User's Manual

Line Scan Camera

Type: XCM4085TLCT6

NIPPON ELECTRO-SENSORY DEVICES CORPORATION

For Customers in the U.S.A.

  This equipment has been tested and found to comply with the limits for a Class A digital device, in accordance with Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense.

For Customers in the EU

  This equipment has been tested and found to comply with the essential requirements of the EMC Directive 2004/108/EC, based on the following specifications applied:
EU Harmonized Standards
EN55022:2010 Class A
EN61000-6-2:2005

  Warning
  This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Directive on Waste Electrical and Electronic Equipment (WEEE)
Please return all End of Life NED products to the distributor from whom the product was purchased for adequate recycling and / or disposal. All costs of returning the Product to NED are borne by the shipper.

Introduction

Thank you for purchasing NED's Line Scan Camera. We look forward to your continued custom in the future.

For safety use

◆ For your protection, please read these safety instructions completely before operating the product and keep this manual for future reference.

◆ The following symbols appear next to important information regarding safe product handling.

⚠ Warning	If the product is not handled properly, this may result in serious injury or possible death.
⚠ Caution	If the product is not handled properly, this may result in physical injury or cause property damage.

Safety precaution

⚠ Warning

◆ Never disassemble or modify this product, unless otherwise specified to do so in this manual.

◆ When hands are wet, avoid handling this product and do not touch any of the connection cable pins or other metallic components.

◆ Do not operate this product in an environment that is exposed to rain or other severe external elements, hazardous gases or chemicals.

◆ If the product is not to be used for an extended period of time, as a safety precaution, always unplug the connection cable from the camera unit.

◆ If the product installation or inspection must be executed in an overhead location, please take the necessary measures to prevent the camera unit and its components from accidentally falling to the ground.

◆ If smoke, an abnormal odor or strange noise is emitted from the camera unit, first turn OFF power, then unplug the cable from the camera unit.

◆ This product is not intended for use in a system configuration built for critical applications.

Instructions before use

◆ Only operate this product within the recommended environmental temperature range.

◆ Use only the specified power source and voltage rating.

◆ Do not drop this product. Avoid exposure to strong impact and vibrations.

◆ Install the camera unit in a well-ventilated environment, in order to prevent the camera from overheating.

◆ If the camera must be installed in an environment containing dust or other particles, take required measures to protect the camera unit from dust adhesion.

◆ Do not unplug the cable while power is being supplied to the camera unit. To prevent product damage, always shut down the power supply before unplugging the power cable.

◆ When the surface of the camera window becomes dirty due to dust or grime, black smudges appear in the displayed image. Use an air blower to remove the dust particles. Dip a cotton swab into ethanol alcohol and clean the camera window. Be careful not to scratch the glass.

◆ Use of non-infrared lighting such as a fluorescent lamp is recommended. If halogen lighting is employed, always install an infrared filter into your system configuration.

◆ Please note that exposure to long wavelength light outside of the sensors visible optical range can affect the image.

◆ Sensitivity may fluctuate depending on the spectral response level of the light source. In cases like this, changing the light source to one with a different spectral response level may reduce this problem.

◆ Do not expose the sensor to excessive amount of light. The exposure of excessive amount of light causes a saturated output and other harmful unwanted characteristics.

◆ Suitable measures should be taken to protect the colour filter on sensor from bright light when it is not in use.

   If the sensor is continually exposed to excessive amount of light over time, the colour filter may become faded.

◆ For stabilized image capturing, turn ON the power supply and execute aging for ten to twenty minutes before actually using the camera unit.

◆ Do not share the power supply with motor units or other devices that generate noise interference.

◆ The signal ground (SG) and the frame ground (FG) are connected inside the camera unit. Design the system configuration so that a loop will not be formed by the ground potential differential.

◆ Do not disconnect the camera while rewriting an embedded memory.

◆ When you change exposure mode that is set at NED factory, input control signal (CC1) from the capture board.

Product Warranty

Warranty Period
◆ The product warranty period, as a general rule, is two years from purchase; however for detailed conditions please contact the sales representative for your region/country.
◆ However, in some cases due to the usage environment, usage conditions and/or frequency of use, this warranty period may not be applicable.

Warranty Scope
◆ Product repair will be performed on a Return To Manufacturer basis. On-site maintenance will incur additional charges.
◆ If defects in material or workmanship occur during the warranty period, the faulty part will be replaced or repaired by us free of charge. Return shipping charges must be paid by the sender. However, the following cases fall outside of the scope of this warranty:

Exclusions from Warranty Coverage
◆ We will under no circumstances assume responsibility for the following cases: damage caused by fire, earthquake, other acts of a third party, other accidents, negligent or intentional misuse by the user, or other usage under extraordinary circumstances.
◆ Damages (e.g. loss of business profits, business interruption, etc.) resulting from use or non-use.
◆ Damages caused by use other than as described in this document.
◆ Damages resulting from malfunction due to a connected device.
◆ Damages resulting from repairs or modifications performed by the customer.

Fault Diagnosis
◆ As a general rule, in the first instance fault diagnosis should take the form of a telephone call or an email to enable us to assess the circumstances of the malfunction.
◆ However, depending on the customer's requests, we, or our agent, may require an additional fee for this service.

Exclusion of Liability for Compensation for Missed Opportunities
◆ Regardless of whether within the warranty period or not, our warranty does not cover compensation for missed opportunities for our customers, or our customers' customers, caused by a fault of our products, nor for damage to products other than our own, or related business.

Note about Product Usage

◆ This product has been designed and manufactured as a general-purpose product for general industry. In applications expected to be life-critical or safety-critical, the installer or user is requested to install double or triple failsafe systems.

Repair Service Outline

◆ The cost of dispatching engineers etc. for repair service is not included in the price of purchased and supplied goods. On request, arrangements can be made separately.

Scope of Repair Service

◆ The above assumes business dealings and usage to take place in the customer's region / country. In cases of business dealings and/or usage outside the customer's region/country, separate consultation is required.

Table of Contents

1. Product Outline

1.1 Features（**XCM4085TLCT6**）

- High speed readout 85MHz(6 taps for R,G,B x 2 of odd/even)
- Easy control of gain / offset / video output with external software.
- Easy connection with a variety of frame grabber boards via Camera Link interface
- Single power source DC 12V to 15V for operation
- Auto white balance function
- Exposure time control mode function

1.2 Application

- Inspection of PCBs
- Visual inspection of colour printed materials
- Colour identification and inspection of foreign material.
- Inspection of sheet film
- Wood surface inspection

An example of Visual Inspection is shown below.
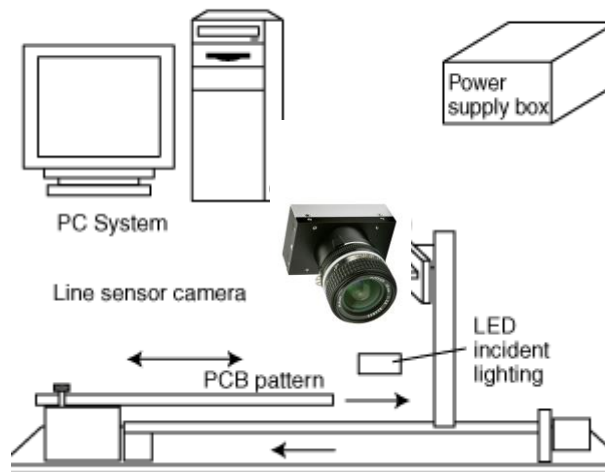
Figure 1-2-1   Visual Inspection of PCBs

Object of inspection (example)   ・printed circuit boards
Device specification   1. Camera: Colour Line scan camera
                                         2. Controller: Dedicated software for PC system

1.3 Image Sensor

The camera uses a CMOS sensor to acquire high quality images with high sensitivity. The pixel size is 10µm x 10µm. The camera uses RGB with 4096 pixels each.

1.4 Performance Specifications

The Performance Specifications are shown in Table 1-4-1. It shows the data when the camera is operating at maximum scan rate, unless otherwise specified.

Table 1-4-1   Performance Specifications

Items		Specifications
		XCM4085TLCT6
Number of Pixels		4096 x 3 Lines
Pixel Size H x V (µm)		10 x 10
Sensor Length (mm)		40.96
Distance between two lines(µm) *between G and R, between R and B (Line positions from the top: G-R-B)		20 (equivalent to 2 lines width)
Data Rate (MHz)		170(each colour)
Min. Scan Period (µs) / Max. Scan Rate [kHz]		25/[40] ＊Data output 85MHz 2taps at each color
Saturation Exposure (lx·s) (typically) [Minimum Gain, Pixel Correction Initial Value, Daylight Fluorescent Light]		0.05 ＊ Visible Area (400～700nm)
Responsivity (V/ [lx·s]) (typically) [Minimum Gain, Pixel Correction Initial Value,]		100 ＊ Visible Area (400～700nm) ＊ Analog 5V Conversion Sensitivity
Gain Adjustable Range *Analog Amplifier +Digital (RGB Shared)		Analog Amplifier： x 1 to x 5.5 (6 Steps) Digital ： x 1 to x 2 (512 Steps)
Digital Offset Adjustable Range (RGB shared)		-40 to 40 DN (161Steps): 8bit -160 to 160 DN (161 Steps): 10bit
Video output Camera Link		Camera Link Medium/Base/Full Configuration
Control Input		CC1: External Trigger Signal, CC2-4: Not in use
Connectors	Data/Controller	3M: SDR26 [Mini Camera Link]
	Power Supply	Hirose: HR10A (6Pin)
Lens Mount		Nikon F Mount
Operating Temperature (℃)		0 to 50 *No Condensation
Power Supply Voltage (V)		DC 12 to 15 [+/-5%]

Consumption Current (mA)　(typically)	800
Size　W x H x D (mm)	62x100x72(F Mount)
Mass (g)　(Camera only)	400(F Mount)
Additional Functions	1 Shading Correction 2 Gain/Offset/Video Output Adjustable 3 Programmable Exposure Control 4 Scan Direction Switching 5 Line delay function

Note :

*1) DN : Digital Number (8bit : 0-255 / 10bit : 0-1023)

*2) Measurements were made at room temperature, daylight fluorescent light.

The spectral responsivity is shown below.
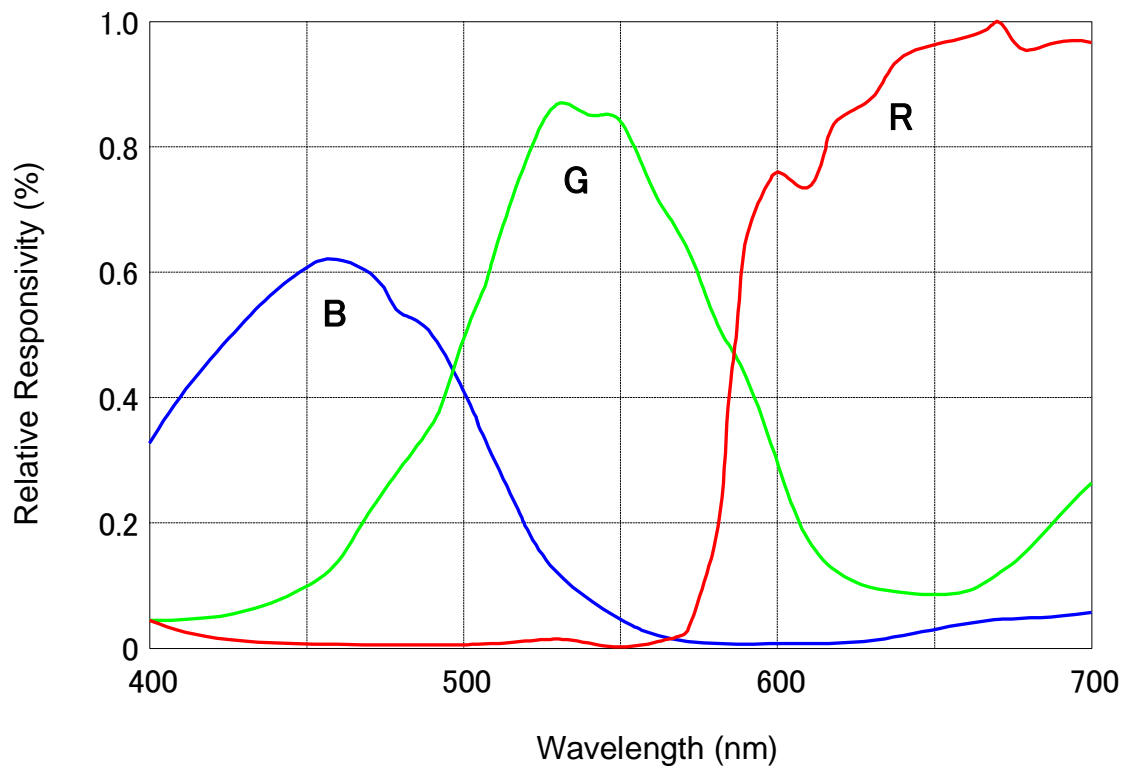
Figure 1-4-1 Spectral Responsivity

2. Camera Setting and Optical Interface

2.1 Setting the Camera

Use the M4 screw holes or the tripod screw hole to set the camera.

2.2 Fixing the Camera

Use the M4 screw holes (4 at the front) to set the camera.

The screw length for fixing the camera should be less than 6mm.

No X-, Y-axis orientation and tilt adjustment mechanism is available. Please prepare an adjustment mechanism if required.

