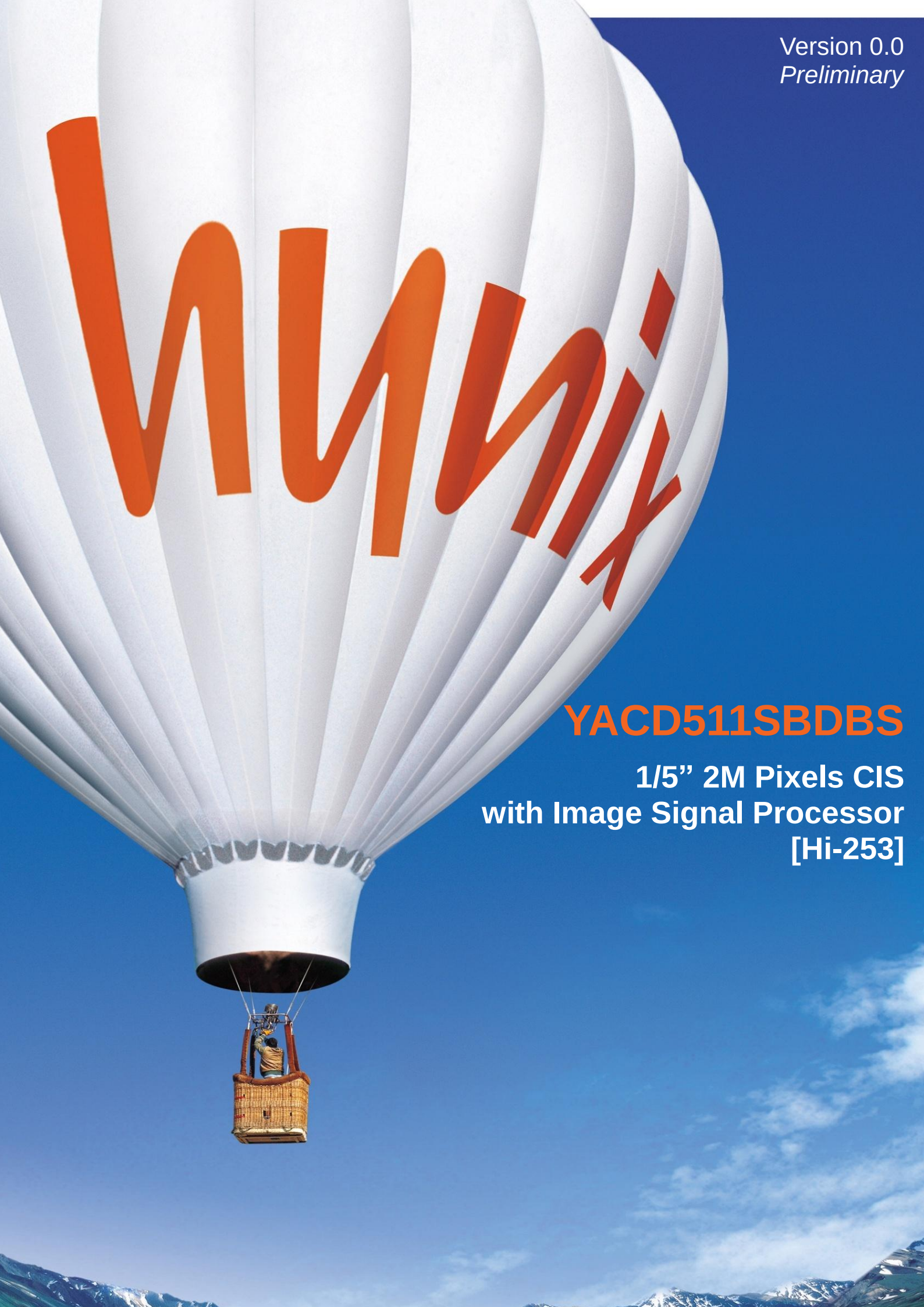
Version 0.0
Preliminary



YACD511SBDBS

1/5” 2M Pixels CIS with Image Signal Processor [Hi-253]

Revision History

Version	Date	Comments
0.0	2010/04/30	YACD511SBDBC Preliminary is released

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This document is subjected to change without notice to customers.

General Precautions
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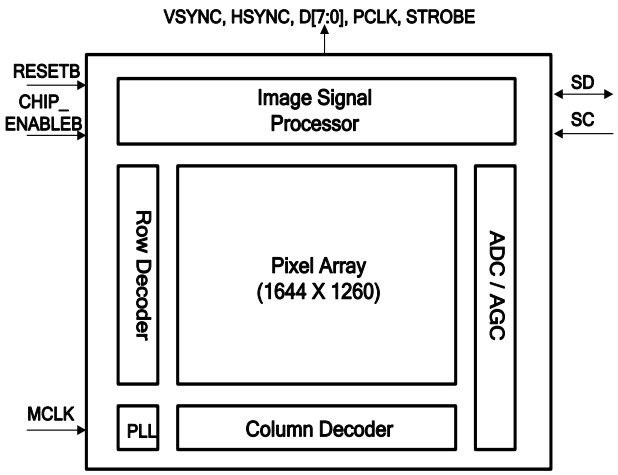
1. OVERVIEW

1.1. Description

YACD511SBDBC is a high quality 2mega-pixel single chip CMOS image sensor for mobile phone camera applications and digital still camera products.

YACD511SBDBC incorporates a 1644 x 1260 pixel array, on-chip 10-bit ADC, and an image signal processor. Unique sensor technology enhances image quality by reducing FPN (Fixed Pattern Noise), horizontal/vertical line noise, and random noise.

<Figure 1. Block Diagram>



1.2. Applications

- Mobile Phone Camera / Digital Still Camera
- PC Camera / Video Conference

1.3. Key Features

- **Pixel Size: 1.75um X 1.75um**
- **Active Image Size : 2.856mm (H) X 2.156mm(V)**
- **Resolution: 1,600H X 1,200V**
- **Optical Format: 1/5 inch**
- **Frame Rate: 15fps@UXGA, 30fps@SVGA**
- **Power Supply: 2.8V / 1.8V**
- **Power Consumption: TBD @ 15fps, UXGA**
- **ADC: 10bit**
- **PLL: On Chip**
- **Operation Temperature: -20 ~ 60°C**
- **Master Clock: 48MHz(Max)**
- **Host Interface: two-wire serial bus interface**
- **Output Format: YUV4:2:2, RGB5:6:5, ITU656-like**
- **Edge Data for Auto Focus**
- **Motion Data for Auto Focus**
- **Windowing: Programmable**
- **Sub-Sample: 1/2, 1/4 (SVGA, QSVGA)**
- **Image Scaling : 1x ~ 1/64x**
- **Image Flip: X/Y Flip**
- **Auto Exposure**
- **Auto White Balance**
- **Anti-Flicker(50Hz / 60Hz): Auto/Manual**
- **Noise Reduction**
- **Black Level Calibration**
- **Strobe Control: Support Xenon / LED Type**
- **On-Chip Dead Pixel Correction**
- **Edge Enhancement**
- **Brightness**
- **Color Saturation**
- **Gamma Correction**
- **Color Correction**
- **Lens Shading Correction**
- **Image Effect: Mono, Sepia, Solarization, Negative, Sketch, Embossing**

2. Electrical characteristics

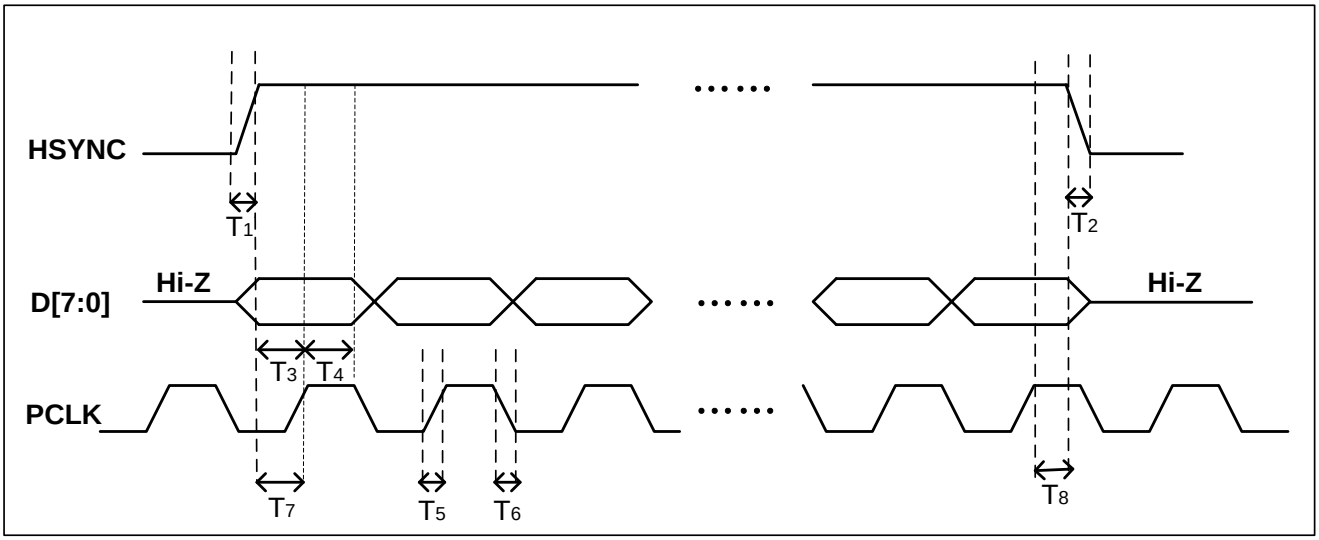
2.1. Key Features

[Table 1. DC Characteristics]

Item	Symbol	Min	Typ	Max	Unit	Note
Digital Core Circuit Power Supply Voltage	$V_{DD:D}$	1.7	1.8	1.9	V	
Analog Circuit Power Supply Voltage	$V_{DD:A}$	2.7	2.8	3.0	V	
Analog Pixel Circuit Power Supply Voltage	$V_{DD:P}$	2.7	2.8	3.0	V	
Digital I/O Circuit Power Supply Voltage	$V_{DD:I}$	1.7	1.8/2.8	3.0	V	
H level Input Voltage	V_{IH}	0.7 * $V_{DD:I}$			V	
L level Input Voltage	V_{IL}			0.3 * $V_{DD:I}$	V	
Output High Current ($V_{DD:I}$ =2.8V, V_{OH} = 2.4V)	I_{OH}		3.8		mA	1
Output High Current ($V_{DD:I}$ =1.8V, V_{OH} = 1.4V)	I_{OH}		2.8		mA	1
Output Low Current($V_{DD:I}$ =2.8V, V_{OL} = 0.4V)	I_{OL}		4.5		mA	1
Output Low Current($V_{DD:I}$ =1.8V, V_{OL} = 0.4V)	I_{OL}		3.6		mA	1

Note1) Users can control the amount of current by controlling bit[7:3] of PWRCTL[0x01:P0].
Above values are output current when bit[7:3] of PWRCTL[0x01:P0] is 5'b01010.

<Figure 1. C Timing of output PAD>



[Table 2. AC Characteristics]

Item	Symbol	Min	Typ	Max	Unit	Note
MCLK	Frequency	18		48	MHz	
MCLK	Duty Cycle	45	50	55	%	
PCLK	Frequency			72	MHz	
PCLK	Duty Cycle	40	50	60	%	
SC	Frequency			400	KHz	
HSYNC(VSYNC) rising time	T_1			5.3	Ns	2

HSYNC(VSYNC) falling time	T_2			4.4	Ns	2
PCLK rising time	T_5			5.4	Ns	2
PCLK falling time	T_6			4.5	Ns	2
HSYNC(VSYNC) rising time	T_1			5.5	ns	3
HSYNC(VSYNC) falling time	T_2			3.9	ns	3
PCLK rising time	T_5			5.8	ns	3
PCLK falling time	T_6			4.1	ns	3
Setup time of PCLK - HSYNC	T_7	2			ns	
Hold time of PCLK - HSYNC	T_8	2			ns	
Setup time of PCLK – D[7:0]	T_3	2			ns	
Hold time of PCLK – D[7:0]	T_4	2			ns	

Note2) Output load capacitance = 20pF, $V_{DD:A}$ &$V_{DD:P}$=2.8V, $V_{DD:C}$=1.8V, $V_{DD:I}$ =2.8V, V_{OH} =2.4V, V_{OL} =0.4V
Note3) Output load capacitance = 20pF, $V_{DD:A}$ &$V_{DD:P}$=2.8V, $V_{DD:C}$=1.8V, $V_{DD:I}$ =1.8V, V_{OH} =1.4V, V_{OL} =0.4V
Users can control the rising(falling) time by controlling bit[7:3] of PWRCTL[0x01:P0].
Above values are rising time when bit[7:3] of PWRCTL[0x01:P0] is 5'b01010.

[Table 3. Temperature Characteristics]

Item	Symbol	Rating	Unit	Note
Storage Temperature	T_{STR}	-40 ~ 80	°C	
Functional Operating Temperature	T_{FUN}	-20 ~ 60	°C	Camera fully functional

[Table 4. Power Consumption]

Item	Condition	Min	Typ	Max	Unit	Note
UXGA @15fps	$V_{DD:A}$ &$V_{DD:P}$=2.8V		TBD		mA	4
	$V_{DD:I}$ =2.8V		TBD		mA	5
	$V_{DD:C}$=1.8V		TBD		mA	
SVGA @ 30fps	$V_{DD:A}$ &$V_{DD:P}$=2.8V		TBD		mA	4
	$V_{DD:I}$ =2.8V		TBD		mA	5
	$V_{DD:C}$=1.8V		TBD		mA	
Stand by Current				TBD	uA	6

Note4) Because current of analog circuit depends on the registers' values, it is measured at specific register's value .
Note5) Because power consumption of VDD:I depends on the output load and system environment, users should supply enough current to sensor for stable operation. It is measured when output load is floated.
Note6) Standby current is measured at Chip Enable = LO and MCLK = LO.
We recommend that power should be turned off, when low standby power consumption is required

[Table 5. Absolute Maximum Ratings]

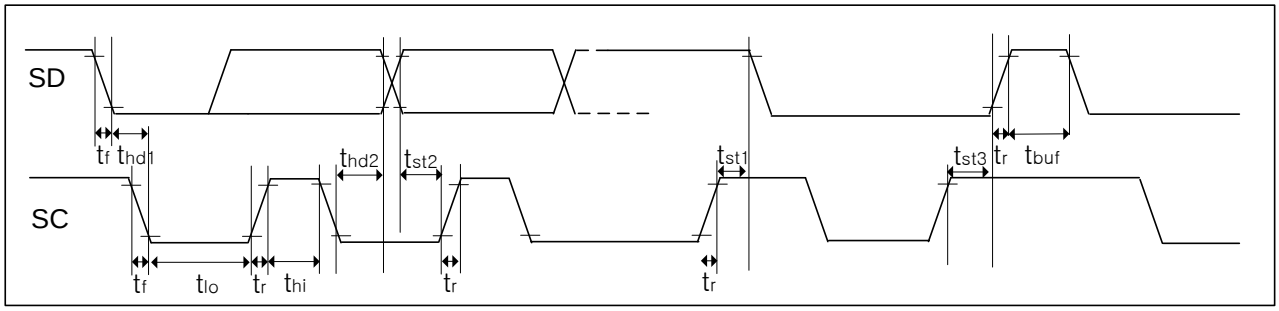
Item	Symbol	Min	Max	Note
Digital Core Power	$V_{DD:C}$	-0.3V	2.1 V	7
Analog and Pixel Power	$V_{DD:A}$ &$V_{DD:P}$	-0.3V	3.3V	7
Digital I/O Power	$V_{DD:I}$	-0.3V	3.3V	7
Input Pin Voltage	V_{IN}	-0.2V	$V_{DD:I}$ + 0.2V	7
Output Pin Voltage	V_{OUT}	-0.2V	$V_{DD:I}$ + 0.2V	7

Note7) Exposure to absolute maximum rating conditions for extended periods may affect reliability.

3. Two-Wire Serial Bus Interface

3.1. Timing Specifications

<Figure 2. AC Timing of Two Wire Serial Bus>



[Table 6. AC Characteristics of Two Wire Serial Bus]

Parameter	Symbol	Min.	Typ.	Max.	Unit
SC frequency	f_{sck}			400	KHz
SC low period	t_{lo}	1.2		-	us
SC high period	t_{hi}	0.6		-	us
SC setup time for START condition	t_{st1}	0.6		-	us
SC setup time for STOP condition	t_{st3}	0.6		-	us
SC hold time for START condition	t_{hd1}	0.6		-	us
SD setup time	t_{st2}	0.6		-	us
SD hold time	t_{hd2}	0.6		-	us
Bus free time Between STOP and START condition	t_{buf}	0.6		-	us
Rising time of both SD and SC	t_r	-		0.3	us
Falling time of both SD and SC	t_f	-		0.3	us
Capacitive load of SC/SD	C_b	-		100	pF
Pull-up resistor on SC and SD			1.5		kΩ

3.2. Bus Operation

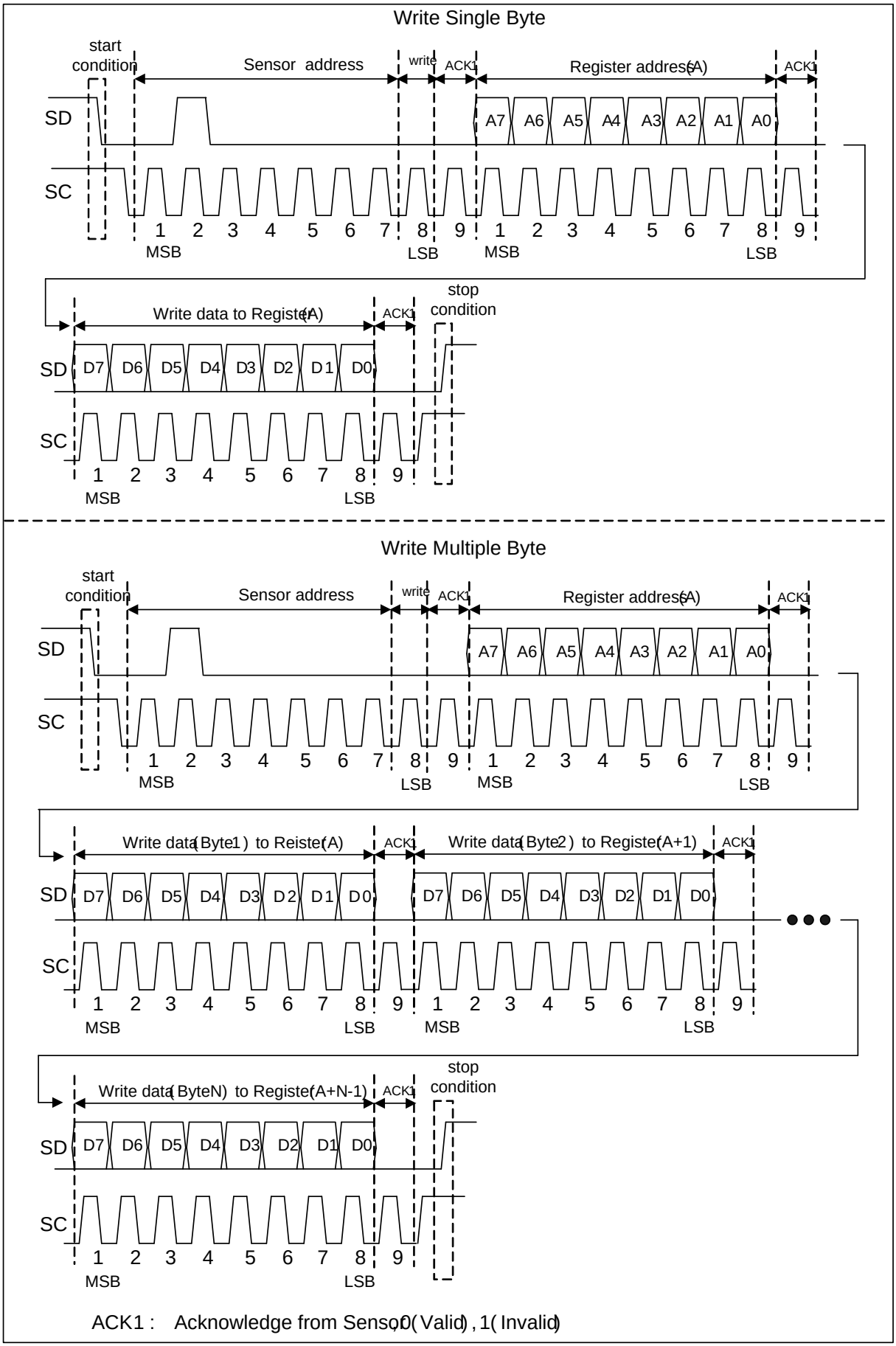
The two-wire serial bus interface is used to write and read the required data into registers in this sensor. Sensor can operate as a slave device only. The two-wire serial bus interface is controlled by SD (serial data) and SC (serial clock). SD is bidirectional bus.

Operation has single byte programming and multiple byte programming. Users doesn't need to set continuously register address on programming multiple byte because the sensor increases register address automatically. This will reduce time to program registers.

