

Color line scan camera Instruction Manual



Model: TLC-2098CLD



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1. Outline

TLC-2098CLD is the color line scan camera with 3-lines of 2098-pixels CCD image sensor and has the following features.

2. Features

- CCD line scan camera with 2098 pixels of image sensor and of 25MHz data rate.
- The pixel size is large enough ($14\mu\text{m}\times 14\mu\text{m}$) to capture high S/N images.
- 10 or 8 bit digital image signal output complying with Camera Link standard (Medium/Base Configuration).
- GAIN and OFFSET characteristic and 8/10 bits format can be easily adjusted with RS232C communication (Camera Link spec.).
- The equipment operates with a single DC12V power source.
- Stable output at the scan rate of 11kHz or less thanks to electronic shutter function.
- Energy-saving camera, of which consumption current is less than 300mA (at DC+12V). This enables the camera to obtain stable images.
- Equipped with color gap correction function and shading correction function.
- Possible to get stable video signal despite a change of ambient temperature, as the dark current correction circuit is incorporated.
- Despite a periodic fluctuation of input pulse of the external encoder, stable images can be obtained thanks to exposure control function.(at a scan rate of 11kHz or less).

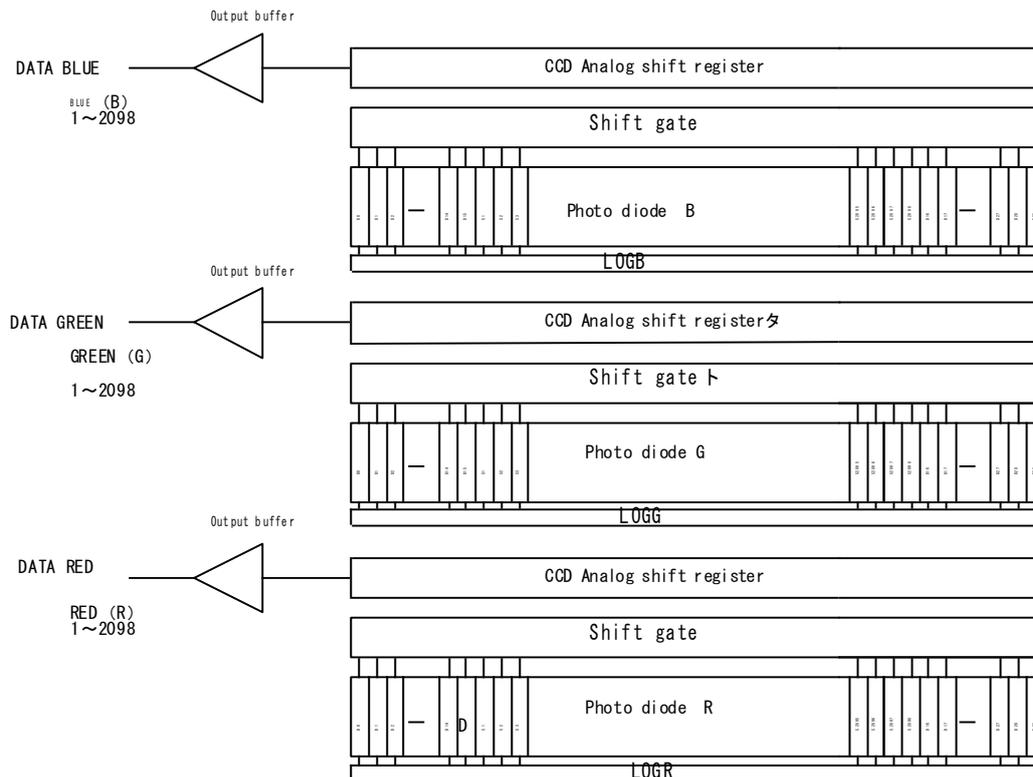
3. Applications

- Image input device for image processor.
- Color tone appearance inspection system.
- Surface inspection system for sheet-like object such as film, Al/Cu foil or printed matter etc..
- Inspection system of foreign matter in cotton, rice grain, polymer etc..

4. CCD image sensor

The CCD image sensor is characterized by $14\mu\text{m}$ square pixel, 2098 effective pixels and high speed performance. Charges accumulated in single-row photo diodes are output through ODD/EVEN analog shift registers (not shown) for each RGB color lines, respectively. 2 lines shift register enables the camera to increase transfer efficiency and to obtain homogeneous images. Each shift register operates at the rate of 25MHz.

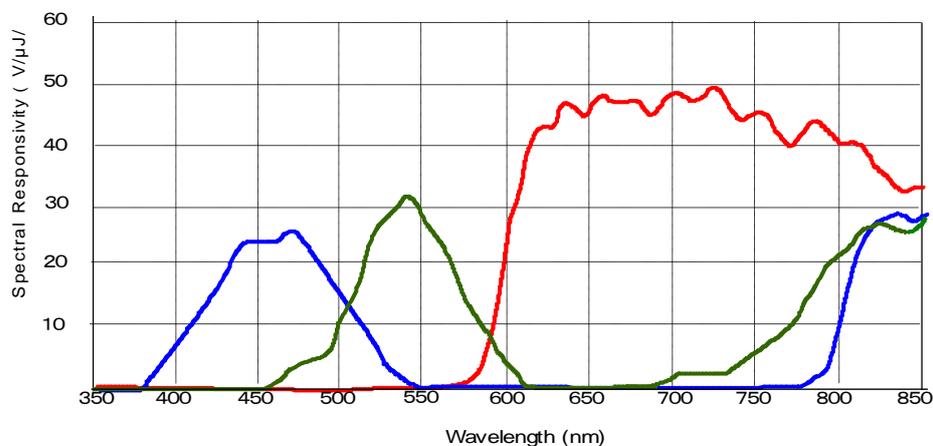
Block diagram of CCD device (TLG-2098CLD)



