Mitsubishi Contact Image Sensor （CIS）

KD6R309MX/ KD6R617MX/ KD6R926MX

KD6R309MX-NL/ KD6R617MX-NL / KD6R926MX-NL

KD6R309MX-DL

Function Specification

Mitsubishi Electric Corporation

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Specifications are subject to change without notice.

MITSUBISHI ELECTRIC

目　次

1. Application

This specification is applied to Monochrome version of Mitsubishi Electric Contact Image Sensor (CIS) for web surface inspection.

This document is for explanation about the control method and memory Configuration of Mitsubishi Electric Contact Image sensor for Optical inspection machines.

And it is applied for the following products.

KD6R309MX
KD6R617MX
KD6R926MX
KD6R309MX-NL
KD6R617MX-NL
KD6R926MX-NL
KD6R309MX-DL

KD6R309MX, KD6R309MX-DL, KD6R617MX, and KD6R926MX (referred to as built-in lighting model) include built-in illumination. KD6R309MX-NL, KD6R617MX-NL, and KD6R926MX-NL (referred to as non-lighting model) don't include illumination.

2. General overview

2.1 Product overview

Followings are main components of the product:

① Sensor array
② GRIN Lens array(SLA)
③ LED drive circuit＋LED illumination×2　(just for the product with illuminations)
④ Signal processing circuit board
- ICs (AFE,FPGA,ASIC) for Signal processing
- EEPROM stored register data for start-up when power is turned on .
- Flash Memory stored 4 groups of register data for CIS function.

2.2　Serial communication (UART) control and function setting

This product can be controlled by Serial communication (UART (Universal Asynchronous Receiver / Transmitter) through Camera Link® Connectors.

The communication speed can be selected from 3 modes (9.6, 19.2, 115.2kbps).**Initial setting is 9.6k baud mode** and the setting every when power for this product is turned on will be set 9.6kbps mode in spite of any mode before setting. Refer the chapter 4.2 for understanding how to change the Communication speed.

Serial communication setting is as following table.

table 2－1 Serial communication setting

Item	Specification
Baud Rate	9.6kbps,19.2kbps,115.2kbps
Data bit	8
Paityn	N/A
Start bit	1
Stop bit	1
Flow control	N/A

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

2.3 Controllable operations by Serial communication

The following operations are controlled through Serial port.

- Selecting baud rate for Serial communication (9.6k,19.2k,115.2kbps)
- Scanning function control by commands
- Read out Identified information of the product by a command
- Data transfer between Operation setting memory and ASIC/FPGA registers by a command
- Read and write from/to Operation setting memory through Serial port.

The initial setting for Serial communication speed is 9.6kbps.

2.4 Signal processing

CIS has several basic functions for Image Signal processing and scanning control as following. Function is built in CIS. This enables basic signal processing and switching output mode.

- Synchronization mode setting
- The range of a scanning line period is　Switch external/internal synchronization signal setting（Internal signal is 23us/line～780us/line：84MHz）
- Camera Link® Output clock frequency setting（48～84MHz：28 steps）
- LED pulse duty setting (Pulse width, Pulse numbers)
- Interpolation
- γ correction
- Dark and White correction
- PGA (Programmable Gain Amplifier)
- Selecting resolution　（600dpi/300dpi/150dpi/75dpi）
- Select output mode
- Pixel overwrap setting (64pixels)

2.5 Operation setting memory

Operational setting memory consists of includes a one factory setting area and three user setting areas for each operation mode which include function parameters, white,　dark, and γ correction table. Each operation mode can switch to other mode by one command through Serial communication. And all parameters of an operation mode can be also stored in an area of operation setting memory by one command. Refer chapter 3 and 4 about how to handle operation setting memory.

2.6 Memory for stored initial function parameters and initial function setting

Every when the power for this product is turned on, all of the initial parameters for scanning function is automatically booted up to ASICs and FPGAs from EEPROMs in this product. (It takes around 5 sec to boot up all parameters.) This parameter which stored as an initial function setting in memory, EEPROMs, is called as “the initial function setting.” And when the software-boot is executed, the initial booting sequence will be done.

The initial parameters in EEPROMs are same as Factory setting parameters and these parameters are also stored in Flash memory as a function setting, “Factory setting”.

Refer chapter 3 and 4 about how to change initial setting.

3. Control and communication setting

The function control of this product (to change conditions of Image scanning, to rewrite white and Black correction data, to transfer data between memory and register) is done by Serial communication through Camera Link® interface. The memory configuration and data-flow are shown in this Chapter.

3.1 Memory configuration and communication

Every when +5V Power to this product is turned on, Setting data are loaded from memory storing initial setting data (EEPROM).In other word, Initial data are automatically loaded into ASIC/FPGA registers from initial data storing memory (EEPROM) and this product starts to operate on this setting. On every start-up of this product, the initial data which storing in to 2 memory block ,EEPROM and Factory setting area of FLASH memory, at Factory are automatically loaded.

On the case of using other operation setting for Image scanning, it is necessary to change ASIC/FPGA register data on designated address by Serial communication.

And the new setting data is stored internally into one of user setting memories by a command through Serial communication.

3.2 Memory configuration and operation control

The configuration of internal memories is shown in Figure 3.1. Data is transferred via a MICON between user's frame grabber boards, setting data memory and operation registers in ASIC/FPGA.

It is not possible to change a content of the initial data memories (EEPROM) from user's frame grabber board for this product. And the content of the initial data memories is same as the factory setting data of setting data memory (Flash memory).

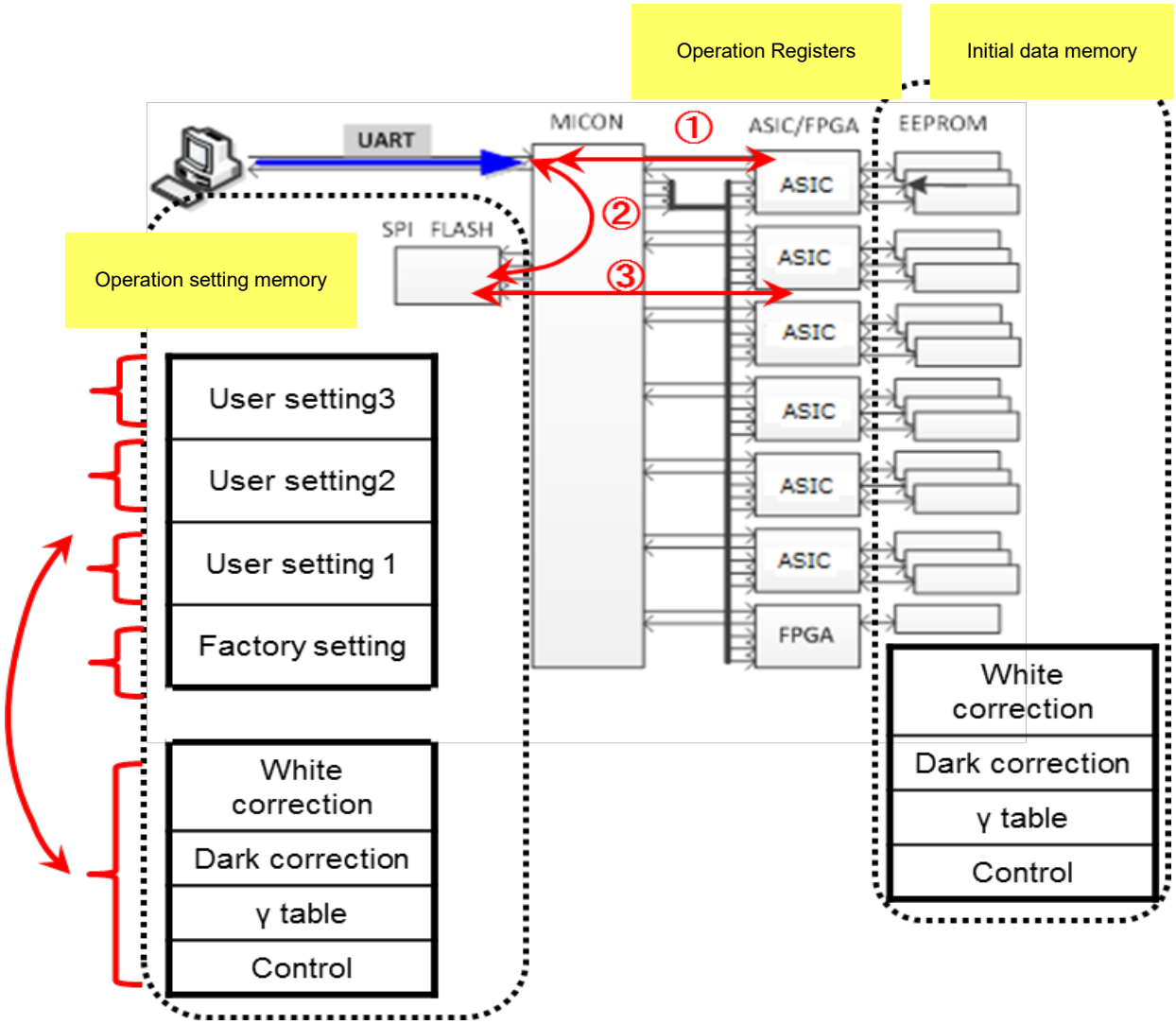


Figure3-1　CIS circuit block di

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

① Serial(UART) ⇔ Operation registers in ASIC/FPGA.
② Serial(UART) ⇔ Setting data memory (FLASH memory)
③ Setting memory ⇔ Operation registers in ASIC/FPGA.

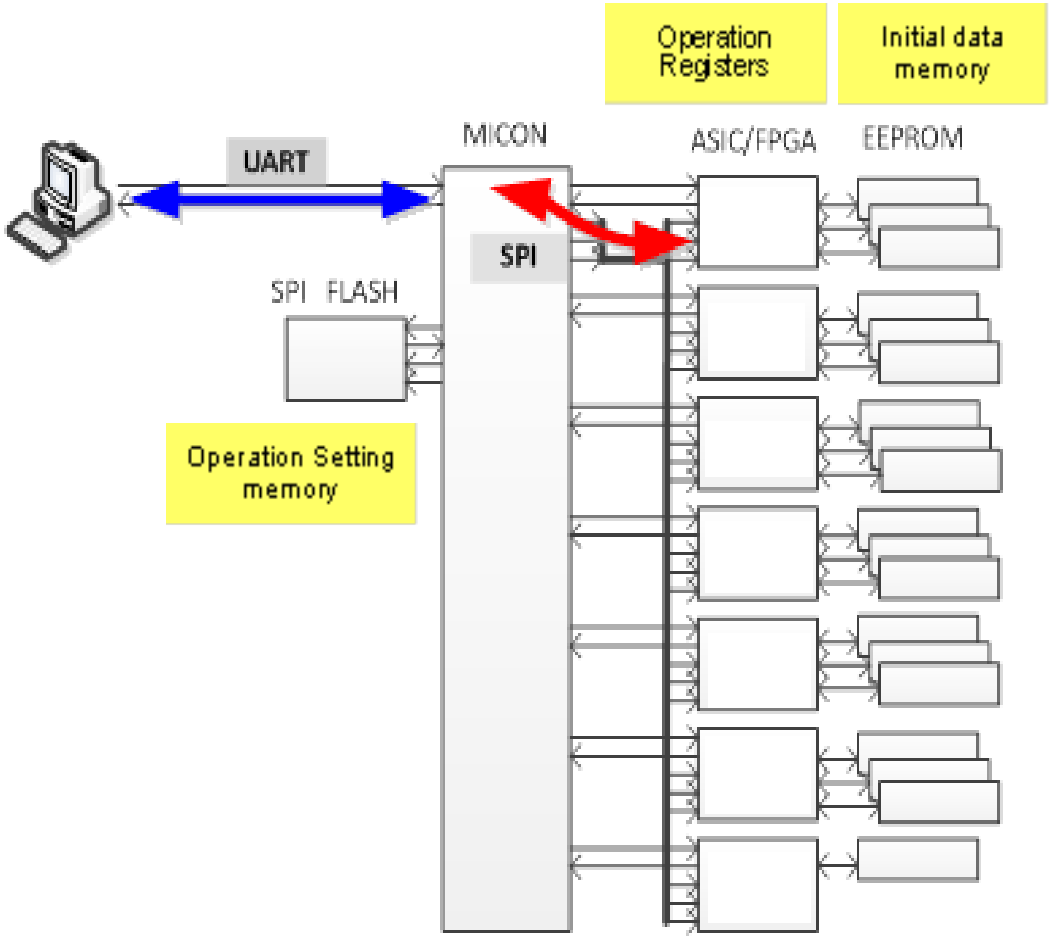
3.2.1 System ⇔ Operation registers

This route of communication is to read/write data from/to operation registers in ASIC/FPGA which define a scanning condition of this product. The data which is written to operation register changes a scanning condition immediately.

The changed data on operation registers are not available and not maintained on registers after when power is turned off. On this communication, commands change the data on operation registers.

Basically almost of function setting to operation registers in ASIC/FPGA are handled by commands. But it is necessary to write data directly, in the case of setting data on white correction table, black correction table and γ correction table.