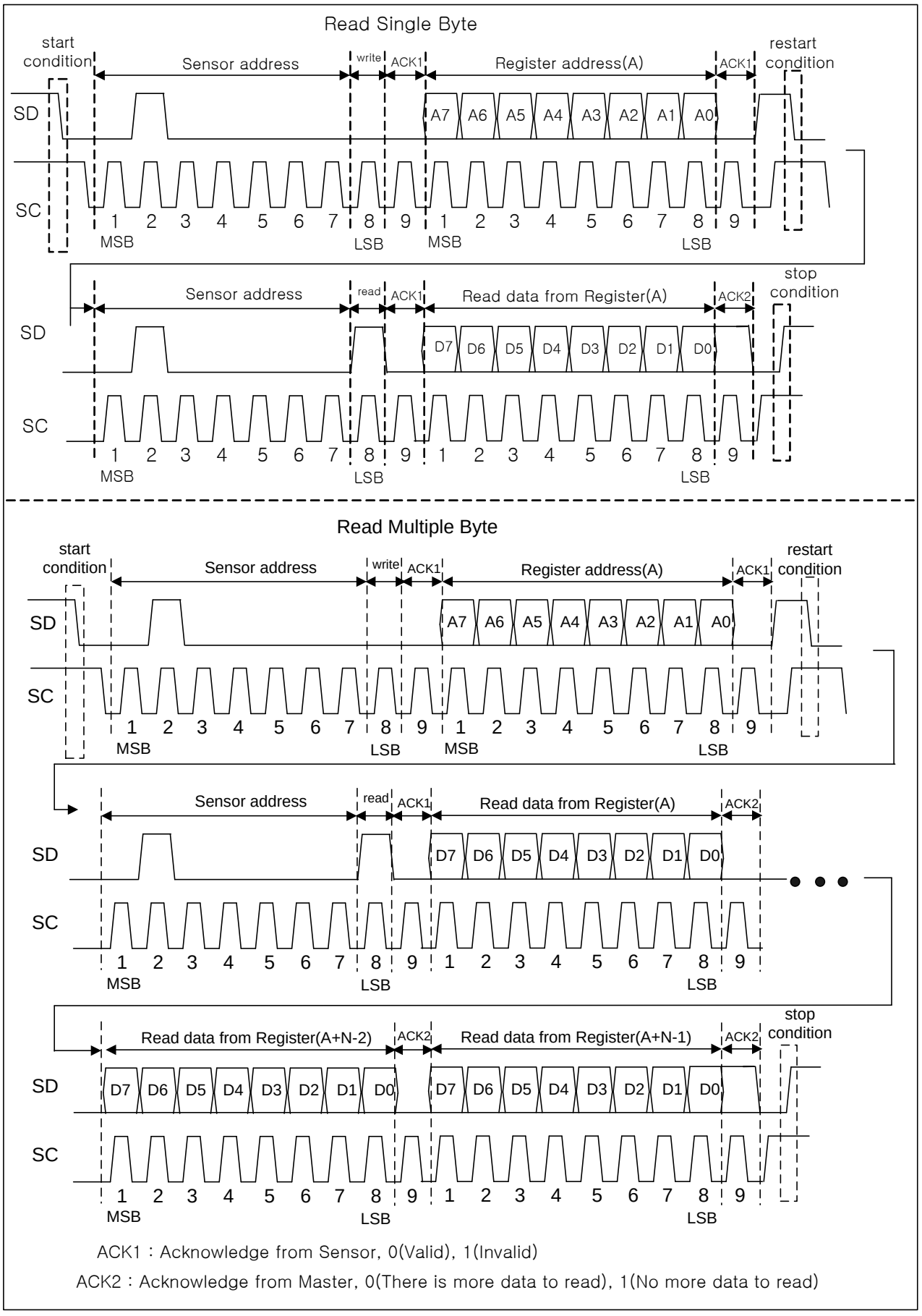
Following figures show write and read operations.

Note) Before programming the two-wire serial bus interface, MCLK and RESETB should be supplied.

<Figure 3. Write Operation through Two Wire Serial Bus>



<Figure 4. Read Operation through Two Wire Serial Bus >



4. FUNCTION DESCRIPTION

[Table 7. Functional Description]

Function	Page Mode	Address	Description
Power control	P0(0x00)	0x01	Power sleep(Software power down)
PLL	P0(0x00)	0x0E,0x0F	Control PLL(Phase locked loop)
Page mode	Common	0x03	Users should change this register before controlling functions in other pages.
Device ID	P0(0x00)	0x04	To find version of SENSOR reads this register.
Image Size	P0(0x00)	0x10, 0x11	Binning Mode, Sub-sampling, Preview, X/YFlip, Bad Frame Skip, Fixed Frame Rate.
Windowing	P0(0x00)	0x20 ~ 0x27	Control image size by controlling windowing
H/VSYNC	P0(0x00)	0x12 ~ 0x13 0x40 ~ 0x4B	Control VSYNC/HSYNC Horizontal Synchronization / Vertical Synchronization[Type1] Vertical Synchronization[Type2]
Black Level Calibration	P0(0x00)	0x80 ~ 0xA6	Calculate black level and calibrate it automatically.
Strobe	P0(0x00)	0xC0 ~ 0xC2	Control XENON / LED type for strobe
Output Data Format	P10(0x10)	0x10	YUV4:2:2, RGB5:6:5, RGB4:4:4, ITU656-like
Image Effect	P10(0x10)	0x11 ~ 0x50, 0x70 ~ 0x71	Brightness, Chrominance Offset/Constant, Sketch, Embossing, Solarization, Mono, Sepia etc
Color Saturation	P10(0x10)	0x60 ~ 0x6D	Control the gain of U/V chrominance to get vivid color reproduction.
Noise Reduction	P11(0x11)	0x10 ~ 0x53	Control D-LPF for noise reduction
	P12(0x12)	0x20 ~ 0x63	Control YC-LPF for noise reduction
Dead Pixel Concealment	P12(0x12)	0x90	Control the dead pixel concealment
Edge Enhancement	P13(0x13)	0x10 ~ 0xAB	Control gain of edge enhancement
Lens Shading Correction	P14(0x14)	0x10 ~ 0x70	Control the coefficient of lens shading correction
Color Correction	P15(0x15)	0x10 ~ 0x58	Control the color correction
Gamma Correction	P16(0x16)	0x10 ~ 0x82	Control the piecewise linear lines for Gamma Correction
Auto Flicker Cancellation	P17(0x17)	0xC0~0xC7	To detect 100Hz / 120Hz, control the coefficient of auto flicker cancellation.
Image Scaling	P18(0x18)	0x10 ~ 0x30	Image Scaling : 1x ~ 1/64x
Auto Exposure	P20(0x20)	0x10 ~ 0xD3	Control the method of auto exposure.
Auto White Balance	P22(0x22)	0x10 ~ 0xD3	Control the method of auto white balance.
Auto Focus	P24(0x24)	0x10 ~ 0x19 0x40 ~ 0x51 0xA0 ~ 0xB7	Control the edge data for auto focus
Anti - Shaking	P24(0x24)	0x10 ~ 0x19 0x40 ~ 0x51 0xB8 ~ 0xCF	Control the motion data for anti-shaking

4.1. Black Level Calibration(BLC)

Black level is caused from pixel characteristics and analog channel offset. It makes poor image quality in dark condition and misleads color balance. To reduce these phenomenon, sensor automatically calibrates the black level every frame. The masked pixels in pixel array are used to calculate the black level.

4.2. Lens Shading Correction(LSC)

The circumstance area of pixel array does not have enough quantity of light due to optical characteristics of lens. It causes reduction of signal near peripheral of pixel array. The reduction of signal depends on both pixel' s location and color. To compensate this problem, shading correction is done by controlling the correction gain which depends on pixel's location and color.

It is possible to compensate the deviation between center of lens and center of pixel array by controlling XCEN[0x20:P15] ~ YCEN[0x21:P15].

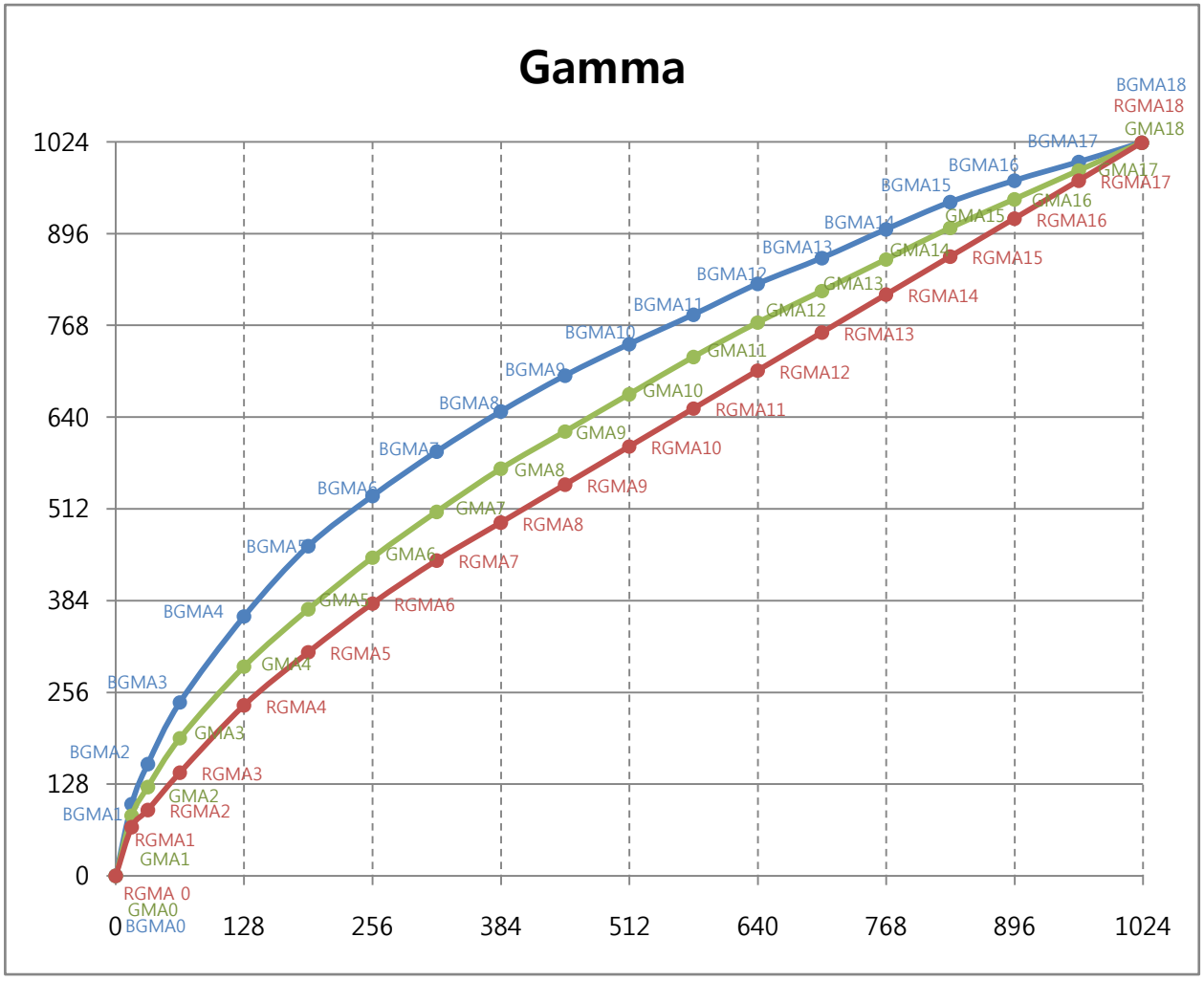
(Option for bayer center control : Gb_XCEN[0x14:P14], Gb_YCEN[0x15:P14], R_XCEN[0x16:P14], R_YCEN[0x17:P14], B_XCEN[0x18:P14], B_YCEN[0x19:P14], Gr_XCEN[0x20:P14], Gr_YCEN[0x21:P14])

4.3. Gamma Correction

Gamma correction operates on each of the Red,Green and Blue data to compensate non-linear characteristics of display device. Sensor can implement gamma correction by converting from 10bit input data to 10bit output data. In a following figure, piecewise linear lines are made implement gamma curve by using 19 points. Users can get various gamma curves by controlling 19 points.

X-axis is 10bit-input of gamma block and Y-axis is 10bit-output of gamma block.

<Figure 5. Gamma curve >



4.4. Color Correction

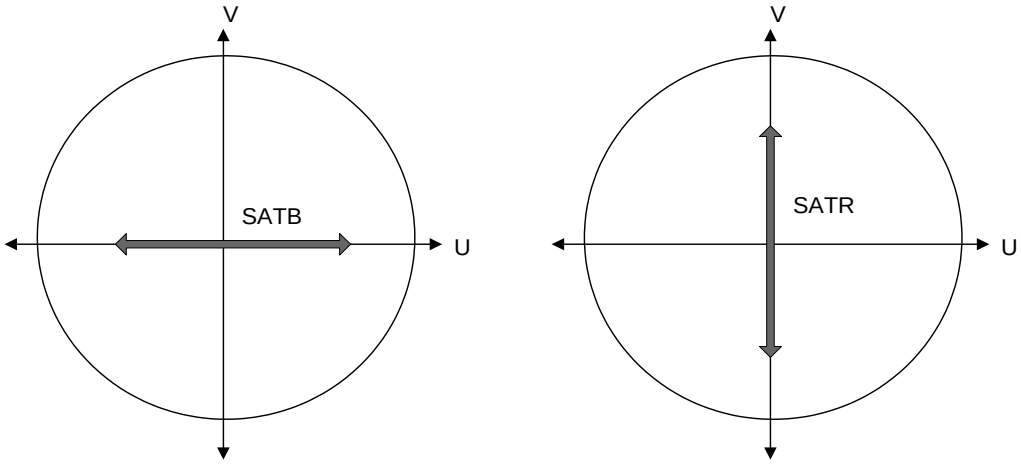
The spectral response of image sensor caused by color filter is not the same with that of human eye. This spectral response is compensated by programming 3X3 matrix. 9-elements of matrix are controlled by CMC11[0x30:P15] ~ CMC33[0x38:P15] and CMCSIGN[0x17:P15].

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} CMC11 & CMC12 & CMC13 \\ CMC21 & CMC22 & CMC23 \\ CMC31 & CMC32 & CMC33 \end{bmatrix} * \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

4.5. Color Saturation

Users can get more vivid color reproduction by adjusting chrominance U/V. Color saturation is adjusted by controlling bit[3:0] of SATCTL[0x60:P10], SATB[0x61:P10] and SATR[0x62:P10]. Color saturation controls the gain of U/V chrominance. As AG[0xB0:P20] is increased, color saturation is decreased by adjusting bit[3:2] of SATCTL [0x60:P10] automatically.

<Figure 6. Color Saturation>



4.6. Color Space Conversion

Equation of RGB to YUV color space conversion

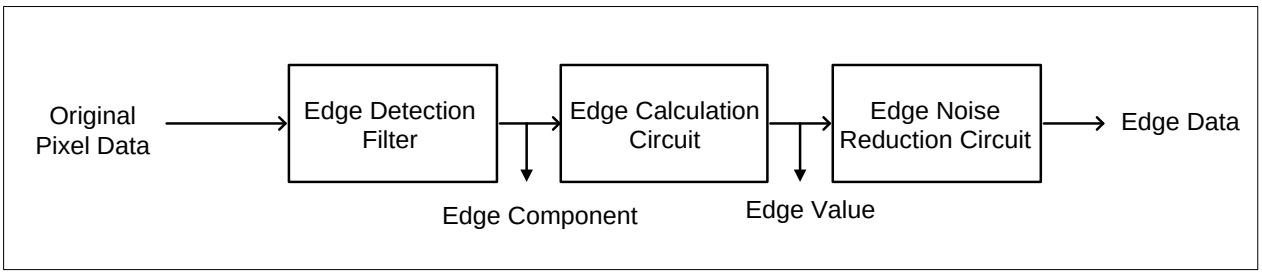
$$Y = 0.301*R + 0.586*G + 0.113*B$$
$$U = -0.168*R - 0.332*G + 0.5*B + 128$$
$$V = 0.5*R - 0.418*G - 0.082*B + 128$$

Equation of YUV to RGB color space conversion

$$R = Y + 1.402*(V - 128)$$
$$G = Y - 0.344*(U - 128) - 0.715*(V - 128)$$
$$B = Y + 1.773*(U - 128)$$

4.7. Edge Enhancement

<Figure 7. Edge Enhancement>



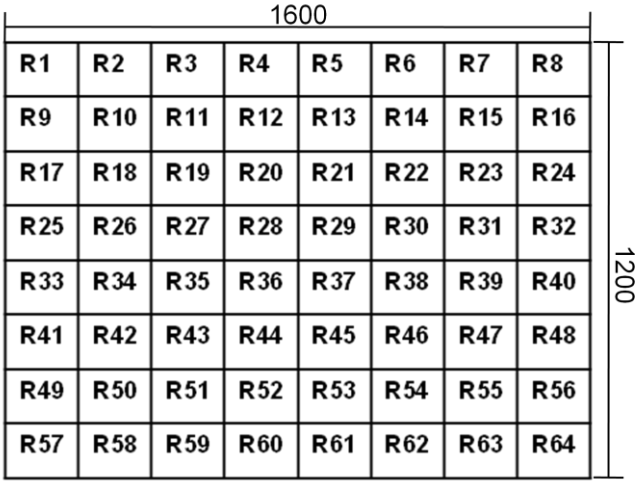
To get clear and sharp image, sensor has edge enhancement function that is composed of edge detection filter, edge calculation circuit and edge noise reduction circuit. Users can control the each function by adjusting related registers[PAGE13].

4.8. Auto Exposure Control

AE function controls AG (automatic gain) and exposure time to maintain the proper luminance level that is determined by YLVL and image statistics. When bit[7] of AECTL1 [0x10:P20] is enabled, automatic gain and exposure time will be controlled to get a good image quality automatically. Then overall luminance on image will be entered into convergence region near to proper luminance level. If overall luminance comes out of convergence region, control of exposure time, automatic gain and digital gain will be continued until it goes inside convergence region. As overall luminance is far from convergence region, it will take longer time to enter convergence region. To overcome this problem, users can control the convergence speed by adjusting some registers. Convergence speed depends on the steps of exposure time and automatic gain.

Luminance for AE operation depends on the AE weight.
AE weighting area is divided by 64 region as following figure, users can adjust the weight of each region by setting AEWGT1[0x60:P20] ~ AEWGT16[0x6F:P20].

<Figure 8. AE Weight Area >



4.9. Auto White Balance

AWB function controls RGAIN, GGAIN and BGAIN to compensate for color temperature of the light source. When bit[7] of AWBCTL1 [0x10:P22] is enabled, RGAIN and BGAIN will be controlled to get a color balanced image automatically. Then overall chrominance on image will be entered into convergence region near to ULVL[0x30:P22] and VLVL[0x31:P22]. If overall chrominance comes out of convergence region, control of RGAIN and BGAIN will be continued until it goes inside convergence region. However, when overall chrominance is far from locking region or in color region, control of RGAIN and BGAIN will be stopped. And it is possible to define convergence region and color region by adjusting ULVL[0x30:P22], VLVL[0x31:P22], UVTH1[0x38:P22] and UVTH2[0x39:P22]

Convergence Region) ULVL - UVTH1[7:4] <= Overall Chrominance U <=ULVL + UVTH1[7:4] and
VLVL - UVTH1[7:4] <= Overall Chrominance V <=VLVL + UVTH1[7:4]
Color Region) Overall Chrominance U >=ULVL + 8 * UVTH2[3:0]
or Overall Chrominance U <=ULVL – 8 * UVTH2[3:0]
Overall Chrominance V >=VLVL + 8 * UVTH2[3:0]
or Overall Chrominance V <=VLVL – 8 * UVTH2[3:0]

4.10. PLL(Phase Locked Loop) Control

PLL is controlled by adjusting PLLCTL1[0x0E:P0].

Sequence of setting PLL

1) Enable power sleep mode (bit[0] of PWRCTL[0x01:P0])
2) Set PLL lock time and PLL Mode
3) Enable PLL1 and PLL2
4) Wait PLL lock time
5) Disable power sleep mode.

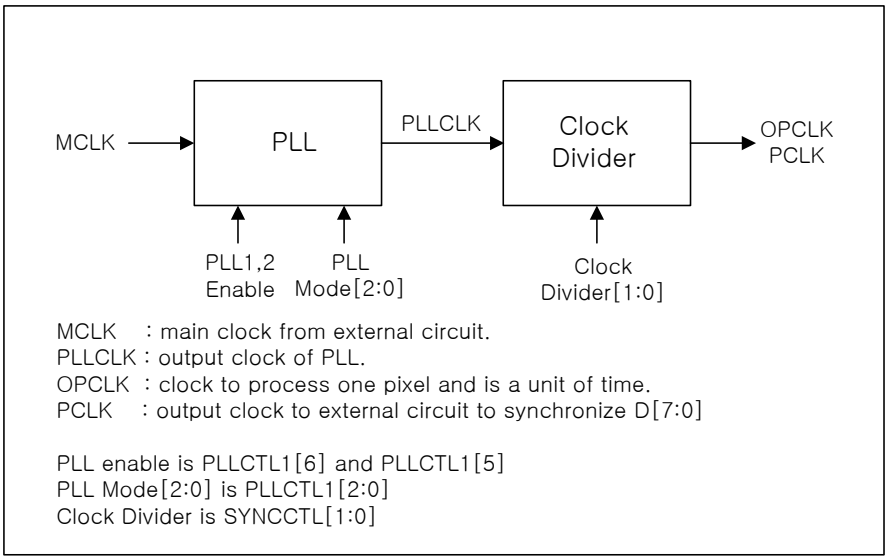
0x0E [page mode 0]: PLLCTL1 [default=0x00, r/w]

Bit	Function	Description	Default
B[6]	**Enable PLL2**	This bit should be enabled after PLL mode is set.	0b
B[5]	**Enable PLL1**	This bit should be enabled after PLL mode is set.	0b
B[4:3]	**PLL Bias**	Recommended value is 0x00.	00b
B[2:0]	**PLL Mode**	PLL mode should be set before enabling PLL. Select output clock of PLL. The output clock of PLL is multiple of external main clock 010: 1.5x, 011: 2x, 100: 2.5x, 101: 3x, 110: 3.5x, 111: 4X.	011b

0x0F[page mode 0]: PLLCTL2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:5]	**Locking Time**	PLL locking time : B[7:5] * 512 * MCLK's period Recommended value is over the 10msec..	000b
B[4:0]		Reserved.	0_0000b

<Figure 9. Block diagram 1 of PLL>



PLLCLK = [Scale of PLL Mode] * MCLK

OPCLK = [Scale of PLL Mode * Scale of Clock Divider * 1/2] * MCLK

PCLK = [Scale of PLL Mode * Scale of Clock Divider * Scale of Sub-Sample] * MCLK

PLL operation	ON						OFF
PLL Mode(bit[2:0] of PLLCTL1[0x0E]	2	3	4	5	6	7	X
Scale	1.5	2	2.5	3	3.5	4	1

Clock Divider (bit[1:0] of SYNCCTL[0x12:P0])	0	1	2	3
Scale	1	1/2	1/4	1/8

Sub-Sample(bit[5:4] of VDOCTL1[0x10])	0	1	2	3
Scale	1	1/2	1/4	1/8

Example) MCLK:24Mhz, PLL Enable, Scale of PLL Mode=2, Scale of Clock Divider=1, Scale of Sub-Sample=1

OPCLK = 2 * 1/2 * 24Mhz =24Mhz, PCLK = 2 * 24Mhz = 48Mhz

Note) OPCLK should be greater than the 12Mhz

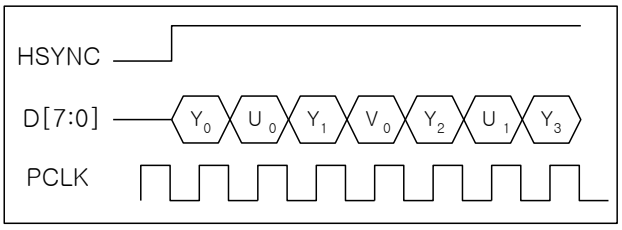
4.11. Video Output Data Format

Video output data format is controlled by adjusting ISPCTL1[0x10:P10].