The dimensions of the camera are shown below.
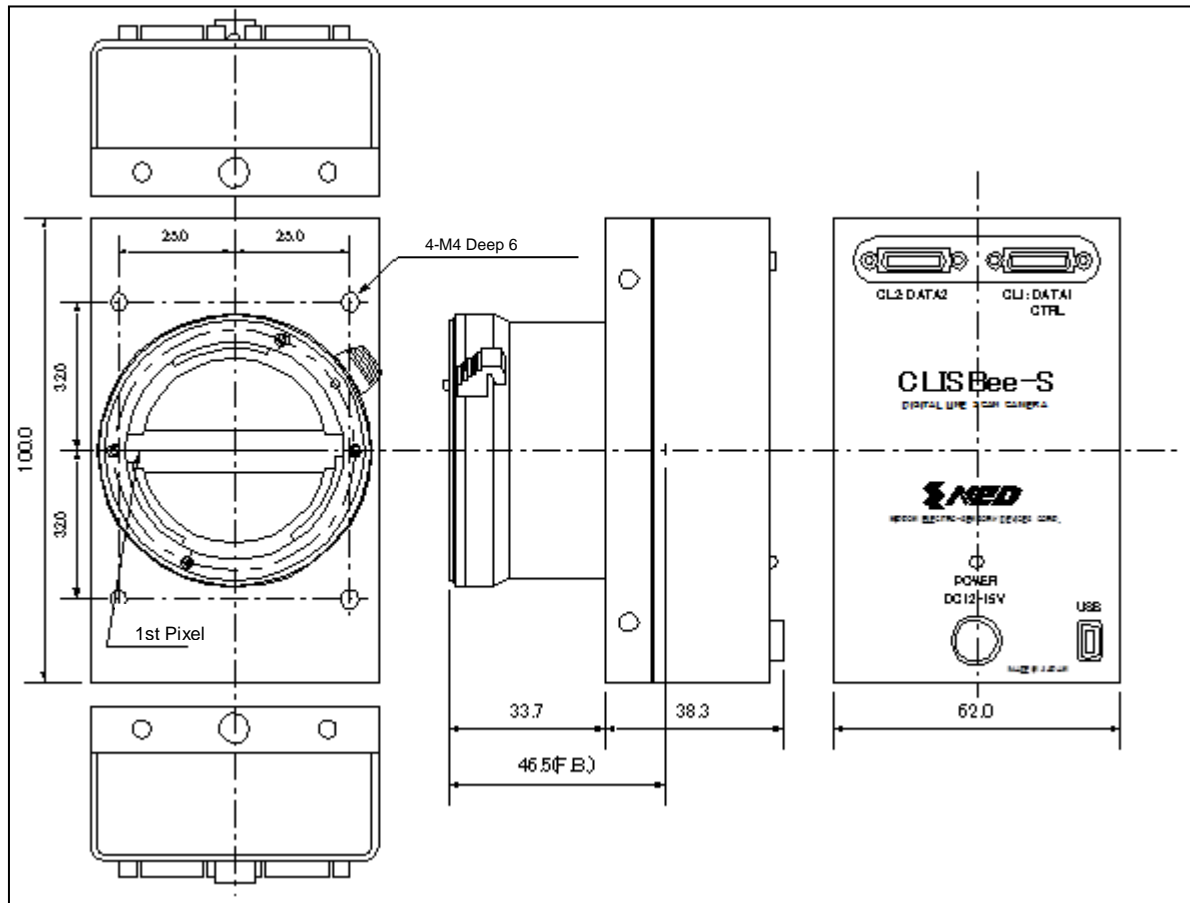
Unit: mm

Figure 2-2-1 Dimensions of the Camera (F Mount)

2.3 Optical Interface

Nikon F mount is provided as standard.

Notes:

1) The amount and wavelengths of light required to capture useful images depend on the intended use. Factors include the physical properties, speed, the object's spectral characteristics, exposure time, the light source characteristics, the specifications of the acquisition system and so on.

   The exposure amount (exposure time x light amount) is the most important factor in getting desirable images. Please determine the exposure amount after studying what is most important to your system.

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

   ● LED light sources are relatively inexpensive, provide a uniform field and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity.

   ● Halogen light sources generally provide very little blue light but have high infrared light (IR) proportions.

   ● Fiber-optic light distribution systems generally transmit very little blue light relative to IR.

   ● Metal halide light sources are very bright but have a shorter life span compared to other light sources.

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

3. Hardware

3.1 Camera Connection

Use the camera in the following way:

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

   Notes:

    1)   When using 2 taps at each colour or 10-bit, two Camera Link cables are required. The cables should be of the same length and from the same manufacturer.

    2)   When using 1 tap at each colour with 8-bit, one Camera Link cable is used. Connect the cable to the CL1 connector (CL2 is unused).

    3)   Use asymmetric Camera Link cables and connect the camera with the connector labeled as "Camera side".

    4)   A Medium and Full Configuration-compatible frame grabber has 2 connectors. Check the specification of your frame grabber before connecting.

② Connect the camera with the designated power supply.

   Notes:

    Use the designated power cable to connect the camera with the power source for the camera. Insert the plug end of the cable into the camera. Attach the opposite end (loose wires) to the power unit. Other than those above, a personal computer, a frame grabber board, a compatible lens, a lens mount, a light source and an encoder are necessary, depending on the situation.
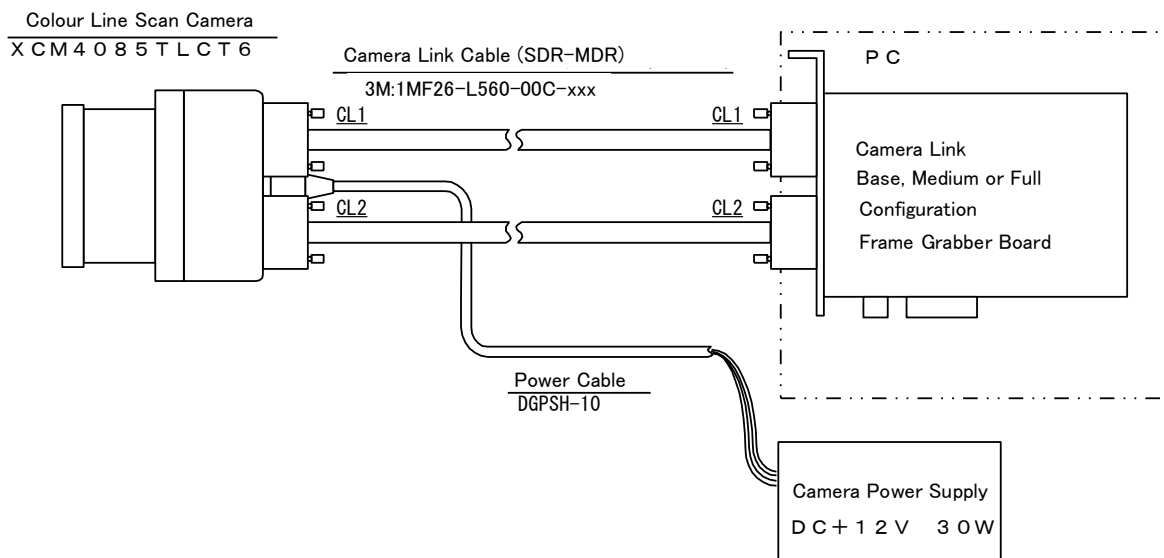
Figure 3-1-1 Connections between Camera and Frame Grabber Board and Power Supply

<Note: Choosing the appropriate Camera Link cable length >

According to the Camera Link Specification, the maximum cable length is 10m. But the maximum cable length to be able to transfer data depends on the type of cable performance and clock speed. The actual maximum transmission distance becomes less than 10m at faster clock speeds, though the transmission distance of 10m is feasible at slower clock speeds.

The following table shows values being calculated in accordance with the Camera Link Specification 2007.Version1.2, using a typical cable (14B26-SZLB-xxx-0LC from 3M) and frame grabber board (Solios from Matrox). Please choose the appropriate Camera Link cable type and length for your application. We recommend you perform a connection test in advance.

Table 3-1-1 calculated value of maximum cable length

Solios model	clock speed (MHz)	maximum cable length (m)
SOL 6M CL E* (20~66MHz)	40	9.8
	66	8.0
SOL 6M FC E* (20~85MHz)	75	7.6
	85	5.8

3.2 Input / Output Connectors and Indicator

The layout of input /output connectors and the LED indicator are as follows.
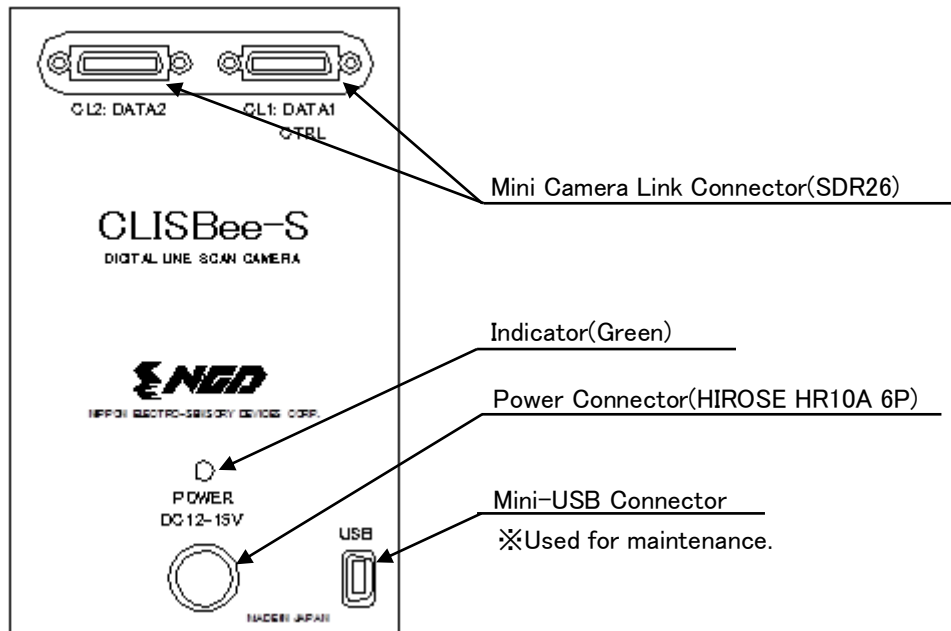
Figure 3-2-1 Input / Output connectors and Power connector

3.3 Connectors・Pin Assignments・Cables

This camera adopts Configurations of Camera Link interface standards.

-Base Configuration for output of 1 tap at each colour with 8 bits,

-Medium Configuration for output of 2 taps at each colour with 8 bits, output of 2 taps at each colour or output 1 tap at each colour with 10 bits

-Full Configuration for output of 2 taps at each colour with 10bits

Figure 3-3-1 shows the interface for the camera and a typical implementation for the frame grabber interface. (Example of Medium Configuration)
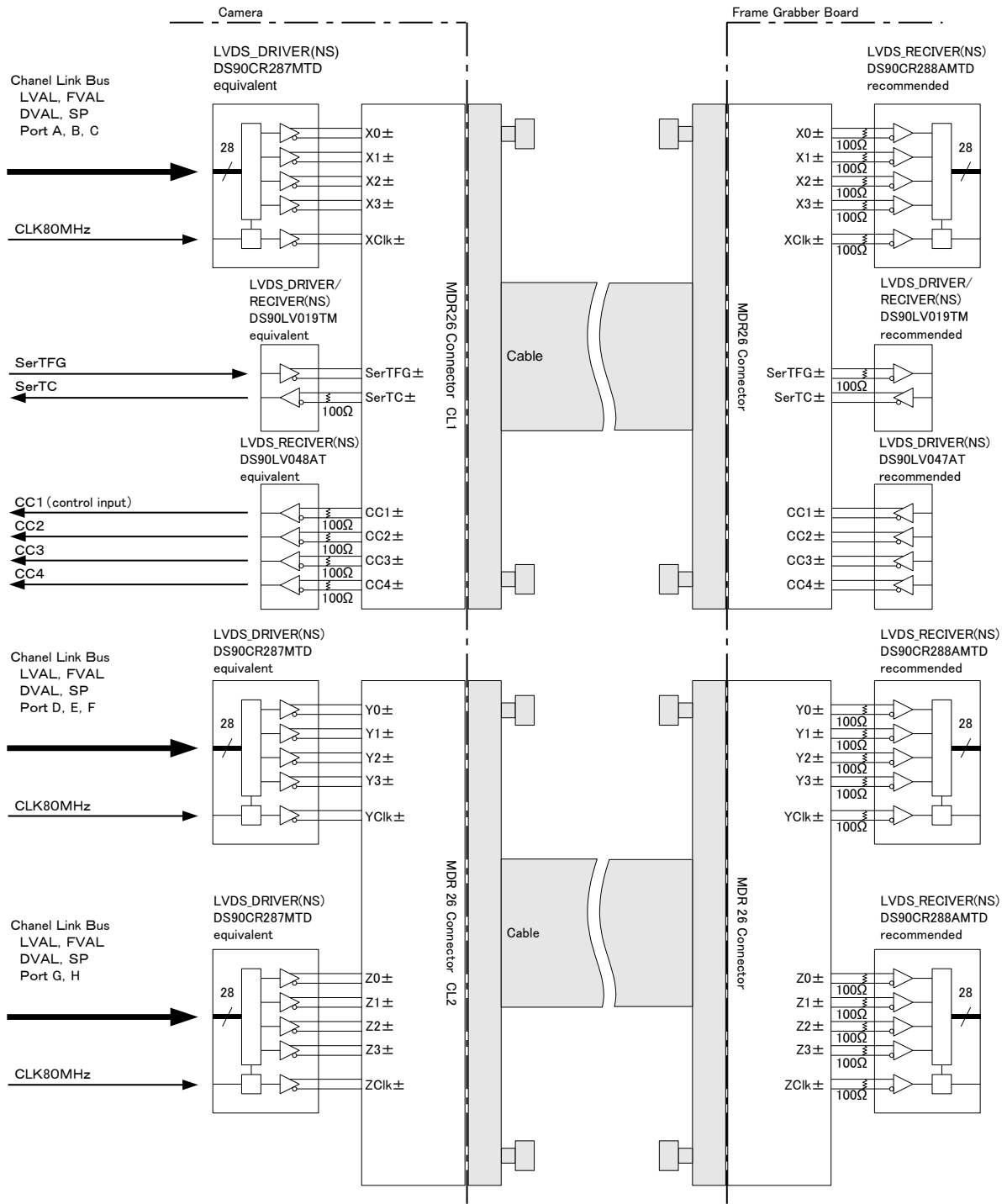
Figure 3-3-1 Camera / Frame Grabber Interface

The camera link port assignment is shown in the table below in case of output of 2 taps at each colour with 8 bits and output of 2 taps at each colour with 10 bits.

