MITSUBISHI ELECTRIC

Changes for the Better

CONTACT IMAGE SENSOR (CIS)
KD Series for Web Surface Inspection

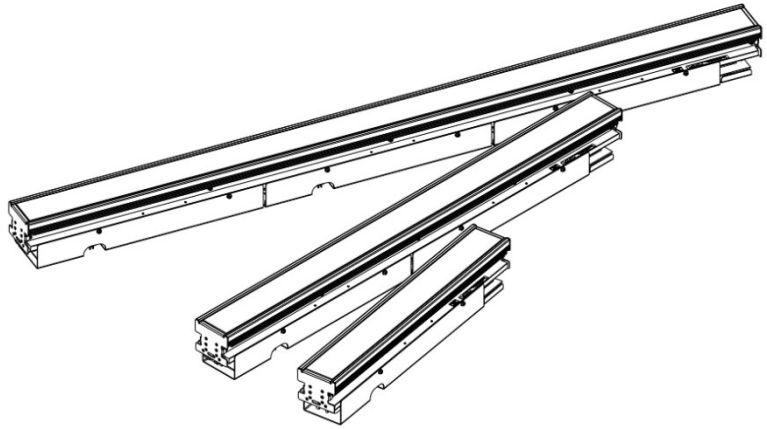
KD6R309MX, KD6R617MX, KD6R926MX

KD6R309MX-NL, KD6R617MX-NL, KD6R926MX-NL

User's Manual

TM-XG537C

January 31st 2020



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 be used 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 LIMITEDTO ANY AND ALL RESPONSIBILITY OR LIABILITY BASED ON CONTRACT, WARRANTY, TORT, PRODUCT LIABILITY) FOR ANY INJURY OR DEATH TO PERSONS OR LOSS OR DAMAGE TOPROPERTY 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

Warning	This indicates that improper use of this product may result in a hazard such as death or catastrophic bodily injury.
Caution	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
	**Do not operate this product in a place where it is explosive, combustible or inflammable.** Operating in a place having propane gas, gasoline or flammable gas may cause a fire and/or an explosion.
	**Use power supply specified or intended in this product's specification, data sheet or manual.** Otherwise, a fire, an electric shock or a malfunction may occur.
	**Stop operation when you find any abnormalities or defects.** Otherwise, a fire or an electric shock may occur.
	**Do not repair, disassemble and/or modify by yourself.** 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.
	**Do not get this product wet. Handle this product with water-proofing.** 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.
	**Keep this product clean. And do not touch the glass surface of this product.** 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.
	**Do not operate this product outdoors.**

1-2 PRECAUTIONS

	Warning
	**Do not put anything on this product.** Otherwise, a fire or electrical shock may occur because of the things or materials in this product.
	**Do not put this product on an unstable surface, slanting and/or vibrating.** Otherwise, drop and/or fail of this product may cause injury.
	**Do not look at the internal illumination directly.** This product comprises a bright illumination.
	**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.** Doing so may cause serious damage.

1-2 PRECAUTIONS

	Caution
	**Do not store this product in the following places.** ●In a vibrating or precarious place ●In a humid, smoky, vaporized or dusty place ●In a slanting place ●In a place exposed by direct sun light ●In a temperature vasying place ●Near anything generating heat (eg. A stove, heater, etc) ●In a corrosive gas atmosphere（CL_2, H_2S, NH_3, SO_2, NO_X etc.）
	**Care should always be exercised when handling and operating this product with your equipment or device**. ●Do not drop or damage this product. ●Do not put things on this product. ●No food or drink beside this product. ●Do not put any materials or liquids on this product. ●Avoid any ingression of materials, metals or smoke into this product and its connector.
	**Use the specified power cable connector and Camera Link® cable.**
	**Power OFF when you insert or remove cables.** Otherwise, an electric shock or a malfunction may occur.

1-2 PRECAUTIONS

	Caution
	**Put cables in a fixed position appropriately while operating.** Otherwise, a connection failure and damage may occur.
	**Do not use or operate this product in a slanting or unstable place**
	**Do not use or operate this product in a humid, smoky, vaporized or dusty place.**
	**Do not disassemble the side-bracket for mechanical mounting to your equipment or device.** Otherwise, an ingression of materials and dust, or a defect or a malfunction may occur.
	**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.** Doing so may cause serious damage.
	**Be cautious of your cloths and arms for not to be caught by the sheet metal attached to the edge of the glass side.** It may cause injury.

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 "2-8 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 CE marking

This product is designed to comply with EMC Directive 2004/108/EC of EU legislation. However, to be compliant, 5V and 24V power cables have to be 2m or less, and also in order to reduce the noise emission from the cables, the cables must attach the ferrite cores, as described below.

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 in conformity with the following EMC directives and standards.

EMC directives	2004/108/EC	
Applicable standards	Immunity	EN 61000-6-2 : 2005
	Emission	EN 61000-6-4 : 2007

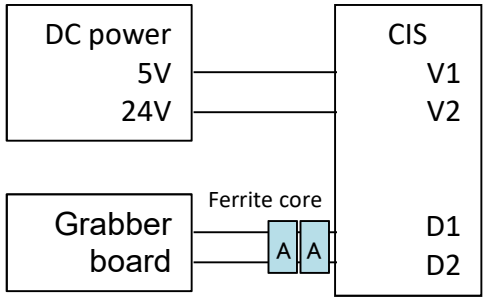
Category of ISM equipment by EN55011: Comply with Group 1, Class A test standard

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.

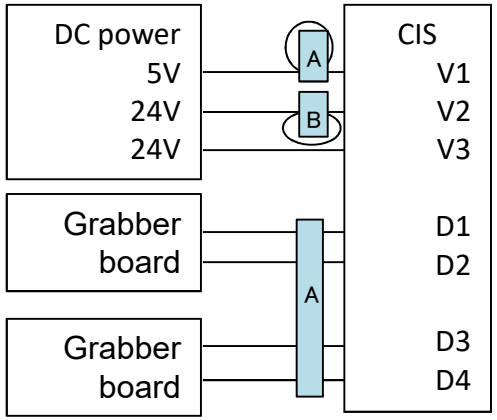
1-3 CE marking

1-3-1 CE marking applicable conditions

1. KD6R309MX (A3 type)



2. KD6R617MX (A1 type)



In order to be compliant to the above mentioned standards,
attach ferrite cores as shown in the left diagrams, and reduce the noise emission from the cables.

Recommenced ferrite cores are as shown below.

Ferrite core A : RFC-20, KITAGAWA INDUSTRIES CO.,LTD
Ferrite core B : GRFC-13, KITAGAWA INDUSTRIES CO.,LTD
Ferrite core C : RFC-H13, KITAGAWA INDUSTRIES CO.,LTD

1. KD6R309MX (A3 type)

Attach ferrite cores as described below.
- Connector D1, D2 / Frame grabber board connecting cables
Bundled: Two Ferrite core A (1 turn)

2. KD6R617MX (A1 type)

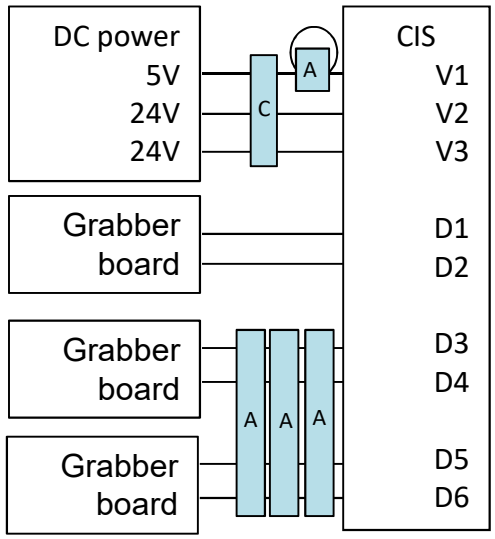
Attach ferrite cores as described below.
- Connector V1 / 5V power connecting cable: One Ferrite core A (2 turn)

- Connector V2 / 24V power connecting cable: One Ferrite core B (2 turn)

- Connector D1, D2, D3, D4 / Frame grabber board connecting cables
Bundled: One Ferrite core A (1 turn)

1-3 CE marking

3. KD6R926MX (A0 type)



3. KD6R926MX (A0 type)

Attach ferrite cores as described below.

- Connector V1 / 5V power connecting cable: One Ferrite core A (2 turn)

- Connector V1 / 5V power connecting cable
  Connector V2 / 24V power connecting cable
  Connector V3 / 24V power connecting cable
  Bundled: One Ferrite core C (1 turn)

- Connector D3, D4, D5, D6 / Frame grabber board connecting cables
  Bundled: Three Ferrite core A (1 turn)

1-4 WARRANTY

1-4-1 Warranty scope

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

1-4-2 Warranty period

18 months from the delivery date to the customers who purchased this product.

1-4-3 Out of warranty

Notwithstanding the above, Mitsubishi Electric's warranty shall not cover, extend or apply to any defect attributable to;

In the following circumstances, this product are not covered under warranty.

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

The cost of repair or replacement shall be charged to the customer who requested to repair the Out of Warranty product.

1-5 REPAIR

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 within the warranty period.

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 compatible 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 bore by sending party.

1-5-3 Repair period

This product basically would be repaired for 1 year after the final production of this product, provided that Mitsubishi Electric would be able to maintain production equipments 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.

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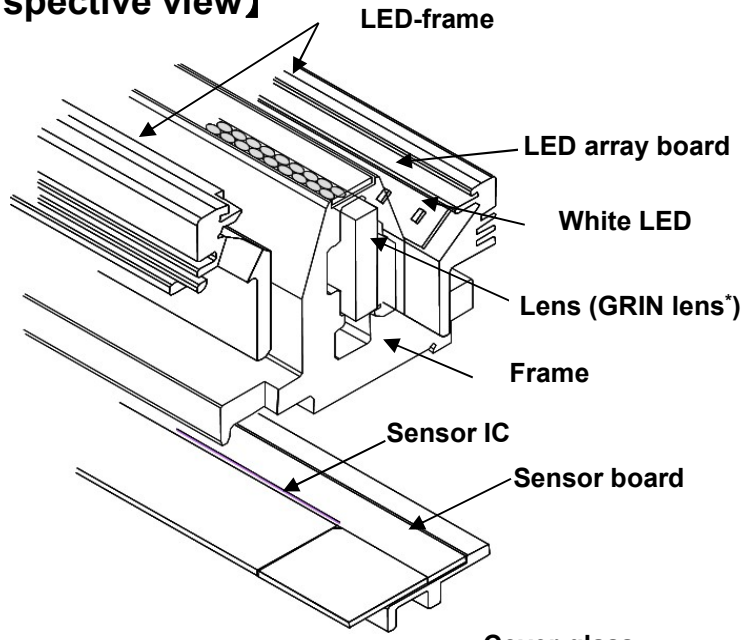
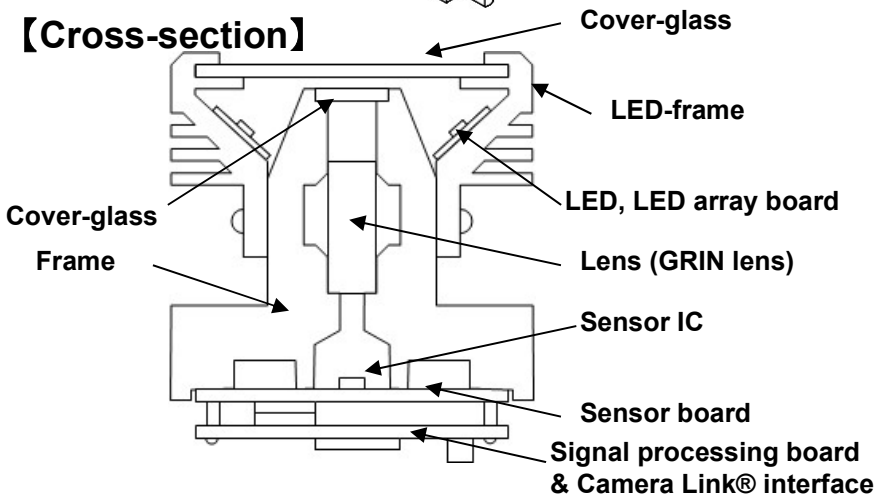
Chapter 2 : Overview

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.

*GRIN lens : Gradient Index lens

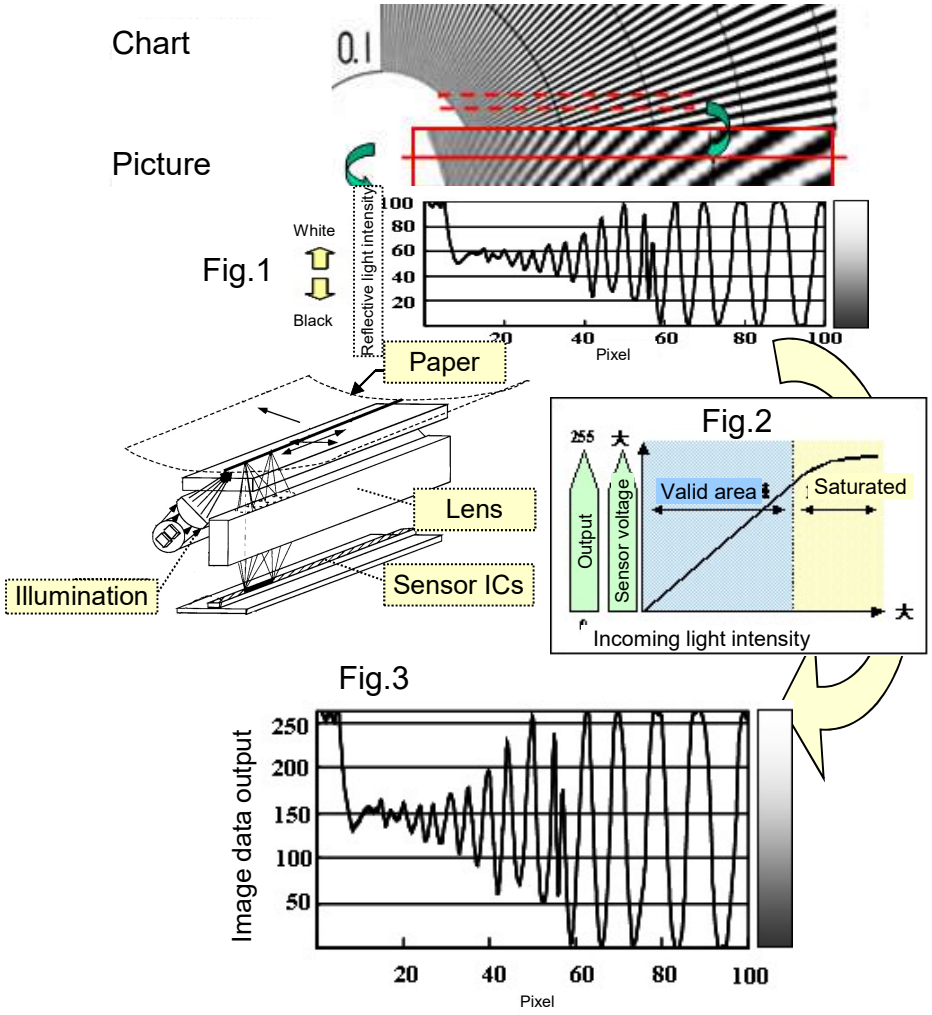
The features of CIS can be compared to line camera as follows;

	CIS	Optical reduction system
① Resolution	Fixed	Flexible
② Depth of focus	Shallow (±0.5～ 2mm)	Deep (～ 4mm)
③ Distortion	Small	Large
④ Light path	Short (10～50mm)	Long(～200mm)
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

Camera Link® is a registered trademark of AIA(Automated Imaging Association)

2-2 Principal technology of CIS

【How to acquire reflective light】



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.

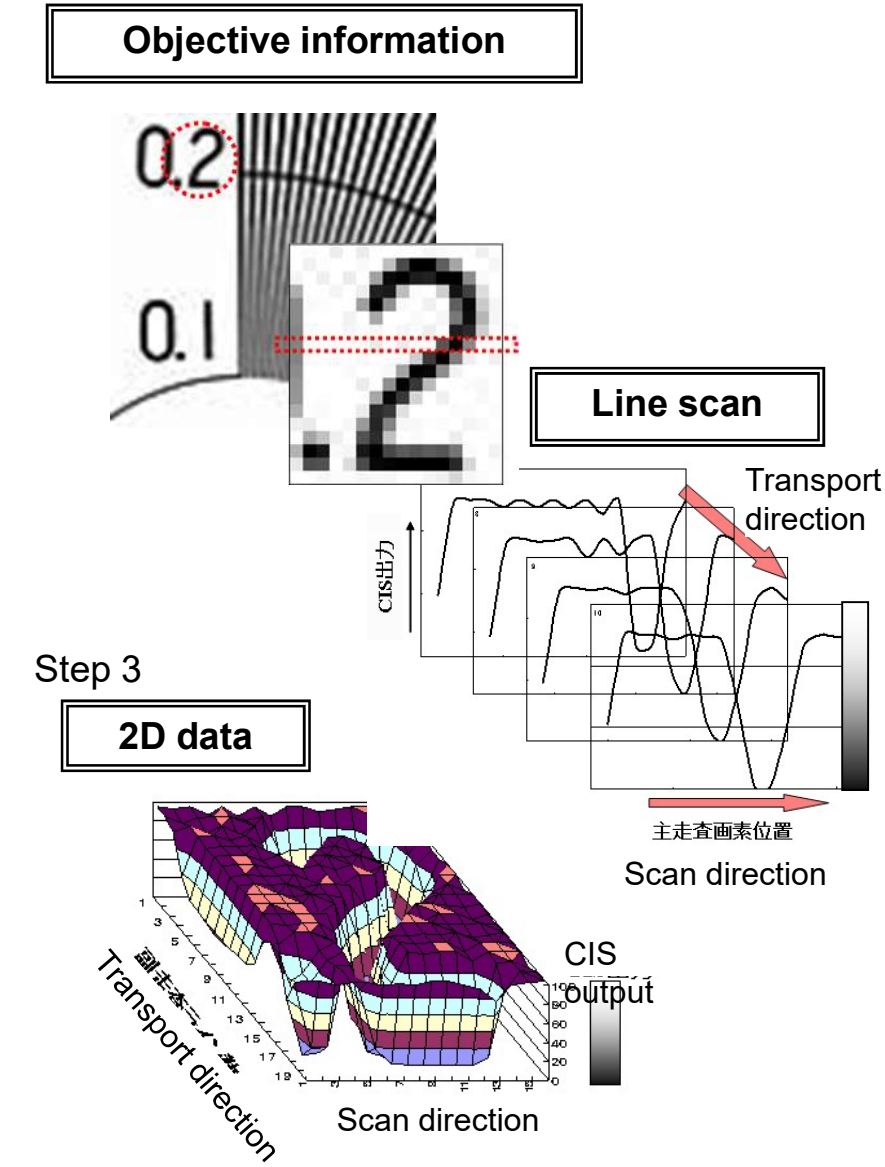
・The object reflects the light. Generally the illuminated black object reflects weaker reflective light. On the other hand, the illuminated white object reflects stronger one.

・Refer to the drawing on left side (Fig.1). The black and white chart has 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).

2-2 Principal technology of CIS



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 drawing.

【Example of scanning “2”】

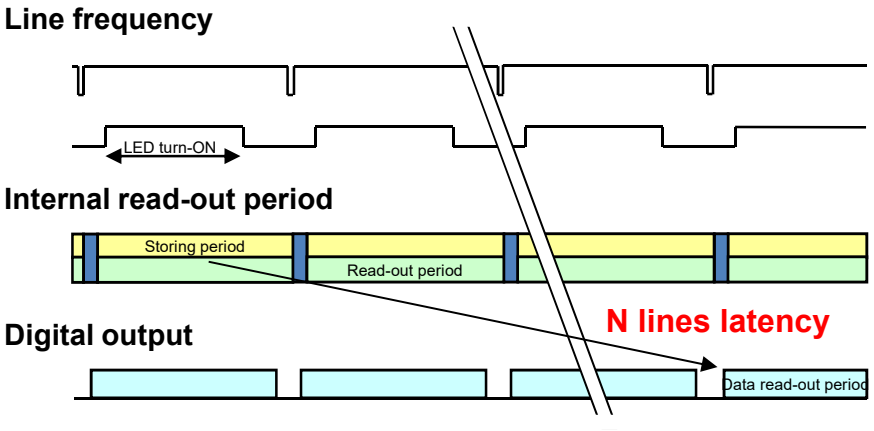
・Step 1: Sensor IC reads one line in red point-line area. The size of the line in transport direction is based on the size of pixel.

・Step 2: The scanning line is transported in transport direction.

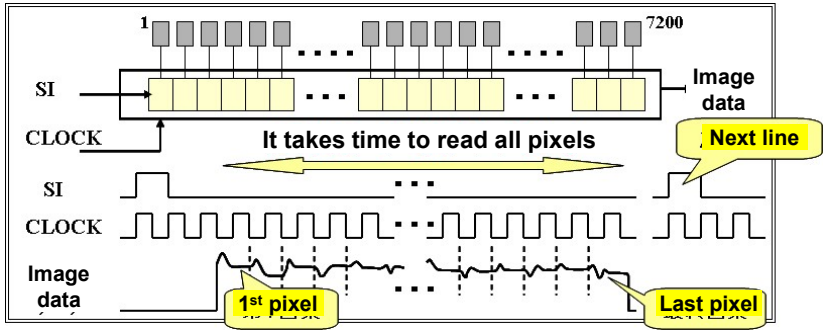
・Step 3: Repeating Step 1 and 2 generates 2D image data. (The height of the 2D-data means the strength of CIS output.)

2-2 Principal technology of CIS

【Data output timing】



【Data read-out and Clock frequency】



【Data output timing】

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

1) Sensor converts the information by light into the information by electric. (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 in a line (1 line)
4) Period to process internal image processing (3 lines ~10 lines)

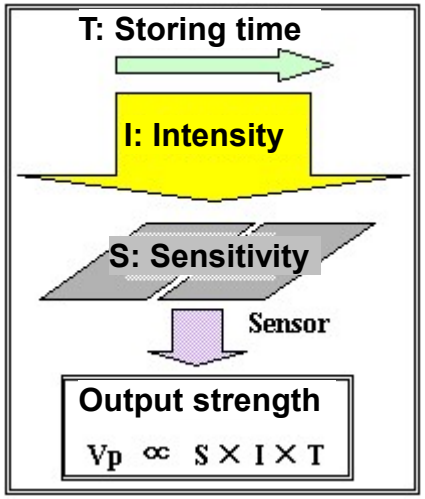
Additionally, line scan frequency of this product is limited by internal pixel clock frequency and pixel quantity. Because the pixel read-out is synchronized by pixel clock.

