OMRON

16:9 Format 2160p (4K UHDTV)

Color CMOS Camera

STC-HD853HDMI

Product Specifications and User's guide

OMRON SENTECH CO., LTD.

OMRON

Table of Contents

Precautions for safe use

Please read carefully this “Precautions for safe use” before use the camera. Then the camera uses correctly with agreeing with below notes.

In this “Precautions for safe use”, notes divides into “Warning” and “Caution” to use the camera safety and prevent to harm and damage.

⚠ Warning	This shows, assumption for possibility of serious accident leading death or serious injury if ignore this note and camera uses incorrectly.
⚠ Caution	This shows, assumption for possibility of bear the damage or physical damage if ignore this note and camera uses incorrectly.

About Graphic symbols


This symbol shows general prohibition.


This symbol shows completion or instruction.

[Environment / condition]

⚠ Warning	
Do not use flammable or explosiveness atmospheres. This will cause of personal injury or fire.	Do not use for “safety for human body” related usage. This camera is designed for use “do not harm human body immediately” if by any chance the camera has malfunction.
⚠ Caution	
Use and store under specified environmental conditions (Vibration, shock, temperature, humidity) in the specifications for this camera. This will cause of fire or damage the camera.	

[Installation and cable wiring]

⚠ Warning	
Do not use with out of power voltage range that is specified in the specifications for this camera. This will cause of fire, electrification or malfunction.	Do not wrong wiring. This will cause of fire or malfunction.

⚠ Caution	
The camera housing is not connecting to 0 V Line of camera inside circuit. There is a risk of short circuit between camera inside ciurcuit and frame ground through other devices. This will cause of malfunction.	It is necessary to wiring and mounting that is specified in the specifications for this camera. This will cause of fire or malfunction.
It is necessary to wiring with turn off the camera. This will cause of electrification or malfunction.	It is necessary to mounting the camera without stress for the cable. This will case of electrification or fire.

[Usage instruction]

⚠ Warning	
Do not touch the terminal and PCB board While turn on the camera. This will cause of electrification or accident caused by malfunction.	Do not put combustibles near the camera. This will cause of fire.
Do not use without usage that is specified in the specifications for this camera. This will cause of personal injury or malfunction.	Do not push metals including screw driver into radiation holes. This will cause of electrification or malfunction.
⚠ Caution	
Do not push contamination into opening of the camera. This will cause of electrification or malfunction.	Do not block the radiation holes. This will cause of fire due to increase the camera inside temperature.

[Maintenance]

⚠ Caution	
Do not disassemble or repair the camera. This will cause of fire, electrification or malfunction.	It is turn off the camera when maintaining or inspecting the camera. This will cause of electrification.

[Disposal]

⚠ Caution	
It is necessary to dispose as industrial waste.	

1 Product Precautions

- Do not give shock to the camera.
- Do not haul or damage the camera cable.
- Do not wrap the camera with any material while using the camera. This will cause the internal camera temperature to increase.
- When the camera moving or using the place that temperature difference is extreme, countermeasure for dew condensation (heat removal / cold removal) is necessary.
- While the camera is not using, keep the lens cap on the camera to prevent dust or contamination from getting in the sensor or filter and scratching or damaging it.
  Do not keep the camera under the following conditions.
  - In wet, moist, high humidity or dusty place
  - Under direct sunlight
  - In extreme high or low temperature place
  - Near an object that releases a strong magnetic or electric filed
  - Place with strong vibrations
- Apply the power that satisfies the specified in specifications for the camera.
- The defective pixels may appear due to the sensor characteristics.
- Use below recommend materials (or equivalent materials) to clean the surface of glass.
  - Air dust: Non Freon air duster (NAKABAYASHI Co., LTD.)
  - Alcohol: Propan-2-ol (SAN'EI KAKO Co., LTD.)
  - Non-woven: nikowipe clean room (NKB)
- Use a soft cloth to clean the camera.

2 Warranty

■Warranty period

One year after delivery (However, the camera had malfunction with camera uses correctly)

In below case for a fee even within warranty period.

- The malfunction caused by incorrect usage, incorrect modify or repair.
- The malfunction caused by external shock including the camera dropping after delivery the camera.
- The malfunction caused by fire, earthquake, flood disaster, thunderbolt struck, other natural disaster or wrong voltage.

■Warranty coverage

Exchange or repair the malfunction camera if the malfunction is occurred by our responsibility.

"Warranty" mean is warranty for the delivered camera itself. Please accept the induction damage by the camera malfunction is not included.

3 Introduction

This document describes the specification of the following camera:

STC-HD853HDMI

3.1 Features

- **2160p or 1080p output is selectable**
- **HDMI Output**
- **CMOS rolling shutter**
- **C mount**
- **OSCD (On Screen Character Display) through Remoter Controller (Option)**
- **Configurable many parameters through Control Software**
- **Eight configurable DSP can be saved**
- **Defective Pixel Correction (KPACtrl is required)**

3.2 Peripheral Equipment

OMRON SENTECH provides as follow peripheral equipment as option.

(1) +12V DC Power Supply: UN310-1210
(2) Remote Controller: RC-HD133
(3) Communication Tool (PC can communicate through USB port): JIG-USB-HD
(4) Control Software: KPACtrl

(1)

(2)

(3)

4 Specifications

4.1 Electronic Specifications

Product		STC-HD853HDMI
Image Sensor		1/2.5" 8.51M Progressive CMOS (SONY)
Shutter Type		Rolling shutter
Active Picture Elements		3,840 (H) x 2,160 (V) (QFHD), 1,920 (H) x 1,080 (V) (Full HD)
Chip Size		8.365 (H) x 6.615 (V) mm
Cell Size		1.62 (H) x 1.62 (V) µm
Sensitivity		1,070 Lux (*1)
Sync. System		Internal
Video output		HDMI (RGB 8bit 4:4:4) 2160P59.94 / 2160P60 / 2160P50 / 2160P29.97 / 2160P30 / 2160P25, 1080P59.94 / 1080P60 / 1080P50 / 1080P119.88 /1080P120 / 1080P100 **(Default: Auto)** (*2)
Camera Functions		
	ALC	ALC mode (auto electronic shutter and AGC) is configurable via UART communication **(Default: ALC ON)**
	Shutter Speed	Auto shutter or Fixed shutter selectable via UART communication **(Default: Auto)**
		2160P59.94: 1/21737.3 seconds (46.0 µseconds) to 1/60.2 seconds (16.62 mseconds), 2160P60: 1/21737.3 seconds (46.0 µseconds) to 1/60.2 seconds (16.62 mseconds), 2160P50: 1/18218.6 seconds (54.9 µseconds) to 1/50.1 seconds (19.95 mseconds), 2160P29.97: 1/10959.9 seconds (91.2 µseconds) to 1/30.1 seconds (33.25 mseconds), 2160P30: 1/10959.9 seconds (91.2 µseconds) to 1/30.1 seconds (33.25 mseconds), 2160P25: 1/9173.1 seconds (109.0 µseconds) to 1/25.1 seconds (39.90 mseconds), 1080P59.94: 1/31266.9 seconds (32.0 µseconds) to 1/60.2 seconds (16.61 mseconds), 1080P60: 1/31266.9 seconds (32.0 µseconds) to 1/60.2 seconds (16.61 mseconds), 1080P50: 1/26383.3 seconds (37.9 µseconds) to 1/50.2 seconds (19.93 mseconds), 1080P119.88: 1/61071.4 seconds (16.4 µseconds) to 1/120.4 seconds (8.31 mseconds), 1080P120: 1/61071.4 seconds (16.4 µseconds) to 1/120.4 seconds (8.31 mseconds), 1080P100: 1/51724.1 seconds (19.3 µseconds) to 1/100.3 seconds (9.97 mseconds)
	Gain	AGC or Fixed gain selectable via the UART communication 0 to 27 dB
	Gamma	8 preset gamma can be selectable (Manual / 0.30 / 0.45 / 0.50 / 0.60 / 0.70 / 0.80 / 0.90 / 1.00) Gamma is selectable via UART communication **(Default: Manual)**
	White Balance	Auto white balance / manual white balance / push to set white balance White balance is selectable via the UART communication **(Default: Auto white balance)**
	Mirror Image	Normal image / horizontal flip / vertical flip / horizontal vertical flip (180 deg. rotation) **(Default: Normal image)**
	DSP Preset	Selectable 8 user preset modes can be selectable User preset mode is selectable via UART communication **(Default: Preset 0)**
	Line Generator	Both horizontal and vertical with all available colors (Line number: 2) Color, thickness and position for individual line are adjustable via UART communication **(Default: Disable)**
	Communication	+3.3V UART communication via Φ 3.5 mm stereo jack (Baud rate: 38,400 bps, 19,200 bps, 9,600 bps) **(Default: 38,400 bps)**
	Character Generator	Built-in character generation function via UART communication
	Defective Pixel Correction	Up to 512 points **(Default: ON)**
Power	Input voltage	+9 to +15 Vdc (Typical: +12 Vdc)
	Consumption	6.0 W

Precautions

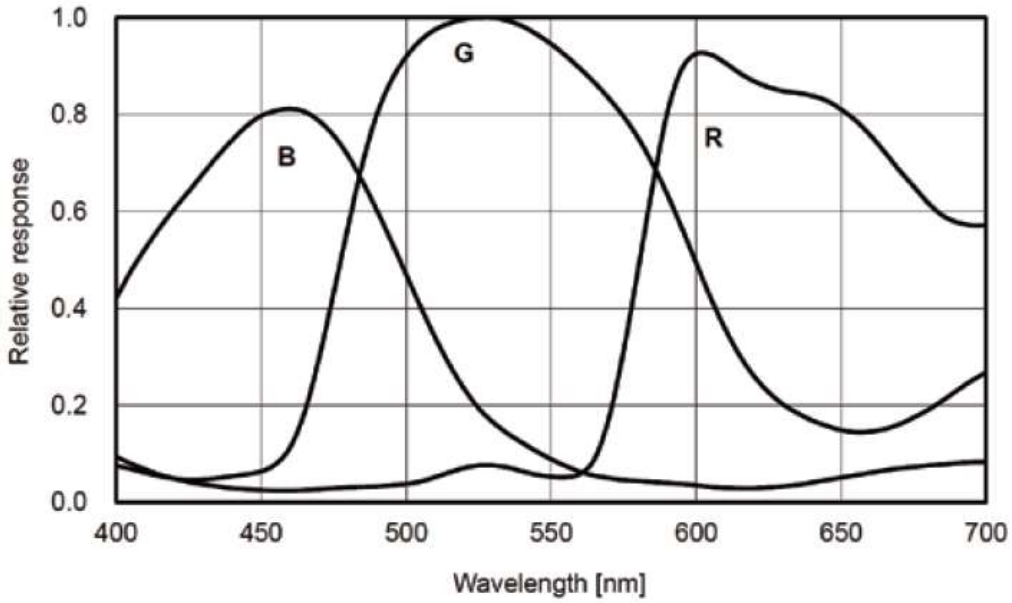
(*1) The sensitivity is measuring the luminance when white level achieved 100 % in below conditions.

Camera Setting		Environment	
Parameter	Setting	Parameter	Setting
Gain Up	0 dB	Light Source	Light Box (White)
AGC	Off	Color temperature	5,100K
White Balance	Optimum	Lens	
Electrical Shutter	1/30 seconds	F on Lens	F5.6
Black Level	Optimum	Target Luminance	IM-600 (Topcon)
Gamma	Factory Setting		

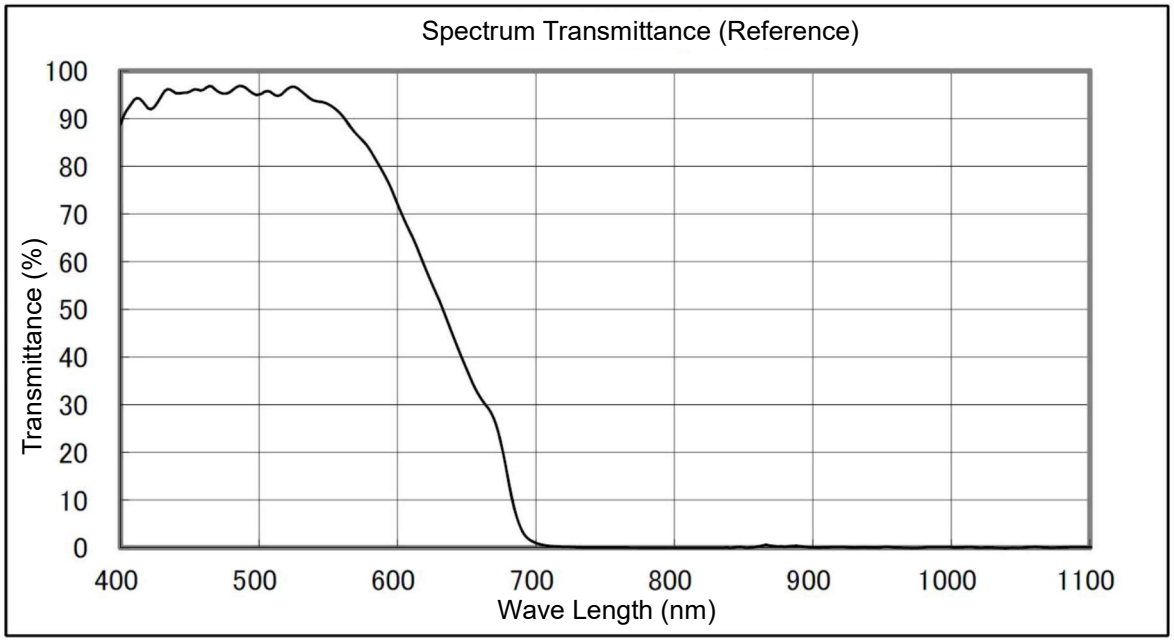
(*2) When selecting “Auto” at video output, video output format is selecting automatically based on connected monitor supported format.
e.g. If the monitor supports up to 2160P30, video output format of camera selects 2160P30 automatically.

4.2 Spectral Sensitivity Characteristics

4.2.1 STC-HD853HDMI



4.2.2 IR Cut Filter



4.3 Mechanical Specifications

Product	STC-HD853HDMI
Dimensions	Φ 70 x 60 (H) x 50.7 (D) mm (*1)
Optical Filter	IR cut filter with OPLF
Material	Aluminum (AC)
Lens Mount	C mount (*2)
Interface Connector	Video Output: HDMI connector,
	Power Input: Φ 2.5 mm power jack
	External Control: Φ 3.5 mm stereo jack with SW board
	Communication: Φ 3.5 mm stereo jack
Camera Mounting	Two 1/4" tripod (One on top and bottom plate) Sixteen M4 screw holes (Four on top, bottom, front and rear plate)
Weight	Approximately 300 g

(*1) Excluding the connectors

(*2) Please use 2.5 μm or 2.2 μm resolution lens for 2160P output

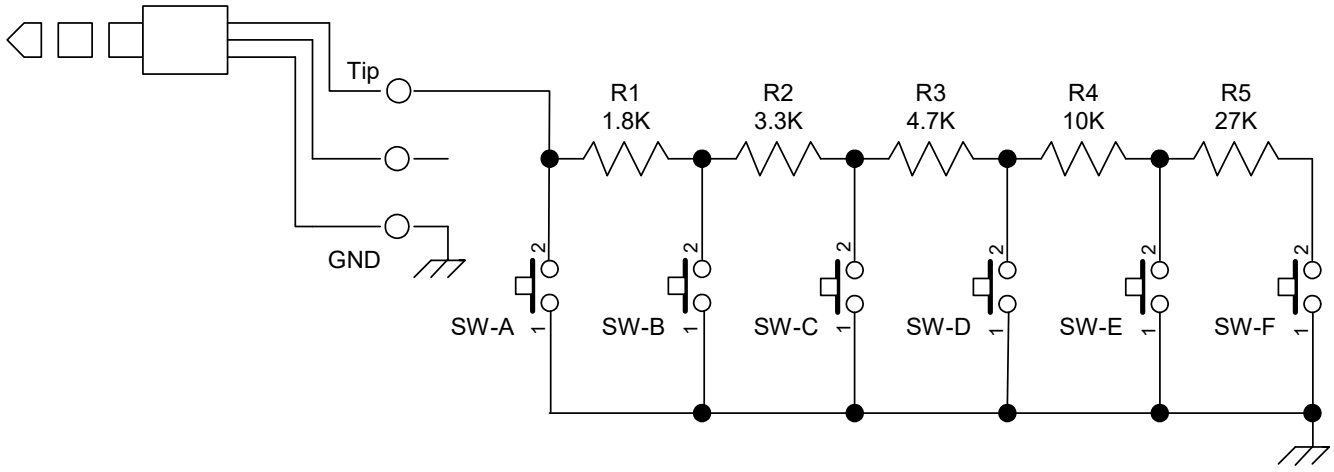
(*3) Please use Φ 2.1 mm plug for power input connector

4.4 Environmental Specifications

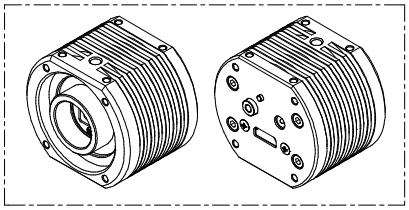
Product	STC-HD853HDMI
Operational Temperature / Humidity	Environmental Temperature: 0 to +40 deg. C, Environmental Humidity: 0 to 80 %RH (No condensation)
Storage Temperature / Humidity	Environmental Temperature: -10 to +75 deg. C, Environmental Humidity: 0 to 80 %RH (No condensation)
Vibration	20 Hz to 200 Hz to 20 Hz (5 min. / cycle), acceleration 10 G, XYZ 3 directions 30 min. each
Shock	Acceleration 38 G, half amplitude 6 msec., XYZ 3 directions 3 times each
Standard compliancy	EMS: EN61000-6-2, EMI: EN55011
RoHS	TBD

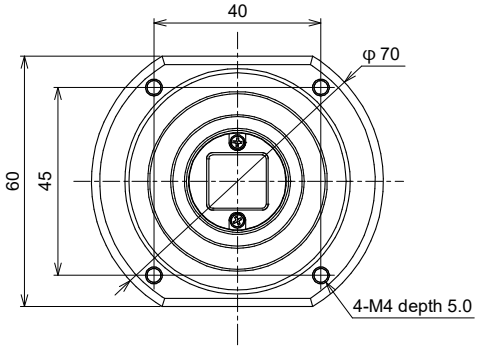
4.5 External Control Specification

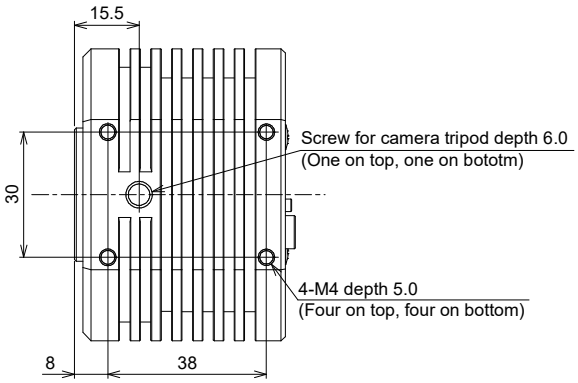
Circuit Diagram of SW Board to connect 3.5φ Stereo Pin Jack

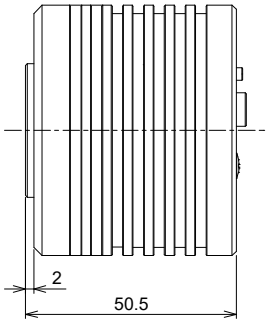


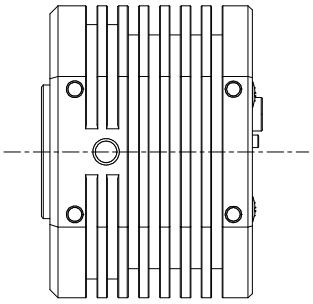
5 Dimensions

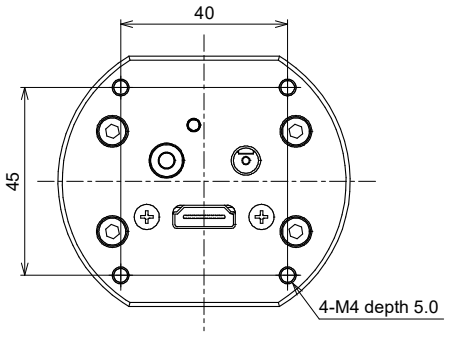












Unit: mm

6 Camera instruction guide

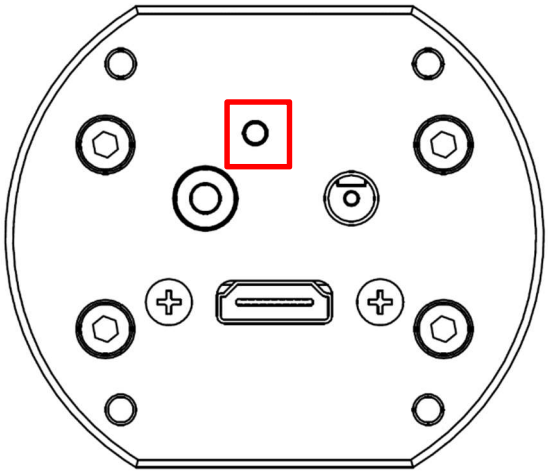
This camera can be set camera settings through three methods in below.