Table 3-3-1 Port Assignment of Output

	8bit RGB o/e	10bit RGB o/e		8bit RGB o/e	10bit RGB o/e
	Medium Configuration	Full Configuration		Medium Configuration	Full Configuration
Port A0	Ro0	Ro0	Port E0	Ge0	Bo0
Port A1	Ro1	Ro1	Port E1	Ge1	Bo1
Port A2	Ro2	Ro2	Port E2	Ge2	Bo2
Port A3	Ro3	Ro3	Port E3	Ge3	Bo3
Port A4	Ro4	Ro4	Port E4	Ge4	Bo4
Port A5	Ro5	Ro5	Port E5	Ge5	Bo5
Port A6	Ro6	Ro6	Port E6	Ge6	Bo6
Port A7	Ro7	Ro7	Port E7	Ge7	Bo7
Port B0	Go0	Ro8	Port F0	Be0	Bo8
Port B1	Go1	Ro9	Port F1	Be1	Bo9
Port B2	Go2	—	Port F2	Be2	Be1
Port B3	Go3	—	Port F3	Be3	Be0
Port B4	Go4	Go8	Port F4	Be4	Re8
Port B5	Go5	Go9	Port F5	Be5	Re9
Port B6	Go6	—	Port F6	Be6	Be8
Port B7	Go7	—	Port F7	Be7	Be9
Port C0	Bo0	Go0	Port G0	—	Ge0
Port C1	Bo1	Go1	Port G1	—	Ge1
Port C2	Bo2	Go2	Port G2	—	Ge2
Port C3	Bo3	Go3	Port G3	—	Ge3
Port C4	Bo4	Go4	Port G4	—	Ge4
Port C5	Bo5	Go5	Port G5	—	Ge5
Port C6	Bo6	Go6	Port G6	—	Ge6
Port C7	Bo7	Go7	Port G7	—	Ge7
Port D0	Re0	Re0	Port H0	—	Ge8
Port D1	Re1	Re1	Port H1	—	Ge9
Port D2	Re2	Re2	Port H2	—	Be2
Port D3	Re3	Re3	Port H3	—	Be3
Port D4	Re4	Re4	Port H4	—	Be4
Port D5	Re5	Re5	Port H5	—	Be5
Port D6	Re6	Re6	Port H6	—	Be6
Port D7	Re7	Re7	Port H7	—	Be7

Notes:

1） In 24-bit colour, Base Configuration is used, so it is not necessary to connect a cable to CL2.

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

3） Set the LVDS, Channel Link receiver side to 100-ohm termination.
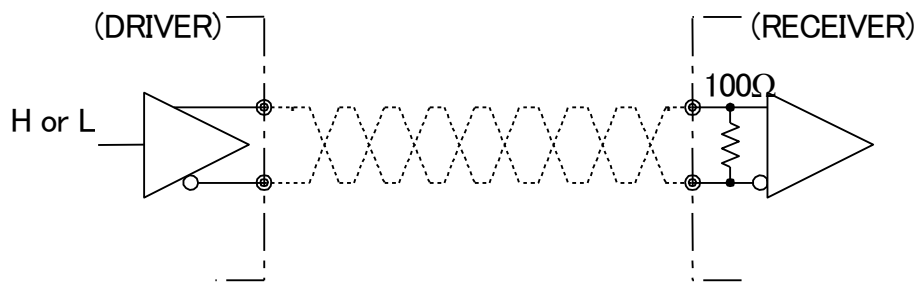
Figure 3-3-2 Circuit of LVDS

The camera has 26-pin SDR connectors for control signals of Camera Link, data signals and serial communications.
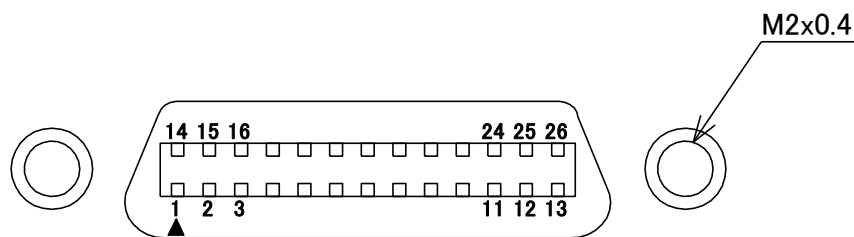
Figure 3-3-3 Camera Link Connector

Table 3-3-1   Camera Link Connector (26-pin SDR Connector) pin assignments

CL1(Base/Medium Configuration)   CL2(Medium/Full Configuration)

No	NAME	No	NAME	I/O	No	NAME	No	NAME	I/O
1	Inner Shield	14	Inner Shield	-	1	Inner Shield	14	Inner Shield	-
2	X0 -	15	X0 +	OUT	2	Y0 -	15	Y0 +	OUT
3	X1 -	16	X1 +	OUT	3	Y1 -	16	Y1 +	OUT
4	X2 -	17	X2 +	OUT	4	Y2 -	17	Y2 +	OUT
5	Xclk -	18	Xclk+	OUT	5	Yclk -	18	Yclk +	OUT
6	X3 -	19	X3 +	OUT	6	Y3 -	19	Y3 +	OUT
7	SerTC +	20	SerTC -	IN	7	100Ωterminated	20	100Ωterminated	-
8	SerTFG -	21	SerTFG +	OUT	8	Z0 -	21	Z0 +	OUT
9	CC1 -	22	CC1 +	IN	9	Z1 -	22	Z1 +	OUT
10	CC2 +	23	CC2 -	IN	10	Z2 -	23	Z2 +	OUT
11	CC3 -	24	CC3 +	IN	11	Zclk -	24	Zclk +	OUT
12	CC4 +	25	CC4 -	IN	12	Z3 -	25	Z3 +	OUT
13	Inner Shield	26	Inner Shield	-	13	Inner Shield	26	Inner Shield	-

● Explanation of Signals

Inner Shield: Shield cable (GND)

X0+, X0-…X3+, X3-: Data output (Channel Link)

Xclk+, Xclk-:   Clock output for above data output synchronization
                           (Channel Link)

Y0+,Y0-···Y3+,Y3-: Data output (Channel Link)

Yclk+,Yclk-:   Clock output for above data output synchronization
                           (Channel Link)

Z0+,Z0-···Z3+,Z3-:Data output (Channel Link)

Zclk+,Zclk -:Clock output for above data output synchronization (Channel Link)

SerTC+, SerTC- :   Serial data input (LVDS)

SerTFG+, SerTFG-: Serial data output (LVDS)

CC1+, CC1- :   External synchronous signal input (LVDS)

CC2+, CC2-, CC3+, CC3-, CC4+, CC4-: Not in use (LVDS)

● Camera Link compatible cable

3M: 1MF26-L560-00C-xxx by or equivalent

Notes:

1）To avoid uncoupling of the cable connectors during power on, make sure to
   clamp them with the locking screws.

2）Do not unplug the cables while power is being supplied to the camera.

This camera uses 6-pin round shape push-pull lock type connector for the Power Supply
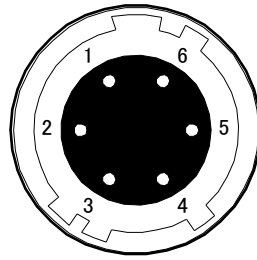
Figure 3-3-4 Power Supply Connector (HIROSE: HR10G-7R-6PB)

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

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

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

3.4 Power Supply

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

The indicator (LED green) blinks when power is supplied. After a short period, it changes to a constant light, indicating that the camera is operational.

Notes:

1) When selecting a power source, choose one with the capacity to allow for inrush current. (30 W or more recommended)

2) Insert the cable plug securely until it locks into position. This is to prevent the connector from coming loose during power transmission.

3) If the lamp fails to illuminate even after power is switched on, turn OFF power immediately. Inspect wiring. Check the voltage and capacity of the supplied power source.

4) It is recommended that the shield processing of the power cable to be connected with GND on the power supply side.

Compatible Cable (Compatible plug): DGPSH10 (HIROSE:HR10A-7P –6S)

Power supply voltage: DC+12 –15V (+/-5%)

Consumption Current (rated): DC+12V: 800mA

4 Camera Control

The camera can be controlled through the serial communication.

Once the camera has been set up according to your requirements, the camera can be used to read data without need of controlling it via the serial interface.

4.1 Flow of Camera Control

4.1.1 Command Overview

The serial interface uses a simple ASCII-based command.

- Communication begins when the computer sends control commands to the camera.
- The camera receives and interprets the computer commands and then executes control operations accordingly.
- Transmission ends when the camera returns the analyzed results of the control commands to the computer.
- Always allow the previous transmission to end before starting the next transmission. (Only one command can be sent per transmission.)

4.1.2 Camera Receiving Message (PC Sending Command)

- Format S1   CMD CR
- Format S2   CMD □ VAL 1 CR
- Format S3   CMD □ VAL 1 □ VAL2 CR

CMD：Control text (3 Bytes) Use 3～5 lowercase letters only. No numerals allowed.

CR：   Carriage Return (0x0D)

□：   Space (0x20) or Comma (0x2C)

VAL1：Setting value (decimal), numerical values only

VAL2：Setting value (decimal), numerical values only

4.1.3 Camera Sending Message (PC Receiving Message)

- Format R 1   >R CR >[SB] CR EOT
- Format R 2   >R CR >[MEM] CR >[SB] CR EOT

> **:**   Results start text (0 x 3E)

R **:**   Camera receive command analyzed results (See table 4-1-3-1)

[SB] **:**   Camera receive command send back

[MEM] **:**   Memory data readout value

CR **:**   Separated text (0 x 0D)

EOT **:**   Send command all text end text (0 x 04)

Table 4-1-3-1 Error Messages

Camera Response	Meaning
OK	Camera executed command
CMD ERR!	Command is not valid
CMD OVR ERR!	Command text line is too long When the control character exceeds 254 characters
CMD FAIL !	When trying to perform acquisition of pixel correction data, but pixel correction mode is set to any mode other than User Setting.
VAL ERR!	Parameter accepted was outside of specified
MEM ERR!	Camera memory error
TRG ERR!	When the scanning interval becomes more than a few seconds when arbitrary pixel correction data is acquired.
ADJ ERR!	When automatic white balance cannot be performed

4.1.4 Camera Control Commands

Table 4-1-4-1 shows the list of Camera Control Commands.