For instance, in the case of 60 MHz as a pixel clock frequency and 7,296 pixels as a pixel quantity, the minimum line scan period is calculated as follows;

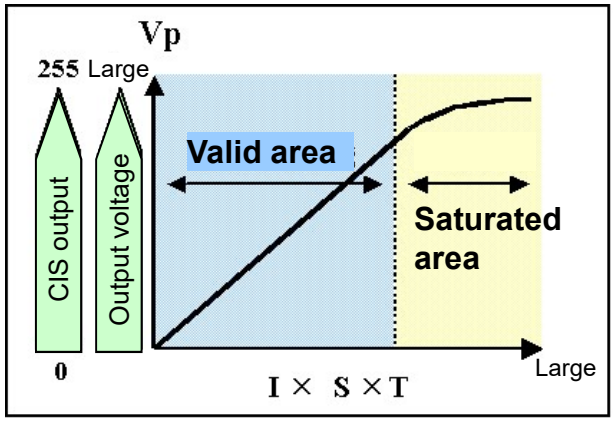
7,296 (pixels) / 60 (MHz) = 121.6 µsec

2-2 Principal technology of CIS

【Strength of Sensor IC output】



【Property of Sensor IC】



【CIS output】

CIS output (Vp) is defined below;

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

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

(k: coefficient)

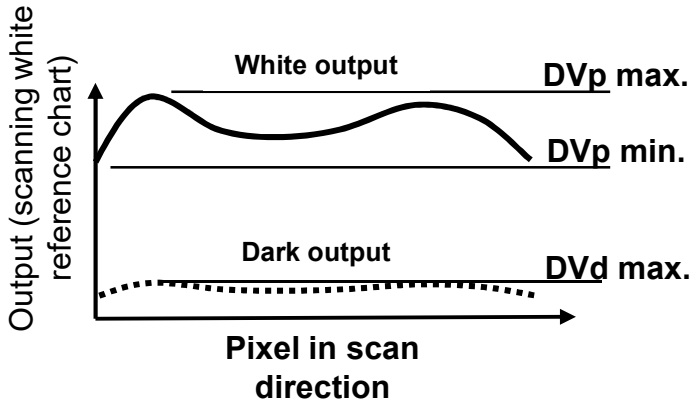
【Remark】

1) To keep a quality of the image, Vp is an important factor. So that Light intensity (I) and Storing time (T) have to be planned appropriately.

2) It would be too raise the intensity of the light source and CIS output is saturated. Therefore, set the illuminations intensity (LED-duty) so as not to be CIS output is saturated.

2-3 Definition

【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 affects the CIS output. CIS output is defined in below.

1. Dark output uniformity

Dark output uniformity is the output when turning OFF illuminations.

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 .

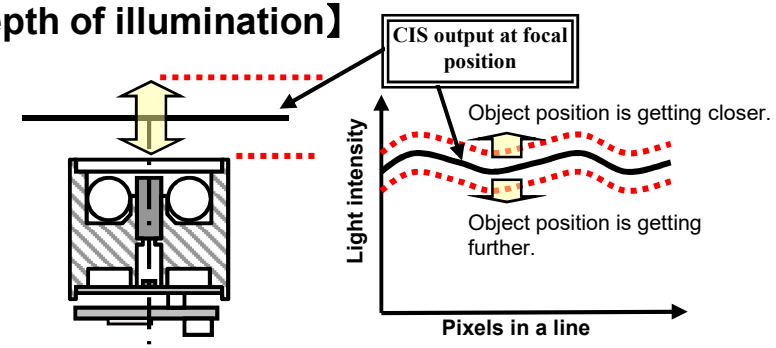
White output uniformity (UEp) indicates the output variation when scanning white reference chart.

White output uniformity is calculated as follows;

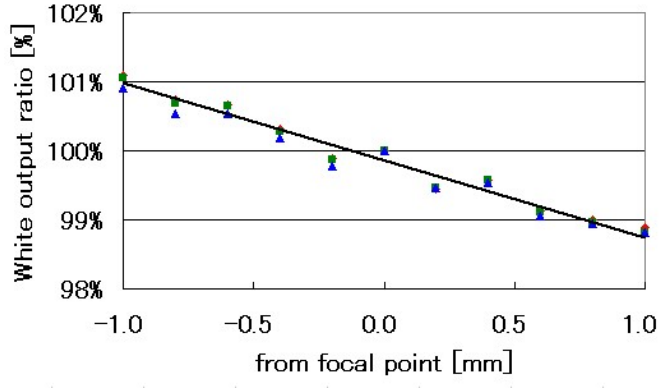
$$UEp = (DVEp\ max.- DVEp\ min.)／DVEp\ max.$$

2-3 Definition

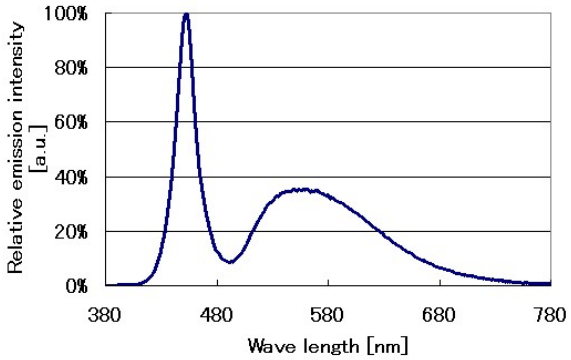
【Depth of illumination】



【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 Vp is controlled by “Light intensity (I)” * “Storing time (T)”. Therefore, in order to increase scanning speed, Light intensity is also needed to be increased.

4. DOI : Depth of Illumination

It is shown in the figure on the left of the variation of illumination intensity due to the position of the lens optical axis direction of the object. If the object at a position close to the illumination system is present, the CIS output is large, the original is away from the CIS output will be reduced.

Larger variation of DOI would make a difficulty to recognize that the output variation is caused by reflectance of the object or position of the object.

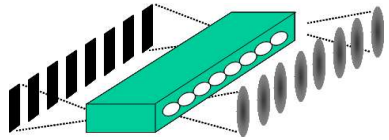
5. Spectrum of illumination

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

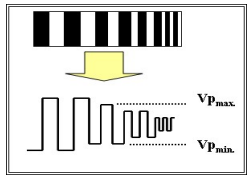
2-3 Definition

【Depth of Focus】

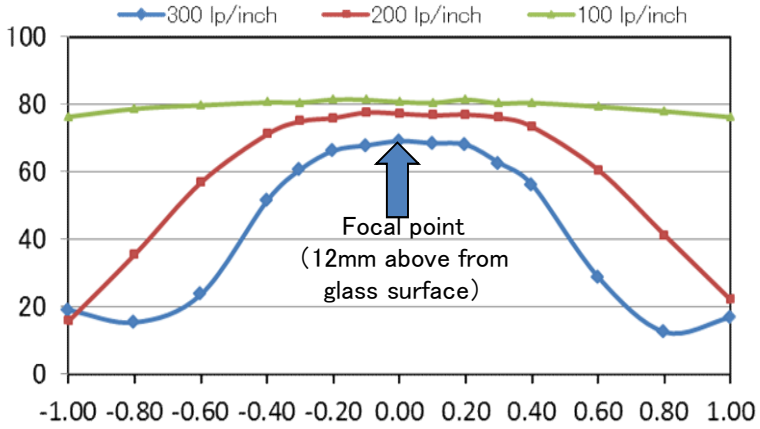
Definition of resolution



Object　　Image (erected and same size)



Depth of Focus on KD series



Scan images

【Definition of CIS output】

6. DOF : Depth of Focus

Depth of Focus indicates a-tolerance of a resolution on various positions of the object from focal position in a lens-axis direction.

Generally, the resolution is getting 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.

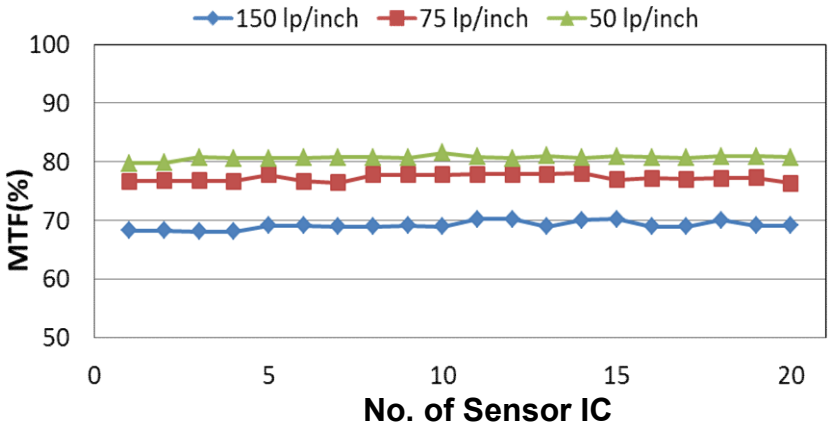
$$\mathrm{MTF} = \frac{\mathrm{DVEp\ max.} - \mathrm{DVEp\ min.}}{\mathrm{DVEp\ max.} + \mathrm{DVEp\ min.}} \times 100\ (\%)$$

•lp/inch: lp/inch indicates the resolution. The resolution will be defined by reading the black and white stripe chart. 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.

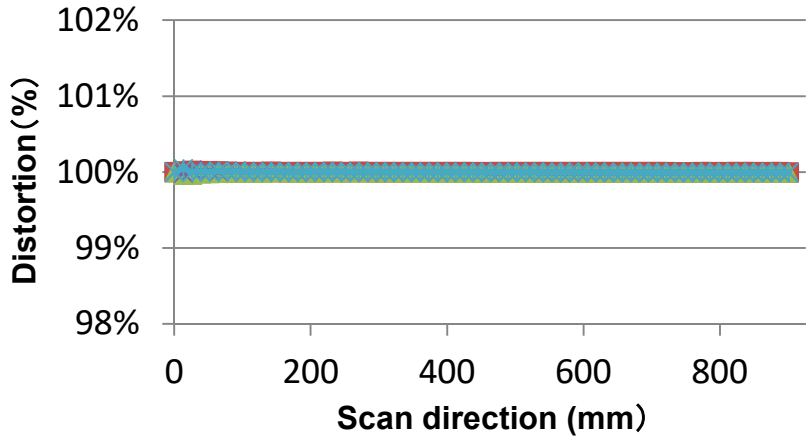
For example, “150 lp/inch chart” means the chart with 150 pairs of black and white stripes are printed in 1 inch, which shall be calculated as 25.4 / 300 = 84.66, about 85μm width strips are printed .

2-3 Definition

【MTF variation on main scan direction】



Variation of MTF value (KD6R309MX：A3 size)



Distortion ratio of KD6R926MX (A0 size)

【Resolution Uniformity】

The graph on the left shows a property of resolution uniformity in the scanning direction of KD6R309MX (A3 size CIS). 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 left shows an example of MTF values of each sensor ICs. This shows that this CIS have uniform resolution in whole scanning width.

2. Distortion

The graph on the left shows an example of distortion values in 1st pixel of each sensor ICs, which is calculated by measurement value of each pixel after assemble (n = 5).

Distortion(%)
= Measured position* / Designed position* × 100

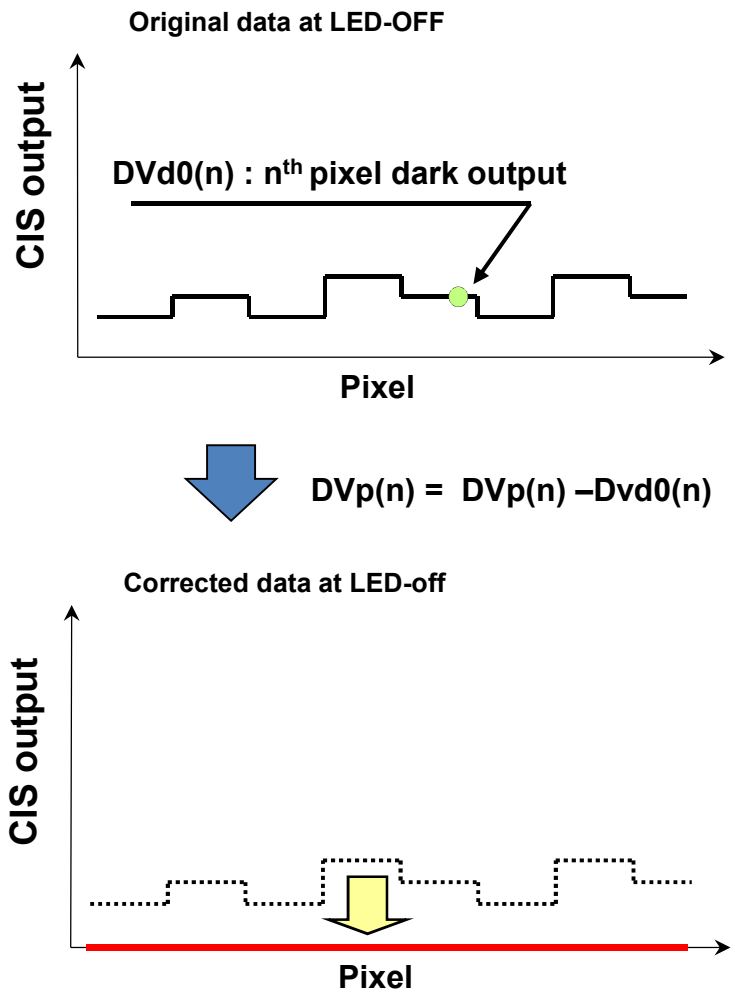
*Measured position and Designed position are distances from the first pixel.

.

This shows that this CIS have uniform resolution in whole scanning width.

2-3 Definition

【Dark correction】



【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, the sensitivity variation and the lens and the illuminations, for each pixel of the CMOS sensor and provide good images.

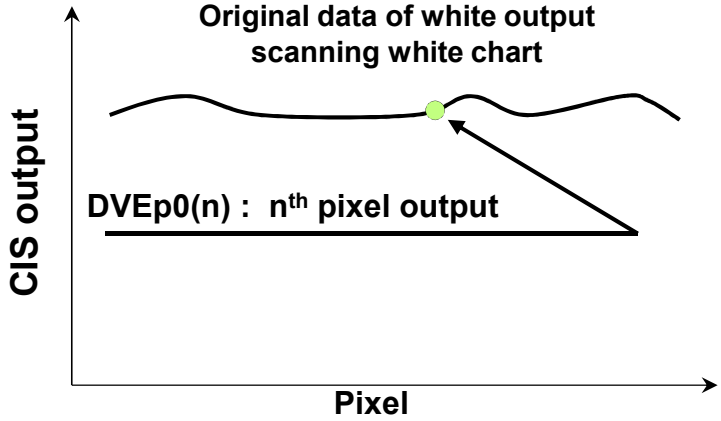
1. Dark correction

This is a function that corrects DC-offset on each pixel into zero as the dark output. 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 us to get the only dynamic range responding the incoming light.

2-3 Definition

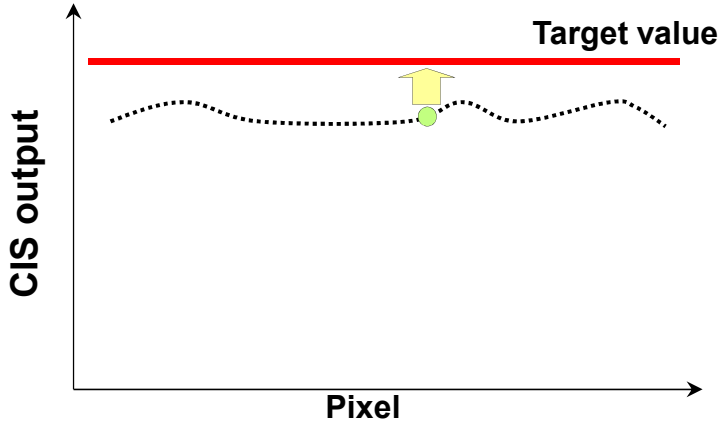
【White correction】



$$DVEp0(n) = DVp0(n) - DVd0(n)$$

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

Corrected data scanning reference white chart



【 CIS output and signal processing function 】

2. White correction

CIS output corrected with Dark correction is the variation in the impact of the sensitivity of the CMOS sensor, the imaging efficiency of the lens and the illuminations intensity. By correcting the variations using this function, read a document having a uniform reflectivity the uniform output will be obtained.

White correction is a procedure to correct the variation of the output on each pixel when scanning an uniform reflectance object or chart.

White correction corrects the white output (DVEp (n)) when scanning an object by using the white correction data (DVEp0(n)) stored when scanning another object having an uniform reflectance according to the following formula.

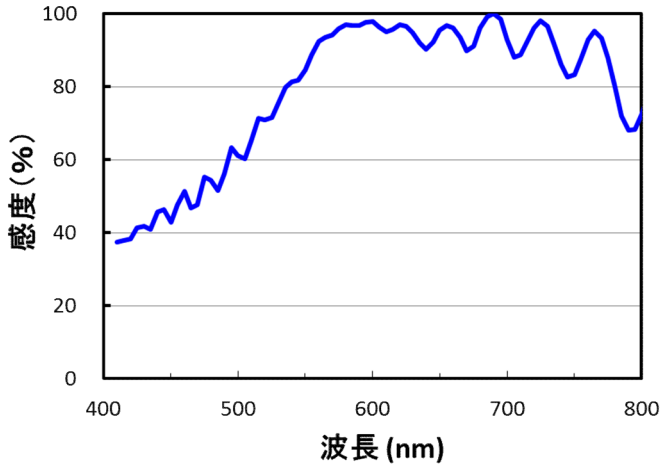
So, CIS output corrected by White correction, DVp'(n) is

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

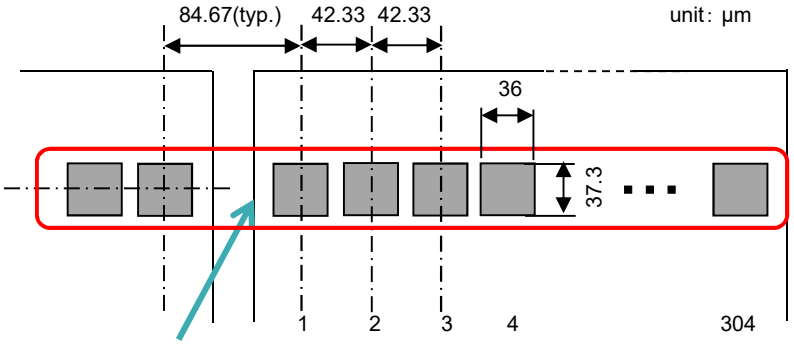
Target value can be set by register value.
There are several methods to create White correction data.
Refer to Function specification for further detailed information.

2-4 Features of scanning pixels

【Sensor IC spectral sensitivity 】



【 Pixel alignment of Sensor ICs】



Capture image on this line

【Sensor IC spectral sensitivity】

This product comprises a monochrome ICs. The Sensor ICs 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 Sensor ICs for each length are as follows;

309 mm size : 24 chips
617 mm size : 48 chips
926 mm size : 72 chips

Each sensor chip has 304 pixels.

At the edge of Sensor ICs, complying with a semiconductor design rule and keeping a dicing area are necessary.

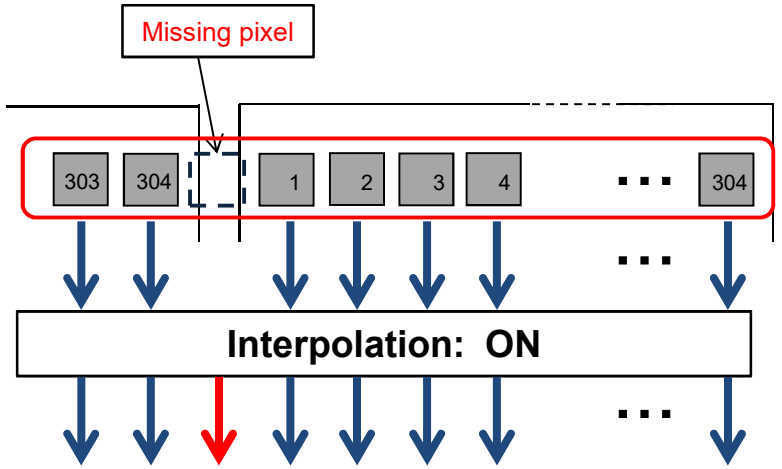
Therefore the gap between neighboring Sensor ICs is not 600 dpi, and is designated to be 300 dpi (84μm) pitch and controlled ±15μm tolerance.

Due to the fact that between the sensor IC are arranged in 300dpi pitch The missing of one pixel called the missing pixel.

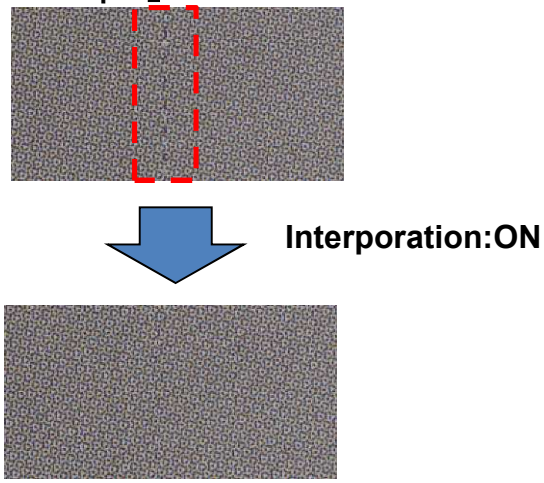
Additionally, a function of Interpolation that can insert a pixel data created by neighboring pixels data for each gap between neighboring Sensor ICs is available on this product.

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 because of the Sensor ICs gap. 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 gaps between neighboring Sensor ICs are designated to be 300dpi and precisely controlled by the tolerance of ±15μm in X/Y direction.

Interpolation process will create the missing pixel data from the neighboring pixels, and emulates the data output as if the 600 dpi is fully realized for the whole width.

“One dimensional filter interpolation” is used which utilizes each 5 pixels in right and left.