5. Specifications

Imaging device	2098 pixels 3 lines color CCD	
Effective pixels	2098 x 3	
Unit cell size	14 μ m x 14 μ m	
Distance between R,G,B lines	112 μ m (Effective 8 lines)	
Image size	29.37 mm (H) x 0.24 mm (V)	
Data rate	25MHz	
Scan rate	11KHz	
Line transfer pulse input	90 μ sec (min.) 100 Ω terminating	
Video output	Base Configuration 8bit Medium Configuration 10 bit	RGB data
Charge conversion factor (device)	11.5 mV/electron	
Charge transfer efficiency (device)	0.99999 / 1 transfer	
Saturated charge capacity (device)	170,000 electrons	
Dynamic range (device)	76 dB	
Power supply	DC+12V \pm 0.5V (typ. 290mA)	
Communication	RS232C (Via Camera Link Interface)	
External dimension	64(W) x 64(H) x 80.5(D)	
Optical filter	Non	
Lens mount	F Mount	
Weight	350 g	
Operational ambient temperature	0 ~ 40 $^{\circ}$ C	
Operational humidity range	85% Max.	
Storage temperature range	-10 $^{\circ}$ C ~ + 65 $^{\circ}$ C	

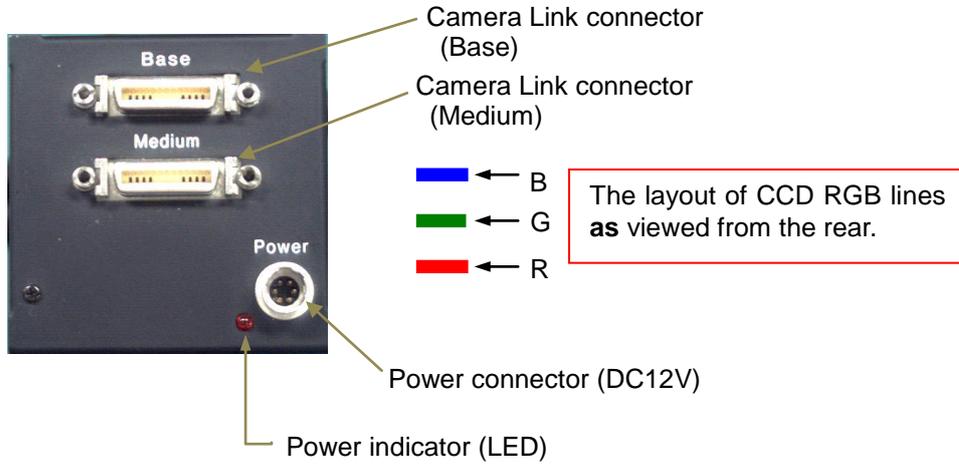
6. Spectral sensitivity characteristic



7. Camera I/O

Camera Link connector MDR-26 pin connector (3M) or equivalents.

Power connector HR10A-7R-6PB (HIROSE) or equivalents.



7-1 Connector pin assignment of Power connector

Signal name	Pin No.	Signal name
+ 1.2 V	4	GND
+ 1.2 V	5	GND
+ 1.2 V	6	GND

7-2 Connector pin assignment of Camera Link connector

(Base)

Pin No.	Signal name	Pin No.	Signal name
1	GND	14	GND
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk -	18	Xclk +
6	X3-	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG+	21	SerTFG+
9	CC1-(Ext Sync)	22	CC1+(Ext Sync)
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND	26	GND

(Medium)

Pin No.	Signal name	Pin No.	Signal name
1	GND	14	GND
2	Y0-	15	Y0+
3	Y1-	16	Y1+
4	Y2-	17	Y2+
5	Yclk -	18	Yclk +
6	Y3-	19	Y3+
7	100Ω terminate	20	100Ω terminate
8	Z0-	21	Z0+
9	Z1-	22	Z1+
10	Z2-	23	Z2+
11	Zclk-	24	Zclk+
12	Z3-	25	Z3+
13	GND	26	GND