Figure3-1 Communication mode 1



3.2.2 System ⇔ Setting data storing memory

This route of communication is to read/write data from/to setting data storing memory (FLASH memory) which can store one factory setting data and 3 user setting data. The changed data on setting data storing memory (FLASH memory) are not available until they copied to copying them to operation registers in ASIC/FPGA by command (refer from chapter 3.2.3).

And the changed data on setting data storing memory (FLASH memory) are maintained after when power is turned off.

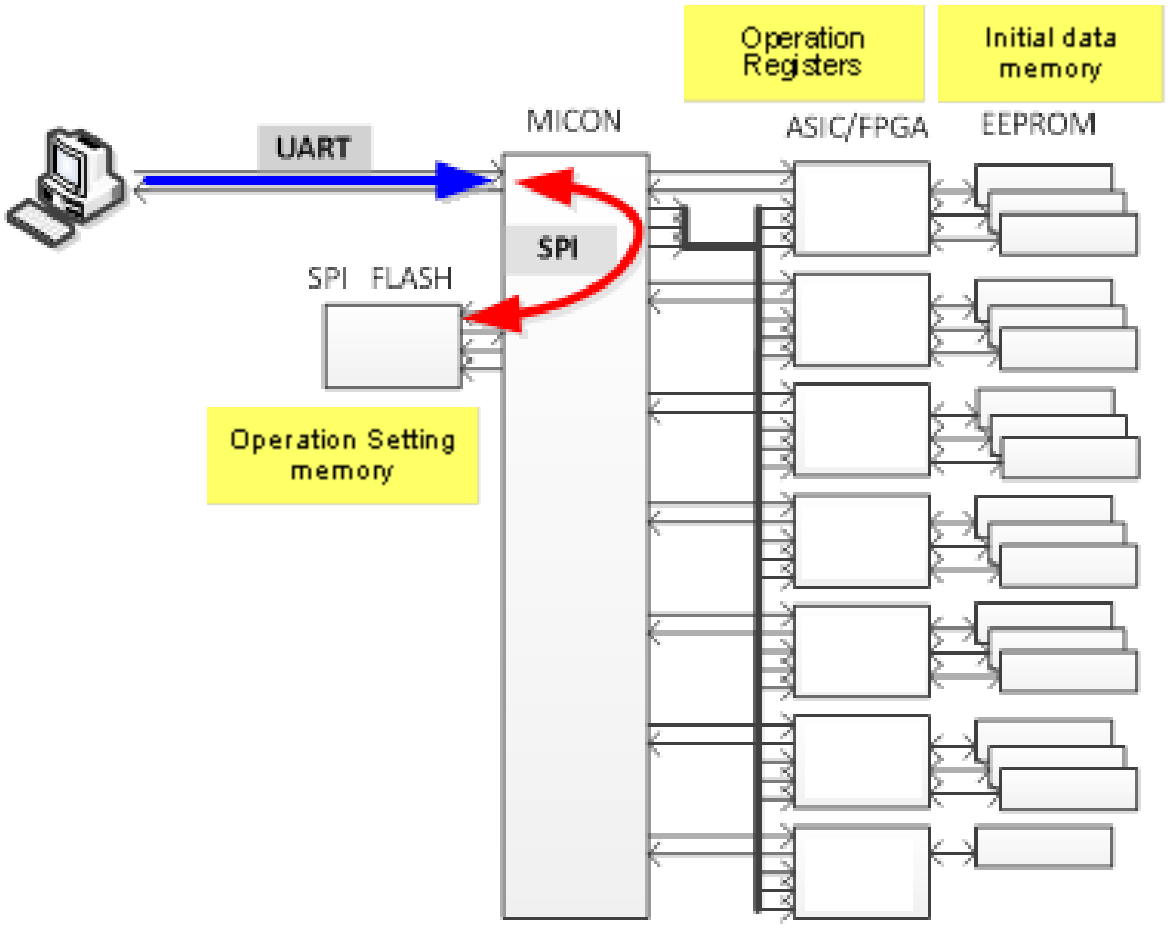


Figure3-2 Communication mode 2

3.2.3 Setting memory ⇔ Operation register

This route of communication is to transfer a block of data between one block of setting data storing memory (FLASH memory) and operation registers in ASIC/FPGA.

The setting data storing memory (FLASH memory) has 4 blocks of setting data area, a factory setting and 3 user settings.

Please choose either one of user settings, when you transfer data from the operation register to the setting data storing memory (FLASH memory). You are not able to write on the memory which is our factory setting stored. Refer to 3.3 for address map of the setting data storing memory.

Data transfer from operation registers is just available to a block of setting data area.

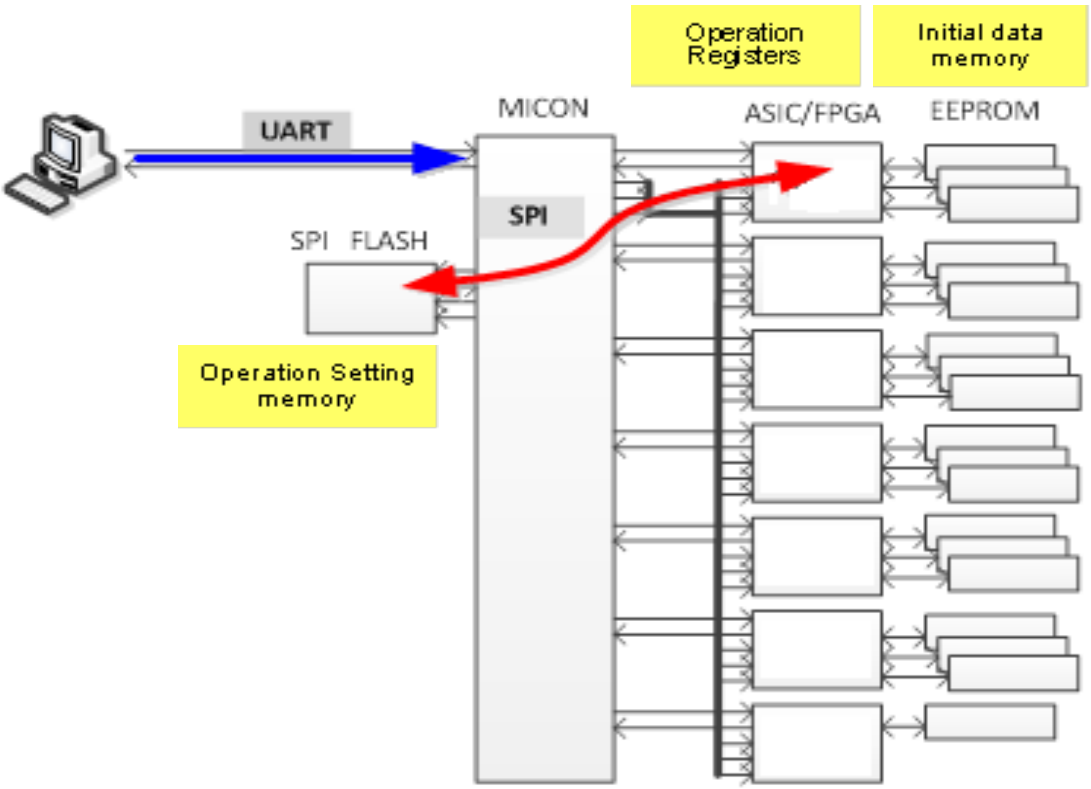


Figure3-3 Communication mode 3

3.3 Memory and register map of operation setting memory

Operational setting memory consists of includes a one factory setting area and three user setting areas for each operation mode. Memory and register map of operation setting memory as following table3-1.

- The area of factory setting in memory is protected. (Read only)
- The “not to use” area of flash memory is protected. If it is necessary to write any information to flash memory, please use the memory area which is not assigned for correction data in white and black correction area.
- The start address and the occupied area of memory by data of white and black correction depend on the valid scanning width of CIS as following table3-2.

Table3-1　Memory and register map of operation setting memory

ADDRESS		Setting Mode	Content	Read/Write
Upper	Lower			
00	0000	Factory setting (Read Only)	Base setting & product Information	Read only protected
	0FFF			
	1000		Registers for CIS Operation	
	70FF			
	7100		γ correction table	
	74FF			
	7500		Not to use	
	FFFF			
01	0000		Black correction table	
	AAFF			
	AB00		Not to use	
	FFFF			
02	0000		White correction table	
	AAFF			
	AB00		Not to use	
	FFFF			
03	0000	User setting1	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only
	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
04	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
05	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
06	0000	User setting2	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only

	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
07	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
08	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
09	0000	User setting3	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only
	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
0A	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
0B	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			

Table3-2 Memory and register map of black/write correction data

ADDRESS		KD6R309MX KD6R309MX-NL KD6R309MX-DL	KD6R617MX KD6R617MX-NL	KD6R926MX KD6R926MX-NL
Upper	Lower			
01/02/04/05 07/08/0A/0B	0000 ~ 38FF	—	—	○
	3900 ~ 71FF	○	○	○
	7200 ~ AAFF	—	○	○

4. CIS function

4.1 Output / Input interface

This product can be controlled by Serial communication on Camera Link® interface.
After receiving a command, this product replies Reply code to your system.

- Send : System for Users ⇒ This Product
  【Command】 【Parameter】 （Data） （Data） 【End Code】

- Reply : This Product ⇒ System for Users
  【Result】 【Parameter】 （Data） （Data） 【End Code】

【Caution】

- **ASCIIcode in capital letter is effective in the command.**
- End Code is fixed as CR (ASCII code：0x0D).
- Number of data in a command depends on Parameter setting. For example, 5 Byte of data (10 ASCII code) are output, in the case of a command for reading-out the product information.
- Refer to 4.6.3 for Read status of this product.
- Each bit of Parameter has each definition how CIS is controlled by a command and these bits are combined to a byte data. Each 4 of upper and lower bits is sent as 2 byte ASCII code. In this case, Only Capital letter is valid for A~F（ASCII code 0x41～0x46） of hexadecimal.

  【Parameter bit】

MSB							LSB
1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0
R/W	Mode		Operation parameter				

- Same as Parameter, data is converted from hexadecimal into 2byte ASCII code. In this case also, capital letter is valid for A~F of hexadecimal (0x41～0x46).
- When a procedure sending a command is interrupted, the sent command many not be accepted by this product. In this case, please power off this product and re-power up.
- In order to start the communication stably, power up this product after completing to set up your system. (An unstable input by your system to this product may cause the similar situation mentioned above.

【Command】
Followings are command list.

Table4-1　Command list

No.	Command	Description	Format	Detail
1	BR	Select Baud rate	C P E	Set an Baud Rate of Serial communication via Serial communication
2	OF	Select output CLK frequency	C P E	Set output clock frequency
3	OC	Select Output format	C P E	Set an output format of Camera Link®
4	RC	Select resolution	C P E	Set a resolution
5	SS	Select Synchronization mode	C P E C P D D E	Switch a synchronization mode (Internal/External) and line period for internal mode
6	LC	LED control	C P E C P D D E	Turn On/Off LED, Control a pulse width and illumination mode
7	DC	Dark correction setting	C P E	Generate a dark correction data and apply it
8	WC	White correction setting	C P E C P D D E	Generate a white correction data and apply it.
9	PG	PGA setting	C P E C P D D E	Setting output gain
10	GC	γ correction setting	C P E C P D D E	Set γ characteristics
11	TP	Test pattern setting	C P E	Set a test pattern
12	SR	Software boot	C P E	Initialize operation mode
13	SI	CIS product information	C P E	Load the product type and S/N information
14	DT	Data transfer between memories	C P E	Operate a register and data between memories
15	DA	Data transfer directly to CIS	CPDDE	Direct access to correction memory

C：Command　P：Parameter　D：Data　E：End Code

【Result】
CIS reply to commands during communication.

Table4-2 Reply list

No.	Command	Description	Reply format	Detail
1	BR	Select Baud rate	-	Immediate control, no Reply
2	OF	Select output CLK frequency	R P E	P: frequency setting
3	OC	Select Output format	R P E	P: output format, overlap, interpolation, and etc…
4	RC	Select resolution	R P E	P：Resolution setting
5	SS	Select Synchronization mode	R P E R P D D E	P：Internal synchronization frequency setting
6	LC	LED control	R P E R P D D E	P：illumination condition, division number P：LED illumination frequency setting
7	DC	Dark correction setting	R P E	P：Dark correction generating status, Dark correction On/Off
8	WC	White correction setting	R P E R P D D E	P：White correction generation status, White correction On/Off P：White correction target value
9	PG	PGA setting	R P E R P D D E	P：PGA On/Off P：PGA gain setting
10	GC	γ correction setting	R P E R P D D E	P：γ correction On/Off P：Value of γ correction
11	TP	Test pattern setting	R P E	P：Test pattern output On/Off, pattern
12	SR	Software boot	R P E	P：Control IC boot condition
13	SI	CIS product information	R P E R P D D D E	P：CIS operation mode P：Product information
14	DT	Data transfer between memories	R P E	P：Transfer mode
15	DA	Data transfer directly to CIS	R P E	P：Transfer mode

R：Result P：Parameter D：Data E：End Code

Table4-3 Result list

Value	Result	Description
00	Command sent	Command is successfully entered.
F1	Command error	Entering command not existing.
F2	Parameter error	Entering a parameter not expected.
F3	Address error	Set address not existing
F4	Data error	Error with N of data
FF	Others	Communication error and etc…

4.2 Serial communication rata setting (BR)

【Overview】
Select Serial communication rate (9.6kbps、19.2kbps、115.2kbps) through Camera Link® by this command.