2-6 Specification

Item	Unit	A3：KD6R309MX A1：KD6R617MX A0：KD6R926MX	A3：KD6R309MX-NL A1：KD6R617MX-NL A0：KD6R926MX-NL
Scanning width	mm	309.7 / 619.7 / 929.6	309.7 / 619.7 / 929.6
# of Valid pixels	pixel	7,296 /14,592 / 21,888 Monochrome	7,296 /14,592 / 21,888 Monochrome
Resolution	dpi	600	600
Line scan frequency	kHz	43 max	43 max
I/F Format	—	Camera Link ®	Camera Link ®
Output format	—	Refer a next page	Refer a next page
Clock frequency	MHz	84 max.	84 max.
Additional Signal Processing	—	- White Correction function - Dark correction function - Programmable Gain Amplifier - γ correction - Pixel Offset Adjustment - Pixel interpolation etc.	- White Correction function - Dark correction function - Programmable Gain Amplifier - γ correction - Pixel Offset Adjustment - Pixel interpolation etc.
illumination	—	White-LED Array	none
Focal point	mm	52 from reference holes of Both sides of CIS	51.4 from reference holes of Both sides of CIS
Outline (L×W×H)	mm	**377 / 688 / 997 ×62×MAX102**	**377 / 688 / 997 ×62×MAX102**
Weight	kg	**2.0 / 3.6 / 5.1**	**1.3 / 2.6 / 3.6**
Release	—	July 2015	July 2015

2-6 Specification

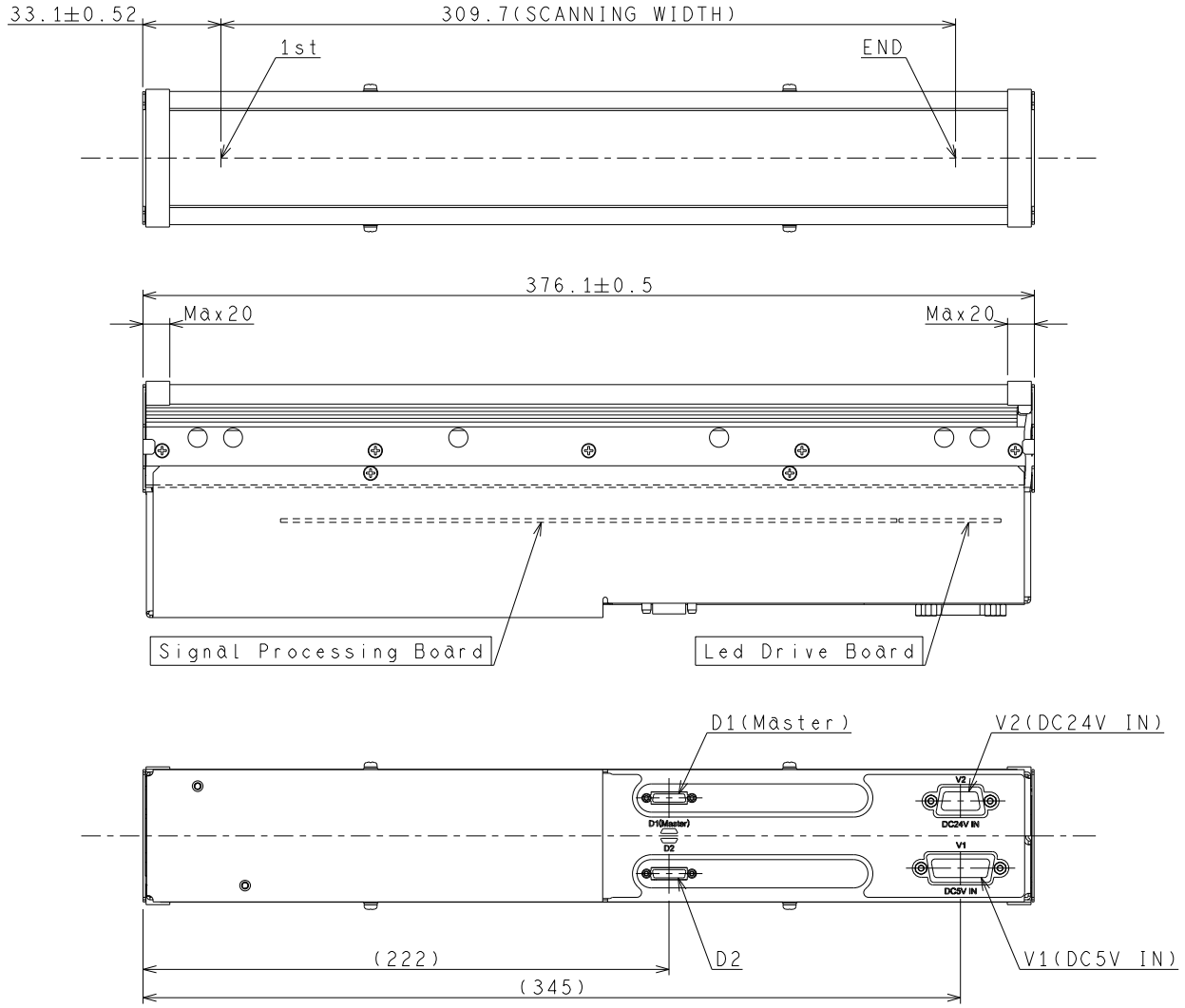
Output format and Scan rate

	Camera Link® # of ch.	Data output format	A3/ Line frequency (kHz)	A1/ Line frequency .(kHz)	A0/ Line frequency (kHz)
Base Configuration	1	8/10 bit 2 tap	23 max.	11 max.	7.6 max.
Medium Configuration	1	8/10 bit 4 tap	43 max.	23 max.	15 max.
Medium Configuration ×2	2	8/10 bit 4 tap ×2	—	43 max.	29 max.
Medium Configuration ×3	3	8/10 bit 4 tap ×3	—	—	43 max.

— : not supported

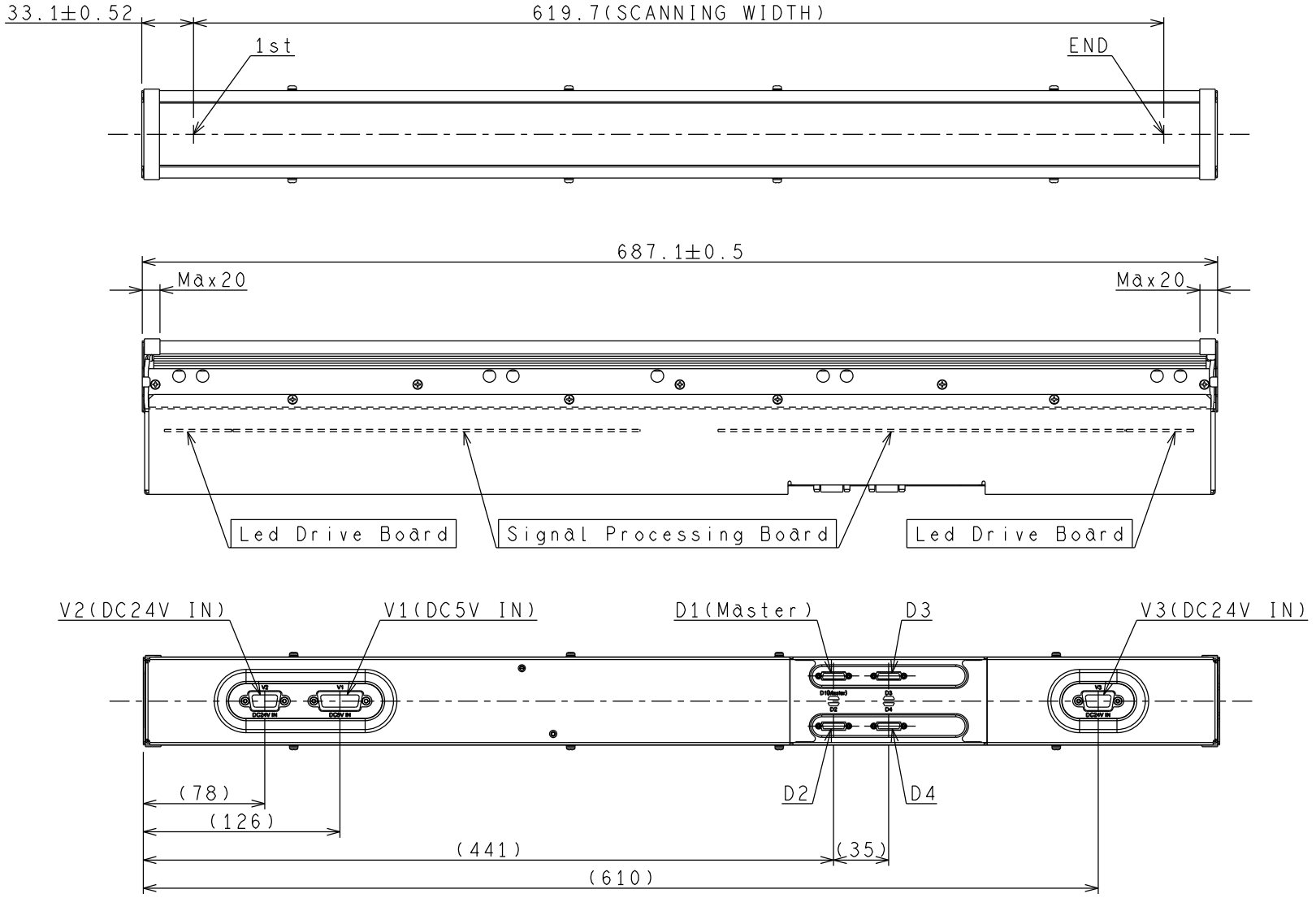
2-6 Specification

【A3-type（KD6R309MX）Outline】



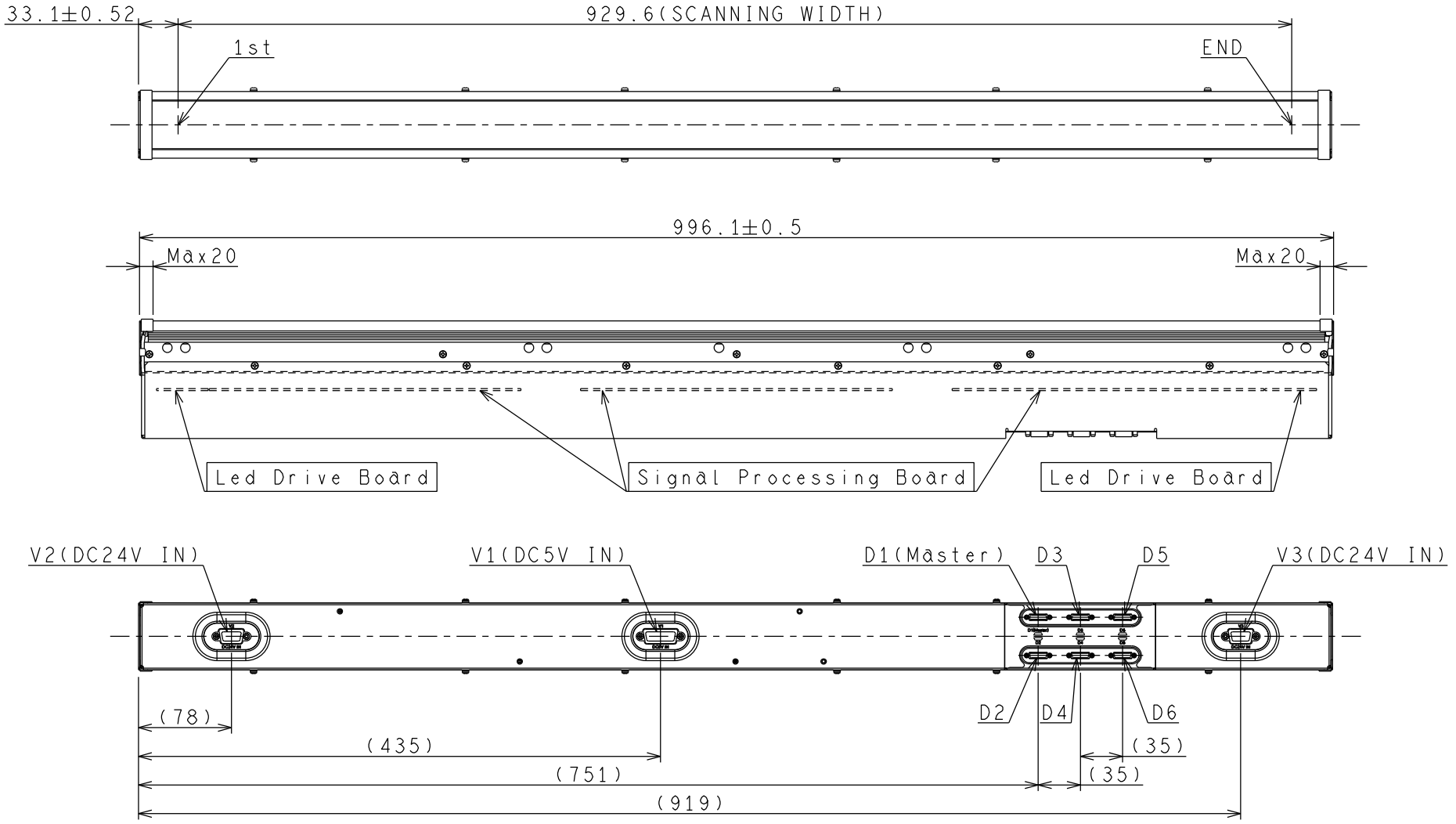
2-6 Specification

【A1-type（KD6R617MX）Outline】



2-6 Specification

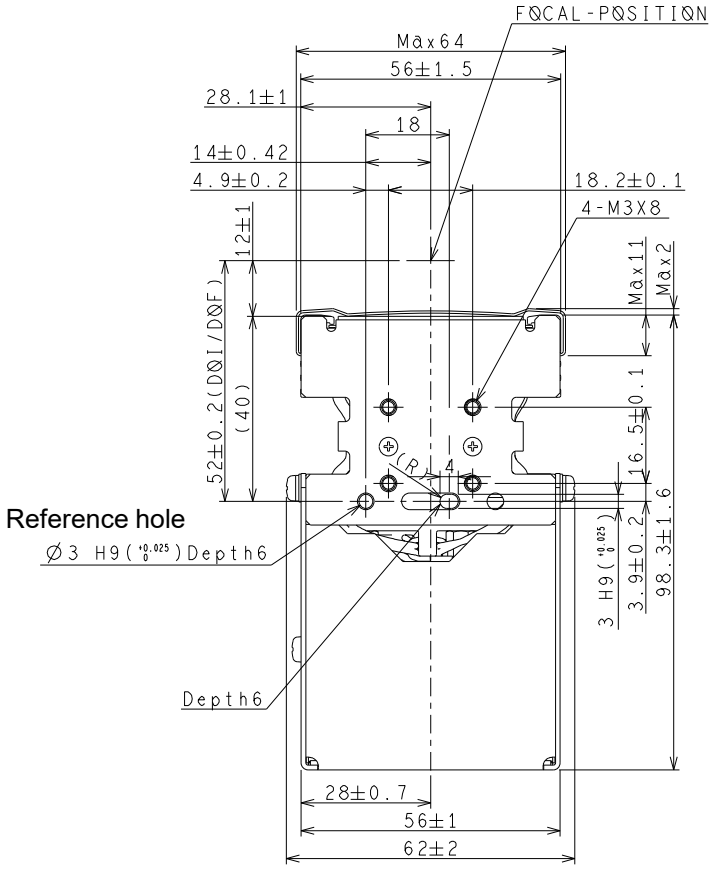
【A0-type（KD6R926MX）Outline】



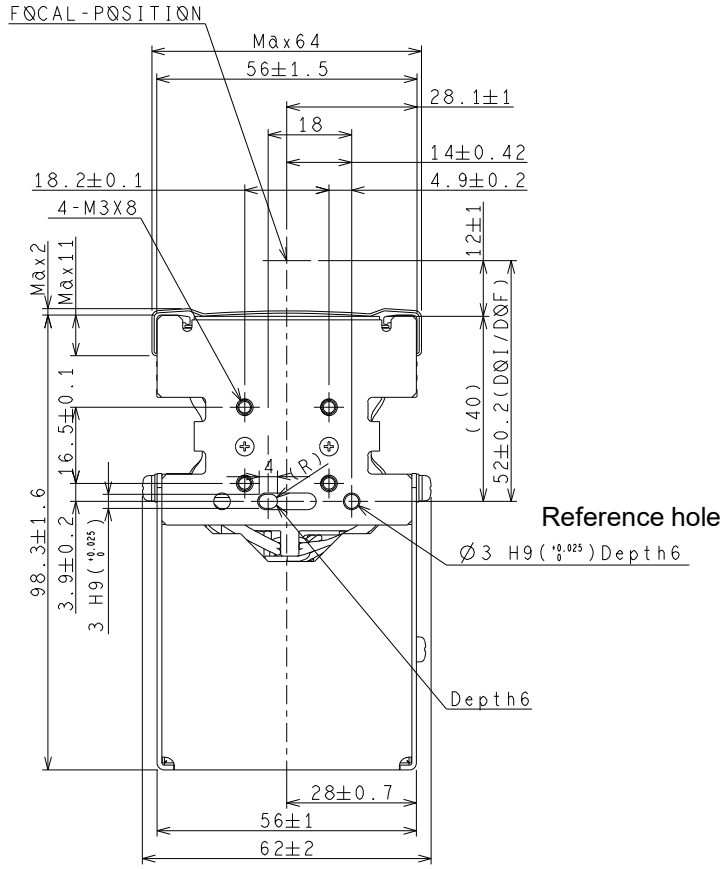
2-6 Specification

【A3/A1/A0（KD6R309/617/926MX）Side viewing（common）】

1st-side Bracket



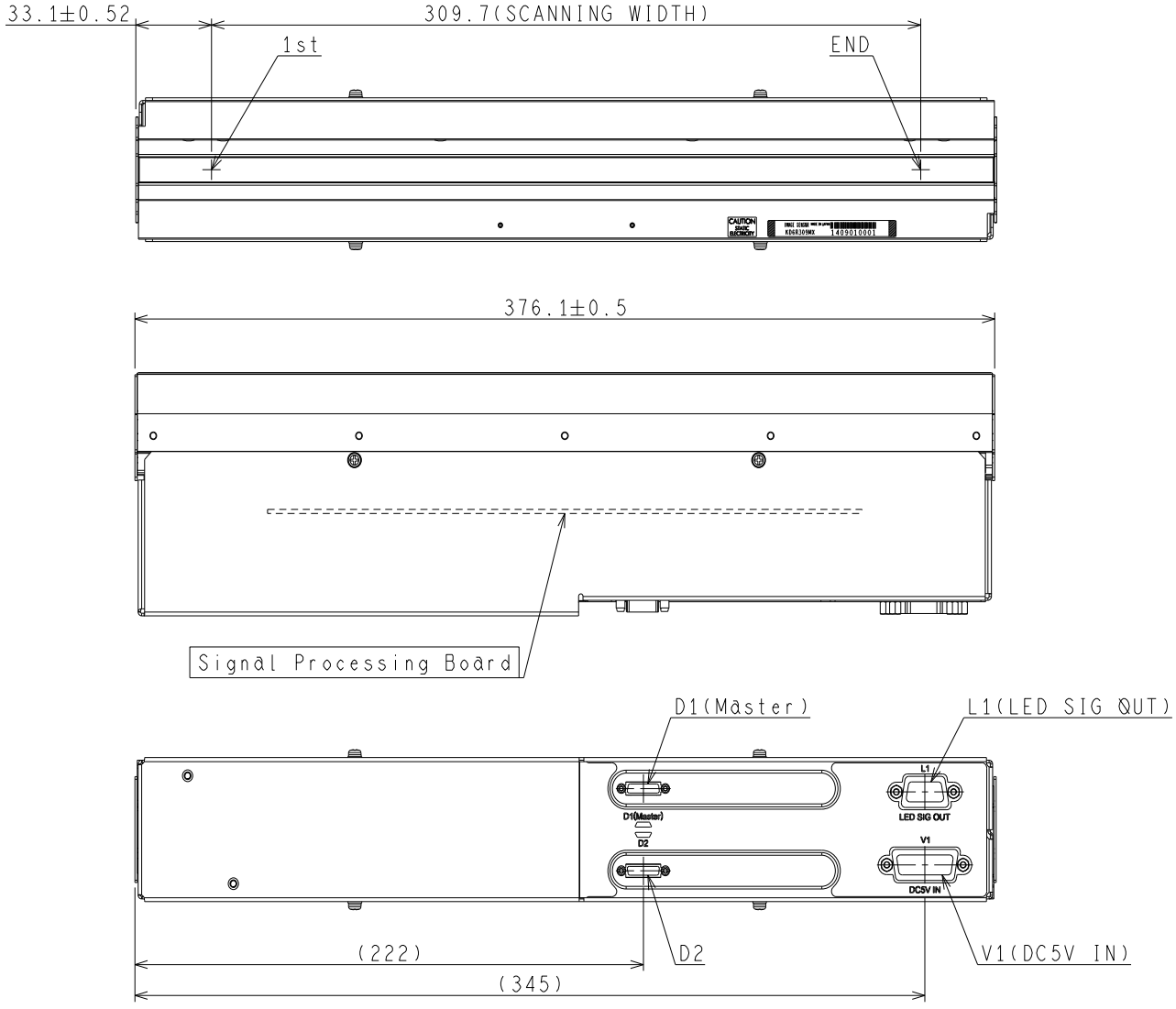
end-side Bracket



When attaching this CIS to a system chassis , adjust the position of CIS by using each two reference holes on both sides of CIS and fix it by M3-screws at both side of CIS .