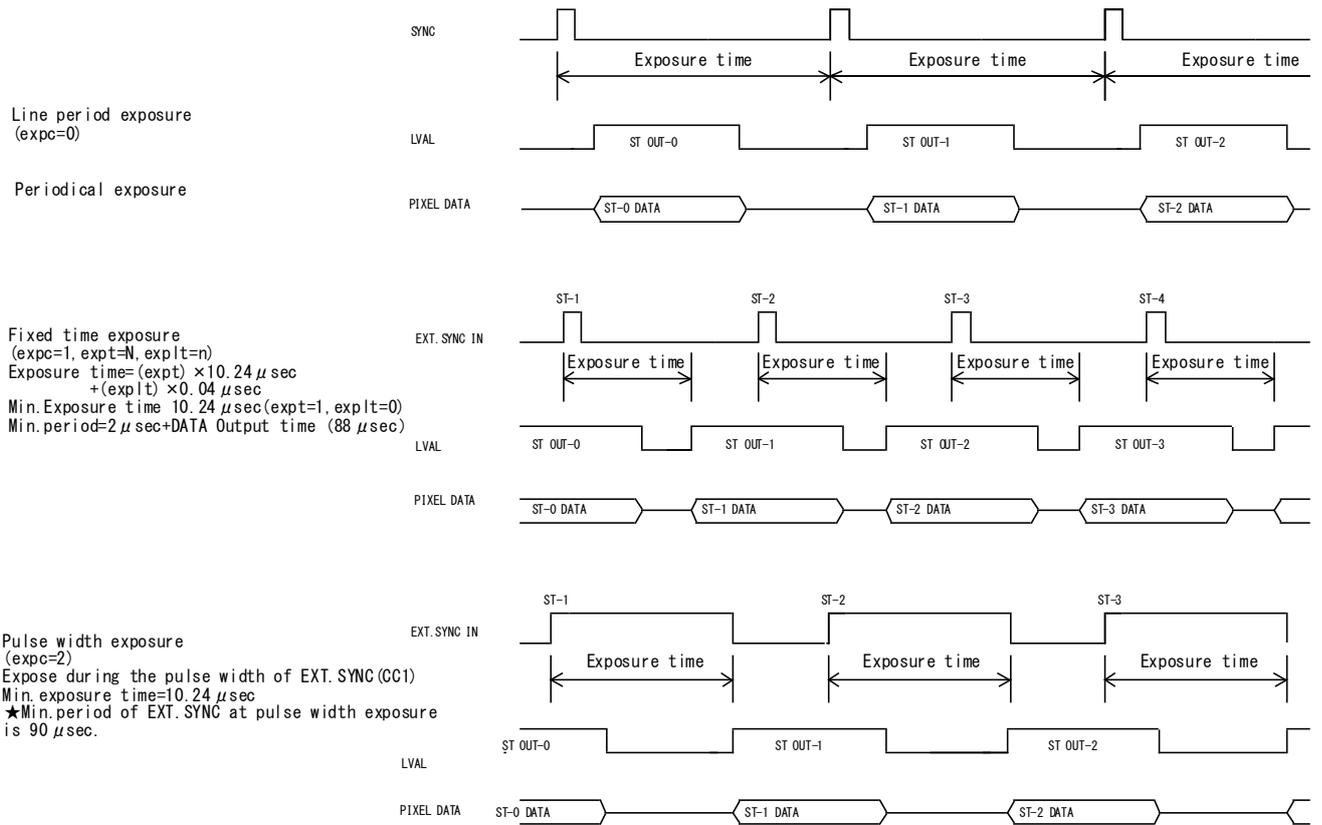
Bit assignment of Medium configuration

Base connector		
Port/bit	8-bit × RGB	10-bit × RGB
Port A0	R0	R0
Port A1	R1	R1
Port A2	R2	R2
Port A3	R3	R3
Port A4	R4	R4
Port A5	R5	R5
Port A6	R6	R6
Port A7	R7	R7
Port B0	G0	R8
Port B1	G1	R9
Port B2	G2	NC
Port B3	G3	NC
Port B4	G4	B8
Port B5	G5	B9
Port B6	G6	NC
Port B7	G7	NC
Port C0	B0	B0
Port C1	B1	B1
Port C2	B2	B2
Port C3	B3	B3
Port C4	B4	B4
Port C5	B5	B5
Port C6	B6	B6
Port C7	B7	B7

Medium connector		
Port/bit	8-bit × RGB	10-bit × RGB
Port D0	NC	NC
Port D1	NC	NC
Port D2	NC	NC
Port D3	NC	NC
Port D4	NC	NC
Port D5	NC	NC
Port D6	NC	NC
Port D7	NC	NC
Port E0	NC	G0
Port E1	NC	G1
Port E2	NC	G2
Port E3	NC	G3
Port E4	NC	G4
Port E5	NC	G5
Port E6	NC	G6
Port E7	NC	G7
Port F0	NC	G8
Port F1	NC	G9
Port F2	NC	NC
Port F3	NC	NC
Port F4	NC	NC
Port F5	NC	NC
Port F6	NC	NC
Port F7	NC	NC

8. Exposure mode

This camera has following three Exposure modes



9. Communication specification

This camera is equipped with the communication function allowing computerized external control.

[Network transmission setting]

Baud rate	:9600bps
Data Length	:8bit
Start Bit	:1bit
Stop Bit	:1bit
Parity	:Non
Xon / Xoff Control	:Non

[Notes]

- Command name must be lower-case. Upper-case character is not valid.
- Input character must be one-byte character. Double-byte character is not valid.
- Blank is not valid.
- Line feed code is indicated by "CR(0x0D)". And also "LF(0x0A)" and "CR+LF" are usable. However returning line feed code must be CR only.

<When in use of Hyper terminal>

- Retyping is required in case of inputting error. (Correction by cursor movement is not valid.)

[Description of exceptional case]

* NG is returned in case of command input error or inputting nonexistent command.

e.g. : Command input error (Gain position No. is not designated.)

Input: ch1gain=96

Output: NG

e.g. : Input of nonexistent command

Input: chake

Output: NG

* NE is returned in case of numeric entry error.

e.g. : Input error (Input value is beyond the setting range.)

Input: gainpos=96

Output: NE

e.g. : Input error (Input value is beyond the setting range.)

Input: ch1gain1=2000

Output: NE

* NC is returned in case of inputting invalid value under the condition that the ctrl setting (DIP-SW setting) is 0.

e.g. :

Input: ch1gain=96 (at ctrl=0)

Output: NC

* TO is returned if a command input period overruns the time-out period (15 sec.).

e.g. :

Input: gainpo (No CR entry)

Output: TO

* " ? " at the bottom of Command is omissible

e.g. :

Input: id

Output: 0

[Glossary]

[]omissible
<CR>carriage return
Narbitrary numeral indicating some value
Aarbitrary numeral indicating GAIN position
Xarbitrary numeral indicating channel
Gain position.....	GAIN position of the camera
ChannelChannel to specify the GAIN control device for each CCD output line
EEPROMEEPROM incorporated in the camera

【Command Protocol】(PC→Camera)