Table 4-1-4-1 Lists of Camera Control Commands

Control Item	CMD	VAL1	VAL2	Control Description
Analog Gain (RGB Shared)	gax	0 to 5		x1,x1.5,x2,x3,x4,x5.5 (x1-x3 recommended)
Digital Gain (RGB Shared)	gdx	0 to 511		x1… x2 （1+VAL1/511）
Digital Gain R	gdxr	0 to 1022		x1~x3 (1+VAL1/511)
Digital Gain G	gdxg	0 to 1022		x1~x3 (1+VAL1/511)
Digital Gain B	gdxb	0 to 1022		x1~x3 (1+VAL1/511)
Auto white balance Setting	awb			Run gdxr,gdxg,gdxb auto balance function
Auto white balance reset	rwb			Set gdxr,gdxg,gdxb to x1
Digital Offset （RGB Shared）	odx	-80 to 80		-40~+40DN （0.5DN/step at 8bit） -160~+160DN （2.0DN/step at 10bit）
Digital Offset R	odxr	-40 to 40		-20~+ 20DN （0.5DN/step at 8bit） -80~+80DN （2.0DN/step at 10bit）
Digital Offset G	odxrg	-40 to 40		- 20~+ 20DN （0.5DN/step at 8bit） -80~+80DN （2.0DN/step at 10bit）
Digital Offset B	odxb	-40 to 40		- 20~+ 20DN （0.5DN/step at 8bit） -80~+80DN （2.0DN/step at 10bit）
Exposure Mode	inm	0 /1/2		Free Run / Ext Edge / Ext Level
Programmable Exposure Time	int	64	31 to 32767	22.12~23373.17 µs *See 4.8 for more information
Data Output Clock	clkcl	85/40		85MHz/40MHz
Output Tap Setting	tap	1/2		Number of taps at each RGB for output
Output Bit Setting	dep	8/10		Number of bits at each RGB for output
Line Delay Setting	ldly	-8～8		Numbers of delay lines between output datas at each RGB
Line Fine Adjusting Correction	ldlys	-5～5		Line fine adjusting correction for output datas at each RGB
Test Pattern	tpn	0/1/2		Off/Gray/Gray XY/Color Bar
Pixel Correction Setting	shc	0/1/2/3		0：Correction Off 1：Factory correction On 2：User arbitrary correction 1 On 3：User arbitrary correction 2 On

Scanning Direction	rev	0 /1		0: Forward / 1: Reverse
Memory Initializing	rst			Reset to factory settings
Memory Load	rfd			Readout setup data in memory
Memory Save	sav			Store present setup data in memory
Pixel Correction Data Save [gray]	wht			Arbitrary user's correction data is acquired and stored in the memory.
Pixel Correction target value (factory settings) R	MFr	0 to 1023		Factory correction data R target value（10bit DN）
Pixel Correction target value (factory settings) G	MFg	0 to 1023		Factory correction data G target value（10bit DN）
Pixel Correction target value (factory settings) B	MFb	0 to 1023		Factory correction data B target value（10bit DN）
Pixel Correction target value (user settings 1) R	MUr	0 to 1023		User arbitrary correction data 1 R target value（10bit DN）
Pixel Correction target value (user settings 1) G	MUg	0 to 1023		User arbitrary correction data 1 G target value（10bit DN）
Pixel Correction target value (user settings 1) B	MUb	0 to 1023		User arbitrary correction data 1 B target value（10bit DN）
Pixel Correction target value (user settings 2) R	MVr	0 to 1023		User arbitrary correction data 2 R target value（10bit DN）
Pixel Correction target value (user settings 2) G	MVg	0 to 1023		User arbitrary correction data 2 G target value（10bit DN）
Pixel Correction target value (user settings 2) B	MVb	0 to 1023		User arbitrary correction data 2 B target value（10bit DN）
Gamma Correction setting	gamma	0/1/2/3		Off(1.0)/0.45/0.56/Negative-Positive
Operation Status Readout	sta			Readout the current camera settings

4.1.5 Memory Setup Values (Factory Settings)

The memory setup values (factory settings) are shown in Table 4-1-5-1.

Table 4-1-5-1 Memory Setup Values (Factory Settings)

Control Item	CMD	VAL1	VAL2	Control Description
Analog Gain	gax	0		x1 (0 dB)
Digital Gain (RGB Shared)	gdx	0		x1 (0 dB)
Digital Gain R	gdxr	0		x1 (0 dB)
Digital Gain G	gdxg	0		x1 (0 dB)
Digital Gain B	gdxb	0		x1 (0 dB)
Digital Offset (RGB Shared)	odx	0		±0DN
Digital Offset R	odxr	0		±0DN
Digital Offset G	odxg	0		±0DN
Digital Offset B	odxb	0		±0DN
Exposure Mode	inm	0		Free Run
Programmable Exposure Time	int	64	200	142.7µs
Data Output Clock	clkcl	85		85MHz
Output Tap Setting	tap	2		2 taps at each RGB for output
Output Bit Setting	dep	8		8 bits at each RGB for output
Line Delay Setting	ldly	2		2 delay lines between output datas at each RGB
Line Fine Adjusting Correction	ldlys	0		No fine adjusting correction for output line at each RGB
Test Pattern	tpn	0		Off
Pixel Correction Setting	shc	1		Factory correction data On, (Daylight Fluorescent Light)
Scanning Direction	rev	0		Forward
Pixel Correction target value (factory settings) R	MFr	768		Factory correction data R target value（768 DN）
Pixel Correction target value (factory settings) G	MFg	768		Factory correction data G target value（768 DN）
Pixel Correction target value (factory settings) B	MFb	768		Factory correction data B target value（768 DN）
Pixel Correction target value (user settings 1) R	MUr	768		User arbitrary correction data 1 R target value（768 DN）
Pixel Correction target value (user settings 1) G	MUg	768		User arbitrary correction data 1 G target value（768 DN）

Pixel Correction target value (user settings 1) B	MUb	768		User arbitrary correction data 1 B target value（768 DN）
Pixel Correction target value (user settings 2) R	MVr	768		User arbitrary correction data 2 R target value（768 DN）
Pixel Correction target value (user settings 2) G	MVg	768		User arbitrary correction data 2 G target value（768 DN）
Pixel Correction target value (user settings 2) B	MVb	768		User arbitrary correction data 2 B target value（768 DN）
Gamma Correction Setting	gamma	0		Off (1.0)

4.2 Details on Commands

4.2.1 Setting Analog Gain

Sets analog gain in 6 steps between x 1 to x 5.5.

- Format S2　CMD □ VAL1 CR　　Format R1 >R CR >[SB] CR EOT
- CMD　　　　gax
- VAL　　　　0 (x1) to 5 (x5.5)

    <Example>

    Send: gax □ 2 CR (Setting analog gain 2(x2))

    Receive: >OK CR>gax □ 2 CR EOT

4.2.2 Setting Digital Gain (1)

Sets the camera digital gain.

RGB Shared (gdx): Sets digital gain in 512 steps between x1 and x2.

R, G, B individual (gdxr, gdxg, gdxb): Sets digital gain in 1023 steps between x1 and x3.

- Format　S2　CMD □ VAL1　CR,　Format　R1 >R CR >[SB] CR EOT
- CMD　　　gdx, gdxr, gdxg, gdxb
- VAL　　　　Shared : 0 (x 1) to 511 (x 2)　R,G,B individual: 0 (×1）～1022（×3）

    <Example>

    Send : gdxb □ 256 CR (Setting digital gain B 256 (1+256/511) =x1. 50))

    Receive: : >OK CR > gdxb □ 256 CR EOT

4.2.3 Setting Digital Gain (2)

Set individual R, G, B gain (gdxr, gdxg, gdxb), "automatically".

- Format   S1   CMD CR   Format   R2   >R CR >[MEM] CR >[SB] CR EOT
- CMD   awb
  <Example>
    Send：awb CR
    Receive:：>OK CR > awb CR EOT

4.2.4 Setting Digital Gain (3)

Set R,G,B individual digital gain settings (gdxr, gdxg, gdxb) to initial value of "0"

- Format   S1   CMD CR   Format   R2   >R CR >[MEM] CR >[SB] CR EOT
- CMD   rwb
  <Example>
    Send：rwb CR
    Receive:：>OK CR > rwb CR EOT

4.2.5 Setting Digital Offset

Sets digital offset -60 to 60(0.5DN/step at 8bit), -240 to 240(2.0DN/step at 10bit)

- Format   S2   CMD □ VAL1 CR,   Format   R1   >R CR >[SB] CR EOT
- CMD   odx,odxr, odxg, odxb
- VAL   -80 to 80 (odx) ,-40 to 40(odxr, odxg, odxb)
  <Example>
    Send：odxg □ 5 CR (Sets Digital Offset G to +10DN at 10bit)
    Receive:：>OK CR >odxg □ 5 CR EOT

4.2.6 Setting Exposure Mode

Sets the exposure mode.

- Format S2   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   inm
- VAL   0,1,2
  <Example>
    Send：inm □ 0 CR (Sets the exposure mode to free run)
    Receive:：>OK CR >inm □ 0 CR EOT

4.2.7 Setting Exposure Time

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

- Format S3 CMD □ VAL1 □ VAL2 CR,   Format R1   >R CR >[SB] CR EOT
- CMD   int
- VAL1   64 (Fixed Dividing setting)
- VAL2   *31～32767 (Setting Counter value)

    Note: *The ranges of these counter values vary according to Output data

    formats as follows.

        31～32767 (at 85MHz 2taps)

        65～32767(at 85MHz 1tap)

        70～32767(at 40MHz 2taps)

        141～32767(at 40MHz 1tap)

<Example>

    Send : int □ 64 □ 140 CR (Setting exposure time 100μs)

    Receive: : >OK CR >int □ 64 □ 140 CR EOT

 Note:

 See 4.8.1.1 for the calculation of the exposure time.

4.2.8 Setting Data Output Clock Frequency

Sets the clock frequency of the camera data output.

- Format S3   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   clkcl
- VAL1   85,40（85:85MHz,40:40MHz）

    <Example> Clock Frequency of Data output, 40MHz

        Send : clkcl □ 40 □ CR

        Receive: : >OK CR >clkcl □ 40 □ CR EOT

4.2.9 Setting Data Output Tap Number

Sets the tap numbers of the camera data output.

- Format S3   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   tap
- VAL1   1,2（1:1 tap at each RGB、2:2 taps at each RGB）

    <Example>   Tap numbers of the data output, 1

        Send : tap □ 1 □ CR

        Receive: : >OK CR >tap □ 1 □ CR EOT

4.2.10 Setting Data Output Bit Number

Sets the bit numbers of the data output.

- Format S3   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   dep
- VAL1   8,10（8: 8bits output at each RGB, 10: 10bits output at each RGB）

  <Example>   Bit numbers of the data output, 10bit

    Send : dep □ 10 □ CR

    Receive: : >OK CR >dep □ 10 □ CR EOT

4.2.11 Setting Delay Line Number

Sets the delay line numbers between the output datas at each RGB

- Format S3   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   ldly
- VAL1   -8～8（delay line numbers between the datas at each RGB）

  <Example> Reverse movement direction, 1:1 of reduced scale ratio of length
                    and width at image acquisition

    Send : ldly □ -2 □ CR

    Receive: : >OK CR >ldly □ -2 □ CR EOT

4.2.12 Setting Line Fine Adjusting Correction Between Output Datas

Sets the line fine adjusting correction between the output datas at each RGB

- Format S3   CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   ldlys
- VAL1   -5～5（line fine adjusting correction value between the output datas
                    at each RGB）

  <Example>   0.5 line correction in the movement direction

    Send : ldlys □ 5 □ CR

    Receive: : >OK CR >ldlys □ 5 □ CR EOT

4.2.13 Setting Scanning Direction

Switch scanning direction.

- Format S2 CMD □ VAL1 CR, Format R1 >R CR >[SB] CR EOT
- CMD   rev
- VAL1   0,1 (0:Forward, 1:Reverse)

  <Example>

    Send : rev □ 1 CR (Reverse output)

    Receive: : >OK CR >rev □ 1 CR EOT

4.2.14 Saving Pixel Correction Data

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

- Format   S1   CMD CR,   Format R1   >R CR >[SB] CR EOT
- CMD   wht
  <Example>
          Send：wht CR
          Receive:：>OK CR >wht CR EOT

4.2.15 Setting Pixel Correction (1)

Switches between pixel correction data settings.

- Format S2 CMD □ VAL1 CR,   Format R1 >R CR >[SB] CR EOT
- CMD   shc
- VAL1   0,1,2,3 (0:Correction Off
                  1: Factory correction data On
                  2: User arbitrary correction data 1 On
                  3: User arbitrary correction data 2 On)
  <Example>
    Send：shc □ 2 CR (User arbitrary correction data 1)
    Receive:：>OK CR >shc □ 2 CR EOT

4.2.16 Setting Pixel Correction (2)

Manually sets the pixel correction target value.

- Format S2 CMD □ VAL1 CR,   Format R1 >R CR >[SB] CR EOT
- CMD   MFr、MFg、MFb、MUr、MUg、MUb、MVr、MVg、MVb
- VAL1   0~1023

<Example>Sets the Blue target value to 900DN while using User arbitrary correction data 1

    Send：MUb □ 900 CR
    Receive:：>OK CR > MUb □ 900 CR EOT

4.2.17 Generating Test Pattern

Switches between test pattern displays.

- Format   S2 CMD □ VAL1 CR , Format R1 >R CR >[SB] CR EOT
- CMD   tpn
- VAL   0,1,2,3 (0:Image data, 1:x direction Gray test pattern, 2:xy direction
                  Gray test pattern,3:Colour bar test pattern)
  <Example>
          Send：tpn □ 1 CR (Generating x direction gray test pattern)
          Receive:：>OK CR >tpn □ 1 CR EOT

4.2.18 Setting Gamma correction

Switches Gamma correction value.

- Format   S2 CMD □ VAL1 CR, Format   R1 >R CR >[SB] CR EOT
- CMD   gamma
- VAL   0,1,2,3（0:Off(1.0),1:0.45, 2:0.56 3: Reverse Negative-Positive）

<Example> Set the gamma adjustment to 0.45

Send : gamma □ 1 CR

Receive : >OK CR > bin □ 1 CR EOT

4.2.19 Memory Initializing (Initializing Camera Settings)

Reset the flash memory to the factory default.

- Format S1 CMD CR, Format R2 >R CR >[MEM] CR >[SB] CR EOT
- CMD   rst

<Example>

Send : rst CR

Receive: : >OK CR >Type=XCM4085TLCT6 CR >Ver.= 1.10_0xff14 CR

>Serial=0 CR

>gax 0 CR >gdxr 0 CR >gdxg 0 CR >gdxb 0 CR

>odx 0 CR >odxr 0 CR >odxg 0 CR >odxb 0 CR

>inm 0 CR >int 64,200 CR >dep 8 CR >tap 2 CR

>tpn 0 CR >ldly 2 CR >ldlys 0 CR >shc 1,0 CR

>MFr 768 CR >MFg 768 CR >MFb 768 CR

>MUr 768 CR >MUg 768 CR >MUb 768 CR

>MVr 768 CR >MVg 768 CR >MVb 768 CR

>rev 0 CR >clkcl 85 CR >gamma 0 CR >rst CR EOT

4.2.20 Memory Load

Reads out the camera settings from the flash memory.

