

### 5-2-9 Dark correction

#### [Function]

Corrects the variation of the dark outputs pixel by pixel  
(Dark output: Output based on LED OFF)  
For more detail, refer Chapter 2-3.



The following procedures shows how to generate Dark correction data.

- 1) Normal Trigger mode: DarkCorrectionExecute  
Dark correction generation sequence is initiated by executing "DarkCorrection Execute" over GenICam™. The Dark correction data (average of 32 lines of pixel data) is save on this product.

This product has memory for saving correction data every resolution. Correction data is saved in memory for current resolution by this operation. If using multiple resolution, execute this operation in each resolution. The correction data which is applied for CIS is automatically changed when resolution is changed.

#### [Remark]

- 1) CIS has an initial dark correction data in factory setting memory. After turning on power, the initial dark correction data are booted in ASIC and FPGA registers automatically and dark correction function becomes available.
- 2) Periodic Re-generation of dark correction data is recommended caused by Values of Black output change by Temperature and Line period etc.
- 3) Scanning Image has some unusual strips by using incorrect dark correction data .
- 4) White correction has to be turned on under the condition that dark correction is turned on .
- 5) Refer the function specification about how to generate new dark correction data .

## 5-2 Setting⑨: White correction

※When operating Dark/White correction, input external sync. signal continuously, or conduct with internal sync. mode.

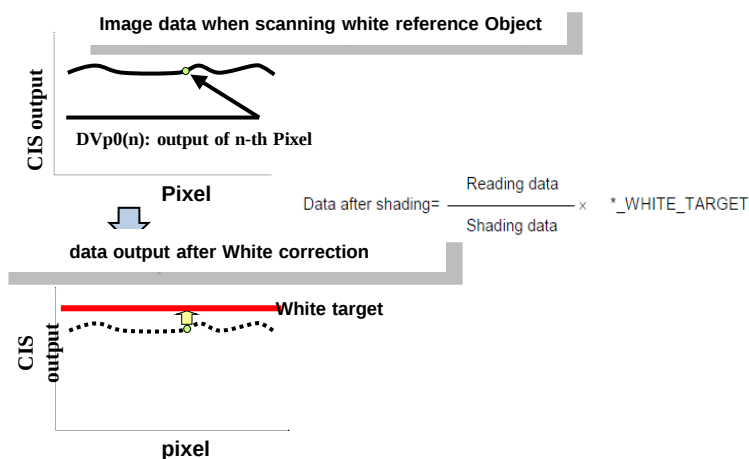
| Address | Register name              | R/W | Val       | Result                                                                    | Initial |
|---------|----------------------------|-----|-----------|---------------------------------------------------------------------------|---------|
| 7070    | WhiteCorrectionEnable      | R/W | 0 or 1    | Set White Correction On/Off<br>0:OFF /1:ON                                | 0       |
| 7074    | WhiteTarget_R              | R/W | 0 to 4095 | Set Red White Correction Target value                                     | 4000    |
| 7078    | WhiteTarget_G              | R/W | 0 to 4095 | Set Green White Correction Target value                                   | 4000    |
| 707C    | WhiteTarget_B              | R/W | 0 to 4095 | Set Blue White Correction Target value                                    | 4000    |
| 7080    | WhiteCorrectionExecute     | R/W | 1         | Generate White Correction data (Normal Trigger mode)                      | -       |
| 7084    | WhiteCorrectionExtraTriger | R/W | 0 or 1    | Generate White Correction data (External Trigger mode)<br>0:END / 1:START | 0       |

### 5-2-10 White correction

[Funcion]

This function is to correct variation of output from sensor IC pixel by pixel caused by variation of illumination strength and Pixel sensitivities . It makes all output of pixels uniform.

Refer chapter 2-3. , “how to use CIS” .



There are two (2) types of procedures to generate White correction data as follows.

- 1) Normal Trigger mode: WhiteCorrectionExecute  
White correction data generation sequence is initiated by executing “WhiteCorrection Execute” over GenlCamTM . The White correction data (average of 32 lines of pixel data) is save on the product.
- 2) External Trigger mode: WhiteCorrectionExtraTriger  
White correction data generation sequence is initiated by providing a start command at “WhiteCorrectionExtra Trigger” over GenlCamTM interface. The White correction data (maximum values of the average of 32 lines of pixel data until the end command is provided to CIS) are saved on this product.  
“WhiteTarget\_R,G,B” is a register to set a target value of the output of White Correction ON when CIS scans a white chart. The target value is based on 12 bit depths.

[Remark]

- 1) To prepare new White correction data , start to send command after turning on dark correction function under scanning white reference object having uniform reflection ratio .
- 2) Scanning Image has some unusual strips by using incorrect white correction data caused by scanning scratches , dirt and dusts on white reference object when re-generate white correction data.
- 3) This product has memory for saving correction data every resolution as same as dark correction. The white correction data which is applied for CIS is automatically changed when resolution is changed.

## 5-2 Setting⑩: PGA

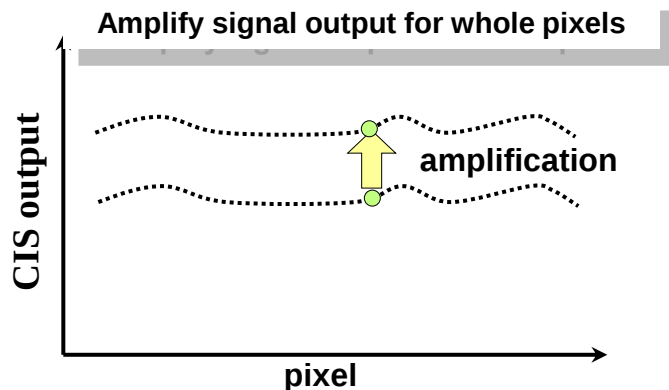
| Address | Register name     | R/W | Val           | Result                                                                                                                         | Initial |
|---------|-------------------|-----|---------------|--------------------------------------------------------------------------------------------------------------------------------|---------|
| 70A0    | DigitalGainEnable | R/W | 0 or 1        | Set PGA On/Off<br>0:OFF /1:ON                                                                                                  | 0       |
| 70A4    | DigitalGain_R     | R/W | -1024 to 3071 | Set a value of Red PGA (0 to 4.0)<br>$\text{Output data} = \text{Input data} \times \frac{1024 + \text{Register value}}{1024}$ | 0       |
| 70A8    | DigitalGain_G     | R/W | -1024 to 3071 | Set a value of Green PGA (0 to 4.0)                                                                                            | 0       |
| 70AC    | DigitalGain_B     | R/W | -1024 to 3071 | Set a value of Blue PGA (0 to 4.0)                                                                                             | 0       |

### 5-2-11 PGA

#### [Function]

Amplify image signals for whole pixels in a line by the designated magnification. Adjustable from 0 to 4.0 times for each color.

This amplification is performed by digital calculation. Thereby, Signal level increases by PGA function, but noise level also increases same as signal amplification.



#### [Remark]

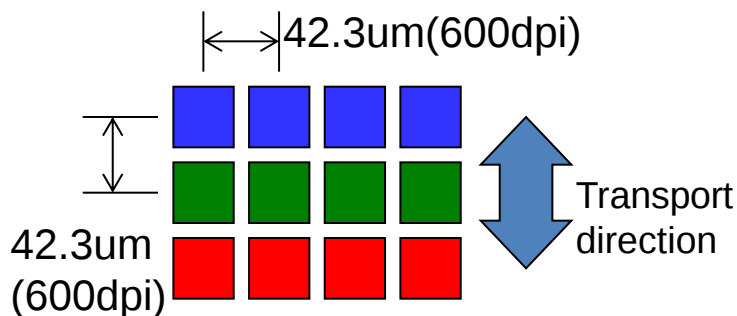
- 1) When you apply PGA with each color's output, make sure about White balance of color scanning.
- 2) The register value at "DigitalGain\_R,G,B" is defined to be a "Signed integer". When you set the register values based on hex number, make sure the sign of "Positive (+)" or "Negative (-)" of the register value.