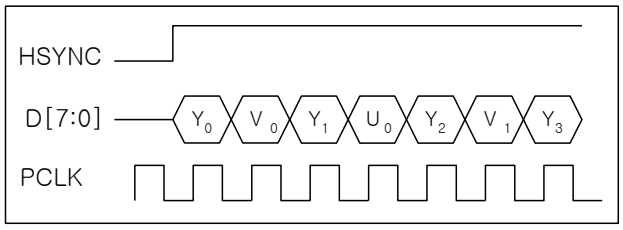
- YUV4:2:2

<Figure 10. Timing of YUV4:2:2>

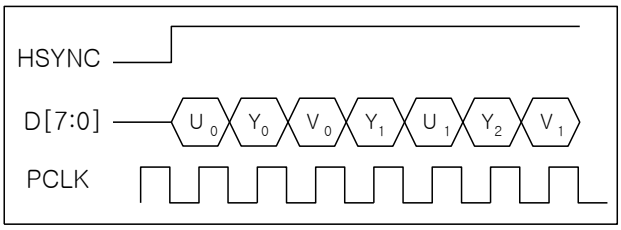
Case1) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: ON



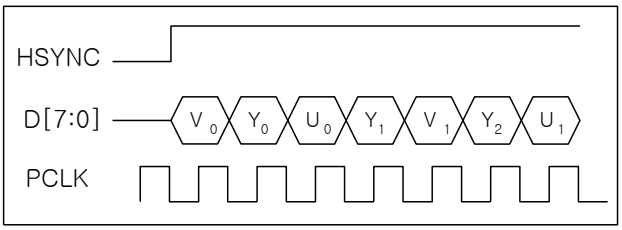
Case2) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: OFF



Case3) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: ON



Case4) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: OFF

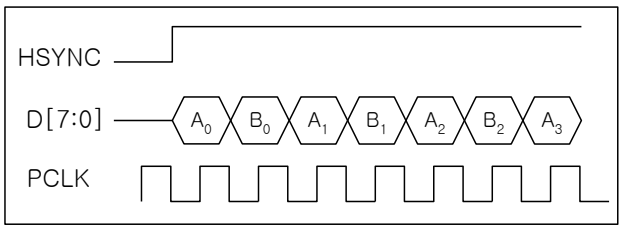


- RGB5:6:5

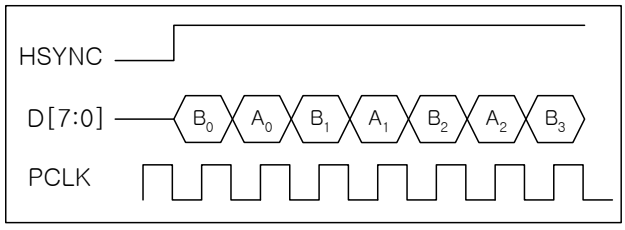
Following figure shows the output timing of RGB 5:6:5 8bit

<Figure 11. Timing of RGB5:6:5>

B[7] of ISPCTL2[0x11:P10] : Byte Swap = OFF



B[7] of ISPCTL2[0x11:P10] : Byte Swap = ON



Case 1) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: ON, Where is A = (G[7:2],B[7:6]), B = (B[5:3],R[7:3]).

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	G[7]	G[6]	G[5]	G[4]	G[3]	G[2]	B[7]	B[6]
B	B[5]	B[4]	B[3]	R[7]	R[6]	R[5]	R[4]	R[3]

Case 2) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: OFF, Where is A = (G[7:2],R[7:6]), B = (R[5:3],B[7:3]).

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	G[7]	G[6]	G[5]	G[4]	G[3]	G[2]	R[7]	R[6]
B	R[5]	R[4]	R[3]	B[7]	B[6]	B[5]	B[4]	B[3]

Case 3) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: ON, Where is A = (B[7:3],G[7:5]), B = (G[4:2],R[7:3]).

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	B[7]	B[6]	B[5]	B[4]	B[3]	G[7]	G[6]	G[5]
B	G[4]	G[3]	G[2]	R[7]	R[6]	R[5]	R[4]	R[3]

Case 4) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: OFF, Where is A = (R[7:3],G[7:5]), B = (G[4:2],B[7:3]).

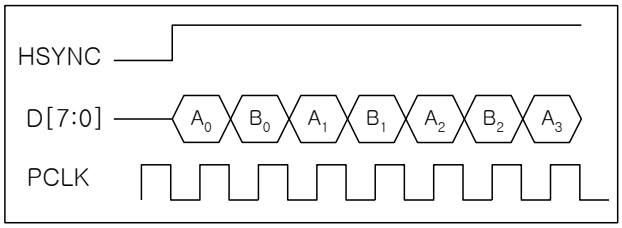
Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	R[7]	R[6]	R[5]	R[4]	R[3]	G[7]	G[6]	G[5]
B	G[4]	G[3]	G[2]	B[7]	B[6]	B[5]	B[4]	B[3]

- RGB4:4:4

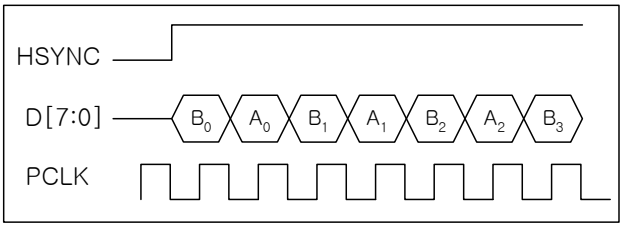
Following figure shows the output timing of RGB 4:4:4 8bit.

<Figure 12. Timing of RGB4:4:4>

B[7] of ISPCTL2[0x11:P10] : Byte Swap = OFF



B[7] of ISPCTL2[0x11:P10] : Byte Swap = ON



Case 1) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: ON

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	0	0	0	0	G[7]	G[6]	G[5]	G[4]
B	B[7]	B[6]	B[5]	B[4]	R[7]	R[6]	R[5]	R[4]

Case 2) bit[1] of ISPCTL1: ON and bit[0] of ISPCTL1: OFF

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	0	0	0	0	G[7]	G[6]	G[5]	G[4]
B	R[7]	R[6]	R[5]	R[4]	B[7]	B[6]	B[5]	B[4]

Case 3) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: ON

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	0	0	0	0	B[7]	B[6]	B[5]	B[4]
B	G[7]	G[6]	G[5]	G[4]	R[7]	R[6]	R[5]	R[4]

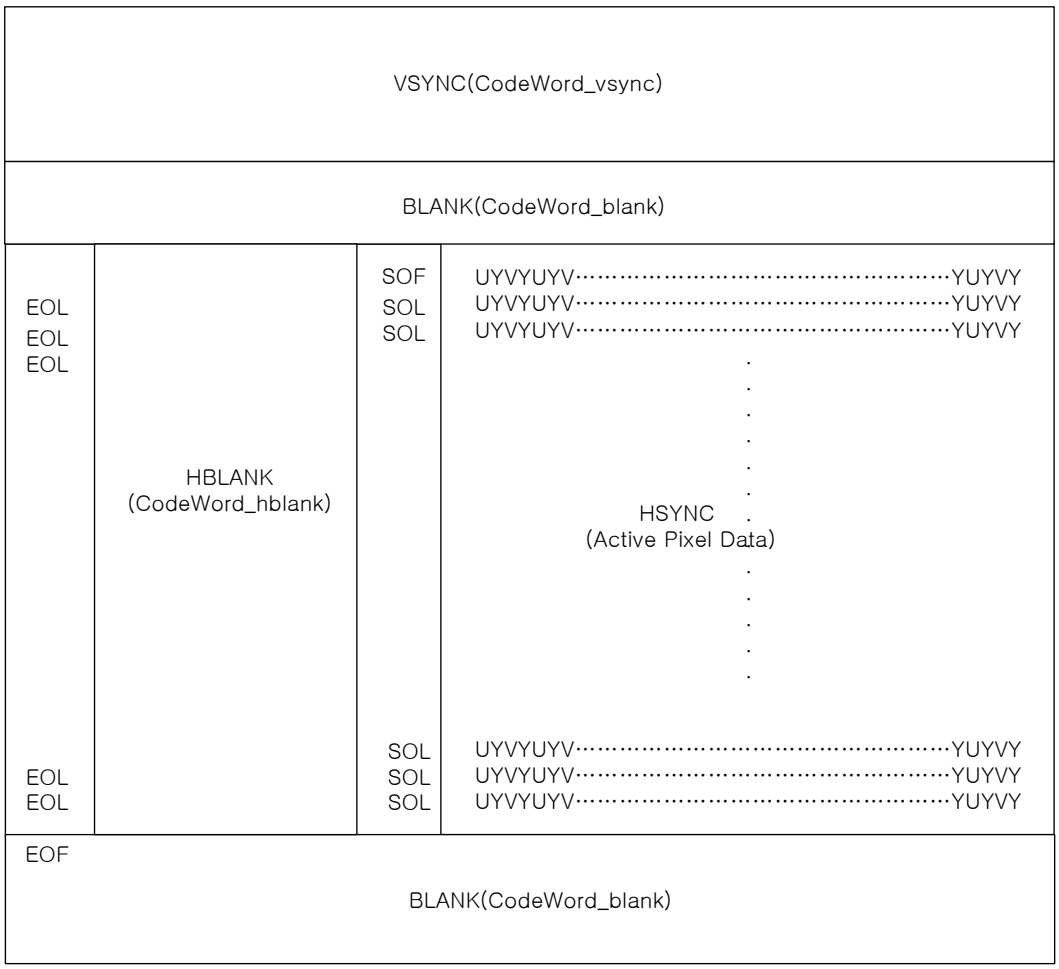
Case 4) bit[1] of ISPCTL1: OFF and bit[0] of ISPCTL1: OFF

Pin Name	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
A	0	0	0	0	R[7]	R[6]	R[5]	R[4]
B	G[7]	G[6]	G[5]	G[4]	B[7]	B[6]	B[5]	B[4]

- ITU656-like

To use this mode, users should set bit[2] of ISPCTL1[0x10:P10] to ON.

<**Figure 13**. Frame structure of ITU656-like>



VSYNC(CodeWord_vsync) = 0x8010 for bit[4] of ITUCTL[0x20:P10] = OFF

0x0000 for bit[4] of ITUCTL [0x20:P10] = ON

HBLANK(CodeWord_hblank) = 0x8010 for bit[4] of ITUCTL [0x20:P10] = OFF

0x0000 for bit[4] of ITUCTL [0x20:P10] = ON

BLANK(CodeWord_blank) = 0x8010 for bit[4] of ITUCTL [0x20:P10] = OFF

0x0000 for bit[4] of ITUCTL [0x20:P10] = ON

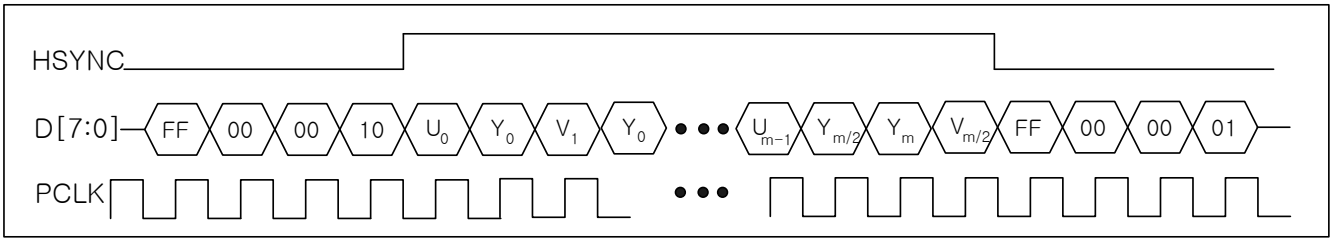
SOF = 0xFF0000XX : XX is ITUSOF[0x24:P10]

EOF = 0xFF0000XX : XX is ITUEOF[0x26:P10]

SOL = 0xFF0000XX : XX is ITUSOL[0x25:P10]

EOL = 0xFF0000XX : XX is ITUEOL[0x27:P10]

Following figure shows the SOL, EOL and image data in one line.



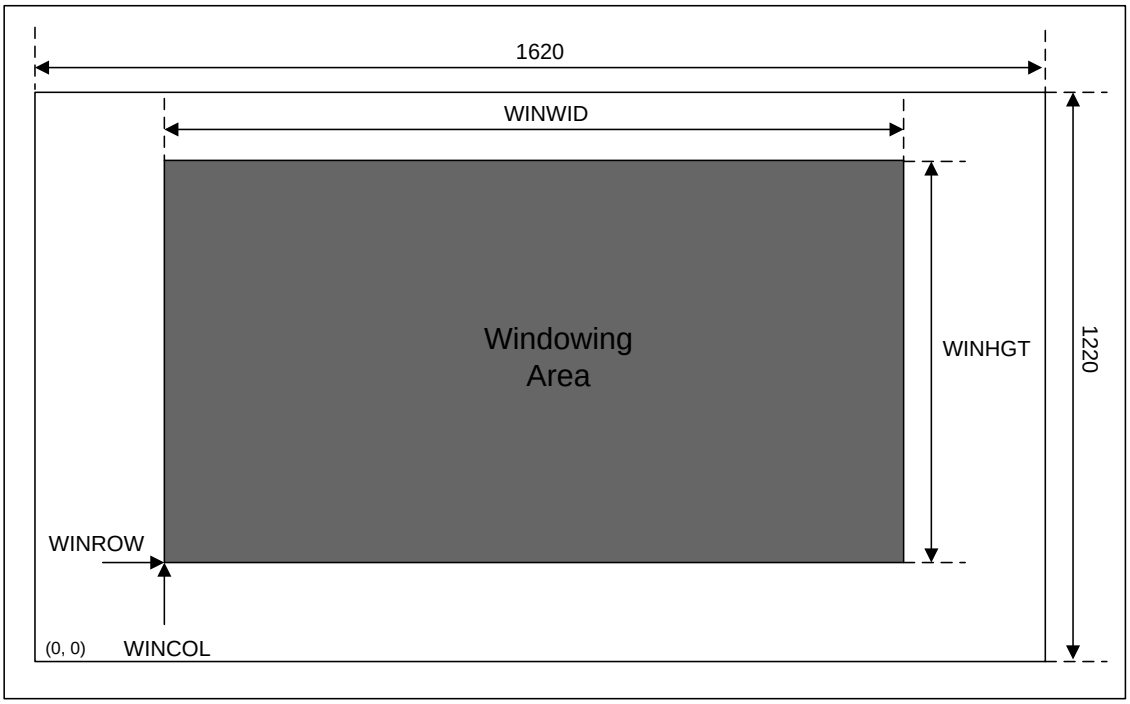
4.12. Windowing

Sensor has a rectangular pixel array 1620 X 1220. The array can be windowed by controlling WINROW[0x20, 0x21:P0], WINCOL[0x22,0x23:P0], WINHGT[0x24, 0x25:P0] and WINWID[0x26, 0x27:P0] when bit[7] of VDOCTL2[0x11:P0] is enabled.

Following Table shows the recommended setting for each image size.

	Output Image Size	VDOCTL1 [0x10:P0]	Preview 1	WINROW [0x20, 21:P0]	WINCOL [0x22, 23:P0]	WINHGT [0x24, 25:P0]	WINIWID [0x26, 27:P0]
UXGA	1600 X 1200	0x00	OFF	0x00, 0x0A	0x00, 0x0A	0x04, 0xB0	0x06, 0x40
SVGA	800 X 600	0x10	OFF	0x00, 0x0A	0x00, 0x0A	0x04, 0xB0	0x06, 0x40
	800 X 600	0x11	ON	0x00, 0x02	0x00, 0x0A	0x04, 0xB0	0x06, 0x40
QSVGA	400 X 300	0x20	OFF	0x00, 0x0A	0x00, 0x0A	0x04, 0xB0	0x06, 0x40
	400 X 300	0x21	ON	0x00, 0x02	0x00, 0x0A	0x04, 0xB0	0x06, 0x40

<Figure 14. Windowing>



4.13. Frame Structure

Frame Structure is frame timing, and it is controlled by HBLANK[0x40,0x41:P0] and VSYNC[0x42, 0x43E:P0] and VSCLIP[0x44:P0].

When exposure time is less than the data line time, figure 15 and figure 16 is valid.

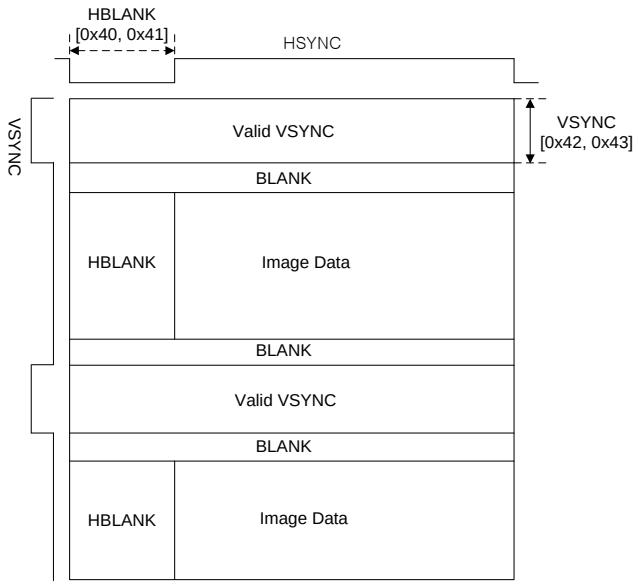
If the exposure time is over the data line time, the difference will be inserted between Image Data and Valid VSYNC.

Where data line time is (1640 + HBLANK) X 1248 X OPCLK's period for full size,

(1640 + HBLANK) X 632 X OPCLK's period for preview1,

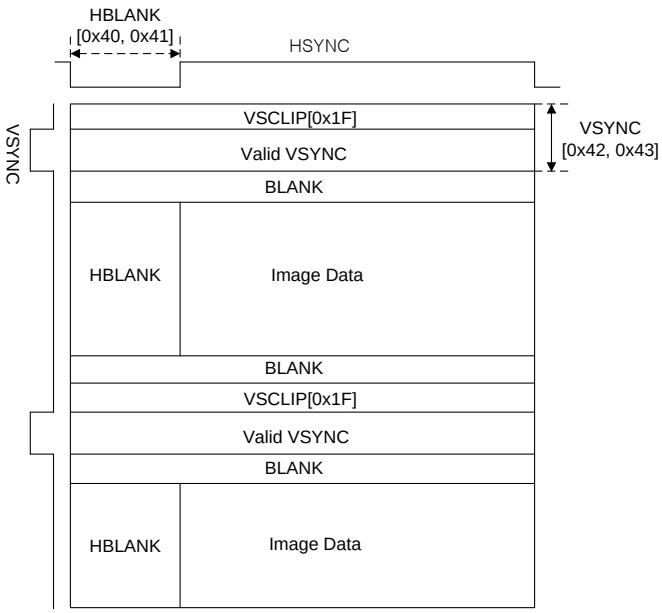
<Figure 15. Frame Structure when VSYNC Clip is disabled>

Case1) bit[3] of SYNCCTL [0x12:P0] is OFF



<Figure 16. Frame Structure when VSYNC Clip is enabled>

Case2) bit[3] of SYNCCTL [0x12:P0] is ON



4.14. Image Scaling

Sensor supports an image scaling when the output scaling size is smaller than the original image size. An image scaling is done by using the YUV data. Output scaling size is controlled in x or y direction independently with ZOUTWID[0x20, 0x21:P18] and ZOUTHGT[0x22, 0x23:P18]. And users should also set the ZFIFODLY[0x30:P18], ZVERSTEP[0x2C, 0x2D:P18] and ZHORSTEP[0x2E, 0x2F:P18].

Following is the register setting for scaling

ZHORSTEP[Horizontal step] = (Image Width / ZOUTWID) x 2048
ZVERSTEP[Vertical step] = (Image Height / ZOUTHGT) x 2048

where
Image Height = WINHGT[0x24, 0x25:P0] for full size
= WINHGT [0x24, 0x25:P0] /2 for preivew1
Image Width = WINWID[0x26, 0x27:P0] for full size or preview 1

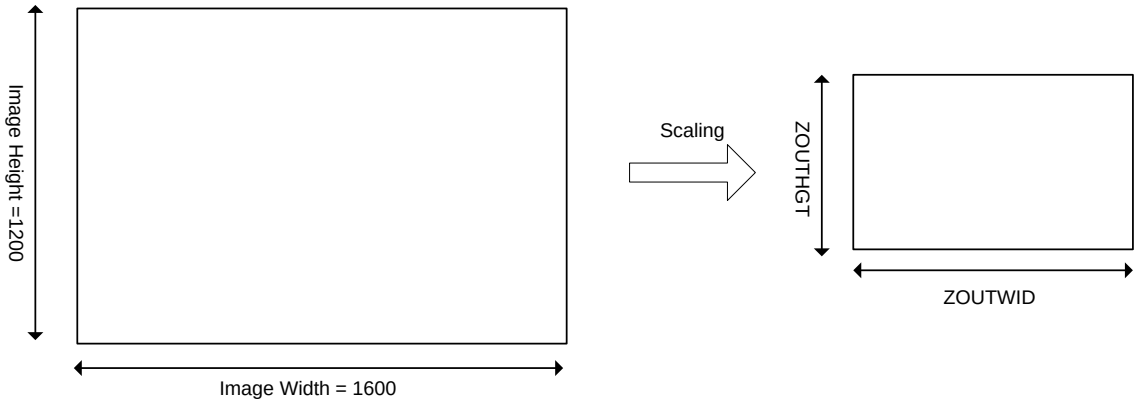
Users can control the speed of PCLK on scaling by adjusting bit[0] of ZOOMCTL2[0x11:P18]
When Bit[0] of ZOOMCTL2[0x11:P18] is 0, PCLK is not changed.
ZFIFODLY = {[(Niw – Now) x Now)] / Niw +5} / 4 + 1

When Bit[0] of ZOOMCTL2[0x11:P18] is 1, PCLK is 2times slower than that of full mode.
ZFIFODLY = {[(Niw –Now) x Now] / Niw + 5} / (4 x ZCLK) + ZWINSTX[0x28, 0x29:P18]

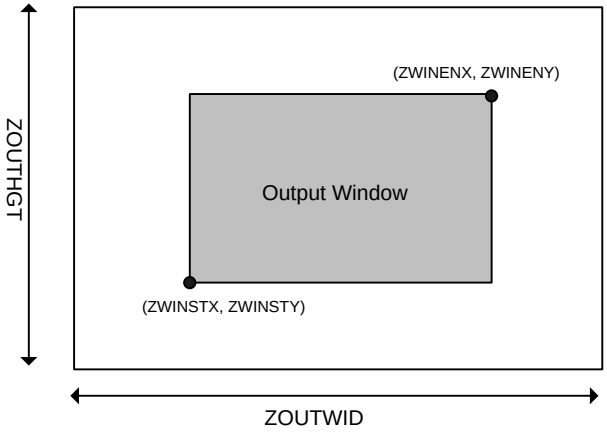
Where
Niw = WINWID[0x26,0x27:P0] + 24,
Now =[(Niw*2048)/ZHORSTEP[Horizontal step]] * ZCLK
ZCLK = 1 for PCLK(1x), 2 for PCLK(1/2x)

Horizontal scaling factor = (ZOUTWID / Image Width)
Vertical scaling factor = (ZOUTHGT / Image Height)
Image scaling factor = Horizontal scaling factor * Vertical scaling factor
Programmable scaling factor is 1x~1/64x. Following figure shows how to scale the data from the sensor.