【Initial setting】
9.6kbps

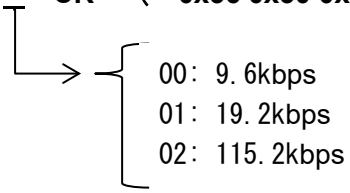
【Setting】
Send following commands through Serial.

Table4-4　Baud rate setting

Command	Parameter (HEX)	mode	Initial setting	Response
BR	00	9.6kbps	○	N/A
	01	19.2kbps		N/A
	02	115.2kbps		N/A
	80	Read status		00/01/02

【Example 1】Select Serial communication rate to 9.6kbps.
Send　：**C　P　E**
　　BR　00　CR　（　0x42 0x52 0x30 0x30 0x0D　）
Reply　：There is no reply, when the command is done successfully.
　　N/A

【Example 2】Read Serial communication rate status.
*If there is mismatch between status of CIS's baud rate and your system's it, CIS can't send correct reply.
Send　：**C　P　E**
　　BR　80　CR　（　0x42 0x52 0x38 0x30 0x0D　）
Reply　：**R　P　E**
　　00　**　CR　（　0x36 0x30 0x 0x** 0x0D　）**



【Detail】
Initial setting is 9.6k bps. Just after sending command above, the communication speed changes immediately.

4.3 Output mode setting

4.3.1 Output clock frequency (OF)

【Overview】

A frequency of image transfer clock of Camera Link® interface is set by this command. The range of image transfer clock frequency is able to select one value from 48MHz to 84MH by 29 steps.

【Initial setting】

84MHz

【Setting】

Send following commands through Serial Communication.

Table4-5 Command of output clock frequency

Command	Parameter (HEX)	Setting	Initial setting	Return value
OF	00	48MHz		00
	01	50.7 MHz		01
	02	51.0 MHz		02
	03	51.4 MHz		03
	04	52.0 MHz		04
	05	52.8 MHz		05
	06	53.3 MHz		06
	07	54.0 MHz		07
	08	54.9 MHz		08
	09	56.0 MHz		09
	0A	57.0 MHz		0A
	0B	57.6 MHz		0B
	0C	58.3 MHz		0C
	0D	60.0 MHz		0D
	0E	61.7 MHz		0E
	0F	52.4 MHz		0F
	10	64.0 MHz		10
	11	65.1 MHz		11
	12	66.0 MHz		12
	13	67.2 MHz		13
	14	68.0 MHz		14
	15	68.6 MHz		15
	16	72.0 MHz		16
	17	76.0 MHz		17
	18	76.8 MHz		18
	19	78.0 MHz		19
	1A	80.0 MHz		1A
	1B	81.6 MHz		1B
	1C	84.0 MHz	○	1C
	80	Read status		00～1C

【Example 1】Set output Clock frequency to 84MHz.

Send : **C P E**
OF 1C CR (0x4F 0x46 0x31 0x43 0x0D)

Reply : **R P E**
00 1C CR (0x30 0x30 0x31 0x43 0x0D)

【Example 2】Read status of Clock frequency.

Send : **C P E**
OF 80 CR (0x4F 0x46 0x38 0x30 0x0D)

Reply : **R P E**
00 ** CR (0x30 0x30 0x 0x** 0x0D)**

→ 00～1C

【Detail】

This function allows you to select pixel clock frequency output from Camera Link®. With the setting, a clock setting of internal digital process also changes.

When an image transfer clock frequency is changed by this command, the internal clock frequency for signal processing is also changed. Thereby if this clock frequency is not fit with scanning condition, the result of scanning is not correct.

The frequency is calculated as following:

$$\frac{Image\ transfer\ clock\ frequency\ (MHz)}{scanning\ line\ frequency\ (kHz)} \gg \text{No. of pixels in 1 channel (kpixel)}$$

4.3.2 Select output format (OC)

【Overview】

This product has several output format and output configuration of Camera Link® as following. Output format is selectable from serial or parallel data output. And output configuration also is selectable from the following.

- 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

Additionally No. of output pixels from every channel of Camera Link® Interface is variable by internal function, real pixel output, Pixel Interpolation, Pixel overlap(64pixels) and output Resolution setting.

Table4-6 Camera Link® output and output mode

Output mode	N of Camera Link® Ch	N of connectors	Data format	Product		
				KD6R309MX, KD6R309MX-NL KD6R309MX-DL	KD6R617MX, KD6R617MX-NL	KD6R926MX, KD6R926MX-NL
Base Configuration	1	1	Serial	22kHz	11kHz	7kHz.
			Parallel	22kHz.	11kHz.	7kHz.
Medium Configuration	1	2	Serial	43kHz.	22kHz.	15kHz.
			Parallel	43kHz.	22kHz.	15kHz.
Medium Configuration	2	4	Serial	—	43kHz.	29kHz.
			Parallel	—	43kHz.	29kHz
Medium Configuration	3	6	Serial	—	—	43kHz
			Parallel	—	—	43kHz

* These line rates are calculated at Output transfer clock frequency 84MHz.

【Initial setting】

10bit Serial Base Configuration

【Setting】

Send command through Serial communication.

Table4-7　Command list of output format

Command	Parameter (HEX)	設定	Initial setting	Return value
OC	00	Output Format : 10bit Serial Base Configuration	○	00
	01	Output Format : 10bit Serial Medium Configuration		01
	02	Output Format : 10bit Serial Medium Configuration2		02
	03	Output Format : 10bit Serial Medium Configuration3		03
	04	Output Format : 10bit Parallel Base Configuration		04
	05	Output Format : 10bit Parallel Medium Configuration		05
	06	Output Format : 10bit Parallel Medium Configuration2		06
	07	Output Format : 10bit Parallel Medium Configuration3		07
	08	Output Format :　8bit Serial Base Configuration		08
	09	Output Format :　8bit Serial Medium Configuration		09
	0A	Output Format :　8bit Serial Medium Configuration2		0A
	0B	Output Format :　8bit Serial Medium Configuration3		0B
	0C	Output Format :　8bit Parallel Base Configuration		0C
	0D	Output Format :　8bit Parallel Medium Configuration		0D
	0E	Output Format :　8bit Parallel Medium Configuration2		0E
	0F	Output Format :　8bit Parallel Medium Configuration3		0F
	20	Overlap Output Off		20
	21	Overlap Output On		21
	40	Interpolation function Off		40
	41	Interpolation function On		41
	80	Output Format information Read-Out		00～0F
	A0	Overlap status Read-Out		00/01
	C0	Interpolation Status Read-Out		00/01

【Ex】　Change output mode to 10bit Serial Medium Configuration.

Send　: **C　P　E**

OC　01　CR　（　0x4F 0x43　0x30 0x31　0x0D　）

Reply　: **R　P　E**

00　01　CR　（　0x30 0x30　0x30 0x41　0x0D　）

【Detail】

An output mode on which image data is transfer to user system via Camera Link® cable is set by this command. Each 3 types of CIS support different output setting.
Followings are explanation.

The configuration of data output is as followings:

Table4-8　Output format list

Output mode	N of Tap	N of Camera Link® Ch	N of connectors	Configuration	KD6R309MX, KD6R309MX-NL KD6R309MX-DL	KD6R617MX, KD6R617MX-NL	KD6R926MX, KD6R926MX-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	×	×	○

*○ : support, × : not support

Table4-9　Base Configuration Pixel Arrangement

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)			
KD6R309MX/MX-NL KD6R309MX-DL	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

Table4-10　Medium Configuration-1 Pixel Arrangement

Model	Output mode	Tap	Output pixel				Output pixel (Interpolation ON)			
KD6R309MX/MX-NL KD6R309MX-DL	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

Table4-11　Medium Configuration-2 Pixel Arrangement

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

Table4-12　Medium Configuration-3 Pixel Arrangement

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

4.3.3 Interpolation (OC)

【Overview】

This function is to place additional pixels to gap between sensor ICs which is generated by mechanical limitation. This product is consisted of plural sensor ICs which is fabricated by CMOS technologies and these ICs are placed to one line with high accuracy.

Each No. of ICs is placed on a substrate for CISs as following.

KD6R309AX2/AX2-NL: 24 ICs
KD6R617AX2/AX2-NL: 48 ICs
KD6R926AX2/AX2-NL: 72 ICs

It is difficult to arrange pixels within 42.3um pitch (600dpi) between ICs. Because ICs are required to have marginal area around active electronic circuits for keeping performance and for dicing a wafer to each piece of IC. These areas have more space than pixel pitch. Thereby the pixel pitch between ICs is designed to be 300dpi. In other word there is one “missing pixel” between ICs.

The mechanical tolerance of pixel pitch between sensor ICs is controlled in less than one 3rd of pixel size (around +/- 15 um).

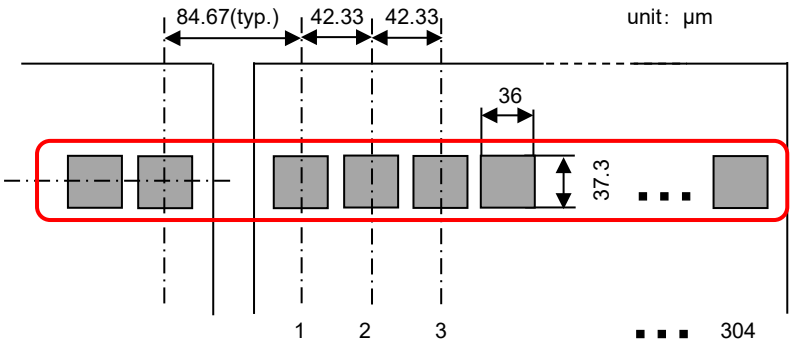


Figure4-1 Image of between ICs

This product has a function by which additional pixels between ICs are generated for interpolating each “missing pixels” from image data of neighboring pixels.

【Initial setting】

Interpolation function: Off

【Setting】

Send the following command through Serial communication.

Table4-13 Command list of interpolation

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
OC	40	Interpolation OFF	N/A	○	40
	41	Interpolation ON	N/A		41
	C0	Read status	N/A		40/41

【例】 Set interpolation ON

Send : **C P E**
OC 41 CR （ 0x4C 0x4D 0x34 0x31 0x0D ）

Reply : **R P E**
O0 41 CR （ 0x30 0x30 0x34 0x31 0x0D ）

【Detail】

The data of interpolation pixel is generated by calculation using the following specified filter. Each data of interpolated pixel is inserted between designated position between sensor ICs, and No. of pixel increases +1 every IC gap.

The filter of interpolation function is as following.

1st neighbor pixel of left side of “missing pixel”: Dl1
2nd neighbor pixel of left side of “missing pixel”: Dl2
3rd–5th neighbor pixel of left side of “missing pixel”: Dl3 – Dl5
1st neighbor pixel of right side of “missing pixel”: Dr1
2nd neighbor pixel of right side of “missing pixel”: Dr2
3rd–5th neighbor pixel of right side of “missing pixel”: Dr3 – Dr5

$$Dx = \frac{k1 \times (Dl1 + Dr1) + k2 \times (Dl2 + Dr2) + k3 \times (Dl3 + Dr3) + k4 \times (Dl4 + Dr4) + k5 \times (Dl5 + Dr5)}{256}$$

Initial setting from factory
k1 = 254
k2 = -208
k3 = 144
k4 = -74
k5 = 12

【Caution】

1) The interpolation function is that additional pixels are created by the estimation from information of neighboring pixels of “missing pixel”. Interpolation data is not real scanning one.

2) In the case of using this function, decide availability to use this function after evaluating the result of scanning target object. (About the detail of setting to clock frequency, refer to chapter 4.3.1)

4.3.4 Overlap (OC)

This function is available only for 617 and 926 size CIS which have 2 or 3 Camera Link® channels.

【Overview】

64 pixels overlap image data are additionally output from front side of adjacent channels and are same as 1st to 64th data of second channel.

This output configuration of CIS is same as a system using plural line cameras. And it is easy to use each channel of CIS as one line camera.

【Initial setting】

Overlap function: OFF

【Setting】

Send the following command through Serial communication.

Table4-14 Command list of overlap

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
OC	20	Overlap: OFF	N/A		20
	21	Overlap: ON	N/A	○	21
	A0	Read status	N/A		20/21

【Ex.】 Set overlap on.

Send : **C P E**
OC 20 CR (0x4F 0x43 0x32 0x30 0x0D)

Reply : **R P E**
00 20 CR (0x30 0x30 0x32 0x30 0x3D)

【Detail】

By turning on the function, the output of first half of the module will contain adjacent channels of second half of the module.

【Caution】

① Overlap image of 64pixels are one scanned at the same timing and the same line of CIS.

② Number of output pixel per channel changes when turning on the function. Please set output clock frequency to read out whole pixel data correctly with your preferable line frequency. (Refer to 4.3.1 for setting of the output clock frequency.)

4.3.5 Select resolution (RC)

【Overview】

This command is for switching output image resolution in 150,300,600 dpi.

Optical resolution fixed in 600dpi. The function changes image resolution by averaging 2/3/4 pixel data of 600dpi through latter part of digital processing. Maximum line frequency is 23 kHz no matter with any image resolution. Switching output image makes compress data volume. (Refer to 4.3.2 for the output mode for maximum line frequency.)