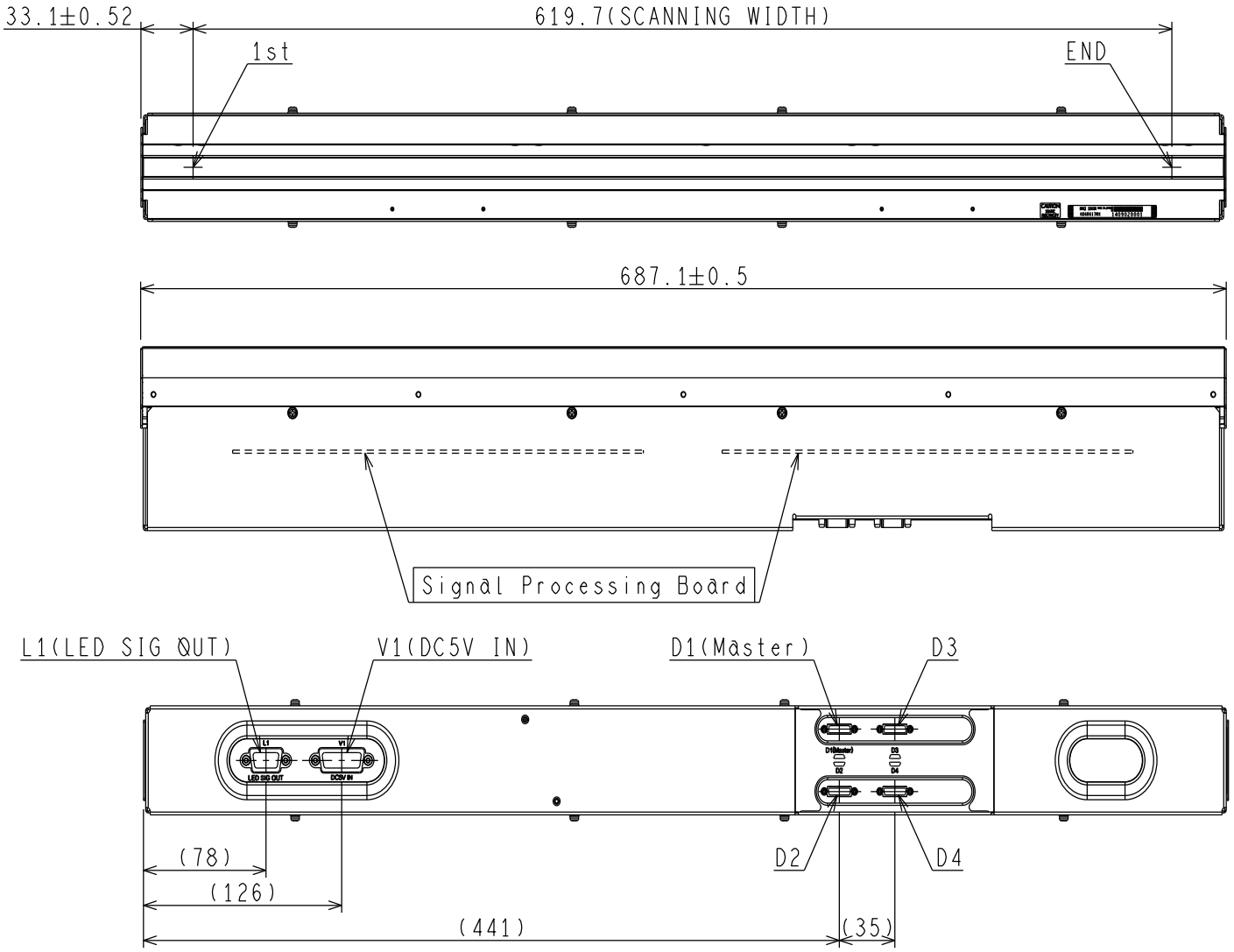
2-6 Specification

【A3-type（KD6R309MX-NL）Outline】



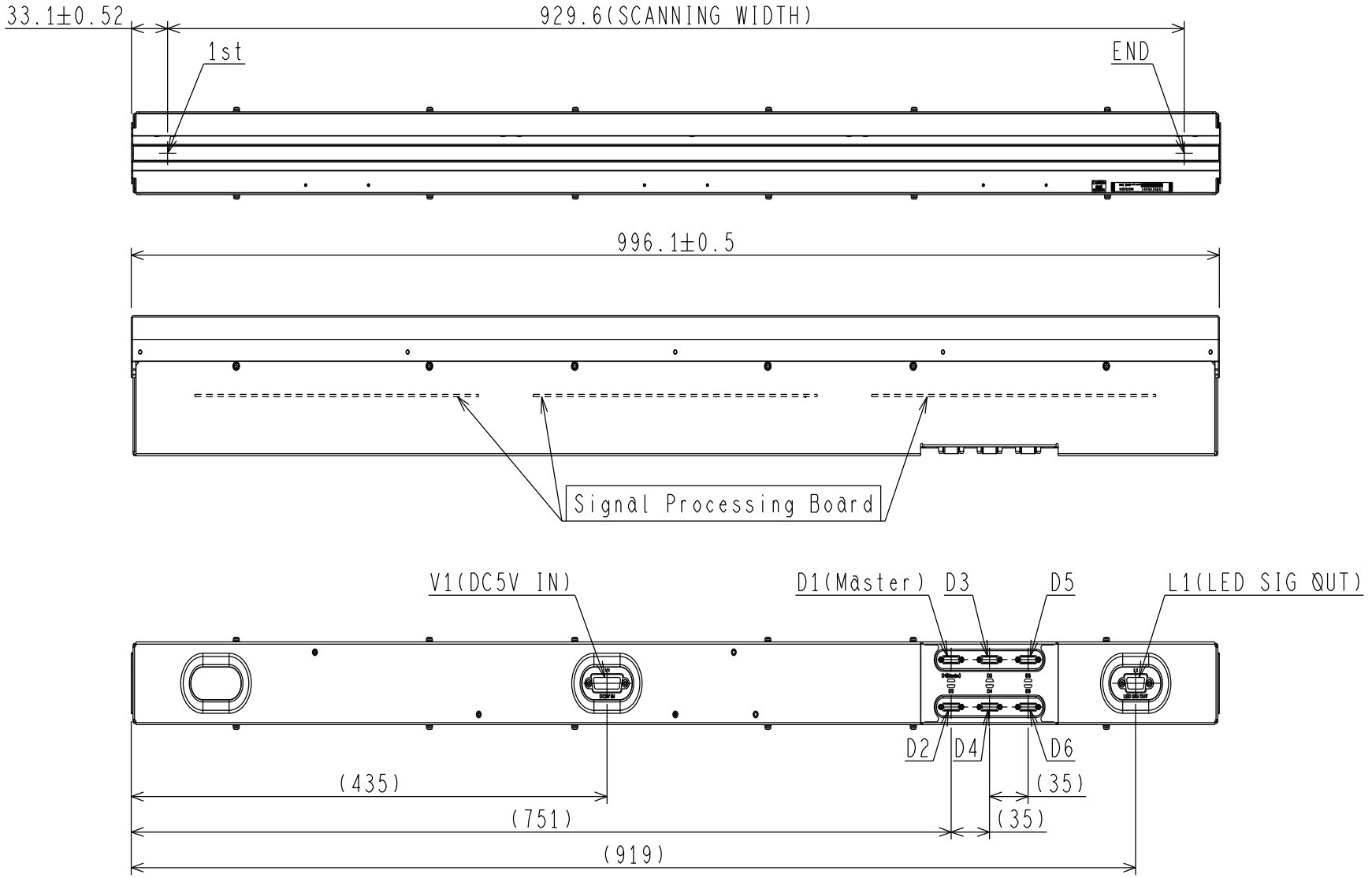
2-6 Specification

【A1-type（KD6R617MX-NL）Outline】



2-6 Specification

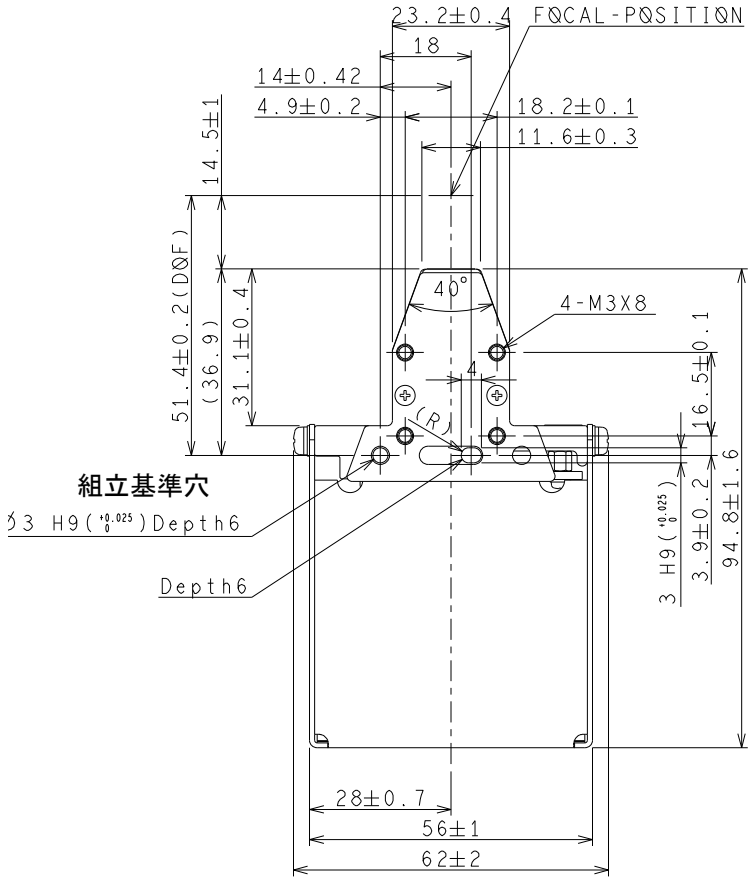
【A0-type（KD6R926MX-NL）Outline】



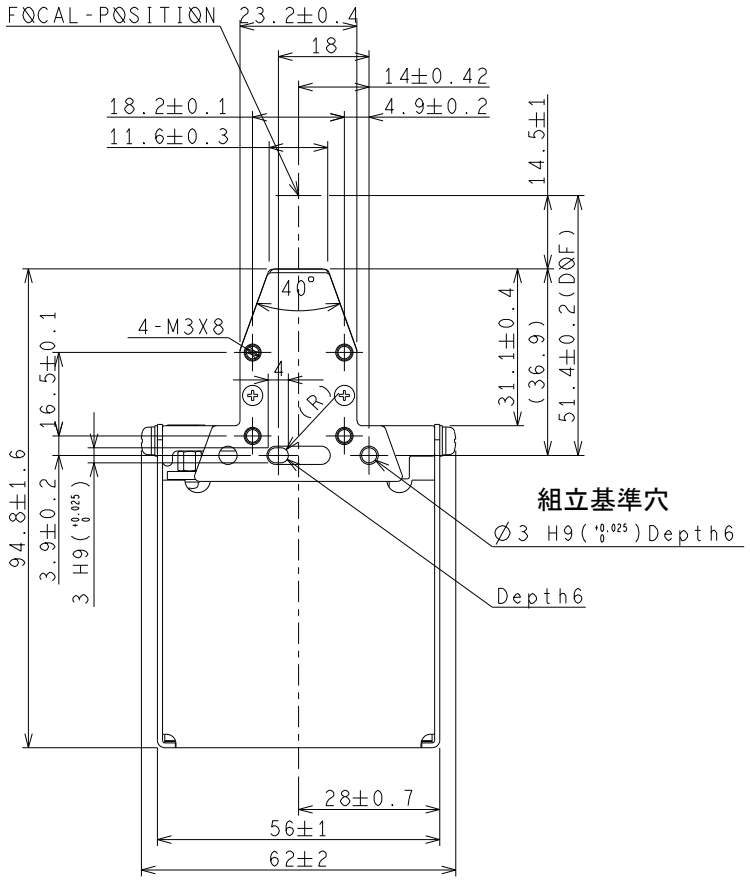
2-6 Specification

【A3/A1/A0（KD6R309/617/926AX2-NL）Side viewing（Common）】

1st-side Bracket

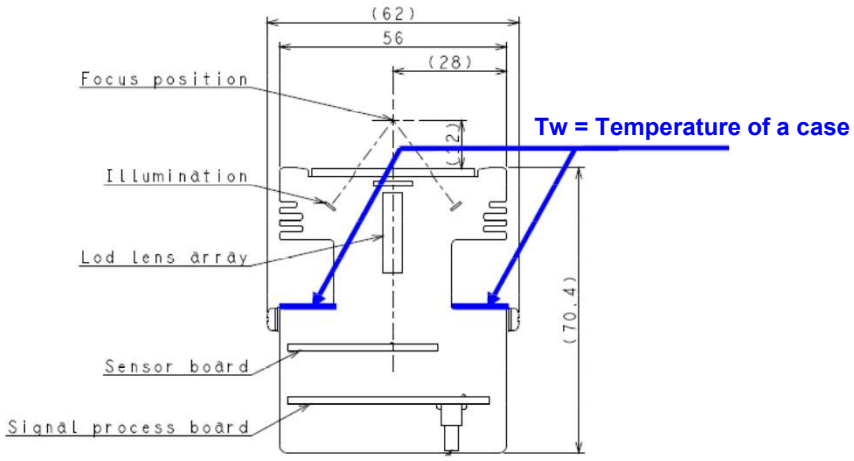


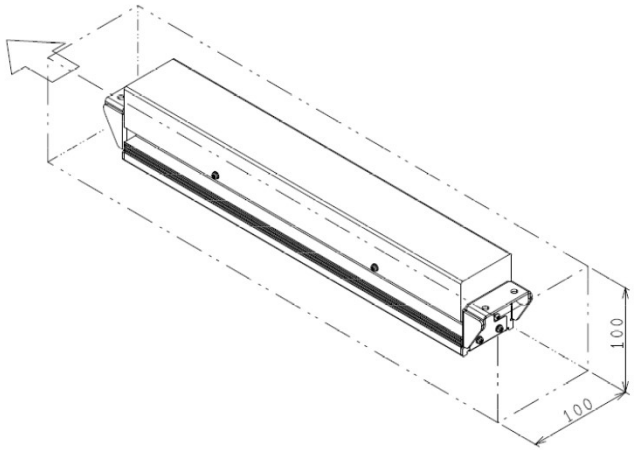
end-side Bracket



2-7 Handling precautions

【Thermal management】





This product will operate between +5 to +50℃ of environmental temperature (Ta), under natural air cooling circumstance.

In other circumstance, such as the product temperature may be raised by the incoming heat from the peripheral devices and/or the connecting part, check the case temperature Tw (refer left diagram), and use the product while the Tw to be kept between +5 to +70℃.

If the case temperature exceeds the specified temperature, apply an appropriate cooling or forced air cooling as follows.

A variable of flow rate **u (m / s)** required for air cooling is ambient temperature and operating conditions **Ta**. **Flow rate u** is calculated from the equation #1. Valuables of Air quantity v (m^3 / s) are a space in cross-sectional area of this product **A_{air}(m^2)** and wind speed **u(m/s).** The air amount is calculated from the equation#2. The constants and the equations are followings.

Equation #1

$$u = \left(\frac{\frac{Q}{A \cdot (Tw - Ta)} - 4 \cdot \varepsilon \cdot \sigma \times \left(\frac{Tw + Ta}{2} \right)^3}{3.92} \right)^2 \times L$$

Equation #2

$$V = Aair \times u$$

Symbol	Explanation		Unit	KD6R309MX	KD6R617MX	KD6R926MX
Q	Heat value	Base(23kHz)	W	29.3	55.6	94.8
		Medium(43kHz)		43.7	81.1	144.6
L	Length		m	0.37	0.68	0.99
A	Surface area		m2	0.16	0.27	0.38
ε	Emissivity		-	0.77		
Tw	Max temperature of case		K	343.15		
σ	Stefan-Boltzmann's constant		W/m2・K4	5.6687E-08		

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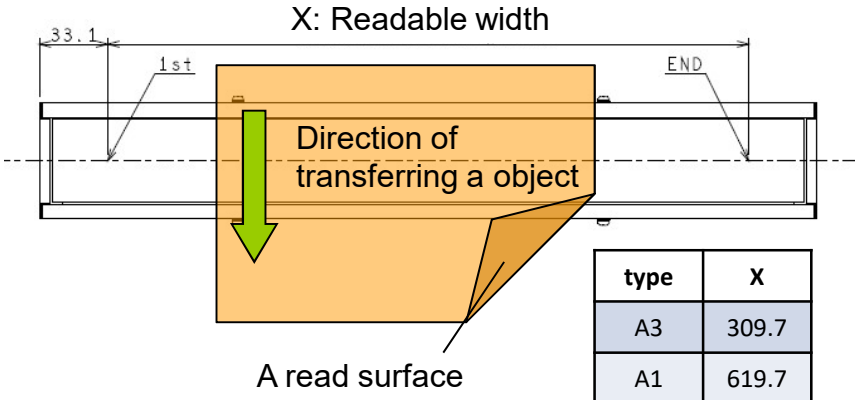
Chapter 3 : Installation

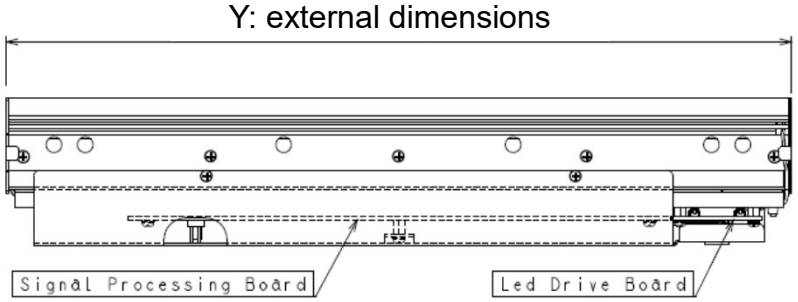
3-1 Dimensions

3-1-1 Top view



type	X
A3	309.7
A1	619.7
A0	929.6

3-1-2 Side view



type	Y
A3	376.1
A1	687.1
A0	996.1

【Remark】 Where to place an object

① Set an object against the glass surface of CIS.

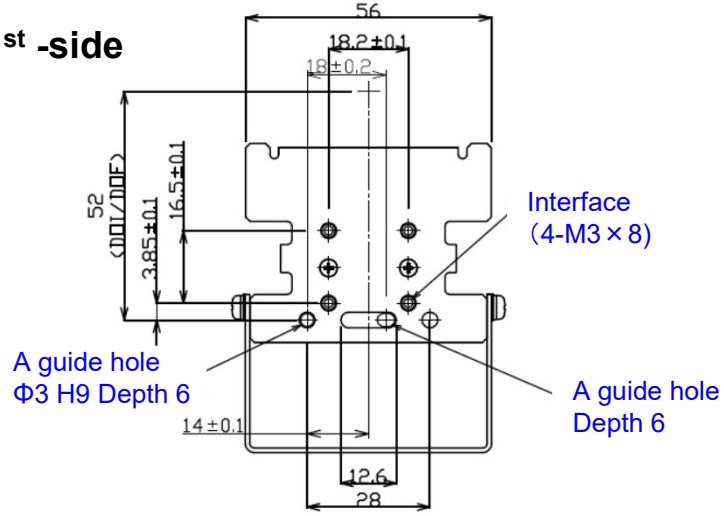
② Set the upper left side of an object at 1st pixel side of CIS.

③ Transfer an object like the figure 3-1-1.

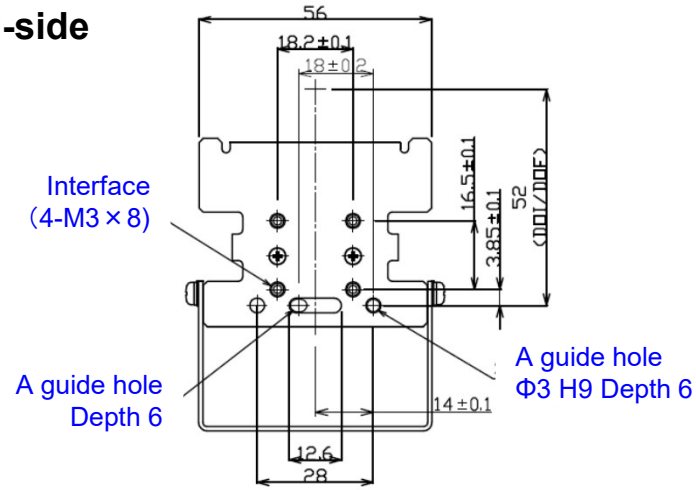
3-1 Dimensions

3-1-3 Side view

1st -side



End-side

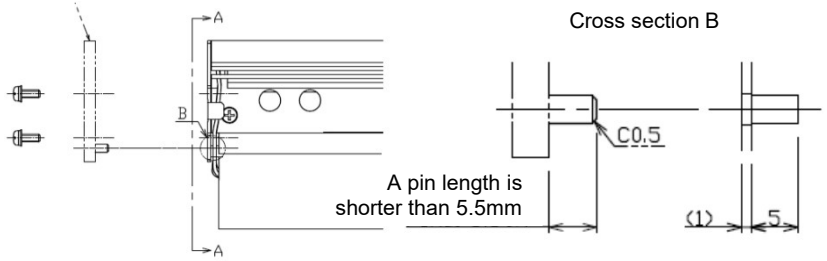


【Remark】How to install CIS into your device

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 with illumination at 52.0mm and without illumination at 51.4mm form the guide holes .
3) For a reference , CIS with illumination the gap is located at 12+/-1 mm from glass surface .
4) There are 4screw 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 from 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 ± 7
Stainless (SUS 304)	63 ± 6
Brass (C3601BD)	42 ± 4

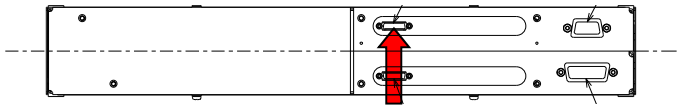
6) Shorter than 5.5mm is recommended for a length of the pin for guide holes.



3-1 Dimensions

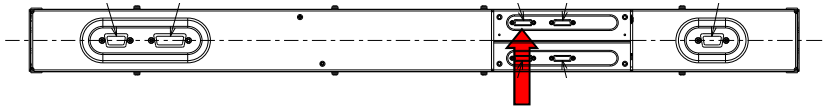
3-1-4 Bottom view

A3(KD6R309MX/MX-NL)



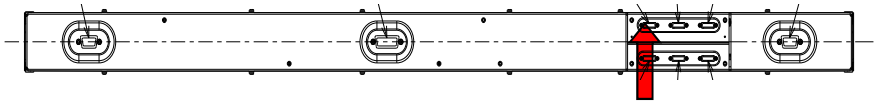
Master port
D1

A1(KD6R617MX/MX-NL)



Master port
D1

A0(KD6R926MX/MX-NL)



Master port
D1

【Interface of connectors】

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

Item	No.	Model		
		A3	A1	A0
Power supply voltage(+5V)	V1	○	○	○
Camera Link® Connector ※◎:Master port	D1	◎	◎	◎
	D2	○	○	○
	D3	×	○	○
	D4	×	○	○
	D5	×	×	○
	D6	×	×	○
Power supply for illumination (+24V) *Unavailable for AX2-NL series.	V2	○	○	○
	V3	×	○	○

3-2 Components (necessary to prepare separately)

3-2-1 Necessary to prepare separately

*** DC24V cable and DC24V power supply are not necessary for AX2-NLseries.**

① DC5V power cable (for sensor)

② DC24V power cable (for illumination)

③Camera Link® cable
* This product has mini Camera Link® connector

④DC5V, DC24V power supply
⑤Grabber board and PC

【Necessary to prepare separately】

Prepare the following items to use this product separately by yourself.

1) DC 5V power supply (A3-unit MAX 3A) and cables
2) DC24V power supply (MAX 3A) and cables
3) Camera Link® cables
   This product has mini Camera Link® connectors for image transfer interface .
4) Frame Grabber board and its software

No	Item	Quantity		
		A3	A1	A0
①	DC5V power cable	1	1	1
②	DC24V power cable	1	2	2
③	Camera Link® cable	1, 2	1, 2, 4	1, 2, 4, 6
④	DC5V, DC24V power supply	1EA		
⑤	Grabber board and PC	1		

【Remark】

1) This product doesn't contain the cables, Frame grabber board, power supply listed above.
2) Current capacity is listed in the left table.

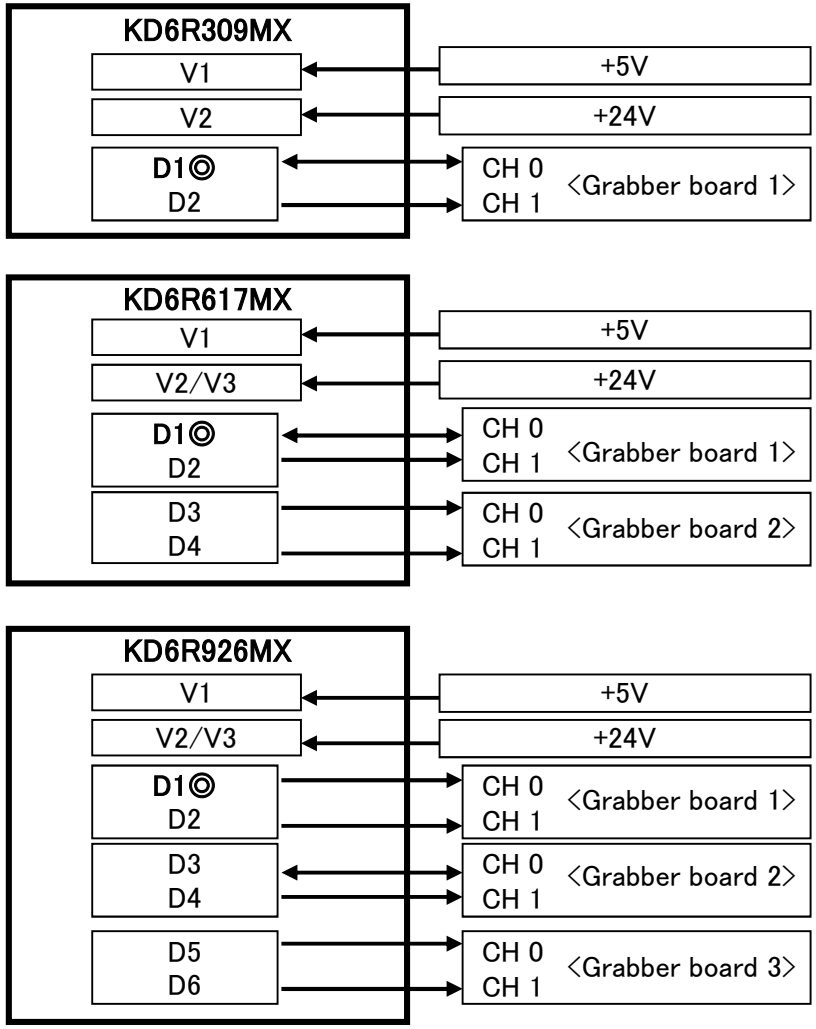
No	Item	Current capacity (A)		
		A3	A1	A0
①	DC5V	3	6	9
②	DC24V	1.0	1.5	2.0

3-3 Connections

3-3-1 Cable connection

◎ : Master port

* MX-NL series don't have V2, V3.