A. Push Button
B. External Switch (Remote controller: RC-HD133, separate accessory)
C. Control software (KPACtrl) (Communication tool: JIG-USB-HD, separate accessory)

6.1 Push Button

White Balance can be set through push button. (*1)

Single Push: Push to set White Balance
Hold: Auto White Balance



Push button position

(*1) This push button can be assigned another function through control software

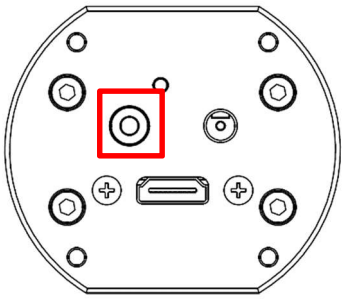
6.2 External Switch (Remote Controller)

Remote controller (Model:RC-HD133) is option, remote controller is separate accessory.

6.2.1 Camera Setting through Switch that has 3.5φ Stereo Pin Jack

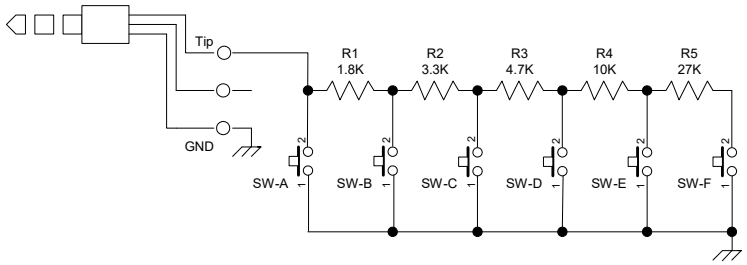
A. Please assign function for each button on switch through control software in advance

B. Connector

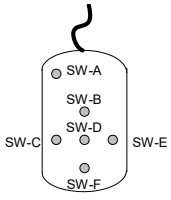


3.5φ Stereo Pin Jack position

C. Switch Circuit Diagram



D. Switch Example



E. Switch Function

The default function assigns for SW-A to SW-F as follow functions.

SW-A: Display OSD Menu
SW-B: Up Cursor (Menu and Select Setting)
SW-C: Left Cursor (Select Setting)
SW-D: Execute
SW-E: Right Cursor (Select Setting)
SW-F: Down Cursor (Menu and Select Setting)

6.2.2 Menu on screen with External Switch

Page 1

```
PAGE 1 2 3 4 5 6
 ALC                ON
 LUMINANCE          100
 AGC                ON
 AEE                ON
 GAIN
 SHUTTER
 GAMMA              MANUAL
```

1) ALC

Selects the auto exposure (AEE) and auto gain (AGC) operation mode from below two modes.
Selection: ON / OFF
Default: ON

a) ON

The auto exposure and AGC operation mode, which is expose and gain adjust automatically based on brightness of image.

b) OFF

The fixed exposure and fixed gain operation mode (auto exposure and AGC are OFF),
which is fixed exposure time controls by “SHUTTER” and fixed gain controls by “GAIN” manually.

2) LUMINANCE

Sets the target Brightness for ALC operation.
The brightness of image maintains by auto exposure and AGC operation.
Setting range: 0 (Dark) to 255 (Bright)
Default: 100

3) AGC

Sets the gain mode for ALC operation from below two modes.
Selection: AUTO / FIXED
Default: AUTO

a) AUTO

The AGC for ALC operation. which is gain adjust automatically based on brightness of image.

b) FIXED

The fixed gain for ALC operation.
The fixed gain controls by “GAIN” manually.

4) AEE

Sets the exposure mode for ALC operation from below two modes.
Selection: AUTO / FIXED
Default: AUTO

a) AUTO

The auto exposure for ALC operation, which is exposure adjusts automatically based on brightness of image.

b) FIXED

The fixed exposure for ALC operation.
The fixed exposure time controls by “SHUTTER” manually.

5) GAIN

Sets the fixed gain, which is valid when “OFF” is selecting at “ALC” or “FIXED” is selecting at “GAIN”.
Setting range: 0 (0.00 dB) to 392 (27.05 dB)

6) SHUTTER

Sets the fixed exposure time, which is valid when “OFF” is selecting at “ALC” or “FIXED” is selecting at “AEE”.
Setting range:

0 (1/60.2 sec.) to 746 (1/21737.3 sec.) at 2160P59.94
0 (1/60.2 sec.) to 746 (1/21737.3 sec.) at 2160P60
0 (1/50.1 sec.) to 746 (1/18218.6 sec.) at 2160P50
0 (1/30.1 sec.) to 746 (1/10959.9 sec.) at 2160P29.97
0 (1/30.1 sec.) to 746 (1/10959.9 sec.) at 2160P30
0 (1/25.1 sec.) to 746 (1/9173.10 sec.) at 2160P25
0 (1/60.2 sec.) to 746 (1/31266.9 sec.) at 1080P59.94
0 (1/60.2 sec.) to 746 (1/31266.9 sec.) at 1080P60
0 (1/50.2 sec.) to 746 (1/26383.3 sec.) at 1080P50
0 (1/120.4 sec.) to 746 (1/61071.4 sec.) at 1080P119.88
0 (1/120.4 sec.) to 746 (1/61071.4 sec.) at 1080P120
0 (1/100.3 sec.) to 746 (1/51724.1 sec.) at 1080P100

7) GAMMA

Selects the Gamma from below nine gamma selection.
It is necessary to set the manual gamma setting with control software through PC.
Setting selection: MANUAL / 0.30 / 0.45 / 0.50 / 0.60 / 0.70 / 0.80 / 0.90 / 1.00
Default: MANUAL (optimal gamma setting)

Page 2

```
PAGE 1 2 3 4 5 6
 WB MODE              AUTO
 R GAIN
 G GAIN               0256
 B GAIN
 SHARPNESS            H04   V04
 CORING               03
```

1) WB MODE

Selects the white balance mode from below two modes.
Selection: AUTO / MANUAL
Default: AUTO

a) AUTO

The auto white balance operation.

b) MANUAL

The manual white balance operation.
The manual white balance adjusts by “R GAIN” and “B GAIN”.

2) R GAIN

Sets the manual R gain for manual white balance.
This is valid when “MANUAL” is selecting at “WB MODE”.
Setting range: 0 to 1,023

3) G GAIN

Sets the G gain for white balance.
Setting range: 0 to 1,023
Default: 256

4) B GAIN

Sets the manual B gain for manual white balance.
This is valid when “MANUAL” is selecting at “WB MODE”.
Setting range: 0 to 1,023

5) SHARPNESS

Sets the Sharpness (Edge Enhancement) of image.

a) H

Sets the sharpness for horizontal direction.
Setting range: 00 (Soft) to 15 (Strong)
Default: 04

b) V

Sets the sharpness for vertical direction.
Setting range: 00 (Soft) to 15 (Strong)
Default: 04

6) CORING

The noise level also emphasizes when using sharpness function.
The SN ratio deteriorates for other than edge parts is prevented by cutting signal level that smaller than this setting.
(The image becomes soft image if this setting sets too large.)

Setting range: 0 to 63
Default: 03

Page 3

PAGE 1 2 **3** 4 5 6			
LINE		ON	
LINE1	H	POS 0000	SIZE 0000
		COLOR BLACK	
	V	POS 0000	SIZE 0000
		COLOR BLACK	
LINE2	H	POS 0000	SIZE 0000
		COLOR BLACK	
	V	POS 0000	SIZE 0000
		COLOR BLACK	

1) LINE

Selects enable or disable for Line markers display.
Four horizontal and four vertical line makers can be display.
This setting is linked “LINE” setting on PAGE 4.
Selection: ON / OFF
Default: ON

a) ON

The line makers can be display.

b) OFF

Line Markers do NOT display.

2) LINE1, LINE2

Sets the color, size (thickness) and position for each line.

a) H POS

Sets the position for horizontal line.
Setting range: 0 (Top) to 2,160 (Bottom)
Default: 0

b) H SIZE

Sets the size (thickness) for horizontal line.
Setting range: 0 (0 line, no horizontal line) to 2,160 (2,160 lines)
Default: 0

c) H COLOR

Selects the color for horizontal line from below sixteen selections.
It is necessary to set the USER0 to USER7 color by control software through PC.
Setting selection: BLACK / WHITE / RED / GREEN / BLUE / CYAN / MAGENTA / YELLOW /
USER0 / USER1 / USER2 / USER3 / USER4 / USER5 / USER6 / USER7
Default: BLACK

d) V POS

Sets the position for vertical line.
Setting range: 0 (Left) to 3,840 (Right)
Default: 0

e) V SIZE

Sets the size (thickness) for vertical line.
Setting range: 0 (0 pixel, no vertical line) to 3,840 (3,840 pixels)
Default: 0

F) V COLOR

Selects the color for vertical line from below sixteen selections.
It is necessary to set the USER0 to USER7 color by control software through PC.
Setting selection: BLACK / WHITE / RED / GREEN / BLUE / CYAN / MAGENTA / YELLOW /
USER0 / USER1 / USER2 / USER3 / USER4 / USER5 / USER6 / USER7
Default: BLACK

Page 4

PAGE 1 2 3 **4** 5 6			
LINE		ON	
LINE3	H	POS 0000	SIZE 0000
		COLOR BLACK	
	V	POS 0000	SIZE 0000
		COLOR BLACK	
LINE4	H	POS 0000	SIZE 0000
		COLOR BLACK	
	V	POS 0000	SIZE 0000
		COLOR BLACK	

1) LINE

Selects enable or disable for Line markers display.
Four horizontal and four vertical line makers can be display.
This setting is linked “LINE” setting on PAGE 3.
Selection: ON / OFF
Default: ON

a) ON

The line makers can be display.

b) OFF

Line Markers do NOT display.

2) LINE3, LINE4

Sets the color, size (thickness) and position for each line.

a) H POS

Sets the position for horizontal line.
Setting range: 0 (Top) to 2,160 (Bottom)
Default: 0

b) H SIZE

Sets the size (thickness) for horizontal line.
Setting range: 0 (0 line, no horizontal line) to 2,160 (2,160 lines)
Default: 0

c) H COLOR

Selects the color for horizontal line from below sixteen selections.
It is necessary to set the USER0 to USER7 color by control software through PC.
Setting selection: BLACK / WHITE / RED / GREEN / BLUE / CYAN / MAGENTA / YELLOW /
USER0 / USER1 / USER2 / USER3 / USER4 / USER5 / USER6 / USER7
Default: BLACK

d) V POS

Sets the position for vertical line.
Setting range: 0 (Left) to 3,840 (Right)
Default: 0

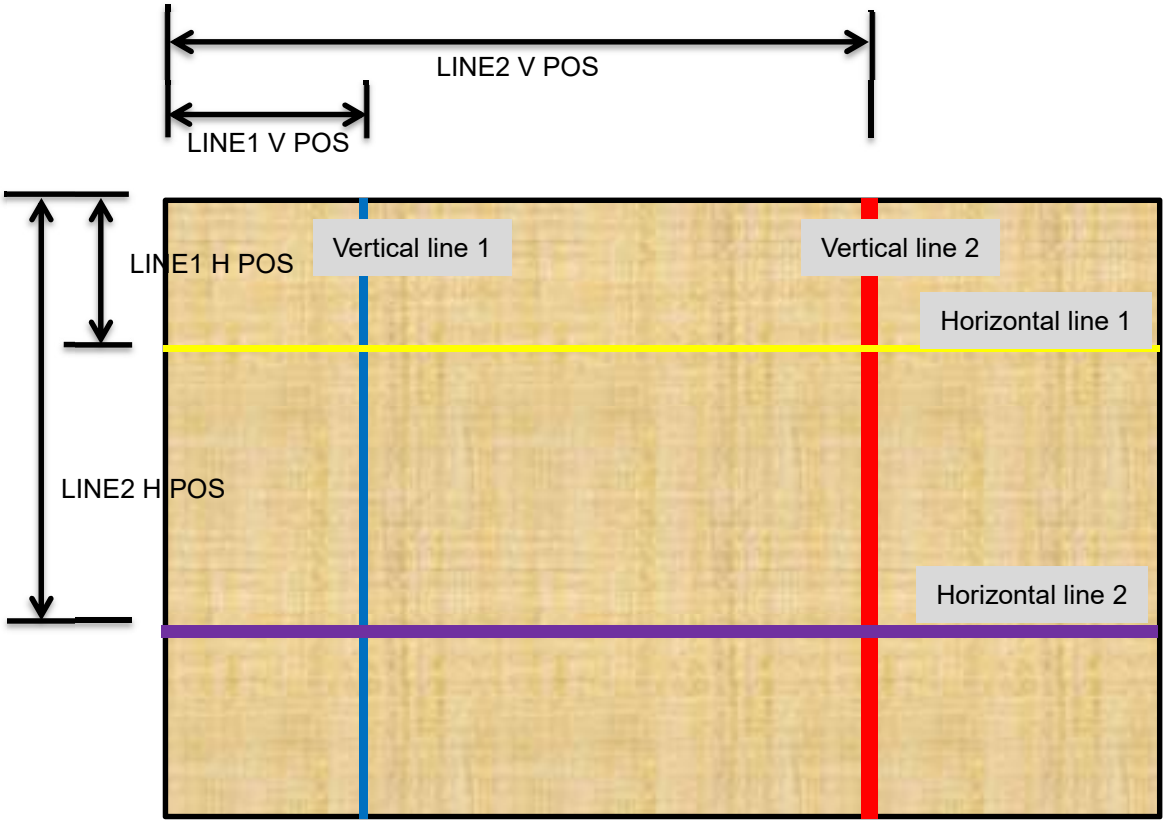
e) V SIZE

Sets the size (thickness) for vertical line.
Setting range: 0 (0 pixel, no vertical line) to 3,840 (3,840 pixels)
Default: 0

F) V COLOR

Selects the color for vertical line from below sixteen selections.
It is necessary to set the USER0 to USER7 color by control software through PC.
Setting selection: BLACK / WHITE / RED / GREEN / BLUE / CYAN / MAGENTA / YELLOW /
USER0 / USER1 / USER2 / USER3 / USER4 / USER5 / USER6 / USER7
Default: BLACK

The example of display lines



Page 5

PAGE 1 2 3 4 **5** 6	
RES / FPS	AUTO
OSD SIZE	x2
PROFILES	PRESET0
PATTERNS	OFF
IMAGE OUTPUT	STANDARD

1) RES / FPS

Selects the image format and frame rate for video output from below twelve output formats.
Please selects the video output format and frame rate to meet specifications of monitor or capturing devices.
When selecting “AUTO”, the camera checks maximum supported video output format and frame rate of connecting monitor or capturing devices then selects video format and frame rate automatically.
Setting selection:
2160P 59.94 / 2160P 60 / 2160P 50 / 2160P 29.97 / 2160P 30 / 2160P 25 /
1080P 59.94 / 1080P 60 / 1080P 50 / 1080P 119.88 / 1080P 120 /1080P 100 / AUTO
Default: AUTO

2) OSD SIZE

Sets the character size of OSD from below eight sizes.
Selection: x1 / x2 / x3 / x4 / x5 / x6 / x7 / x8
Default: x2

3) PROFILE

Preset data PRESET0 to PRESET7 can be apply to the camera.
To change the PRESET, select PRESET and use SAVE function after change the settings.
Setting selection: PRESET0 / PRESET1 / PRESET2 / PRESET3 / PRESET4 / PRESET5 /
PRESET6 / PRESET7
Default: PRESET0

4) PATTERNS

Selects the output signal from below four output signals.
The test pattern can be output from camera to adjust monitor.
Selection: OFF / GRAY / COLOR / GRAY+COLOR
Default: OFF (Video output)

a) OFF

The video is output from camera.

b) GRAY

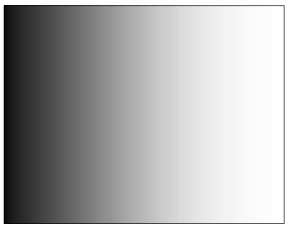
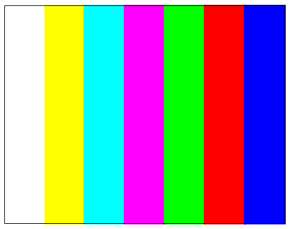
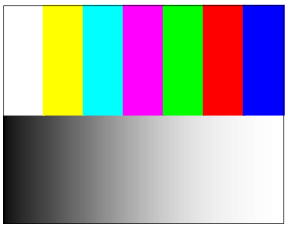
The gray scale test pattern is output from camera.

c) COLOR

The color test pattern is output from camera.

d) GRAY+COLOR

The color pattern (Top) + gray scale (Bottom) test pattern is output from camera.