【Initial setting】

600dpi

【Setting】

Send the following command through Serial communication.

Table4-15 Command list of resolution

Command	Parameter(HEX)	Setting	Data	Initial setting	Return value
RC	00	600dpi	N/A	○	00
	01	300dpi	N/A		01
	02	150dpi	N/A		02
	03	75dpi	N/A		03
	80	Read status	N/A		00～03

【例】 Select resolution: 600dpi

Send : **C P E**
RC 00 CR （ 0x52 0x43 0x30 0x30 0x0D ）

Reply : **R P E**
00 00 CR （ 0x30 0x30 0x30 0x30 0x0D ）

【Detail】

The function decrease output data volume by signal processing of CIS.

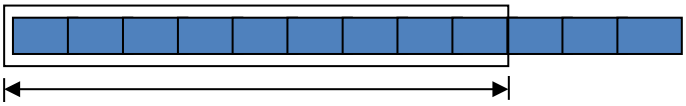
In the case of resolution 75,150,300dpi, the procedures of resolution conversion are as following. Every pixel data after resolution conversion is calculated from the simple arithmetic average of data of adjacent pixels. This procedure is done in the last circuit block of CIS.

In the case of 75dpi, 8 adjacent pixel data is averaged.
In the case of 150dpi, 4 adjacent pixel data is averaged.
In the case of 300dpi, 2 adjacent pixel data is averaged.

Schematic views are shown below.

In the case of 600dpi mode:

In the case of 75dpi mode:



In the case of 150dpi mode:

In the case of 300dpi mode:

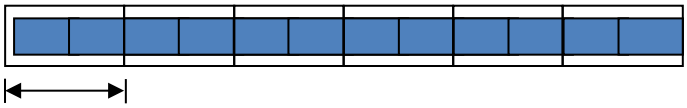


Figure4-2 Schematic views of resolution switching

【Caution】

1) Optical resolution of this product is 600dpi. In the case of lower resolution mode, maximum scanning line rate does not change.
2) CIS might not be able to average 1st pixel and end pixel because it switches image resolution by average pixels.
3) If it is necessary to have square scanning image under lower resolution mode, transfer speed of scanning object have to change to resolution.

75dpi: Transfer speed is 8 times faster than 600dpi
150dpi: Transfer speed is 4 times faster than 600dpi
300dpi: Transfer speed is 2 times faster than 600dpi

4.3.6 Select synchronization mode (SS)

【Overview】

This function is set to synchronize with the signal which is generated internally or is from user system through CC1 line of Camera Link® interface by this command. This product has 2 synchronous modes as following.

1) External mode : the image scanning is synchronized with external signal form CC1 line of Camera Link® interface.

2) Internal mode : the image scanning is synchronized with the signal which is generated in this product itself. A period of internal signal is defined by a command. In the case of internal synchronous mode, image scanning, the generation of internal signal, continues automatically.

* When you select internal mode, you need to set internal counter to define the line period.

【Initial setting】

External synchronization mode

【Setting】

Send following commands through Serial communication.

Table4-16 Command list of synchronization mode

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
SS	00	Internal synchronization	2byte		00
	01	External synchronization	N/A	○	01
	80	Read status	2byte		00/01

【Ex 1】Set internal synchronization, output clock frequency 84MHz, line frequency 88μsec/line.

* When you select internal mode, you need to set internal counter to define the line period (2byte, max FFFFh).

Send : **C P D D E**
SS 00 1C DF CR
(0x53 0x53 0x30 0x30 0x31 0x43 0x44 0x46 0x0D)

Reply : **R P D D E**
00 00 1C DF CR
(0x30 0x30 0x30 0x30 0x31 0x43 0x44 0x46 0x0D)

【Ex 2】Select external synchronization

Send : **C P E**
SS 01 CR
(0x53 0x53 0x30 0x31 0x0D)

Reply : **R P E**
00 00 CR
(0x30 0x30 0x30 0x30 0x0D)

【Ex 3】Read status of synchronization mode

Send : **C P E**
SS 80 CR
(0x53 0x53 0x38 0x30 0x0D)

Reply: In the case of using internal synchronization mode, CIS sends EX1's reply, and in the case of using external synchronization mode, CIS sends EX2's reply.

*There is a different from byte size of CIS's reply from synchronization mode.

【Detail】

In both synchronous modes, a line signal which is generated in a circuit of a Master module and a synchronous signal which is from user's system through Camera Link® Interface are received in a circuit of a Master module through a Master port and are spread to other modules from a Master module directly. Thereby all of modules of a product are operated line-synchronously.

In the internal mode, the line period has to be set for determining scanning condition.

The line period is determined by 2 bytes data and the following formula.

$$\textit{Line period (usec)} = \frac{Register\ Value\ (2\ bytes)}{Image\ transfer\ clock\ frequency\ (MHz)}$$

For example, in the case of register value is 0x1CDF (7,391dec: initial setting) and the image transfer clock frequency is 84MHz,

$$\frac{Register\ Value}{image\ tarnsfer\ clock\ frequency\ (MHz)} = \frac{7{,}392}{84} = \textit{88 (usec): line period}$$

In the external synchronization mode, CIS operates in synchronization with an external signal inputting through Camera Link® Interface. In this case, keep frequency of external signal lower than maximum line rate which is specified on data sheet.
(Maximum line rate: 43 kHz (22μsec/line)

4.4 LED control (LC)

4.4.1 Constitution of illumination and initial setting

【Overview】

MX series control of illuminations which CIS include. And, MX-NL series output the illumination emission synchronization trigger signal externally.

It is not necessary to set the pulse period (width) of illumination after executing this command, caused by this command controlling output circuit of illumination control pulses itself and not changing current

This product has 2 separated LED array illuminations. And each illumination can be turned on/off independently.

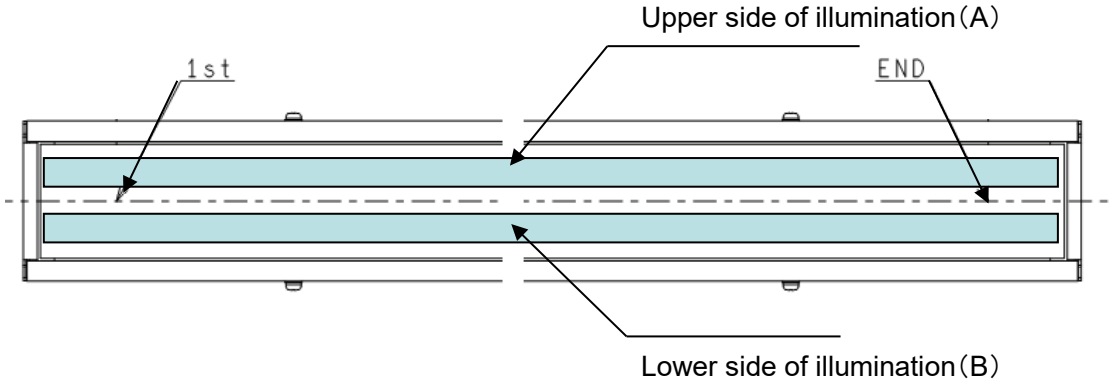


Figure4-3 Layout of illuminations

【Initial setting】

ON/OFF: Both side of illuminations ON

*In the case of external signal mode, illuminations turn on after CIS gets external signal for user system.

Division number: Pulse 2 (KD6R309MX, KD6R617MX, KD6R926MX)

Pulse 1 (KD6R309MX-DL)

LED duty: factory setting

4.4.2 Division of pulse mode

【Overview】

This command is for setting condition of LED control pulse. LED control pulse can be divided 1 to 8 pulses in a line period and total pulse period setting by LEDW is same under all conditions. The period of LED control pulse is fixed by registers LEDW. Therefore if line rate is lower than specified condition, illumination ratio in a line period is lower. And lower duty of pulse may influence scanning images to make some difference with images under normal condition. In such case, the illumination by plural LED control pulses may improve scanning images caused by uniform illumination in a line period.

【Setting】

Send following commands through Serial communication.

*Refer to 4.4.3 for information about the setting of LED duty.

Table4-17 Command list of LED control

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
LC	00	Pulse1：Turn off	N/A		00
	01	Pulse1：Turn on illumination A	N/A		01
	02	Pulse1：Turn on illumination B	N/A		02
	03	Pulse1：Turn on A and B	N/A	●	03
	04	Pulse2：Turn off	N/A		04
	05	Pulse2：Turn on illumination A	N/A		05
	06	Pulse2：Turn on illumination B	N/A		06
	07	Pulse2：Turn on A and B	N/A	○	07
	08	Pulse4：Turn off	N/A		08
	09	Pulse4：Turn on illumination A	N/A		09
	0A	Pulse4：Turn on illumination B	N/A		0A
	0B	Pulse4：Turn on A and B	N/A		0B
	0C	Pulse8：Turn off	N/A		0C
	0D	Pulse8：Turn on illumination A	N/A		0D
	0E	Pulse8：Turn on illumination B	N/A		0E
	0F	Pulse8：Turn on A and B	N/A		0F
	60	Effective LED illumination period setting (LEDT)	2byte		N/A
	80	Read status of division number and ON/OFF	N/A		00～0F
	E0	Read status of the effective LED illumination period setting (LEDT)	2byte		60

○：KD6R309MX、KD6R617MX、KD6R926MX

●：KD6R309MX-DL

【Example 1】Turn on illumination A and B as One Pulse mode

Send : **C P E**
LC 03 CR （ 0x4C 0x43 0x30 0x33 0x0D ）
Reply : **R P E**
00 03 CR （ 0x30 0x30 0x30 0x33 0x0D ）

【Example 2】 Maximum illumination period setting within the line frequency

Send : **C P D D E**
LC 60 01 2C CR
（ 0x4C 0x43 0x36 0x30 0x30 0x31 0x32 0x43 0x0D ）
Reply : **R P D D E**
00 60 01 2C CR
（ 0x30 0x30 0x36 0x30 0x30 0x31 0x32 0x43 0x0D ）

【Detail】

The duty setting work independently from the setting change of the function. Before and after setting the function, you don't need to reset illumination duty.

This function is to illuminate by dividing the valid illumination period (LEDT) into specified no. of equal periods.

The valid illumination period (LEDT) is able to be set in a line period, but maximum period is up to a line period. If LEDT is set longer period than a line, LED control cycle stop and reset at begging of the next line cycle.

Every LED control pulse period is equal to divide LEDW into specified equal parts for each side of illuminations (A side and B side).

Therefore total pulse period is followings

$$\textit{Total LED pulse period} = \sum_{n=1}^{No.of\ division} (Pulse\ period(n))$$

However, the illumination period is different from LED pulse period setting caused by the switching delay which LED driver circuits make illuminations turn-on and turn-off. In the case of plural pulse mode, illumination intensity is weaker than one pulse mode even under same setting of LED pulse period.
Please consider pulse switching delay and adjust pulse period each for pulse mode.

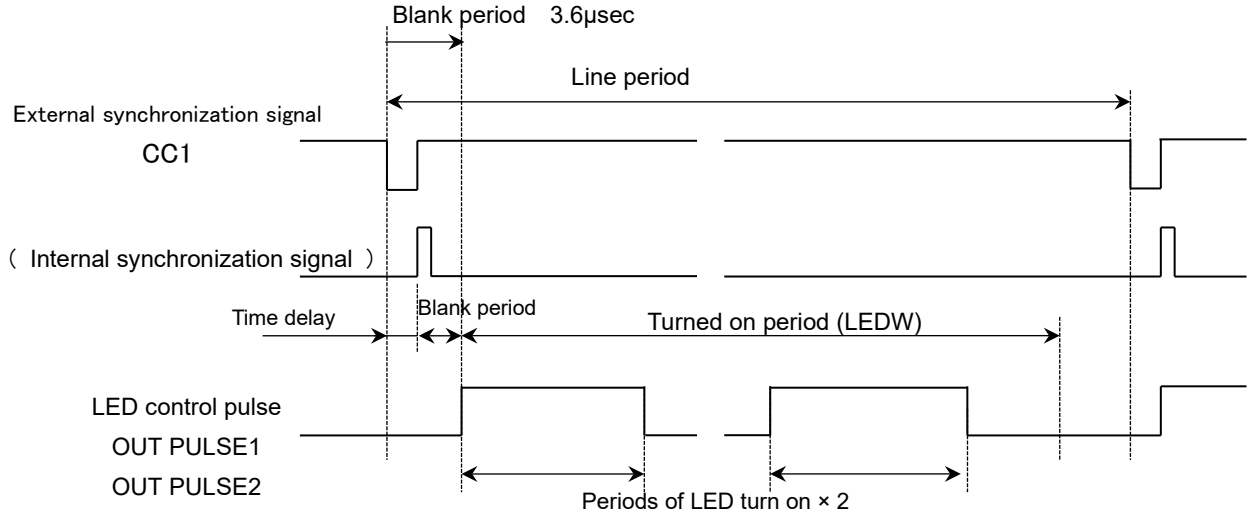


Figure4-4 Timing diagram of Pulse2 mode

4.4.3 LED duty

【Overview】

The illumination intensity is adjusted by changing the LED illumination pulse width of the lighting signal (LEDW).