【Remarks】(for connection)

When using multiple grabber boards, make sure to input External synchronization signal and Communication control only through the connecter defined as Master port on the left.

【Remarks】

This product is synchronized based on a line data.

However, it is operated by individually independent CLK for each 309mm-size block. In other word, each 309mm-size block are not synchronized based on CLK.

The length of the Camera Link® cable varies depending on the environment and connection status.

Please select cables that can communicate and acquire images normally.

If an error occurs in communication and image acquisition, please lower the frequency of Camera Link® (minimum).

And please adjust the length of the recommended cable (P.48) and re-acquire communications and images.

If communication and acquisition the images is possible, it is presumed that the cause is Camera Link® or the length of Camera Link® , not a trouble of this product.

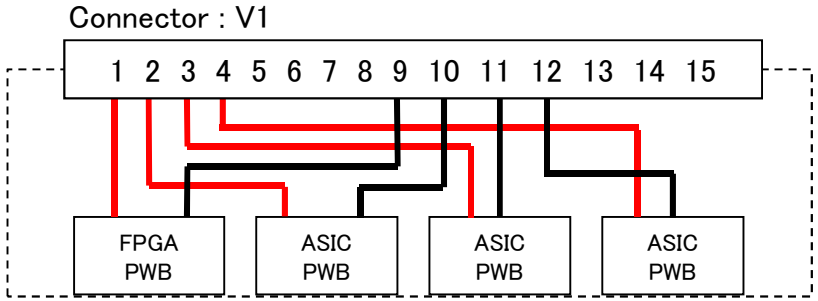
In such a case, Mitsubishi Electric assumes no responsibility.

3-3 Connections

Be sure to check connection interface (connector joint, wire diameter) before using the product.

3-3-2 DC5V Connector

Internal Cable connection



Fabricating Cable

1) **2 wires which are connected 1st and 9th pin, 2nd and 10th pin, 3rd and 11th , 4th and 12th pin should be as a twist pair wiring each other.**
2) **It is recommended strongly to connect all pins assigned as +5V and GND on the pin connection table .**

【Remarks】
Please decide the thickness of the cable in consideration of the wiring resistance of the cable.

Recommended cable is below.
AWG#16-#22
(#16 is recommended)

【Power supply Cable for DC5V】

* Cable is not in product package.
Prepare it by yourself.

1) To connect V1 connector from 5V power Supple
2) Parts No. of connectors are as following
   from CIS unit : **DAU-15S-F0R（JAE）、**
   from Power supply :**030-50634（JAE）、**
3) Connector for Power Cable (strongly recommend using)
   to CIS unit :DAU-15P-F0R（JAE）
   * Contact pin :**030-50635（JAE）**
4) Pin connection

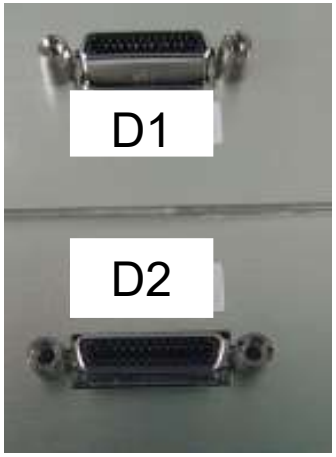
No	Name			Symbol
Product	KD6R309MX/MX-NL	KD6R617MX/MX-NL	KD6R926MX/MX-NL	-
1	+5VP/S	+5VPS	+5VPS	VDD
2	NC	+5VPS	+5VPS	VDD
3	+5VPS	+5VPS	+5VPS	VDD
4	NC	NC	+5VPS	VDD
5	NC	NC	NC	
6	NC	NC	NC	
7	NC	NC	NC	
8	NC	NC	NC	
9	GND	GND	GND	GND
10	NC	GND	GND	GND
11	GND	GND	GND	GND
12	NC	NC	GND	GND
13	NC	NC	NC	
14	NC	NC	NC	
15	NC	NC	NC	

3-3 Connections

Be sure to check connection interface (connector joint, wire diameter) before using the product.

3-3-3 Camera Link® Connector

*** Prepare mini Camera Link® connector for connecting to this product .**



item	No.	Product type		
		A3	A1	A0
Camera Link® Cable connection ◎: Master port	D1	◎	◎	◎
	D2	○	○	○
	D3	×	○	○
	D4	×	○	○
	D5	×	×	○
	D6	×	×	○

【Camera Link® Cable connection】

* Cable is not in product package.
Prepare it by yourself.

1) Camera Link® Cables are connected with **D1, D2, D3, D4, D5, D6**
2) In the case of Base Configuration
one , 2 , 3 cables are necessary
each for A3- type , A1-type and A0-type CIS .
In the case of Medium Configuration
2 , 4 , 6 cables are necessary
each for A3- type , A1-type and A0-type CIS .

3) 12226-1150-00PL（by 3M : based on Camera Link® ）is recommended .

4) Please use the cable that is based on Camera Link® Specification. Recommended cable is below.
・CL-S-SS-020 (Oki Electric Cable Co., Ltd.)
・DTCL-26P02MM (Daitron Co., Ltd.)

※please read and receive the remarks on P.48 and decide Camera Link® cable.

5) Pin assignment is based on Camera Link® Specification.

6) Master port which is received external synchronized signal and communicates with Frame Grabber by the UART is D1 (common).

3-3 Connections

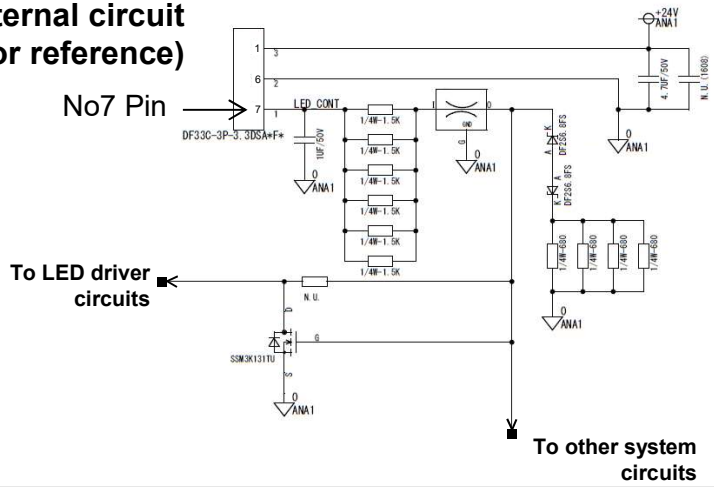
Be sure to check connection interface (connector joint, wire diameter) before using the product.

3-3-4 DC24V Connectors

* These connectors are available only for the product with illumination .

item	No.	Product type		
		A3	A1	A0
Power supply for illumination（+24V）	V2	○	○	○
	V3	×	○	○

Internal circuit (for reference)



【DC24V Cable connection (for illumination)】

*Cable is not in product package. Prepare it by yourself.

1) V2,V3 connectors are connected with 24V power supply .
2) CIS is equipped with
DEU-9S-F0R（by JAE) as connectors,
030-50634（by JAE) as contact socket.
3) Connector for Power Cable (strongly recommend using)
DEU-9P-F0R（by JAE） as contact socket housing,
030-50635（ by JAE) as contact pin.
4) Turning On/Off control for illumination can be done by the signal “LED_CONT” assigned to 7-pin of connector .
5) Connect 7-pin of connector to GND signal directly , if it is not necessary to use the external control of illumination.
6) 24V power supply have to be turned On/Off during 5V power supply turned On . Refer on chapter 4 .
7) Pin assignment table is following .

KD-MX series			
No	Name	I/O	Note
1	+24V	I	VLED
2	NC	–	
3	NC	–	
4	NC	–	
5	NC	–	
6	GND	I	GNDLED
7	LED_CONT	I	Open : Off GND : On
8	NC	–	
9	NC	–	

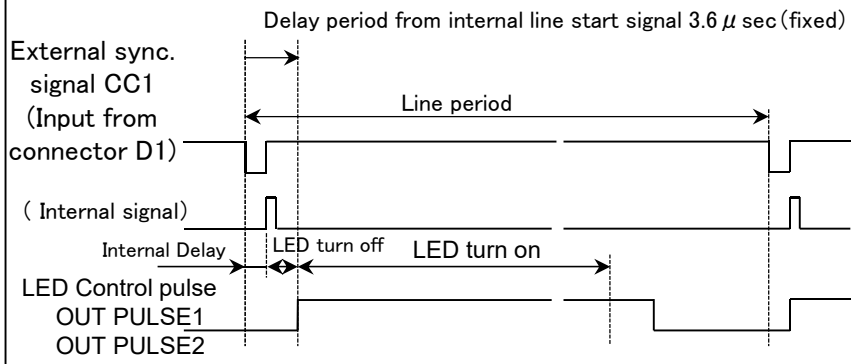
3-3 Connections

Be sure to check connection interface (connector joint, wire diameter) before using the product.

3-3-5 MX-NL series LED Control signal output

* This Connector is available only for MX-NL series CIS without illumination .

Signal Timing chart



【LED Control signal Output】

Cable is not in product package. Prepare it by yourself.

1) It is available to control External illumination by using illumination control signals (OUT_PULSE1, OUT_PULSE2) output from Connector L1 ,4th and 8th-pin .

2) CIS is equipped with
DEU-9S-F0R（by JAE) as connectors,
030-50640（by JAE) as contact socket.

3) Connector for Power Cable (strongly recommend using)
DEU-9P-F0R（by JAE） as contact socket housing,
030-50641（ by JAE) as contact pin.

*** Connector and Contact socket are different between MX-NL series without illumination and MX series with illumination.**

4) Pin assignment table is following .

(KD-MX-NL series)			
No	Name	I/O	note
1	NC	–	
2	NC	–	
3	NC	–	
4	OUT PULSE1	O	3.3V LVTTL
5	NC	–	
6	NC	–	
7	NC	–	
8	OUT PULSE2	O	3.3V LVTTL
9	GND	I	

5) When adjusting the pulse width of the lighting trigger signal to control commands. Refer to the functional specification for more information.

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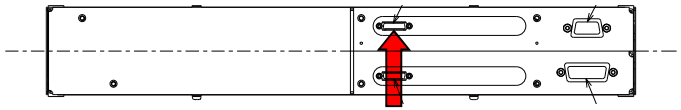
Chapter 4 ： How to control CIS

4-1 Communication port

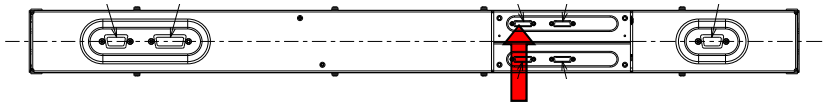
4-1-1 Master and slave port for communication

A3(KD6R309MX/MX-NL)



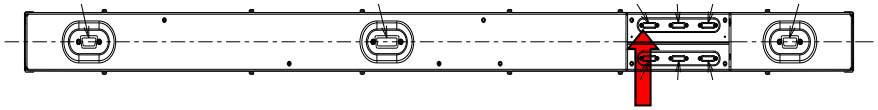
Master port
D1

A1(KD6R617MX/MX-NL)



Master port
D1

A0(KD6R926MX/MX-NL)



Master port
D1

【Control method】
This product receives the communication control and a synchronization signal through Communication port.

【Control through Communication port】
- Input external synchronization signal (CC1)
- Communication (UART)

【Communication port connectors】
Each product has each Communication port connector as described on the left. Communication port connector is D1.

【Line synchronization signal】
In the case of external sync. mode , the sync. signal inputted from CC1 signal line of Communication port is distributed into other modules (Camera Link® channels). Therefore All modules are synchronized by same sync. signal.

【Internal synchronization mode】
The sync. signal, generated by the internal control circuit, is distributed into other modules. Therefore All modules are synchronized by same lines.

【Remarks】
1)This product doesn't accept communication signal through other than Master port.
2)Make sure the connector assignment on a grabber board you would use first.

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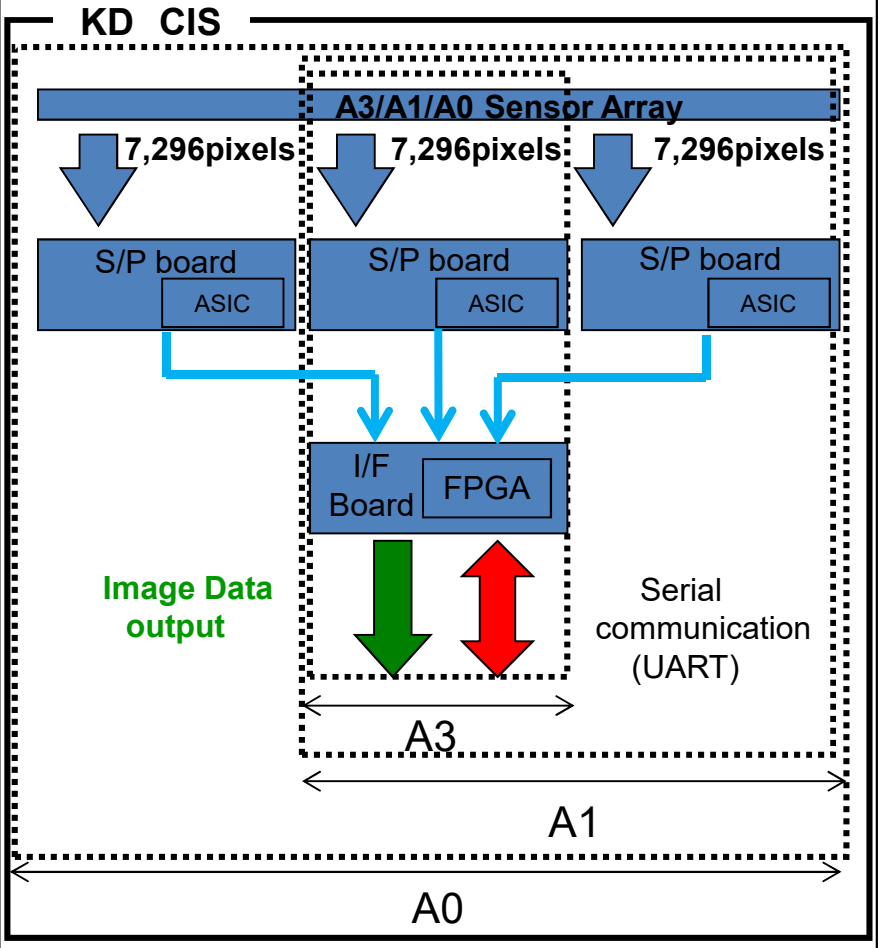
4-2 Communication（Abstract）

4-2-1 Block diagram for UART communication



S/P board : Signal Processing Board

【Serial Communication】

1) This product has a function to communicate with user's system by using standard Camera Link® UART . And it is possible to control a lot of function and parameter of CIS through UART communication.
2) Communication specification

Baud rate	9.6k, 19.2k, 115.2k
Data bit	8bit
Parity	None
Stop Bit	1bit
Flow Control	None

- The initial setting of communication speed is 9.6kbaud .
- 3) The UART Communication for all products ,A3 , A1 and A0 CIS , can be handled only 1 UART port of Communication port .

4-2 Communication (Command list)

4-2-2 Command list for UART communication

- Command system are different between AX/AX2 and MX series .
- <CR> means ASCII code “0x0d”
- Refer to Appendix D in this document for more information.

Function	Command	Communication format	Description
Select Baud rate	BR	BR parameter <CR>	Select Bard Rate (9.6kbps,19.2kbps,115.2kbps)
Select Output format	OC	OC parameter <CR>	Select output format
Select output CLK frequency	OF	OF parameter <CR>	Set output CLK frequency by selecting it from 17types of them（48～84MHz)
Select Synchronization mode	SS	SS parameter (Data) (Data) <CR>	Select external/internal synchronization mode
LED Control	LC	LC parameter (Data) (Data) <CR>	Control turning on/off of LED(illumination)
Set Dark correction	DC	DC parameter <CR>	Set dark collection on/off
Set White correction	WC	WC parameter (Data) (Data) <CR>	Set white collection on/off and collection value
PGA	PG	PG parameter (Data) (Data) <CR>	Set PGA on /off and amplification degree
Set γ correction	GC	GC parameter (Data) (Data) <CR>	Set gamma correction on/off
Select resolution	RC	RC parameter <CR>	Select output resolution from 4options. (75/150/300/600dpi). Optical resolution is 600dpi fixed.
Test Pattern	TP	TP parameter <CR>	Output test pattern signal. Several test patterns are selectable.
Software reset	SR	SR parameter <CR>	Software Reset for ASIC/FPGA
Select Control mode	DT	DT parameter <CR>	Select from a factory setting or user settings

4-2 Communication（structure of command）

4-2-3 Command format and examples

1) Input　Command　Parameter　（DATA）（DATA）　End code
　　（2Byte）　（2Byte）　（2Byte）（2Byte）　CR

2) Output　Result　Parameter　（DATA）（DATA）　End code
　　（2Byte）（2Byte）　（2Byte）（2Byte）　CR

3) Detail

<Parameter>　MSB　LSB
　　0　00　00000

R/W
0: Write
1: Read

2bit
Mode setting

Lower 5bit
Control parameter

<DATA>

One byte of hexadecimal data translates to 2 byte of ASCII cord.
00（0×30　0×30）～FF（0×46　0×46）
Hexadecimal A-F should be translated as a capital letter.（0×41～46）

<Result >　Response for Input procedure

00（0×30　0×30）	finish normal
F1（0×46　0×31）	irregular command input
F2（0×46　0×32）	out of range of parameter
F3（0×46　0×33）	out of address mapping
F4（0×46　0×34）	mismatch of No. of data
FF（0×46　0×46）	other error

Example： to set baud rate as 19.2kbaud
Input

	Command	Parameter	End code
	BR	01	CR
=>	0x42 0x52	0x30 0x31	0x0d

【Command】

The structure of UART command are shown on left side of page . Refer the function specification for the detail of commands .

【Remarks】

1）Command system are different between AX/AX2 and MX series .

2）As far as there is no designation especially, an ASCII code is used for Commands and parameters.
A parameter or data of hexadecimal transcription is handled by ASCII cord of each 4bit unit hexadecimal data.

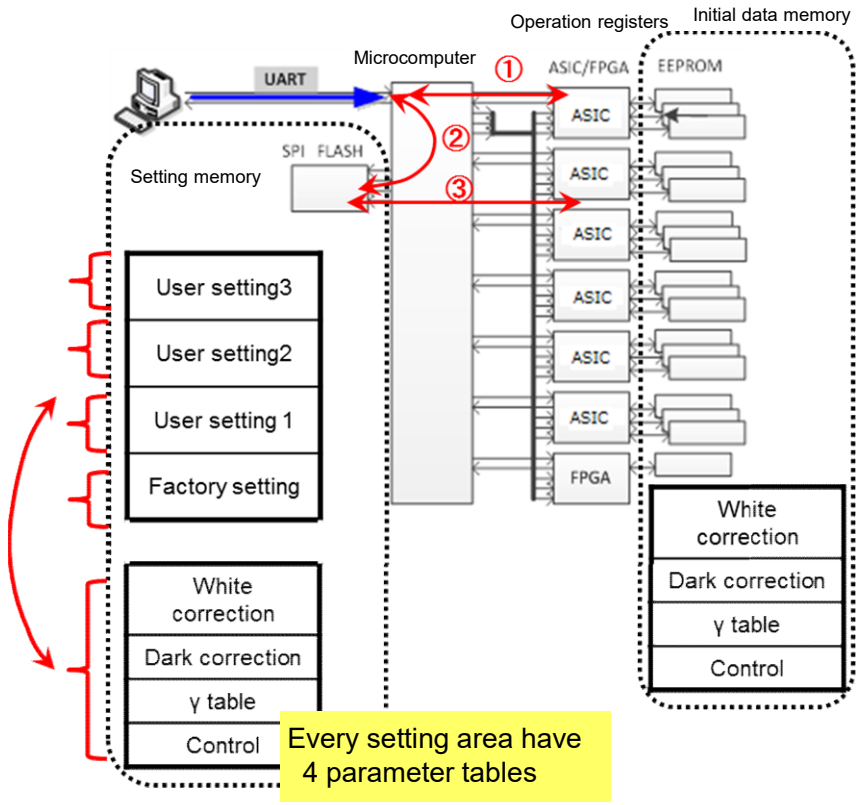
3）It's possible to communicate by the same command for all size of MX, and MX-NL series product .

4）A detail setting procedure is shown on chapter 5 of this document and the function specification .

4-2 Communication (User setting)

4-2-4 Memory (user setting)

Directions of Communication



Following ①～③ in the diagram show the route of operation data transference.

① UART ⇔ Operation registers in ASIC/FPGA.

② UART ⇔ Setting memory (FLASH memory)

③ Setting memory ⇔ Operation registers in ASIC/FPGA.

【User setting memory area】

This product has 3 memory area, User setting1,User setting2 and User setting3 , for storing setting data which customer makes under unique conditions.

The procedure to make new setting data is as following.

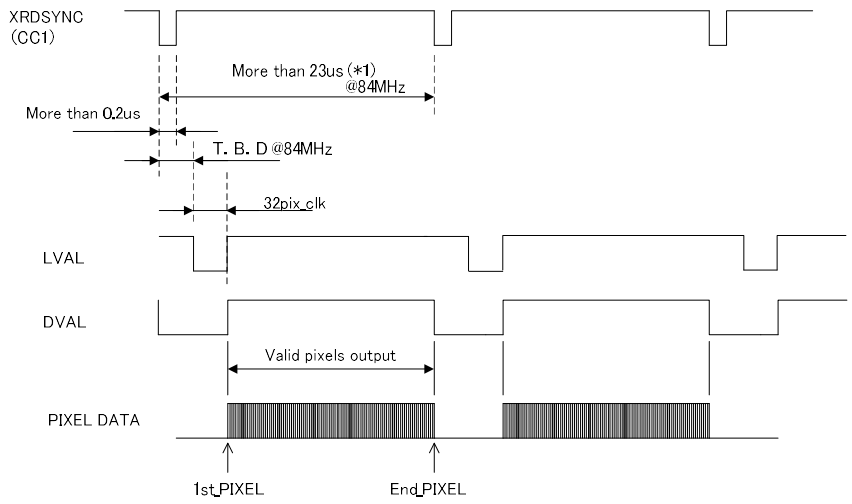
1) Adjust Registers on ASIC/FPGA by UART under target condition of the Inspection.
2) Store ASIC/FPGA register data to User setting memory area .(Using memory transfer command from UART)

【Remarks】

1) It is available to read out the following data from the storing memory .
   - γ correction data
   - Control register value
   - White correction data
   - Dark correction data
2) Refer Chapter 5 of this document and the function specification document how to store user setting data to the storing memory and detail procedure of it .
3) The initial data which are set at factory adjustment are stored in this memory area . Customer can not over-write date in this area .