A setting example: Register parameter data  
= -2 (decimal digit) = FFFFFFFEh (hex digit)

## 5-2 Setting⑪: Line adjustment

| Address | Register name           | R/W | Val        | Result                                                                                                                                  | Initial |
|---------|-------------------------|-----|------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------|
| 70C0    | LineAdjustment Enable   | R/W | 0 or 1     | Set Line adjustment On/Off<br>0:OFF /1:ON                                                                                               | 1       |
| 70C4    | LineAdjustmentDirection | R/W | 0 or 1     | Set transport direction<br>0: Normal (B → G → R :B-line first)<br>1: Opposit (R → G → B :R-line first)                                  | 0       |
| 70C8    | LineAdjustmentRatio     | R/W | 1 to 16384 | Resolution in transport direction / 600dpi Ratio (0.03 to 4.0)<br>LineAdjustmentRatio = Resolution(transport direction) / 600dpi × 4096 | 4096    |
| 70CC    | LineAdjustmentOfset     | R/W | 0 to 4096  | Offset setting of Green pixel (0 to 1.0)<br>$Offset = \frac{(Register\ value)}{4096}$                                                   | 0       |

### 5-2-12 Line adjustment



Each line of RGB photo-diodes on Sensor IC is assembled based on 600 dpi as described above. Line adjustment function creates internal line delay by using embedded line memory and adjust each line data position. (Initial setting)

#### [Function]

This function adjusts the different position of each RGB line into a certain position that scans same area of object.

Set the value of LineAdjustmentRatio according to the ratio of the resolution in transportation direction.

Example: Reslution in transportation direction 300dpi  
LineAdjustmentRatio = 300dpi / 600dpi × 4096 = 2048

#### [Remark]

- 1) An unstable transportation speed may cause a color bleeding or blurring.
- 2) This function is not to completely control a color bleeding or blurring. Use the effect of this function after confirmation enough.
- 3) When you organize Line adjustment by yourself, use this product as Line adjustment OFF.
- 4) For more details, please refer to Function Specification.

## 5-2 Setting⑫: $\gamma$ correction

| Address | Register name         | R/W | Val    | Result                                        | Initial |
|---------|-----------------------|-----|--------|-----------------------------------------------|---------|
| 70E0    | GammaCorrectionEnable | R/W | 0 or 1 | Set $\gamma$ correction On/Off<br>0:OFF /1:ON | 0       |

### 5-2-13 $\gamma$ correction function

#### [Function]

Change output linearity based on Look-up table ( $\gamma$  correction table).

The initial setting is  $\gamma=1$  ( $\gamma$  correction OFF).

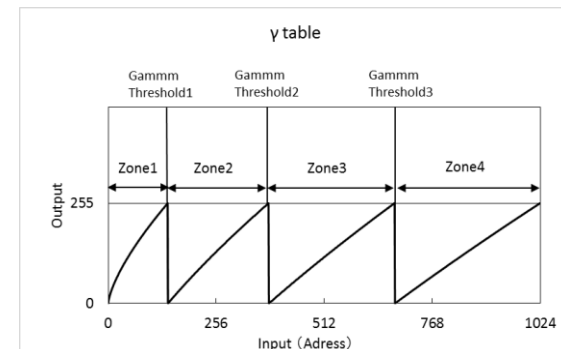
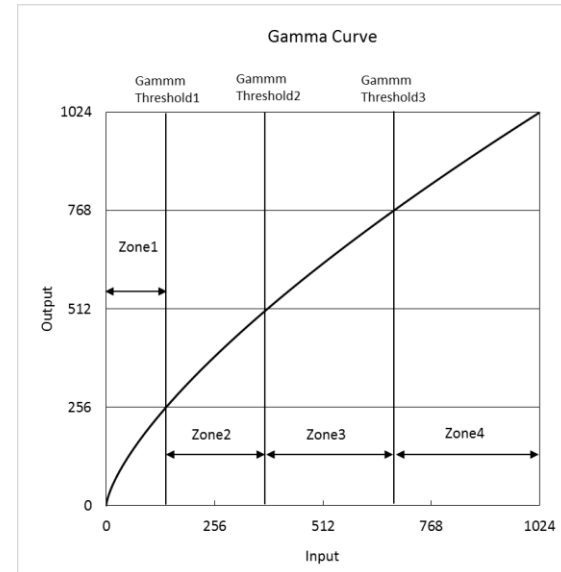
#### [Factory setting at look-up table]

$\gamma$  table :  $\gamma=2.2$

#### [Remark]

1)  $\gamma$  correction selects or specifies a gradation of 256 steps (8 bit length), that is one of 4 blocks that 1024 steps (10bit length) are divided by 4.

2) For more details of  $\gamma$  correction, refer to the Function Specification.



## 5-2 Setting⑬: Mono mode

| Address | Register name  | R/W | Val    | Result                                                                                                                                                                                                                                                                                            | Initial |
|---------|----------------|-----|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7110    | MonoModeSelect | R/W | 0 to 3 | Select Mono mode<br>(This function can change the output of RGB color mode.)<br>Mono mode 0: Green pixel output, 1: Luminance value output<br>2: R pixel output, 3: B pixel output<br>RGB color mode 0: Color output, 1: Luminance value output<br>2: Can not be selected, 3: Can not be selected | 0       |

### 5-2-14 Mono mode

#### [Function]

Select and switch a type of output image data when output format when you set Output format to be Mono mode.

Output data : Green pixel output, Luminance value output

Luminance value =  $77/256 \times R + 150/256 \times G + 29/256 \times B$

#### [Remark]

When you select RGB color mode and set "MonoModeSelect=1" (Luminance value), each of R, G, and B pixels outputs becomes the luminance value, providing monochrome image.

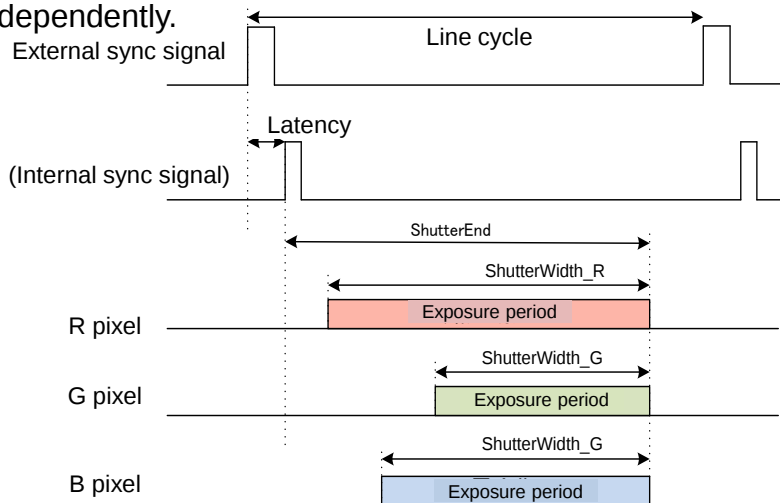
## 5-2 Setting⑭: Electronic shutter

| Address | Register name  | R/W | Val        | Result                                  | Initial |
|---------|----------------|-----|------------|-----------------------------------------|---------|
| 7030    | ShutterEnable  | R/W | 0 or 1     | Set Electric shutter On/Off 0:OFF /1:ON | 0       |
| 7034    | ShutterEnd     | R/W | 0 to 32765 | Set exposure end timing                 | 130     |
| 7038    | ShutterWidth_R | R/W | 1 to 32764 | Set Red exposure period                 | 1       |
| 703C    | ShutterWidth_G | R/W | 1 to 32764 | Set Green exposure period               | 1       |
| 7040    | ShutterWidth_B | R/W | 1 to 32764 | Set Blue exposure period                | 1       |

### 5-2-15 Electric Shutter

#### [Function]

Control exposure period of sensor IC for R, G and B independently.