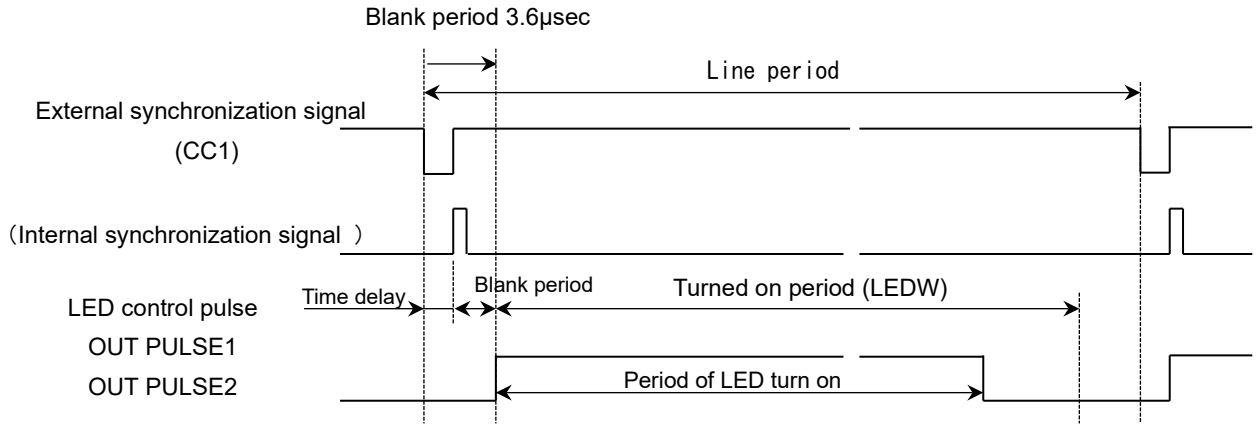


Figure4-5 Timing diagram of Pulse1 mode

【Initial setting】

Factory setting 15us(KD6R309MX、KD6R617MX、KD6R926MX)
9us(KD6R309MX-DL)

【Setting】

Send following commands through Serial communication.

Table4-18 Command list of LED duty setting

Command	Parameter (HEX)	Setting	Data	Initial setting		Return value
				KD6R309MX KD6R617MX KD6R926MX	KD6R309MX-DL	
LC	20	Illumination A pulse width (LEDW)	2byte	0x00F0	0x0090	20
	40	Illumination B pulse width (LEDW)	2byte	0x00F0	0x0090	40
	A0	Illumination A pulse width read-out	2byte			20
	C0	Illumination B pulse width read-out	2byte			40

【Example 1】 Illumination pulse width 37.5μsec

Send : **C P D D E**
LC 20 02 58 CR
（ 0x4C 0x43 0x32 0x30 0x30 0x32 0x35 0x38 0x0D ）

Reply : **R P D D E**
00 20 02 58 CR
（ 0x30 0x30 0x32 0x30 0x30 0x32 0x35 0x38 0x0D ）

【Detail】

This sets duration of the illumination. By turning on the Division of pulse mode, a pulse becomes the duration of illumination divided by number of pulse. （Refer to 4.4.2 for Division of pulse mode）Base unit for Illumination duration is 16MHz. It is fixed based on the clock of internal signal processing IC. You are able to set longer period than one in chapter 4.4.1. The period exceeds effective illumination is not valid.

$$\text{LED control pulse (μsec)} = \frac{register\ value\ (LEDW)}{16}$$

【Caution】

The period setting on register is different from LED turn-on period. Because LED switching circuit has switching delay for rising up or falling down of pulse signal.

When you increase number of pulse, light intensity gets darker due to accumulation of delayed pulse. On the illumination adjustment procedure, please consider these switching delay and set register values in registers LEDW.

If you would like to know how much delay each pulse has, please request data to us. Please choose whether divide pulse or not by evaluation of actual images.

4.5 Data correction functions

On this chapter, 4 types of correction function are shown. They are the functions for improving image quality of scanning data. (Dark correction, White correction, Programmable Gain Amplifier, γ correction)

4.5.1 Dark correction (DC)

【Overview】

This product is equipped with CMOS sensor ICs. Each pixel of CMOS sensor has different value of DC offset. This function reduces the difference in DC offset by subtracting data which are acquired under illuminations turned off and stored in line memories from scanning data pixel by pixel.

The product shipped from the factory has initial Dark correction data in factory setting memory and this function is enable just by sending a command.

It is able to generate new Black correction data and use new one.

【Initial setting】

Dark correction: OFF

【Setting】

Send following commands through Serial communication.

Table4-19 Command list of Dark correction

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
DC	00	Black correction OFF	N/A	○	00
	01	Black correction ON	N/A		01
	21	generate new correction data	N/A		
	80	Read status ON/OFF	N/A		00/01
	A0	Read status of data generation 0: finish to generate 1: under generation	N/A		00/01

【例】 Set Dark correction: on

Send : **C P E**
DC 01 CR
（ 0x44 0x43 0x30 0x31 0x0D ）

Reply : **R P E**
00 01 CR
（ 0x30 0x30 0x30 0x31 0x0D ）

【Detail】
This product is equipped with CMOS sensor ICs. Each pixel of CMOS sensor has different value of DC offset. The outputs of sensor ICs are a signal response from incident light the added DC offset. For the purpose, in the case of not to use Dark correction, DC offset is not removed, and output data has fixed pattern noise.
This is a function to remove DC offset from data output on each pixel of sensor IC and to makes data including only signal which varies in response to intensity of illumination.
Dark correction is done by calculated based on 12bit data.

1) Operation of Dark correction function and 2) the procedure of generating new Dark correction data generation are explained as below.

1) Operation of Dark correction function
This command is for switching Dark correction function between turned-on and off.
Send following commands of Dark correction through Serial communication.

The procedure of Black correction is as following.

Dark correction data on each pixel	DVd0(n)
Scanning data	DVp(n)
Data after Dark correction	DVp'(n)

$$DVp'(n) = DVp(n) - DVd0(n)$$

"n" means n-th pixel of image data

DVd0(n) means image data of n-th pixel which is captured under illumination turned-off and the DC offset as above.

2) The procedure of generating new Dark correction data
The procedure of generating new Dark correction data is easy to start by a command (DC 21h CR) through Serial communication.
New Dark correction data is generated by simple arithmetic average of 32 line sampling on each pixel and automatically stored in the operation registers of ASIC. During generation of Dark correction data, the data output from CIS are invalid. The progress of the data generation process is checked by Serial communication.
If it is necessary to keep new black correction data after CIS is turned off, a data block transfer command (DT) by which the data are stored in one of User setting memories is required.

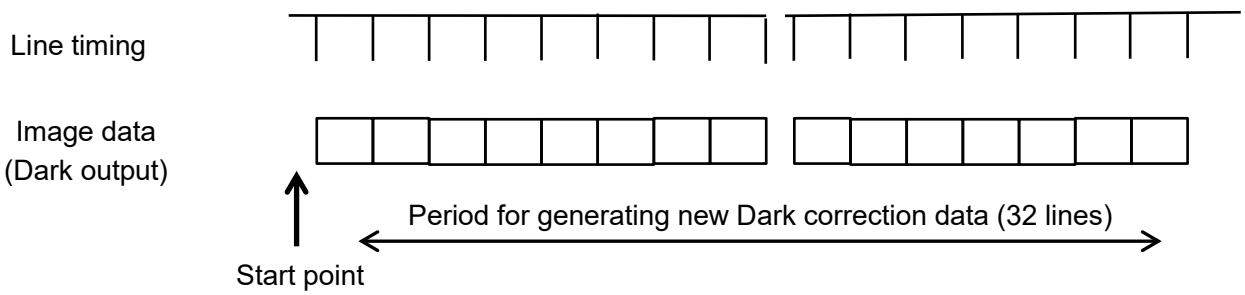


Figure4-6 Conceptual diagram of making new Dark correction data

The following calculation is done for generating new data.

Image data from n-th pixel and m-th scan line	Vdm(n)
Black correction data of n-th pixel	Vd0(n)

$$\mathbf{Vd0(n)} = \frac{\sum_{m=1}^{32} Vdm(n)}{32}$$

【Caution】

1) The product shipped from the factory has initial Dark correction data in factory setting memory and this function is enable just by sending a command.
2) Dark output level varies by ambient temperature and line scan rate. To Re-generate new black correction data every when CIS re-starts is strongly recommended.
3) There are some possibilities to find fixed stripe pattern in scanning images, if the black correction data is not fit to CIS.
4) When new white correction data is generated, black correction function must be turned on.

4.5.2 White correction (WC)

【Overview】

Image sensors have variation of image output caused from variation of sensitivity on each pixel and Inhomogeneity of the illumination. These variations of image output make scanning images lower quality and capture images with fixed stripe pattern.

This product has white correction function for capturing homogeneous and high quality images. White correction is the function by which all of pixels output same data when CIS scans a reference paper with uniform reflective ratio.

The product shipped from the factory has initial White correction data in factory setting memory and this function is enable just by sending a command.

It is able to generate new White correction data and use new one.

【Initial setting】

White correction: OFF

【Setting】

Send the following command through Serial communication.

Table4-20 Command list of White correction

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
WC	00	White correction function Off	N/A	○	00
	01	White correction function On	N/A		01
	21	generate new correction data	N/A		21
	22	Stop external triggered generation	N/A		22
	23	Start external triggered generation	N/A		23
	40	Set target value for white correction	2Byte		40
	60	Start Normal data generation mode	N/A		60
	61	External triggered mode setting	N/A		61
	80	Read status	N/A		00/01
	A0	Read status of data generation 0: finish to generate 1: under generation 2:end of external trigger mode 3: under generation on EX mode	N/A		00～03
	C0	Read the values of white target	2Byte		
	E0	Read white correction mode	N/A		00/01

【例】 Set White correction: ON

Send : **C P E**
WC 01 CR
（ 0x57 0x43 0x30 0x31 0x0D ）

Reply : **R P E**
00 01 CR
（ 0x30 0x30 0x30 0x31 0x0D ）

【Detail】

This function is for correcting variations of CIS output caused by variation of sensitivity of each photo-diode on sensor ICs and inhomogeneity of illuminations.

This correction is to calculate image output from all pixels to same target value when CIS scans a uniform white paper (reference paper). The calculation is done by 12bit width data on each pixel.

[How to generate new white correction data]

New White correction data is easily and automatically generated by a command when a white reference paper is scanned.

$$DVp'(n) = \frac{WHITE\_TARGET}{DVp0(n)} \times DVp(n)$$

$DVp'(n)$	:	n-th image data in a scanning line after white correction
$DVp(n)$	:	n-th image data in a scanning line after white correction
$DVp0(n)$	:	n-th white correction data
$WHITE\_TARGET$	:	target output value (set by register)

“WHITE_TARGET” is output value from cis after white correction when CIS scan a uniform white paper (reference paper) and it is set 0x0FA0 (4,000dec) as an initial setting (Factory setting).

[How to generate new white correction data]

New White correction data is easily and automatically generated by a command when a white reference paper is scanned. The procedure of generating white correction data is as following flow chart. (Please refer chap. 4.5.1 about Black correction)

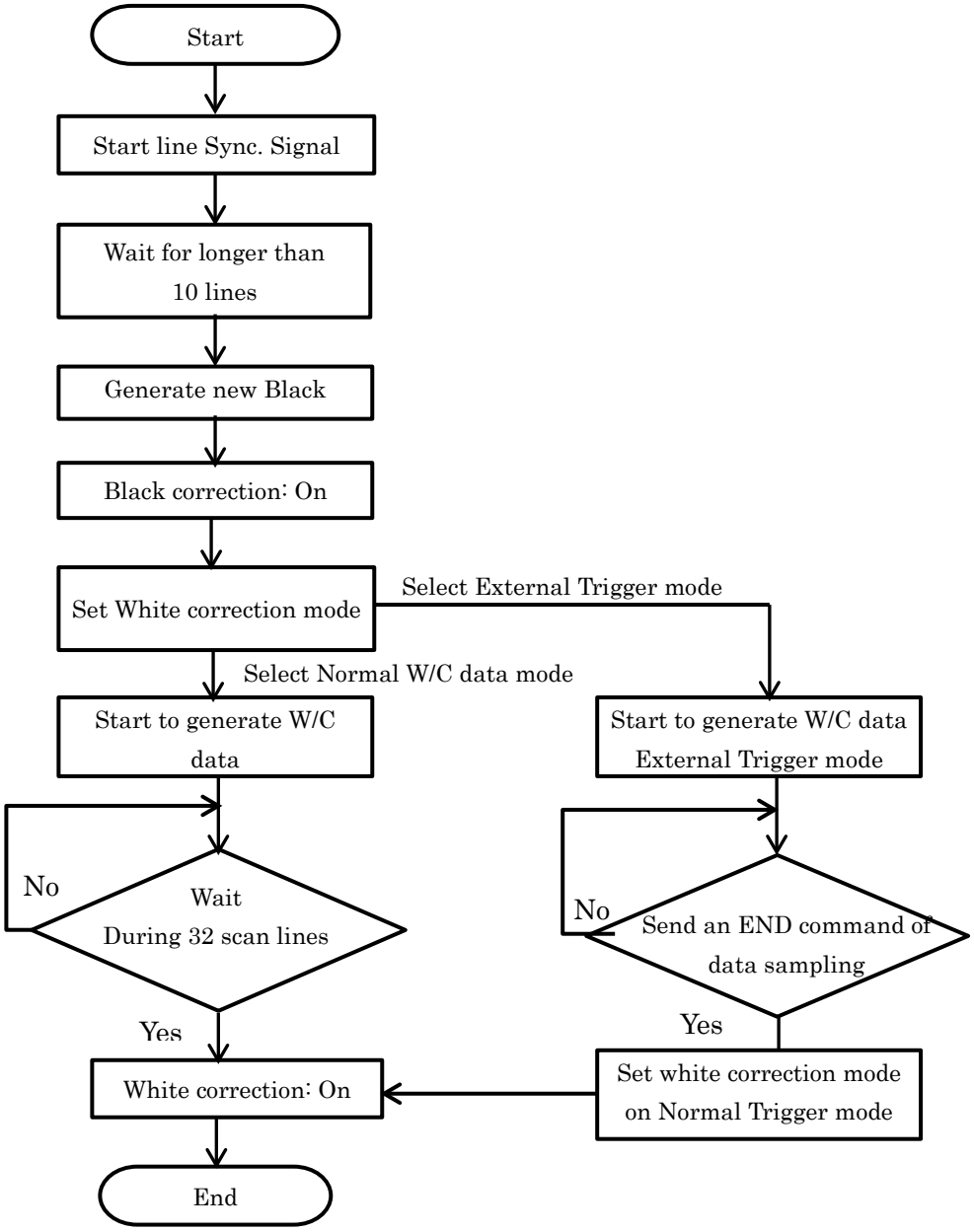


Figure4-7 Flow chart for generating new white correction data

【Caution】

1) It is necessary to generate new white correction data under stable scanning operation.
2) In the case of External synchronous mode, start to generate new correction data after waiting longer than stable 10 scanning cycles. Because internal circuits of CIS are refreshed only by every line synchronous signal.