4-3 Line Sync. Timing (External Sync. Mode)

4-3-1 Line timing



*1 The highest Scanning rate is 23usec (= the shortest period of scanning). The time is common for the products.

*2 The highest Scanning rate is depended on Output mode (Camera Link® Output Configuration) .

Example

1) set External Sync. mode
   SS 01 CR
2) Set internal Sync. Mode and Line period
   SS 00 (data) (data) (data) (data) CR

【External Sync. mode】

Initial synchronous mode is set on the External Sync.

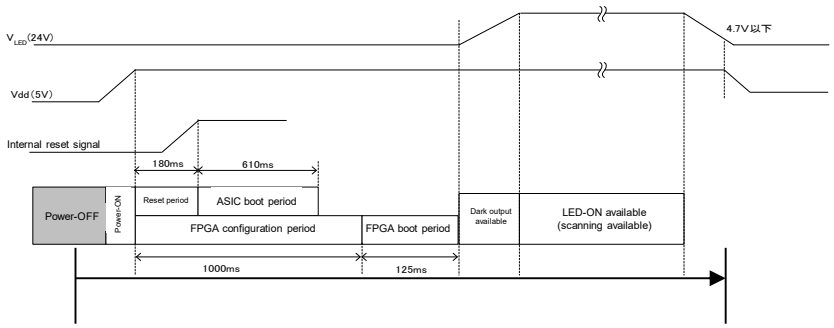
1) The trigger (Sync.) signal is necessary for CIS to scan images on the external sync. mode .
2) The trigger (Sync.) signal , RDSYNC through CC1 line of Camera Link® Interface is input to the Master port (D1) of CIS .
3) The scanning sequence is synchronized with falling-trigger (Sync.) signal , RDSYNC .
   "L" level period of RDSYNC needs to be 0.2usec min. at least .
4) It will be able to synchronize Image scanning function with Conveyer system by inputting Sync. Signal generated from Encoder circuit of conveyer system to a Frame Gabber Board through CC1 signal line

【Remarks】

1) Keep the line period longer than designated one. In the case of shorter line period , Scanning image will be not correct .
2) Image data in Min. 10 lines after starting to input regular sync. Signal are not valid .

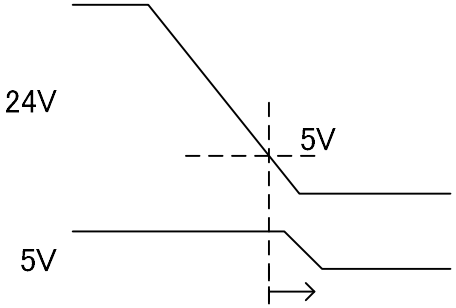
4-4 Power supply condition

4-4-1 Power-ON sequence



Wait 1.2 seconds after charging 5V

4-4-2 Power-OFF sequence



【Power-ON sequence】

1) Power-ON sequence described on the left is recommended to start up this product appropriately. (Although operations other than the recommended does not damage the product, but it may illuminations shine strongly moment.)
2) After rising up 5V power supply (more than 4.8 V), wait for 1.2 seconds and start charging 24V power supply. Initial boot is completed in 1.2 seconds after rising up of 5V power supply.
3) Read Status register “XBOOT” in order to monitor whether initial boot is completed or not. For more details, refer to Chapter 5-2 Setting (others): Software boot function.

【Power-OFF sequence】

1) Start shutting down of power supply after finishing communication control.
2) Power-OFF sequence described on the left is recommended to shut down this product appropriately. (Although operations other than the recommended does not damage the product, but it may illuminations shine strongly moment.)
3) After 24V power supply falls into less than 5V, start shutting down 5V power supply.

【Remark】

1) Each timing of Power-ON and Power-OFF depends on the performance of your power supply. Make sure the timing of power supply before starting to use.

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Chapter 5 : Getting started

5-1 Initial settings

5-1-1 Initial settings

Items	Initial setting
Pixel clock frequency	84MHz
Output format	10bit Base Configuration, Serial, 2 Tap
Resolution	600dpi
Sync. Signal mode	External Sync. Mode
Dark correction	None
illumination mode ※MX-NL series output the illumination emission sync. trigger signal externally	Turn On Both side illumination Illumination period :15us
White correction	None
PGA	None (gain = 1.0)
Pixel Interpolation	None
Pixel Overlap	None
γ correction	None

【CIS initial settings】

1) Initial settings of this product is described on the left table.
2) The initial status of this product immediately after Power-ON is in below.

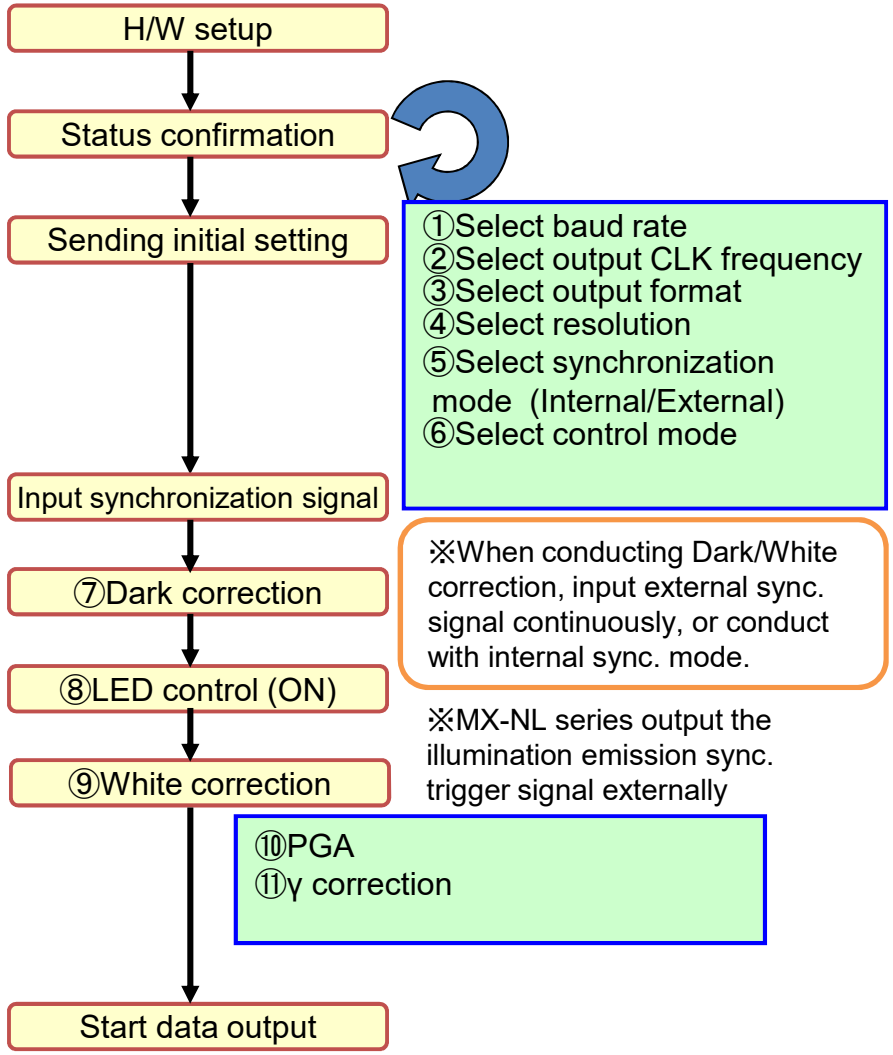
・CIS data output :
CIS data output starts after inputting external synchronization signal. Image data starts to be valid 10 lines after synchronization signal.

・Illumination (LED) :
After Power-ON, the illumination remains to be turned OFF. After inputting external synchronization signal, the illumination starts to be turning ON.

3) For more detailed settings for your application, refer to each setting , see next pages.

5-2 Procedure of function settings

5-2-1 Procedure of function settings



【 Procedure of function settings】

1) This product contains several image processing functions that can be controlled through Camera Link® I/F in order to arrange several settings accommodating your application.
2) Follow the procedure of several function settings is described on the left chart.
   - ①Select Baud rate
   - ②Select output CLK frequency
   - ③Select output format
   - ④Select resolution
   - ⑤Select synchronization mode
   - ⑥Select control mode
   - ⑦Dark correction
   - ⑧LED control
     (* Trigger signal output control for MX-NL series)
   - ⑨White correction
   - ⑩PGA
   - ⑪γ correction
3) This product is recommended to control some functions (such as White and Dark corrections) while monitoring a time-dependent output-change in a continuous operation.
4) It is also available to store the setting which big amount of transfer necessary. See technical specification for further detail.

[Remarks]
- When conducting Dark/White correction, input external sync. signal continuously, or conduct with internal sync. mode.
- Generate data for each scan when conducting Dark/White correction.

5-2 Setting ①Select Baud rate

5-2-1 Communication Speed setting

【Input】

Command Parameter End code

BR ** CR

[initial setting] 9.6kbps

[Selectable setting]

9.6kbps
19.2kbps
115.2kbps

Parameter	Baud rate
00	9.6kbaud
01	19.2kbaud
02	115.2kbaud

Example

Select Baud rate to 115.2kbaud .

BR 02 <CR>

【UART Serial Communication speed setting 】

[Function]

This command sets a baud rate of Serial communication , UART , from 3 type of speed .

Initial Baud rate is 9.6kbaud .

【Remarks】

1) For communication speed to change just after CR of a command line “CR” was sent, there is no answer output.

5-2 Setting ②Set output CLK frequency

5-2-2 Output CLK frequency setting

【Input】 【Output】

Command	Parameter	End code	Result	Parameter	End code
OF	**	CR	**	**	CR

[initial value] 84MHz（maximum CLK frequency)

[Range of setting] 48MHz - 84MHz
the selectable CLK frequency is following.

Parameter	frequency	Rad value	parameter	Frequency	Read value
00	48MHz	—	10	64MHz	—
01	50.7MHz	—	11	65.1MHz	—
02	51.0MHz	—	12	66MHz	—
03	51.4MHz	—	13	67.2MHz	—
04	52.0MHz	—	14	68MHz	—
05	52.8MHz	—	15	68.6MHz	—
06	53.3MHz	—	16	72MHz	—
07	54.0MHz	—	17	76MHz	—
08	54.9MHz	—	18	76.8MHz	—
09	56MHz	—	19	78MHz	—
0A	57MHz	—	1A	80MHz	—
0B	57.6MHz	—	1B	81.6MHz	—
0C	58.3MHz	—	1C	84MHz	—
0D	60MHz	—	80	READ setting	00 - 1C
0E	61.7MHz	—			
0F	62.4MHz	—			

Example

Select output CLK frequency on 66MHz
OF 12 <CR> ⇒ 00 12 <CR>

【Output CLK frequency setting】

[Function]
Pixel CLK frequency of Camera Link® I/F is set by this command .
Scanning rate and amount of output data per line should be considered to define pixel CLK frequency

[Remarks]
1) The relationship between Pixel CLK frequency and scanning line rate should be satisfied with following equations.
x= The number of pixels per 1ch 1tap
(Refer to Appendix A ③, ④, ⑦ for x of each mode)

① In the case of Base Configuration
CLK frequency (MHz) > $(\frac{x}{2} + 30) \times$ Line frequency (kHz)

② In the case of Medium Configuration
CLK frequency (MHz) > $(\frac{x}{4} + 30) \times$ Line frequency (kHz)

③ In the case of Medium Configuration 2
CLK frequency (MHz) > $(\frac{x}{8} + 30) \times$ Line frequency (kHz)

④ In the case of Medium Configuration 3
CLK frequency (MHz) > $(\frac{x}{16} + 30) \times$ Line frequency (kHz)

2) Refer the function specification for more information .
3) Use parameter value only in the table . If a parameter value is not in the table , data output will be not correct .

5-2 Setting ③Select output format

5-2-3 Pixel-data Output setting

【Input】

Command	Parameter	End code
OC	**	CR

【Output】

Result	Parameter	End code
**	**	CR

[Initial setting] 10bit- 2Tap Output Base Configuration without Pixel interpolation and Overlap

[settings]

Output data depth	8bit / 10bit
Output arrangement	Single/parallel
Output Configuration and No. of channel	Camera Link® Base / Medium / Medium x2 / Medium x3
Pixel interpolation	On/Off
Pixel Overlap	On/Off

Example

Select format : 10bit 2Tap / single output
/ Base Configuration
/ without pixel interpolation & Overlap

OC 00 <CR> ⇒ 00 00 <CR>

【 Pixel-data Output setting 】

[Function]

Image data output format is set by this command .
The bit Depth of image data is selected from 8 and 10 bit width .

1) There are 2 mode of output data alinement as following.
   - Single output : Image data is output from 1st pixel to end pixel of taps sequentially .
   - Parallel output : Image data of Odd and even pixels of taps is output at a same time .
2) Output format is based on Camera Link® standard and correspond to Base and Medium Configuration.

3) The function of pixel interpolation and overlap is available . A1 and A0 size CIS can output each as 2 and 3 of A3 size CISs .

Detail information are shown in Appendix A .

【Remarks】

1) The functions , Output format , line frequency and Pixel clock frequency, are related each other . Therefore set them carefully .

5-2 Setting ④Select resolution

5-2-4 Resolution setting for Main scan direction

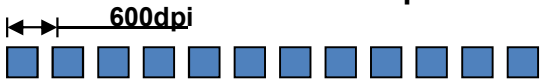
【Input】 【Output】

Command	Parameter	CR	Result	Parameter	CR
RC	**	CR	**	**	CR

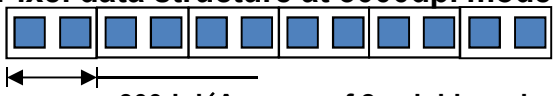
[initial Value] 600dpi

[Settings] Resolution 75dpi , 150dpi ,300dpi ,600dpi

1）Pixel data structure at 600dpi mode



2）Pixel data structure at 3000dpi mode

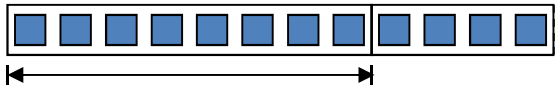


300dpi（Average of 2 neighbor pixels）

3）Pixel data structure at 150dpi mode

150dpi Average of 4 neighbor pixels ）

4）Pixel data structure at 75dpi mode



75dpi（ Average of 8 neighbor pixels ）

Example

Set resolution to 600dpi mode

RC 00 <CR> ⇒ 00 00 <CR>

【 Resolution setting for Main scan direction】

[Function]

to define a resolution of output image data .

Pixel pitch of sensor IC is 600dpi and Optical resolution is also same as Pixel pitch (600dpi).

Variation of output resolution is realized by digital processing on data output circuit . Each resolution data comes from calculation of neighbor 2,4,8 pixel averaging.

【Remarks】

1) Pixel pitch of sensor IC is 600dpi and Optical resolution is also same as Pixel pitch (600dpi). And internal data processing of CIS is handled as 600dpi data .
2) Scan rate is not faster than specified line rate on spec. sheet even so resolution of data output is lower .
3) If it is necessary for scanning image to have square pixel , should be change the transfer speed of the object as following .
   300dpi : 2 times faster than 600dpi mode
   150dpi : 4 times faster than 600dpi mode
   75dpi : 8 times faster than 600dpi mode

5-2 Setting ⑤Select Synchronization mode

5-2-5 Sync. mode

【Input】
Command Parameter （DATA） （DATA） CR
SS ** Upper Lower CR

【Output】
Result Parameter （DATA） （DATA） CR
** ** Upper Lower CR

* In the case of setting Internal Sync. Mode , Line period is set by 2 byte data.
in the case of setting External Sync. Mode , not need data setting.

[initial state] External Sync. Mode
It needs Sync. Signal through CC1 signal line of Camera Link® I/F .

[mode setting]
External Sync. Mode or Internal Sync. mode

* Refer chapter 4-3. about The Limitation for External Sync. Signal

Example

Select to External Sync. mode
SS 01 <CR> ⇒ 00 01 <CR>

【Sync. Mode setting】

[Function]
it is possible to select the line Synchronous modes by this command.

In the case of synchronized scanning with Conveyer system , it needs a sync. Signal from outside of CIS as External Sync. Mode .
Refer chapter 4-3..
In the case of scanning at fixed line rate and using an internal Sync. Signal of CIS , set internal Sync. Mode and line period .
line period can be set up to 780usec (at 84MHz pixel clock) .

【Remarks】

1）In the case of External Sync. Mode , a line sync. Signal has to be input from a Frame Grabber . The line period should be considered by scanning condition , transfer speed of Objects and resolution .

2）In the case of Internal Sync. mode , CIS generates a sync. Signal in itself . Line period is calculated as following . Pixel clock is 16MHz.
Formula :

$$Line\ Period\ (usec) = \frac{(Register\ value\ ) + 1}{16\mathrm{MHz}}$$

5-2 Setting ⑥Select Control mode

5-2-6 Select Control mode

【Input】 【Output】

Command	Parameter	CR	Result	Parameter	CR
DT	**	CR	**	**	CR

[initial] Factory setting mode
* CIS starts by register data of Factory setting memory.

[mode] Factory setting
User setting mode1
User setting mode2
User setting mode3

[Operation]
1) boot data :
A setting data of 4 mode in Flash memory copy to ASIC and FPGA registers .
2) Store data :
All register data of FPGA and ASIC copy to a designated area (Factory , user setting1 ,2 and 3) of flash memory .

Example

Copy user setting1 data to ASIC and FPGA registers
DT 01 <CR> ⇒ 00 01 <CR>

【Select Control mode】

[Function]
select the function mode of CIS .

CIS start to function on Factory setting mode just after turning on Power .
If it is necessary for CIS to function on a different parameter which stored user memory area , use this command and switch a mode.

It is possible to store 3 deferent data each to 3 areas of a Flash memory . By using this command user setting data can be stored in a user setting area of a Flash memory .

【Remarks】

1) User setting mode can only use after preparing user setting data and storing them in a user setting area of a Flash memory . There is no user setting data in CIS which is just shipped from the factory .
2) Refer the function specification about how to prepare user setting data .

5-2 Setting ⑦Dark correction

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

5-2-7 Dark Correction

【Input】

Command	Parameter	End code
DC	**	CR

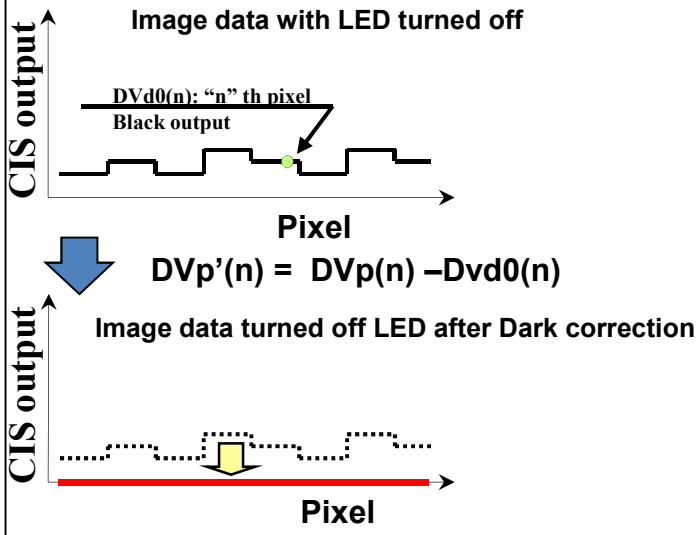
【Output】

	Result	Parameter	End code
	**	**	CR

[Initial setting] Dark Correction : OFF

[Setting]

1) Automated Dark correction data generation
2) Dark Correction ON/OFF



Example

Switch Dark correction mode to turn on :

DC 01 <CR> ⇒ **00 01 <CR>**

【Dark Correction】

[Function]

Correct the variation of dark outputs pixel by pixel when illumination is turned off .

Refer chapter 2-3. about the details of this function.

【Remarks】

1) CIS has initial dark correction data in Factory setting memory . After turning on power , initial dark correction data are booted in ASIC and FPGA registers automatically and dark correction will be start by the command .
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 .
6) Generate data for each scan when conducting Dark/White correction.

5-2 Setting ⑧LED control

※MX-NL series output the illumination emission sync. trigger signal externally

5-2-8 Illumination control

【Input】

Command Parameter （DATA） （DATA） CR
LC ** Upper Lower CR

【Output】

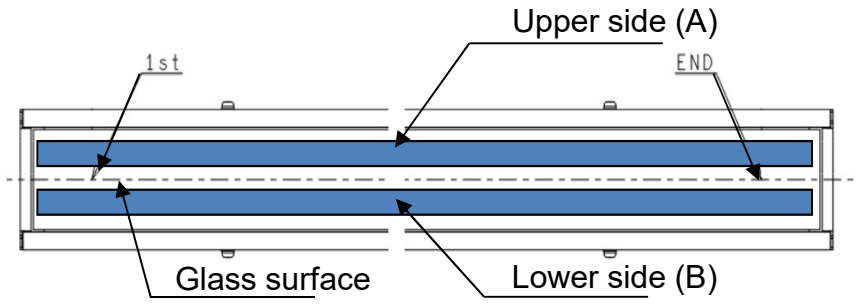
Result Parameter （DATA） （DATA） CR
** ** Upper Lower CR

* Illumination periods are defined by 2 byte data . Commands except for setting Illumination period have no data.

[initial] Double side of illumination : turn on
Illumination period : 15usec

[Mode]

1) Double side mode : A,B both side are turned on
2) A-side (single side) mode : A side is turned on
3) B-side (single side) mode : B side is turned on



Example

A,B both side of illumination are turned on :
LC 03 <CR> ⇒ 00 03 <CR>

【 Illumination control 】

[Function]
Set Light-source turn on/off control and illumination period .

For CIS with light-sources
This function be able to control built-in illumination .
For CIS without light-source(NL)
This function be able to control external illumination by using 2 signals of the connector.

Illumination period is changeable up to 4095usec and initial value is set 15usec at the factory .

【Remarks】

1) Illumination is controlled by Serial Communication of Camera Link®. Therefore LED control does not synchronize with line scan signal.
2) White correction data is available only for one designated Illumination mode .
3) MX-NL CIS has illumination trigger pulse signals adjusted by this command and these signals output a connector. Refer the function specification .

5-2 Setting ⑨White correction

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

5-2-9 White Correction

【Input】

Command Parameter （DATA） （DATA） CR

WC ** Upper Lower CR

【Output】

Result Parameter （DATA） （DATA） CR

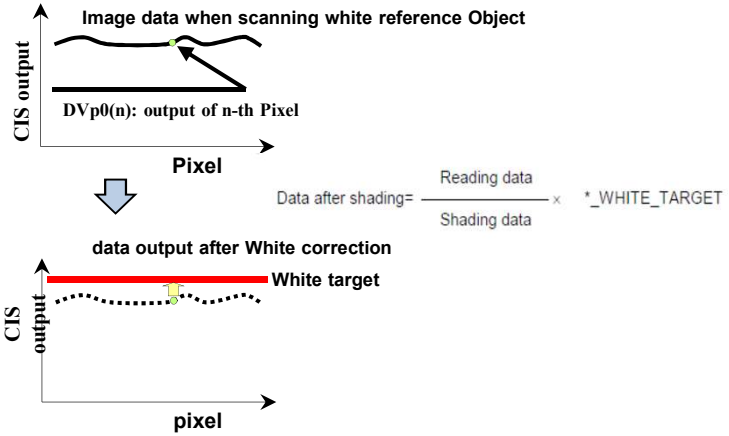
** Upper Lower CR

* A Value of White target are defined by 2 byte data . Commands except for setting a Value of White target have no data.