**ShutterEnd:** Set end timing of exposure for RGB together  
 $\text{End timing}[\mu\text{s}] = \text{ShutterEnd} / 35$

**ShutterWidth\_R,G,B :** Set exposure period of RGB individually  
 $\text{Exposure period}[\mu\text{s}] = \text{ShutterWidth\_R,G,B} / 35$

#### [Remark]

1) This function is supposed to be used when you use an external lighting (continuous-wave mode) with this product. When you use built-in LED on this product, LED control function to adjust exposure period is recommended without using this function.  
 2) Set the value of "ShutterEnd, ShutterWidth" fulfilling with the following formula. (When setting Electric shutter ON, you need to control each exposure period of RGB according to your application.)

① Electric shutter ON (ShutterEnable='1')

$$A \leq \text{ShutterEnd} \leq \text{Line cycle (usec)} \times 35 - 6$$

$$A = 620@600\text{dpi}, 358@300\text{dpi}, 262@200\text{dpi}, 214@150\text{dpi}$$

② Electric shutter OFF (ShutterEnable='0')

$$130 \leq \text{ShutterEnd} \leq \text{Line cycle (usec)} \times 35 - 6$$

※ When you set the value of "ShutterEnd" is less than "①A" or "②130", some defective images are output.

※ When you set the value of "ShutterEnd" greater than "Line cycle x35-6", a sync signal might be ignored and the number of the output line may not correspond to the line cycle. When you use external trigger mode, keep a margin between the value of "ShutterEnd" and Line cycle.

3) Set the value of "ShutterWidth\_R,G,B" fulfilling with the following formula.

$$1 \leq \text{ShutterWidth\_R,G,B} \leq \text{ShutterEnd} - 1$$

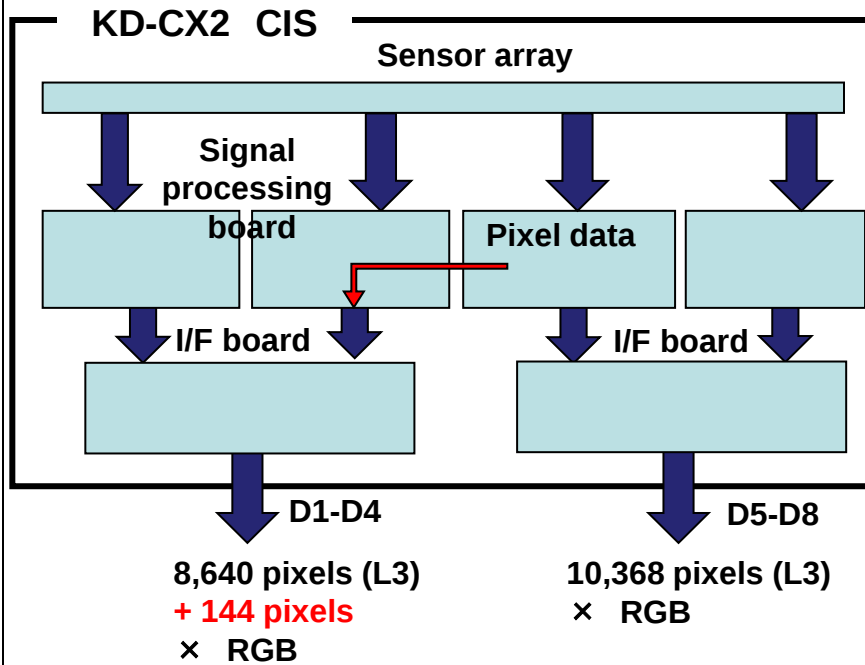
4) Electronic Shutter settings affect sensor outputs. When changing Electronic Shutter settings, generate Dark /White correction data again.

## 5-2 Setting⑮: Overwrap output

| Address | Register name | R/W | Val    | Result                                    | Initial |
|---------|---------------|-----|--------|-------------------------------------------|---------|
| 7120    | OverlapEnable | R/W | 0 or 1 | Set Overwrap output On/Off<br>0:OFF /1:ON | 0       |

### 5-2-16 Overwrap output

This function enables to add first 144 pixels data (6.1mm width of image ) of a next module on the output of a module.



#### [Function]

L3 type have 2 channels of CoaXPress™ and output parallel image data. This product can output image data from 2 different channels, which the image data are overwrapped partially. This function contribute to acquire the image data between the 2 different channels of CoaXPress™.

The number of the added or overwrapped pixels depend of the output resolution. (The total overwrapped image data correspond to the 6.1mm width of the acquired image.)

Number of the added pixels :

- 144 pixels @600dpi
- 72 pixels @300dpi
- 48 pixels @200dpi
- 36 pixels @150dpi

## 5-2 Setting⑯: Output width setting

| Address | Register name | R/W | Val        | Result                                                       | Initial                              |
|---------|---------------|-----|------------|--------------------------------------------------------------|--------------------------------------|
| 6008    | Width         | R/W | 0 to 16380 | Set number of output pixels in scan direction (output width) | L1:8672<br>L2:13872<br>L3:8816/10404 |

### 5-2-17 Output width setting

#### [Function]

Set the number of output pixel in scan direction.

※Each initial value is based on the maximum number of the pixels (600dpi, interpolation ON, Overwrap ON).

#### [Remark]

- 1) When you select lower resolution and operate faster than 55Khz of Line rate, this register values need to be changed.
- 2) The value of “Width” has to be greater than the actual number of output pixel and be a multiple of 4. Refer to the following table regarding the minimum number of “Width”.
- 3) The value of “Width” needs to be set on master channel and slave channel respectively.

| Model        |              | L1                                              | L2                     | L3                   |                        |
|--------------|--------------|-------------------------------------------------|------------------------|----------------------|------------------------|
| Min of Width | Overwrap OFF | Channel1                                        | Channel1               | Channel1             | Channel2               |
|              |              | 600dpi Interpolation ON<br>8672<br>(8669+dummy) | 13872<br>(13871+dummy) | 8672<br>(8670+dummy) | 10404<br>(10403+dummy) |
|              |              | 600dpi                                          | 13824                  | 8640                 | 10368                  |
|              |              | 300dpi                                          | 6912                   | 4320                 | 5184                   |
|              |              | 200dpi                                          | 4608                   | 2880                 | 3456                   |
|              |              | 150dpi                                          | 3456                   | 2160                 | 2592                   |
|              | Overwrap ON  | 600dpi Interpolation ON                         | Same as Overap OFF     | 8816<br>(8814+dummy) | Same as Overap OFF     |
|              |              | 600dpi                                          |                        | 8784                 |                        |
|              |              | 300dpi                                          |                        | 4392                 |                        |
|              |              | 200dpi                                          |                        | 2928                 |                        |
|              |              | 150dpi                                          |                        | 2196                 |                        |

## 5-2 Setting(others): Test pattern

| Address | Register name     | R/W | Val        | Result                                                                            | Initial |
|---------|-------------------|-----|------------|-----------------------------------------------------------------------------------|---------|
| 6020    | TestImageSelector | R/W | 0 to 3     | Set test pattern<br>0:OFF /1:Grey ramp horizontal<br>2:Grey ramp vertical /3:RGBW | 0       |
| 6024    | TestLineRate      | R/W | 0 to 55000 | Set line rate for test pattern<br><i>Line Rate[Hz] = (register value)</i>         | 55000   |
| 6028    | TriggerMode       | R/W | 0 or 1     | Set source of sync signal<br>0:Internal sync mode, 1: External sync mode          | 0       |

### 5-2-18 Test pattern

[Function]

Output a test pattern over CoaXPress™ in order to make sure image data communication from CIS to frame grabber. Please use this function when you setup your system.

#### 1) Grey ramp horizontal



#### 2) Grey ramp vertical



#### 3) RGBW



[Remark]

- 1) When you use this function based on Internal sync mode, you need to set Line rate and to switch the setting of "TriggerMode" to be "0→1→0". After running a sequence of "0→1→0" at "TriggerMode", Test pattern starts output.(When using External sync mode, this sequence is not necessary.)
- 2) The purpose of this function is to make sure if the data transfer is appropriated operated. When you use this function, the image data is not output.
- 3) After using Test pattern function, please run Device discovery process again in order to restart scanning. (Before Device discovery, some defective images output.)