- Format S1 CMD CR, Format R2   >R CR >[MEM] CR >[SB] CR EOT
- CMD   rfd

<Example>

Send : rfd CR

Receive: : >OK CR >Type=XCM4085TLCT6 CR >Ver.= 1.10_0xff14 CR

>Serial=0 CR

>gax 0 CR >gdxr 0 CR >gdxg 0 CR >gdxb 0 CR

>odx 0 CR >odxr 0 CR >odxg 0 CR >odxb 0 CR

>inm 0 CR >int 64,200 CR >dep 8 CR >tap 2 CR

>tpn 0 CR >ldly 2 CR >ldlys 0 CR >shc 1,0 CR

>MFr 768 CR >MFg 768 CR >MFb 768 CR

>MUr 768 CR >MUg 768 CR >MUb 768 CR

>MVr 768 CR >MVg 768 CR >MVb 768 CR

>rev 0 CR >clkcl 85 CR >gamma 0 CR >rfd 4 CR EOT

4.2.21 Memory Save

Stores the current camera settings in the flash memory.

- Format   S1   CMD CR, Format R1   >R CR >[SB] CR EOT
- CMD   sav

<Example>

Send：sav CR

Receive:：>OK CR >sav CR EOT

4.2.22 Returning the Camera Settings to its original status

Returns the current camera settings.

- Format   S1   CMD CR, Format R2   >R CR >[MEM] CR >[SB] CR EOT
- CMD   sta

<Example>

Send：sta CR

Receive:：>OK CR >Type=XCM4085TLCT6 CR >Ver.=1.10_0xff14 CR

>Serial=0 CR

>gax 0 CR >gdxr 0 CR>gdxg 0 CR>gdxb 0 CR

>odx 0 CR >odxr 0 CR>odxg 0 CR>odxb 0 CR

>inm 0 CR >int 64,200 CR >dep 8 CR >tap 2 CR

>tpn 0 CR >ldly 2 CR >ldlys 0 CR >shc 1,0 CR

>MFr 768 CR >MFg 768 CR >MFb 768 CR

>MUr 768 CR >MUg 768 CR >MUb 768 CR

>MVr 768 CR >MVg 768 CR >MVb 768 CR

>rev 0 CR >clkcl 85 CR >gamma 0 CR >sta CR EOT

4.3 Digital Processing flow in FPGA

The digital processing flow in FPGA is shown below.
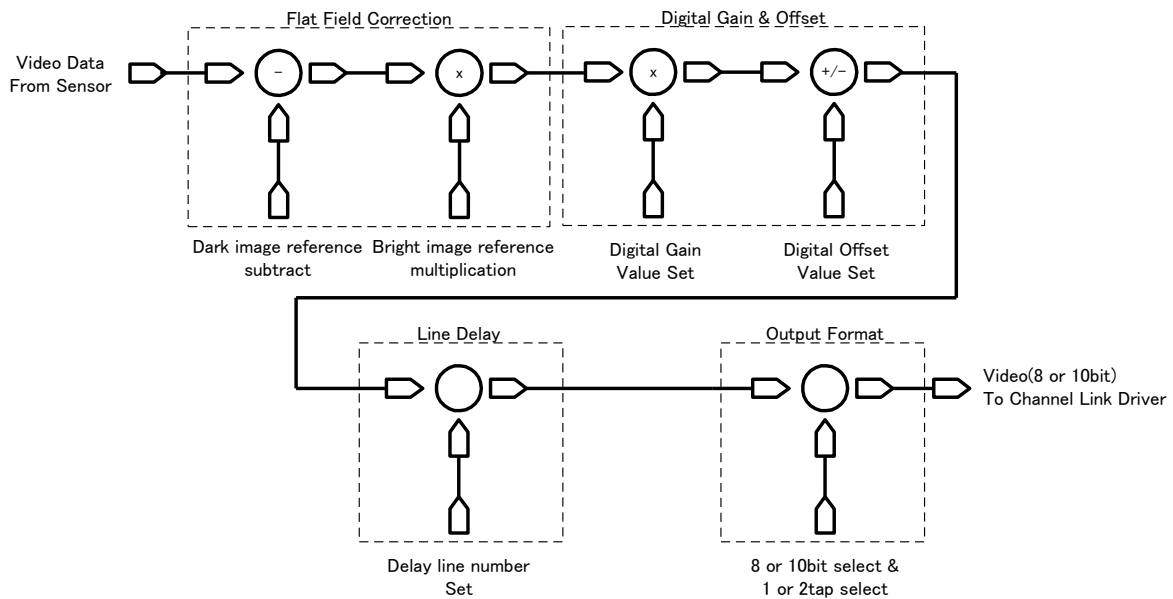
Figure 4-3-1 FPGA Processing Block Diagram

4.4 Startup

After turning on, the camera runs a startup procedure before it starts getting images and outputting data. It takes about 15 seconds.

The startup procedure is as follows:

.

(1) The camera hardware initializes. The indicator (LED green) blinks.

(2) Reads out the latest camera settings from the flash memory. (User settings if any or factory default settings)

(3) Set up the camera with the setting value from the flash memory.

The indicator (LED green) changes from blinking into lighting.

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

4.5 Saving and Loading Camera Settings

The camera settings data is saved in the internal memory (flash memory) and is loaded from the memory when turning on the power supply or loading (sending the "rfd" command).

Commands for rewriting the memory are as follows.

● Reset to factory settings (rst)

● Store present setup data in memory (sav)

● Store pixel correction data in memory (wht)

Notes:

1) The number of times the flash memory can be rewritten will vary depending on actual operational conditions.

2) After turning on the power supply, the camera always checks the memory status. If the data is not within the designated range due to a malfunction or other type of trouble, the memory will be automatically reset to the factory settings.

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

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

5) When changing the factory setting exposure mode, be sure to send the control input signal (CC1). If you do not send CC1 or sending control input signals are out of the designated range, you cannot get images and cannot change the settings. See 4.8.2 and 4.8.3.

Table 4-5-1 Camera Operation Mode and Control Input

Camera operation mode (Exposure mode)	Control input (From frame grabber board)
Free Run (Programmable time setting) (Factory Setting)	Not in use
Ext Edge (External trigger edge + Programmable time setting)	External trigger (CC1) is required
Ext Level (External trigger level time setting)	External trigger (CC1) is required

4.6 Serial Communication Settings

Serial communication is performed through the Camera Link Interface

Table 4-6-1 shows serial communication settings.

Table 4-6-1 Serial Communication Settings

Parameter Items	Setup Value
Communication Speed (Baud rate)	115200bps
Data Length	8bit
Parity Bit	None
Stop bit	1bit
Flow Control	None

4.7 Video Output Format

The camera outputs 8-bit or 10-bit digital data.

The A/D converter of the camera has a 10-bit resolution. For 8-bit output, the upper 8-bits of the signal can be output as video data.
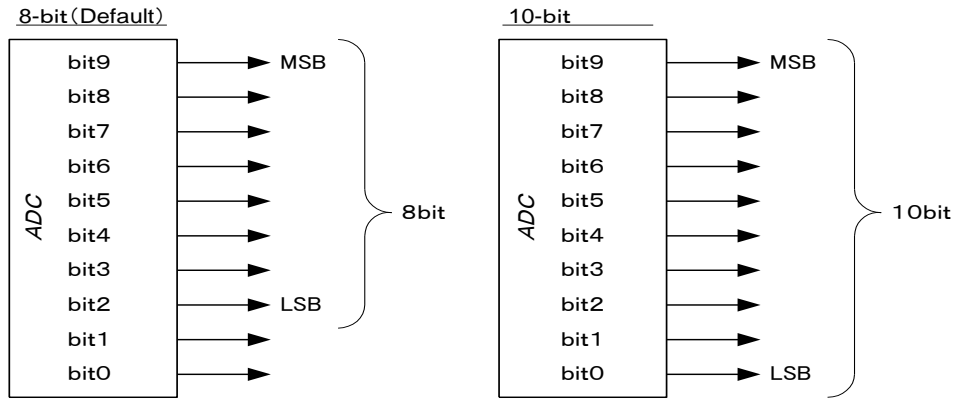
Figure 4-7-1 Pin Assignments of Digital Data

Video output phase of the camera is shown below.
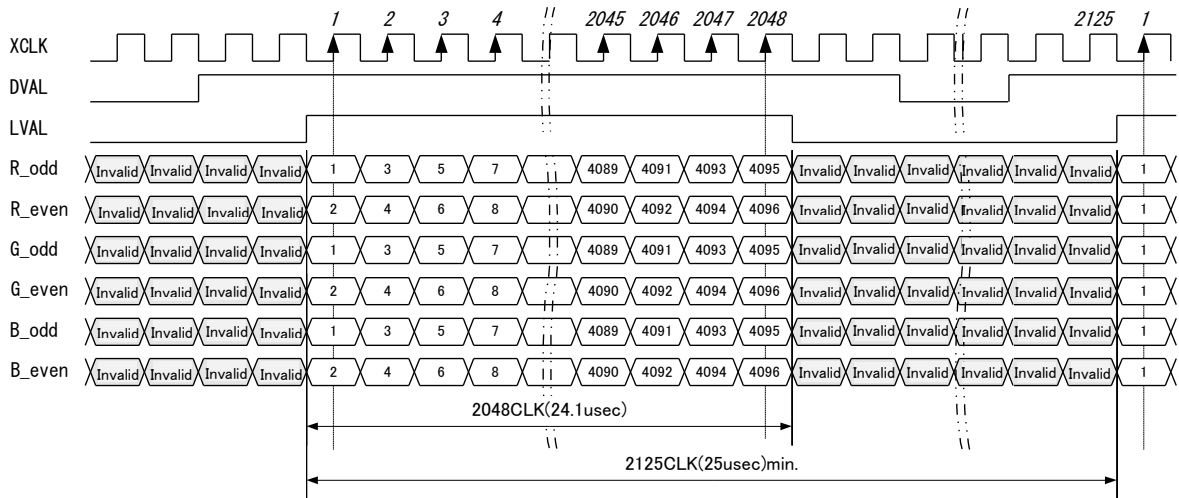
Figure 4-7-2 Video Output Phase of the Camera (with 85MHz 2taps at each R,G,B for data output)
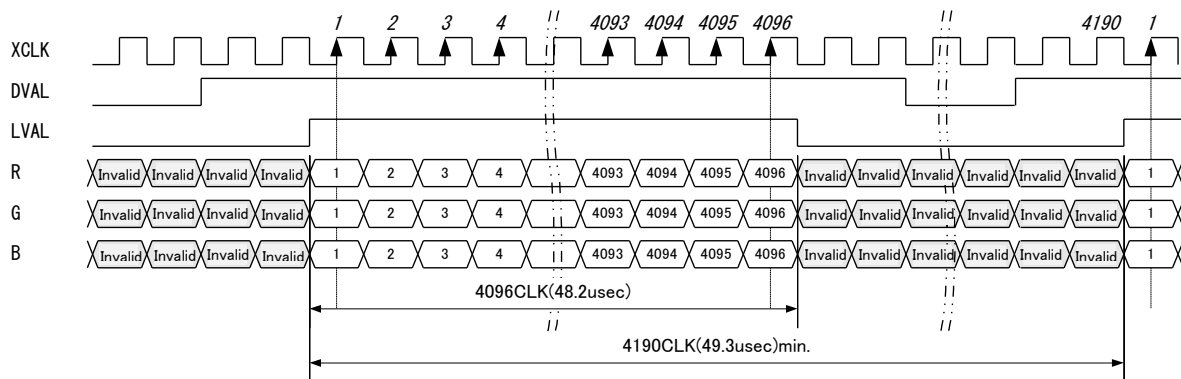
Figure 4-7-3 Video Output Phase of the Camera (with 85MHz 1tap at each R,G,B for data output)

Note:
1) FVAL = 0 (low level) fixed
2) The configurations of Camera Link interface are shown below when the following outputs are used.
   Output of 1 tap at each colour with 24 bits: Camera Link Base Configuration
   Output of 1 tap at each colour with 30 bits: Camera Link Medium Configuration
   Output of 2 taps at each colour with 24 bits: Camera Link Medium Configuration
   Output of 2 taps at each colour with 30 bits: Camera Link Full Configuration

4.8 Exposure Mode and Timing Chart

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

4.8.1 Free Run Exposure Mode (Programming time setting)

In free-run exposure mode, the camera generates its own internal control signal based on two programmable parameters, exposure time and readout time.