[initial] White Correction function Off

[setting]

1) automated White correction data generation
2) white Correction



Example

Switch White correction mode to turn on :

WC 01 <CR> ⇒ 00 01 <CR>

【White Correction】

[Function]

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” .

【Remarks】

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) Refer the function specification about how to generate new white correction data

5-2 Setting ⑩PGA

5-2-10 PGA

【Input】

Command Parameter （DATA） （DATA） CR

PG ** Upper Lower CR

【Output】

Result Parameter （DATA） （DATA） CR

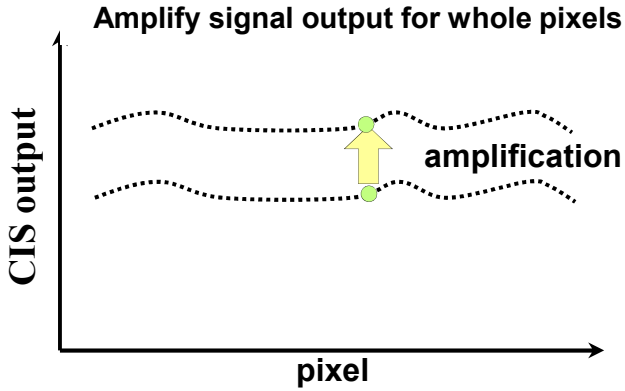
** ** Upper Lower CR

* a gain is defined by 2 byte data . Commands except for setting a gain have no data.

[Initial] gain = 1.0

[setting]

1) PGA setting On/Off
2) PGA gain setting



Example

Switch PGA function turn on

PG 01 <CR>

【PGA（Programmable Gain Amp）】

[Function]

Amplify image signals for whole pixels in a line by the designated magnification .

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

Output level after PGA is calculated as following .

$$Output\ data = \frac{1024+Register\ data}{1024} \times Input\ data$$

5-2 Setting ⑪γ correction

5-2-11 γ correction function

【Input】

Command Parameter （DATA） （DATA） CR

GC ** Upper Lower CR

【Output】

Result Parameter （DATA） （DATA） CR

** ** Upper Lower CR

* a gain is defined by 2 byte data . Commands except for setting a gain have no data.

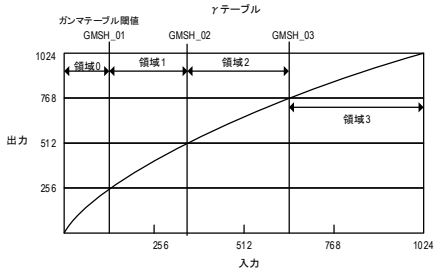
[initial]

γ correction : OFF (γ＝1)

Preset γ table : γ=2.2

[setting]

γ correction ON/OFF



	領域0	領域1	領域2	領域3
変換後データ	0～128階調	129～346階調	347～640階調	641～1023階調
9	0	0	1	1
8	0	1	0	1
7	8bit-SRAM FFh~00h	8bit-SRAM FFh~00h	8bit-SRAM FFh~00h	8bit-SRAM FFh~00h
6				
5				
4				
3				
2				
1				
0 LSB				

Example

Switch γ correction turn on

GC 00 <CR> ⇒ 00 00 <CR>

【γ correction function】

[Function]

Change the linearity from input data to output data by LUT .

* LUT : Look Up Table

The output property of Photo-diodes on sensor ICs against light power input is linear.

This function change the of Input-Output property (γ) to fit visible images .

【Remarks】

1) γ table consists of 4 of LUT which made output correspond to 256 of input which shared 1024 steps with 4 groups.
2) Refer the function specification about details of γ correction function .

5-2 Setting ⑫Test pattern

5-2-14 Test pattern

【Input】 【Output】

Command	Parameter	CR	Result	Parameter	CR
TP	**	CR	**	**	CR

[initial]

Test Pattern : Off (normal images output)

Test pattern :

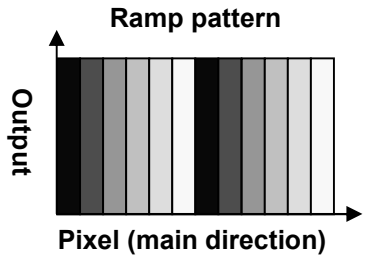
Ramp pattern on main scan direction)

4digit steps

[setting]

Test pattern output On/Off

Images



Example

Switch test pattern output turn on

TP 01 <CR> ⇒ 00 01 <CR>

【Test pattern】

[Function]

CIS output fixed test pattern data instead of Image data to Camera Link® connector .

By using this test pattern ,it is easy to check the bus line of image data.

【Remarks】

1) This function is for checking the bus line of image data .

2) Image data from sensor ICs is not available during the test pattern mode is on .

3) When using Test pattern, set each parameters off of Dark correction, White correction, y correction, PGA correction.

Appendix. A Data output ①

Settings for the Camera Link® data output format.
Output formats are as follows;
・10bit Serial Base Configuration
・10bit Serial Medium Configuration
・10bit Parallel Base Configuration
・10bit Parallel Medium Configuration
・ 8bit Serial Base Configuration
・ 8bit Serial Medium Configuration
・ 8bit Parallel Base Configuration
・ 8bit Parallel Medium Configuration

With the above output formats,
・Camera Link® Pixel overlap between the Channels. (64 pixels)
・Interpolation pixels
・Resolution conversion, are added for the data outputs.

Output mode	No. of tap	No. of Camera Link® Ch	No. of connecter	Configuration	KD6R309MX, MD6R309MX-NL	KD6R617MX, MD6R617MX-NL	KD6R926MX, MD6R926MX-NL
Serial	2	1	1	Base	○	○	○
	4	1	2	Medium	○	○	○
	8	2	4	Medium	×	○	○
	12	3	6	Medium	×	×	○
Parallel	2	1	1	Base	○	○	○
	4	1	2	Medium	○	○	○
	8	2	4	Medium	×	○	○
	12	3	6	Medium	×	×	○

Appendix. A Data output ②

A-1 Output format bit assignment

Base Configuration

8bit 2tap		10bit2tap	
D1			
Port A0	T1[0]	Port A0	T1[0]
Port A1	T1[1]	Port A1	T1[1]
Port A2	T1[2]	Port A2	T1[2]
Port A3	T1[3]	Port A3	T1[3]
Port A4	T1[4]	Port A4	T1[4]
Port A5	T1[5]	Port A5	T1[5]
Port A6	T1[6]	Port A6	T1[6]
Port A7	T1[7]	Port A7	T1[7]
Port B0	T2[0]	Port B0	T1[8]
Port B1	T2[1]	Port B1	T1[9]
Port B2	T2[2]	Port B2	nc
Port B3	T2[3]	Port B3	nc
Port B4	T2[4]	Port B4	T2[8]
Port B5	T2[5]	Port B5	T2[9]
Port B6	T2[6]	Port B6	nc
Port B7	T2[7]	Port B7	nc
Port C0	nc	Port C0	T2[0]
Port C1	nc	Port C1	T2[1]
Port C2	nc	Port C2	T2[2]
Port C3	nc	Port C3	T2[3]
Port C4	nc	Port C4	T2[4]
Port C5	nc	Port C5	T2[5]
Port C6	nc	Port C6	T2[6]
Port C7	nc	Port C7	T2[7]

Medium Configuration

8bit 4tap				10bit 4tap			
D1		D2		D1		D2	
Port A0	T1[0]	Port D0	T4[0]	Port A0	T1[0]	Port D0	T4[0]
Port A1	T1[1]	Port D1	T4[1]	Port A1	T1[1]	Port D1	T4[1]
Port A2	T1[2]	Port D2	T4[2]	Port A2	T1[2]	Port D2	T4[2]
Port A3	T1[3]	Port D3	T4[3]	Port A3	T1[3]	Port D3	T4[3]
Port A4	T1[4]	Port D4	T4[4]	Port A4	T1[4]	Port D4	T4[4]
Port A5	T1[5]	Port D5	T4[5]	Port A5	T1[5]	Port D5	T4[5]
Port A6	T1[6]	Port D6	T4[6]	Port A6	T1[6]	Port D6	T4[6]
Port A7	T1[7]	Port D7	T4[7]	Port A7	T1[7]	Port D7	T4[7]
Port B0	T2[0]	Port E0	nc	Port B0	T1[8]	Port E0	T3[0]
Port B1	T2[1]	Port E1	nc	Port B1	T1[9]	Port E1	T3[1]
Port B2	T2[2]	Port E2	nc	Port B2	nc	Port E2	T3[2]
Port B3	T2[3]	Port E3	nc	Port B3	nc	Port E3	T3[3]
Port B4	T2[4]	Port E4	nc	Port B4	T2[8]	Port E4	T3[4]
Port B5	T2[5]	Port E5	nc	Port B5	T2[9]	Port E5	T3[5]
Port B6	T2[6]	Port E6	nc	Port B6	nc	Port E6	T3[6]
Port B7	T2[7]	Port E7	nc	Port B7	nc	Port E7	T3[7]
Port C0	T3[0]	Port F0	nc	Port C0	T2[0]	Port F0	T3[8]
Port C1	T3[1]	Port F1	nc	Port C1	T2[1]	Port F1	T3[9]
Port C2	T3[2]	Port F2	nc	Port C2	T2[2]	Port F2	nc
Port C3	T3[3]	Port F3	nc	Port C3	T2[3]	Port F3	nc
Port C4	T3[4]	Port F4	nc	Port C4	T2[4]	Port F4	T4[8]
Port C5	T3[5]	Port F5	nc	Port C5	T2[5]	Port F5	T3[9]
Port C6	T3[6]	Port F6	nc	Port C6	T2[6]	Port F6	nc
Port C7	T3[7]	Port F7	nc	Port C7	T2[7]	Port F7	nc

Appendix. A Data output ③

A-2 Output format output pixels

Base Configuration output pixels

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)			
KD6R309MX/MX-NL	Single	T1	1	2	…	3648	1	2	…	3660
		T2	3649	3650	…	7296	3661	3662	…	7320
	Parallel	T1	1	3	…	7295	1	3	…	7319
		T2	2	4	…	7296	2	4	…	7320
KD6R617MX/MX-NL	Single	T1	1	2	…	7296	1	2	…	7320
		T2	7297	7298	…	14592	7321	7322	…	14640
	Parallel	T1	1	3	…	14951	1	3	…	14639
		T2	2	4	…	14952	2	4	…	14640
KD6R926MX/MX-NL	Single	T1	1	2	…	10944	1	2	…	10980
		T2	10945	10946	…	21888	10981	10982	…	21600
	Parallel	T1	1	3	…	21887	1	3	…	21959
		T2	2	4	…	21888	2	4	…	21600

Appendix. A Data output ④

A-3 Output format output pixels

Medium Configuration

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)			
KD6R309MX/MX-NL	Single	T1	1	2	…	1824	1	2	…	1830
		T2	1825	1,826	…	3648	1831	1832	…	3660
		T3	3649	3,650	…	5472	3661	3662	…	5490
		T4	5473	5,474	…	7296	5491	5492	…	7320
	Parallel	T1	1	5	…	7293	1	5	…	7317
		T2	2	6	…	7294	2	6	…	7318
		T3	3	7	…	7295	3	7	…	7319
		T4	4	8	…	7296	4	8	…	7320
KD6R617MX/MX-NL	Single	T1	1	2	…	3648	1	2	…	3660
		T2	3649	3650	…	7296	3661	3662	…	7320
		T3	7297	7298	…	10944	7321	7322	…	10980
		T4	10945	10946	…	14592	10981	10982	…	14640
	Parallel	T1	1	5	…	14589	1	5	…	14367
		T2	2	6	…	14590	2	6	…	14638
		T3	3	7	…	14591	3	7	…	14639
		T4	4	8	…	14592	4	8	…	14640
KD6R926MX/MX-NL	Single	T1	1	2	…	5472	1	2	…	5490
		T2	5473	5474	…	10944	5491	5492	…	10980
		T3	10945	10946	…	16416	10981	10982	…	16470
		T4	16417	16418	…	21888	16471	16472	…	21960
	Parallel	T1	1	5	…	21885	1	5	…	21957
		T2	2	6	…	21886	2	6	…	21958
		T3	3	7	…	21887	3	7	…	21959
		T4	4	8	…	21888	4	8	…	21960

Appendix. A Data output ⑤

A-4 Output format bit assignment

Medium Configuration *2 (8bit)

8bit 4tap*2							
D1		D2		D3		D4	
Port A0	T1[0]	Port D0	D4[0]	Port A0	T5[0]	Port D0	D8[0]
Port A1	T1[1]	Port D1	D4[1]	Port A1	T5[1]	Port D1	D8[1]
Port A2	T1[2]	Port D2	D4[2]	Port A2	T5[2]	Port D2	D8[2]
Port A3	T1[3]	Port D3	D4[3]	Port A3	T5[3]	Port D3	D8[3]
Port A4	T1[4]	Port D4	D4[4]	Port A4	T5[4]	Port D4	D8[4]
Port A5	T1[5]	Port D5	D4[5]	Port A5	T5[5]	Port D5	D8[5]
Port A6	T1[6]	Port D6	D4[6]	Port A6	T5[6]	Port D6	D8[6]
Port A7	T1[7]	Port D7	D4[7]	Port A7	T5[7]	Port D7	D8[7]
Port B0	T2[0]	Port E0	nc	Port B0	T6[0]	Port E0	nc
Port B1	T2[1]	Port E1	nc	Port B1	T6[1]	Port E1	nc
Port B2	T2[2]	Port E2	nc	Port B2	T6[2]	Port E2	nc
Port B3	T2[3]	Port E3	nc	Port B3	T6[3]	Port E3	nc
Port B4	T2[4]	Port E4	nc	Port B4	T6[4]	Port E4	nc
Port B5	T2[5]	Port E5	nc	Port B5	T6[5]	Port E5	nc
Port B6	T2[6]	Port E6	nc	Port B6	T6[6]	Port E6	nc
Port B7	T2[7]	Port E7	nc	Port B7	T6[7]	Port E7	nc
Port C0	T3[0]	Port F0	nc	Port C0	T7[0]	Port F0	nc
Port C1	T3[1]	Port F1	nc	Port C1	T7[1]	Port F1	nc
Port C2	T3[2]	Port F2	nc	Port C2	T7[2]	Port F2	nc
Port C3	T3[3]	Port F3	nc	Port C3	T7[3]	Port F3	nc
Port C4	T3[4]	Port F4	nc	Port C4	T7[4]	Port F4	nc
Port C5	T3[5]	Port F5	nc	Port C5	T7[5]	Port F5	nc
Port C6	T3[6]	Port F6	nc	Port C6	T7[6]	Port F6	nc
Port C7	T3[7]	Port F7	nc	Port C7	T7[7]	Port F7	nc

Appendix. A Data output ⑥

A-5 Output format bit assignment

Medium Configuration *2 (10bit)

10bit 4tap*2							
D1		D2		D3		D4	
Port A0	T1[0]	Port D0	T4[0]	Port A0	T5[0]	Port D0	T8[0]
Port A1	T1[1]	Port D1	T4[1]	Port A1	T5[1]	Port D1	T8[1]
Port A2	T1[2]	Port D2	T4[2]	Port A2	T5[2]	Port D2	T8[2]
Port A3	T1[3]	Port D3	T4[3]	Port A3	T5[3]	Port D3	T8[3]
Port A4	T1[4]	Port D4	T4[4]	Port A4	T5[4]	Port D4	T8[4]
Port A5	T1[5]	Port D5	T4[5]	Port A5	T5[5]	Port D5	T8[5]
Port A6	T1[6]	Port D6	T4[6]	Port A6	T5[6]	Port D6	T8[6]
Port A7	T1[7]	Port D7	T4[7]	Port A7	T5[7]	Port D7	T8[7]
Port B0	T1[8]	Port E0	T3[0]	Port B0	T5[8]	Port E0	T7[0]
Port B1	T1[9]	Port E1	T3[1]	Port B1	T5[9]	Port E1	T7[1]
Port B2	nc	Port E2	T3[2]	Port B2	nc	Port E2	T7[2]
Port B3	nc	Port E3	T3[3]	Port B3	nc	Port E3	T7[3]
Port B4	T2[8]	Port E4	T3[4]	Port B4	T6[8]	Port E4	T7[4]
Port B5	T2[9]	Port E5	T3[5]	Port B5	T6[9]	Port E5	T7[5]
Port B6	nc	Port E6	T3[6]	Port B6	nc	Port E6	T7[6]
Port B7	nc	Port E7	T3[7]	Port B7	nc	Port E7	T7[7]
Port C0	T2[0]	Port F0	T3[8]	Port C0	T6[0]	Port F0	T7[8]
Port C1	T2[1]	Port F1	T3[9]	Port C1	T6[1]	Port F1	T7[9]
Port C2	T2[2]	Port F2	nc	Port C2	T6[2]	Port F2	nc
Port C3	T2[3]	Port F3	nc	Port C3	T6[3]	Port F3	nc
Port C4	T2[4]	Port F4	T4[8]	Port C4	T6[4]	Port F4	T8[8]
Port C5	T2[5]	Port F5	T3[9]	Port C5	T6[5]	Port F5	T8[9]
Port C6	T2[6]	Port F6	nc	Port C6	T6[6]	Port F6	nc
Port C7	T2[7]	Port F7	nc	Port C7	T6[7]	Port F7	nc

Appendix. A Data output ⑦

A-6 Output format output pixels

Medium Configuration *2

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)				Output pixel (Interpolation ON, Overwrap ON)			
KD6R617MX/MX-NL	Single	T1	1	2	…	1824	1	2	…	1830	1	2	…	1846
		T2	1825	1826	…	3648	1831	1832	…	3660	1847	1848	…	3692
		T3	3649	3650	…	5472	3661	3662	…	5490	3693	3694	…	5538
		T4	5473	5474	…	7296	5491	5492	…	7320	5539	5540	…	7384
		T5	7297	7298	…	9120	7321	7322	…	9150	7321	7322	…	9166
		T6	9121	9122	…	10944	9151	9127	…	10980	9167	9168		11012
		T7	10945	10946	…	12768	10981	10982	…	12810	11013	11014		12858
		T8	12769	12770	…	14592	12811	12812	…	14640	12859	12860		14704
	Parallel	T1	1	5	…	7293	1	5	…	7317	1	5	…	7381
		T2	2	6	…	7294	2	6	…	7318	2	6	…	7382
		T3	3	7	…	7295	3	7	…	7319	3	7	…	7383
		T4	4	8	…	7296	4	8	…	7320	4	8	…	7384
		T5	7297	7301	…	14589	7321	7325	…	14637	7321	7325	…	14701
		T6	7298	7302	…	14590	7322	7326	…	14638	7322	7326	…	14702
		T7	7299	7303	…	14591	7323	7327	…	14639	7323	7327	…	14703
		T8	7300	7304	…	14592	7324	7328	…	14640	7324	7329	…	14704
KD6R926MX/MX-NL	Single	T1	1	2	…	2736	1	2	…	2745	1	2	…	2761
		T2	2737	2738	…	5472	2746	2747	…	5490	2762	2763	…	5522
		T3	5473	5474	…	8208	5491	5492	…	8235	5523	5524	…	8283
		T4	8209	8210	…	10944	8236	8237	…	10980	8284	8285	…	11044
		T5	10945	10946	…	13680	10981	10982	…	13725	10981	10982	…	13741
		T6	13681	13682	…	16416	13726	13727	…	16470	13742	13743	…	16502
		T7	16417	16418	…	19152	16471	16472	…	19215	16503	16504	…	19263
		T8	19153	19154	…	21888	19216	19217	…	21960	19264	19265	…	22024
	Parallel	T1	1	5	…	10941	1	5	…	10977	1	5	…	11041
		T2	2	6	…	10942	2	6	…	10978	2	6	…	11042
		T3	3	7	…	10943	3	7	…	10979	3	7	…	11043
		T4	4	8	…	10944	4	8	…	10980	4	8	…	11044
		T5	10945	10949	…	21885	10981	10985	…	21957	10981	10985	…	22021
		T6	10946	10950	…	21886	10982	10986	…	21958	10982	10986	…	22022
		T7	10947	10951	…	21887	10983	10987	…	21959	10983	10987	…	22023
		T8	10948	10952	…	21888	10984	10988	…	21960	10984	10988	…	22024

Appendix. A Data output ⑧

A-7 Output format bit assignment

Medium Configuration *3 (8bit)

8bit 4tap*3											
D1		D2		D3		D4		D5		D6	
Port A0	T1[0]	Port D0	D4[0]	Port A0	T5[0]	Port D0	T8[0]	Port A0	T9[0]	Port D0	T12[0]
Port A1	T1[1]	Port D1	D4[1]	Port A1	T5[1]	Port D1	T8[1]	Port A1	T9[1]	Port D1	T12[1]
Port A2	T1[2]	Port D2	D4[2]	Port A2	T5[2]	Port D2	T8[2]	Port A2	T9[2]	Port D2	T12[2]
Port A3	T1[3]	Port D3	D4[3]	Port A3	T5[3]	Port D3	T8[3]	Port A3	T9[3]	Port D3	T12[3]
Port A4	T1[4]	Port D4	D4[4]	Port A4	T5[4]	Port D4	T8[4]	Port A4	T9[4]	Port D4	T12[4]
Port A5	T1[5]	Port D5	D4[5]	Port A5	T5[5]	Port D5	T8[5]	Port A5	T9[5]	Port D5	T12[5]
Port A6	T1[6]	Port D6	D4[6]	Port A6	T5[6]	Port D6	T8[6]	Port A6	T9[6]	Port D6	T12[6]
Port A7	T1[7]	Port D7	D4[7]	Port A7	T5[7]	Port D7	T8[7]	Port A7	T9[7]	Port D7	T12[7]
Port B0	T2[0]	Port E0	nc	Port B0	T6[0]	Port E0	nc	Port B0	T10[0]	Port E0	nc
Port B1	T2[1]	Port E1	nc	Port B1	T6[1]	Port E1	nc	Port B1	T10[1]	Port E1	nc
Port B2	T2[2]	Port E2	nc	Port B2	T6[2]	Port E2	nc	Port B2	T10[2]	Port E2	nc
Port B3	T2[3]	Port E3	nc	Port B3	T6[3]	Port E3	nc	Port B3	T10[3]	Port E3	nc
Port B4	T2[4]	Port E4	nc	Port B4	T6[4]	Port E4	nc	Port B4	T10[4]	Port E4	nc
Port B5	T2[5]	Port E5	nc	Port B5	T6[5]	Port E5	nc	Port B5	T10[5]	Port E5	nc
Port B6	T2[6]	Port E6	nc	Port B6	T6[6]	Port E6	nc	Port B6	T10[6]	Port E6	nc
Port B7	T2[7]	Port E7	nc	Port B7	T6[7]	Port E7	nc	Port B7	T10[7]	Port E7	nc
Port C0	T3[0]	Port F0	nc	Port C0	T7[0]	Port F0	nc	Port C0	T11[0]	Port F0	nc
Port C1	T3[1]	Port F1	nc	Port C1	T7[1]	Port F1	nc	Port C1	T11[1]	Port F1	nc
Port C2	T3[2]	Port F2	nc	Port C2	T7[2]	Port F2	nc	Port C2	T11[2]	Port F2	nc
Port C3	T3[3]	Port F3	nc	Port C3	T7[3]	Port F3	nc	Port C3	T11[3]	Port F3	nc
Port C4	T3[4]	Port F4	nc	Port C4	T7[4]	Port F4	nc	Port C4	T11[4]	Port F4	nc
Port C5	T3[5]	Port F5	nc	Port C5	T7[5]	Port F5	nc	Port C5	T11[5]	Port F5	nc
Port C6	T3[6]	Port F6	nc	Port C6	T7[6]	Port F6	nc	Port C6	T11[6]	Port F6	nc
Port C7	T3[7]	Port F7	nc	Port C7	T7[7]	Port F7	nc	Port C7	T11[7]	Port F7	nc