## 5-2 Setting(others): Error and temperature indications

| Address | Register name                  | R/W | Val    | Result                                                                                                                                                                                                                                                             | Initial |
|---------|--------------------------------|-----|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7224    | DeviceTemperature<br>Mainboard | R   | -      | Indicate an internal temperature (°C) of FPGA on Image processing board (When using multiple image processing boards, this function indicates the maximum value.)                                                                                                  | -       |
| 7228    | DeviceTemperature<br>I/fboard  | R   | -      | Indicate an internal temperature (°C) of FPGA on I/F board. (When using multiple image processing boards, this function indicates the maximum value.)                                                                                                              | -       |
| 7230    | DeviceError                    | R   | 0 to 7 | Return “Error” indications about cooling fan and FPGA temperature.<br>0: Operating normally<br>'1' at 0bit: Error of cooling fan.<br>'1' at 1bit: Abnormal temperature of FPGA on Image processing board<br>'1' at 2bit: Abnormal temperature of FPGA on I/F board | -       |

### 5-2-19 Error and temperature indications

#### [Function]

This function enables to provide some indications of errors, when cooling fan is stopped or operates at slow speed or a temperature of internal FPGA becomes abnormally high. Additionally, this function can provide an information of the temperature of the internal FPGA.

#### [Remark]

- 1) When you read the registers, this product returns a value which shows the internal status of this product. Please confirm by reading the registers if there is an error or not. (On your control software attached with your frame grabber, the software indicates the last value you operated “read”. This value will not be updated until you will operate “read” again.

## 5-2 Setting(others):Prevention for Exposure Saturation

| Address | Register name                | R/W | Parameter Data | Function                                                                                                                                                                              | Initial |
|---------|------------------------------|-----|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7400    | STSP_Enable                  | R/W | 0 to 1         | Switching prevention for exposure saturation On/Off<br>0:OFF /1:ON                                                                                                                    | 0       |
| 7404    | STSP_MaxLine Period Counter  | R/W | 0 to 65535     | Setting the period to judge whether occurring the condition without external sync. signal or not.<br>$\text{Setting Period(} \mu\text{sec)} = \frac{(\text{register value}) + 1}{35}$ | 65535   |
| 7408    | STSP_Prohibited Time Counter | R/W | 0 to 65535     | Setting prohibited period for resuming to input sync. signal<br>$\text{Setting Period(} \mu\text{sec)} = \frac{(\text{register value}) + 1}{35}$                                      | 636     |

### 5-2-20 Prevention for Exposure Saturation

#### [Function]

In case of external sync mode, if you start CIS operating again with no external sync signal cannot be input while CIS operating, image will be flare or underexposed.

If the following settings are made when the function is on, image flare and under exposure will be suppressed when you re-operate.

- 1) Setting the period to judge whether occurring the condition without external sync. signal or not in operating condition of CIS shown in above.
- 2) When you restart CIS to take image, output image data from CIS taken on first sync signal may be incorrect due to previous shutter is taken automatically and exposure period is not sure.  
Therefore, it sets the period to prohibit reinputting sync signal.

#### 【Remark】

1) Set the STSP MaxLine Period Counter is longer than cycle time of input sync. signal.

2) Set the STSP Prohibited Time Counter according to below range.

$$1/\text{max. line rate} \leq \text{Prohibited Time} \leq \text{cycle time of input sync. signal}$$

※Max. line rate is change by data output format, output frequency, output resolution. Refer to 2-6 Specifications for detail.

# Appendix A: Control register list ①

| Address | Register name     | R/W | Val                                                                                                     | Result                                                                                                                                                                                                                                                                                                       | Initial                              |
|---------|-------------------|-----|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| 4014    | LinkConfig        | R/W | 0x40048,<br>0x40040,<br>0x40038,<br>0x20048,<br>0x20040,<br>0x20038,<br>0x10048,<br>0x10040,<br>0x10038 | Set Output data bitrate and number of output channel<br>0x40048:CXP6_X4,0x40040:CXP5_X4,0x40038:CXP3_X4<br>0x20048:CXP6_X2,0x20040:CXP5_X2,0x20038:CXP3_X2<br>0x10048:CXP6_X1,1x20040:CXP5_X1,0x10038:CXP3_X1<br><br>※CXP6=6.25 ,CXP5=5 ,CXP3=3.125 [Gbps/ch]<br>X1=Single(1ch) ,X2=Dual (2ch) ,X4=Quad(4ch) | 0x40048                              |
| 6004    | Height            | R   | 1                                                                                                       | 1Line fixed                                                                                                                                                                                                                                                                                                  | 1                                    |
| 6008    | Width             | R/W | 0 to 16380                                                                                              | Set number of output pixels in scan direction (output width) (*1)                                                                                                                                                                                                                                            | L1:8672<br>L2:13872<br>L3:8816/10404 |
| 600C    | OffsetX           | R/W | 0                                                                                                       | Line pixel position offset 0 fixed                                                                                                                                                                                                                                                                           | 0                                    |
| 6010    | PixelFormat       | R/W | 0x0401,<br>0x0402,<br>0x0101,<br>0x0102                                                                 | Switch image output format<br>0x0401:24bit RGB color, 0x0402:30bit RGB color<br>0x0101:8bit mono, 0x0102:10bit mono                                                                                                                                                                                          | 0x0401                               |
| 6014    | AcquisitionStart  | R/W | 1                                                                                                       | AcquisitionStart 1: Start                                                                                                                                                                                                                                                                                    | -                                    |
| 6018    | AcquisitionStop   | R/W | 1                                                                                                       | AcquisitionStop 1: Stop                                                                                                                                                                                                                                                                                      | -                                    |
| 601C    | AcquisitionMode   | R   | 0                                                                                                       | 0x00000000(Continuous) fixed                                                                                                                                                                                                                                                                                 | 0                                    |
| 6020    | TestImageSelector | R/W | 0 to 3                                                                                                  | Set test pattern<br>0:OFF /1:Grey ramp horizontal<br>2:Grey ramp vertical /3:RGBW                                                                                                                                                                                                                            | 0                                    |
| 6024    | TestLineRate      | R/W | 0 to 55000                                                                                              | Set line rate for test pattern<br>$Line\ Rate[Hz] = (register\ value)$                                                                                                                                                                                                                                       | 55000                                |
| 6028    | TriggerMode       | R/W | 0 or 1                                                                                                  | Set a source of sync signal<br>0: Internal sync mode 1: External sync mode                                                                                                                                                                                                                                   | 0                                    |

(\*) The register values of less than 7000 of Address values need to be set on master and slave channels respectively. (\*1) The setting values of Width of Master and Slave channels are respectively different.