<Figure 17. Image Scaling>



<Figure 18. Windowing after Image Scaling>



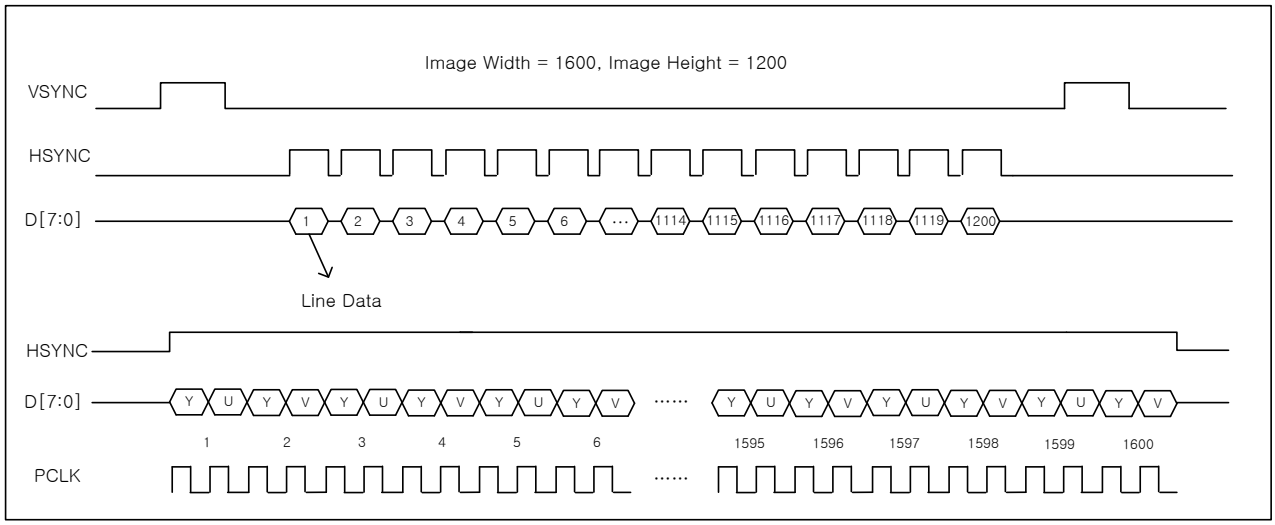
The window size can be programmed with bit[1] of ZOOMCTL1[0x10:P18], ZWINSTX[0x24, 0x25:P18], ZWINSTY[0x26,0x27:P18], ZWINENX[0x28, 0x29:P18] and ZWINENY [0x2A,0x2B:P18].

Timing of Image Scaling

In image scaling, the width and period of HSYNC are changed but the period of frame is not changed.

Following figures show the difference of the timing diagram between normal image and scaling image.

<Figure 19. Frame before Image Scaling>



<Figure 20. Frame after Image Scaling>

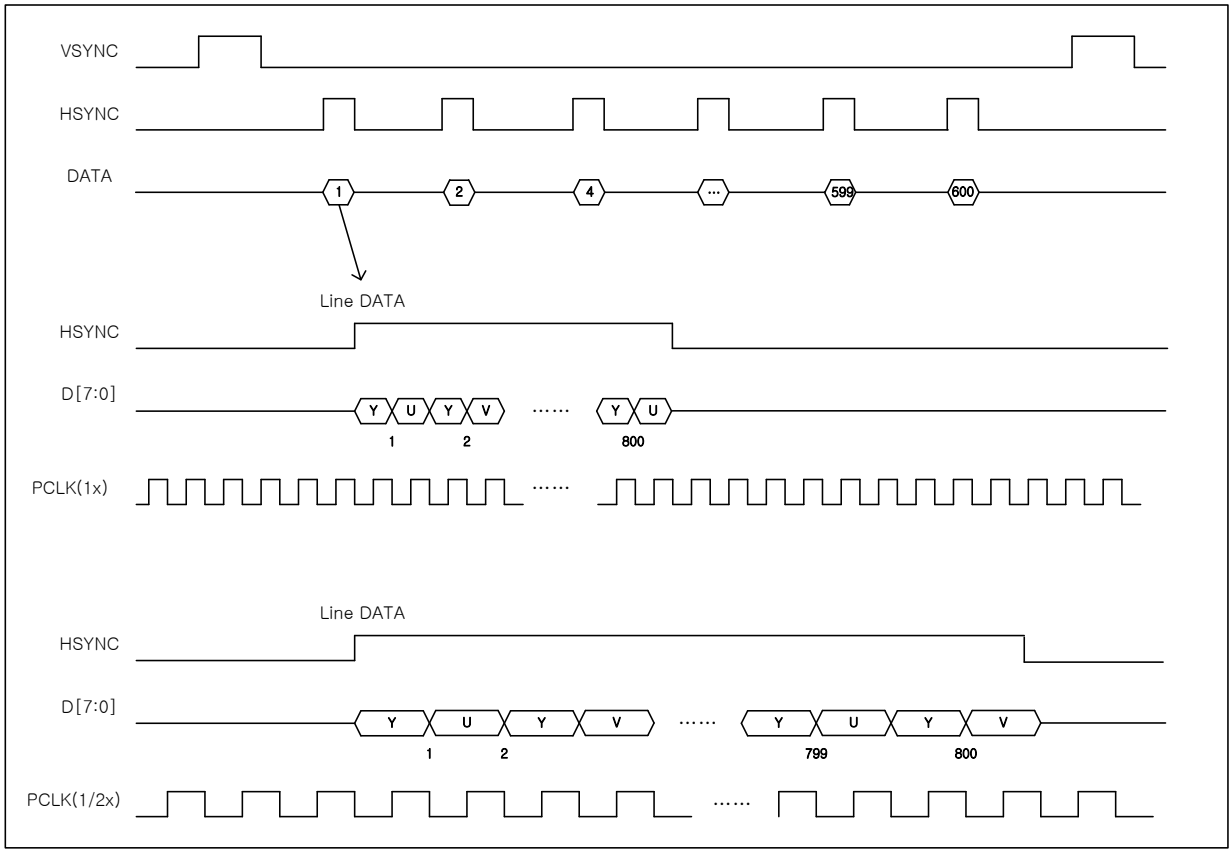


Figure 20. shows timing diagram of scaling image mode at PCLK(1x) and PCLK(1/2x). Sensor supports various scaling output clock period such as 1x or 1/2x. It can be selected by the bit[1:0] of ZOOMCTL2[0x11:P18] register setting. In PCLK(1/2x) mode, HSYNC period is twice longer than PCLK(1x) mode but the period of frame is not changed. So maximum image size is a half of the full size.

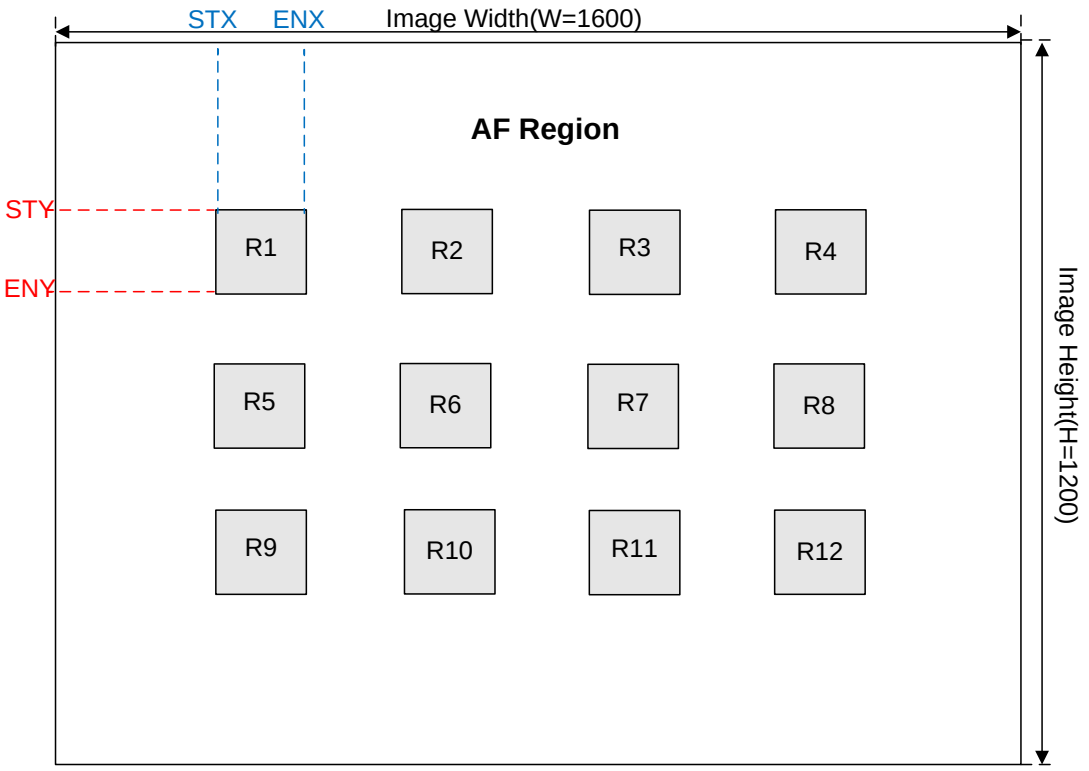
Following table show maximum image size of each clock mode

Zoom Clock	ZOUTWID [0x20, 0x21]	ZOUTHGT [0x22, 0x23]
PCLK(1x)	1600	1200
PCLK(1/2x)	800	600

4.15. Edge Data for Auto Focus and Motion Data for Anti-Shaking

Sensor has 12 regions for auto focus or anti-shaking.
12 regions have the edge data for auto focus or motion data for anti-shaking. Users can select the data type of 12 regions.
Each region is controlled by(AFROWSTR1[0x40:P24] ~ AFCOLLSB[0x51:P24]) as followings.

<Figure 21. Auto Focus Region>



R1 : STX= AFCOLSTR1[0x48:P24] * 8, ENX= AFCOLENR1[0x49:P24] * 8 + bit[7:6] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR1[0x40:P24] * 8, ENY= AFROWENR1[0x41:P24] * 8 + bit[7:6] of AFROWLSB [0x50:P24] * 2
R2 : STX= AFCOLSTR2[0x4A:P24] * 8, ENX= AFCOLENR2[0x4B:P24] * 8 + bit[5:4] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR1[0x40:P24] * 8, ENY= AFROWENR1[0x41:P24] * 8 + bit[7:6] of AFROWLSB [0x50:P24] * 2
R3 : STX= AFCOLSTR3[0x4C:P24] * 8, ENX= AFCOLENR3[0x4D:P24] * 8 + bit[3:2] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR1[0x40:P24] * 8, ENY= AFROWENR1[0x41:P24] * 8 + bit[7:6] of AFROWLSB [0x50:P24] * 2
R4 : STX= AFCOLSTR4[0x4E:P24] * 8, ENX= AFCOLENR4[0x4F:P24] * 8 + bit[1:0] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR1[0x40:P24] * 8, ENY= AFROWENR1[0x41:P24] * 8 + bit[7:6] of AFROWLSB [0x50:P24] * 2

R5 : STX= AFCOLSTR1[0x48:P24] * 8, ENX= AFCOLENR1[0x49:P24] * 8 + bit[7:6] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR2[0x42:P24] * 8, ENY= AFROWENR2[0x43:P24] * 8 + bit[5:4] of AFROWLSB [0x50:P24] * 2
R6 : STX= AFCOLSTR2[0x4A:P24] * 8, ENX= AFCOLENR2[0x4B:P24] * 8 + bit[5:4] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR2[0x42:P24] * 8, ENY= AFROWENR2[0x43:P24] * 8 + bit[5:4] of AFROWLSB [0x50:P24] * 2
R7 : STX= AFCOLSTR3[0x4C:P24] * 8, ENX= AFCOLENR3[0x4D:P24] * 8 + bit[3:2] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR2[0x42:P24] * 8, ENY= AFROWENR2[0x43:P24] * 8 + bit[5:4] of AFROWLSB [0x50:P24] * 2
R8 : STX= AFCOLSTR4[0x4E:P24] * 8, ENX= AFCOLENR4[0x4F:P24] * 8 + bit[1:0] of AFCOLLSB [0x51:P24] * 2
STY= AFROWSTR2[0x42:P24] * 8, ENY= AFROWENR2[0x43:P24] * 8 + bit[5:4] of AFROWLSB [0x50:P24] * 2

R9 : STX= AFCOLSTR1[0x48:P24] * 8, ENX= AFCOLENR1[0x49:P24] * 8 + bit[7:6] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR3[0x44:P24] * 8, ENY= AFROWENR3[0x45:P24] * 8 + bit[3:2] of AFROWLSB [0x50:P24] * 2
R10 : STX= AFCOLSTR2[0x4A:P24] * 8, ENX= AFCOLENR2[0x4B:P24] * 8 + bit[5:4] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR3[0x44:P24] * 8, ENY= AFROWENR3[0x45:P24] * 8 + bit[3:2] of AFROWLSB [0x50:P24] * 2
R11 : STX= AFCOLSTR3[0x4C:P24] * 8, ENX= AFCOLENR3[0x4D:P24] * 8 + bit[3:2] of AFCOLLSB [0x51:P24] * 2,
STY= AFROWSTR3[0x44:P24] * 8, ENY= AFROWENR3[0x45:P24] * 8 + bit[3:2] of AFROWLSB [0x50:P24] * 2
R12 : STX= AFCOLSTR4[0x4E:P24] * 8, ENX= AFCOLENR41[0x4F:P24] * 8 + bit[1:0] of AFCOLLSB [0x51:P24] * 2
STY= AFROWSTR3[0x44:P24] * 8, ENY= AFROWENR3[0x45:P24] * 8 + bit[3:2] of AFROWLSB [0x50:P24] * 2

AF data of Anti-shaking of each region are stored at following register, and updated by every frame.

	AF Data	AS Data
Region1	AFDATAR1[0xA0, 0xA1:P24]	ASDATAR1[0xB8, 0xB9:P24]
Region2	AFDATAR2[0xA2, 0xA3:P24]	ASDATAR2[0xBA, 0xBB:P24]
Region3	AFDATAR3[0xA4, 0xA5:P24]	ASDATAR3[0xBC, 0xBD:P24]
Region4	AFDATAR4[0xA6, 0xA7:P24]	ASDATAR4[0xBE, 0xBF:P24]
Region5	AFDATAR5[0xA8, 0xA9:P24]	ASDATAR5[0xC0, 0xC1:P24]
Region6	AFDATAR6[0xAA, 0xAB:P24]	ASDATAR6[0xC2, 0xC3:P24]
Region7	AFDATAR7[0xAC, 0xAD:P24]	ASDATAR7[0xC4, 0xC5:P24]
Region8	AFDATAR8[0xAE, 0xAF:P24]	ASDATAR8[0xC6, 0xC7:P24]
Region9	AFDATAR9[0xB0, 0xB1:P24]	ASDATAR9[0xC8, 0xC9:P24]
Region10	AFDATAR10[0xB2, 0xB3:P24]	ASDATAR10[0xCA, 0xCB:P24]
Region11	AFDATAR11[0xB4, 0xB5:P24]	ASDATAR11[0xCC, 0xCD:P24]
Region12	AFDATAR12[0xB6, 0xB7:P24]	ASDATAR12[0xCE, 0xCF:P24]

4.16. Timing Description

Sensor supports UXGA(1600 X 1200), SVGA(800 X 600), QSVGA(400 X 300). Following table shows the register value for each image size.

Image Type	Output Image Size	VDOCTL1[0x10:P0]
UXGA	1600 X 1200	0x00
SVGA	800 X 600	0x10
	800 X 600	0x11
QSVGA	400 X 300	0x20
	400 X 300	0x21

Timing parameters

T_o : period of OPCLK that is internal clock to process one pixel. It is a unit of time in this device.

OPCLK = [Scale of PLL Mode * Scale of Clock Divider * 1/2] * MCLK

T_p : period of PCLK that is output clock to external circuit for synchronizing D[7:0].

To catch YUV data, use the PCLK because YUV data is changed by period of PCLK

PCLK = [Scale of PLL Mode * Scale of Clock Divider * Scale of Sub-Sample] * MCLK

PLLCLK = [Scale of PLL Mode] * MCLK

OPCLK = [Scale of PLL Mode * Scale of Clock Divider * 1/2] * MCLK

PCLK = [Scale of PLL Mode * Scale of Clock Divider * Scale of Sub-Sample] * MCLK

PLL operation	ON						OFF
PLL Mode(bit[2:0] of PLLCTL1[0x0E]	2	3	4	5	6	7	X
Scale	1.5	2	2.5	3	3.5	4	1

Clock Divider (bit[1:0] of SYNCCTL[0x12:P0	0	1	2	3
Scale	1	1/2	1/4	1/8

Sub-Sample(bit[5:4] of VDOCTL1[0x10])	0	1	2	3
Scale	1	1/2	1/4	1/8

Example) MCLK:24Mhz, PLL Enable, Scale of PLL Mode=2, Scale of Clock Divider=1, Scale of Sub-Sample=1.

OPCLK = 2 * 1/2 * 24Mhz =24Mhz, PCLK = 2 * 24Mhz = 48Mhz

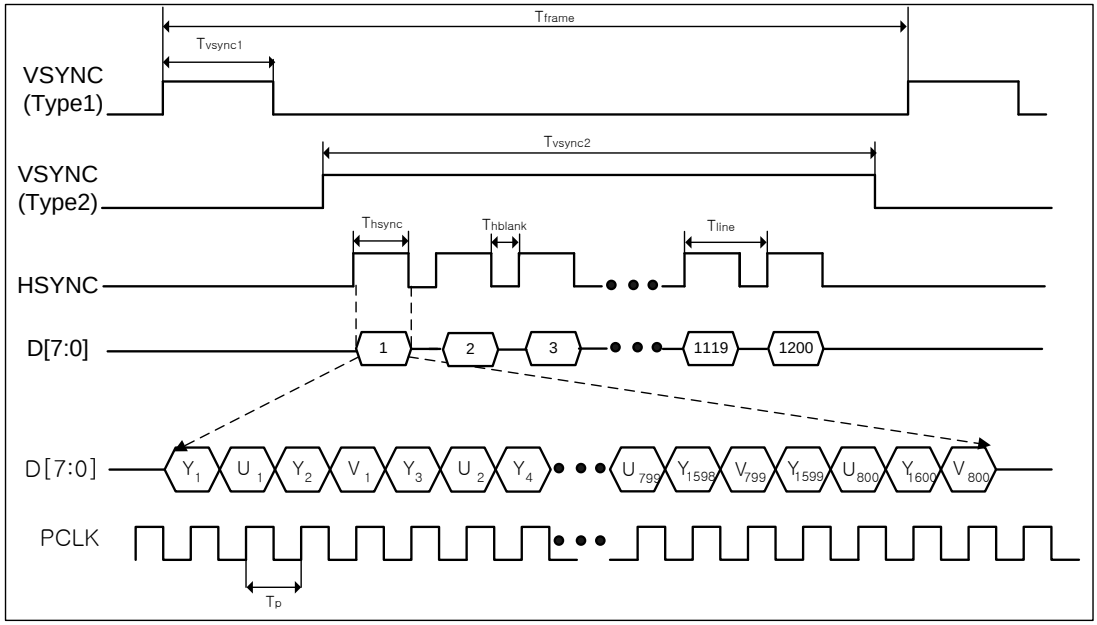
Note) OPCLK should be greater than the 12 MHz

Note) Type of VSYNC is selected by bit[3] of VDOCTL1[0x10:P0] in following figures.

VSYNC of type1 is controlled by VSYNC[0x42, 43:P0] registers.