Appendix. A Data output ⑨

A-8 Output format bit assignment

Medium Configuration *3 (10bit)

10bit 4tap*3											
D1		D2		D3		D4		D5		D6	
Port A0	T1[0]	Port D0	T4[0]	Port A0	T5[0]	Port D0	T8[0]	Port A0	D9[0]	Port D0	T12[0]
Port A1	T1[1]	Port D1	T4[1]	Port A1	T5[1]	Port D1	T8[1]	Port A1	D9[1]	Port D1	T12[1]
Port A2	T1[2]	Port D2	T4[2]	Port A2	T5[2]	Port D2	T8[2]	Port A2	D9[2]	Port D2	T12[2]
Port A3	T1[3]	Port D3	T4[3]	Port A3	T5[3]	Port D3	T8[3]	Port A3	D9[3]	Port D3	T12[3]
Port A4	T1[4]	Port D4	T4[4]	Port A4	T5[4]	Port D4	T8[4]	Port A4	D9[4]	Port D4	T12[4]
Port A5	T1[5]	Port D5	T4[5]	Port A5	T5[5]	Port D5	T8[5]	Port A5	D9[5]	Port D5	T12[5]
Port A6	T1[6]	Port D6	T4[6]	Port A6	T5[6]	Port D6	T8[6]	Port A6	D9[6]	Port D6	T12[6]
Port A7	T1[7]	Port D7	T4[7]	Port A7	T5[7]	Port D7	T8[7]	Port A7	D9[7]	Port D7	T12[7]
Port B0	T1[8]	Port E0	T3[0]	Port B0	T5[8]	Port E0	T7[0]	Port B0	D9[8]	Port E0	T11[0]
Port B1	T1[9]	Port E1	T3[1]	Port B1	T5[9]	Port E1	T7[1]	Port B1	D9[9]	Port E1	T11[1]
Port B2	nc	Port E2	T3[2]	Port B2	nc	Port E2	T7[2]	Port B2	nc	Port E2	T11[2]
Port B3	nc	Port E3	T3[3]	Port B3	nc	Port E3	T7[3]	Port B3	nc	Port E3	T11[3]
Port B4	T2[8]	Port E4	T3[4]	Port B4	T6[8]	Port E4	T7[4]	Port B4	D10[8]	Port E4	T11[4]
Port B5	T2[9]	Port E5	T3[5]	Port B5	T6[9]	Port E5	T7[5]	Port B5	D10[9]	Port E5	T11[5]
Port B6	nc	Port E6	T3[6]	Port B6	nc	Port E6	T7[6]	Port B6	nc	Port E6	T11[6]
Port B7	nc	Port E7	T3[7]	Port B7	nc	Port E7	T7[7]	Port B7	nc	Port E7	T11[7]
Port C0	T2[0]	Port F0	T3[8]	Port C0	T6[0]	Port F0	T7[8]	Port C0	D10[0]	Port F0	T11[8]
Port C1	T2[1]	Port F1	T3[9]	Port C1	T6[1]	Port F1	T7[9]	Port C1	D10[1]	Port F1	T11[9]
Port C2	T2[2]	Port F2	nc	Port C2	T6[2]	Port F2	nc	Port C2	D10[2]	Port F2	nc
Port C3	T2[3]	Port F3	nc	Port C3	T6[3]	Port F3	nc	Port C3	D10[3]	Port F3	nc
Port C4	T2[4]	Port F4	T4[8]	Port C4	T6[4]	Port F4	T8[8]	Port C4	D10[4]	Port F4	T12[8]
Port C5	T2[5]	Port F5	T3[9]	Port C5	T6[5]	Port F5	T8[9]	Port C5	D10[5]	Port F5	T12[9]
Port C6	T2[6]	Port F6	nc	Port C6	T6[6]	Port F6	nc	Port C6	D10[6]	Port F6	nc
Port C7	T2[7]	Port F7	nc	Port C7	T6[7]	Port F7	nc	Port C7	D10[7]	Port F7	nc

Appendix. A Data output ⑩

A-9 Output format output pixels

Medium Configuration *3

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)				Output pixel (Interpolation ON, Overwrap ON)			
KD6R926MX/MX-NL	Single	T1	1	2	…	1824	1	2	…	1830	1	2	…	1846
		T2	1825	1826	…	3648	1831	1832	…	3660	1847	1848	…	3692
		T3	3649	3650	…	5472	3661	3662	…	5490	3693	3694	…	5538
		T4	5473	5474	…	7296	5491	5492	…	7320	5539	5540	…	7384
		T5	7297	7298	…	9120	7321	7322	…	9150	7321	7322	…	9166
		T6	9121	9122	…	10944	9151	9152	…	10980	9167	9168	…	11012
		T7	10945	10946	…	12768	10981	10982	…	12810	11013	11014	…	12858
		T8	12769	12770	…	14592	12811	12812	…	14640	12859	12860	…	14704
		T9	14593	14594	…	16416	14641	14642	…	16470	14641	14642	…	16486
		T10	16417	16418	…	18240	16471	16472	…	18300	16487	16488	…	18332
		T11	18241	18242	…	20064	18301	18302	…	20130	18333	18334	…	20178
		T12	20065	20066	…	21888	20131	20132	…	21960	20179	20180	…	22024
	Parallel	T1	1	5	…	7293	1	5	…	7317	1	5	…	7381
		T2	2	6	…	7294	2	6	…	7318	2	6	…	7382
		T3	3	7	…	7295	3	7	…	7319	3	7	…	7383
		T4	4	8	…	7296	4	8	…	7320	4	8	…	7384
		T5	7296	7300	…	14589	7321	7325	…	14637	7321	7325	…	14701
		T6	7297	7301	…	14590	7322	7326	…	14638	7322	7326	…	14702
		T7	7298	7302	…	14591	7323	7327	…	14639	7323	7327	…	14703
		T8	7299	7303	…	14592	7324	7328	…	14640	7324	7328	…	14704
		T9	14592	14596	…	21885	14641	14645	…	21957	14641	14645	…	22021
		T10	14593	14597	…	21886	14642	14646	…	21958	14642	14646	…	22022
		T11	14594	14598	…	21887	14643	14647	…	21959	14643	14647	…	22023
		T12	14595	14599	…	21888	14644	14648	…	21960	14644	14648	…	22024

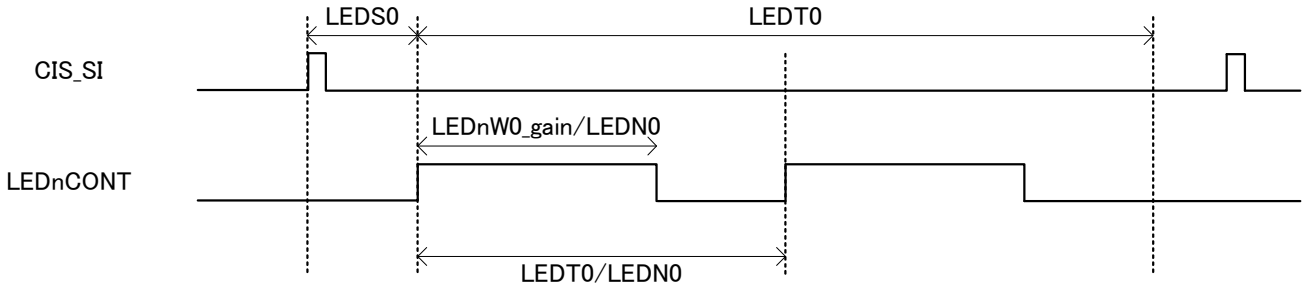
Appendix. B LED lighting control

LED lighting control of MX series

As described in 5-2 Setting ⑧, the initial setting of the LED-duty time is 15μs.
However, in order to reduce noise, which is also required for the CE mark compliance, the clock module has the SSCG function. Therefore, depending on the LED-duty time, the product output may cyclically fluctuate in intensity, and the output image may have horizontal stripes. To avoid the situation, use the product with the following restriction condition.
*SSCG: Spread Spectrum Clock Generator

1) Use with Line period 34.5μs or under (30kHz or over)
   Do not change the initial setting of lighting control (Division number, Lighting time)
   *Output will be slightly dark with the Line period 27 to 23μs (37 to 43kHz)
2) Line period 34.5μs or over (30kHz or under), and no change on brightness
   Do not change the initial setting of lighting control (Division number, Lighting time)
3) Line period 34.5μs or over (30kHz or under), and change brightness (extend lighting time)
   Set multiple number of 31.25μs for LEDW0, LEDT0.

Initial setting of the LED lighting:
LEDW0: 15μs
LEDT0: 31.25μs
LEDN0: 2 (dual divided)
LEDS0: 3.25μs (fixed value)
*LEDS0 setting must be 3.25μs



LEDnW0_gain=LEDnW0×(128+LEDGAIN0)/256

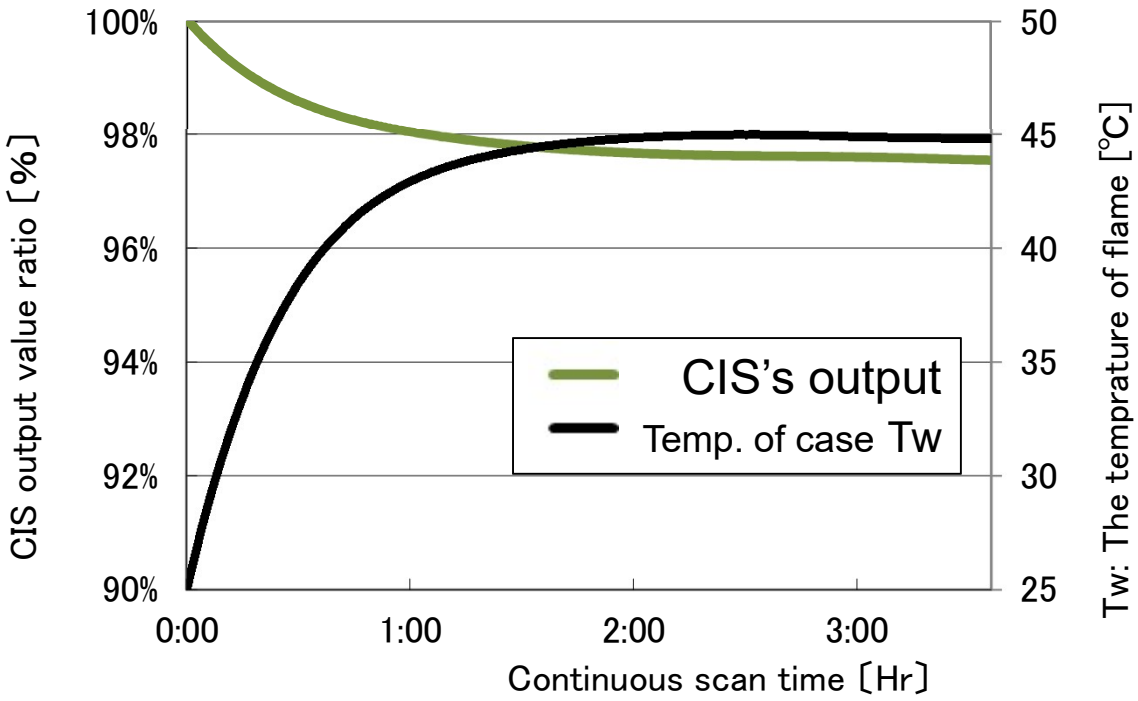
Timing diagram of LED lighting control

*For details of the LED lighting control, refer to the “Function specification” document.

Appendix C: Output on continuous operation

Output may change depends on heat of LED and fluctuation of ambient temperature.
If CIS's output level change after white/dark correction, operate those correction again.
See reference data C.
*Regarding to the definition of the temperature of case : Tw, see item 2-7.

Reference data C: Correlation between CIS's output on continuous operation and the temperature of case, Tw



<Condition>
- Ta=25±5℃
- LED-Duty = 65%
- White-basis-chart (O.D.=0.05～0.09)

Appendix D: Command list①

It shows the control commands listed below.

No.	Command	function	Code	Detail	Note
1	BR	Serial Communication speed select	BR 00 CR	set 9.6kBaud	
			BR 01 CR	set 19.2kBaud	
			BR 02 CR	set 115.2Baud	
2	OC	Output format select	OC 00 CR	Output Format : 10bit Serial Base Configuration	
			OC 01 CR	Output Format : 10bit Serial Medium Configuration	
			OC 02 CR	Output Format : 10bit Serial Medium Configuration2	
			OC 03 CR	Output Format : 10bit Serial Medium Configuration3	
			OC 04 CR	Output Format : 10bit Parallel Base Configuration	
			OC 05 CR	Output Format : 10bit Parallel Medium Configuration	
			OC 06 CR	Output Format : 10bit Parallel Medium Configuration2	
			OC 07 CR	Output Format : 10bit Parallel Medium Configuration3	
			OC 08 CR	Output Format : 8bit Serial Base Configuration	
			OC 09 CR	Output Format : 8bit Serial Medium Configuration	
			OC 0A CR	Output Format : 8bit Serial Medium Configuration2	
			OC 0B CR	Output Format : 8bit Serial Medium Configuration3	
			OC 0C CR	Output Format : 8bit Parallel Base Configuration	
			OC 0D CR	Output Format : 8bit Parallel Medium Configuration	
			OC 0E CR	Output Format : 8bit Parallel Medium Configuration2	
			OC 0F CR	Output Format : 8bit Parallel Medium Configuration3	
			OC 20 CR	Overlap Output OFF	
			OC 21 CR	Overlap Output ON	
			OC 40 CR	Interpolation function OFF	
			OC 41 CR	Interpolation function ON	
			OC 80 CR	Output Format Information Read-Out	
			OC A0 CR	Overlap status Read-Out	
			OC C0 CR	Interpolation Status Read-Out	

Appendix D: Command list②

No.	Command	function	Code	Detail	Note
3	OF	CameralLink® Clock Frequency Control	OF 00 CR	Output Clock Frequency setteing : 48MHz	
			OF 01 CR	Output Clock Frequency setteing : 50.7 MHz	
			OF 02 CR	Output Clock Frequency setteing : 51.0 MHz	
			OF 03 CR	Output Clock Frequency setteing : 51.4 MHz	
			OF 04 CR	Output Clock Frequency setteing : 52.0 MHz	
			OF 05 CR	Output Clock Frequency setteing : 52.8 MHz	
			OF 06 CR	Output Clock Frequency setteing : 53.3 MHz	
			OF 07 CR	Output Clock Frequency setteing : 54.0 MHz	
			OF 08 CR	Output Clock Frequency setteing : 54.9 MHz	
			OF 09 CR	Output Clock Frequency setteing : 56.0 MHz	
			OF 0A CR	Output Clock Frequency setteing : 57.0 MHz	
			OF 0B CR	Output Clock Frequency setteing : 57.6 MHz	
			OF 0C CR	Output Clock Frequency setteing : 58.3 MHz	
			OF 0D CR	Output Clock Frequency setteing : 60.0 MHz	
			OF 0E CR	Output Clock Frequency setteing : 61.7 MHz	
			OF 0F CR	Output Clock Frequency setteing : 62.4 MHz	
			OF 10 CR	Output Clock Frequency setteing : 64.0 MHz	
			OF 11 CR	Output Clock Frequency setteing : 65.1 MHz	
			OF 12 CR	Output Clock Frequency setteing : 66.0 MHz	
			OF 13 CR	Output Clock Frequency setteing : 67.2 MHz	
			OF 14 CR	Output Clock Frequency setteing : 68.0 MHz	
			OF 15 CR	Output Clock Frequency setteing : 68.6 MHz	
			OF 16 CR	Output Clock Frequency setteing : 72.0 MHz	
			OF 17 CR	Output Clock Frequency setteing : 76.0 MHz	
			OF 18 CR	Output Clock Frequency setteing : 76.8 MHz	
			OF 19 CR	Output Clock Frequency setteing : 78.0 MHz	
			OF 1A CR	Output Clock Frequency setteing : 80.0 MHz	
			OF 1B CR	Output Clock Frequency setteing : 81.6 MHz	
			OF 1C CR	Output Clock Frequency setteing : 84.0 MHz	
			OF 80 CR	Read-Out Set Value	

Appendix D: Command list③

No.	Command	function	Code	Detail	Note
4	SS	Syncronous Sygnal mode setting	SS 00 (1C) (DF) CR	Internal Sync. Mode & Pulse width setting	Set 88usec/line at Camera Link® Output Frequency 84MHz * () shows setting data.
			SS 01 CR	External sync. <Mode	
			SS 80 CR	Sync. Mode setting Read-Out	
5	LC	Light Source Control	LC 00 CR	Light Source Turn-OFF	
			LC 01 CR	1 pulse setting : Light-Source A turn ON	
			LC 02 CR	1 pulse setting : Light-Source B turn ON	
			LC 03 CR	1 pulse setting : Light-Source A/B turn ON	
			LC 04 CR	Light Source Turn-OFF	
			LC 05 CR	2 pulse setting : Light-Source A turn ON	
			LC 06 CR	2 pulse setting : Light-Source B turn ON	
			LC 07 CR	2 pulse setting : Light-Source A/B turn ON	
			LC 08 CR	Light Source Turn-OFF	
			LC 09 CR	4 pulse setting : Light-Source A turn ON	
			LC 0A CR	4 pulse setting : Light-Source B turn ON	
			LC 0B CR	4 pulse setting : Light-Source A/B turn ON	
			LC 0C CR	Light Source Turn-OFF	
			LC 0D CR	8 pulse setting : Light-Source A turn ON	
			LC 0E CR	8 pulse setting : Light-Source B turn ON	
			LC 0F CR	8 pulse setting : Light-Source A/B turn ON	
			LC 20 (02) (58) CR	Light Source A Pulse width setting	set pulse width 37.0usec *() shows setting-data
			LC 40 (02) (58) CR	Light Source B Pulse width setting	set pulse width 37.0usec *() shows setting-data
			LC 60 (02) (D0) CR	Pulse-width valid perid setting	set Valid period of the pulse width 45.0usec *() shows setting-data
			LC A0 CR	Read-Out Setting Value of Light source A	
			LC C0 CR	Read-Out Setting Value of Light source B	
			LC E0 CR	Read-Out Setting Value of Pulse-width valid perid	

Appendix D: Command list④

No.	Command	function	Code	Detail	Note
6	DC	Dark Correction Control	DC 00 CR	Dark Correction OFF	
			DC 01 CR	Dark Correction ON	
			DC 21 CR	Start Trigger ON for preparing new Dark Correction Data	
			DC 80 CR	Read-Out Dark correction function status	
			DC A0 CR	Read-Out the status of preparing new Dark Correction data	Read Out data 20 : finish procedure 21 : under preparing
7	WC	White Correction Controle	WC 00 CR	White Correction OFF	
			WC 01 CR	White Correction ON	
			WC 21 CR	Start Trigger ON for preparing new Wark Correction Data on Normal averraging mode	
			WC 22 CR	Set Trigger OFF for preparing new Wark Correction Data on Extrernal Trigger mode	
			WC 23 CR	Set Trigger ON for preparing new Wark Correction Data on External Trigger mode	
			WC 40 (0F) (00) CR	Target value of White Correction	set F00h(12bit) as White Target data (240dec at 8bit) *() shows setting-data
			WC 60 CR	set Normal Averaging mode	
			WC 61 CR	set External Trigger mode	
			WC 80 CR	Read-Out White Correction status	
			WC A0 CR	Read-Out the status of preparing new White Correction data	Read Out data 20 : finish procedure 21 : under preparing 22 : Finish External Trigger 23 : under Preparing data on External Trigger mode
			WC C0 CR	Read-Out White Corrction Target Data	
			WC E0 CR	Read -Out White correction mode	

Appendix D: Command list⑤

No.	Command	function	Code	Detail	Note
8	PG	Programable Gain Controle	PG 00 CR	PGA function OFF : Signals are through PGA block	
			PG 01 CR	PGA function ON	
			PG 20 (00) (00) CR	set PGA gain Positive side	
			PG 21 (00) (00) CR	set PGA gain Negative side	
			PG 80 CR	Read-Out the status of PGA function	
			PG A0 CR	Read-Out PGA gain value	
9	GC	Ganmma Correction Controle for Output Signals	GC 00 CR	Gamma Correction functio OFF : Signals are through Gamma Correction Block	
			GC 01 CR	Gamma Correction functio ON	
			GC 20 CR	set 1st Threshhold value	
			GC 21 CR	set 2nd Threshhold value	
			GC 22 CR	set 3rd Threshhold value	
			GC 80 CR	Read-Out the status of Gamma Correction function	
			GC A0 CR	Read-Out 1st Threshhold value	
			GC A1 CR	Read-Out 2nd Threshhold value	
			GC A2 CR	Read-Out 3rd Threshhold value	
10	RC	Output Resolution Controle	RC 00 CR	set 600dpi output mode	
			RC 01 CR	set 300dpi output mode	
			RC 02 CR	set 150dpi output mode	
			RC 03 CR	set 75dpi output mode	
			RC 80 CR	Read-Out Output Resolution setting	
11	TP	Test Pattern Output	TP 00 CR	Test Pattern Output OFF	
			TP 01 CR	Test Pattern Output ON	
			TP 20 CR	Stripe Pattern output on main scan direction	
			TP 21 CR	Ramp pattern Output on main scan direction	
			TP 22 CR	Read-Out the status of Test Pattern	
			TP 80 CR	Read-Out the Test Pattern setting	
			TP A0 CR	Read-Out the number of Test Pattern	
12	SR	Software Reset Controle	SR 01 CR	FPGA software boot start	
			SR 21 CR	ASIC software boot start	
			SR 80 CR	Read-Out the status of booting FPGA	
			SR A0 CR	Read-Out the status of booting ASICs	

Appendix D: Command list⑥

No.	Command	function	Code	Detail	Note
13	SI	Product Information read	SI A0 CR	Read-Out product function mode	
			SI C0 CR	Read-Out the information of the product	
14	DT	Memory-Register Control	DT 00 CR	Copy factory setting data from Flash memory to Controle Ics	
			DT 01 CR	Copy user1 setting data from Flash memory to Controle Ics	
			DT 02 CR	Copy user2 setting data from Flash memory to Controle Ics	
			DT 03 CR	Copy user3 setting data from Flash memory to Controle Ics	
			DT 80 CR	Copy register data in Controle Ics to factory setting area of Flash memory	not available
			DT 81 CR	Copy register data in Controle Ics to user1 setting area of Flash memory	
			DT 82 CR	Copy register data in Controle Ics to user2 setting area of Flash memory	
			DT 83 CR	Copy register data in Controle Ics to user3 setting area of Flash memory	