5) IMAGE OUTPUT

Selects the flip image setting for video output from below four flip modes.
This setting does NOT apply for the test pattern outputs.
Selection: STANDARD / H INVERSION / V INVERSION / HV INVERSION
Default: STANDARD

a) STANDARD

The normal image (no-flip).

b) INVERSION

The horizontal flip image.

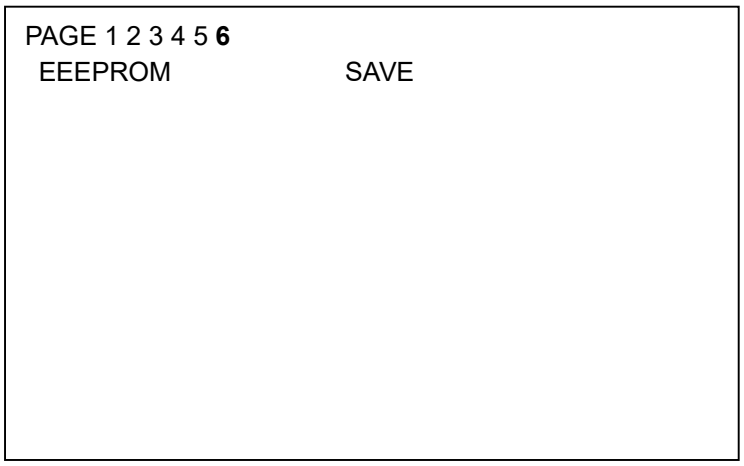
c) V INVERSION

The vertical flip image.

d) HV INVERSION

The horizontal and vertical flip (180 deg. rotate) image.

Page 6



1) EEPROM

The camera settings in page1 to page5 can be saved into camera as PRESET.
OSD SIZE and PATTERNS settings cannot be saved.
To change the PRESET, select PRESET and use this function after change the settings.

SAVE

When executing “SAVE”, the confirmation message “ARE YOU OK?” is displayed.
When executing again, the settings save into camera.
The message “COMPLETE” is displayed after settings are saved.
The setting save is abort when selecting other than “Execute” button while “ARE YOU OK?” message is displaying.

RESET

When executing “PRESET”, the confirmation message “ARE YOU OK?” is displayed.
When executing again, the factory default settings load onto camera.
The message “COMPLETE” is displayed after factory default settings are loaded.
It is necessary to power off / on camera to apply factory default settings to camera.
The setting save is abort when selecting other than “Execute” button while “ARE YOU OK?” message is displaying.

Note: When executing “RESET”, all preset number of PRESET go back to factory default.

7 Control Software User's Guide

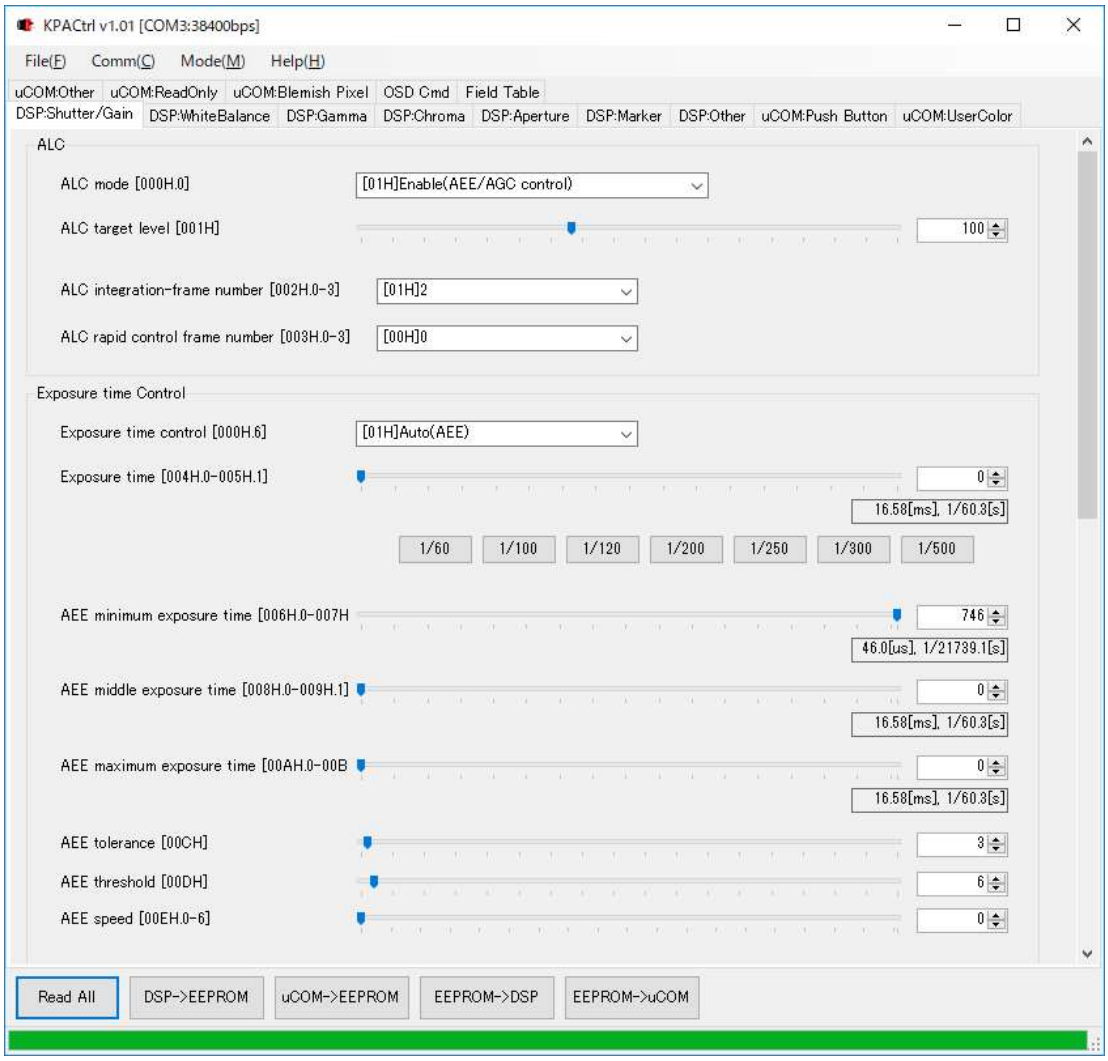
7.1 System Requirements

- **+12V DC Power Supply: UN310-1210**
- **Communication Tool (communicate through USB port): JIG-USB-HD**
- **Control Software: KPACtrl**

7.2 Basic Operating Procedure

The power supply connects to camera, and communication tool connects to PC through USB cable

After installing KPACtrl, control software can be launched from KPACtrl.exe.



Selects the COM port number through "Port Setting" under "Comm(C)" in menu.
Selects "Read All" button to read all settings from camera.

All camera settings can be configurable through control software.

7.3 Button Descriptions

Read All
Read out All DPS register and uCOM register values from camera.
Please execute this button when power on camera every time.

DSP -> EEPROM
Save the DSP register values (that values are on DSP Tabs) into EEPROM on camera.

uCOM -> EEPROM
Save the uCOM register values (that values are on uCOM Tabs) into EEPROM on camera.

EEPROM -> DSP
Read the DSP register values from EEPROM on camera.

EEPROM -> uCOM
Read the uCOM register values from EEPROM on camera.

7.4 The Difference of uCOM register and DSP register

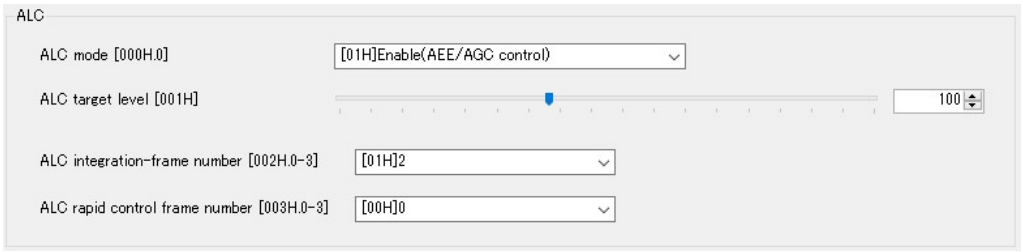
Mainly video control functions are in DSP register area.
The communication settings and other functions such as button settings are in uCOM register.
DSP has eight User Presets and user can configure each DSP Preset for each application.

7.5 Functional Description

DSP: Shutter/Gain

The shutter and gain settings are adjustable. These settings can be change each DSP preset.

ALC



1) ALC Mode
   Enable (AEE/AGC control) or disable (Fixed exposure / fixed gain) is selectable for ALC mode.
   When selecting “Enable” at ALC mode, “Exposure time control”, “Gain control”, “ALC Target level”, “ALC integration-frame number” and “ALC rapid control frame number” can be configurable.
   Please selects “Disable” at ALC mode when camera operating with fixed exposure and fixed gain.

2) ALC Target level
   The target brightness level for AEE and AGC operation.
   Adjust the brightness of image with AEE and AGC control, to brightness of image becomes same as this target brightness level with AEE and AGC control.

3) ALC integration-frame number
   ALC control speed that is brightness of image becomes same as ALC target level.

4) ACL rapid control frame number
   Sets number of frames for ALC rapid control when power on camera or change “Resolution / Framer rate”.
   ALC control speed (ALC integration-frame number) is disregard within this frames.

Exposure time Control

1) Exposure time control
"Fixed Exposure time" or "Auto (AEE)" is selectable for Exposure time control.

2) Exposure time
Sets the exposure time for Fixed Exposure time.

3) AEE minimum exposure time
4) AEE middle exposure time
5) AEE maximum exposure time
Sets range of minimum, middle and maximum exposure time for AEE control.
These three settings should be
"AEE minimum exposure time" =< "AEE middle exposure time" =< "AEE maximum exposure time".
Please refer "ALC operation" for more details.

6) AEE tolerance
AEE control stops when difference between "current brightness of image" and "ALC target level" becomes within this value.

7) AEE threshold
AEE control starts when difference between "current brightness of image" and "ALC target level" becomes greater than "AEE tolerance + AEE threshold".

8) AEE speed
Sets the maximum amount of exposure time change for AEE control.
(There is no limitation for maximum amount of exposure time when setting "0")

Gain Control

1) Gain control
“Fixed Gain” or “Auto (AGC)” is selectable for Gain control.

2) Gain value
Sets the gain value for “Fixed Gain”

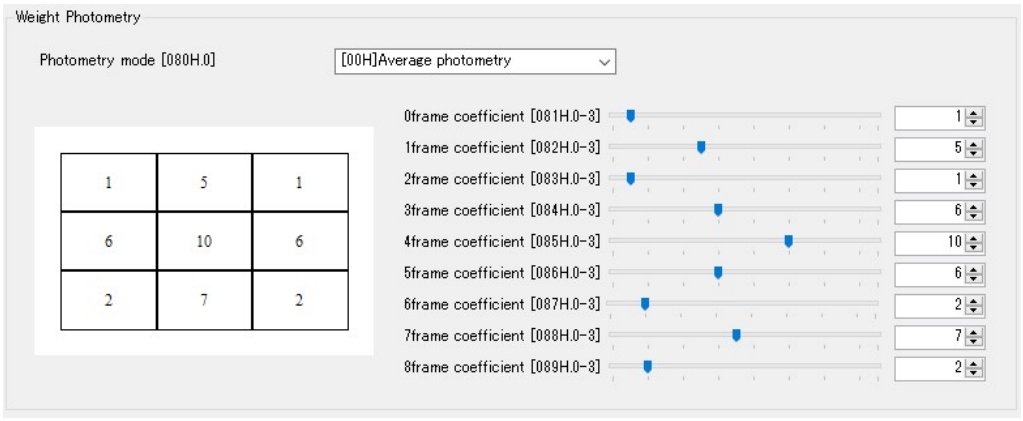
3) AGC minimum gain
4) AGC middle gain
5) AGC maximum gain
Sets range of minimum, middle and maximum gain for AGC control.
These three settings should be
“AGC minimum gain” =< “AGC middle gain” =< “AGC maximum gain”.
Please refer “ALC operation” for more details.

6) AGC tolerance
AGC control stops when difference between “current brightness of image” and “ALC target level” becomes smaller than this value.

7) AGC threshold
AGC control starts when difference between “current brightness of image” and “ALC target level” becomes greater than “AGC tolerance + AGC threshold”.

8) AGC speed
Sets the maximum amount of gain change for AGC control.
(There is no limitation for maximum amount of gain when setting “0”)

Weight Photometry



1) Photometry mode
“Average photometry” or “Weight photometry” is selectable for Photometry mode.
The brightness of image adjusts automatically by weighting for nine frames on image.

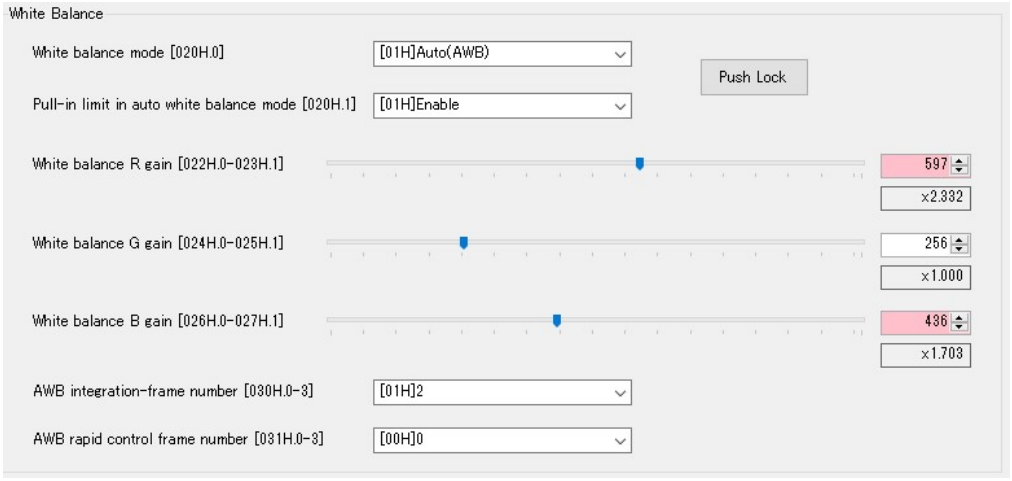
a) Average photometry
Equal weighting for all nine frames

b) Weight photometry
Sets weighting for each frame

DSP: WB

The white balance settings are adjustable. These settings can be change each DSP preset.

White Balance



1) White balance mode
“Manual” or “Auto (AWB)” white balance is selectable for White balance mode.

   a) Manual
   The camera operates with manual white balance.

   b) Auto (AWB)
   The camera operates with auto white balance.

2) Pull-in limit in auto white balance mode
“Enable” or “Disable” is selectable for Pull-in limit in auto white balance mode.
When selecting “Enable”, pull-in gain (R, B gain) is limited for auto white balance operation.

3) Push Lock
Executes push to set white balance then save white balance mode and gain into EEPROM.

4) White balance R gain
Sets R gain for manual white balance operation.

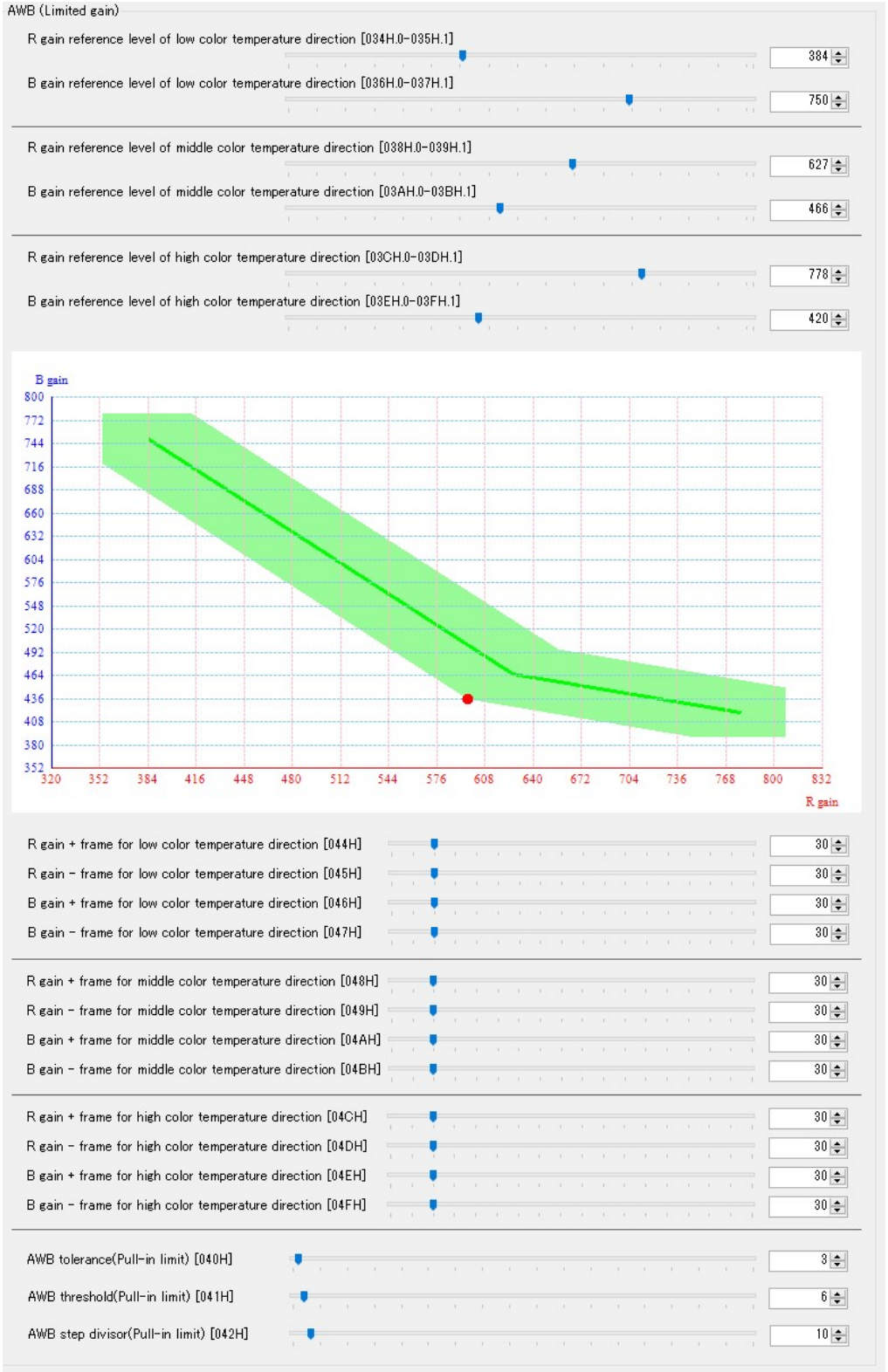
5) White balance G gain
Sets G gain for white balance.