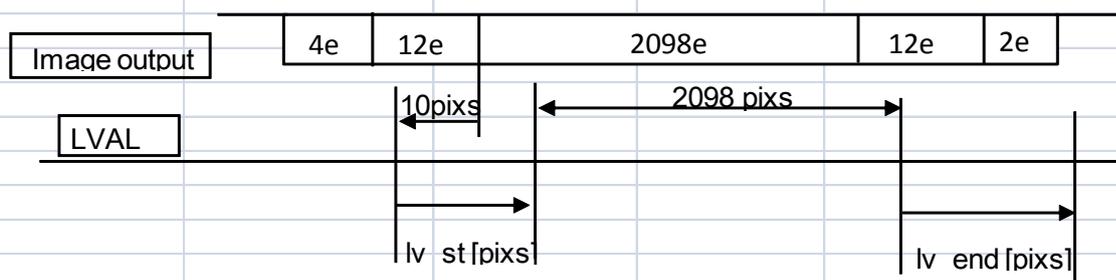
No	Command Name	Format	Argument	Return value	Explanation
Communication					
1	Check	check<CR>	Non	OK	Command for communication test
Camera setting					
2	Ctrl (view)	ctrl[?]<CR>	Non	0:Dip Switch 1:Com	View the effective state of Communication setting value/DIP SW.
3	Ctrl (set)	ctrl=N<CR>	N=0:Dip Sw N=1:Com	OK	Set the effective state of Communication setting value/DIP SW.
4	Dip Sw (view)	dipsw<CR>	Non	0~255	View the state of DIP SW Return the state of DIP SW in decimal number
User ID					
5	ID (view)	id[?]<CR>	Non	ID(default:0)	View the camera ID. Administrative use for plural cameras. For user's operation.
6	ID (set)	id=N<CR>	N:0~255	OK	Set the camera ID. Administrative use for plural cameras. For user's operation.
Output bit					
7	Output bit (view)	bit[?]<CR>	Non	8: 8bit(default) 10: 10bit	View the output bit format of the camera.
8	Output bit (set)	bit=N<CR>	N= 8 : 8bit N=10 : 10bit	OK	Set the output bit format of the camera. *Settable only at ctrl=1.
SYNC switching					
9	Sync (view)	sync[?]<CR>	Non	0: Auto 1: Ext Sync 2: Int Sync 3: Ext Sync & Anti Blooming *1	View the state of SYNC mode. *Effective value only at ctrl=1. *1 ...only for specific models.
10	Sync (set)	sync=N<CR>	N=0:Auto N=1:Ext Sync N=2:Int Sync N=3: Ext Sync & Anti Blooming *1	OK	Set the SYNC mode. *Settable only at ctrl=1. *1 ...only for specific models.
Exposure control					
11	Exposure control (view)	expc[?]<CR>	Non	0:Line period exposure 1:Fixed time exposure 2,3:Pulse width exposure	View the exposure control state of the camera. *Effective value only at ctrl=1.
12	Exposure control (set)	expc=N<CR>	0:Line period exposure 1:Fixed time exposure 2,3:Pulse width exposure	OK	Set the exposure control state of the camera. *Settable only at ctrl=1.
Exposure time					
13	Exposure time (view)	expt[?]<CR>	Non	0-255 :Exposure time	View the period at Fixed time exposure mode. *Effective value only at ctrl=1
14	Exposure time (set)	expt=N<CR>	N=0-255:Exposure time	OK	Set the period at Fixed time exposure mode. *Settable only at ctrl=1
Gain					
15	Gain Position (view)	gainpos[?]<CR>	Non	1-8: gain position	View the Gain position of the camera. *Effective value only at ctrl=1
16	Gain Position (set)	gainpos=A<CR>	A=1-8:gain position	OK	Set the Gain position of the camera. *Settable only at ctrl=1
17	chXgainA (view)	chXgainA[?]<CR>	X=1 ch: Red X=2 ch: Green X=4:ch: Blue A=1-8: gain position	0-255:gain level	View the Gain value for each Gain position of each channel.
18	chXgainA (set)	chXgainA=N<CR>	X=1 ch: Red X=2 ch: Green X=4:ch: Blue A=1-8:gain position N=0-255:gain level	OK	Set the Gain value for each Gain position of each channel. *Settable only at ctrl=1
Offset					
19	chXoffset (view)	chXoffset[?]<CR>	X=1 ch: Red X=2 ch: Green X=4:ch: Blue	0-31:offset level	View the offset value of each channel.
20	chXoffset (set)	chXoffset=N<CR>	X=1 ch: Red X=2 ch: Green X=4:ch: Blue N=0-31:offset level *	OK	Set the offset value of each channel. *Settable only at ctrl=1
EEPROM					
21	Save	save<CR>	Non	OK	Save the setting to EEPROM.
22	Load	load<CR>	Non	OK	Load the setting from EEPROM.
System					
23	Version	ver<CR>	Non	Version	View the version of microcomputer control program of the camera.
24	Revision	rev<CR>	Non	Revision	View the version of EPGA.(unsupported)
25	Initialize	init<CR>	Non	OK	Load the factory default.
26	config	cfg<CR>	Non	(data output)	View the all current setting data of the camera.

Offset "0 to 31" Is the range for 10 bit outputting.

【Command Protocol】 (PC->Camera)			Only when set ctrl=1, following command is effective.		
No	Command Name	Format	Set value	Return value	Explanation
	LVAL control	lval=N<CR>	0:OFF 1:ON	OK	LVAL control on/off Set and View
	on/off	lval[?]<CR>	Non	0:OFF 1:ON	
Lval Control	LVAL start timing	lv_st=N<CR>	0-255	OK	LVAL start timing Set and View
		lv_st[?]<CR>	Non	0-255	
	LVAL end timing	lv_end=N<CR>	0-255	OK	LVAL end timing Set and View
		lv_end[?]<CR>	Non	0-255	

Timing Diagram

Line timing



【Command Protocol】 (PC->Camera)			Only when set ctrl=1, following command is effective.		
No	Command Name	Format	Set value	Return value	Explanation
	Color gap control	rgb_on=N<CR>	0:OFF 1:ON	OK	Color gap control on/off Set
	on/off	rgb_on[?]<CR>	Non	0:OFF 1:ON	Color gap control on/off View
Color Gap	Color gap dir	rgb_dir=N<CR>	0:RGB 1:BGR	OK	Color gap scan direction Set
		rgb_dir[?]<CR>	Non	0:RGB 1:BGR	Color gap scan direction View
	Color gap line	rgb_ldelay=N<CR>	0-31	OK	Color gap delay lines Set
		rgb_ldelay[?]<CR>	Non	0-31	Color gap line setting View

【Command Protocol】(PC→Camera) Only when set ctrl=1, following command is effective.