[Normal Trigger mode]

New white correction data are generated by one command on this mode.

New White correction data is generated by the following operation during scanning a reference white paper which is homogeneous and has uniform reflection ratio.

1) Send a following command and start the sequence for white correction data generation.
   WC 21Hex CR (ASCII code: 57 43 32 21 0D)
2) This sequence finish automatically after waiting 32 scanning lines and new White correction data is transferred to and stored in Operation registers for white correction.

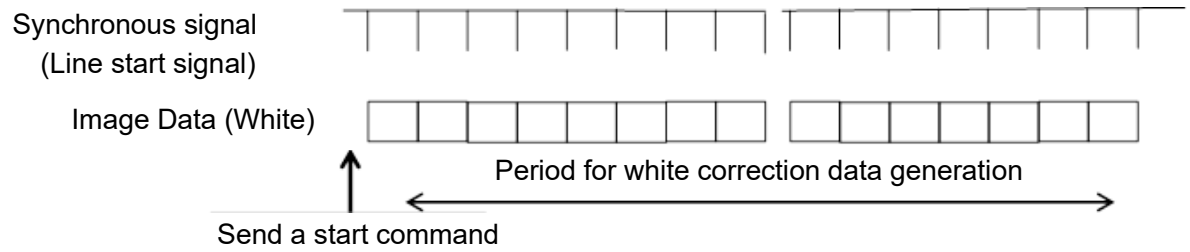


Figure4-8 Sequence for white correction data generation

New white correction data is generated by the following equation.

$Vpm(n)$: n-th image data in m-th scanning line

$Vp0(n)$: n-th white correction data

$$\mathbf{Vp0(n)} = \frac{\sum_{m=1}^{32} Vpm(n)}{32}$$

[External Trigger mode]

The generation of New White correction data starts by a command “Start External Triggered generation”.

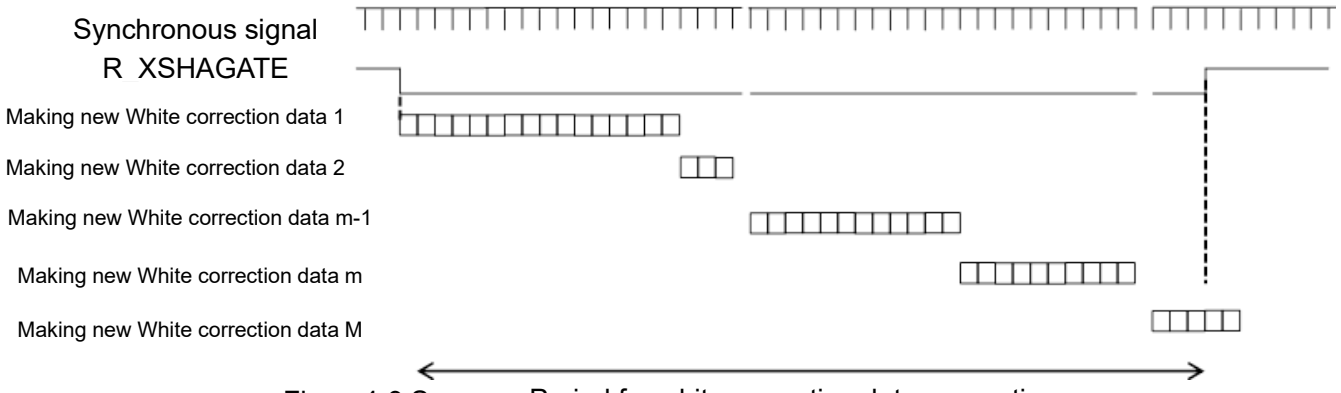


Figure4-9 Seque

After starting the sequence, White correction data are generated at every 32 scanning lines same as Normal mode and stored temporal line memory. This data is compared with the data from the next sequence by every pixel and bigger data at every pixel is stored in temporal memory instead of old one. This sequence is continued until sending “End” command.
The product just after receiving “End” command, the sequence is terminated, the data form the unfinished sequence is ignored, only a data form the completed sequence is automatically stored in Operation registers for white correction.

New White correction data is generated by the following equation.

M	:	total Number of Sequence by 32 scanning lines
m	:	sequence number
Vp0(n)m	:	white correction data at n-th pixel of m-th sequence

$$Vp0(n) = \max_{M} Vp0(n)m$$

White collection value for each pixel is the maximum value in collection data per each 32lines.

【Caution】

1) Initial data which is generated in Factory is stored in Flash memory as Factory setting.
   White correction function can be available only by ON/OFF operation.
2) White and dark data from CIS change by operation temperature and scanning line rate. Therefore, re-generate white correction data and dark correction data at suitable timing.
3) In the case of generating white correction data, turn on Dark correction at first and start to generate new white correction data by scanning white reference paper with uniform reflection ratio.
4) Image output is not correct like with fixed stripe noise, if white correction data is generated incorrectly, in the case of putting some dusts or stains on white reference paper or surface glass.
5) It is effective to generate good white correction data by moving white reference paper on transport direction, when white correction data is generated on the external triggered mode. But in the case of dust having higher reflection ratio than reference paper, correction error becomes bigger.

4.5.3 PGA: Programmable Gain Amplifier (PG)

【Overview】

This function is for multiplying a designated gain (0 - 4) to scanning image data for all of pixels in a line.

This function is useful to correct signal valuation by temperature change and decreasing light power of illuminations.

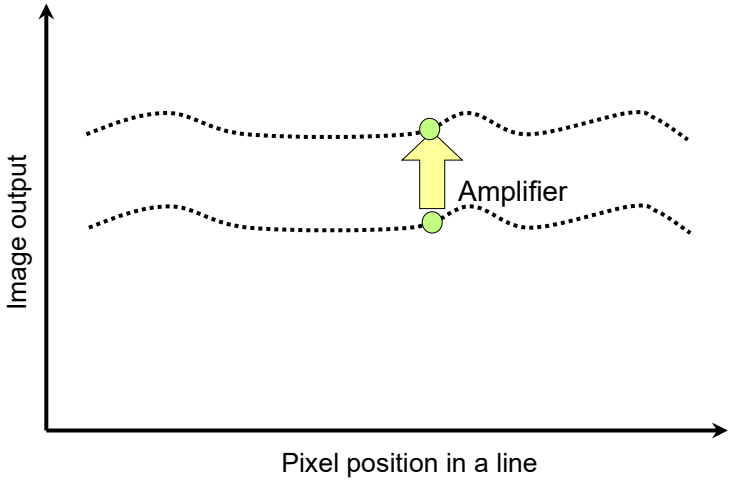


Figure4-10 Concept of PGA

【Initial setting】

PGA gain: 1.0

【Setting】

Send the following command through Serial communication.

Table4-21 Command list of PGA

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
PG	00	PGA OFF	N/A	○	
	01	PGA ON	N/A		
	20	PGA Gain setting Pos. value	2Byte		
	21	PGA Gain Setting Neg. Value	2Byte		
	80	PGA Status Read	N/A		00/01
	A0	PGA Gain Value read	2Byte		00/01

【Example 1】 PGA function: ON

Send : **C P E**
PG 01 CR
(0x50 0x47 0x30 0x31 0x0D)

Reply : **R P E**
00 01 CR
(0x30 0x30 0x30 0x31 0x0D)

【Detail】
A gain value set to PGA register is applied for data of all pixels in a line.
Image output is calculated on PGA function as a following formula.

$$Image\ data\ after\ PGA\ = \frac{1024 + PGA\ Register\ Value}{1024} \times Image\ data\ before\ PGA$$

PGA gain
Main registers of gain setting are composed of 13 bit. This value is applied for all pixel data.
13bit MSB describes +/- sign. The latter 12bit is a setting value.
Main registers of gain setting are composed of 12 bit.
The range of register value is available from 0 to 3071 for Positive sign.
The range of register value is available from 0 to 1027 for Negative sign.
If a value which is out of range is set. Gain calculation is performed as each maximum value instead of setting value.

【Caution】
This function is for Digital gain setting.
Thereby if big gain is set to PGA, there is a possibility for the precision of digital Image to be declined.
Validate the change of image quality by PGA.

4.5.4 γ correction (GC)

【Overview】

This function adjusts the linearity property of Image input and output. This function makes scanning images with suitable grayscale for any image products. Data is operated 10bit width for input and the 10bit width for output.

γ property: This means the relationship between input data and output data of images. It's called grayscale property or Output linearity too.

【Initial setting】

γ correction: OFF

【Setting】

Send the following command through Serial communication.

Table4-22 Command list of γ correction

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
GC	00	γ correction: OFF		○	00
	01	γ correction: ON			01
	20	Base data of γ tabel-1	2byte		
	21	Base data of γ tabel-2	2byte		
	22	Base data of γ tabel-3	2byte		
	80	γ correction status read			00/01
	A0	Read Base data of γ tabel-1	2byte		00
	A1	Read Base data of γ tabel-2	2byte		01
	A2	Read Base data of γ tabel-3	2byte		02

【Example 1】 γ correction: ON

Send : **C P E**
GC 01 CR
（ 0x47 0x43 0x30 0x31 0x0D ）

Reply : **R P E**
00 01 CR
（ 0x30 0x30 0x30 0x31 0x0D ）

【Detail】

Image signal with 10bit width is output after doing γ correction to input data with 10-bit width.

The γ correction data is stored in 1,024 addressed memory table which is composed from 4 blocks which has 256 addresses and 3 threshold values. Upper 2 bits of output data indicates each block number and lower 8bits of data are related with input data in a block.

The input image data is compared to three γ table thresholds determined by registers. This determines the block of the allocation gamma table (LUT). The lower 8 bits of the input data and the lookup table of 256 addresses are used to determine the lower 8 bits of the image data in the corresponding γ table (LUT) block, and the γ corrected image data is output. (Refer to Figure4-11)

The process of γ correction is as following.

* Each input data is compared with 3 threshold values defined by registers

* A table is selected from 4 tables according to this comparison result.