6) White balance B gain
Sets B gain for manual white balance operation.

7) AWB integration-frame number
AWB processing speed (frame).

8) AWB rapid control frame number
Sets number of frames for AWB rapid control when power on camera or change “Resolution / Framer rate”.
AWB processing speed (AWB integration-frame number) is disregard within this frames.

AWB (Limited gain)



1) R gain reference level and B gain reference level for low color temperature direction
Sets the reference level for R gain and B gain at low color temperature side of pull-in AWB operation.

2) R gain reference level and B gain reference level for middle color temperature direction
Sets the reference level for R gain and B gain at middle color temperature side of pull-in AWB operation.

3) R gain reference level and B gain reference level for high color temperature direction
Sets the reference level for R gain and B gain at high color temperature side of pull-in AWB operation.

4) “R gain +/- frame” and “B gain +/- frame” for low color temperature direction
Sets the range of R gain and B gain at low color temperature side of pull-in AWB operation.

5) “R gain +/- frame” and “B gain +/- frame” for middle color temperature direction
Sets the range of R gain and B gain at middle color temperature side of pull-in AWB operation.

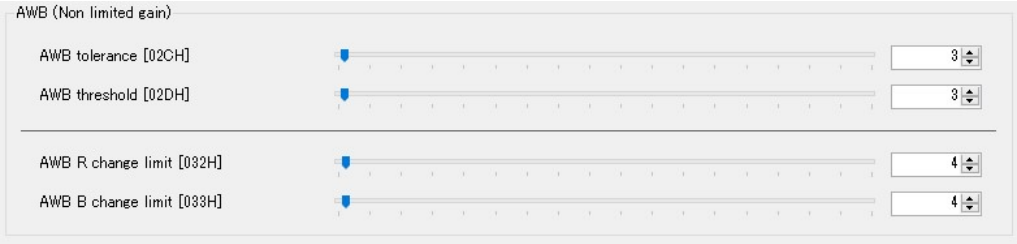
6) “R gain +/- frame” and “B gain +/- frame” for high color temperature direction
Sets the range of R gain and B gain at high color temperature side of pull-in AWB operation.

7) AWB tolerance (Pull-in limit)
Pull-in AWB processing stops when AWB tolerance becomes smaller than this value.

8) AWB threshold (Pull-in limit)
Pull-in AWB processing starts when AWB tolerance becomes greater than
“AWB tolerance (Pull-in limit)” + AWB threshold (Pull-in limit)”.

9) AWB step division (Pull-in limit)
Sets step division for AWB for Pull-in AWB operation.

AWB (Non limited gain)



1) AWB tolerance
The tolerance for none pull-in AWB operation.
(This is valid when selecting “Disable” at Pull-in limit in auto white balance mode)
AWB processing stops when AWB tolerance becomes smaller than this value.

2) AWB threshold
The threshold for none pull-in AWB operation.
(This is valid when selecting “Disable” at Pull-in limit in auto white balance mode)
AWB processing starts when AWB tolerance becomes smaller than this value.

3) AWB R and B change limit
Sets none pull-in AWB processing speed.
Sets the maximum amount of R and B gain change for none pull-in AWB processing.
(This is valid when selecting “Disable” at Pull-in limit in auto white balance mode)
(There is no limitation for maximum amount of gain when setting “0”)

DSP: Gamma

The Gamma settings are adjustable. These settings can be change each DSP preset.

Gamma

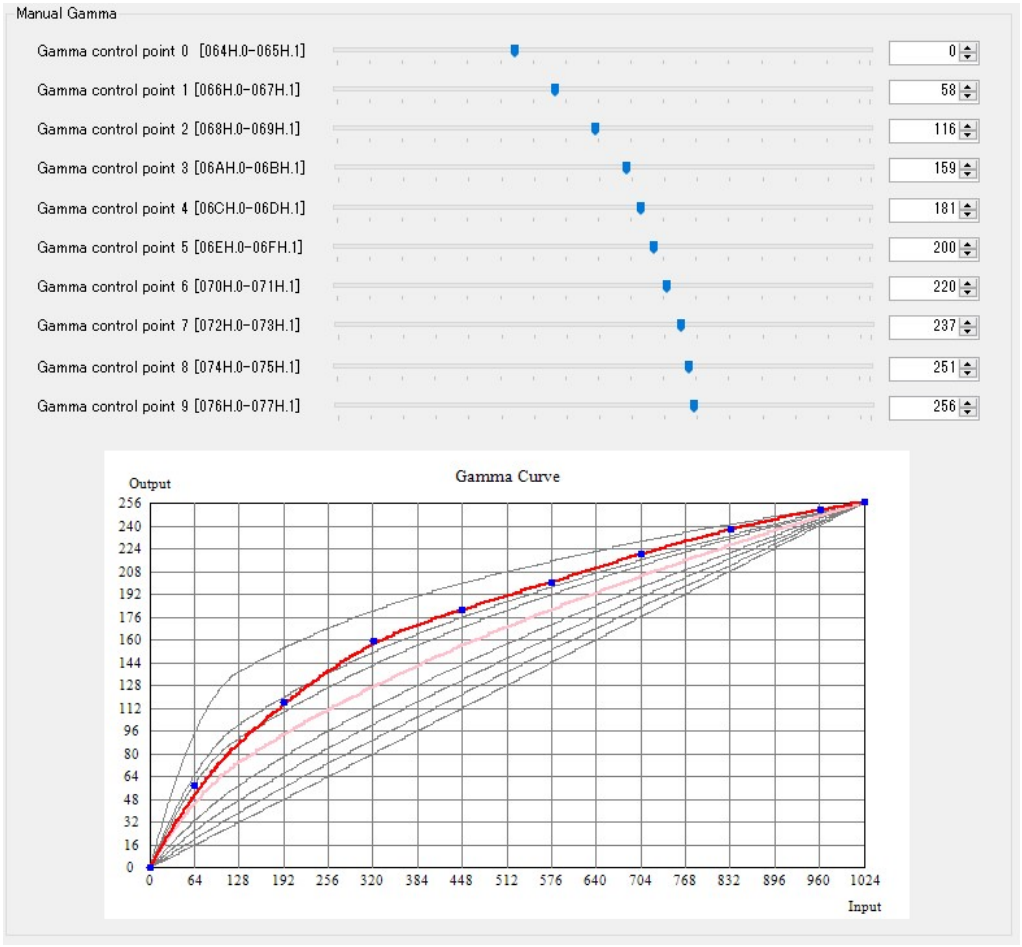
1) Gamma mode
“Preset” or “Manual” is selectable for Gamma mode.

   a) Preset
   Selects gamma from “Through, 0.3, 0.45, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0” at “Preset gamma”.

   b) Manual
   Sets the manual gamma control point 0 to point 9 with checking below gamma curve.

2) Preset gamma
Selects gamma from “Through, 0.3, 0.45, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0” when selecting “Preset” at Gamma mode.

Manual Gamma

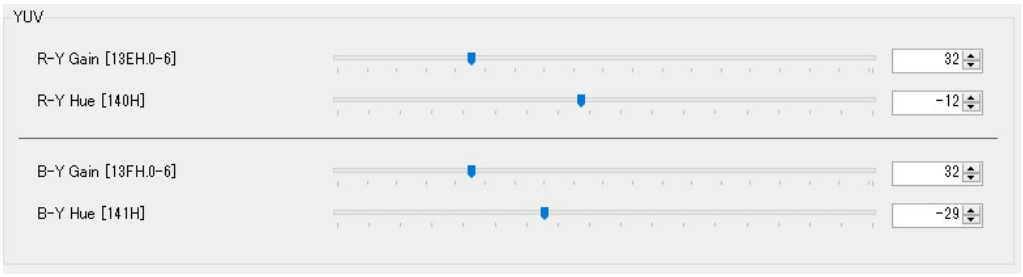


1) Manual Gamma Control Points
   Sets the manual gamma control point 0 to point 9 with checking gamma curve.

DSP: Chroma

The chroma settings are adjustable. These settings can be change each DSP preset.

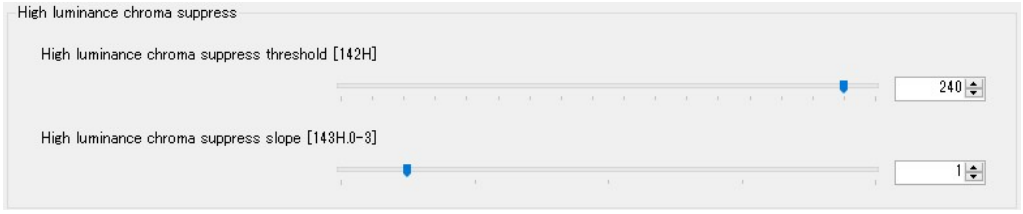
YUV



1) Color Saturation
   Set R-Y Gain and B-Y Gain for color saturation.

2) Color hue
   Set R-Y Hue and B-Y Hue for color hue.

High luminance chroma suppress



1) High luminance chroma suppress
   The false color may appear on high luminance part of image.
   Adjust “High luminance chroma suppress threshold” and “High luminance chroma suppress slope” to eliminate false color.

DSP: Aperture

The apertures (edge enhancement) settings are adjustable. These settings can be change each DSP preset.

Aperture

1) Aperture H. gain
   Sets aperture for horizontal direction.
   When setting greater value for this, horizontal edge enhancement becomes strong.

2) Aperture V. gain
   Sets aperture for vertical direction.
   When setting greater value for this, vertical edge enhancement becomes strong.

3) Aperture coring
   When using aperture processing, noise level is also enhanced.
   The signal level smaller than this value will be cut then prevent deterioration of SN ratio at flat part (excluding edge) of image.

DSP: Marker

The line maker settings are adjustable. These settings can be change each DSP preset.

Maker

1) Line maker

“Disabled” or “Enabled” is selectable for Line maker.

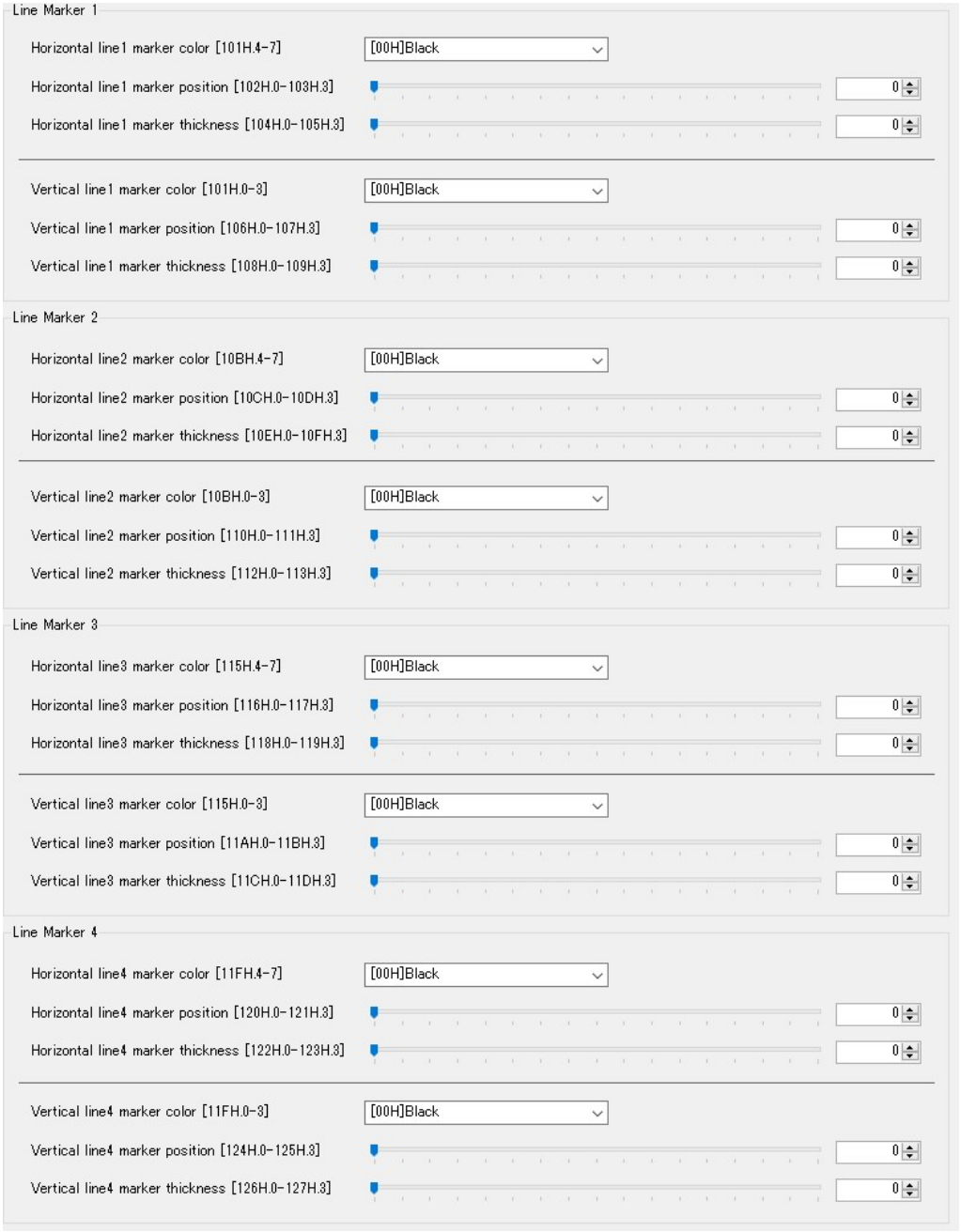
a) Disabled

Disabled the line maker displays. (No display)

b) Enabled

Enabled the line maker displays.
Sets the color and thickness of horizontal and vertical lines.
When the thickness of line is “0”, line maker does not display.
Adjusts display position of line maker with “Line maker position”.

Line Maker 1 to 4



1) Horizontal line maker color (Line Maker 1 to 4)
   Selects color for individual horizontal line.

2) Horizontal line maker position (Line Maker 1 to 4)
   Sets display position for individual horizontal line.

3) Horizontal line maker thickness (Line Maker 1 to 4)
   Sets thickness for individual horizontal line.

4) Vertical line maker color (Line Maker 1 to 4)
Selects color for individual vertical line.

5) Vertical line position (Line Maker 1 to 4)
Sets display position for individual vertical line.

6) Vertical line thickness (Line Maker 1 to 4)
Sets thickness for individual vertical line.

DSP: Other

“Resolution / Frame rate”, horizontal flip, vertical flip and “color / black and white” settings are adjustable. These settings can be change each DSP preset.

1) Resolution / Frame rate

“Auto”, “2160P 59.94”, “2160P 60”, “2160P 50”, “2160P 29.97”, “2160P 30”, “2160P 25”, “1080P 59.94”, “1080P 60”, “1080P 50”, “1080P 119.88”, “1080P 120” or “1080P 100” is selectable for “Resolution / Frame rate”.

When selecting “Auto”, the camera checks maximum supported video output format and frame rate of connecting monitor or capturing devices then selects video format and frame rate automatically.

2) Horizontal flip

“OFF” or “ON” are selectable for horizontal flip.

a) OFF
The normal image is out.

b) ON
The horizontal flipped image is out.

3) Vertical flip

“OFF” or “ON” is selectable for vertical flip.

a) OFF
The normal image is out. (when selecting “OFF” at “Horizontal flip”)

b) ON
The vertical flipped image is out.

4) Color / Black and white

“Color” or “Black and white” is selectable.

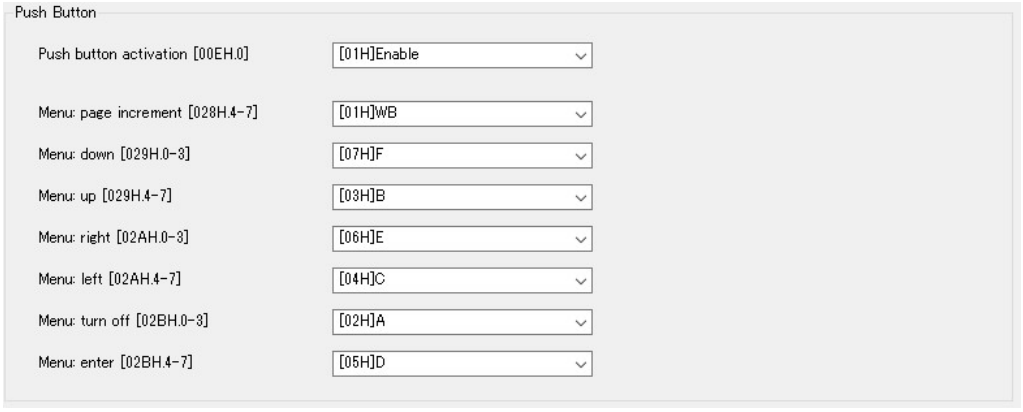
a) Color
The color image is out.

b) Black and white
The monochrome image is out.

uCOM: Push Button

The push button settings are adjustable. These settings are common settings for all DSP preset.

Push button



1) Push button activation
   “Enable” or “Disable” is selectable for push button activation.

   a) Enable
      The camera settings can be change by push button or external switch.

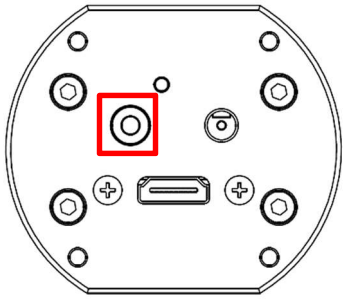
   b) Disable
      The push button and external switch have no function.

2) OSD control switch
   Selects switch for below functions while display menu.

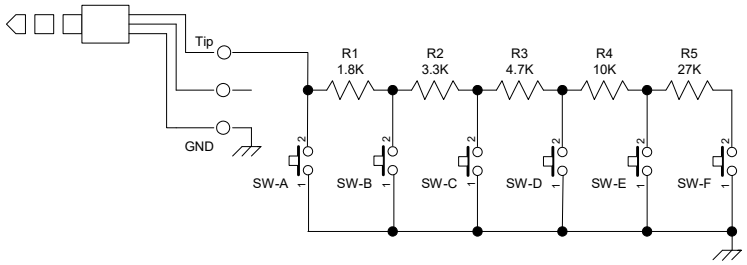
   a) Menu page increment
   b) Menu down
   c) Menu up
   d) Menu right
   e) Menu left
   f) Menu turn off
   g) Menu enter

3) External switch

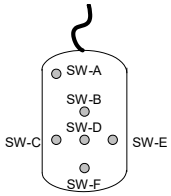
Please use 3.5ϕ Stereo Pin Jack for external switch.