VSYNC of type2 is controlled by VSCTL1[0x45:P0], VSCTL2[0x46:P0] and VSCTL3[0x47:P0],

<Figure 22. Frame Timing of UXGA(1600 X 1200)>



T_p = 1/2*T_o , T_{hsync} = 1600*T_o , T_{hblank} = (HBLANK+40)*T_o , T_{line} = (1640 + HBLANK)*T_o,

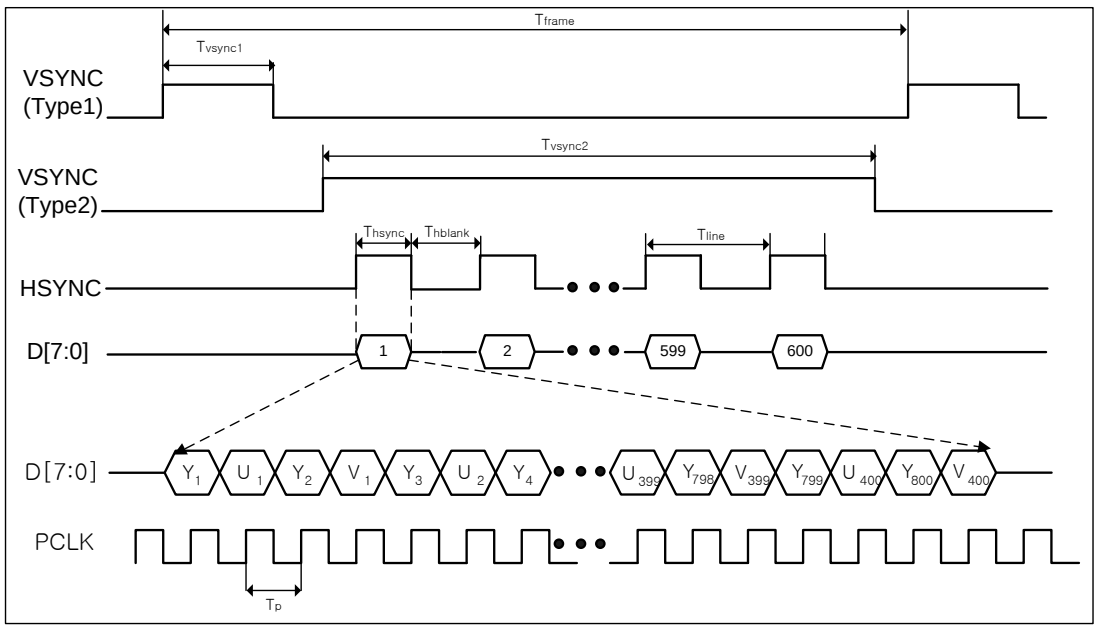
T_{vsync1} =VSYNC * (1640 + HBLANK)*T_o for type1,

T_{vsync2} = ((VSCTL1[3:0]*256 + VSCTL3[7:0]) – (VSCTL1[7:4]*256 + VSCTL2[7:0])) * (1640+ HBLANK)*T_o for type2,

T_{frame} = (1248 + VSYNC) *(1640 + HBLANK)*T_o, for EXPINT[0x80,81,82:P20] <= 1248 * (1640 + HBLANK)*T_o

= EXPINT + VSYNC * (1640 + HBLANK)*T_o, elsewhere

<Figure 23. Frame Timing of SVGA(800 X 600) when VDOCTL1[0x10:P0] is 0x10 >



T_p = T_o , T_{hsync} = 1600*To, T_{hblank} = (2*HBLANK+1680)*T_o, T_{line}= 2*(1640 + HBLANK)*T_o,

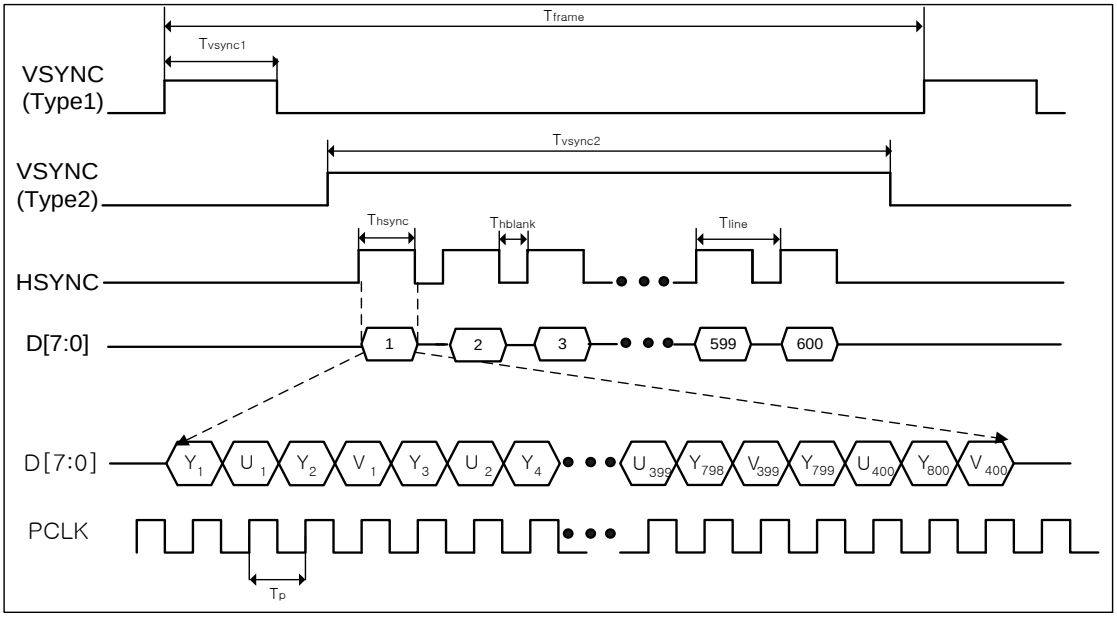
T_{vsync1}=VSYNC * (1640 + HBLANK)*To for type1,

T_{vsync2}= ((VSCTL1[3:0]*256 + VSCTL3[7:0]) – (VSCTL1[7:4]*256 + VSCTL2[7:0])) * (1640 + HBLANK)*T_o for type2,

T_{frame} = (1248 + VSYNC) *(1640 + HBLANK)*T_o, for EXPINT[0x80,81,82:P20] <= 1248 * (1640 + HBLANK)*T_o

= EXPINT + VSYNC * (1640 + HBLANK)*T_o, elsewhere

<Figure 24. Frame Timing of SVGA(600 X 800) when VDOCTL1[0x10:P0] is 0x11 >



$T_p=T_o$, Thsync=1600*T_o, Thblank = (HBLANK+40)*T_o, Tline= (1640 + HBLANK)*T_o,

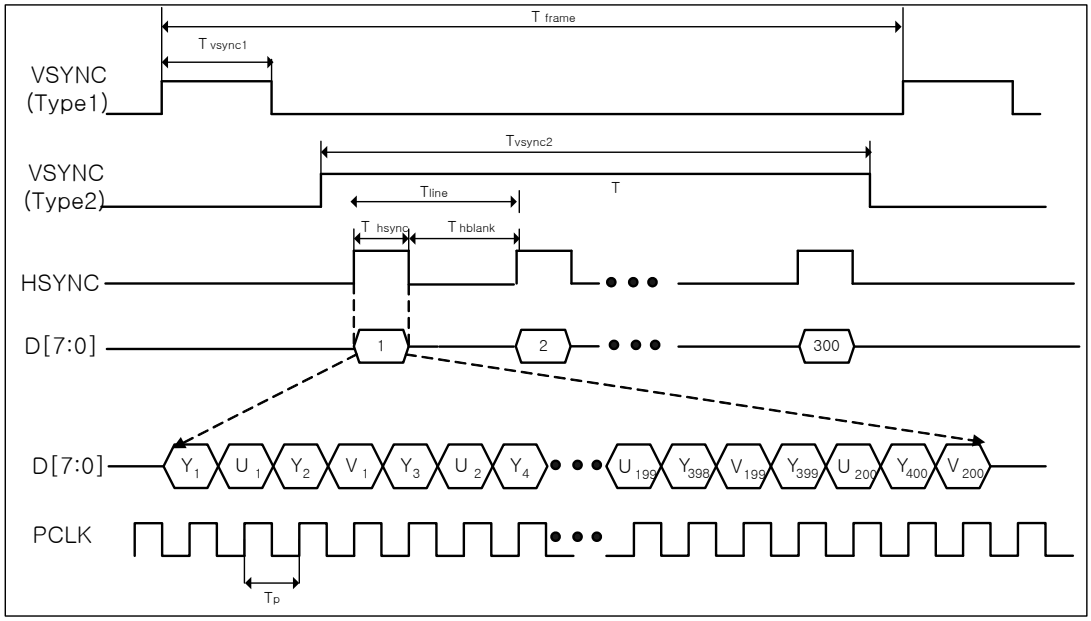
Tvsync1=VSYNC * (1640 + HBLANK)*T_o for type1,

Tvsync2= ((VSCTL1[3:0]*256 + VSCTL3[7:0]) – (VSCTL1[7:4]*256 + VSCTL2[7:0])) * (1640 + HBLANK)*T_o for type2,

Tframe = (632 + VSYNC) *(1640 + HBLANK)*T_o, for EXPINT[0x80,81,82:P20] <= 632 * (1640 + HBLANK)*T_o

= EXPINT + VSYNC * (1640 + HBLANK)*T_o, elsewhere

<Figure 25. Frame Timing of QSVGA(400 x 300) when CDOCTL1 [0x10:P0] is 0x20>



$T_p=2*T_o$, Thsync=1600*T_o, Thblank = (4*HBLANK+4960)*T_o, Tline= 4*(1640 + HBLANK)*T_o,

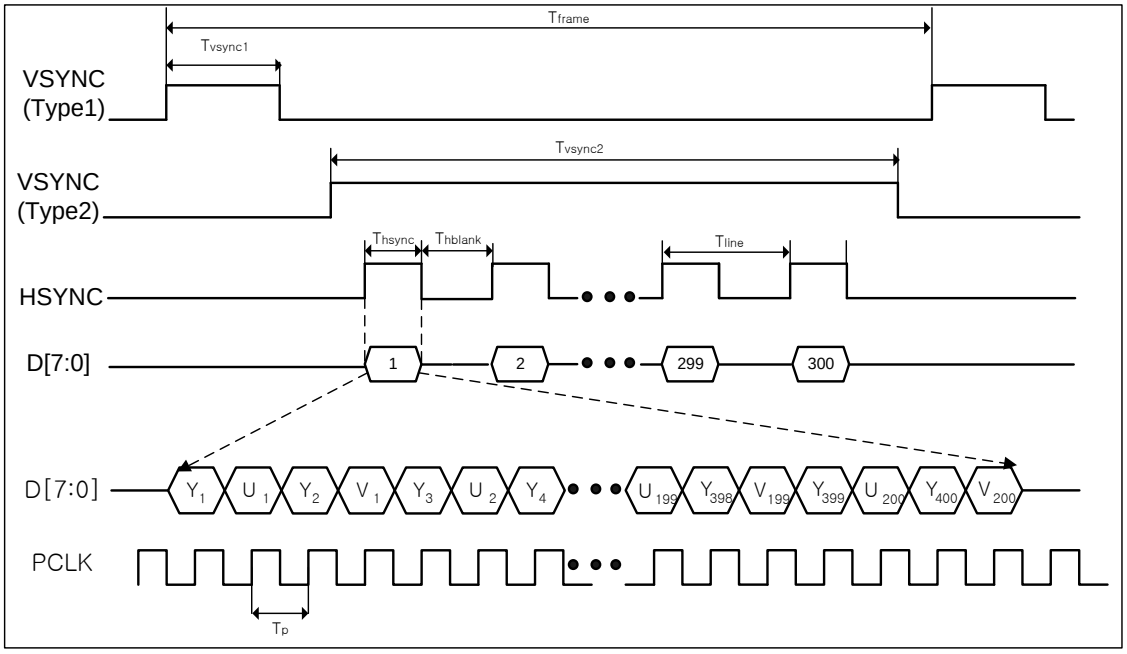
Tvsync1=VSYNC * (1640 + HBLANK)*T_o for type1,

Tvsync2= ((VSCTL1[3:0]*256 + VSCTL3[7:0]) – (VSCTL1[7:4]*256 + VSCTL2[7:0])) * (1640 + HBLANK)*T_o for type2,

Tframe = (1248 + VSYNC) *(1640 + HBLANK)*T_o, for EXPINT[0x80,81,82:P20] <= 1248 * (1640 + HBLANK)*T_o

= EXPINT + VSYNC * (1640 + HBLANK)*T_o, elsewhere

<Figure 26. Frame Timing of QSVGA(400 X 300) when VDOCTL1[0x10:P0] is 0x21>



T_p=2*T_o , T_{hsync}=1600*T_o, T_{hblank} = (2*HBLANK+1680)*T_o, T_{line}= 2*(1640 + HBLANK)*T_o,

T_{vsync}1=VSYNC * (1640 + HBLANK)*T_o for type1,

T_{vsync2}= ((VSCTL1[3:0]*256 + VSCTL3[7:0]) – (VSCTL1[7:4]*256 + VSCTL2[7:0])) * (1640 + HBLANK)*T_o for type2,

T_{frame} = (632 + VSYNC) *(1640 + HBLANK)*T_o, for EXPINT[0x80,81,82:P20] <= 632 * (1640 + HBLANK)*To

= EXPINT + VSYNC * (1640 + HBLANK)*T_o, elsewhere

4.17. Fixed Frame Rate Timing

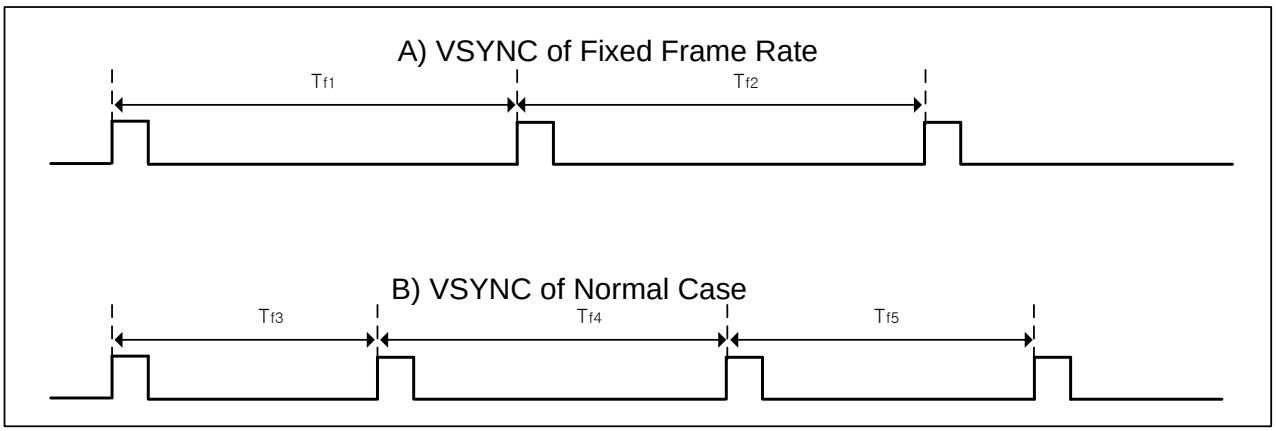
There are two kinds of frame rate. One is fixed frame rate and another is variable frame rate.
Fixed frame rate depends on the EXPMAX and EXPFIX. It has constant frame rate regardless of changing exposure time.
Following table shows the frame time as various condition of EXPMAX

Note) Users should consider EXPMAX, HBLANK and Frame time for auto flicker cancellation (50Hz/60Hz)
1) EXPMAX should be multiple of 1/100sec and 1/120sec for auto flicker cancellation.
Therefore 50msec, 100msec, 150msec and 200msec are possible for EXPMAX.
2) Frame time should be not the multiple of 1/100sec and 1/120sec for auto flicker cancellation.
3) HBLANK should be set to meet following equations for auto flicker cancellation
Equation1) (EXP100[0x8B,8C:P20] * 8 * TOPCLK) / Line Time should be integer .
Equation2) (EXP120[0x8D,8E:P20] * 8 * TOPCLK) / Line Time should be integer.
Line Time = (1640 + HBLANK) * T_{OPCLK}

Fixed Frame Time	
Case1	Following register should be set at fixed frame mode AECTL2[0x11:P20] = 0x00, AEFINECTL3[0x2A:P20] = 0x03, AEFINECTL4[0x2B:P20] = 0x35 EXPMAX <= (Horizontal width + HBLANK) * Vertical Line * T_{OPCLK}
	EXPFIX[0x91, 0x92, 0x93:P20] >= (Horizontal Width + HBLANK) * Vertical Line * T_{OPCLK} + 10(8.3333)msec + 24 * T_{OPCLK}. where Horizontal Width is 1640 for both full size and preview1. where Vertical Line is 1248 for full size and 632 for preview1. where 8.333msec for 120Hz flicker cancellation and 10msec for 100Hz flicker cancellation. Frame time = EXPFIX[0x91, 0x92, 0x93:P20] + (Horizontal Width + HBLANK) * VSYNC[0x42, 0x43:P0] * T_{OPCLK}
Variable Frame Time	
Case 1	Condition : EXPINT[0x80,81,82:P20] <= (Horizontal Width + HBLANK) * Vertical Line * T_{OPCLK}.
	Frame time = (Horizontal Width + HBLANK) * (Vertical Line + VSYNC) * T_{OPCLK}
Case 2	Condition : EXPINT > (Horizontal Width + HBLANK [0x40,0x41:P0]) * Vertical Line * T_{OPCLK}
	Frame time = EXPINT + (Horizontal Width + HBLANK) * VSYNC * T_{OPCLK}

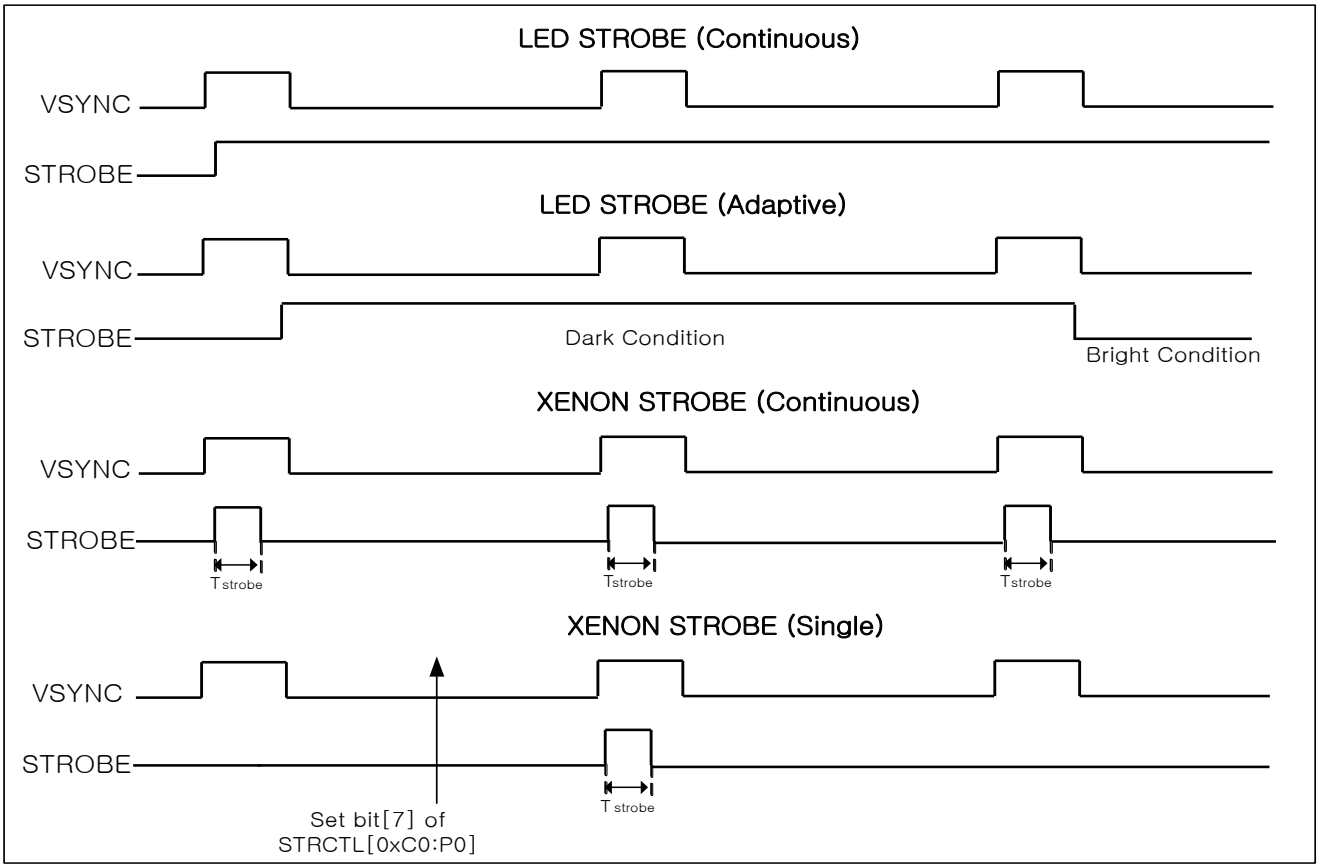
In below figure, T_{f1} is always same asT_{f2}. However, T_{f3} and T_{f4} and T_{f5} are related to the change of exposure time.

<Figure 27. Timing of Fixed Frame Rate >



4.18. Strobe Timing

<Figure 28. Timing of Strobe>



Since the sensor cannot get good quality images at very low light condition despite long exposure time and large gain, the strobe control is needed. The sensor has the 4 types output of strobe pulse, when bit[3] of VDOCTL2[0x11:P0] is ON.

Type1) Continuous LED Strobe

Strobe pulse is always enabled regardless of environment condition, when bit[5] of STRCTL[0xC0:P0] is enabled

Type2) Adaptive LED Strobe

Strobe pulse depends on the environment condition, when bit[6] of STRCTL[0xC0:P0] is enabled

At dark condition, strobe pulse is enabled, and it is disabled at bright condition.

Users can define dark condition and bright condition by adjusting STRTIME[0xC2:P0].

Type3) Continuous XENON Strobe

Strobe pulse is enabled near to every VSYNC at dark condition, when bit[4] of STRCTL[0xC0:P0] is enabled

Users can control the width of strobe pulse by adjusting SRTWID[0xC1:P0].

Type4) Single XENON Strobe

Strobe pulse is enabled once when bit[7] of STRCTL[0xC0:P0] is enabled.