Table 4-8-1-1 Programmable Exposure Time

Item	symbol	XCM4085TLCT6
Programmable exposure time	P	Data output at each colour at 85MHz 2taps：22.12～23373.17 at 85MHz 1tap：46.37～23373.17 at 40MHz 2taps：49.94～23373.17 at 40MHz 1tap：100.58～23373.17

Readout time	R	Data output at each colour at 85MHz 2taps：24.10 at 85MHz 1tap：48.19 at 40MHz 2taps：50.73 at 40MHz 1tap：101.45
Scan Rate	S	Data output at each colour at 85MHz 2taps：24.97～23376.02 at 85MHz 1tap：49.22～23376.02 at 40MHz 2taps：52.79～23376.02 at 40MHz 1tap：103.44～23376.02

(unit：µs)
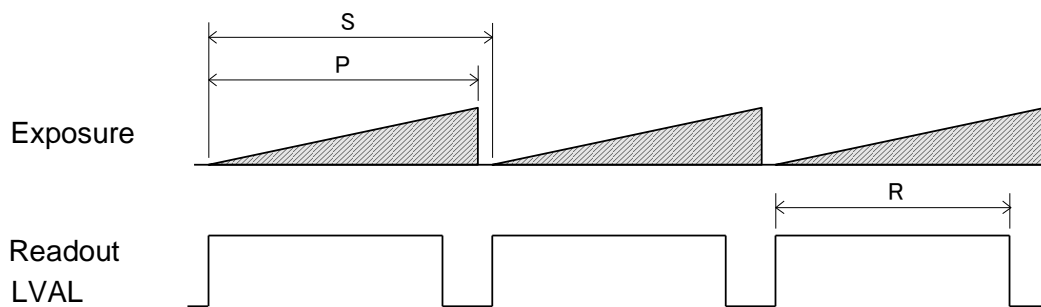
Figure 4-8-1-1 Free Run Exposure Mode

4.8.1.1 Programmable exposure setting time and calculation of scan rate

Calculation 1) P = Counter ÷ {Clock ÷ Dividing}

Calculation 2) S = P + [Padding ÷ {Clock ÷ Dividing}]

P	Programmable exposure time (µs)
S	Scan rate (µs)
Clock	89.722 (MHz)
Padding	4（fixed）
Dividing	64（fixed）
Counter	31~32767

(Example)

In case of the camera is "XCM4085TLCT6" and the command is "int □ 64 □ 100"

Clock = 89.722, Dividing = 64, Counter = 100

Programmable exposure time (µs) = 100 ÷ {89.722 ÷ 64} =71.33

Scan rate (µs) = 71.33 + [4 ÷ {89.722 ÷ 64}]= 74.18

4.8.2 External Trigger Exposure Mode (External trigger edge)

In external trigger exposure mode (Trigger Edge), the exposure time is determined by the setting through the serial communication, each exposure starts with the rising edge and the line period is determined by the time from rising edge to rising edge of the trigger pulse. The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

Table 4-8-2-1 Programmable Exposure Time

Item	symbol	XCM4085TLCT6
Programmable exposure time	P	22.12 ~ 23373.17
Readout time	R	Data output at each colour at 85MHz 2taps：24.10 at 85MHz 1tap：48.19 at 40MHz 2taps：50.73 at 40MHz 1tap：101.45
Trigger pulse H time	T1	≧1.50
Trigger pulse L time	T2	≧2.86
Trigger pulse cycle(Scan rate)	T3	≧P + 2.86 But the scan rate must be as follows. Data output at each colour at 85MHz 1tap：≧49.22 at 40MHz 2taps：≧52.79 at 40MHz 1tap：≧103.44

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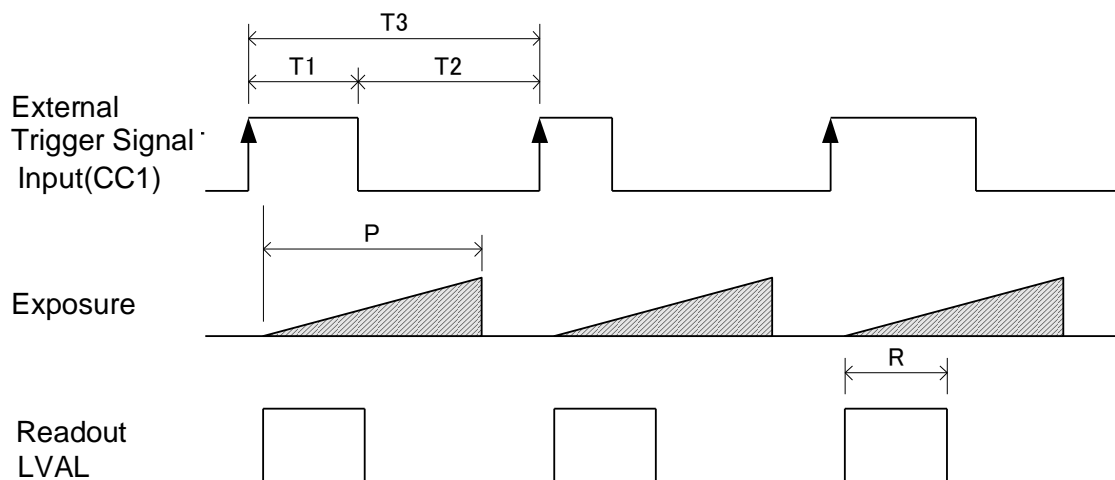
Figure 4-8-2-1 External Trigger (Trigger Edge) Exposure Mode

4.8.3 External Trigger Exposure Mode (Trigger Level)

In external trigger exposure mode (Trigger Level), the exposure time is determined by the high trigger pulse time, each exposure starts with the rising edge and the line period is determined by the time rising edge to rising edge of trigger pulse. The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

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

Item	Symbol	XCM4085TLCT6
Readout time	R	Data output at each colour at 85MHz 2taps：24.10 at 85MHz 1tap：48.19 at 40MHz 2taps：50.73 at 40MHz 1tap：101.45
Trigger pulse H time (Exposure Time)	T1	≧22.12
Trigger pulse L time	T2	≧2.86
Trigger pulse cycle (Scan Rate)	T3	The value of trigger pulse cycle must be as follows. Data output at each colour at 85MHz 2taps：≧24.98 at 85MHz 1tap：≧49.22 at 40MHz 2taps：≧52.79 at 40MHz 1tap：≧103.44

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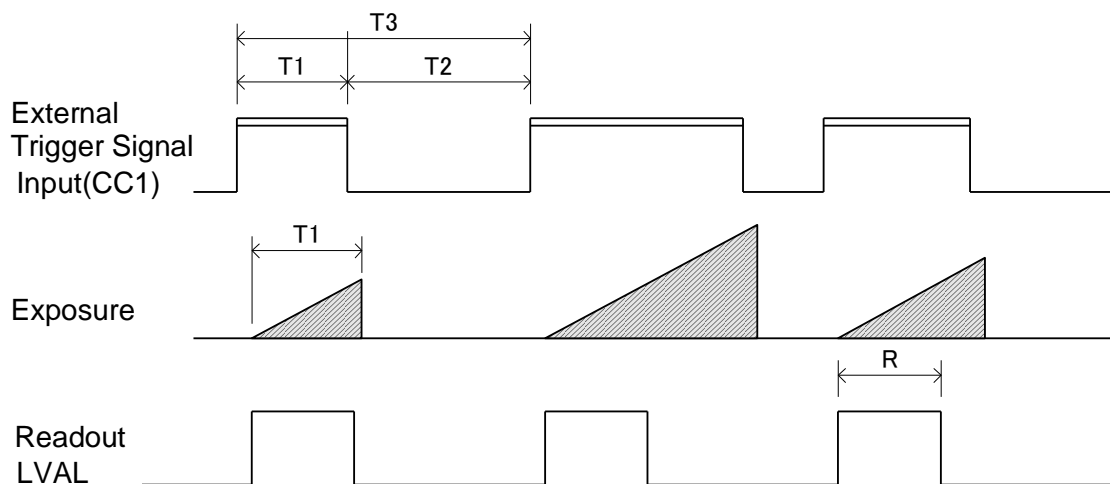
Figure 4-8-3-1 External Trigger (Trigger Level) Exposure Mode

4.9 Digital Gain / Offset Settings

4.9.1 Setting Digital Gain (1)

Digital gain is set with the following commands: Digital Gain (Common) "gdx"; digital gain (R) "gdxr"; digital gain (G) "gdxg"; digital gain (B) "gdxb". RGB (Common) digital gain setting should be used when making small adjustments to multiple cameras. Individual colours' digital gain should be used for adjusting white balance etc.

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

4.9.2 Setting Digital Gain (2) Automatic White Balance

By automatically adjusting R, G, B gain, white balance can be adjusted. Setting is done by sending the command "awb". The camera calculates the average value of the central 256 pixels, then adjusts the other 2 colours to the level of the brightest colour. To return to the previous value, send the command "rwb" to reset each gain level to x1.

Note : If the data change is too large, the image is saturated, or the maximum level is exceeded, an error will occur and adjustment will be cancelled.。

4.9.3 Setting Digital Offset

Through the RGB (Common) setting, offset can be set within the range of -40 ~ +40 (DN) for 8-bit, or -160 ~ +160 (DN) for 10-bit output. Through the individual R, G, B settings, offset can be set within the range of -20 ~ +20 (DN) for 8-bit or -80 ~ +80 (DN) for 10-bit output. Offset is set with the following commands: Offset RGB (Common) "odx"; Offset R "odxr"; Offset G "odxg"; Offset B "odxb".
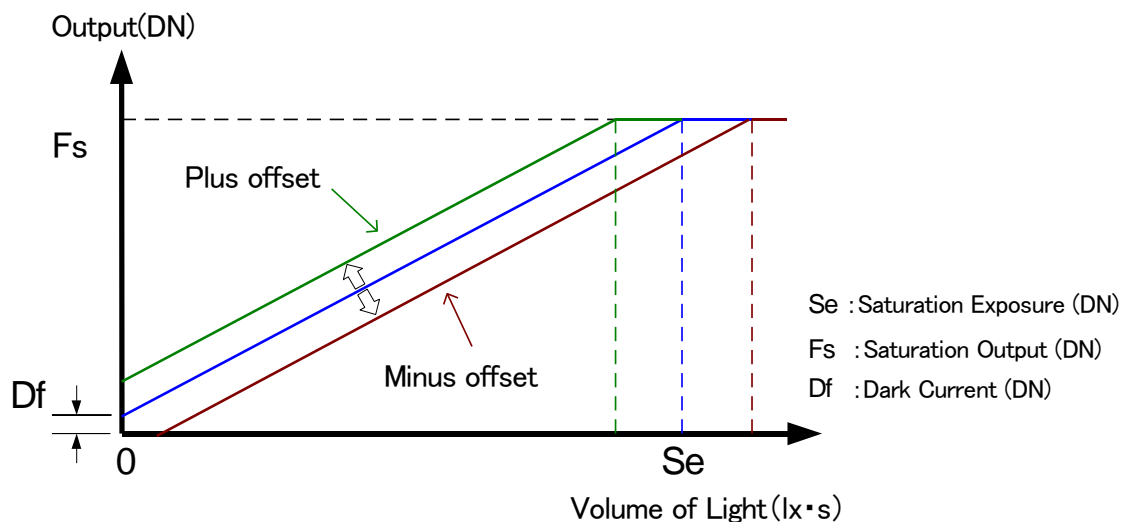
Figure 4-9-3 Saturation Exposure and Dark Current Output

Note : Adjust amount of offset in accordance with the requirements of your camera
          system. The gradients of lines do not change.

4.10 Setting Analog Gain

Gain can be adjusted by setting analog gain (6 steps, x1~x5.5) or digital gain (512
steps, x1~x2). In both cases, increasing the gain setting increases the slope of the
camera's response curve, so that the output saturates at a lower level of light.
Conversely, with less light, a higher output can be obtained; that is to say, the
cameras sensitivity has been increased. Analog gain can be adjusted with the "gax"
command.
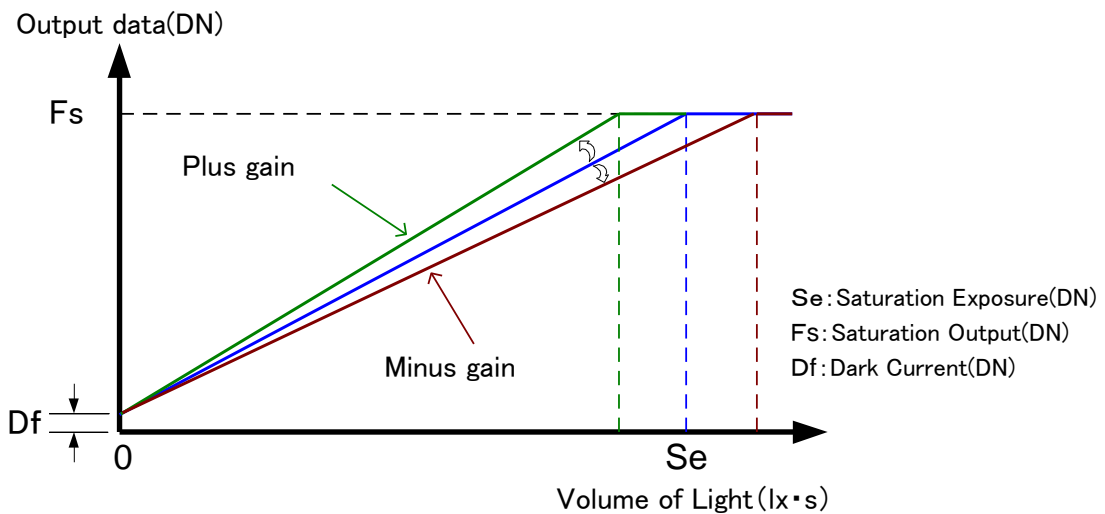
Figure 4-10-1 Gain Adjustment

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

Table 4-10-1 Gain-Sensitivity

	Analog gain	Sensitivity V/ (lx・s)
1	X1	100
2	X1.5	150
3	X2	200
4	X3	300
5	X4	400
6	X5.5	550

Note:

Gain and noise values are proportionally related. Adjust amount of gain in accordance
with the requirements of your camera system. We recommend using gain from x1 to
x3.