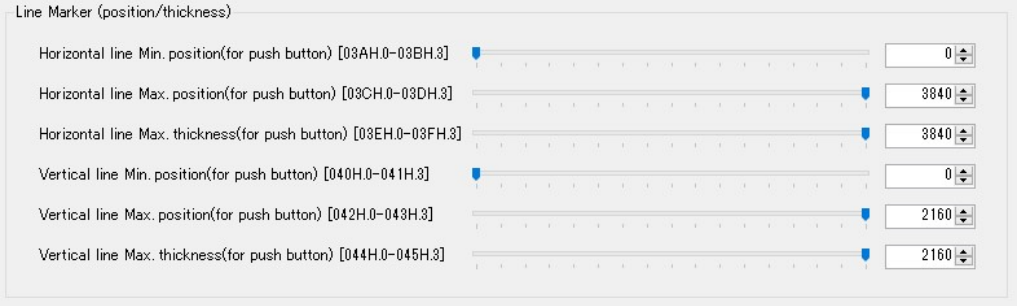
Switch Circuit Diagram



Switch Example



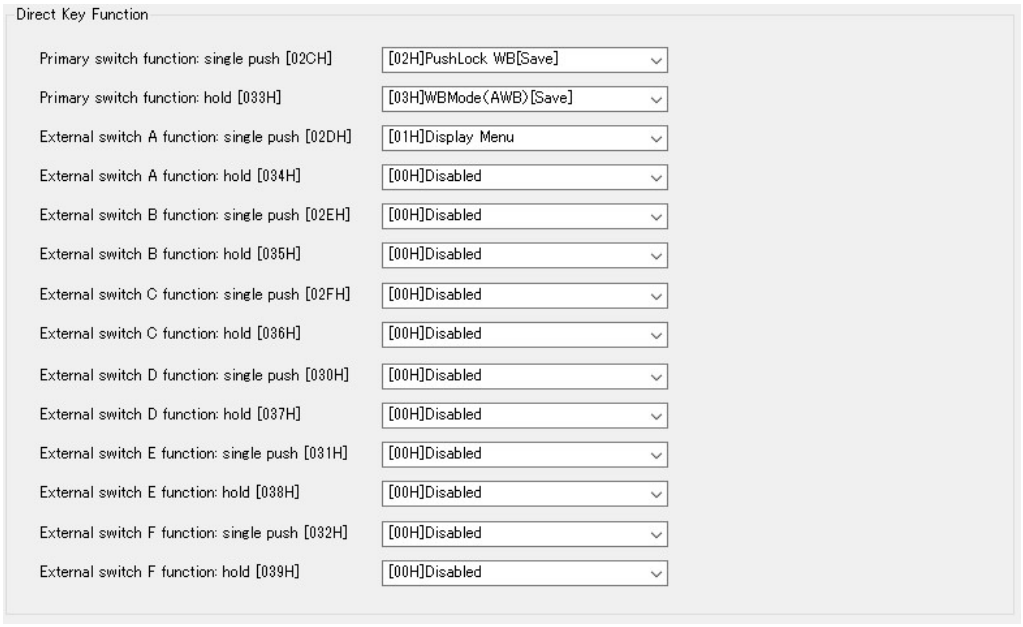
Line Maker (position / thickness)



1) Controllable range for line maker position by push button
   The line maker position can be change between “Min. position” and “Max. position”.
   The controllable range for position can be adjusting individually.

2) Controllable range for line maker thickness by push button
   The line maker thickness can be change between “Min. thickness” and “Max. thickness”.
   The controllable range for thickness can be adjusting individually.

Direct Key Function



1) Switch function (push / hold)
Selects function (push and hold) to assign “Push button (SW-WB)” on camera and external switch SW-A to SW-F.

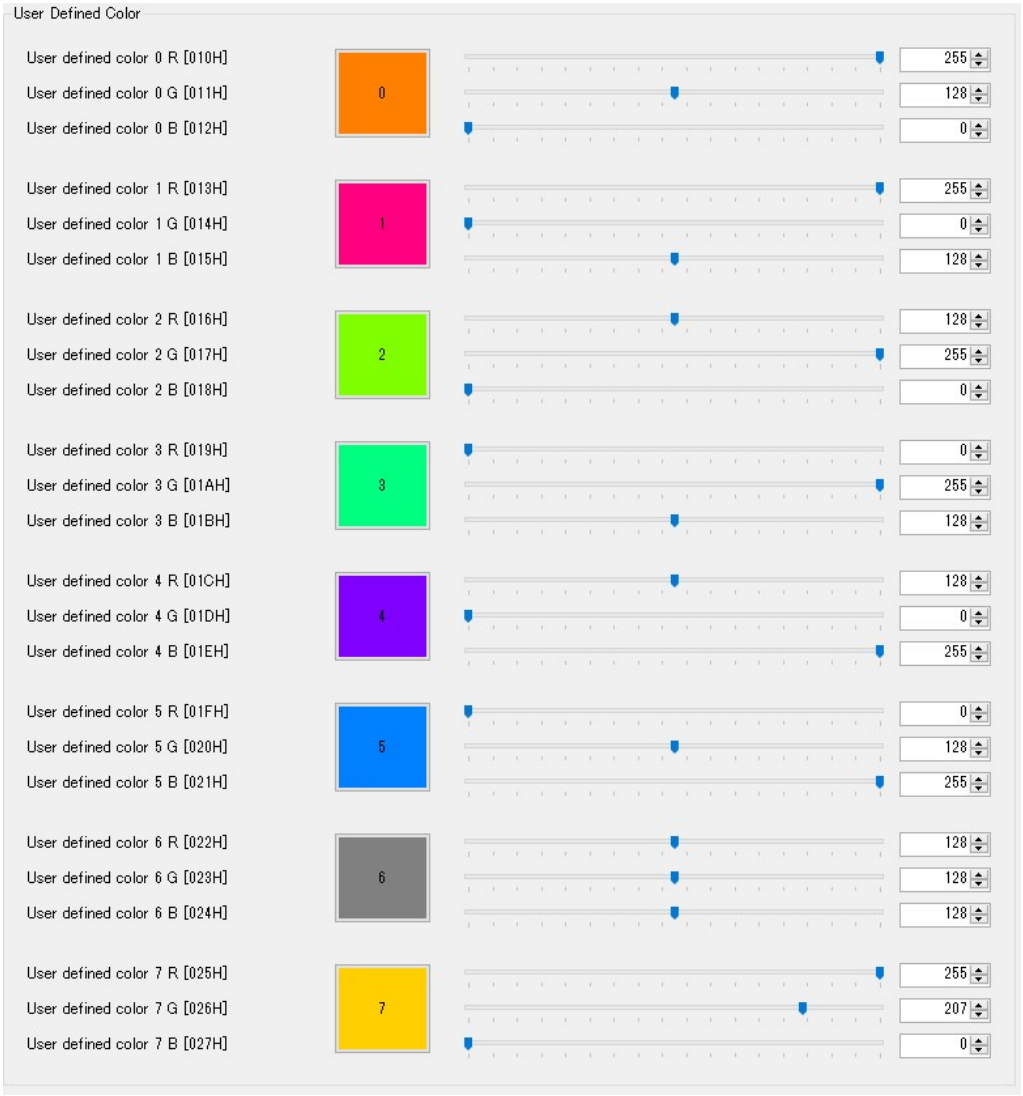
The below functions are assignable for switch.

Disable	Display Menu
PushLock WB [Save]	WBMode (AWB) [Save]
Change H Inversion	Change V Inversion
Change HV Inversion	Change H Inversion [Save]
Change V Inversion [Save]	Change HV Inversion [Save]
Change display line	Change display line [Save]
H Line Maker 1 Position (+)	H Line Maker 1 Position (-)
V Line Maker 1 Position (+)	V Line Maker 1 Position (-)
H Line Maker 2 Position (+)	H Line Maker 2 Position (-)
V Line Maker 2 Position (+)	V Line Maker 2 Position (-)
H Line Maker 3 Position (+)	H Line Maker 3 Position (-)
V Line Maker 3 Position (+)	V Line Maker 3 Position (-)
H Line Maker 4 Position (+)	H Line Maker 4 Position (-)
V Line Maker 4 Position (+)	V Line Maker 4 Position (-)
UserPreset (+)	UserPreset Reset

uCOM: User Color

The user color can be assign for line maker color, is adjustable.
These settings are common settings for all DSP preset.

User Defined Color



1) User defined color (1 to 7)
Adjust Red, Green and Blue component for each user defined color.

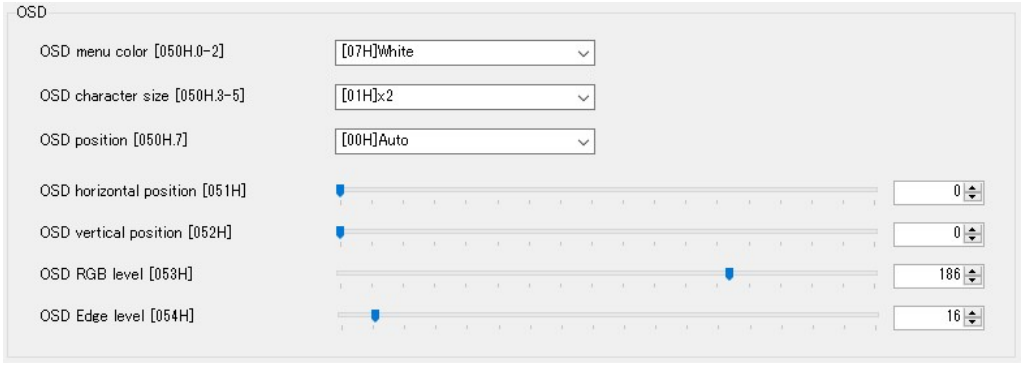
uCOM: Other

The user preset, OSD display, communication, output range and test pattern settings are adjustable.

User Preset

1) User Preset
“Preset0”, “Preset1”, “Preset2”, “Preset3”, “Preset4”, “Preset5”, “Preset6” or “Preset7” is selectable for current DSP preset.
The parameters on [DSP:] started tab are adjustable for individual preset.

OSD



1) OSD menu color
Selects color for OSD menu.

2) OSD character size
Selects character size for OSD menu.

3) OSD position
“Auto” or “Manual” is selectable for start position of OSD menu.

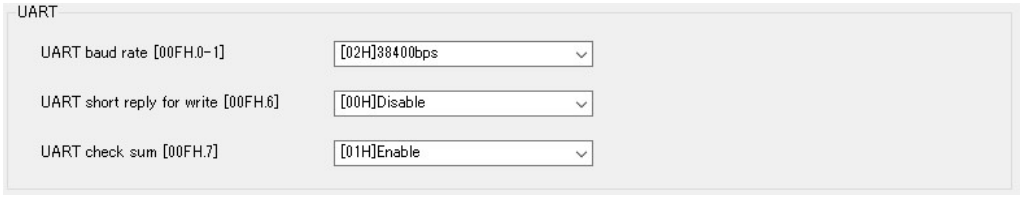
a) Auto
The display starts position for OSD menu adjusts automatically.

b) Manual
The display starts position for OSD menu adjusts manually.
Adjust “OSD horizontal position” and “OSD vertical position”.

4) OSD RGB level
Sets brightness level of character for OSD menu.

5) OSD Edge level
Sets edge level of character for OSD menu.

UART



1) UART baud rate
"9600bps", "19200bps" or "38400bps" is selectable for UART baud rate.

2) UART short replay for write
"Disable" or "Enable" is selectable for UART short replay for write.
When selecting "Disable", return data does not include update data for write command.

3) UART check sum
"Disable" or "Enable" is selecting for UART check sum.
When selecting "Disable", executes sending command even check sum does not match.

Other

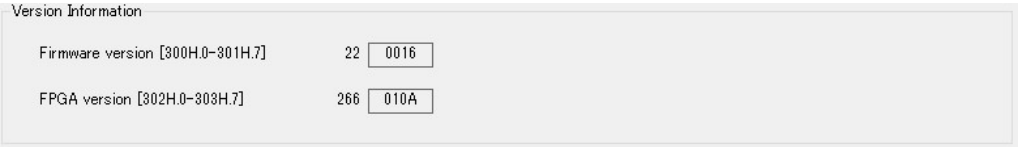
1) HDMI out range
"Limited" or "Full" is selectable for HDM output range.

2) Test pattern selection
"OFF" (image out), "Gray Scale", "Color Bar" or "Color Bar + Gray Scale" is selectable.

uCOM: ReadOnly

The firmware version and FPGA version of camera can be check.

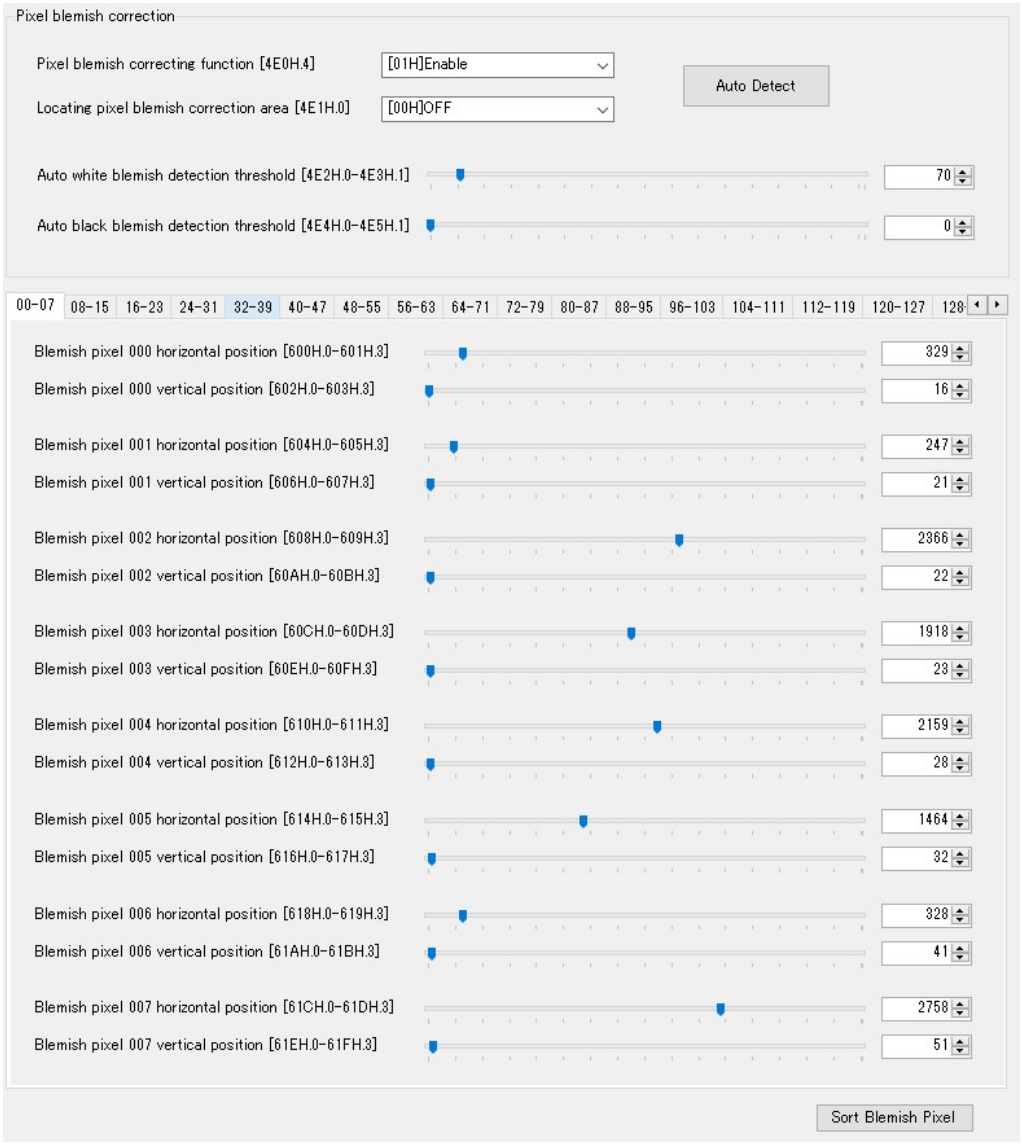
Version Information



uCOM: Blemish Pixel

The defective pixel correction settings are adjustable. The maximum 512 defective pixels can be correct. These settings are common settings for all DSP preset.

Pixel blemish correction



1) Pixel blemish correcting function
   “Enable” or “Disable” is selectable.

   a) Enable
      The defect pixel is corrected image is out.

   b) Disable
      The original image that is not correcting defective pixel.

2) Locating pixel blemish correction area
“OFF” or “ON” is selectable.
When selecting “ON”, defective pixel is highlighted on image.

3) Auto Detect
Executes auto defective pixel detection.
It is necessary to shield camera when executing auto detect.

4) Auto white blemish detection threshold
Sets the detection threshold of white defective pixel for auto defective pixel detection.
If pixel level is greater than this value, pixel is white defective pixel.