To get strobe pulse at next frame, it should set bit[7] of STRCTL[0xC0:P0] again.\

4.19. Power Timing

Power On Sequence

VDD 2.8V(ON) → VDD 1.8V(ON) → CHIP_ENABLEB(H→L) → MCLK(ON) → RESETB(ON) →

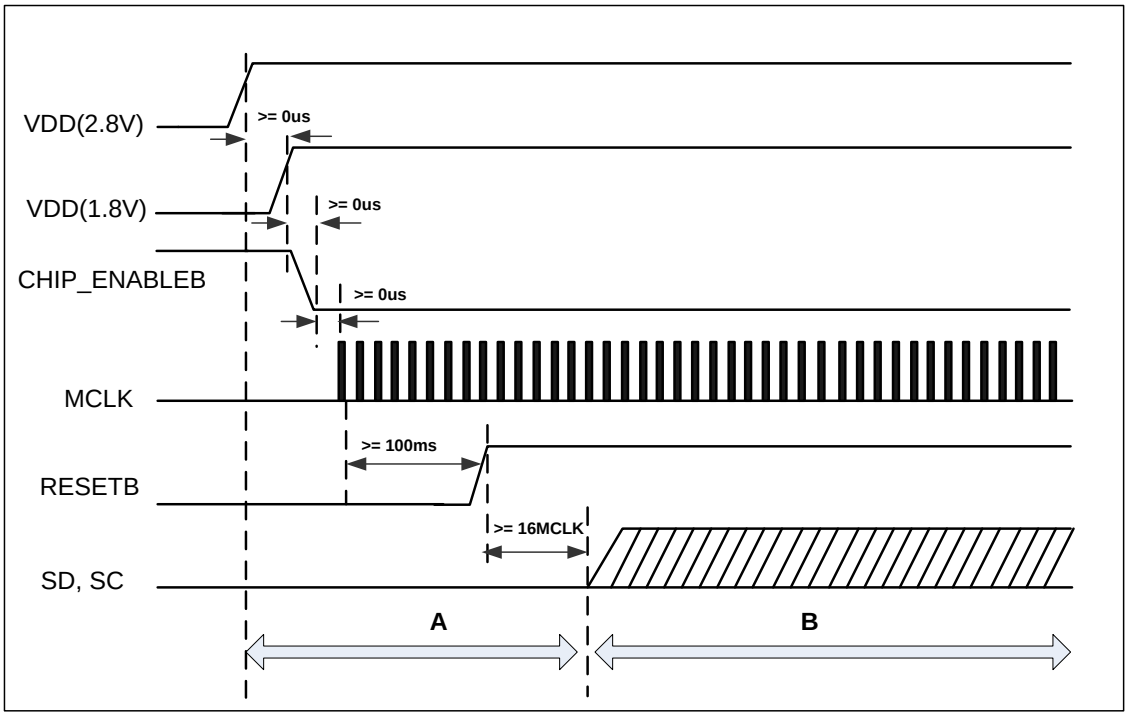
Set Software reset register(Toggle bit[1] of PWRCTL[0x01:P0] : Low → Hi → Low)) →

Set registers for normal operation → Normal Operation

If possible, we recommend that VDD(2.8V) and VDD(1.8V) are supplied at same time.

If the power sequence of VDD:I(2.8V) and VDD:A(2.8V) are separated, VDD:I should be supplied firstly**.**

<Figure 29. Timing of Power On Sequence>



Period	VSYNC	HSYNC	D[7:0]	PCLK	STROBE	Note
A	Unknown	Unknown	Unknown	Unknown	Unknown	
B	High or Low	High or Low	Hi-Z	High or Low	High or Low	1)
	High or Low	High or Low	High or Low	High or Low	High or Low	2)
	High or Low	High or Low	High or Low	High or Low	High or Low	3)
	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Hi-Z	4)

Note 1) Output pin state of “B” period when HSYNC is invalid and ITU656-like mode is not selected

Note 2) Output pin state of “B” period when HSYNC is invalid and ITU656-like mode is selected

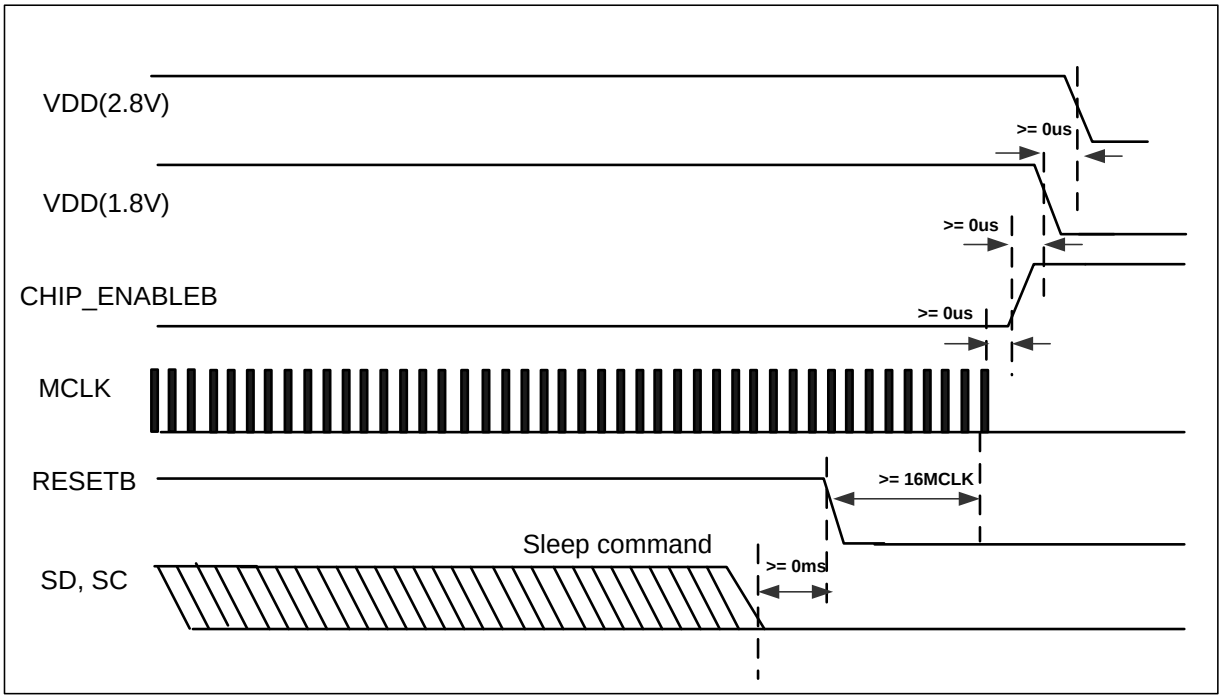
Note 3) Output pin state of “B” period when HSYNC is valid.

Note 4) The state of output pins goes to Hi-Z by setting power sleep in “B” period

Power Off Sequence

Normal Operation → Power Sleep command and disable PLL → Set register[0x55:P2] to 0x10 →SC, SD (OFF) → RESETB(OFF) → MCLK (OFF) → CHIP_ENABLEB(L→H) → VDD:1.8V (OFF) → VDD:2.8V

<Figure 30 Timing of Power Off Sequence>

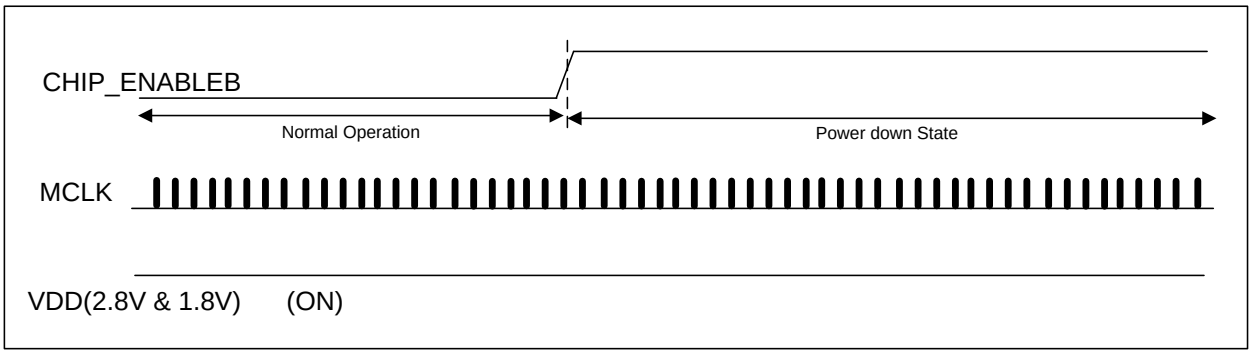


From Normal Operation State to Stand-by(Power down) State

When CHIP_ENABLEB is disabled, output pins go to Hi-Z.

Before CHIP_ENABLEB is disabled, users should set power sleep and disable PLL and set register[0x55:P2] to 0x10 through the two wire serial bus.

<Figure 31. Timing of Normal Operation to Stand-by >



From Stand-by(Power down) State to Normal Operation State

1) Set CHIP_ENABLEB to LOW.

2) Wait 100ms.

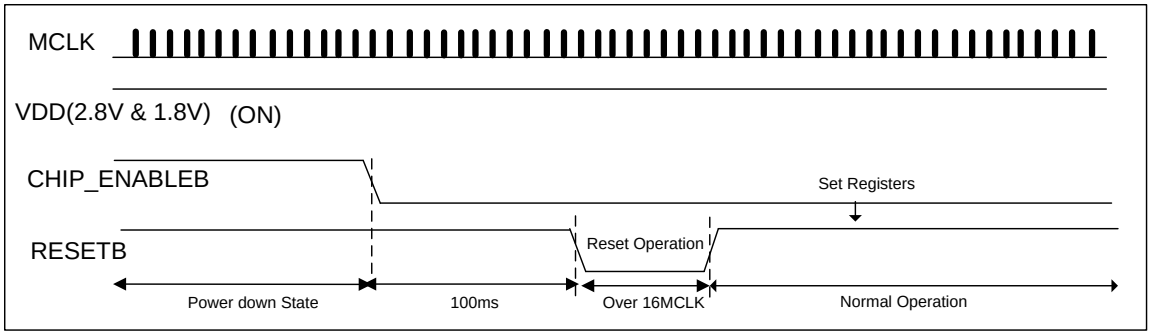
3) Set RESETB from Low to Hi.

4) Set the software reset register(Toggle bit[1] of PWRCTL[0x01:P0] : Low -> Hi -> Low))

5) Set register[0x55:P2] to 0x1C.

6) Set the registers for normal operation

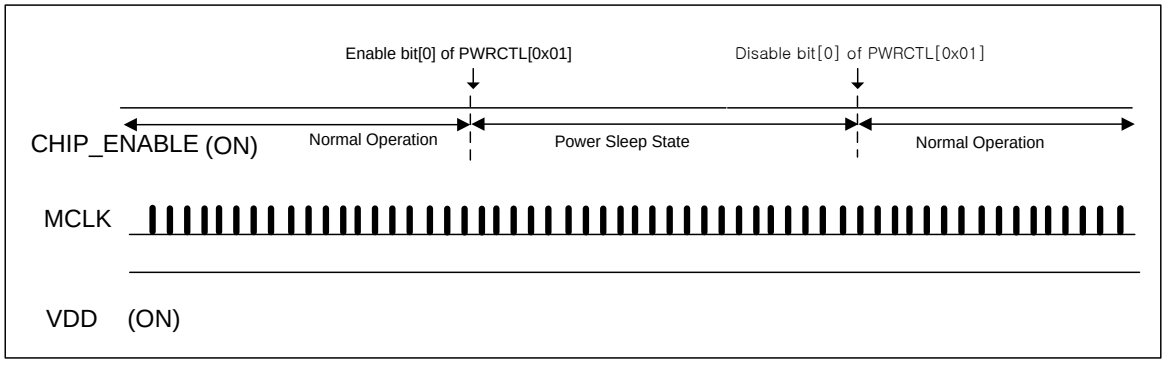
<Figure 32. Timing of Stand-by to Normal Operation>



From Normal Operation State to Power Sleep State

Set the PWLCTL[0x01:P0]'s bit[0] to high and disable PLL.

<Figure 33 Timing of Power Sleep to Normal Operation>



From Power Sleep State to Normal Operation State

Set PWLCTL[0x01:P0]'s bit[0] to low

5. REGISTER DESCRIPTION

[Table 8. Register Description]

sensor address in two-wire serial bus : 40H(write) , 41H(read) RO[read only]

Address (Hex)	Register	Description	Default (Hex)	Renewal Frame
Common Group(Page Mode = 0)				
0x03	PAGEMODE	0x00 = control image size, windowing, sync, black level calibration, strobe 0x10 = control image format, image effect, color saturation 0x11 = control noise reduction(D-LPF) 0x12 = control noise reduction(YC-LPF) and dead pixel concealment 0x13 = control edge enhancement 0x14 = control lens shading correction. 0x15 = control color correction. 0x16 = control gamma correction. 0x17 = control auto flicker cancellation 0x18 = control image scaling 0x20 = control auto exposure 0x22 = control auto white balance. 0x24 = control auto focus, anti-shaking.	0x00	Current
Device ID and Image Size and Windowing and Sync (Page Mode = 0)				
0x01(P0)	PWRCTL	Power sleep mode	0x51	
0x04(P0)	DEVID	Device ID	0x92	RO
0x0E(P0)	PLLCTL1	Control PLL(Phase Locked Loop)	0x03	
0x0F(P0)	PLLCTL2	Control PLL	0x00	
0x10(P0)	VDOCTL1	Control sub-sampling, preview and vsync type	0x00	Next
0x11(P0)	VDOCTL2	Control strobe, windowing, fixed frame rate, X/Y flip and skip frame	0x90	Next
0x12(P0)	SYNCCTL	Control polarity of H/VSYNC and PCLK, and Internal clock divider	0x04	Next
0x13(P0)	HREFCTL	Href mode control	0x00	
0x20(P0)	WINROWH	High byte of row start address for windowing	0x00	Next
0x21(P0)	WINROWL	Low byte of row start address for windowing	0x0A	Next
0x22(P0)	WINCOLH	High byte of column start address for windowing	0x00	Next
0x23(P0)	WINCOLL	Low byte of column start address for windowing	0x0C	Next
0x24(P0)	WINHGTH	High byte of height for windowing	0x04	Next
0x25(P0)	WINHGTL	Low byte of height for windowing	0xB0	Next
0x26(P0)	WINWIDH	High byte of width for windowing	0x06	Next
0x27(P0)	WINWIDL	Low byte of width for windowing	0x40	Next
0x40(P0)	HBLANKH	High byte of duration for horizontal blanking	0x01	Next
0x41(P0)	HBLANKL	Low byte of duration for horizontal blanking	0x68	Next
0x42(P0)	VSYNCH	High byte of duration for vertical synchronization(Type1)	0x00	Next
0x43(P0)	VSYNCL	Low byte of duration for vertical synchronization(Type1)	0x14	Next
0x44(P0)	VSCLIP	Clipping duration in vertical synchronization	0x09	Current
0x45(P0)	VSCTL1	High 4bits of start/stop row position for vertical synchronization(Type2)	0x04	Current
0x46(P0)	VSCTL2	Low byte of start row position for vertical synchronization(Type2)	0x18	Current
0x47(P0)	VSCTL3	Low byte of stop row position for vertical synchronization(Type2)	0xC8	Current
0x48(P0)	HREF1	Start region of Href	0x00	
0x49(P0)	HREF2	End region of Href	0x00	
0x4A(P0)	VSYNCDELAY1	MSB of Vsync delay counter	0x00	
0x4B(P0)	VSYNCDELAY2	Vsync delay counter	0x00	
Black level calibration (Page Mode = 0)				
0x80(P0)	BLCCTL	Control optical black level calibration	0x08	Current
0x90(P0)	BLCTIMETHON	Exposure time threshold to enable additional BLC	0x07	Current

0x91(P0)	BLCTIMETHOFF	Exposure time threshold to disable additional BLC	0x08	Current
0x92(P0)	BLCAGTHH	AG threshold to enable additional BLC	0x60	Current
0x93(P0)	BLCAGTHL	AG threshold to disable additional BLC	0x60	Current
0x94(P0)	BLCDGH	Digital gain threshold to enable additional BLC	0xC8	Current
0x95(P0)	BLCDGL	Digital gain threshold to disable additional BLC	0xC0	Current
0xA0(P0)	BLCOFSDB	Blue color offset for additional BLC	0x00	Current
0xA2(P0)	BLCOFSDGB	GB color offset for additional BLC	0x00	Current
0xA4(P0)	BLCOFSDR	Red color offset for additional BLC	0x00	Current
0xA6(P0)	BLCOFSDGR	GR color offset for additional BLC	0x00	Current
Strobe (Page Mode = 0)				
0xC0(P0)	STRCTL	Control strobe function. (XENON Type and LED Type)	0x09	Current
0xC1(P0)	STRWID	Strobe pulse width	0x0C	Current
0xC2(P0)	STRTIME	Exposure time to enable strobe function	0x43	Current
Image Output Format and Image Effect (Page Mode = 10)				
0x10(P10)	ISPCTL1	Control the format of image data	0x03	Next
0x11(P10)	ISPCTL2	Control image effect and color interpolation and color space conversion	0x03	Next
0x12(P10)	ISPCTL3	Control color offset and brightness	0x00	Next
0x13(P10)	ISPCTL4	Control the image effect	0x00	Next
0x14(P10)	ISPCTL5	Control the image effect	0x02	Next
0x20(P10)	ITUCTL	Control the ITU656-like mode.	0x00	Current
0x24(P10)	ITUSOF	Start of frame data for ITU656-like	0x20	Current
0x25(P10)	ITUSOL	Start of line data for ITU656-like	0x10	Current
0x26(P10)	ITUEOF	End of frame data for ITU656-like	0x01	Current
0x27(P10)	ITUEOL	End of line data for ITU656-like	0x02	Current
0x40(P10)	YOFS	Offset of luminance	0x00	Next
0x41(P10)	DYOFS	Offset of luminance at dark condition	0x00	Current
0x42(P10)	UOFS	Offset of U chrominance	0x00	Next
0x43(P10)	VOFS	Offset of V chrominance	0x00	Next
0x44(P10)	UCON	Constant of U chrominance	0x80	Next
0x45(P10)	VCON	Constant of V chrominance	0x80	Next
0x46(P10)	SOLARI	Solarization coefficient	0xF0	Next
0x47(P10)	BINARY	Threshold of binary effect.	0x7F	Next
0x48(P10)	CONTRAST	Contrast coefficient	0x80	Next
0x50(P10)	AGBRT	Threshold of AG in auto bright	0x60	Current
0x70(P10)	LGRATIO	Luminance gain coefficient.	0x80	Next
0x71(P10)	LGOFS	Offset of luminance gain.	0x00	Next
Color Saturation (Page Mode = 10)				
0x60(P10)	SATCTL	Control color saturation	0x00	Current
0x61(P10)	SATB	Blue color saturation coefficient	0x80	Current
0x62(P10)	SATR	Red color saturation coefficient	0x80	Current
0x63(P10)	AGSAT	Threshold of AG in auto saturation	0x60	Current
0x66(P10)	SATTIMETH	Time threshold of color saturation	0xF4	Current
0x67(P10)	SATOUTDEL	Offset of color saturation	0x00	Current
0x6A(P10)	CBPOSSAT	Positive coefficient of color saturation CB	0x80	Current
0x6B(P10)	CBNEGSAT	Negative coefficient of color saturation CB	0x80	Current
0x6C(P10)	CRPOSSAT	Positive coefficient of color saturation CR	0x80	Current
0x6D(P10)	CRNEGSAT	Negative coefficient of color saturation CR	0x80	Current

D-LPF(Page Mode = 11)				
0x10(P11)	DLPFCTL1	Control D-LPF	0x00	Current
0x11(P11)	DLPFCTL2	Control D-LPF	0x40	Current
0x20(P11)	DLPFAUTOCTL1	Option for D-LPF.	0x00	Current
0x21(P11)	DLPFAUTOCTL2	Option for D-LPF.	0x00	Current
0x26(P11)	LPFAGTHL	Hysteresis of Low threshold between Indoor mode and Dark1 mode	0x30	Current
0x27(P11)	LPFAGTHH	Hysteresis of High threshold between Indoor mode and Dark1 mode	0x38	Current
0x28(P11)	LPFOUTTHL	Hysteresis of Low threshold between outdoor2 mode and outdoor1 mode.	0x10	Current
0x29(P11)	LPFOUTTHH	Hysteresis of High threshold between outdoor2 mode and outdoor1 mode	0x0F	Current
0x2B(P11)	LPFYMEANTHL	Hysteresis of high threshold value between dark2 mode and dark3 mode.	0x40	Current
0x2C(P11)	LPFYMEANTHH	Hysteresis of low threshold value between dark2 mode and dark3 mode.	0x42	Current
0x30(P11)	OUT2YBOUNDH	High luminance boundary under outdoor2 mode.	0xBA	Current
0x31(P11)	OUT2YBOUNDL	Low luminance boundary under outdoor2 mode	0x10	Current
0x32(P11)	OUT2RATIO	D-LPFratio under outdoor2 mode	0x80	Current
0x33(P11)	OUT2THH	Threshold of D-LPF in high luminance region under outdoor2 mode	0x08	Current
0x34(P11)	OUT2THM	Threshold of D-LPF in middle luminance region under outdoor2 mode	0x02	Current
0x35(P11)	OUT2THL	Threshold of D-LPF in low luminance region under outdoor2 mode	0x01	Current
0x36(P11)	OUT1YBOUNDH	High luminance boundary under outdoor1 mode.	0xB0	Current
0x37(P11)	OUT1YBOUNDL	Low luminance boundary under outdoor1 mode	0x18	Current
0x38(P11)	OUT1RATIO	D-LPF ratio under outdoor1 mode.	0x80	Current
0x39(P11)	OUT1THH	Threshold of D-LPF in high luminance region under outdoor1 mode	0x0A	Current
0x3A(P11)	OUT1THM	Threshold of D-LPF in middle luminance region under outdoor1 mode	0x04	Current
0x3B(P11)	OUT1THL	Threshold of D-LPF in low luminance region under outdoor1 mode	0x02	Current
0x3C(P11)	INYBOUNDH	High luminance boundary under indoor mode	0xA0	Current
0x3D(P11)	INYBOUNDL	Low luminance boundary under indoor mode	0x20	Current
0x3E(P11)	INRATIO	D-LPF ratio under indoor mode	0x80	Current
0x3F(P11)	INTHH	Threshold of D-LPF in high luminance region under indoor mode	0x10	Current
0x40(P11)	INTHM	Threshold of D-LPF in middle luminance region under indoor mode	0x08	Current
0x41(P11)	INTHL	Threshold of D-LPF in low luminance region under indoor mode	0x04	Current
0x42(P11)	DARK1YBNDH	High luminance boundary under dark1 mode	0x98	Current
0x43(P11)	DARK 1YBNDL	Low luminance boundary under dark1 mode	0x28	Current
0x44(P11)	DARK 1RATIO	D-LPF ratio under dark1 mode	0x80	Current
0x45(P11)	DARK 1THH	Threshold of D-LPF in high luminance region under dark1 mode	0x12	Current
0x46(P11)	DARK 1THM	Threshold of D-LPF in middle luminance region under dark1 mode	0x0C	Current
0x47(P11)	DARK 1THL	Threshold of D-LPF in low luminance region under dark1 mode	0x08	Current
0x48(P11)	DARK2YBNDH	High luminance boundary under dark2 mode	0x90	Current
0x49(P11)	DARK 2YBNDL	Low luminance boundary under dark2 mode.	0x2A	Current
0x4A(P11)	DARK 2RATIO	D-LPFratio under dark2 mode	0x80	Current
0x4B(P11)	DARK 2THH	Threshold of D-LPF in high luminance region under dark2 mode	0x14	Current
0x4C(P11)	DARK 2THM	Threshold of D-LPF in middle luminance region under dark2 mode	0x0E	Current
0x4D(P11)	DARK 2THL	Threshold of D-LPF in low luminance region under dark2 mode	0x0E	Current
0x4E(P11)	DARK3YBNDH	High luminance boundary under dark3 mode	0x80	Current
0x4F(P11)	DARK 3YBNDL	Low luminance boundary under dark3 mode.	0x30	Current
0x50(P11)	DARK 3RATIO	D-LPF ratio under dark3 mode	0x80	Current
0x51(P11)	DARK 3THH	Threshold of D-LPF in high luminance region under dark3 mode	0x20	Current
0x52(P11)	DARK 3THM	Threshold of D-LPF in middle luminance region under dark3 mode	0x10	Current
0x53(P11)	DARK 3THL	Threshold of D-LPF in low luminance region under dark3 mode	0x12	Current