	Command Name	Format	Argument	Return value	Explanation
SHADE	Shade control mode	shade=N<CR>	0:OFF 1:ON 2:Data out 3:Data in 4:Data all in	OK	Shade control mode value reference/setting (4)
		shade[?]<CR>	Non	0:OFF 1:ON 2:Data out 3:Data in 4:Data all in	
	Auto Shade	shd_to=N<CR>	N:0-255	OK	Dark target Level target Level target Level control start Dark target Level control start
		shd_tg=N<CR>	N:0-255	OK	
		shade=N<CR>	5:ON 6:ON	OK OK	
	Gain/Offset	shd_go=N<CR>	0:OFF 1:Gain 2:Offset	OK	Setting target value reference/setting (3)
		shd_go[?]<CR>	Non	0:OFF 1:Gain 2:Offset	
	Setting channel	shd_ch=N<CR>	0-2:R/G/B	OK	Setting target channel value setting/reference
		shd_ch[?]<CR>	Non	0-2:R/G/B	
	Pixel address (lower)	shd_ad0=N<CR>	N:0-255	OK	Correction target pixel (The lower rank address) value reference/setting (2)
		shd_ad0[?]<CR>	Non	0-255	
	Pixel address (upper)	shd_ad1=N<CR>	N:0-255	OK	Correction target pixel (The upper rank address) value reference/setting (2)
		shd_ad1[?]<CR>	Non	0-255	
	Value set	shd_dat=N<CR>	N:0-255	OK	Data value setting
		shd_dat[?]<CR>	Non	0-255	Data value reference
	Data set	shd_set<CR>	Non	OK	Data set
	EEPROM load	shd_epld<CR>	Non	OK	EEPROM all load (1)
	EEPROM save	shd_epsv<CR>	Non	OK	EEPROM all save (1)
	EEPROM clear	shd_epcl<CR>	Non	OK	EEPROM all clear (1)(5)
	EEPROM status	epm_status<CR>	Non	0:Accept 3:Busy(for write) 4:Busy(for read) 5:Busy(for clear)	EEPROM Communication status

Notice

- (1) This command can send only at "epm_status=0".
- (2) Correction target pixel address : [shd_ad1] x 255 + [shd_ad0]
- (3) Gain or Offset has to be choose before use "Data set" command.
- (4) The setting status is output as is the video out from camera.
- (5) Only the value of EEPROM is cleared. RAM isn't cleared.

Procedure at the time of Data set(->RAM)

1. shd_go/shd_ad0/shd_ad1/shd_dat Set these values for the following procedure.
2. shade=3 Change mode for activate "shd_set".
3. shd_set The value is set as a correction target pixel.
4. shade=1 The setting state is confirmed by output of a camera.

Procedure at the time of Data set(RAM->EEPROM)

1. shd_epsv The set value of all pixels of RAM is preserved in EEPROM

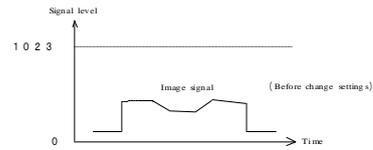
Procedure at the time of Data load(EEPROM->RAM)(either procedure)

- * When turn on to the camera, all pixels are read automatically.
- * shd_epld All pixels are read.

10. Camera function

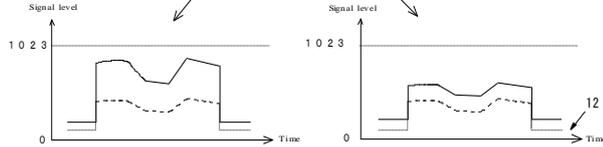
10.1 R · G · B Gain adjustment

Each of six CCD GAINs are adjustable.
 Adjustable GAIN range N=0 to 225
 Gain = -2.36dB + 0.132dB × N
 Signal level at N=27 gets doubled from the value at N=0



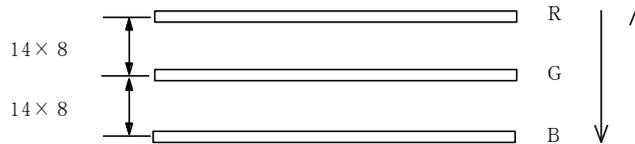
10.2 Offset adjustment

Adjustable for each R · G · B
 Adjustable OFFSET range N=0 to 31
 Zero level=12 (10bit) when OFFSET value is zero.



10.3 Color gap correction

- Color gap direction correction
 R→G→B, B→G→R
- Color gap correction
 Correction steps 1 to 8



<How to make Color gap correction>

- ctrl=1 ↵
- rgb_on = 1 ↵
- rgb_dir = 0 ↵ color gap scan direction
- rgb_ldelay = 4 ↵ value setting

Current setting is in the status as above.

If the object flow is in the reverse direction, set the color gap scan direction as below,

- rgb_dir = 1 ↵

When it is needed to change the correction value of the color gap, set up the value of n

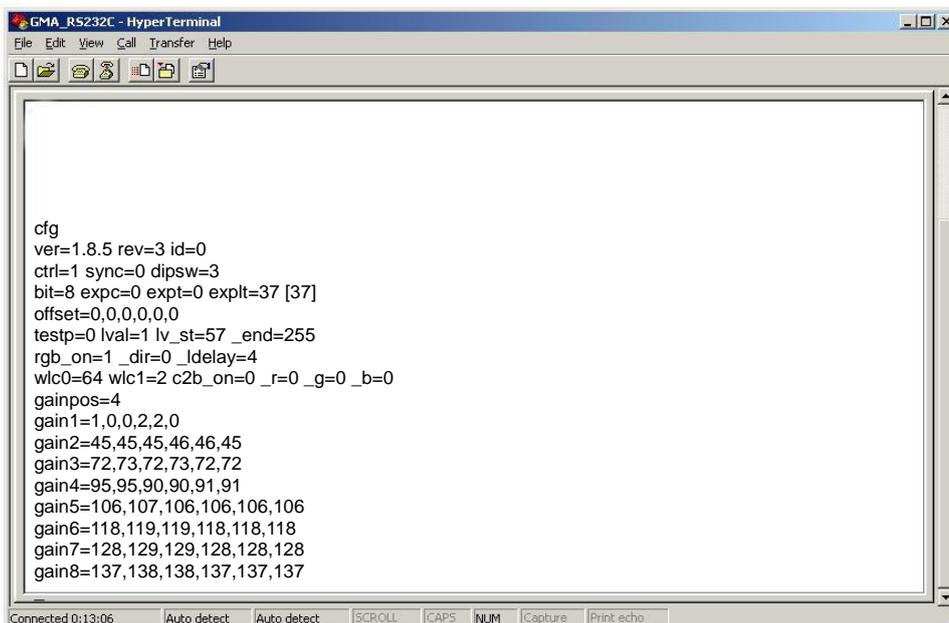
- rgb_ldelay = n ↵

And,

- save ↵

It is able to replicate the last setting status even after an abnormal end of task.