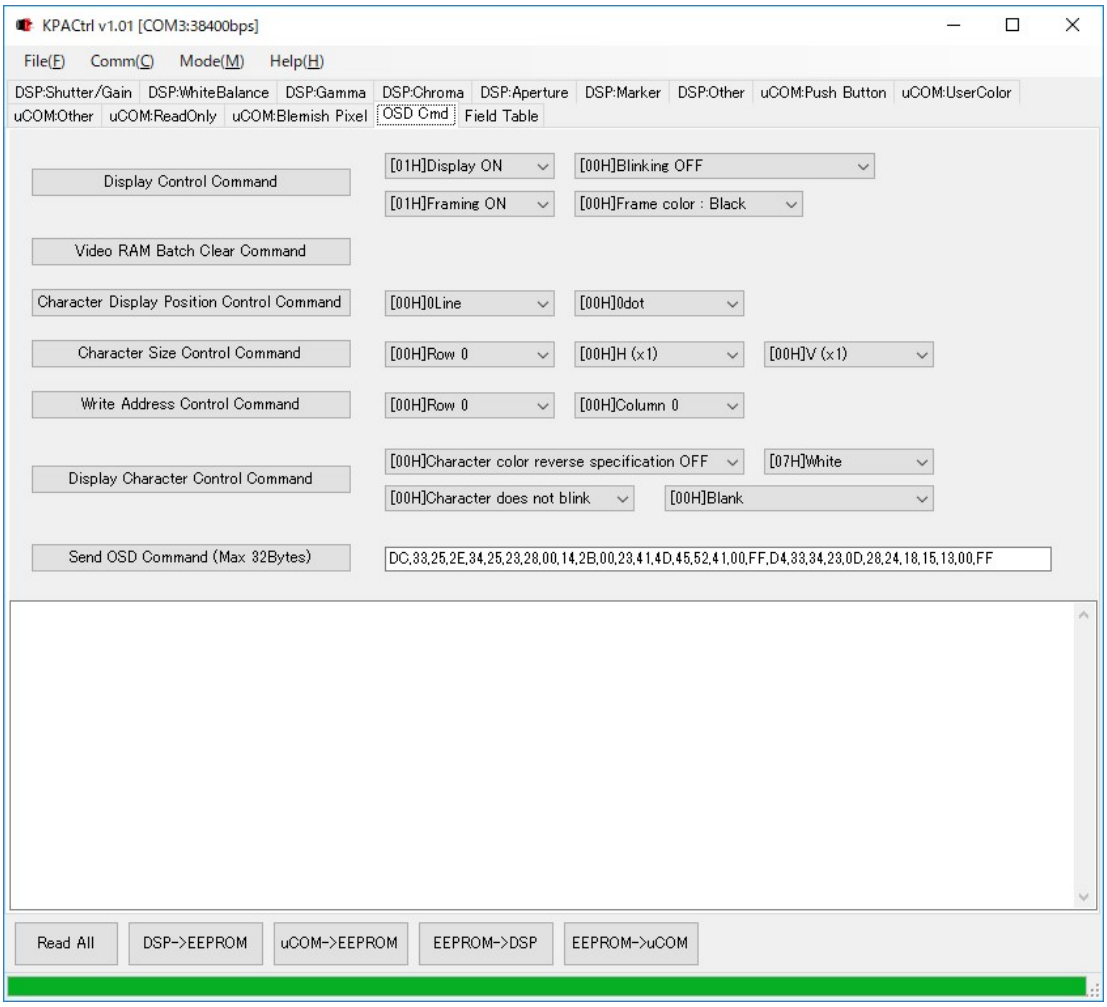
5) Auto black blemish detection threshold
Sets the detection threshold of black defective pixel for auto defective pixel detection.
If pixel level is smaller than this value, pixel is black defective pixel.

6) Blemish pixel 001 to 512 position
Sets horizontal and vertical position for defective pixel.

7) Short Blemish Pixel
The position for defective pixel has to order of raster scan (upper left on image to lower right on image).
The position for defective pixels are sorting as raster scan order.

OSD Cmd

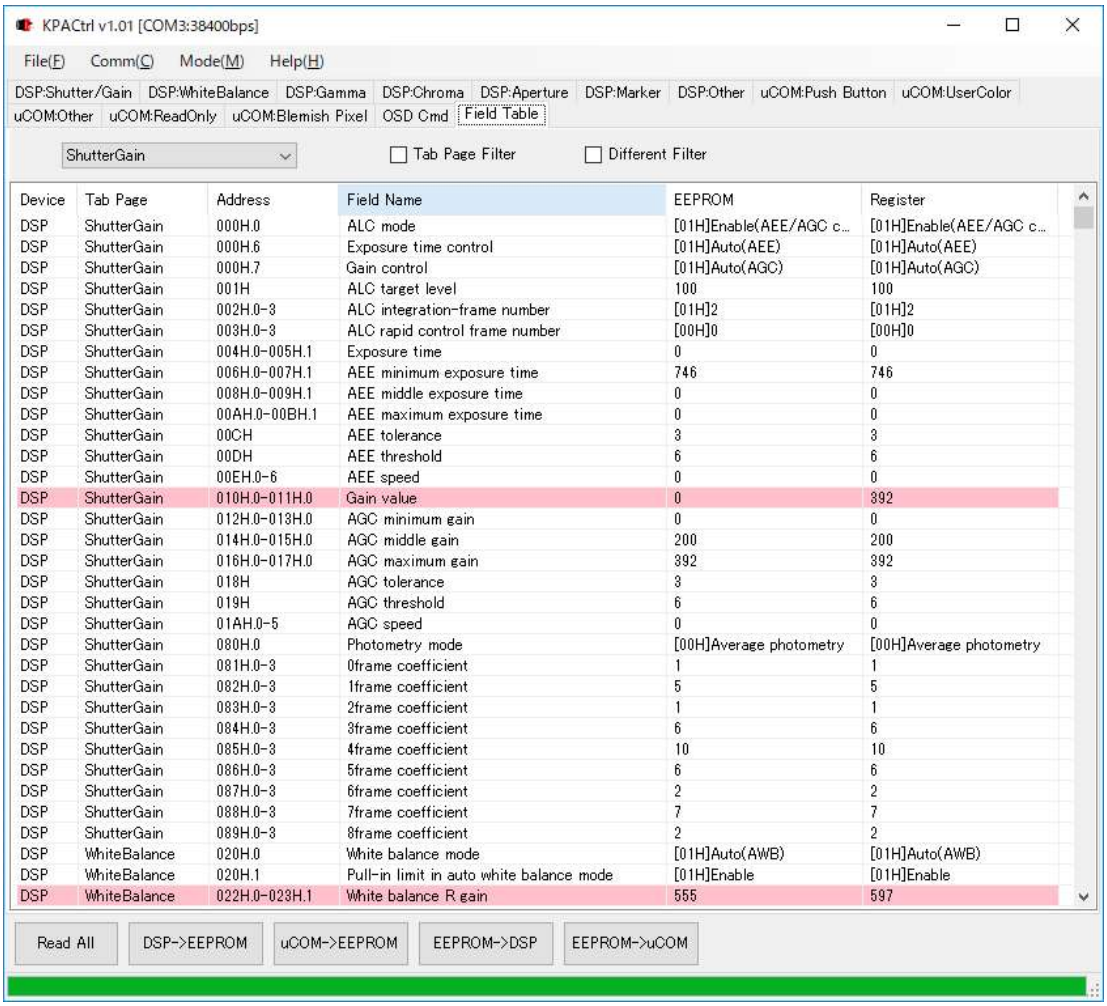
The OSD functionality can be check.



Field: Table

The parameters can be check on the list.

When selecting left click on “Register” value on each parameter, parameter can be change on this list.



8 The communication protocol specifications

8.1 Communication settings

	Setting
Baud rate	9,600 bps / 19,200 bps / 38,400 bps (Default)
Data bit	8 bits
Parity	None
Stop bit	1 bit
Flow control	None

8.2 Communication format

The format for the sending / receiving data between PC and camera is in below:

SOF	Command	Function	Data length	Data	Check sum	EOF
8bits	8bits	1bit	15bits	[Data length] byte (variable)	8bits	8bits

Details for the format

	Details
SOF	Start Of Frame. This value is always “0x02”.
Command	Command code. Please refer “The Camera Control Command” for more details.
Function	0: Reading or receiving data from camera 1: Writing or sending data to camera Note: This value is always “0” when camera responds.
Data length	This “Data length” value tells how many bytes “Data” is contained. This “Data length” must be specified in bytes.
Data	Writing or receiving data. The size must be specified size as “Data length”.
Check sum	“Check sum” function is verifying the integrity of communication transmission. “Check sum” value should equal last (low) eight bits of summary of [“Command” + “Function” + “Data length” + “Data”].
EOF	End Of Frame. This value is always “0x03”.

8.3 Camera control commands

All data in this section is described in “Hexadecimal format (HEX)”.

8.3.1 The command list for the communication

Command (HEX)	Command details
4A	The command to read / write to IC (EEPROM, uCOM or DSP) on camera. In the case of writing, if 256 bytes data must be written, data must be written eight times separately since maximum number of addresses can be written at once is 32 addresses. [SLV]: Slave address (Please refer “Slave address list”) [START_H] x 16 + [START_L]: Start address (0000 to 0DFF) [END_H] x 16 + [END_L]: End address (0000 to 0DFF) [Data (i)]: Data on address I [DataLenH]: Upper Byte of “[END_H] x16 + [END_L]” – “[START_H] x 16 + [START_L]” + 6 [DataLenL]: Lower Byte of “[END_H] x16 + [END_L]” – “[START_H] x 16 + [START_L]” + 6 The format for reading from IC on camera ・Sending data 02, 4A, 00, 05, [SLV], [START_H], [START_L], [END_H], [END_L], [CHK], 03 [CHK] = Lower 8bits of “4A + 00 + 05 + [SLV] + [START_H] + [START_L] + [END_H] + [END_L]” ・Receiving data 02, 4A, [DataLenH], [DataLenL], [SLV], [START_H], [START_L], [END_H], [END_L], [DATA (START)], [DATA (START + 1)], … , [DATA (END)], [CHK], 03 [CHK] = Lower 8bits of “4A + [DataLenH] + [DataLenL] + [SLV] + [START_H] + [START_L] + [END_H] + [END_L] + [DATA (START)] + [DATA (START + 1)] + … + [DATA (END)]” e.g. Sending command read data from 0000 to 03FF addresses of IC (Slave address: 21[h]) (02, 4A, 00, 05, 21, 00, 00, 03, FF, 72, 03)

Command (HEX)	Command details
4A	The format for writing data to IC on camera ・Sending data 02, 4A, [DataLenH] + 80, [DataLenL], [SLV], [START_H], [START_L], [END_H], [END_L], [DATA (START)], [DATA (START + 1)], …, [DATA (END)], [CHK], 03 [CHK] = Lower 8bits of "4A + ([DataLenH] +80) + [DataLenL] + [SLV] + [START_H] + [START_L] + [END_H] + [END_L] + [DATA (START)] + [DATA (START + 1)] + … + [DATA (END)]" ・Receiving data 02, 4A, [DataLenH], [DataLenL], [SLV], [START_H], [START_L], [END_H], [END_L], [DATA (START)], [DATA (START + 1)], …, [DATA (END)], [CHK], 03 [CHK] = Lower 8bits of "4A + [DataLenH] + [DataLenL] + [SLV] + [START_H] + [START_L] + [END_H] + [END_L] + [DATA (START)] + [DATA(START + 1)] + … + [DATA(END)]" e.g. Sending data to write "23" to address 0010 of IC (Slave address: 21[h]) (02, 4A, 80, 06, 21, 00, 10, 00, 10, 23, 34, 03)
50	This command to send OSCD (On Screen Character Display) command to camera. Up to 32 bytes OSCD command can be send at once. In order to generate OSCD, sets "50" at "Command","OSCD command" at "Data" and "number of byets of OSCD command" at "Data length". Please refer "OSCD (On Screen Character Display) command" for more details. e.g. Sending command to display "0123" on third low of first column. (02, 50, 80, 0A 08, 92, 18, 38, DC, 10, 11, 12, 13, FF, E5, 03)

8.3.2 Slave address for the ICs (8 bits) list

IC	Slave address	Descriptions
DSP	81	DSP data
EEPROM	61	Temporary EEPROM zone for DSP data of currently selected DSP Preset.
EEPROM	90	EEPROM zone for Preset0 DSP data
EEPROM	91	EEPROM zone for Preset1 DSP data
EEPROM	92	EEPROM zone for Preset2 DSP data
EEPROM	93	EEPROM zone for Preset3 DSP data
EEPROM	94	EEPROM zone for Preset4 DSP data
EEPROM	95	EEPROM zone for Preset5 DSP data
EEPROM	96	EEPROM zone for Preset6 DSP data
EEPROM	97	EEPROM zone for Preset7 DSP data
uCOM	21	uCOM data
EEPROM	41	EEPROM zone for uCOM data

Note: There is maximum number of writing to EEPROM of 1,000,000 times.

8.3.3 Error code list

If an error occurs, camera sends an error code with the following format:
The Command number of Error Message is FF (HEX). The Data length is 0002.

Error	Receiving data
Check sum error	02, FF, 00, 02, 03, 00, 04, 03
Command being transmitted does NOT exist or invalid	02, FF, 00, 02, 04, 00, 05, 03
Un-processed data remains in receiving buffer	02, FF, 00, 02, 05, 00, 06, 03
Time out error	02, FF, 00, 02, 06, 00, 07, 03
Over run error	02, FF, 00, 02, 08, 00, 09, 03
Framing error	02, FF, 00, 02, 09, 00, 0A, 03
Data length error (data length is too long)	02, FF, 00, 02, 0B, 00, 0C, 03
I2C communication error	02, FF, 00, 02, 10, 00, 11, 03

Note.1: The camera disregards data, which is not start with SOF.
Note.2: The time out error is occurred when does not receive next data three seconds after receive data.

8.4 uCOM register mapping list

Note: Do NOT change “Reserved” Address on this register map.

Address	7	6	5	4	3	2	1	0	Descriptions	Default
000						X	X	X	User Preset DSP register settings can be saved on eight Preset areas. 0: Preset 0 1: Preset 1 2: Preset 2 3: Preset 3 4: Preset 4 5: Preset 5 6: Preset 6 7: Preset 7 * When this value saving to EEPROM, camera starts with saved preset settings at power up camera.	0
	X	X	X	X	X				Reserved	-
001 - 00D	X	X	X	X	X	X	X	X	Reserved	-
00E								X	Enable / disable for “Push button” on camera 0: Disable 1: Enabled	1
	X	X	X	X	X	X	X		Reserved	-
00F							X	X	UART Communication baud rate 0: 9,600 bps 1: 19,200 bps 2: 38,400 bps 3: 9,600 bps * Please change to slower baud rate when communication error is occurring.	2
			X	X	X	X			Reserved	-
		X							Receiving data for write command 0: Receiving data from camera is including exact same data of write command. 1: Receiving data from camera is excluding data of write command and data length is 0.	0
	X								Check sum for UART communication 0: Disabled 1: Enabled * When selecting “Disabled”, camera processes sending command even check sum does not correct.	1

Address	7	6	5	4	3	2	1	0	Descriptions	Default
010	X	X	X	X	X	X	X	X	User defined color 0 Red	255
011	X	X	X	X	X	X	X	X	User defined color 0 Green	128
012	X	X	X	X	X	X	X	X	User defined color 0 Blue	0
013	X	X	X	X	X	X	X	X	User defined color 1 Red	255
014	X	X	X	X	X	X	X	X	User defined color 1 Green	0
015	X	X	X	X	X	X	X	X	User defined color 1 Blue	128
016	X	X	X	X	X	X	X	X	User defined color 2 Red	128
017	X	X	X	X	X	X	X	X	User defined color 2 Green	255
018	X	X	X	X	X	X	X	X	User defined color 2 Blue	0
019	X	X	X	X	X	X	X	X	User defined color 3 Red	0
01A	X	X	X	X	X	X	X	X	User defined color 3 Green	255
01B	X	X	X	X	X	X	X	X	User defined color 3 Blue	128
01C	X	X	X	X	X	X	X	X	User defined color 4 Red	128
01D	X	X	X	X	X	X	X	X	User defined color 4 Green	0
01E	X	X	X	X	X	X	X	X	User defined color 4 Blue	255
01F	X	X	X	X	X	X	X	X	User defined color 5 Red	0
020	X	X	X	X	X	X	X	X	User defined color 5 Green	128
021	X	X	X	X	X	X	X	X	User defined color 5 Blue	255
022	X	X	X	X	X	X	X	X	User defined color 6 Red	128
023	X	X	X	X	X	X	X	X	User defined color 6 Green	128
024	X	X	X	X	X	X	X	X	User defined color 6 Blue	128
025	X	X	X	X	X	X	X	X	User defined color 7 Red	255
026	X	X	X	X	X	X	X	X	User defined color 7 Green	207
027	X	X	X	X	X	X	X	X	User defined color 7 Blue	0
028					X	X	X	X	Reserved	-
	X	X	X	X					Control button that assigns to “Increase page” when displaying OSD 0: Disabled 1: Push button on camera (WB) 2: Switch A 3: Switch B 4: Switch C 5: Switch D 6: Switch E 7: Switch F	1
029					X	X	X	X	Control button assigns to “Select Down” when displaying OSD * Selection is same as Address 028h function	7
	X	X	X	X					Control button assigns to “Select Up” when displaying OSD * Selection is same as Address 028h function	3
02A					X	X	X	X	Control button assigns to “Select Right” when displaying OSD * Selection is same as Address 028h function	6
	X	X	X	X					Control button assigns to “Select Left” when displaying OSD * Selection is same as Address 028h function	4
02B					X	X	X	X	Control button assigns to “Return” when displaying OSD * Selection is same as Address 028h function	2
	X	X	X	X					Control button assigns to “Execute” when displaying OSD * Selection is same as Address 028h function	5