## Appendix A: Control register list ②

| Address | Register name         | R/W | Val              | Result                                                                                                                         | Initial |
|---------|-----------------------|-----|------------------|--------------------------------------------------------------------------------------------------------------------------------|---------|
| 7000    | LinePeriodCounter     | R/W | 0<br>To<br>65535 | Set Line cycle (Internal sync mode)                                                                                            | 692     |
| 7010    | LedSelector           | R/W | 0 to 3           | LED control<br>0:OFF<br>1: Upper-stream LED-A ON<br>2: Down-stream LED-B ON<br>3: Both Upper-stream (A) and Down-stream (B) ON | 3       |
| 7014    | LedPulseDivision      | R/W | 0 to 3           | Set LED Pulse division<br>0:OFF, 1: 2 pulses, 2: 4 pulses, 3: 8 pulses                                                         | 0       |
| 7018    | LedPulseWidthA        | R/W | 0 to 65535       | Upper-stream LED-A lighting period or pulse width                                                                              | 490     |
| 701C    | LedPulseWidthB        | R/W | 0 to 65535       | Down-stream LED-B lighting period or pulse width                                                                               | 490     |
| 7020    | LedEffectivePeriod    | R/W | 0 to 65535       | Set LED Effective Period                                                                                                       | 692     |
| 7030    | ShutterEnable         | R/W | 0 or 1           | Set Electric shutter On/Off 0:OFF /1:ON                                                                                        | 0       |
| 7034    | ShutterEnd            | R/W | 0 to 32765       | Set exposure end timing                                                                                                        | 130     |
| 7038    | ShutterWidth_R        | R/W | 1 to 32764       | Set Red exposure period                                                                                                        | 1       |
| 703C    | ShutterWidth_G        | R/W | 1 to 32764       | Set Green exposure period                                                                                                      | 1       |
| 7040    | ShutterWidth_B        | R/W | 1 to 32764       | Set Blue exposure period                                                                                                       | 1       |
| 7050    | DarkCorrectionEnable  | R/W | 0 or 1           | Set Dark correction On/Off<br>0:OFF /1:ON                                                                                      | 0       |
| 7054    | DarkCorrectionExecute | R/W | 1                | Generate Dark correction data                                                                                                  | -       |
| 7070    | WhiteCorrectionEnable | R/W | 0 or 1           | Set White correction On/Off<br>0:OFF /1:ON                                                                                     | 0       |
| 7074    | WhiteTarget_R         | R/W | 0 to 4095        | Set Red White Correction Target value                                                                                          | 4000    |
| 7078    | WhiteTarget_G         | R/W | 0 to 4095        | Set Green White Correction Target value                                                                                        | 4000    |
| 707C    | WhiteTarget_B         | R/W | 0 to 4095        | Set Blue White Correction Target value                                                                                         | 4000    |

# Appendix A: Control register list ③

| Address | Register name               | R/W | Val           | Result                                                                                                                                                                                                                     | Initial |
|---------|-----------------------------|-----|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7080    | WhiteCorrectionExecute      | R/W | 1             | Generate White Correction data (Normal Trigger mode)                                                                                                                                                                       | -       |
| 7084    | WhiteCorrectionExtraTrigger | R/W | 0 or 1        | Generate White Correction data (External Trigger mode)<br>0:END / 1:START                                                                                                                                                  | 0       |
| 70A0    | DigitalGainEnable           | R/W | 0 or 1        | Set PGA On/Off<br>0:OFF /1:ON                                                                                                                                                                                              | 0       |
| 70A4    | DigitalGain_R               | R/W | -1024 to 3071 | Set a value of Red PGA (0 to 4.0)                                                                                                                                                                                          | 0       |
| 70A8    | DigitalGain_G               | R/W | -1024 to 3071 | Set a value of Green PGA (0 to 4.0)                                                                                                                                                                                        | 0       |
| 70AC    | DigitalGain_B               | R/W | -1024 to 3071 | Set a value of Blue PGA (0 to 4.0)                                                                                                                                                                                         | 0       |
| 70B0    | ResolutionSetting           | R/W | 0 to 4        | Set Resolution and Interpolation On/Off<br>0: 600dpi, Interpolation ON<br>1: 600dpi, Interpolation OFF<br>2: 300dpi mode<br>3: 200dpi mode<br>4: 150dpi mode ※Interpolation is not supported on 300,200, and 150dpi modes. | 1       |
| 70C0    | LineAdjustmentEnable        | R/W | 0 or 1        | Set Line adjustment On/Off<br>0:OFF /1:ON                                                                                                                                                                                  | 1       |
| 70C4    | LineAdjustmentDirection     | R/W | 0 or 1        | Set transport direction<br>0: Normal (B → G → R : B-line first)<br>1: Opposit (R → G → B : R-line first)                                                                                                                   | 0       |
| 70C8    | LineAdjustmentRatio         | R/W | 1 to 16384    | Resolution in transport direction / 600dpi Ratio (0.03 to 4.0)<br>$LineAdjustmentRatio = Resolution(transport\ direction) / 600dpi \times 4096$                                                                            | 4096    |
| 70CC    | LineAdjustmentOffset        | R/W | 0 to 4096     | Offset setting of Green pixel (0 to 1.0)<br>$Offset = \frac{(Register\ value)}{4096}$                                                                                                                                      | 0       |

# Appendix A: Control register list ④

| Address | Register name               | R/W | Val       | Result                                                                                                                                                                                                                                                                                                 | Initial |
|---------|-----------------------------|-----|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 70E0    | GammaCorrectionEnable       | R/W | 0 or 1    | Set γ correction On/Off<br>0:OFF /1:ON                                                                                                                                                                                                                                                                 | 0       |
| 70E4    | GammaThreshold1_R           | R/W | 0 to 1023 | Set Threshold value 1 of γ correction for Red                                                                                                                                                                                                                                                          | 49      |
| 70E8    | GammaThreshold2_R           | R/W | 0 to 1023 | Set Threshold value 2 of γ correction for Red                                                                                                                                                                                                                                                          | 223     |
| 70EC    | GammaThreshold3_R           | R/W | 0 to 1023 | Set Threshold value 3 of γ correction for Red                                                                                                                                                                                                                                                          | 544     |
| 70F0    | GammaThreshold1_G           | R/W | 0 to 1023 | Set Threshold value 1 of γ correction for Green                                                                                                                                                                                                                                                        | 49      |
| 70F4    | GammaThreshold2_G           | R/W | 0 to 1023 | Set Threshold value 2 of γ correction for Green                                                                                                                                                                                                                                                        | 223     |
| 70F8    | GammaThreshold3_G           | R/W | 0 to 1023 | Set Threshold value 3 of γ correction for Green                                                                                                                                                                                                                                                        | 544     |
| 70FC    | GammaThreshold1_B           | R/W | 0 to 1023 | Set Threshold value 1 of γ correction for Blue                                                                                                                                                                                                                                                         | 49      |
| 7100    | GammaThreshold2_B           | R/W | 0 to 1023 | Set Threshold value 2 of γ correction for Blue                                                                                                                                                                                                                                                         | 223     |
| 7104    | GammaThreshold3_B           | R/W | 0 to 1023 | Set Threshold value 3 of γ correction for Blue                                                                                                                                                                                                                                                         | 544     |
| 7110    | MonoModeSelect              | R/W | 0 to 3    | Select Mono mode<br>(This function can change the output of RGB color mode.)<br>Mono mode 0: Green pixel output, 1: Luminance value output<br>2: Red pixel output, 3: Blue pixel output<br>RGB color mode 0: Color output, 1: Luminance value output<br>2: Can not be selected, 3: Can not be selected | 0       |
| 7120    | OverlapEnable               | R/W | 0 or 1    | Set Overwrap output On/Off<br>0:OFF /1:ON                                                                                                                                                                                                                                                              | 0       |
| 7200    | UserSet_1_Save              | R/W | 1         | Save CIS settings to User Setting 1 on Flush Memory.                                                                                                                                                                                                                                                   | -       |
| 7204    | UserSet_2_Save              | R/W | 1         | Save CIS settings to User Setting 2 on Flush Memory.                                                                                                                                                                                                                                                   | -       |
| 7208    | UserSet_3_Save              | R/W | 1         | Save CIS settings to User Setting 3 on Flush Memory.                                                                                                                                                                                                                                                   | -       |
| 720C    | UserSet_1_Load              | R/W | 1         | Read out CIS settings on User Setting 1.                                                                                                                                                                                                                                                               | -       |
| 7210    | UserSet_2_Load              | R/W | 1         | Read out CIS settings on User Setting 2.                                                                                                                                                                                                                                                               | -       |
| 7214    | UserSet_3_Load              | R/W | 1         | Read out CIS settings on User Setting 3.                                                                                                                                                                                                                                                               | -       |
| 7218    | UserSet_Load_FactoryDefault | R/W | 1         | Read out CIS settings on Factory Setting (Initial Setting).                                                                                                                                                                                                                                            | -       |