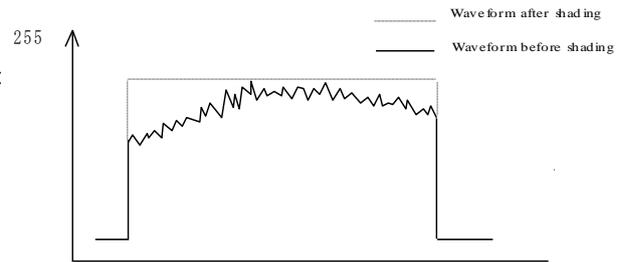
- cfg ↵ The following file is available.



10.4 Shading correction

Correction to achieve the uniformity in brightness against non-uniformities arising from optical or imaging characteristics

- Required number of scanning to determine the shading curve is 384,000 lines.(Meanwhile shading correction must be performed keeping the waveform stable.)
- Shading correction must be set at highest level.



<How to make Shading correction>

- ctrl=1 ↩
- Shd_to = N ↩ Set the target gray level (dark) of dark level.
Standard value = 3 N : 0 to 255
- Shd_tg = N ↩ Set the target gray level (light) of light level.
Standard value = 210 N : 0 to 255

Cover a lens with a lens cap.

- shade = 6 ↩ Start shading correction at dark level.
Approximate time required: 1 minute

- shade = 1 ↩ Make shading correction at dark level.

Uncap the lens and make Gain adjustment of R,G,B level to the level a little lower than target gray level.

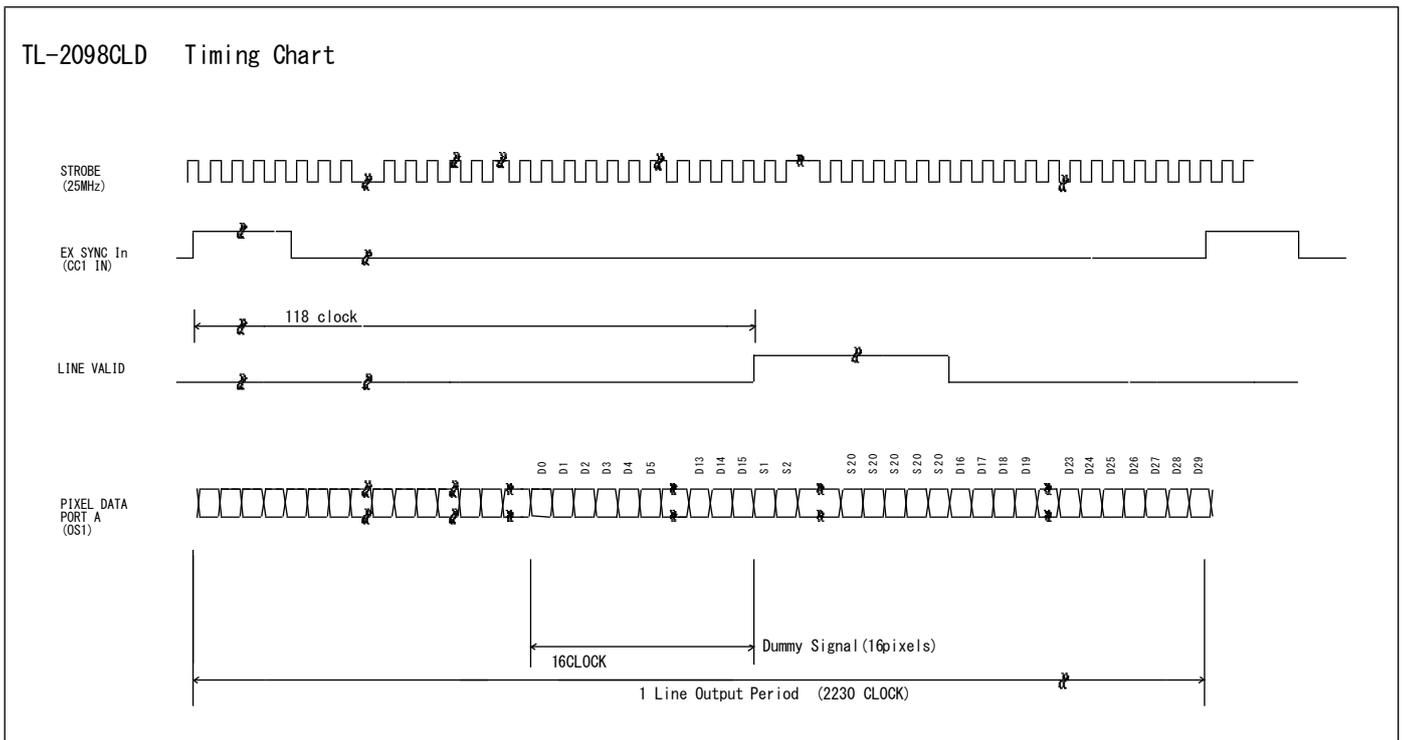
(Color of object sample is white)

- shade = 5 ↩ Start shading correction at light level.
Approximate time required 5 minute* * at scan rate 2 kHz
(It takes longer if it differs greatly from the target gray level(light).
Gray scale image is obtained.

- shd_epsv ↩ All shading correction values are saved to EPROM.