Address	7	6	5	4	3	2	1	0	Descriptions	Default
02C	X	X	X	X	X	X	X	X	Default function of single push for push button on camera * Please refer “Push button function list” for assignable function	2
02D	X	X	X	X	X	X	X	X	Default function of single push for switch A * Please refer “Push button function list” for assignable function	1
02E	X	X	X	X	X	X	X	X	Default function of single push for switch B * Please refer “Push button function list” for assignable function	0
02F	X	X	X	X	X	X	X	X	Default function of single push for switch C * Please refer “Push button function list” for assignable function	0
030	X	X	X	X	X	X	X	X	Default function of single push for switch D * Please refer “Push button function list” for assignable function	0
031	X	X	X	X	X	X	X	X	Default function of single push for switch E * Please refer “Push button function list” for assignable function	0
032	X	X	X	X	X	X	X	X	Default function of single push for switch F * Please refer “Push button function list” for assignable function	0
033	X	X	X	X	X	X	X	X	Default function of hold for push button on camera * Please refer “Push button function list” for assignable function	3
034	X	X	X	X	X	X	X	X	Default function of hold for switch A * Please refer “Push button function list” for assignable function	0
035	X	X	X	X	X	X	X	X	Default function of hold for switch B * Please refer “Push button function list” for assignable function	0
036	X	X	X	X	X	X	X	X	Default function of hold for switch C * Please refer “Push button function list” for assignable function	0
037	X	X	X	X	X	X	X	X	Default function of hold for switch D * Please refer “Push button function list” for assignable function	0
038	X	X	X	X	X	X	X	X	Default function of hold for switch E * Please refer “Push button function list” for assignable function	0
039	X	X	X	X	X	X	X	X	Default function of hold for switch F * Please refer “Push button function list” for assignable function	0
03A	X	X	X	X	X	X	X	X	Minimum horizontal position for line make while controlling by push button	0
03B	0	0	0	0	0	X	X	X		
03C	X	X	X	X	X	X	X	X	Maximum horizontal position for line make while controlling by push button	3,840
03D	0	0	0	0	0	X	X	X		
03E	X	X	X	X	X	X	X	X	Maximum horizontal size for line make while controlling by push button	3,840
03F	0	0	0	0	0	X	X	X		
040	X	X	X	X	X	X	X	X	Minimum vertical position for line make while controlling by push button	0
041	0	0	0	0	0	X	X	X		
042	X	X	X	X	X	X	X	X	Maximum vertical position for line make while controlling by push button	2,160
043	0	0	0	0	0	X	X	X		
044	X	X	X	X	X	X	X	X	Maximum vertical size for line make while controlling by push button	2,160
045	0	0	0	0	0	X	X	X		
046 – 04F	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
050						X	X	X	Color for OSD menu 0: Black 1: Blue 2: Green 3: Cyan 4: Red 5: Magenta 6: Yellow 7: White	7
			X	X	X				Character size for OSD 0: x1 1: x2 2: x3 3: x4 4: x5 5: x6 6: x7 7: x8	1
		X							Reserved	-
	X								OSD position 0: Auto 1: Manual	0
051	X	X	X	X	X	X	X	X	Horizontal display position for OSD 0: Left to 255: Right	0
052	X	X	X	X	X	X	X	X	Vertical display positon for OSD 0: Top to 255: Bottom	0
053	X	X	X	X	X	X	X	X	RGB level for OSD	186
054	X	X	X	X	X	X	X	X	Frame level for OSD	16
055	X	X	X	X	X	X	X	X	Reserved	-
056								X	HDMI output 0: Limited (Standard) 1: Full	0
	X	X	X	X	X	X	X		Reserved	-
057							X	X	Test pattern selection 0: Off (Video out) 1: Gray scale 2: Color bar 3: Color bar + Gary scale	0
	X	X	X	X	X	X			Reserved	-
058 – 2FF	X	X	X	X	X	X	X	X	Reserved	-
300	X	X	X	X	X	X	X	X	Firmware version [little – endian] (Read Only)	
301	X	X	X	X	X	X	X	X		
302	X	X	X	X	X	X	X	X	FPGA version [little – endian] (Read Only)	
303	X	X	X	X	X	X	X	X		
304 – 3FF	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
400 – 4DF	X	X	X	X	X	X	X	X	Reserved	-
4E0								X	Defective pixel auto detection 0: OFF 1: ON It is necessary to switch from “OFF” to “ON” while shading camera. Defective pixel detection starts automatically when switch from “OFF” to “ON”. Switch to “OFF” automatically after detect defective pixel.	0
					X	X	X		Reserved	
				X					Defective pixel correction 0: OFF 1: ON When selecting “ON”, defective pixel that located with from Address 600, will be correct. The position for defective pixel has to order of raster scan. (upper left on image to lower right on image)	1
	X	X	X						Reserved	
4E1	0	0	0	0	0	0	0	X	Display corrected defective pixel 0: OFF 1: ON When selecting “ON”, corrected defective pixel is highlighted on image	0
4E2	X	X	X	X	X	X	X	X	Pixel level threshold for white defective pixel for defective pixel auto detection	70
4E3	0	0	0	0	0	0	X	X	The pixel level is greater than this value, pixel is white defective pixel.	
4E4	X	X	X	X	X	X	X	X	Pixel level threshold for black defective pixel for defective pixel auto detection	0
4E5	0	0	0	0	0	0	X	X	The pixel level is smaller than this value, pixel is black defective pixel.	
4E6 – 5FF	X	X	X	X	X	X	X	X	Reserved	
600	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 000	*
601	0	0	0	0	X	X	X	X		
602	X	X	X	X	X	X	X	X	Vertical position of defective pixel 000	*
603	0	0	0	0	X	X	X	X		
604	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 001	*
605	0	0	0	0	X	X	X	X		
606	X	X	X	X	X	X	X	X	Vertical position of defective pixel 001	*
607	0	0	0	0	X	X	X	X		
608	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 002	*
609	0	0	0	0	X	X	X	X		
60A	X	X	X	X	X	X	X	X	Vertical position of defective pixel 002	*
60B	0	0	0	0	X	X	X	X		
60C	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 003	*
60D	0	0	0	0	X	X	X	X		
60E	X	X	X	X	X	X	X	X	Vertical position of defective pixel 003	*
60F	0	0	0	0	X	X	X	X		
610	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 004	*
611	0	0	0	0	X	X	X	X		
612	X	X	X	X	X	X	X	X	Vertical position of defective pixel 004	*
613	0	0	0	0	X	X	X	X		
614	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 005	*
615	0	0	0	0	X	X	X	X		
616	X	X	X	X	X	X	X	X	Vertical position of defective pixel 005	*
617	0	0	0	0	X	X	X	X		
618	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 006	*
619	0	0	0	0	X	X	X	X		
61A	X	X	X	X	X	X	X	X	Vertical position of defective pixel 006	*
61B	0	0	0	0	X	X	X	X		
61C	X	X	X	X	X	X	X	X	Horizontal position of defective pixel 007	*
61D	0	0	0	0	X	X	X	X		
61E	X	X	X	X	X	X	X	X	Vertical position of defective pixel 007	*
61F	0	0	0	0	X	X	X	X		

Address	7	6	5	4	3	2	1	0	Descriptions	Default
620 – 64F	X	X	X	X	X	X	X	X	Position of defective pixel 008 to 019	*
650 – 67F	X	X	X	X	X	X	X	X	Position of defective pixel 020 to 031	*
680 – 6BF	X	X	X	X	X	X	X	X	Position of defective pixel 032 to 047	*
6C0 – 6FF	X	X	X	X	X	X	X	X	Position of defective pixel 048 to 063	*
700 – 73F	X	X	X	X	X	X	X	X	Position of defective pixel 064 to 079	*
740 – 77F	X	X	X	X	X	X	X	X	Position of defective pixel 080 to 095	*
780 – 7BF	X	X	X	X	X	X	X	X	Position of defective pixel 096 to 111	*
7C0 – 7FF	X	X	X	X	X	X	X	X	Position of defective pixel 112 to 127	*
800 – 83F	X	X	X	X	X	X	X	X	Position of defective pixel 128 to 143	*
840 – 87F	X	X	X	X	X	X	X	X	Position of defective pixel 144 to 159	*
880 – 8BF	X	X	X	X	X	X	X	X	Position of defective pixel 160 to 175	*
8C0 – 8FF	X	X	X	X	X	X	X	X	Position of defective pixel 176 to 191	*
900 – 93F	X	X	X	X	X	X	X	X	Position of defective pixel 192 to 207	*
940 – 97F	X	X	X	X	X	X	X	X	Position of defective pixel 208 to 223	*
980 – 9BF	X	X	X	X	X	X	X	X	Position of defective pixel 224 to 239	*
9C0 – 9FF	X	X	X	X	X	X	X	X	Position of defective pixel 240 to 255	*
A00 – A3F	X	X	X	X	X	X	X	X	Position of defective pixel 256 to 271	*
A40 – A7F	X	X	X	X	X	X	X	X	Position of defective pixel 272 to 287	*
A80 – ABF	X	X	X	X	X	X	X	X	Position of defective pixel 288 to 303	*
AC0 – AFF	X	X	X	X	X	X	X	X	Position of defective pixel 304 to 319	*
B00 – B3F	X	X	X	X	X	X	X	X	Position of defective pixel 320 to 335	*
B40 – B7F	X	X	X	X	X	X	X	X	Position of defective pixel 336 to 351	*
B80 – BBF	X	X	X	X	X	X	X	X	Position of defective pixel 352 to 367	*
BC0 – BFF	X	X	X	X	X	X	X	X	Position of defective pixel 368 to 383	*
C00 – C3F	X	X	X	X	X	X	X	X	Position of defective pixel 384 to 399	*
C40 – C7F	X	X	X	X	X	X	X	X	Position of defective pixel 400 to 415	*
C80 – CBF	X	X	X	X	X	X	X	X	Position of defective pixel 416 to 431	*
CC0 – CFF	X	X	X	X	X	X	X	X	Position of defective pixel 432 to 447	*
D00 – D3F	X	X	X	X	X	X	X	X	Position of defective pixel 448 to 463	*
D40 – D7F	X	X	X	X	X	X	X	X	Position of defective pixel 464 to 479	*
D80 – DBF	X	X	X	X	X	X	X	X	Position of defective pixel 480 to 495	*
DC0 – DFF	X	X	X	X	X	X	X	X	Position of defective pixel 496 to 511	*

8.4.1 Push button function for OSD

When OSD is displaying, following function is assign for each button as default function.

Push button (WB): Increase Page	Increases page number
Switch A: Return	Close menu
Switch B: Select Up	Cursor moves to up, or increase value
Switch C: Select Left	Cursor moves to left
Switch D: Execute	Executes selected function
Switch E: Select Right	Cursor moves to right
Switch F: Select Down	Cursor moves to down, or decrease value

8.4.2 Push button function list

Value	Function	Descriptions
0x00	Disabled	Disabled button control
0x01	Display OSD menu	Displays OSD menu on screen
0x02	Push to set WB [Save to EEPROM]	Executes push to set White balance then save gain settings onto EEPROM
0x03	WB mode (Auto) [Save to EEPROM]	Sets auto white balance mode then saves mode onto EEPROM
0x04	Horizontal flip image	Switches between “Horizontal flipped image” and normal image
0x05	Vertical flip image	Switches between “Vertical flipped image” and normal image
0x06	Horizontal and vertical flip image	Switches between “Horizontal and vertical flipped image” and normal image
0x07	Horizontal flip image [Save to EEPROM]	Switches between “Horizontal flipped image” and normal image then saves setting onto EEPROM
0x08	Vertical flip image [Save to EEPROM]	Switches between “Vertical flipped image” and normal image then saves setting onto EEPROM
0x09	Horizontal and vertical flip image [Save to EEPROM]	Switches between “Horizontal and vertical flipped image” and normal image then saves setting onto EEPROM
0x0A	Display maker	Switches between “Enable” and “Disable” for displays maker
0x0B	Display line maker	Switches between “Enable” and “Disable” for displays line maker
0x0C	Display maker [Save to EEPROM]	Switches between “Enable” and “Disable” for displays maker then saves setting onto EEPROM
0x0D	Display line maker [Save to EEPROM]	Switches between “Enable” and “Disable” for displays line maker then saves setting onto EEPROM
0x10	Horizontal lime maker 1 position (+)	Moves horizontal line maker 1 to bottom direction
0x11	Horizontal line maker 1 position (-)	Moves horizontal line maker 1 to top direction
0x12	Vertical line maker 1 position (+)	Moves vertical line maker 1 to right direction
0x13	Vertical line maker 1 position (-)	Moves vertical line maker 1 to left direction
0x14	Horizontal line maker 2 position (+)	Moves horizontal line maker 2 to bottom direction
0x15	Horizontal line maker 2 position (-)	Moves horizontal line maker 2 to top direction
0x16	Vertical line maker 2 position (+)	Moves vertical line maker 2 to right direction
0x17	Vertical line maker 2 position (-)	Moves vertical line maker 2 to left direction
0x18	Horizontal line maker 3 position (+)	Moves horizontal line maker 3 to bottom direction
0x19	Horizontal line maker 3 position (-)	Moves horizontal line maker 3 to top direction
0x1A	Vertical line maker 3 position (+)	Moves vertical line maker 3 to right direction
0x1B	Vertical line maker 3 position (-)	Moves vertical line maker 3 to left direction
0x1C	Horizontal line maker 4 position (+)	Moves horizontal line maker 4 to bottom direction
0x1D	Horizontal line maker 4 position (-)	Moves horizontal line maker 4 to top direction
0x1E	Vertical line maker 4 position (+)	Moves vertical line maker 4 to right direction
0x1F	Vertical line maker 4 position (-)	Moves vertical line maker 4 to left direction
0x20	User preset (+)	Changes user preset (0 to 1 to … to 7 to 0 to …)
0x21	Rest user preset	Reset user preset (change user preset to “Preset 0”)

8.5 DSP register mapping list

Note: Do NOT change “Reserved” Address on this register map.

Address	7	6	5	4	3	2	1	0	Descriptions	Default
000								X	ALC control 0: Disabled (Fixed shutter / Fixed gain) 1: Enabled (Auto exposure control setting / Gain control setting)	1
			X	X	X	X	X		Reserved	-
		X							Auto exposure control (AEE) 0: Fixed shutter 1: Auto exposure (AEE)	1
	X								Auto gain control (AGC) 0: Fixed gain 1: Auto gain (AGC)	1
001	X	X	X	X	X	X	X	X	ALC Target level	100
002	0	0	0	0	X	X	X	X	ALC integration frame number Automatic brightness control with average brightness of specified frames. 0: 1 frame (No average) 1: 2 frames 2: 4 frames 3: 8 frames 4: 16 frames 5: 32 frames 6: 64 frames 7: 128 frames 8: 256 frames 9: 512 frames	1
003	0	0	0	0	X	X	X	X	ALC rapid control frame number Sets number of frame for ALC rapid control when power on camera or change “Resolution/Frame rate”. ALC integration-frame number is disregard within this frames. 0: 0 frame (No rapid control) 1: 1 frame 2: 2 frames 3: 4 frames 4: 8 frames 5: 16 frames 6: 32 frames 7: 64 frames 8: 128 frames 9: 256 frames 10: 512 frames	0
004	X	X	X	X	X	X	X	X	Exposure time [little-endian]	*
005	0	0	0	0	0	0	X	X	Range: 0 to 746	
006	X	X	X	X	X	X	X	X	Minimum exposure time for AEE [little-endian]	746
007	0	0	0	0	0	0	X	X	Range: 0 to 746	
008	X	X	X	X	X	X	X	X	Middle exposure time for AEE [little-endian]	0
009	0	0	0	0	0	0	X	X	Range: 0 to 746	
00A	X	X	X	X	X	X	X	X	Maximum exposure time for AEE [little-endian]	0
00B	0	0	0	0	0	0	X	X	Range: 0 to 746	
00C	X	X	X	X	X	X	X	X	AEE control tolerance AEE stops when difference between “current brightness” and “ALC target level” is smaller than this value.	3
00D	X	X	X	X	X	X	X	X	AEE control threshold AEE starts when difference between “current brightness” and “ALC target level” is greater than “AEE control tolerance + AEE control threshold”.	6
00E	0	X	X	X	X	X	X	X	AEE control speed Sets the maximum amount of exposure time change for AEE control. (There is no limitation for maximum amount of exposure time when sets “0”)	0
00F	X	X	X	X	X	X	X	X	Reserved	-

The formula for exposure time:

The formula for exposure time is changed based on selection of “Resolution / Frame rate” [0x060].

2160p 60fps / 2160p 59.94fps	Exposure time [msec.] = ((4,500 – SHR) x 266 + 112) / (71.82 x 1,000)
2160p 50fps	Exposure time [msec.] = ((4,500 – SHR) x 320 + 112) / (72.00 x 1,000)
2160p 30fps / 29.97fps	Exposure time [msec.] = ((4,500 – SHR) x 532 + 112) / (71.82 x 1,000)
2160p 25fps	Exposure time [msec.] = ((4,500 – SHR) x 640 + 112) / (72.00 x 1,000)

* 2160p resolution, SHR = exposure time setting x 6 + 12.

1080p 60fps / 1080p 59.94fps	Exposure time [msec.] = ((2,250 – SHR) x 532 + 169) / (71.82 x 1,000)
1080p 50fps	Exposure time [msec.] = ((2,250 – SHR) x 640 + 169) / (72.00 x 1,000)
1080p 120fps / 119.88fps	Exposure time [msec.] = ((2,250 – SHR) x 266 + 112) / (71.82 x 1,000)
1080p 100fps	Exposure time [msec.] = ((2,250 – SHR) x 320 + 112) / (72.00 x 1,000)

* 1080p resolution, SHR = exposure time setting x 3 + 8

Address	7	6	5	4	3	2	1	0	Descriptions	Default
010	X	X	X	X	X	X	X	X	Gain [little-endian]	*
011	0	0	0	0	0	0	0	X	Range: 0 to 392	
012	X	X	X	X	X	X	X	X	Minimum gain for AGC control [little-endian]	0
013	0	0	0	0	0	0	0	X	Range: 0 to 392	
014	X	X	X	X	X	X	X	X	Middle gain for AGC control [little-endian]	200
015	0	0	0	0	0	0	0	X	Range: 0 to 392	
016	X	X	X	X	X	X	X	X	Maximum gain for AGC control [little-endian]	392
017	0	0	0	0	0	0	0	X	Range: 0 to 392	
018	X	X	X	X	X	X	X	X	AGC tolerance AGC stops when difference between “current brightness” and “ALC target level” is smaller than this value.	3
019	X	X	X	X	X	X	X	X	AGC threshold AGC starts when difference between “current brightness” and “ALC target level” is greater than “AEE control tolerance + AEE control threshold”.	6
01A	0	0	X	X	X	X	X	X	AGC control speed Sets the maximum amount of gain change for AGC control. (There is no limitation for maximum amount of gain when sets “0”)	0
01B – 01F	X	X	X	X	X	X	X	X	Reserved	-

The formula for gain:

Gain [dB] = - 20 x log ((2,048 – PGC) / 2,048)

PGC = Gain setting x 5 (When Gain setting is 392, PGC = 1,957)

ALC operation

The auto exposure control (AEE) and auto gain control (AGC) interlock as below:

Object		Exposure time setting	Gain setting
Bright		Minimum exposure time for AEE	Minimum gain for AGC
		Change	
		Middle exposure time for AEE	Change
		Change	Middle gain for AGC
		Maximum exposure time for AEE	Change
Dark			Maximum gain for AGC

It is necessary to set as
AEE Minimum exposure time =< AEE Middle exposure time =< AEE Maximum exposure time
It is necessary to set as
AGC Minimum gain =< AGC Middle gain =< AGC Maximum gain

The minimum exposure time for AEE sets at [0x006 - 0x007].
The middle exposure time for AEE sets at [0x008 - 0x009].
The maximum exposure time for AEE sets at [0x00A - 0x00B].

The minimum gain for AGC sets at [0x012 - 0x013].
The middle gain for AGC sets at [0x014 - 0x015].
The maximum gain for AGC sets at [0x016 - 0x017].