# Appendix A: Control register list ⑤

| Address | Register name                   | R/W | Val        | Result                                                                                                                                                                                                                                                             | Initial |
|---------|---------------------------------|-----|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 7224    | DeviceTemperature<br>Mainboard  | R   | -          | Indicate an internal temperature (°C) of FPGA on Image processing board (When using multiple image processing boards, this function indicates the maximum value.)                                                                                                  | -       |
| 7228    | DeviceTemperature<br>I/fboard   | R   | -          | Indicate an internal temperature (°C) of FPGA on I/F board. (When using multiple image processing boards, this function indicates the maximum value.)                                                                                                              | -       |
| 7230    | DeviceError                     | R   | 0 to 7     | Return "Error" indications about cooling fan and FPGA temperature.<br>0: Operating normally<br>'1' at 0bit: Error of cooling fan.<br>'1' at 1bit: Abnormal temperature of FPGA on Image processing board<br>'1' at 2bit: Abnormal temperature of FPGA on I/F board | -       |
| 7240    | UserSet_BootSet_select          | R/W | 0 to 3     | Select a setting to boot after power-ON.<br>0:Factory Setting, 1:User Setting 1, 2:User Setting 2, 3:User setting 3                                                                                                                                                | 0       |
| 7248    | UserSet_Use_600dpi              | R/W | 0 to 1     | Correction data for 600dpi resolution<br>0:Disable / 1:Activate                                                                                                                                                                                                    | 1       |
| 724C    | UserSet_Use_300dpi              | R/W | 0 to 1     | Correction data for 300dpi resolution<br>0:Disable / 1:Activate                                                                                                                                                                                                    | 0       |
| 7250    | UserSet_Use_200dpi              | R/W | 0 to 1     | Correction data for 200dpi resolution<br>0:Disable / 1:Activate                                                                                                                                                                                                    | 0       |
| 7254    | UserSet_Use_150dpi              | R/W | 0 to 1     | Correction data for 150dpi resolution<br>0:Disable / 1:Activate                                                                                                                                                                                                    | 0       |
| 7300    | DevicePassword                  | R/W | 0 to 65535 | To access Dark/White correction data and γ-correction data                                                                                                                                                                                                         | -       |
| 7400    | STSP_Enable                     | R/W | 0 to 1     | Switching prevention for exposure saturation On/Off<br>0:OFF /1:ON                                                                                                                                                                                                 | 0       |
| 7404    | STSP_MaxLine Period<br>Counter  | R/W | 0 to 65535 | Setting the period to judge whether occurring the condition without external sync. signal or not.                                                                                                                                                                  | 65535   |
| 7408    | STSP_Prohibited Time<br>Counter | R/W | 0 to 65535 | Setting prohibited period for resuming to input sync. signal                                                                                                                                                                                                       | 636     |

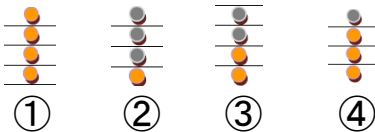
# Appendix A: Control register list ⑥

| Address | Register name         | R/W | Val              | Result                                             | Initial |
|---------|-----------------------|-----|------------------|----------------------------------------------------|---------|
| 2020    | DeviceModelName       | R   | 32Byte<br>String | The model name is stored.<br>example:KD6R367CX2    | -       |
| 2090    | DeviceFirmwareVersion | R   | 32Byte<br>String | The firmware version is stored.<br>example:3.2.0.0 | -       |
| 20B0    | DeviceID              | R   | 16Byte<br>String | The serial number is stored.<br>example:2411601001 | -       |

## Appendix B: Error indicator

LED indicator on this product shows this product's status (refer to Chapter 4-2) and Error indications based on register values (refer to Chapter 5-2-19).

The details of this error indicator are described in below.

| Item | Status                                                                                                                                                                                                                                                                                          | Contents of errors and necessary treatment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | After power on, a part of status LED keeps indicating Red and Orange alternatively.<br>                                                                                                                        | This status shows a failure of the connection with your frame grabber over CXP link and a status of keeping "CXP link establishing". Please check the following point.<br>①Is CoaXPress™ cable whose status LED indicates the error unplugged?                                                                                                                                                                                                                                                                                                                                           |
| 2    | After power on, all of status LED keeps indicating Red and Orange alternatively.<br>                                                                                                                           | This status shows a failure of the connection with your frame grabber over CXP link. Please check the following points.<br>①Is CoaXPress™ cable whose status LED indicates the error unplugged?<br>②Is the setup of your frame grabber completed correctly?                                                                                                                                                                                                                                                                                                                              |
| 3    | After power on, the status LED keeps indicating Orange continuously.<br>①Ch1 - 4: Solid orange<br>②Ch1 - 3: OFF Ch4:Solid orange<br>③Ch1 - 2: OFF Ch3 - 4:Solid orange<br>④Ch1: OFF Ch2 - 4:Solid orange<br> | This status shows a failure of System-boot operation of this product. If an appropriate voltage is not provided to CIS, this status happens. Please check the following points.<br>①Is the pin assignment (5V or GND) of V1/V3 connectors of DC5V correct? (If +5V and GND pins specified on the pin assignment table are not connected, the sensor board cannot operate correctly.<br>②Is the current limiter setting of your DC5V power unit too low when power on?<br>③Is the voltage of DC5V less than 4.75V?<br>If you don't see any of them above, CIS might be broken or damaged. |
| 4    | All status LED indicates Red.<br>                                                                                                                                                                            | This status shows an abnormal temperature of FPGA on /F board. Make sure if the surrounding temperature of this product is too high.<br>When necessary, prepare additional cooling solution to this product.                                                                                                                                                                                                                                                                                                                                                                             |

## Appendix B: Error indicator

| Item | Status                                                                                                                                                             | Contents of errors and necessary treatment                                                                                                                                                                                                                                                         |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5    | Error indicator register<br>'1' at 0bit of DeviceError<br>(DeviceError = 1,3,5,7 )                                                                                 | This status indicates that the cooling fan is stopped or operates at slow speed. Please check the following point.<br>①Is there anything that bothers cooling fan?<br>If there is nothing that bothers the cooling fan's operations, the cooling fan may be broken or at the end of the life time. |
| 6    | Error indication register "DeviceError"<br>"1" at 1bit (DeviceError = 2,3,6,7 )<br>Error indication register "DeviceError"<br>"1" at 2bit (DeviceError = 4,5,6,7 ) | This status indicates an abnormal temperature of FPGA. Please make sure if the surrounding temperature of this product is too high. When necessary, please prepare additional cooling method to this product.                                                                                      |

## Appendix C: How to connect with frame grabber

A setup sequence in Chapter 4-1) is described in below.

- Run Device discovery process by control software attached with your frame grabber.
- Control CIS by the control software attached with your frame grabber.

① APX-3664 manufactured by Avaldata

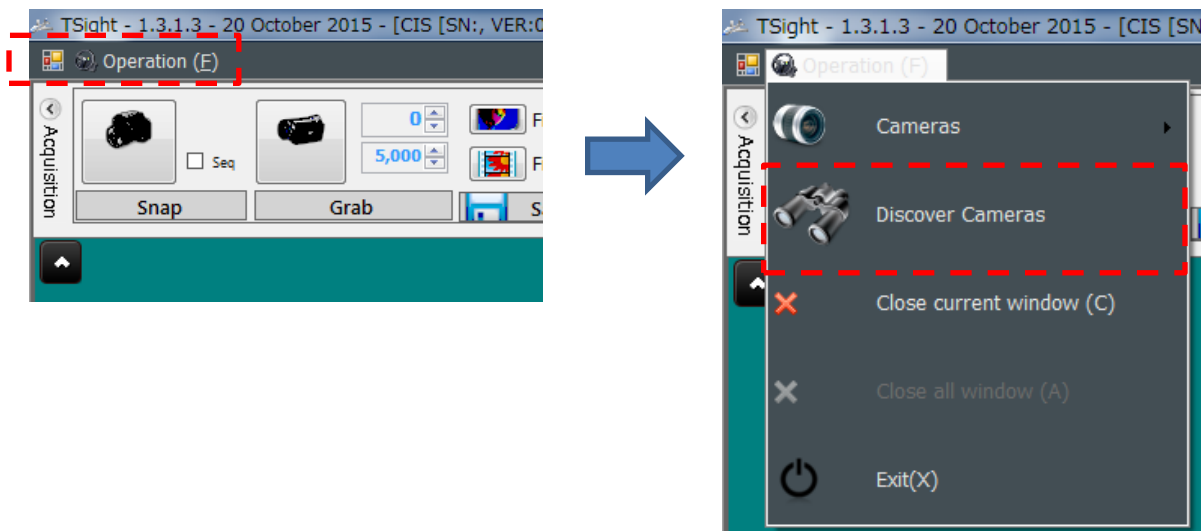
② Radient eV-CXP manufactured by Matrox

① APX-3664 manufactured by Avaldata

**【Device discovery process】**

1) Initiate Control software TransFlyer – Tsight.