4.11 Pixel Correction

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

Cal_bl : Output data of each pixel in perfect dark (factory correction)
Cal_wh : Output data of each pixel in uniform illumination (factory correction)
or when viewing a subject for correction (user white correction)
Target_Val : Target value for user correction (10bit output conversion value)
Fix_bl : Fixed value 32DN (10bit output conversion value)
Vin: Input data (Before correction)   Vout :Output data (After correction)
The corrected data is expressed by the following equation.
Vout=[(Vin-Cal_bl) x (Target_val-Fix_bl) / (Cal_wh-Cal_bl)] + Fix_bl
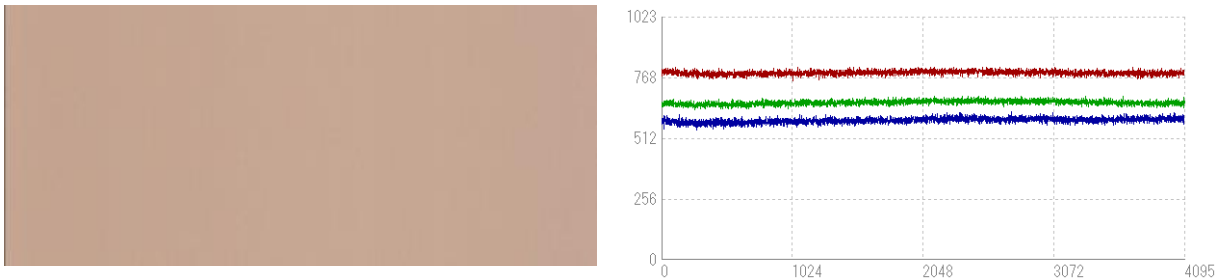
Image "before" user arbitrary pixel is corrected.   Luminance Profile of left image
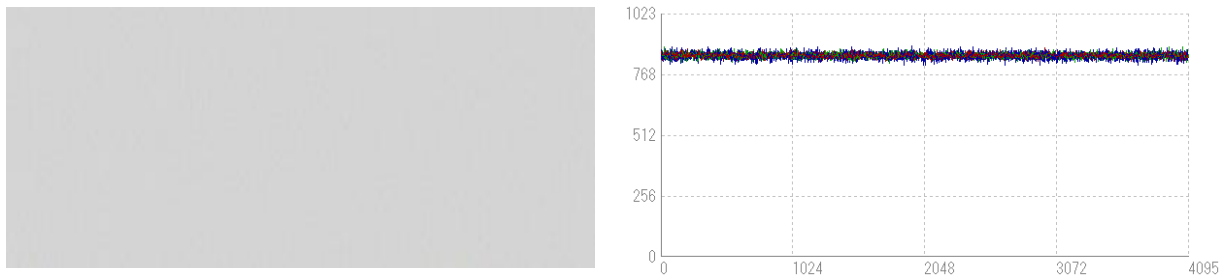
Image "after" user arbitrary pixel is corrected   Luminance Profile of left image

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

4.11.1 Operating Procedure

Pixel Correction settings are done for either User Arbitrary Correction Data 1 or 2. Send the command "shc2 CR" or "shc3 CR" via the COM port; User Arbitrary Correction Data will be made active.

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

To set the pixel correction target value, proceed as below:

Send the command "MurVal CR" via the COM port. The camera should return ">OK" ">Mur" ">Val". With this, the pixel correction target value R is set.

Send the command "MugVal CR" via the COM port. The camera should return ">OK" ">Mug" ">Val". With this, the pixel correction target value G is set.

Send the command "MubVal CR" via the COM port. The camera should return ">OK" ">Mub" ">Val". With this, the pixel correction target value B is set.

Notes:

  1) For "Val" above, substitute the target value, 0~1023 (10-bit).
  2) The pixel correction target value should be set slightly higher than the obtained image brightness in order to attain the full range of output.

4.12 Adjusting White Balance

The white balance on this camera has been adjusted without lens and mount, and using a daylight fluorescent light. Depending on the lens and light source you use, it may be necessary to adjust the white balance in one of the two ways described below.

Note: In the following cases, please use the pixel (bit) correction function:

If a variable responsivity pattern appears across the image when using a light source that does not have a broad wavelength, such as a 3-wavelength fluorescent lamp.

The difference between the colour levels is large, and exceeds the maximum value of digital gain.

4.12.1 Pixel (Bit) Correction Function

Correct the white balance using the User White Correction function（see 4.11）

4.12.2 Digital Gain Function

Adjust the white balance by adjusting the digital gain of each RGB colour.（see 4.9.1）Adjust automatically using the automatic white balance function（see 4.9.2）

4.13 Test Pattern

The test pattern can be used to check whether your system is correctly receiving the camera data.

The gray test patterns for 24 and 30-bit colour are shown below.
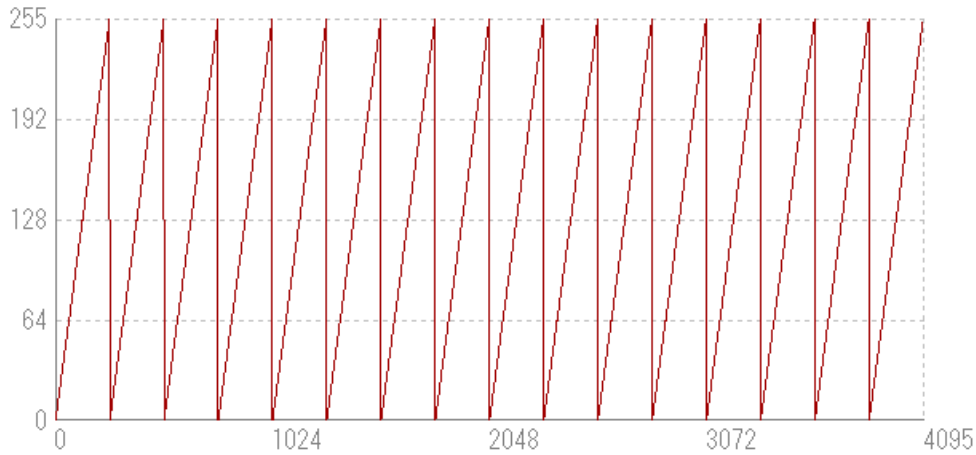
Figure 4-13-1 24-bit Colour Gray Test Pattern
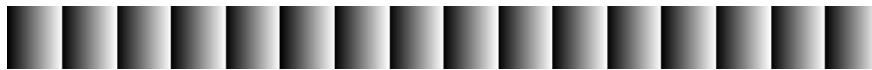
Figure 4-13-2 24-bit Colour Gray Test Image

Where pixel 0 has the value 0DN, the value increases by 1DN each pixel, up to 255DN, then the pattern repeats.
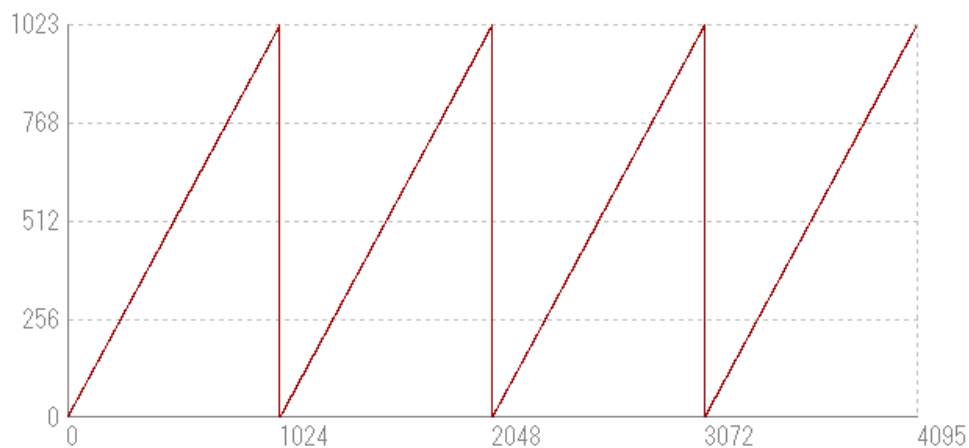
Figure 4-13-3 30-bit Colour Gray Test Pattern

Figure 4-13-4 30-bit Colour Gray Test Image

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

The gray XY test pattern for 24 and 30-bit colour are shown below.
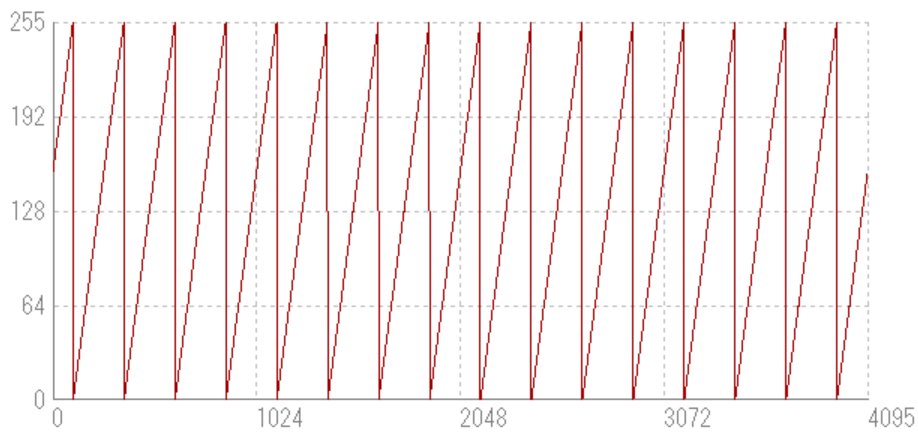
Figure 4-13-5 24-bit Colour Gray XY Test Pattern

Figure 4-13-6 24-bit Colour Gray XY Test Image

The value increases by 1DN each pixel, up to 255DN in both X-direction and Y-direction(downward), then the pattern repeats.
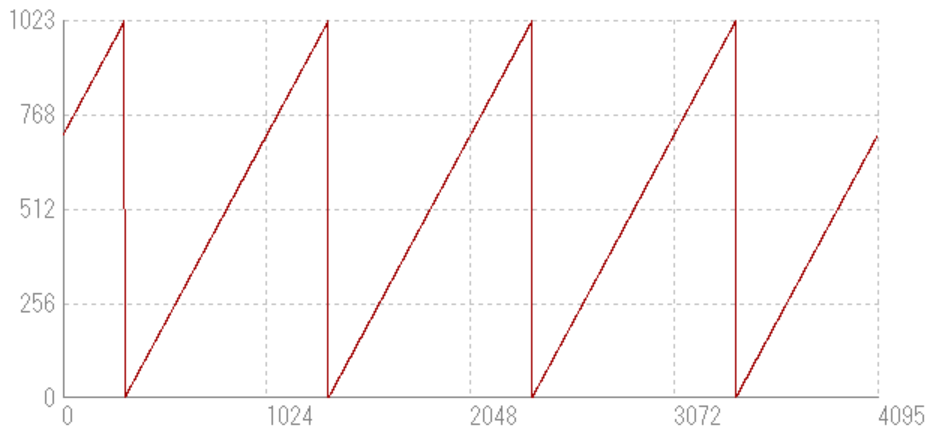
Figure 4-13-7 30-bit Colour Gray XY Test Pattern

Figure 4-13-8 30-bit Colour Gray XY Test Image

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

The Colour 24-/30-bit colour bar test pattern is shown below.
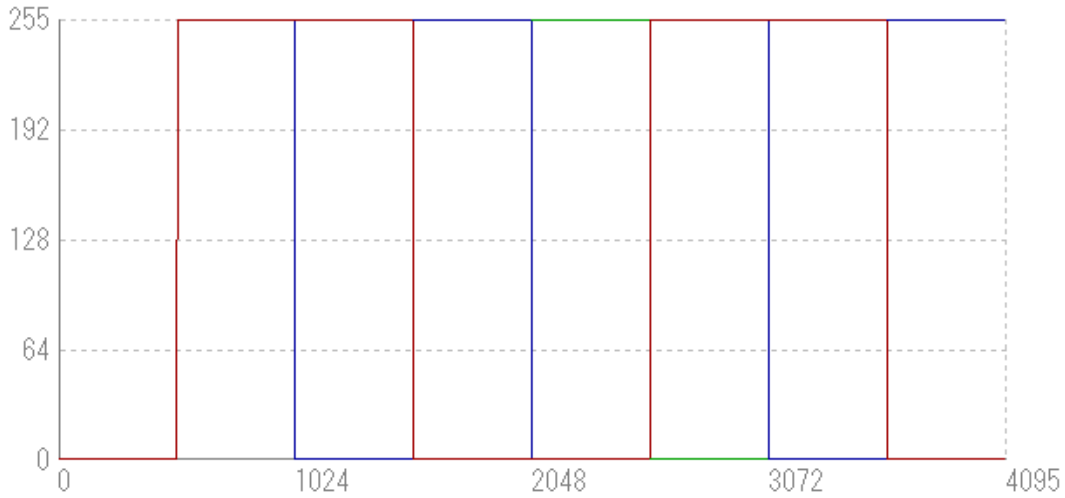
Figure 4-13-9   24-bit Colour Bar Test Pattern