γ table -1	0x0000	LUT address	0x1100 – 0x11FF
γ table -2set	by registers	LUT address	0x1200 – 0x12FF
γ table -3set	by registers	LUT address	0x1300 – 0x13FF
γ table -4set	by registers	LUT address	0x1400 – 0x14FF

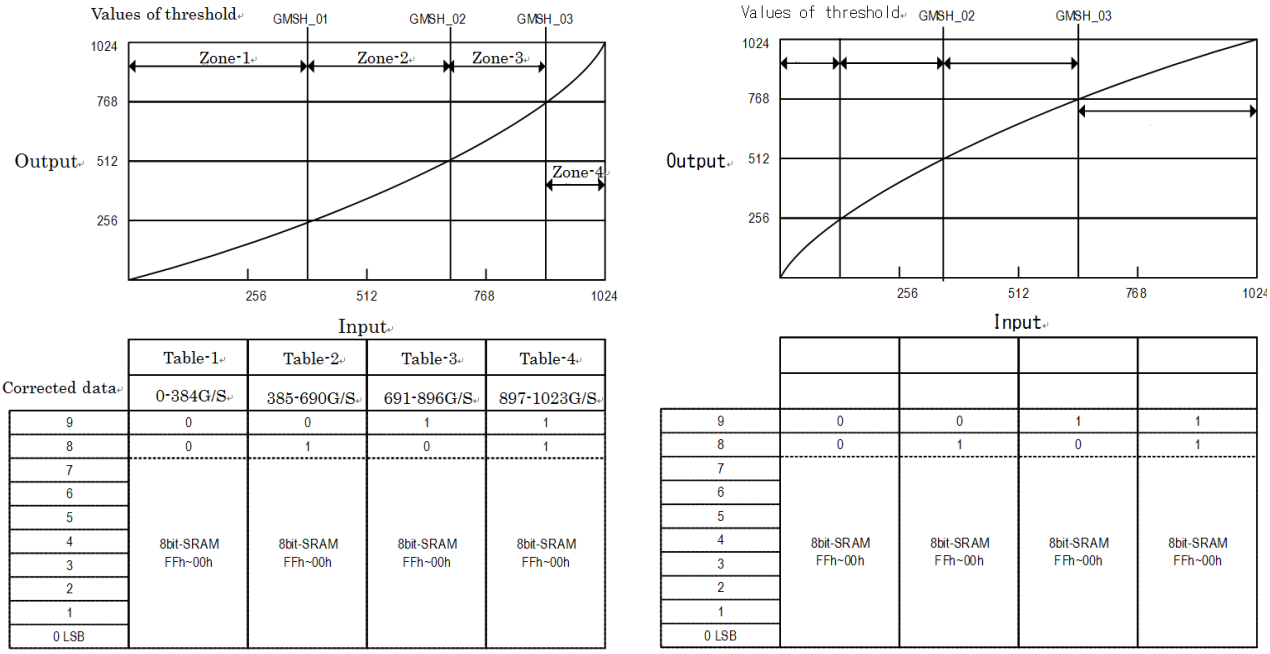


Figure4-11　γ table and address map

【Caution】

1) When γ correction function is off, there is no influence to image data by γ table.
2) As for γ-table setting, only simple increase is possible.

4.6 Other convenient functions

In this chapter, functions except for image adjustments are explained. For example, using to operating check.

4.6.1 Test pattern generator (TP)

【Overview】

This function is to change normal image output to pattern outputs. 2 test patterns, stripe and Ramp signal, are selectable on this function. It will be easily to check data communication line.

【Initial setting】

Test pattern function: OFF

【Setting】

Send the following command through Serial communication.

Table4-23 Command list of test pattern

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
TP	00	Image output	N/A	○	00
	01	Test pattern output	N/A		01
	20	Stripe pattern output	N/A		20
	21	Ramp pattern Output	N/A		21
	22	Read Status	N/A		00/01
	80	Image output	N/A		00/01

【Example 1】Test pattern: ON

Send : **C P E**
TP 01 CR
（ 0x54 0x50 0x30 0x31 0x0D ）

Reply : **R P E**
00 01 CR
（ 0x30 0x30 0x30 0x31 0x0D ）

【Detail】

Test pattern data is generated by digital circuit in CIS and is outputted by changing signals from scanning image output. Pattern output of this function is repeated at every 304 pixels.

It is usable to check about image transfer system, for example, Camera Link® connection, Signal timing and noise.

Refer test pattern as the following.

【Stripe pattern】

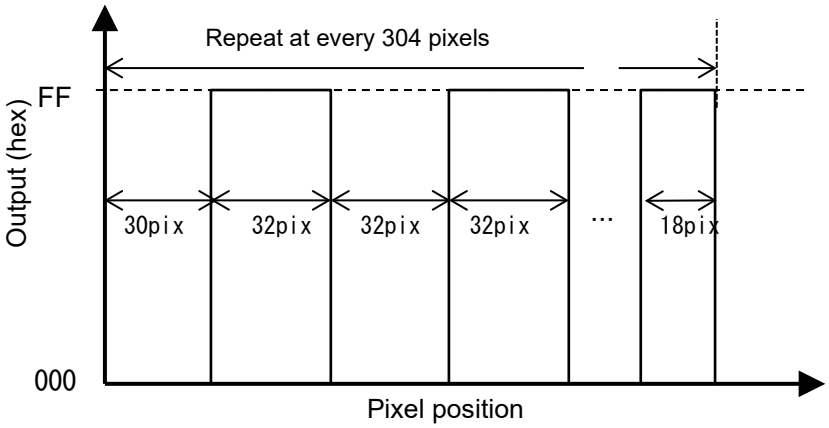


Figure4-12 Stripe pattern (8bit)

【Ramp pattern】

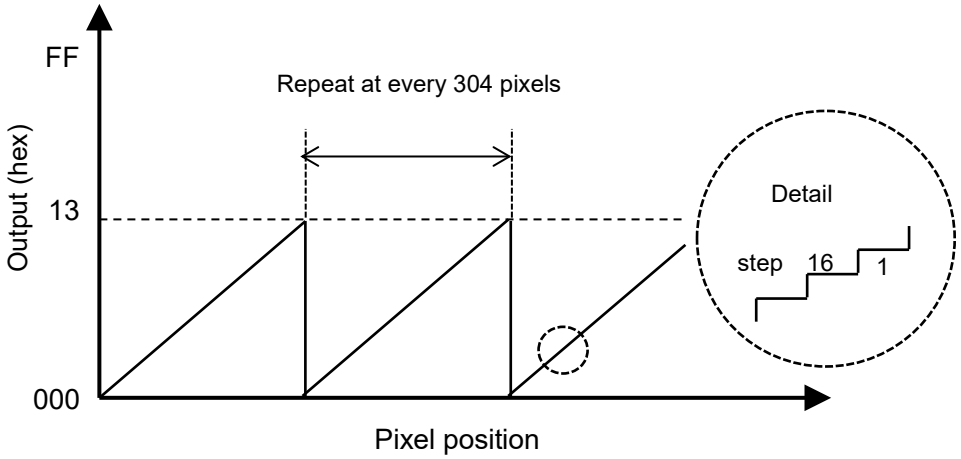


Figure4-13 Ramp pattern (8bit)

【Caution】

During this function operating, CIS outputs only a designated test pattern and Scanning image never output.
Use this function for evaluation of Data sampling timing and noise from data lines.

4.6.2 Software reset (SR)

【Overview】
Software reset for CIS is available by this command.
After this command, CIS internal controls ICs start to operate on the factory setting.

【Initial setting】
Not available

【Setting】
Send the following command through Serial communication.

Table4-24 Command list of software reset

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
SR	01	FPGA software reset	N/A		
	21	ASIC software reset	N/A		
	80	FPGA Boot status read	N/A		00/01*1
	A0	ASIC Boot status read	N/A		00/01*1

*1 00 : under booting 01 finish operation

【Example 1】FPGA software reset: run
Send : **C P E**
SR 01 CR
(0x53 0x52 0x30 0x31 0x0D)
Reply : **R P E**
00 01 CR
(0x30 0x30 0x30 0x31 0x0D)

【Detail】
This function is to initialize CIS and has 2 commands for initialization.

Table4-25 Function list for initialization

Function	FPGA	ASIC
CLK frequency	×	○
Output Configuration	○	×
Resolution	○	×
Sync. mode	○	×
Black correction	×	○
LED illumination setting	×	○
White correction	×	○
PGA	×	○
Pixel Interpolation	○	×
γ correction	○	×

The function setting of CIS returns to a factory setting by software Boot operation.

Please send 2 lines commands as following for initializing all functions.
* It is necessary to wait to send a command on 2nd line after 600msec from sending a command on 1st line.

SR 21 CR : initialize ASIC registers
SR 01 CR : initialize FPGA registers

It needs 10 seconds at least to get new images after sending software boot commands. It needs time to write data of factory setting to the registers of CIS.

【Caution】
Because all values of registers is replaced to data of factory setting, please store the values of registers before software boot operation as needed in one of user setting memory. (Refer from chapter 4.7.1)

4.6.3 Read out the product information

【Overview】
This function is for reading out function modes and product information of CIS.

【Initial setting】
N/A (Product No., year and month of production and serial No. are stored in CIS)

【Setting】
Send the following command through Serial communication.

Table4-26 Command list of read out the product information

Command	Parameter (HEX)	Setting	Data	Initial setting	Return value
SI	A0	Read-out function mode	N/A		00～03
	C0	Read-out product information	N/A		5byte

【Example 1】Read out function mode (In the case of CIS is operated on factory setting)
(Please refer Detail information 1)

Send : **C P E**
SI A0 CR
(0x53 0x49 0x41 0x30 0x0D)
Reply : **R P E**
00 00 CR
(0x30 0x30 0x30 0x30 0x0D)

【Example 2】Read out the product information. (Please refer Detail information 2)

Send : **C P E**
SI C0 CR
(0x53 0x49 0x43 0x30 0x0D)
Reply : **R P D D D D D E**
00 C0 01 23 07 07 15 CR
(0x30 0x30 0x43 0x30 0x30 0x31 0x32 0x33 0x30 0x37 0x30 0x37 0x31 0x35 0x0D)

【Detail】
By this function the function mode and product identified information are read out.

1) Read out the function mode
Operation status of CIS is read out by this command.
CIS replies an operation status as “00 00(01/02/03) CR”.
Each value of reply means as following.
00 : Factory setting mode
01 : User setting mode-1
02 : User setting mode-2
03 : User setting mode-3

2) Read out product identified information

Unique information of product to be given when this product was shipped from the factory is read out by this command. Unique information of product is serial No, product name, month and year of shipping.

Replies are as the following format.

00 C0 01 23 07 07 15 CR

(as ASCII cord, **0x30 0x30 0x43 0x30 0x30 0x31 0x32 0x33 0x30 0x37 0x30 0x37 0x31 0x35 0x0D**)

Means of data part are as following.

4 bytes	ASCII code	:	product serial No. read out from Upper to lower numbers.
2btyes	ASCII code	:	Product type
2bytes	ASCII code	:	year of shipping
2bytes	ASCII code	:	month of shipping

In the case of above example, data part is "**0x30 0x31 0x32 0x33 0x30 0x37 0x30 0x37 0x31 0x35**" and becomes "0 1 2 3 0 7 0 7 1 5" by translating this code to hexadecimal notation.

Product serial No.	0123	
Product type	07	: KD6R309MX (refer the following table4-27)
Month of shipping	07	: July
Year of shipping	15	: 2015

Unique information of this product has meaning as following.

Table4-27 List of product type

Product type	Product name	Note
01	KD6R309AX2	Color CIS for Web inspection （KD-AX2 series, not this product.）
02	KD6R617AX2	
03	KD6R926AX2	
04	KD6R309AX2-NL	
05	KD6R617AX2-NL	
06	KD6R926AX2-NL	
07	KD6R309MX	Monochrome CIS for Web inspection with illuminations (KD-MX series)
08	KD6R617MX	
09	KD6R926MX	
10	KD6R309MX-NL	Monochrome CIS for Web inspection without illuminations (KD-MX-NL series)
11	KD6R617MX-NL	
12	KD6R926MX-NL	
57	KD6R309MX-DL	Monochrome CIS for Web inspection with illuminations (KD-MX series) Products for low exposure

4.7 Direct memory control

4.7.1 Data transfer control between Operation setting memory and Operation register (DT)

【Overview】

To transfer whole data between one of Operation setting memory and Operation registers is possible by DT command. This command is useful to transfer whole data of operation registers which is changed to one of User setting memories and to change operation setting.

All setting data are transferred between Operation setting memory (User setting 1/2/3) and Operation registers including in black/white correction data and γ correction data.

This command is used when a user setting which CIS is operated is switched to another user setting or register data which user makes in original condition copy to a user setting memory.

But it is not possible to transfer data from Operation registers to factory setting memory.

【Setting】

Send the following command through Serial communication.

Table4-28 Command list of setting data transfer

Command	Parameter (HEX)	Setting	Return	Factory protect
DT	00	Operation setting memory(Factory setting) => Operation Registers	00	
	01	Operation setting memory(User setting1) => Operation Registers	01	
	02	Operation setting memory(User setting2) => Operation Registers	02	
	03	Operation setting memory(User setting3) => Operation Registers	03	
	80	Operation Registers => Operation setting memory(Factory setting)	80	○*1
	81	Operation Registers => Operation setting memory(User setting1)	81	
	82	Operation Registers => Operation setting memory(User setting2)	82	
	83	Operation Registers => Operation setting memory(User setting3)	83	

*1 to write to a part of “Factory setting” in Flash Memory is impossible.

【Example 1】Transfer data of User setting1 to Operation registers.

Send : **C P E**
DT 01 CR
(0x44 0x54 0x30 0x31 0x0D)

Reply : **R P E**
00 01 CR
(0x30 0x30 0x30 0x31 0x0D)

【Detail】

This function is for transferring a whole of setting data for CIS operation between Operation setting memory and Operation registers. By inputting this command, the procedure for read and write between memory and registers in CIS is automatically executed through a microprocessor.

The period for transferring data between Operation setting memory and Operation registers is as following.

1) Operation setting memory (Factory setting) => Operation Registers **5 seconds**
2) Operation Registers => Operation setting memory (Factory setting) **8 seconds**

【Caution】

1) After sending this command, do not send another command until the procedure finish.
2) Image data from CIS is not guaranteed during executing this operation. And in the case of changing Camera Link® setting, especially Output configuration and mode, confirm User's system condition and send the command.
3) Image data from CIS on user setting is not guaranteed.
4) Do not turn off power supply during executing this operation.
5) When this cis is shipped from factory, any setting data is not stored in User setting memory 1/2/3. Use a User setting after stored any setting data
6) The follow charts for setting User memory are shown as following.