YC-LPF(Page Mode = 12)				
0x20(P12)	YCLPFCTL1	Control YC-LPF	0x02	Current
0x21(P12)	YCLPFCTL2	Control YC-LPF	0x06	Current
0x23(P12)	YCLPFCTL4	Control YC-LPF	0x00	Current
0x30(P12)	YCPRWTH	Threshold of Texture region	0x58	Current
0x31(P12)	YCUNI1TH	Threshold for uniform1 region	0x16	Current
0x32(P12)	YCUNI2TH	Threshold for uniform2 region	0x30	Current
0x33(P12)	YCUNI3TH	Threshold for uniform3 region	0x3A	Current
0x34(P12)	YCNOR1TH	Threshold for normal1 region	0x3A	Current
0x35(P12)	YCNOR2TH	Threshold for normal2 region	0x64	Current
0x36(P12)	YCNOR3TH	Threshold for normal3 region	0x96	Current
0x40(P12)	YCOUT2THH	High luminance boundary under outdoor2 mode	0xB8	Current
0x41(P12)	YCOUT2THL	Low luminance boundary under outdoor2 mode	0x20	Current
0x42(P12)	YCOUT2STDH	Threshold of Y-LPF in high luminance region under outdoor2 mode	0xA7	Current
0x43(P12)	YCOUT2STDM	Threshold of Y-LPF in middle luminance region under outdoor2 mode	0xA7	Current
0x44(P12)	YCOUT2STDL	Threshold of Y-LPF in low luminance region under outdoor2 mode	0xA7	Current
0x45(P12)	YCOUT2RAT	The ratio of Y-LPF under outdoor2 mode	0x40	Current
0x46(P12)	YCOUT1THH	High luminance boundary under outdoor1 mode	0xB0	Current
0x47(P12)	YCOUT2THL	Low luminance boundary under outdoor1 mode	0x20	Current
0x48(P12)	YCOUT1STDH	Threshold of Y-LPF in high luminance region under outdoor1 mode	0xAF	Current
0x49(P12)	YCOUT1STDM	Threshold of Y-LPF in middle luminance region under outdoor1 mode	0xAF	Current
0x4A(P12)	YCOUT1STDL	Threshold of Y-LPF in low luminance region under outdoor1 mode	0xAF	Current
0x4B(P12)	YCOUT1RAT	The ratio of Y-LPF under outdoor1 mode	0x60	Current
0x4C(P12)	YCINTHH	High luminance boundary under indoor mode	0xB0	Current
0x4D(P12)	YCINTHL	Low luminance boundary under indoor mode	0x30	Current
0x4E(P12)	YCINSTDH	Threshold of Y-LPF in high luminance region under indoor mode	0xB7	Current
0x4F(P12)	YCINSTDM	Threshold of Y-LPF in middle luminance region under indoor mode	0xB7	Current
0x50(P12)	YCINSTDL	Threshold of Y-LPF in low luminance region under indoor mode	0xB7	Current
0x51(P12)	YCINRAT	The ratio of Y-LPF under indoor mode	0x80	Current
0x52(P12)	YCDARK1THH	High luminance boundary under dark1 mode	0xA8	Current
0x53(P12)	YCDARK1THL	Low luminance boundary under dark1 mode	0x30	Current
0x54(P12)	YCDARK1STDH	Threshold of Y-LPF in high luminance region under dark1 mode	0xC7	Current
0x55(P12)	YCDARK1STDM	Threshold of Y-LPF in middle luminance region under dark1 mode	0xC7	Current
0x56(P12)	YCDARK1STDL	Threshold of Y-LPF in low luminance region under dark1 mode	0xC7	Current
0x57(P12)	YCDARK1RAT	The ratio of Y-LPF under dark1 mode	0x80	Current
0x58(P12)	YCDARK2THH	High luminance boundary under dark2 mode	0xA0	Current
0x59(P12)	YCDARK2THL	Low luminance boundary under dark2 mode	0x40	Current
0x5A(P12)	YCDARK2STDH	Threshold of Y-LPF in high luminance region under dark2 mode	0xDF	Current
0x5B(P12)	YCDARK2STDM	Threshold of Y-LPF in middle luminance region under dark2 mode	0xDF	Current
0x5C(P12)	YCDARK2STDL	Threshold of Y-LPF in low luminance region under dark2 mode	0xDF	Current
0x5D(P12)	YCDARK2RAT	The ratio of Y-LPF under dark2 mode	0x80	Current
0x5E(P12)	YCDARK3THH	High luminance boundary under dark3 mode	0xA0	Current
0x5F(P12)	YCDARK3THL	Low luminance boundary under dark3 mode	0x40	Current
0x60(P12)	YCDARK3STDH	Threshold of Y-LPF in high luminance region under dark3 mode	0xEF	Current
0x61(P12)	YCDARK3STDM	Threshold of Y-LPF in middle luminance region under dark3 mode	0xEF	Current
0x62(P12)	YCDARK3STDL	Threshold of Y-LPF in low luminance region under dark3 mode	0xEF	Current
0x63(P12)	YCDARK3RAT	The ratio of Y-LPF under dark3 mode	0x80	Current

Dead Pixel Cancellation (Page Mode = 12)				
0x90(P12)	DPCCTL	Control DPC	0x5D	Current
Edge Enhancement (Page Mode = 13)				
0x10(P13)	EDGECTL1	Control edge enhancement	0x28	Current
0x11(P13)	EDGECTL2	Control edge enhancement.	0x17	Current
0x12(P13)	EDGECTL3	Control edge enhancement	0x00	Current
0x14(P13)	EDGECTL5	Control edge enhancement.	0x00	Current
0x20(P13)	EDGENGAIN	Edge gain to emphasize negative edge data	0x08	Current
0x21(P13)	EDGEPGAIN	Edge gain to emphasize positive edge data	0x08	Current
0x23(P13)	EDGEHCLIP1TH	High clip1 threshold.	0x06	Current
0x24(P13)	EDGEHCLIP2TH	High clip2 threshold.	0x0C	Current
0x25(P13)	EDGELCLIPTH	Low clip threshold.	0x08	Current
0x26(P13)	EDGELCLIPLMT	Limit of low clip	0x30	Current
0x29(P13)	EDGETIMETH	Threshold of Exposure time for automatic edge enhancement.	0x10	Current
0x2A(P13)	EDGEAGTH	Threshold of AG for automatic edge enhancement.	0x30	Current
0x80(P13)	EDGE2DCTL1	Control 2nd edge enhancement	0x00	Current
0x81(P13)	EDGE2DCTL2	Control 2nd edge enhancement	0x07	Current
0x82(P13)	EDGE2DCTL3	Control 2nd edge enhancement	0x06	Current
0x83(P13)	EDGE2DCTL4	Control 2nd edge enhancement	0x21	Current
0x85(P13)	EDGE2DCTL6	Control 2nd edge enhancement	0x00	Current
0x90(P13)	EDGE2DNGAIN	Edge gain to emphasize negative edge data for 2nd edge enhancement	0x30	Current
0x91(P13)	EDGE2DPGAIN	Edge gain to emphasize positive edge data for 2nd edge enhancement	0x30	Current
0x93(P13)	EDGE2DLCLIPLMT	Limit of low clip for 2nd edge enhancement	0x30	Current
0x94(P13)	EDGE2DHCLIP1TH	High clip1 threshold for 2nd edge enhancement	0x06	Current
0x95(P13)	EDGE2DHCLIP2TH	High clip2 threshold for 2nd edge enhancement	0x1E	Current
0xA0(P13)	EDGE2DLCOUT2N	Negative threshold of low clip under outdoor2 mode	0x00	Current
0xA1(P13)	EDGE2DLCOUT2P	Positive threshold of low clip under outdoor2 mode	0x00	Current
0xA2(P13)	EDGE2DLCOUT1N	Negative threshold of low clip under outdoor1 mode	0x01	Current
0xA3(P13)	EDGE2DLCOUT1P	Positive threshold of low clip under outdoor1 mode	0x02	Current
0xA4(P13)	EDGE2DLCINN	Negative threshold of low clip under indoor mode	0x02	Current
0xA5(P13)	EDGE2DLCINP	Positive threshold of low clip under indoor mode	0x04	Current
0xA6(P13)	EDGE2DLCD1N	Negative threshold of low clip under dark1 mode	0x03	Current
0xA7(P13)	EDGE2DLCD1P	Positive threshold of low clip under dark1 mode	0x06	Current
0xA8(P13)	EDGE2DLCD2N	Negative threshold of low clip under dark2 mode	0x03	Current
0xA9(P13)	EDGE2DLCD2P	Positive threshold of low clip under dark2 mode	0x06	Current
0xAA(P13)	EDGE2DLCD3N	Negative threshold of low clip under dark3 mode	0x04	Current
0xAB(P13)	EDGE2DLCD3P	Positive threshold of low clip under dark3 mode	0x08	Current
Lens Shading Correction (Page Mode = 14)				
0x10(P14)	LENSCTL1	Control lens shading correction	0x00	Current
0x11(P14)	LENSCTL2	Control lens shading correction	0x0B	Current
0x14(P14)	Gb_XCEN	Optical center on X-axis in pixel array for lens shading correction	0x80	Current
0x15(P14)	Gb_YCEN	Optical center on Y-axis in pixel array for lens shading correction	0x80	Current
0x16(P14)	R_XCEN	Optical center on X-axis in pixel array for lens shading correction	0x80	Current
0x17(P14)	R_YCEN	Optical center on Y-axis in pixel array for lens shading correction	0x80	Current
0x18(P14)	B_XCEN	Optical center on X-axis in pixel array for lens shading correction	0x80	Current
0x19(P14)	B_YCEN	Optical center on Y-axis in pixel array for lens shading correction	0x80	Current
0x20(P14)	(Global or Gr)XCEN	Optical center on X-axis in pixel array for lens shading correction	0x80	Current
0x21(P14)	(Global or Gr)YCEN	Optical center on Y-axis in pixel array for lens shading correction	0x80	Current

0x22(P14)	LENSRGAIN	Global gain for Red Pixel.	0x80	Current
0x23(P14)	LENSGGAIN	Global gain for Green Pixel.	0x80	Current
0x24(P14)	LENSBGAIN	Global gain for Blue Pixel.	0x80	Current
0x25(P14)	LAGOFF	AG threshold to disable Lens Shading Correction Gain	0x60	Current
0x26(P14)	LAGON	AG threshold to enable Lens Shading Correction Gain	0x60	Current
0x28(P14)	LENSSTEP	Incremental step for lens shading correction	0x20	Current
0x40(P14)	LENSRP0	Lens Shading Correction Gain Parameter0 for Red Pixel	0x00	Current
0x50(P14)	LENSGrP0	Lens Shading Correction Gain Parameter0 for Gr Pixel	0x00	Current
0x60(P14)	LENSBP0	Lens Shading Correction Gain Parameter0 for Blue Pixel	0x00	Current
0x70(P14)	LENSGbP0	Lens Shading Correction Gain Parameter0 for Gb Pixel	0x00	Current
Color Correction (Page Mode = 15)				
0x10(P15)	CMCCTL	Control color correction	0x0F	Current
0x14(P15)	CMCOFSGH	High threshold of color offset gain	0x40	Current
0x15(P15)	CMCOFSGM	Middle threshold of color offset gain	0x30	Current
0x16(P15)	CMCOFSGL	Low threshold of color offset gain	0x20	Current
0x17(P15)	CMCSIGN	Sign bit of color correction coefficient	0x2F	Current
0x30(P15)	CMC11	Color correction coefficient 11	0x4C	Current
0x31(P15)	CMC12	Color correction coefficient 12	0x0C	Current
0x32(P15)	CMC13	Color correction coefficient 13	0x00	Current
0x33(P15)	CMC21	Color correction coefficient 21	0x26	Current
0x34(P15)	CMC22	Color correction coefficient 22	0x80	Current
0x35(P15)	CMC23	Color correction coefficient 23	0x1A	Current
0x36(P15)	CMC31	Color correction coefficient 31	0x20	Current
0x37(P15)	CMC32	Color correction coefficient 32	0x80	Current
0x38(P15)	CMC33	Color correction coefficient 33	0xE0	Current
0x40(P15)	CMCOFSL11	Color correction offset coefficient 11 for low color temperature	0x12	Current
0x41(P15)	CMCOFSL12	Color correction offset coefficient 12 for low color temperature	0xA0	Current
0x42(P15)	CMCOFSL13	Color correction offset coefficient 13 for low color temperature	0x0E	Current
0x43(P15)	CMCOFSL21	Color correction offset coefficient 21 for low color temperature	0x84	Current
0x44(P15)	CMCOFSL22	Color correction offset coefficient 22 for low color temperature	0x08	Current
0x45(P15)	CMCOFSL23	Color correction offset coefficient 23 for low color temperature	0x84	Current
0x46(P15)	CMCOFSL31	Color correction offset coefficient 31 for low color temperature	0x8A	Current
0x47(P15)	CMCOFSL32	Color correction offset coefficient 32 for low color temperature	0x02	Current
0x48(P15)	CMCOFSL33	Color correction offset coefficient 33 for low color temperature	0x08	Current
0x50(P15)	CMCOFSH11	Color correction offset coefficient 11 for high color temperature	0x12	Current
0x51(P15)	CMCOFSH12	Color correction offset coefficient 12 for high color temperature	0xA0	Current
0x52(P15)	CMCOFSH13	Color correction offset coefficient 13 for high color temperature	0x0E	Current
0x53(P15)	CMCOFSH21	Color correction offset coefficient 21 for high color temperature	0x84	Current
0x54(P15)	CMCOFSH22	Color correction offset coefficient 22 for high color temperature	0x08	Current
0x55(P15)	CMCOFSH23	Color correction offset coefficient 23 for high color temperature	0x84	Current
0x56(P15)	CMCOFSH31	Color correction offset coefficient 31 for high color temperature	0x8A	Current
0x57(P15)	CMCOFSH32	Color correction offset coefficient 32 for high color temperature	0x02	Current
0x58(P15)	CMCOFSH33	Color correction offset coefficient 33 for high color temperature	0x08	Current
Gamma Correction (Page Mode = 16)				
0x10(P16)	GMACTL	Control gamma correction	0x01	Current
0x30(P16)	GGMA0	Gamma corrected output of green pixel at 0(0)code in 10(8)bit linear input	0x00	Current
0x31(P16)	GGMA1	Gamma corrected output of green pixel at 16(4)code in 10(8)bit linear input	0x15	Current
0x32(P16)	GGMA2	Gamma corrected output of green pixel at 32(8)code in 10(8)bit linear input	0x1F	Current

0x33(P16)	GGMA3	Gamma corrected output of green pixel at 64(16)code in 10(8)bit linear input	0x30	Current
0x34(P16)	GGMA4	Gamma corrected output of green pixel at 128(32)code in 10(8)bit linear input	0x49	Current
0x35(P16)	GGMA5	Gamma corrected output of green pixel at 192(48)code in 10(8)bit t linear input	0x5D	Current
0x36(P16)	GGMA6	Gamma corrected output of green pixel at 256(64)code in 10(8)bit linear input	0x6F	Current
0x37(P16)	GGMA7	Gamma corrected output of green pixel at 320(80)code in 10(8)bit linear input	0x7F	Current
0x38(P16)	GGMA8	Gamma corrected output of green pixel at 384(96)code in 10(8)bit linear input	0x8E	Current
0x39(P16)	GGMA9	Gamma corrected output of green pixel at 448(112)code in 10(8)bit linear input	0x9B	Current
0x3A(P16)	GGMA10	Gamma corrected output of green pixel at 512(128)code in 10(8)bit linear input	0xA8	Current
0x3B(P16)	GGMA11	Gamma corrected output of green pixel at 576(144)code in 10(8)bit linear input	0xB5	Current
0x3C(P16)	GGMA12	Gamma corrected output of green pixel at 640(160)code in 10(8)bit linear input	0xC1	Current
0x3D(P16)	GGMA13	Gamma corrected output of green pixel at 704(176)code in 10(8)bit linear input	0xCC	Current
0x3E(P16)	GGMA14	Gamma corrected output of green pixel at 768(192)code in 10(8)bit linear input	0xD7	Current
0x3F(P16)	GGMA15	Gamma corrected output of green pixel at 832(208)code in 10(8)bit linear input	0xE2	Current
0x40(P16)	GGMA16	Gamma corrected output of green pixel at 896(224)code in 10(8)bit linear input	0xEC	Current
0x41(P16)	GGMA17	Gamma corrected output of green pixel at 960(240)code in 10(8)bit linear input	0xF6	Current
0x42(P16)	GGMA18	Gamma corrected output of green pixel at 1023(255)code in 10(8)bit linear input	0xFF	Current
0x50(P16)	RGMA0	Gamma corrected output of red pixel at 0(0)code in 10(8)bit linear input	0x00	Current
0x51(P16)	RGMA1	Gamma corrected output of red pixel at 16(4)code in 10(8)bit linear input	0x15	Current
0x52(P16)	RGMA2	Gamma corrected output of red pixel at 32(8)code in 10(8)bit linear input	0x1F	Current
0x53(P16)	RGMA3	Gamma corrected output of red pixel at 64(16)code in 10(8)bit linear input	0x30	Current
0x54(P16)	RGMA4	Gamma corrected output of red pixel at 128(32)code in 10(8)bit linear input	0x49	Current
0x55(P16)	RGMA5	Gamma corrected output of red pixel at 192(48)code in 10(8)bit t linear input	0x5D	Current
0x56(P16)	RGMA6	Gamma corrected output of red pixel at 256(64)code in 10(8)bit linear input	0x6F	Current
0x57(P16)	RGMA7	Gamma corrected output of red pixel at 320(80)code in 10(8)bit linear input	0x7F	Current
0x58(P16)	RGMA8	Gamma corrected output of red pixel at 384(96)code in 10(8)bit linear input	0x8E	Current
0x59(P16)	RGMA9	Gamma corrected output of red pixel at 448(112)code in 10(8)bit linear input	0x9B	Current
0x5A(P16)	RGMA10	Gamma corrected output of red pixel at 512(128)code in 10(8)bit linear input	0xA8	Current
0x5B(P16)	RGMA11	Gamma corrected output of red pixel at 576(144)code in 10(8)bit linear input	0xB5	Current
0x5C(P16)	RGMA12	Gamma corrected output of red pixel at 640(160)code in 10(8)bit linear input	0xC1	Current
0x5D(P16)	RGMA13	Gamma corrected output of red pixel at 704(176)code in 10(8)bit linear input	0xCC	Current
0x5E(P16)	RGMA14	Gamma corrected output of red pixel at 768(192)code in 10(8)bit linear input	0xD7	Current
0x5F(P16)	RGMA15	Gamma corrected output of red pixel at 832(208)code in 10(8)bit linear input	0xE2	Current
0x60(P16)	RGMA16	Gamma corrected output of red pixel at 896(224)code in 10(8)bit linear input	0xEC	Current
0x61(P16)	RGMA17	Gamma corrected output of red pixel at 960(240)code in 10(8)bit linear input	0xF6	Current
0x62(P16)	RGMA18	Gamma corrected output of red pixel at 1023(255)code in 10(8)bit linear input	0xFF	Current
0x70(P16)	BGMA0	Gamma corrected output of blue pixel at 0(0)code in 10(8)bit linear input	0x00	Current
0x71(P16)	BGMA1	Gamma corrected output of blue pixel at 16(4)code in 10(8)bit linear input	0x15	Current
0x72(P16)	BGMA2	Gamma corrected output of blue pixel at 32(8)code in 10(8)bit linear input	0x1F	Current
0x73(P16)	BGMA3	Gamma corrected output of blue pixel at 64(16)code in 10(8)bit linear input	0x30	Current
0x74(P16)	BGMA4	Gamma corrected output of blue pixel at 128(32)code in 10(8)bit linear input	0x49	Current
0x75(P16)	BGMA5	Gamma corrected output of blue pixel at 192(48)code in 10(8)bit t linear input	0x5D	Current
0x76(P16)	BGMA6	Gamma corrected output of blue pixel at 256(64)code in 10(8)bit linear input	0x6F	Current
0x77(P16)	BGMA7	Gamma corrected output of blue pixel at 320(80)code in 10(8)bit linear input	0x7F	Current
0x78(P16)	BGMA8	Gamma corrected output of blue pixel at 384(96)code in 10(8)bit linear input	0x8E	Current
0x79(P16)	BGMA9	Gamma corrected output of blue pixel at 448(112)code in 10(8)bit linear input	0x9B	Current
0x7A(P16)	BGMA10	Gamma corrected output of blue pixel at 512(128)code in 10(8)bit linear input	0xA8	Current
0x7B(P16)	BGMA11	Gamma corrected output of blue pixel at 576(144)code in 10(8)bit linear input	0xB5	Current
0x7C(P16)	BGMA12	Gamma corrected output of blue pixel at 640(160)code in 10(8)bit linear input	0xC1	Current