Figure 4-13-10   24-bit Colour Bar Test Image

From the first pixel, the image is a sequence of blocks of 512 pixels: Black (R:0 G:0 B:0), White (R;255, G:255, B:255), Yellow (R:255 G:255 B:0), Aqua (R:0 G:255 B:255), Green (R:0 G:255 B:0) Pink: (R:255 G:0 B: 255), Red (R:255 G:0 B:0), Blue (R:0 G: 0 B:255)
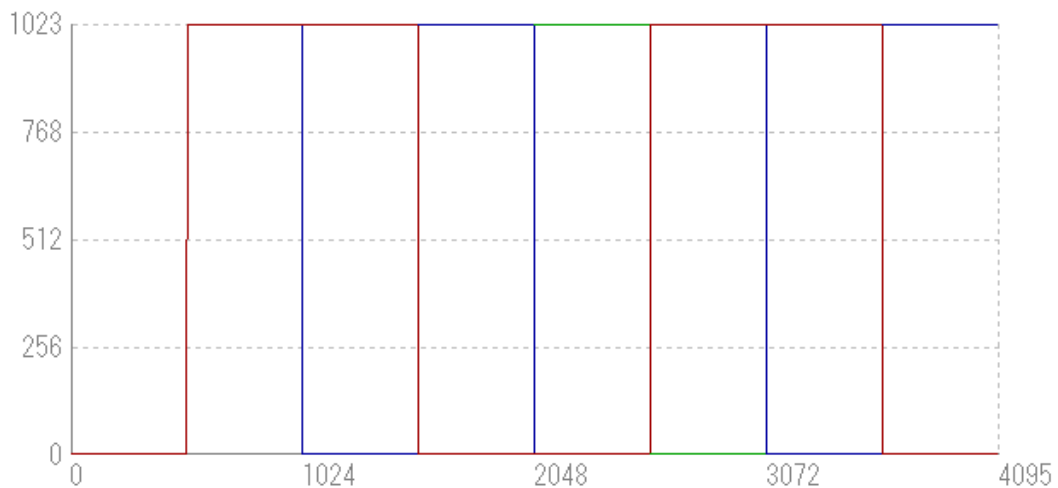
Figure 4-13-11 30-bit Colour Bar Test Pattern

Figure 4-13-12 30-Bit Colour Bar Test Image

From the first pixel, the image is a sequence of blocks of 512 pixels: Black (R:0 G:0 B:0), White (R;1023, G:1023, B:1023), Yellow (R:1023 G:1023 B:0), Aqua (R:0 G:1023 B:1023), Green (R:0 G:1023 B:0) Pink: (R:1023 G:0 B: 1023), Red (R:1023 G:0 B:0), Blue (R:0 G: 0 B:1023)

4.14 Line Delay Correction Setting

Three (3) line sensors of this camera are located laterally at one line interval. Therefore, each RGB output data produces the image which is delayed for two pixels in movement direction in case of an image of 1:1 reduced scale ratio of length and width.

This can be used for correcting the deviation of delay between output datas of each colour at the unit of one line.

For example, when an imaging object moves from the bottom to the upper direction for a camera in case of an image of 1:1 reduced scale ratio of length and width and "ldly □ 2" of command is sent, the image can be corrected on the deviation of delay.

When an imaging object moves from the top to the lower direction, "ldly □ -2" as of command should be sent.
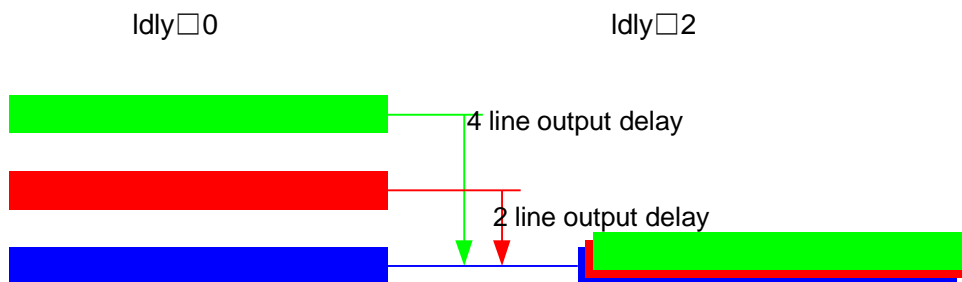
Figure 4-14-1 Line Delay Correction

4.15 Line Fine Adjusting Correction Setting

The Line delay correction setting on 4.14 can be used for correcting the deviation of delay between output datas of each colour at the unit of one line.

This line fine adjusting correction can be used at the unit of a half of line by the corrective calculation.

For example, when the colour shift still generates even if "ldly□2" and "ldly□3" of commands are sent,   "ldlys □ 5" of command may improve the colour shift.

When the value of the command is minus (-), the correction value of "ldly" becomes smaller.

| ldly□2 | ldly□2 and ldlys□5 | ldly□3 |

Figure   4-15-1   Line Fine Adjusting Correction

4.16 Gamma Correction Setting

Switches Gamma correction value.
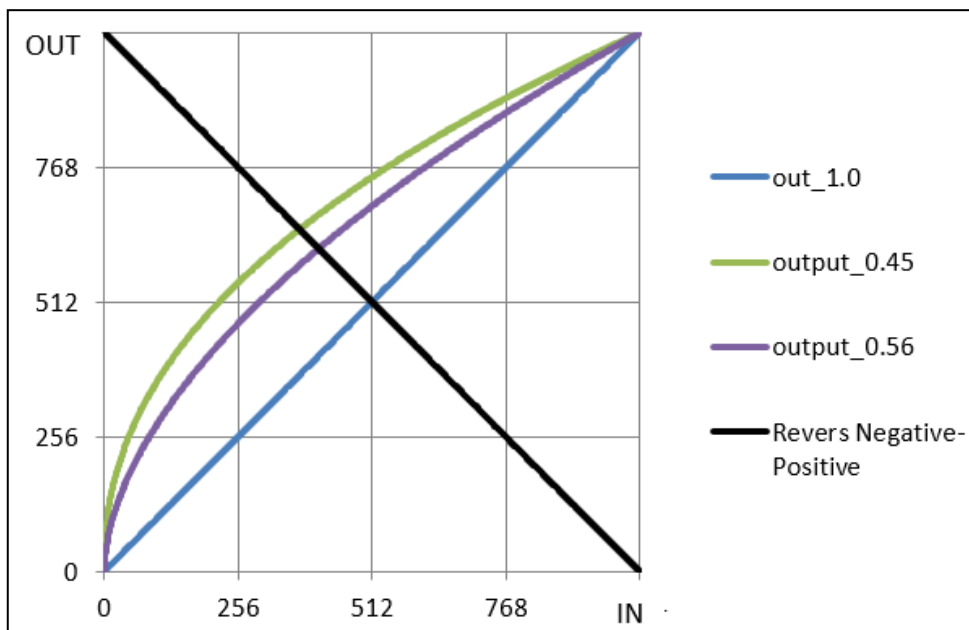
Figure 4-16-1 Gamma Correction Characteristics

4.17 Camera Scan Readout Direction Setting

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

| ① Forward Camera Scan | ②Reverse Camera Scan |
| Readout Direction | Readout Direction |
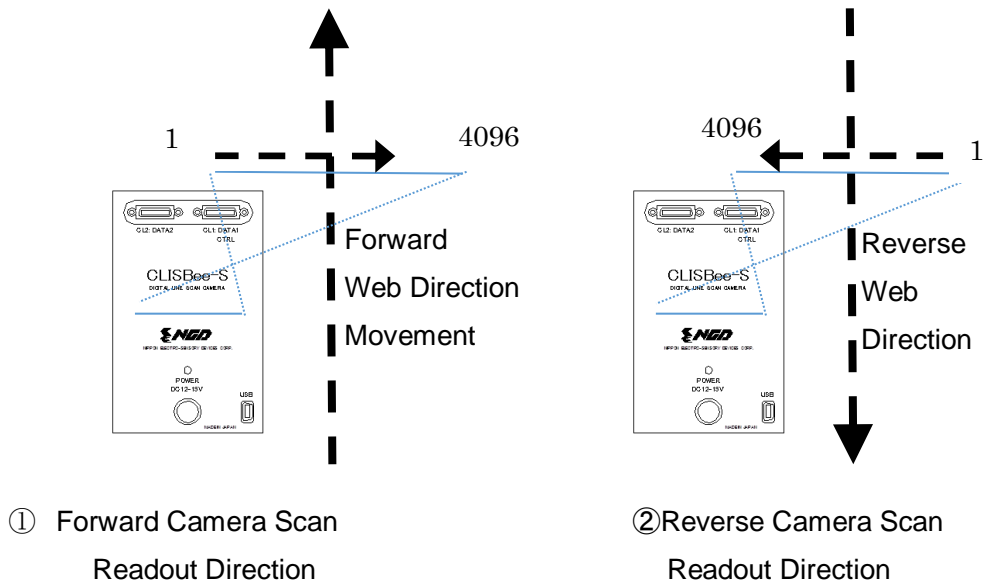
Figure 4-17-1 Correlation of Camera Scan Readout Direction and Object Movement Direction

5 Sensor Handling Instructions

5.1 Electrostatic Discharge and the Sensor

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

5.2 Protecting Against Dust, Oil and Scratches

The CMOS sensor window is part of the optical path and should be handled like other optical components with care. If you use the camera in a dusty area, prepare a dust-proof enclosure. Dust can obscure pixels, producing dark lines on the image.

5.3 Cleaning the Sensor Window

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

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

6 Troubleshooting

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

6.1 When there is no Image

The indicator is glowing. — **No** → Are the correct connectors being used between the camera and the power supply, and are they properly connected? — **No**

↓ **Yes**

Yes ↓

The power source meets the specified voltage. — **No**

↓ **Yes**

When switched on, the power source meets the specified voltage. — **No** → The capacity of the power source is enough. — **No**

↓ **Yes**

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

Yes →

Arrange a power source that meets the specifications.

The camera has the correct connection with the frame grabber. — **No** → **Connect the camera and the frame grabber board with camera cables.**

↓ **Yes**

The frame grabber board is switched on and set up. — **No** → **After being energized, set up the frame grabber board suitably.**

↓ **Yes**

The frame grabber is communicating with the camera successfully. — **No** → Is the sample software program being used to control the camera. — **No**

Yes ↓

The sample software program is used to control the camera and is communicating with the camera successfully. — **No**

Yes ↓

Confirm the communication software, the control protocol for the camera and commands.

To next page **A**

To next page **B**

To next page **B**

A   **B** → The communication port is set correctly. — **No** → **Set the communication port correctly.**

Yes ↓

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

The capturing software program is custom made. — **No** → The capturing software program is provided with the board as a sample program.

Yes ↓

No image is captured with the sample software program provided. — **No** → **Check the compatibility between the camera and the frame grabber board.**

Yes ↓

Nothing blocks off the light. — **No** → **If a lens cap is on, take it off.**

Yes ↓

The amount of the illumination is enough. — **No**

Yes ↓

No image at the full aperture. — **No**

Yes ↓

The optical axes of the camera and the image sensor are aligned. — **No** → **Check the light source. If the images are too dark, try to increase the light intensity, and vice versa.**

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

6.2 When Noise is present in the Image

Noise is present at the point of first use. — **No** →

The camera has been used for 3 or more years, or the ambient temperature is higher than room temperature. — **No** →

Yes ↓

A servomotor or a magnetic valve is placed near the camera. — **No**

Yes ↓

There are some degradable parts in the camera. Please contact us for assistance.

Turning on a servomotor or a magnetic valve generates an electric noise. — **No**

The power supply has been used for 3 or more years, or the ambient temperature is higher than room temperature. — **No**

Yes ↓

Yes ↓

Prevent the noise source from disturbing the camera cables and the power cable.

Check the condition of the power supply.

The camera and or cables are used in a moving environment (attached to a machine which applies stress to the cables). — **No**

Yes ↓

Check the condition of the camera cables and the power supply cable.

To next page
C

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

C

Cables are asymmetric such as thin cables.　　No

Yes

One of the connectors of an asymmetric camera cable is to be connected with a camera. (Labeled as "Camera side")

The camera cables are too long.　　No

Yes

Use camera cables in accordance with the transmission rate. The cables should not be too long to avoid the noise disturbance.

The power source has no fluctuation in voltage and is not deteriorated.　　No

Yes

When the camera gain is on a high level, bright spots occur without incident light.　　No

Use a stable power supply.

Yes

Secondary radiation (rays) could cause bright spots, but this is not malfunction.

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

6.3 When the Camera becomes hot

The consumption current of the power supply is larger than the rating.

No

Yes

The camera is too hot to touch.

No

Yes

The camera will become hotter than the ambient temperature while in operation because of self-heating. Allow sufficient air circulation around the camera to give it the longer life.

Keep the ambient temperature within the range of the specifications.

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

7 Others

7.1 Notice

● No part of this document may be reproduced in any form, in whole or in part, without the expressed written consent of NED.

● Contents of this document are subject to change without prior notice.

● Every care has been taken in the preparation of this User's Manual. If you should discover any errors or omissions, please notify your nearest NED representative.

7.2 Contact for support

Nippon Electro-Sensory Devices Corporation

Head Office
  2-5-12, Itachibori, Nishi-ku, Osaka 550-0012, Japan
  Phone +81-6-6534-5300
  Fax +81-6-6534-6080

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  Fax +81-92-451-9335

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

E-Mail
  sales@ned-sensor.com

7.3 Product Support

   If there is still a problem with your camera after checking it in accordance with the

troubleshooting guide, turn off the power and call your NED representative.

   In such case, please inform us of the status of the camera. You can get the status on console by

(1) executing the "sta" command, or

(2) clicking "Memory Dump" button when using CLISBeeCtrl.

Revision Number	Date	Changes
01	22 October 2015	Initial release
02	25 Jul.2018	Deleted The description on the Camera Control Software.