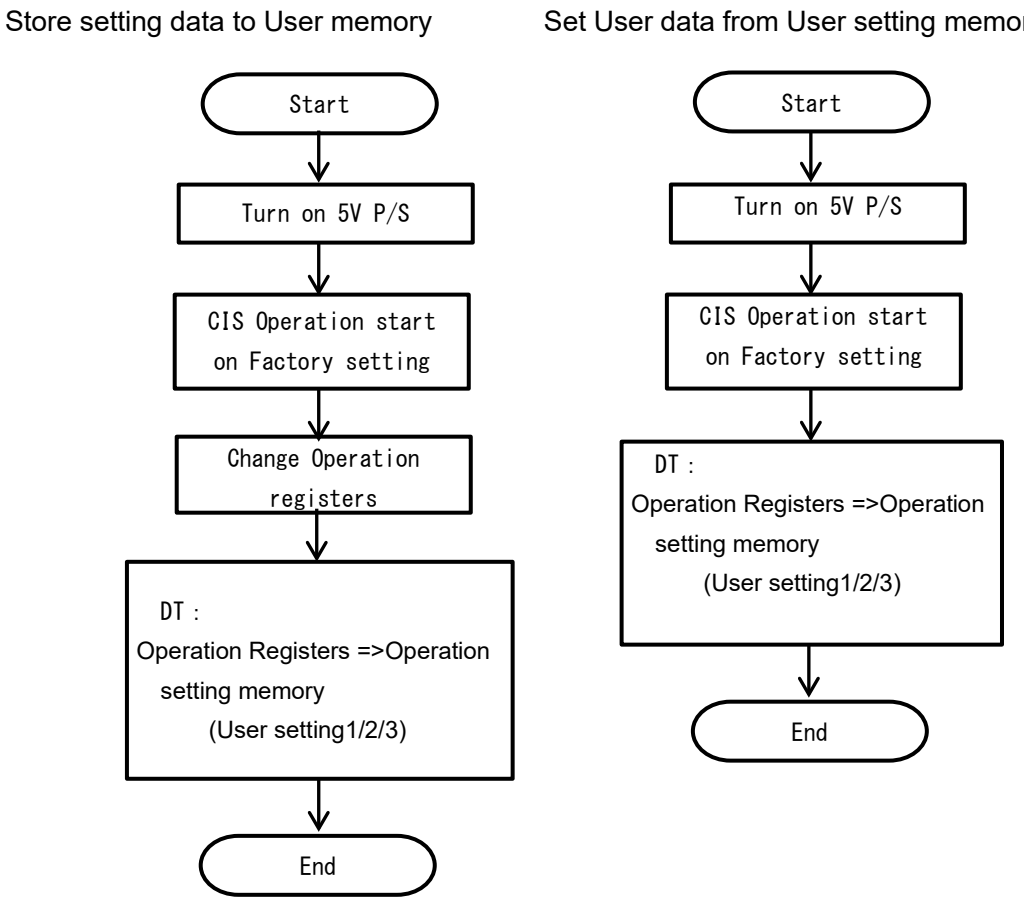


Figure4-14 Flow chart for memory setting

4.7.2 Direct memory access to Operation registers and Operation setting memory (DA)

【Overview】

This command is for reading and writing a byte data or data on continuous address from/to designated address by Serial communication. But there is the limitation for memory area to read and write.

【Setting】

All data in registers and memory can be read by “read” command of DA. But there is limitation to write data to registers and memory by “write” command of DA.

Please set operation registers before Write through transfer command from the operation register to DA.

Table4-29 Memory and register MAP

ADDRESS		Setting Mode	Content	Read/Write
Upper	Lower			
00	0000	Factory setting (Read Only)	Base setting & product Information	Read only protected
	0FFF			
	1000		Registers for CIS Operation	
	70FF			
	7100		γ correction table	
	74FF			
	7500		Not to use	
	FFFF			
01	0000		Black correction table	
	AAFF			
	AB00		Not to use	
	FFFF			
02	0000		White correction table	
	AAFF			
	AB00		Not to use	
	FFFF			
03	0000	User setting1	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only
	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
04	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
05	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
06	0000	User setting2	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only

	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
07	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
08	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
09	0000	User setting3	Not to use	×
	0FFF			
	1000		Registers for CIS Operation	Read only
	70FF			
	7100		γ correction table	Read/Write
	74FF			
	7500		Not to use	×
	FFFF			
0A	0000		Black correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			
0B	0000		White correction table	Read/Write
	AAFF			
	AB00		Not to use	×
	FFFF			

* The memory of γ correction is located from 0 x 0100 to 0x04FF, 256byte * 4 blocks.

Send the following command through Serial communication for reading data directly.

Table4-30 List of read commands

Command	Parameter (HEX)	Target Object	Content	Return
DA	80	Operation setting memory (FLASH Memory)	Operation registers (Factory setting)	00
	81		Operation registers (User setting1)	01
	82		Operation registers (User setting2)	02
	83		Operation registers (User setting3)	03
	88		Black correction table (Factory setting)	08
	89		Black correction table (User setting1)	09
	8A		Black correction table (User setting2)	0A
	8B		Black correction table (User setting3)	0B
	90		White correction table (Factory setting)	10
	91		White correction table (User setting1)	11
	92		White correction table (User setting2)	12
	93		White correction table (User setting3)	13
	A0	FPGA	Operation registers : for all products	20
	A1	ASIC1	Operation registers : for all products	21
	A2	ASIC2	Operation registers : for all products	22
	A3	ASIC3	Operation registers : for KD6R617/926	23
	A4	ASIC4	Operation registers : for KD6R617/926	24
	A5	ASIC5	Operation registers : for KD6R926	25
	A6	ASIC6	Operation registers : for KD6R926	26
	A9	ASIC1	Black correction table : for all products	29
	AA	ASIC2	Black correction table : for all products	2A
	AB	ASIC3	Black correction table : for KD6R617/926	2B
	AC	ASIC4	Black correction table : for KD6R617/926	2C
	AD	ASIC5	Black correction table : forKD6R926	2D
	AE	ASIC6	Black correction table : for KD6R926	2E
	B1	ASIC1	White correction table : for all products	31
	B2	ASIC2	White correction table : for all products	32
	B3	ASIC3	White correction table : for KD6R617/926	33
	B4	ASIC4	White correction table : for KD6R617/926	34
	B5	ASIC5	White correction table : forKD6R926	35
	B6	ASIC6	White correction table : for KD6R926	36

Send the following command through Serial communication for writing data directly.
Factory setting in Operation setting memory is protected to write new data.
Do not write data except for the following area. CIS operation is not guaranteed.
If any changes for registers make CIS unstable operation, please try to replace operation registers to Factory setting or any User setting which was previously confirmed to operate on the CIS by DT command.

Table4-31 List of write commands

Command	Parameter (HEX)	Target Object	Content	Return
DA	01*1	Operation setting memory	Operation registers (User setting1)	01*1
	02*1		Operation registers (User setting2)	02*1
	03*1		Operation registers (User setting3)	03*1
	09		Black correction table (User setting1)	09
	0A		Black correction table (User setting2)	0A
	0B		Black correction table (User setting3)	0B
	11		White correction table (User setting1)	11
	12		White correction table (User setting2)	12
	13		White correction table (User setting3)	13
	29	ASIC1	Black correction table : for all products	29
	2A	ASIC2	Black correction table : for all products	2A
	2B	ASIC3	Black correction table ： for KD6R617/926	2B
	2C	ASIC4	Black correction table ： for KD6R617/926	2C
	2D	ASIC5	Black correction table ： forKD6R926	2D
	2E	ASIC6	Black correction table ：for KD6R926	2E
	31	ASIC1	White correction table : for all products	31
	32	ASIC2	White correction table : for all products	32
	33	ASIC3	White correction table ： for KD6R617/926	33
	34	ASIC4	White correction table ： for KD6R617/926	34
	35	ASIC5	White correction table ： forKD6R926	35
	36	ASIC6	White correction table ：for KD6R926	36

*1 it is enable to write only to memory which is located from 0 x 0100 to 0x04FF, 256byte * 4 blocks.

【Detail】

This command is for reading and writing directly from/to Operation registers and Operation setting memory. Only to read and write from/to γ correction table, Dark correction table and White correction table is valid.

The procedure of this command is as following.

1) Specify a target object, Number of data and starting address which are transferred in a set of the command.
2) Send a Command (DA) and specified parameters.
3) In the case of sending plural data, it is possible to continue to send data up to defined number. In this case, address which write data is automatically incremented.

When error code returns, the write sequence is not completed and any data does not write in registers and memory. In such a case, please make sure contents of the command. (Please make sure consistency between number of data you Write and number of data you Send.)

Timeout is 60 seconds, when a communication is terminated.

Memory allocation of Black and white correction data is as following.

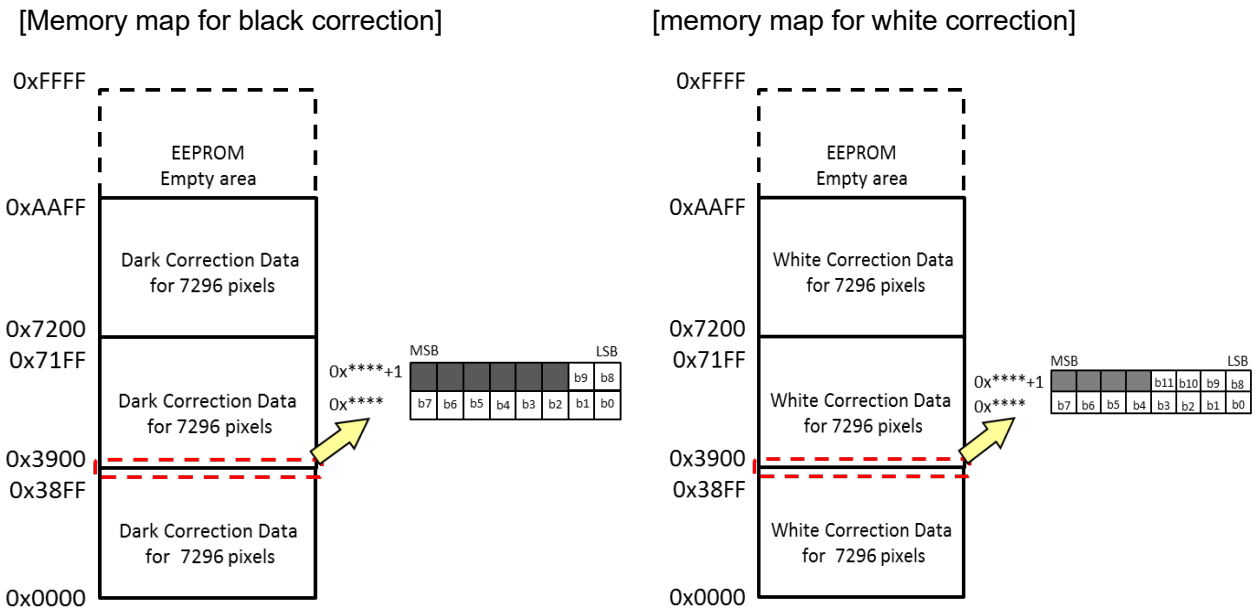


Figure4-15 Memory map

【Caution】

1) Treat this command carefully, not to write incorrect data or address. Because contents in Operation registers and Operation setting memory are changed directly
2) Factory setting in Operation setting memory is protected. Customer can't re-write any data in this area.
3) When you need to store a value such as operation parameter, store in once by register transfer command (DT) after fix an operation setting.

Appendix-A ASCII Code table

char	Hex	char	Hex	char	Hex	char	Hex	char	Hex	char	Hex	char	Hex	char	Hex
NUL	00	DLE	10	SP	20	0	30	@	40	P	50	`	60	p	70
SOH	01	DC1	11	!	21	1	31	A	41	Q	51	a	61	q	71
STX	02	DC2	12	"	22	2	32	B	42	R	52	b	62	r	72
ETX	03	DC3	13	#	23	3	33	C	43	S	53	c	63	s	73
EOT	04	DC4	14	$	24	4	34	D	44	T	54	d	64	t	74
ENQ	05	NAK	15	%	25	5	35	E	45	U	55	e	65	u	75
ACK	06	SYN	16	&	26	6	36	F	46	V	56	f	66	v	76
BEL	07	ETB	17	'	27	7	37	G	47	W	57	g	67	w	77
BS	08	CAN	18	(	28	8	38	H	48	X	58	h	68	x	78
HT	09	EM	19	)	29	9	39	I	49	Y	59	i	69	y	79
LF*	0a	SUB	1a	*	2a	:	3a	J	4a	Z	5a	j	6a	z	7a
VT	0b	ESC	1b	+	2b	;	3b	K	4b	[	5b	k	6b	{	7b
FF*	0c	FS	1c	,	2c	<	3c	L	4c	¥¥	5c	l	6c	|	7c
CR	0d	GS	1d	-	2d	=	3d	M	4d	]	5d	m	6d	}	7d
SO	0e	RS	1e	.	2e	>	3e	N	4e	^	5e	n	6e	~	7e
SI	0f	US	1f	/	2f	?	3f	O	4f	_	5f	o	6f	DEL	7f