Address	7	6	5	4	3	2	1	0	Descriptions	Default
020								X	White balance mode 0; Manual 1: Auto (AWB)	1
							X		Pull-in limit AWB 0: Disabled (without pull-in limit) 1: Enabled (with pull-in limit)	1
			X	X	X	X			Reserved	
		X							Push to set white balance Save white balance mode and gain into EEPROM after process. 0: Disable 1: Enable (switch to 0 automatically)	0
	X								Push to set white balance 0: Off 1: On (switch to 0 automatically)	0
021	X	X	X	X	X	X	X	X	Reserved	-
022	X	X	X	X	X	X	X	X	White Balance R gain [little-endian]	555
023	0	0	0	0	0	0	X	X	(Setting value / 256) times gain	
024	X	X	X	X	X	X	X	X	White balance G gain [little-endian]	256
025	0	0	0	0	0	0	X	X	(Setting value / 256) times gain	
026	X	X	X	X	X	X	X	X	White balance B gain [little-endian]	538
027	0	0	0	0	0	0	X	X	(Setting value / 256) times gain	
028 – 02B	X	X	X	X	X	X	X	X	Reserved	-
02C	X	X	X	X	X	X	X	X	AWB tolerance (Pull-in limit) Pull-in AWB processing stops when AWB tolerance becomes smaller than this value.	3
02D	X	X	X	X	X	X	X	X	AWB threshold (Pull-in limit) Pull-in AWB processing starts when AWB tolerance becomes greater than “AWB tolerance (Pull-in limit)” + AWB threshold (Pull-in limit)”.	3
02E – 02F	X	X	X	X	X	X	X	X	Reserved	-
030	0	0	0	0	X	X	X	X	AWB integration frame number Automatic white balance process with average brightness of specified frames. 0: 1 frame (No average) 1: 2 frames 2: 4 frames 3: 8 frames 4: 16 frames 5: 32 frames 6: 64 frames 7: 128 frames 8: 256 frames 9: 512 frames	1
031	0	0	0	0	X	X	X	X	AWB rapid control frame number Sets number of frames for AWB rapid control when power on camera or change “Resolution / framer rate”. AWB integration-frame number is disregard within this frames. 0: 0 frame (No rapid control) 1: 1 frames 2: 2 frames 3: 4 frames 4: 8 frames 5: 16 frames 6: 32 frames 7: 64 frames 8: 128 frames 9: 256 frames 10: 512 frames	0
032	X	X	X	X	X	X	X	X	R change limit for none pull-in AWB	4
033	X	X	X	X	X	X	X	X	B change limit for none pull-in AWB	4

Address	7	6	5	4	3	2	1	0	Descriptions	Default
034	X	X	X	X	X	X	X	X	R gain reference level for low color temperature direction [little-endian]	384
035	0	0	0	0	0	0	X	X		
036	X	X	X	X	X	X	X	X	B gain reference level for low color temperature direction [little-endian]	750
037	0	0	0	0	0	0	X	X		
038	X	X	X	X	X	X	X	X	R gain reference level for middle color temperature direction [little-endian]	627
039	0	0	0	0	0	0	X	X		
03A	X	X	X	X	X	X	X	X	B gain reference level for middle color temperature direction [little-endian]	466
03B	0	0	0	0	0	0	X	X		
03C	X	X	X	X	X	X	X	X	R gain reference level for high color temperature direction [little-endian]	778
03D	0	0	0	0	0	0	X	X		
03E	X	X	X	X	X	X	X	X	B gain reference level for high color temperature direction [little-endian]	420
03F	0	0	0	0	0	0	X	X		
040	X	X	X	X	X	X	X	X	AWB tolerance (Pull-in limit) Pull-in AWB processing stops when AWB tolerance becomes smaller than this value.	3
041	X	X	X	X	X	X	X	X	AWB threshold (Pull-in limit) Pull-in AWB processing starts when AWB tolerance becomes greater than “AWB tolerance (Pull-in limit)” + AWB threshold (Pull-in limit)”.	6
042	X	X	X	X	X	X	X	X	AWB step division (Pull-in limit)	10
043	X	X	X	X	X	X	X	X	Reserved	-
044	X	X	X	X	X	X	X	X	“R gain + frame” for low color temperature direction	30
045	X	X	X	X	X	X	X	X	“R gain - frame” for low color temperature direction	30
046	X	X	X	X	X	X	X	X	“B gain + frame” for low color temperature direction	30
047	X	X	X	X	X	X	X	X	“B gain - frame” for low color temperature direction	30
048	X	X	X	X	X	X	X	X	“R gain + frame” for middle color temperature direction	30
049	X	X	X	X	X	X	X	X	“R gain - frame” for middle color temperature direction	30
04A	X	X	X	X	X	X	X	X	“B gain + frame” for middle color temperature direction	30
04B	X	X	X	X	X	X	X	X	“B gain - frame” for middle color temperature direction	30
04C	X	X	X	X	X	X	X	X	“R gain + frame” for high color temperature direction	30
04D	X	X	X	X	X	X	X	X	“R gain - frame” for high color temperature direction	30
04E	X	X	X	X	X	X	X	X	“B gain + frame” for high color temperature direction	30
04F	X	X	X	X	X	X	X	X	“B gain - frame” for high color temperature direction	30
050 – 05F	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
060	0	0	0	0	X	X	X	X	Resolution / Frame rate 0: Auto (Camera checks maximum supported video output format and frame rate of connecting monitor or capturing devices then selects video format and frame rate automatically.) 1: 2160p 59.94fps 2: 2160p 60fps 3: 2160p 50fps 4: 2160p 29.97fps 5: 2160p 30fps 6: 2160p 25fps 7: 1080p 59.94fps 8: 1080p 60fps 9: 1080p 50fps 10: 1080p 119.88fps 11: 1080p 120fps 12: 1080p 100fps	0
061								X	Horizontal flip 0: OFF (Nor horizontal flip) 1: ON (Horizontal flip)	0
							X		Vertical flip 0: OFF (No vertical flip) 1: ON (Vertical flip)	0
	X	X	X	X	X	X			Reserved	
062	X	X	X	X	X	X	X	X	Reserved	
063					X	X	X	X	Preset Gamma 0: 1.0 1: 0.9 2: 0.8 3: 0.7 4: 0.6 5: 0.5 6: 0.45 7: 0.3 9: Through	4
		X	X	X					Reserved	-
	X								Gamma mode 0: Preset 1: Manual	1
064	X	X	X	X	X	X	X	X	Manual gamma control point 0 [little-endian] * Please sets with complement on two.	0
065	0	0	0	0	0	0	X	X		
066	X	X	X	X	X	X	X	X	Manual gamma control point 1 [little-endian] * Please sets with complement on two.	58
067	0	0	0	0	0	0	X	X		
068	X	X	X	X	X	X	X	X	Manual gamma control point 2 [little-endian] * Please sets with complement on two.	116
069	0	0	0	0	0	0	X	X		
06A	X	X	X	X	X	X	X	X	Manual gamma control point 3 [little-endian] * Please sets with complement on two.	159
06B	0	0	0	0	0	0	X	X		
06C	X	X	X	X	X	X	X	X	Manual gamma control point 4 [little-endian] * Please sets with complement on two.	181
06D	0	0	0	0	0	0	X	X		
06E	X	X	X	X	X	X	X	X	Manual gamma control point 5 [little-endian] * Please sets with complement on two.	200
06F	0	0	0	0	0	0	X	X		
070	X	X	X	X	X	X	X	X	Manual gamma control point 6 [little-endian] * Please sets with complement on two.	220
071	0	0	0	0	0	0	X	X		
072	X	X	X	X	X	X	X	X	Manual gamma control point 7 [little-endian] * Please sets with complement on two.	237
073	0	0	0	0	0	0	X	X		
074	X	X	X	X	X	X	X	X	Manual gamma control point 8 [little-endian] * Please sets with complement on two.	251
075	0	0	0	0	0	0	X	X		
076	X	X	X	X	X	X	X	X	Manual gamma control point 9 [little-endian] * Please sets with complement on two.	256
077	0	0	0	0	0	0	X	X		
078 – 07F	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
080								X	Weight Photometry 0: Average photometry 1: Weight photometry	0
	X	X	X	X	X	X	X		Reserved	-
081	0	0	0	0	X	X	X	X	0 frame coefficient (valid when selecting weight photometry)	1
082	0	0	0	0	X	X	X	X	1 frame coefficient (valid when selecting weight photometry)	5
083	0	0	0	0	X	X	X	X	2 frame coefficient (valid when selecting weight photometry)	1
084	0	0	0	0	X	X	X	X	3 frame coefficient (valid when selecting weight photometry)	6
085	0	0	0	0	X	X	X	X	4 frame coefficient (valid when selecting weight photometry)	10
086	0	0	0	0	X	X	X	X	5 frame coefficient (valid when selecting weight photometry)	6
087	0	0	0	0	X	X	X	X	6 frame coefficient (valid when selecting weight photometry)	2
088	0	0	0	0	X	X	X	X	7 frame coefficient (valid when selecting weight photometry)	7
089	0	0	0	0	X	X	X	X	8 frame coefficient (valid when selecting weight photometry)	2
08A – 0FF	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
100								X	Line Maker 0: Disabled 1: Enabled	1
	X	X	X	X	X	X	X		Reserved	-
101					X	X	X	X	Vertical Line Maker 1 color * Please refer “Color Code Table” for more details.	0
	X	X	X	X					Horizontal Line Maker 1 color * Please refer “Color Code Table” for more details.	0
102	X	X	X	X	X	X	X	X	Horizontal Line Maker 1 position [little-endian]	0
103	0	0	0	0	X	X	X	X	0: Top 2,160: bottom	
104	X	X	X	X	X	X	X	X	Horizontal Line Maker 1 thickness [little-endian]	0
105	0	0	0	0	X	X	X	X	0: No display 2,160: Maximum thickness	
106	X	X	X	X	X	X	X	X	Vertical Line Maker 1 position [little-endian]	0
107	0	0	0	0	X	X	X	X	0: Left 3,840: Right	
108	X	X	X	X	X	X	X	X	Vertical Line Maker 1 thickness [little-endian]	0
109	0	0	0	0	X	X	X	X	0: No display 3,840: Maximum thickness	
10A	X	X	X	X	X	X	X	X	Reserved	-
10B					X	X	X	X	Vertical Line Maker 2 color * Please refer “Color Code Table” for more details.	0
	X	X	X	X					Horizontal Line Maker 2 color * Please refer “Color Code Table” for more details.	0
10C	X	X	X	X	X	X	X	X	Horizontal Line Maker 2 position [little-endian]	0
10D	0	0	0	0	X	X	X	X	0: Top 2,160: bottom	
10E	X	X	X	X	X	X	X	X	Horizontal Line Maker 2 thickness [little-endian]	0
10F	0	0	0	0	X	X	X	X	0: No display 2,160: Maximum thickness	
110	X	X	X	X	X	X	X	X	Vertical Line Maker 2 position [little-endian]	0
111	0	0	0	0	X	X	X	X	0: Left 3,840: Right	
112	X	X	X	X	X	X	X	X	Vertical Line Maker 2 thickness [little-endian]	0
113	0	0	0	0	X	X	X	X	0: No display 3,840: Maximum thickness	
114	X	X	X	X	X	X	X	X	Reserved	-
115					X	X	X	X	Vertical Line Maker 3 color * Please refer “Color Code Table” for more details.	0
	X	X	X	X					Horizontal Line Maker 3 color * Please refer “Color Code Table” for more details.	0
116	X	X	X	X	X	X	X	X	Horizontal Line Maker 3 position [little-endian]	0
117	0	0	0	0	X	X	X	X	0: Top 2,160: bottom	
118	X	X	X	X	X	X	X	X	Horizontal Line Maker 3 thickness [little-endian]	0
119	0	0	0	0	X	X	X	X	0: No display 2,160: Maximum thickness	
11A	X	X	X	X	X	X	X	X	Vertical Line Maker 3 position [little-endian]	0
11B	0	0	0	0	X	X	X	X	0: Left 3,840: Right	
11C	X	X	X	X	X	X	X	X	Vertical Line Maker 3 thickness [little-endian]	0
11D	0	0	0	0	X	X	X	X	0: No display 3,840: Maximum thickness	
11E	X	X	X	X	X	X	X	X	Reserved	-

Address	7	6	5	4	3	2	1	0	Descriptions	Default
11F					X	X	X	X	Vertical Line Maker 4 color * Please refer “Color Code Table” for more details.	0
	X	X	X	X					Horizontal Line Maker 4 color * Please refer “Color Code Table” for more details.	0
120	X	X	X	X	X	X	X	X	Horizontal Line Maker 4 position [little-endian]	0
121	0	0	0	0	X	X	X	X	0: Top 2,160: bottom	
122	X	X	X	X	X	X	X	X	Horizontal Line Maker 4 thickness [little-endian]	0
123	0	0	0	0	X	X	X	X	0: No display 2,160: Maximum thickness	
124	X	X	X	X	X	X	X	X	Vertical Line Maker 4 position [little-endian]	0
125	0	0	0	0	X	X	X	X	0: Left 3,840: Right	
126	X	X	X	X	X	X	X	X	Vertical Line Maker 4 thickness [little-endian]	0
127	0	0	0	0	X	X	X	X	0: No display 3,840: Maximum thickness	
128 – 13C	X	X	X	X	X	X	X	X	Reserved	-

Color Code Table

16 defined colors can be selected from following table and these colors can be used for Line Marker Color.
As for User Defined Color 0 to 7, user can configure these colors setting through serial communication.

Code	Color
0	Black
1	White
2	Red
3	Green
4	Blue
5	Cyan
6	Magenta
7	Yellow
8	User Defined Color 0
9	User Defined Color 1
10	User Defined Color 2
11	User Defined Color 3
12	User Defined Color 4
13	User Defined Color 5
14	User Defined Color 6
15	User Defined Color 7

Address	7	6	5	4	3	2	1	0	Descriptions	Default
13D		X	X	X	X	X	X	X	Reserved	-
	X								Color / Black and white 0: Color 1: Black and white (monochrome)	0
13E	0	X	X	X	X	X	X	X	R-Y gain for color saturation Range: 0 to 127	32
13F	0	X	X	X	X	X	X	X	B-Y gain for color saturation Range: 0 to 127	32
140	X	X	X	X	X	X	X	X	R-Y hue for color hue * Please sets with complement on two. Range: -128 to 127	-12
141	X	X	X	X	X	X	X	X	B-Y hue for color hue * Please sets with complement on two. Range: -128 to 127	-29
142	X	X	X	X	X	X	X	X	High luminance chroma suppress threshold Range: 0 to 255	240
143	0	0	0	0	X	X	X	X	High luminance chroma suppress slope Range: 0 to 8	1
144					X	X	X	X	Aperture horizontal gain	4
145	X	X	X	X					Aperture vertical gain	4
146	0	0	X	X	X	X	X	X	Aperture coring	3
146– 15F	X	X	X	X	X	X	X	X	Reserved	-

8.6 OSCD (On Screen Character Display) Command

8.6.1 2 Bytes Command

Note: The data have to send as follow order D15-D8, D7-D0.

Function	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Video RAM All Clear Command	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Display Control Command	0	0	0	0	1	0	0	0	DO	0	FC	FA	0	0	BL1	BL0
Character Display Position Control Command	0	0	0	1	0	0	V4	V3	V2	V1	V0	H4	H3	H2	H1	H0
Write Address Control Command	0	0	0	1	1	0	0	AD8	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
Character Size Control Command	0	0	1	0	0	SV2	SV1	SV0	SH2	SH1	SH0	0	AR3	AR2	AR1	AR0

Video RAM All Clear Command

Clear all character data (12 lines 28 digits) on Video RAM.
Meanwhile, display settings are cleared (Display ON, Frame color (Black), Framing ON, Blinking OFF) and character size changes to standard size (x1) on all lines.

Display Control Command

DO: Display (0: Display ON, 1: Display OFF)
FC: Frame color (0: Black, 1: White)
FA: Framing (0: ON, 1: OFF)
BL1, BL0: Blinking (00: Blinking OFF, 01: Blinking (Frequency approximately 2 Hz),
02: Blinking (Frequency approximately 1 Hz), 03: Blinking (Frequency approximately 0.5 Hz))

Character Display Position Control Command

Sets the start position. 32 steps / 32 dots unit on horizontal. 32 steps / 32 lines unit on vertical.
H4, H3, H2, H1, H0: Horizontal 32 dots unit (0 to 31)
V4, V3, V2, V1, V0: Vertical 32 lines unit (0 to 31)

Write Address Control Command

AD8, AD7, AD6, AD5, AD4, AD3, AD2, AD1, AD0: Address (0 to 335)
Sets the address to write character.
The address consists of RAW 0 (Column 0 to 27), RAW 1 (Column 56 to 83) … RAW 11 (Column 308 to 335).

Character Size Control Command

Sets the character size for each RAW.
SV1, SV0: Size on Vertical (000: x1, 001: x2, 010: x3, 011: x4, 100: x5, 101: x6, 110: x7, 111: x8)
SH1, SH0: Size on Horizontal (00:0 x1, 001: x2, 010: x3, 011: x4, 100: x5, 101: x6, 110: x7, 111: x8)
AR3, AR2, AR1, AR0: RAW (0 to 11)

8.6.2 2 Bytes consecutive Command

Note: The data have to send as follow order D15-D8, D7-D0.

Function	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Display Character Control Command	1	1	RV	R	G	B	BL	0	C7	C6	C5	C4	C3	C2	C1	C0

Display Character Control Command

Sets the Writing character data, blinking data and character color into current Video RAM address.
This command is 2 Bytes consecutive command. If more than 2 consecutive character writing is necessary, just send only lower 8bits (C7 to C0) from second character. The write address will be inclement automatically.
When character control is finished, sends “0xFF” (End code of 2 Bytes consecutive command).

RV: Reverse character color (0: OFF, 1: ON)
RGB: Character Color (0: Black, 1: Blue, 2: Green, 3: Cyan, 4: Red, 5: Magenta, 6: Yellow, 7: White)
BL: Character blinking (0: Blinking, 1: Not Blinking)
C7 - C0: Character code (Please refer below character table)

C7 - C0	Character	C7 - C0	Character	C7 - C0	Character	C7 - C0	Character
000	sp	019	9	032	R	04B	k
001	!	01A	:	033	S	04C	l
002	“	01B	;	034	T	04D	m
003	#	01C	<	035	U	04E	n
004	$	01D	=	036	V	04F	o
005	%	01E	>	037	W	050	p
006	&	01F	?	038	X	051	q
007	‘	020	> fill	039	Y	052	r
008	(	021	A	03A	Z	053	s
009	)	022	B	03B	[	054	t
00A	*	023	C	03C	¥	055	u
00B	+	024	D	03D	]	056	v
00C	,	025	E	03E	< fill	057	w
00D	-	026	F	03F	△	058	x
00E	.	027	G	040	▽	059	y
00F	/	028	H	041	a	05A	z
010	0	029	I	042	b	05B	・
011	1	02A	J	043	c	05C	・・
012	2	02B	K	044	d	05D	・・・
013	3	02C	L	045	e	05E	～
014	4	02D	M	046	f	05F	◆
015	5	02E	N	047	g	060	×
016	6	02F	O	048	h	061	÷
017	7	030	P	049	i	0FF	Finish 2 Bytes consecutive Command
018	8	031	Q	04A	j		

9 Revisions

Rev	Date	Changes	Note
00	2018/08/08	New document	

Note.
All specifications are subject to change without prior notice.

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