- save ↩

11. Timing chart



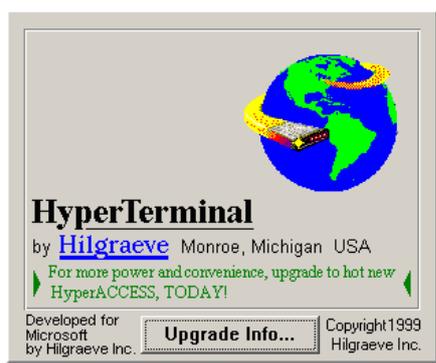
12. Setup steps of Hyper terminal.

[Network transmission setting]

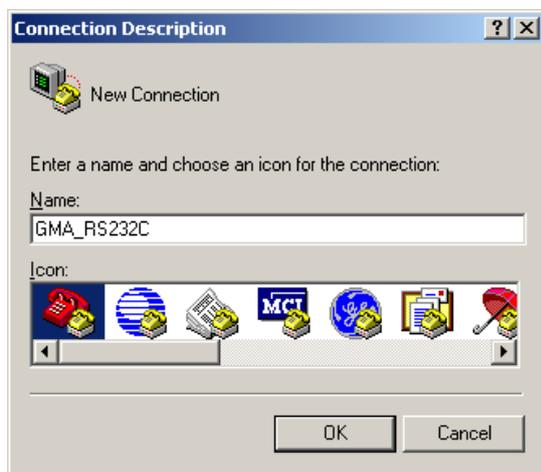
Baud rate : 9600 bps
 Data length : 8 bit
 Start bit : 1 bit
 Stop bit : 1 bit
 Parity : Non
 Xon / Xoff control : Non

[Setup of Hyper terminal] (In the case of Microsoft Windows 2000)

- 1) Select "Start"→ "Programs"→"Accessories"→"Communications"→"Hyper Terminal"
- 2) The windows will appear with the picture below.



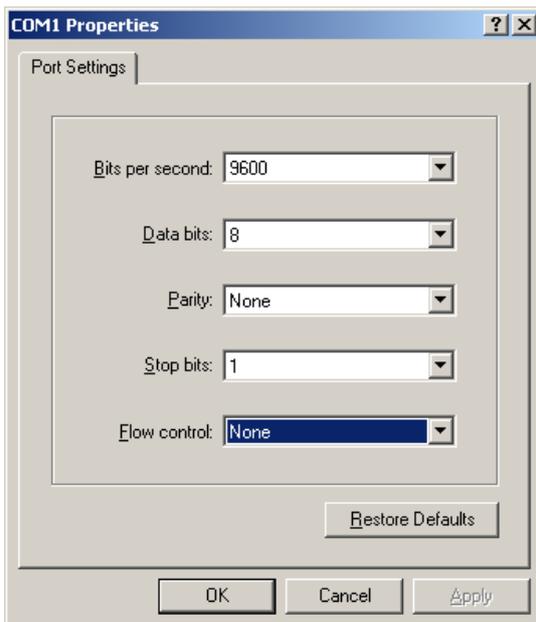
- 3) When the next picture appears, enter any name.(e.g. GMA_RS232C)
 Then click the "OK" button.



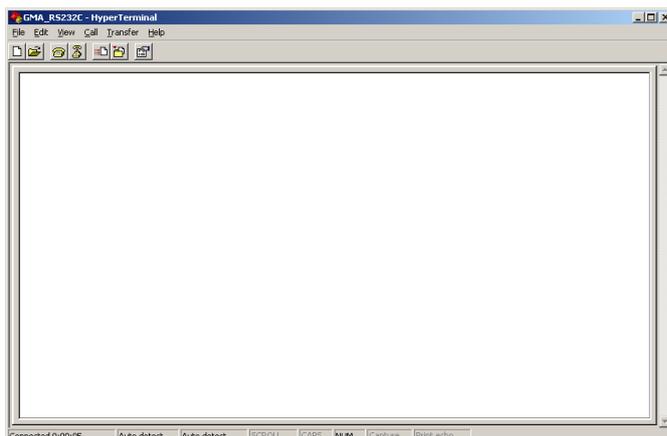
- 4) When the next picture appears, select “ COM? ” on Connect using.
(? changes depending on the setting of the computer.)
Then click the “OK” button.



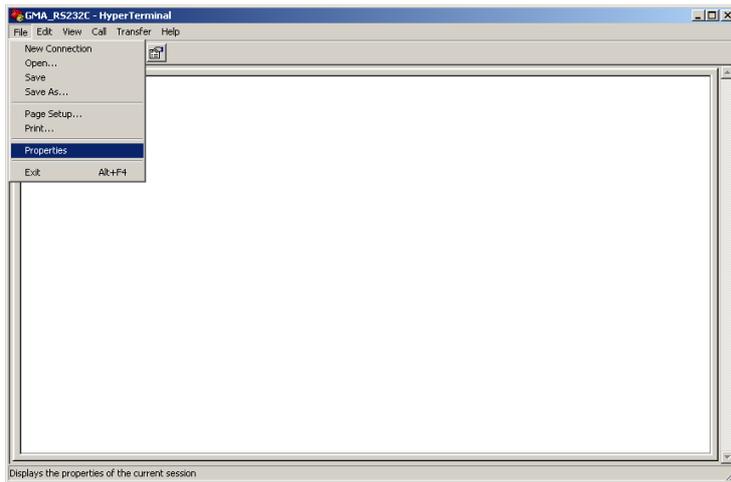
- 5) When the next picture appears, select each items as follows.(9600,8,None,1,Non)
Then click the “OK” button.



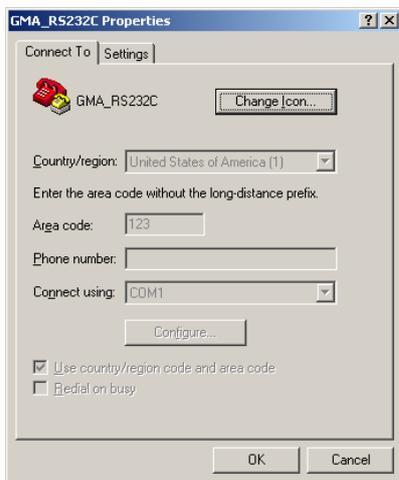
- 6) The next picture will appear.