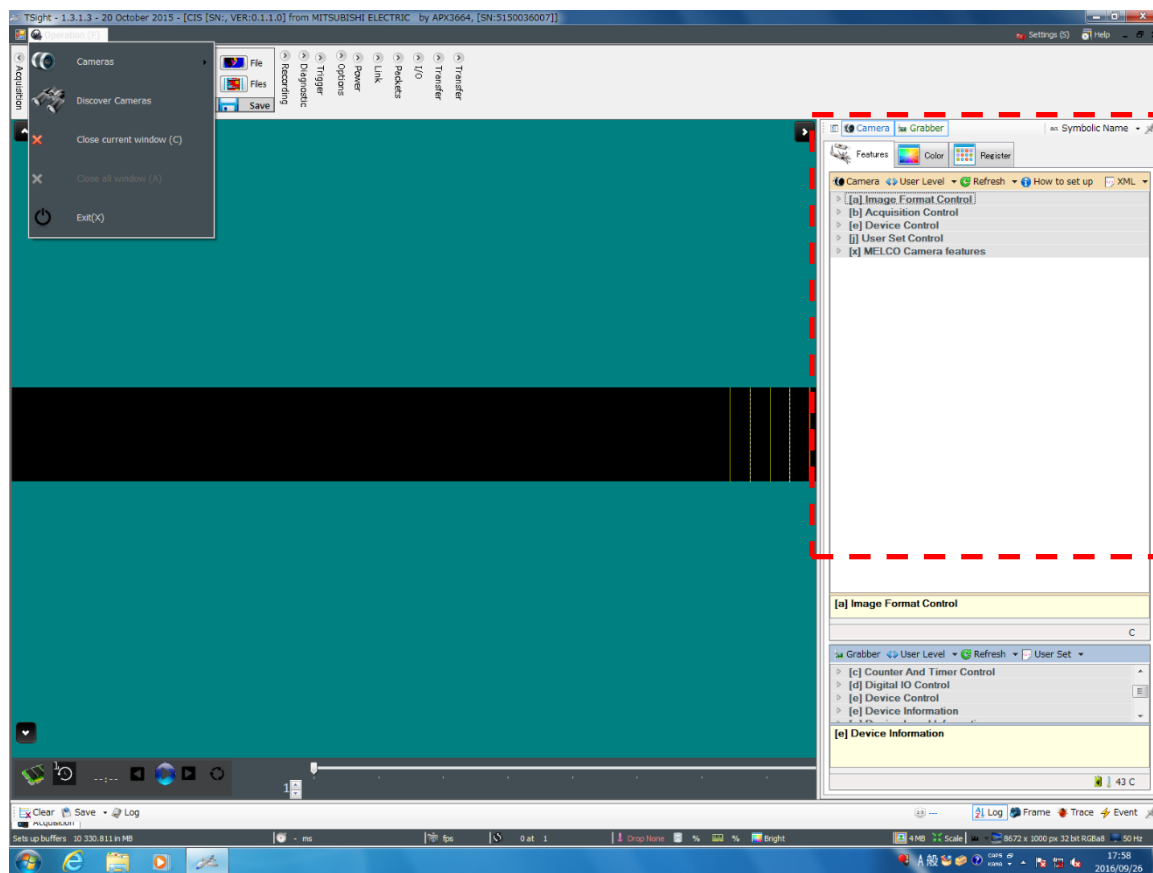
When initiating the software, the device discovery process is automatically operated. When you re-operate the device discovery process, select “Discover Cameras” on the tab of “Operation”.



## Appendix C: How to connect with frame grabber

### 【Indication of register information, Setting method】

Once the Device discovery process is successfully operated, the register information is indicated at the tab of “Features” of “Camera” on your right side of TSight window. When you select a top item, the register information at lower layer will be indicated. You can adjust CIS’ settings by changing these indicated register values.



| Features Color Register                     |          |     |
|---------------------------------------------|----------|-----|
| Camera User Level Refresh How to set up XML |          |     |
| [x] MELCO Camera features                   |          |     |
| LinePeriodCounter                           | 700      |     |
| Clock                                       | 35       | MHz |
| LinePeriod                                  | 20.02857 | us  |
| LedSelector                                 | LedOn_AB |     |
| LedPulseDivision                            | Div0     |     |
| LedPulseWidthA                              | 450      |     |
| LedPulseWidthB                              | 450      |     |
| LedEffectivePeriod                          | 700      |     |
| ShutterEnable                               | Off      |     |
| ShutterEnd                                  | 130      |     |
| ShutterWidth_R                              | 1        |     |
| ShutterWidth_G                              | 1        |     |
| ShutterWidth_B                              | 1        |     |
| DarkCorrectionEnable                        | Off      |     |
| DarkCorrectionExecute                       | Execute  |     |
| WhiteCorrectionEnable                       | Off      |     |
| WhiteTarget_R                               | 4000     |     |