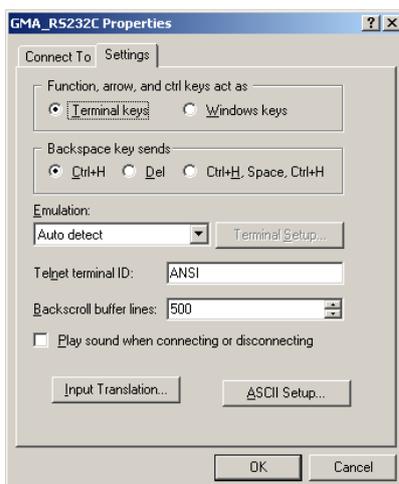
7) Select [File]→ [Properties]



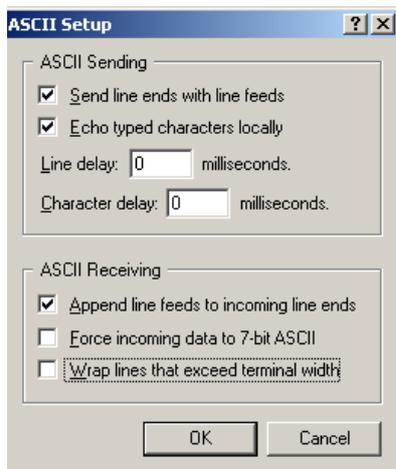
8) When the next picture appears, select "Settings" tag.



9) When the next picture appears, click the "ASCII Setup" button.



- 10) When the next picture appears, select each items as follows.(, , 0, 0, , blank, blank)
Then click the “OK” button.

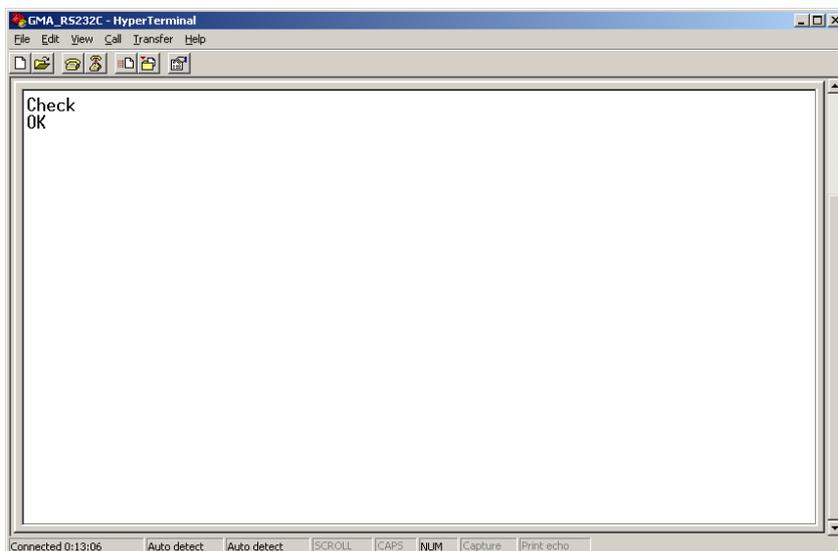


- 11) The screen display will return to the screen of 9).
Then click the OK button.

- 12) End of setup.

Confirm the connection of the camera ,
enter “check” on the screen below
and then send it out.

If “OK” is displayed on the screen, communication processing has been completed.



- 13) Select “Start”→ “Programs”→”Accessories”→”Communications”→”Hyper Terminal” →”(* 1) ”, when to launch the Hyper terminal again with the same settings after having exited the above screen.

* 1.....The name which was entered at section 3)

12. Notes

Precautions for use

- Do not make an impact on the equipment.
- Do not lag the equipment with heat insulating agent. If the equipment is covered with heat insulating agent, it produces an increase in temperature and it causes the equipment to malfunction. (except for low-temperature environment use)
- Take appropriate measures such as heat removal or cold removal to prevent dew condensation, when the equipment is moved to the place where temperature difference is extremely severe.
Usage with dew condensation causes the equipment to malfunction.
- When the equipment is not used for a long time, protect the imaging device from dust or scratch by attaching a lens cap. Do not store the equipment at the following places.
 - The place where is subjected to a lot of dust and moisture.
 - The place where is subjected to direct sunlight.
 - The place where is extremely hot or cold.
 - The place in the vicinity of an object which generates intensive electromagnetic field.
 - The place where is subjected to intensive vibration.
- Please wipe off the dirt on the lens surface with a cotton swab preventing scratch to the lens surface.
Use a soft cloth to clean up the camera body.
- Use the equipment with a voltage within the range of specifications and do not connect the equipment to a power source that contains intense noise components. In such case, the image output from the camera may contain noise components.
- Do not use the equipment in an environment subject to intense electromagnetic field.
In such an environment, malfunction of the camera, disturbance of image and noise are caused by the field.
- In case of the high-intensity object, it may happen that even the low intensity part is displayed whitely like a vertical streak above and below the high-intensity object. This phenomenon is called "smear". However it is the problem specific to CCD and it is not the camera-related failure.
- In case of the linear object, jagged picture may be displayed. Also in case of the pinstripe or checkered pattern, annual rings-like picture may be displayed. However these are also the problem specific to CCD and it is not the camera-related failure.
- The lighting using a commercial power source may cause a perceptible flicker at higher shutter speed.
In cases like this, consider to adjust shutter speed setting of the camera or to use the DC lighting or high-frequency lighting.
- Do not remove a cover and do not insert/remove a Camera Link connector when applying current to the equipment. It causes the equipment to malfunction.

Attention

- All rights on this manual reserved.
- The specifications and operational details described in the manual are subject to change for performance improvement or other reasons without notice.

13. External dimensions