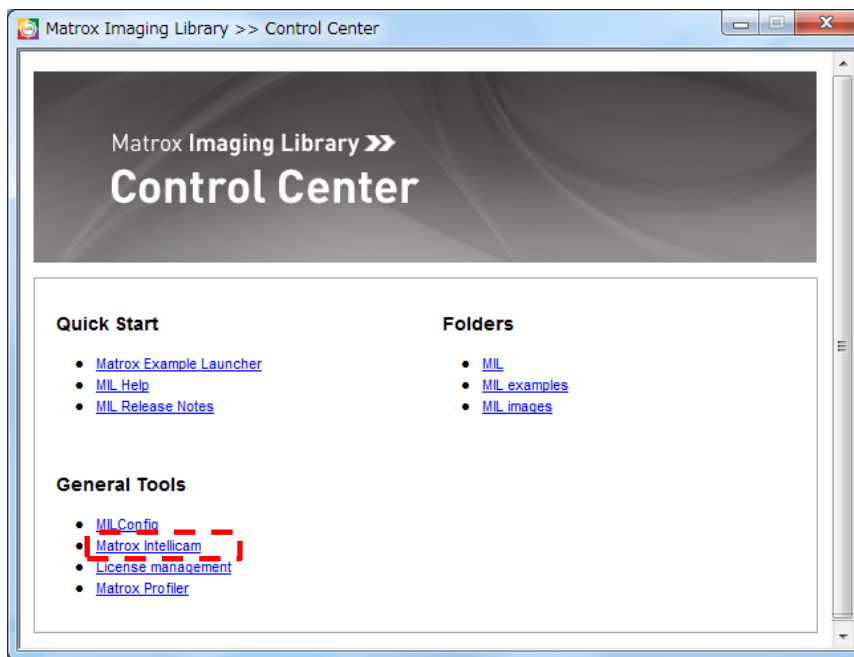
Register  
name

Register value

## ② Radiant eV-CXP manufactured by Matrox

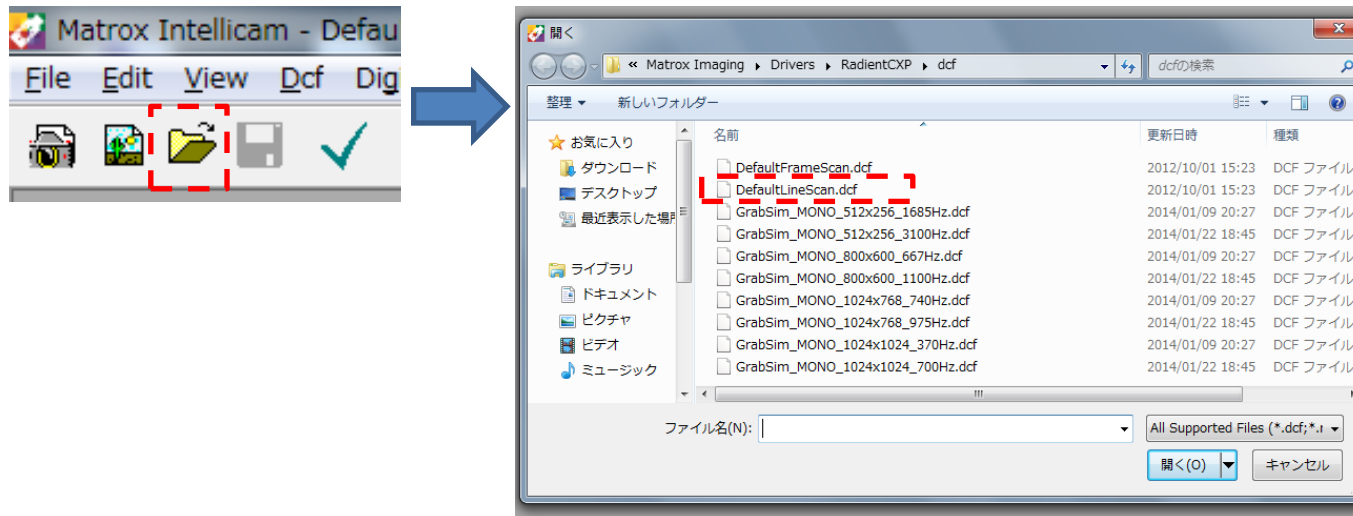
### 【Device discovery process】

1) Initiate “Matrox Intellicam “ on Control Center of Matrox Imaging Library



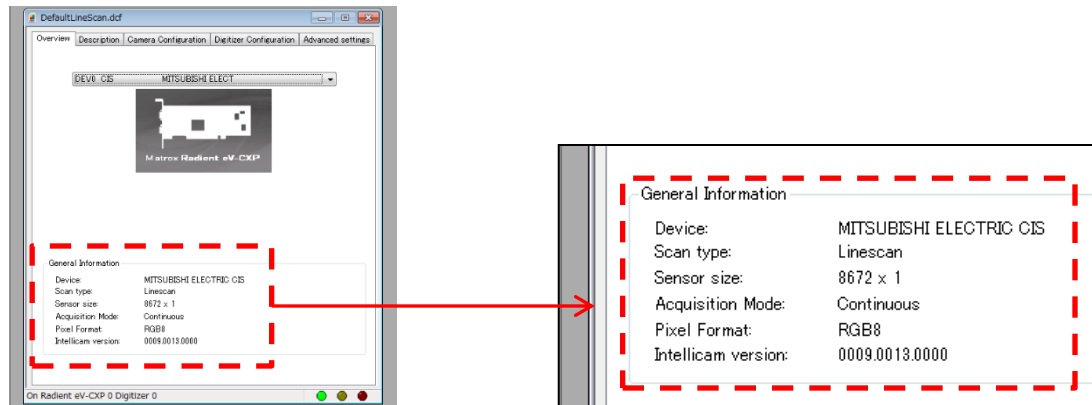
## Appendix C: How to connect with frame grabber

2) Open a dcf file of “DefaultLineScan.dcf” on Intellicam menu.



3) By opening the dcf file, the Device discovery process is operated.

Once the Device discovery process is successfully operated, the result is indicated at the window of dcf file information.



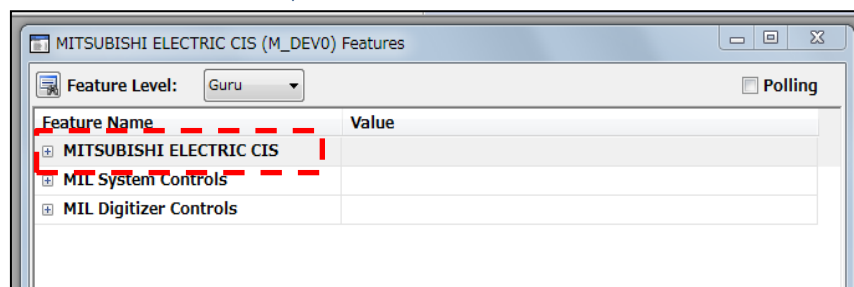
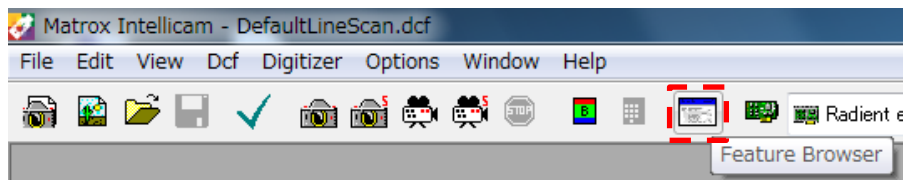
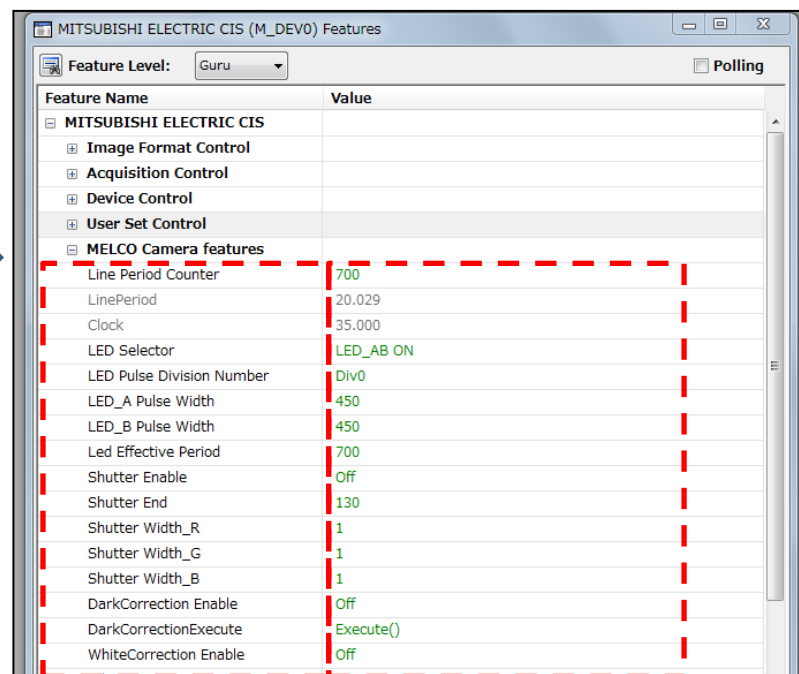
# Appendix C: How to connect with frame grabber

【Indication of register information, Setting method】

Open “Feature Browser” on Intellicam.

When you select a top item, the register information at lower layer will be indicated.

You can adjust CIS’ settings by changing these indicated register values.

| Feature Name                   | Value     |
|--------------------------------|-----------|
| <b>MITSUBISHI ELECTRIC CIS</b> |           |
| Image Format Control           |           |
| Acquisition Control            |           |
| Device Control                 |           |
| User Set Control               |           |
| <b>MELCO Camera features</b>   |           |
| Line Period Counter            | 700       |
| LinePeriod                     | 20.029    |
| Clock                          | 35.000    |
| LED Selector                   | LED_AB ON |
| LED Pulse Division Number      | Div0      |
| LED_A Pulse Width              | 450       |
| LED_B Pulse Width              | 450       |
| Led Effective Period           | 700       |
| Shutter Enable                 | Off       |
| Shutter End                    | 130       |
| Shutter Width_R                | 1         |
| Shutter Width_G                | 1         |
| Shutter Width_B                | 1         |
| DarkCorrection Enable          | Off       |
| DarkCorrectionExecute          | Execute() |
| WhiteCorrection Enable         | Off       |

Register  
name

Register values