0x7D(P16)	BGMA13	Gamma corrected output of blue pixel at 704(176)code in 10(8)bit linear input	0xCC	Current
0x7E(P16)	BGMA14	Gamma corrected output of blue pixel at 768(192)code in 10(8)bit linear input	0xD7	Current
0x7F(P16)	BGMA15	Gamma corrected output of blue pixel at 832(208)code in 10(8)bit linear input	0xE2	Current
0x80(P16)	BGMA16	Gamma corrected output of blue pixel at 896(224)code in 10(8)bit linear input	0xEC	Current
0x81(P16)	BGMA17	Gamma corrected output of blue pixel at 960(240)code in 10(8)bit linear input	0xF6	Current
0x82(P16)	BGMA18	Gamma corrected output of blue pixel at 1023(255)code in 10(8)bit linear input	0xFF	Current
Auto Flicker Cancellation (Page Mode = 17)				
0xC0(P17)	FLKMODE	Number of skipped frames in AFC operation	0x01	Current
0xC4(P17)	FLK200	Number of horizontal line for 1/200sec	0x3C	Current
0xC5(P17)	FLK240	Number of horizontal line for 1/240sec	0x32	Current
0xC6(P17)	FLKTH1	Low threshold to detect flicker noise	0x02	Current
0xC7(P17)	FLKTH2	High threshold to detect flicker noise	0x20	Current
Image Scaling (Page Mode = 18)				
0x10(P18)	ZOOMCTL1	Control image scaling	0x00	Next
0x11(P18)	ZOOMCTL2	Control image scaling	0x00	Next
0x20(P18)	ZOUTWIDH	High byte of image width for image scaling	0x05	Next
0x21(P18)	ZOUTWIDL	Low byte of image width for image scaling	0x00	Next
0x22(P18)	ZOUTHGTH	High byte of image height for image scaling	0x04	Next
0x23(P18)	ZOUTHGTL	Low byte of image height for image scaling	0x00	Next
0x24(P18)	ZWINSTXH	High byte of start x position for windowing after image scaling	0x00	Next
0x25(P18)	ZWINSTXL	Low byte of start x position for windowing after image scaling	0x00	Next
0x26(P18)	ZWINSTYH	High byte of start y position for windowing after image scaling	0x00	Next
0x27(P18)	ZWINSTYL	Low byte of start y position for windowing after image scaling	0x00	Next
0x28(P18)	ZWINENXH	High byte of end x position for windowing after image scaling	0x05	Next
0x29(P18)	ZWINENXL	Low byte of end x position for windowing after image scaling	0x00	Next
0x2A(P18)	ZWINENYH	High byte of end y position for windowing after image scaling	0x04	Next
0x2B(P18)	ZWINENYL	Low byte of end y position for windowing after image scaling	0x00	Next
0x2C(P18)	ZVERSTEPH	High byte of vertical scaling step	0x10	Next
0x2D(P18)	ZVERSTEPL	Low byte of vertical scaling step	0x00	Next
0x2E(P18)	ZHORSTEPH	High byte of horizontal scaling step	0x10	Next
0x2F(P18)	ZHORSTEPL	Low byte of horizontal scaling step	0x00	Next
0x30(P18)	ZFIFODLY	Delay depth for image scaling	0x55	Next
Auto Exposure (Page Mode = 20)				
0x10(P20)	AECTL1	Control automatic exposure	0x0C	Next
0x11(P20)	AECTL2	Control automatic exposure	0x0C	Next
0x20(P20)	AEFRAMECTL1	Frame control for automatic exposure	0x01	Current
0x28(P20)	AEFINECTL1	Option of AE fine control	0x87	Current
0x29(P20)	AEFINECTL2	Option of AE fine control	0xA5	Current
0x2A(P20)	AEFINECTL3	Option of AE fine control	0x3F	Current
0x2B(P20)	AEFINECTL4	Option of AE fine control	0x34	Current
0x2C(P20)	AEFINECTL5	Option of AE fine control	0x23	Current
0x2D(P20)	AEFINECTL6	Option of AE fine control	0x00	Current
0x2E(P20)	AEFINECTL7	Option of AE fine control	0x03	Current
0x2F(P20)	AEFINECTL8	Option of AE fine control	0x0F	Current
0x60(P20)	AEWGT1	AE weight for R1 / R2 /R3 /R4	0x55	Current
0x61(P20)	AEWGT2	AE weight for R5 / R6 /R7 /R8	0x55	Current
0x62(P20)	AEWGT3	AE weight for R9 / R10 /R11 /R12	0x55	Current
0x63(P20)	AEWGT4	AE weight for R13 / R14 /R15 /R16	0x55	Current

0x64(P20)	AEWGT5	AE weight for R17 / R18 /R19 /R20	0x5F	Current
0x65(P20)	AEWGT6	AE weight for R21 / R22 /R23 /R24	0xF5	Current
0x66(P20)	AEWGT7	AE weight for R25 / R26 /R27 /R28	0x5F	Current
0x67(P20)	AEWGT8	AE weight for R29 / R30 /R31 /R32	0xF5	Current
0x68(P20)	AEWGT9	AE weight for R33 / R34 /R35 /R36	0x5F	Current
0x69(P20)	AEWGT10	AE weight for R37 / R38 /R39 /R40	0xF5	Current
0x6A(P20)	AEWGT11	AE weight for R41 / R42 /R43 /R44	0x5F	Current
0x6B(P20)	AEWGT12	AE weight for R45 / R46 /R47 /R48	0xF5	Current
0x6C(P20)	AEWGT13	AE weight for R49 / R50 /R51 /R52	0x55	Current
0x6D(P20)	AEWGT14	AE weight for R53 / R54 /R55 /R56	0x55	Current
0x6E(P20)	AEWGT15	AE weight for R57/ R58 /R59 /R60	0x55	Current
0x6F(P20)	AEWGT16	AE weight for R61/ R62 /R63 /R64	0x55	Current
0x70(P20)	YLVL	Luminance level to converge in AE	0x50	Current
0x78(P20)	YTH1	Threshold1 of hysteresis in AE	0x45	Current
0x79(P20)	YTH2_hi	Threshold2_hi of hysteresis in AE	0x50	Current
0x7c(P20)	YTH2_lo	Threshold2_lo of hysteresis in AE	0x28	Current
0x80(P20)	EXPINTH	High byte of internal exposure time	RO	Current
0x81(P20)	EXPINTM	Middle byte of internal exposure time	RO	Current
0x82(P20)	EXPINTL	Low byte of internal exposure time	RO	Current
0x83(P20)	EXPTIMEH	High byte of manual exposure time	0x01	Next
0x84(P20)	EXPTIMEM	Middle byte of manual exposure time	0x86	Next
0x85(P20)	EXPTIMEL	Low byte of manual exposure time	0xA0	Next
0x86(P20)	EXPMINH	High byte of minimum exposure time	0x01	Current
0x87(P20)	EXPMINL	Low byte of minimum exposure time	0xF4	Current
0x88(P20)	EXPMAXH	High byte of maximum exposure time	0x05	Current
0x89(P20)	EXPMAXM	Middle byte of maximum exposure time	0xB8	Current
0x8A(P20)	EXPMAXL	Low byte of maximum exposure time	0xD8	Current
0x8B(P20)	EXP100H	High byte of exposure time for 1/100sec	0x75	Next
0x8C(P20)	EXP100L	Low byte of exposure time for 1/100sec	0x30	Next
0x8D(P20)	EXP120H	High byte of exposure time for 1/120sec	0x61	Next
0x8E(P20)	EXP120L	Low byte of exposure time for 1/120sec	0xA8	Next
0x91(P20)	EXPFIXH	High byte of exposure time for fixed frame rate	0x06	Current
0x92(P20)	EXPFIXM	Middle byte of exposure time for fixed frame rate	0x06	Current
0x93(P20)	EXPFIXL	Low byte of exposure time for fixed frame rate	0xF8	Current
0x98(P20)	EXPOUT1	Threshold of exposure time to define bright condition.	0x9A	Current
0x99(P20)	EXPOUT2	Threshold of exposure time to define very bright condition.	0x46	Current
0x9C(P20)	EXPLMTH	High byte of exposure time for low limit.	0x09	Current
0x9D(P20)	EXPLMTL	Low byte of exposure time for low limit.	0xC4	Current
0x9E(P20)	EXPUNITH	High byte of unit step of EXPLMT	0x01	Current
0x9F(P20)	EXPUNITL	Low byte of unit step of EXPLMT	0xF4	Current
0xB0(P20)	AG	Automatic gain (AG)	0x10	Next
0xB1(P20)	AGMIN	Minimum AG in AE	0x10	Current
0xB2(P20)	AGMAX	Maximum AG in AE	0x80	Current
0xB3(P20)	AGLVLH	AGLVLH is target of AG to converge on abrupt transition.(Outdoor -> Indoor)	0x10	Current
0xB4(P20)	AGTH1	Minimum threshold of Band AG in AE	0x10	Current
0xB5(P20)	AGTH2	Maximum threshold of Band AG in AE	0x30	Current
0xB6(P20)	AGBTH1	Threshold1 of Adaptive AG in AE.	0x20	Current
0xB7(P20)	AGBTH2	Threshold2 of Adaptive AG in AE.	0x1B	Current

0xB8(P20)	AGBTH3	Threshold3 of Adaptive AG in AE.	0x18	Current
0xB9(P20)	AGBTH4	Threshold4 of Adaptive AG in AE.	0x16	Current
0xBA(P20)	AGBTH5	Threshold5 of Adaptive AG in AE.	0x15	Current
0xBB(P20)	AGBTH6	Threshold6 of Adaptive AG in AE.	0x14	Current
0xBC(P20)	AGBTH7	Threshold7 of Adaptive AG in AE.	0x13	Current
0xBD(P20)	AGBTH8	Threshold8 of Adaptive AG in AE.	0x12	Current
0xC0(P20)	AGSKY	Threshold of AG in very bright condition	0x14	Current
0xC3(P20)	AGLVLL	AGLVLL is target of AG to converge on abrupt transition.(Dark -> Indoor)	0x10	Current
0xC4(P20)	AGTIMETH	Threshold of Band time for Adaptive AG	0x04	Current
0xC8(P20)	DGMAX	Maximum Digital gain in AE.	0xFF	Current
0xC9(P20)	DGMIN	Minimum Digital gain in AE.	0x80	Current
0xD3(P20)	YAVG	Average of luminance.	RO	
Auto White Balance (Page Mode = 22)				
0x10(P22)	AWBCTL1	Control automatic white balance	0x6B	Next
0x11(P22)	AWBCTL2	Control automatic white balance	0x28	Next
0x30(P22)	ULVL	U chrominance level to converge in AWB	0x80	Current
0x31(P22)	VLVL	V chrominance level to converge in AWB	0x80	Current
0x38(P22)	UVTH1	U/V chrominance threshold1 in AWB	0x13	Current
0x39(P22)	UVTH2	U/V chrominance threshold2 in AWB	0x66	Current
0x40(P22)	YRANGE	Valid luminance range to detect white pixel	0x88	Current
0x41(P22)	CDIFF	Threshold of chrominance difference to detect white pixel	0x88	Current
0x42(P22)	CSUM	Threshold of chrominance summation to detect white pixel	0x66	Current
0x46(P22)	WHTPXLTH	Threshold of number of white pixel for AWB	0x0A	Current
0x80(P22)	RGAIN	Red color gain	0x30	Next
0x81(P22)	GGAIN	Green color gain	0x20	Next
0x82(P22)	BGAIN	Blue color gain	0x38	Next
0x83(P22)	RMAX	Maximum RGAIN in AWB	0x50	Current
0x84(P22)	RMIN	Minimum RGAIN in AWB	0x20	Current
0x85(P22)	BMAX	Maximum BGAIN in AWB	0x50	Current
0x86(P22)	BMIN	Minimum BGAIN in AWB	0x20	Current
0x87(P22)	RMAXM	Upper limit of RGAIN in middle bright condition	0x50	Current
0x88(P22)	RMINM	Lower limit of RGAIN in middle bright condition	0x30	Current
0x89(P22)	BMAXM	Upper limit of BGAIN in middle bright condition	0x40	Current
0x8A(P22)	BMINM	Lower limit of BGAIN in middle bright condition	0x20	Current
0x8B(P22)	RMAXB	Upper limit of RGAIN in bright condition	0x50	Current
0x8C(P22)	RMINB	Lower limit of RGAIN in bright condition	0x3E	Current
0x8D(P22)	BMAXB	Upper limit of BGAIN in bright condition	0x2E	Current
0x8E(P22)	BMINB	Lower limit of BGAIN in bright condition	0x20	Current
0x8F(P22)	BGAINPARA1	Parameter1 of BGAIN	0x50	Current
0x90(P22)	BGAINPARA2	Parameter2 of BGAIN	0x4C	Current
0x91(P22)	BGAINPARA3	Parameter3 of BGAIN	0x48	Current
0x92(P22)	BGAINPARA4	Parameter4 of BGAIN	0x46	Current
0x93(P22)	BGAINPARA5	Parameter5 of BGAIN	0x44	Current
0x94(P22)	BGAINPARA6	Parameter6 of BGAIN	0x42	Current
0x95(P22)	BGAINPARA7	Parameter7 of BGAIN	0x40	Current
0x96(P22)	BGAINPARA8	Parameter8 of BGAIN	0x3E	Current
0x97(P22)	BGAINPARA9	Parameter9 of BGAIN	0x3C	Current
0x98(P22)	BGAINPARA10	Parameter10 of BGAIN	0x28	Current

0x99(P22)	BGAINPARA11	Parameter11 of BGAIN	0x26	Current
0x9A(P22)	BGAINPARA12	Parameter12 of BGAIN	0x24	Current
0x9B(P22)	BGAINBND1	Boundary of BGAIN	0x44	Current
0x9C(P22)	BGAINBND2	Boundary of BGAIN	0x44	Current
0x9D(P22)	RAINTH1	Threshold1 of RGAIN	0x40	Current
0x9E(P22)	RAINTH2	Threshold2 of RGAIN	0x30	Current
0x9F(P22)	RAINTH3	Threshold3 of RGAIN	0x20	Current
0xA0(P22)	RDELTA1	The Increment delta value1 of red gain limit boundary	0x04	Current
0xA1(P22)	BDELTA1	The Increment delta value1of blue gain limit boundary	0x60	Current
0xA2(P22)	RDELTA2	The Increment delta value2 of red gain limit boundary	0x22	Current
0xA3(P22)	BDELTA2	The Increment delta value2 of blue gain limit boundary	0x42	Current
0xA4(P22)	AWBEXPLMT1	Threshold1 of red and blue limit boundary automatically	0x10	Current
0xA5(P22)	AWBEXPLMT2	Threshold2 of red and blue limit boundary automatically	0x40	Current
0xA6(P22)	AWBEXPLMT3	Threshold3 of red and blue limit boundary automatically	0x80	Current
0xB2(P22)	MRGAIN	RGAIN for manual white balance	0x48	Current
0xB3(P22)	MBGAIN	BGAIN for manual white balance	0x40	Current
0xD2(P22)	UAVG	Average of U chrominance of white pixels in frame	RO	
0xD3(P22)	VAVG	Average of V chrominance of white pixels in frame	RO	
Edge data for Auto Focus, Motion data for Anti-shaking (Page Mode = 24)				
0x10(P24)	AFCTL1	Control auto focus	0x00	Current
0x12(P24)	AFCTL2	Control auto focus and anti-shaking	0x00	Current
0x13(P24)	AFCTL3	Control auto focus and anti-shaking	0xFF	Current
0x19(P24)	AFCTL4	Control auto focus and anti-shaking	0x10	Current
0x40(P24)	AFROWSTR1	Row start of data region1/2/3/4 for Auto Focus/Anti-shaking.	0x10	Next
0x41(P24)	AFROWENR1	Row end of data region1/2/3/4 for Auto Focus/Anti-shaking.	0x11	Next
0x42(P24)	AFROWSTR2	Row start of data region5/6/7/8 for Auto Focus/Anti-shaking.	0x10	Next
0x43(P24)	AFROWENR2	Row end of data region5/6/7/8 for Auto Focus/Anti-shaking.	0x11	Next
0x44(P24)	AFROWSTR3	Row start of data region9/10/11/12 for Auto Focus/Anti-shaking.	0x70	Next
0x45(P24)	AFROWENR3	Row end of data region9/10/11/12 for Auto Focus/Anti-shaking.	0x71	Next
0x48(P24)	AFCOLSTR1	Column start of data region1/5/9 for Auto Focus/Anti-shaking.	0x14	Next
0x49(P24)	AFCOLENR1	Column end of data region1/5/9 for Auto Focus/Anti-shaking.	0x15	Next
0x4A(P24)	AFCOLSTR2	Column start of data region2/6/10 for Auto Focus/Anti-shaking.	0x8C	Next
0x4B(P24)	AFCOLENR2	Column end of data region2/6/10 for Auto Focus/Anti-shaking.	0x8D	Next
0x4C(P24)	AFCOLSTR3	Column start of data region3/7/11 for Auto Focus/Anti-shaking.	0x14	Next
0x4D(P24)	AFCOLENR3	Column end of data region3/7/11 for Auto Focus/Anti-shaking.	0x15	Next
0x4E(P24)	AFCOLSTR4	Column start of data region4/8/12 for uto Focus/Anti-shaking.	0x8C	Next
0x4F(P24)	AFCOLENR4	Column end of data region4/8/12 for Auto Focus/Anti-shaking.	0x8D	Next
0x50(P24)	AFROWLSB	Control LSB of row address for auto focus and anti-shaking.	0x00	Next
0x51(P24)	AFCOLLSB	Coltrol LSB of column address for auto focus and anti-shaking.	0x00	Next
0xA0(P24)	AFDATAR1H	High byte of auto focus data in region1	RO	
0xA1(P24)	AFDATAR1L	Low byte of auto focus data in region1	RO	
0xA2(P24)	AFDATAR2H	High byte of auto focus data in region2	RO	
0xA3(P24)	AFDATAR2L	Low byte of auto focus data in region2	RO	
0xA4(P24)	AFDATAR3H	High byte of auto focus data in region3	RO	
0xA5(P24)	AFDATAR3L	Low byte of auto focus data in region3	RO	
0xA6(P24)	AFDATAR4H	High byte of auto focus data in region4	RO	
0xA7(P24)	AFDATAR4L	Low byte of auto focus data in region4	RO	
0xA8(P24)	AFDATAR5H	High byte of auto focus data in region5	RO	

0xA9(P24)	AFDATAR5L	Low byte of auto focus data in region5	RO	
0xAA(P24)	AFDATAR6H	High byte of auto focus data in region6	RO	
0xAB(P24)	AFDATAR6L	Low byte of auto focus data in region6	RO	
0xAC(P24)	AFDATAR7H	High byte of auto focus data in region7	RO	
0xAD(P24)	AFDATAR7L	Low byte of auto focus data in region7	RO	
0xAE(P24)	AFDATAR8H	High byte of auto focus data in region8	RO	
0xAF(P24)	AFDATAR8L	Low byte of auto focus data in region8	RO	
0xB0(P24)	AFDATAR9H	High byte of auto focus data in region9	RO	
0xB1(P24)	AFDATAR9L	Low byte of auto focus data in region9	RO	
0xB2(P24)	AFDATAR10H	High byte of auto focus data in region10	RO	
0xB3(P24)	AFDATAR10L	Low byte of auto focus data in region10	RO	
0xB4(P24)	AFDATAR11H	High byte of auto focus data in region11	RO	
0xB5(P24)	AFDATAR11L	Low byte of auto focus data in region11	RO	
0xB6(P24)	AFDATAR12H	High byte of auto focus data in region12	RO	
0xB7(P24)	AFDATAR12L	Low byte of auto focus data in region12	RO	
0xB8(P24)	ASDATAR1H	High byte of anti-shaking data in region1	RO	
0xB9(P24)	ASDATAR1L	Low byte of anti-shaking data in region1	RO	
0xBA(P24)	ASDATAR2H	High byte of anti-shaking data in region2	RO	
0xBB(P24)	ASDATAR2L	Low byte of anti-shaking data in region2	RO	
0xBC(P24)	ASDATAR3H	High byte of anti-shaking data in region3	RO	
0xBD(P24)	ASDATAR3L	Low byte of anti-shaking data in region3	RO	
0xBE(P24)	ASDATAR4H	High byte of anti-shaking data in region4	RO	
0xBF(P24)	ASDATAR4L	Low byte of anti-shaking data in region4	RO	
0xC0(P24)	ASDATAR5H	High byte of anti-shaking data in region5	RO	
0xC1(P24)	ASDATAR5L	Low byte of anti-shaking data in region5	RO	
0xC2(P24)	ASDATAR6H	High byte of anti-shaking data in region6	RO	
0xC3(P24)	ASDATAR6L	Low byte of anti-shaking data in region6	RO	
0xC4(P24)	ASDATAR7H	High byte of anti-shaking data in region7	RO	
0xC5(P24)	ASDATAR7L	Low byte of anti-shaking data in region7	RO	
0xC6(P24)	ASDATAR8H	High byte of anti-shaking data in region8	RO	
0xC7(P24)	ASDATAR8L	Low byte of anti-shaking data in region8	RO	
0xC8(P24)	ASDATAR9H	High byte of anti-shaking data in region9	RO	
0xC9(P24)	ASDATAR9L	Low byte of anti-shaking data in region9	RO	
0xCA(P24)	ASDATAR10H	High byte of anti-shaking data in region10	RO	
0xCB(P24)	ASDATAR10L	Low byte of anti-shaking data in region10	RO	
0xCC(P24)	ASDATAR11H	High byte of anti-shaking data in region11	RO	
0xCD(P24)	ASDATAR11L	Low byte of anti-shaking data in region11	RO	
0xCE(P24)	ASDATAR12H	High byte of anti-shaking data in region12	RO	
0xCF(P24)	ASDATAR12L	Low byte of anti-shaking data in region12	RO	

5.1. Common Group

0x03 [common mode]: PAGEMODE [default=0x00, r/ w]

Bit	Function	Description	Default
B[7:0]	Page Mode	***Users should set this register before controlling registers to adjust functions.*** ***This register classified the group of function to control registers easily.*** 0x00 = control image size, windowing, sync, black level calibration, strobe 0x10 = control image format, image effect 0x11 = control noise reduction(D-LPF) 0x12 = control noise reduction(YC-LPF), dead pixel concealment. 0x13 = control edge enhancement 0x14 = control lens shading correction. 0x15 = control color correction 0x16 = control gamma correction. 0x17 = control auto flicker cancellation 0x18 = control image scaling 0x20 = control auto exposure 0x22 = control auto white balance	0000_0000b

0x01 [page mode 0]: PWRCTL [default=0x51, r/w]

Bit	Function	Description	Default
B[7:6]	PCLK Drive_L	It increases high drivability of PCLK pin as high value	01b
B[5:4]	Output Drive	It increases high drivability of output pin as high value (VSYNC, HSYNC and D[7:0])	01b
B[3]	PCLK Drive_H	Max PCLK drivability option	0b
B[2]		Reserved	0b
B[1]	Soft Reset	Enable software reset. When this bit is high, registers' values are initialized.	0b
B[0]	Power Sleep	Set power sleep by preserving the value of all registers. (0: OFF, 1: ON)	1b

0x0E [page mode 0]: PLLCTL1 [default=0x03, r/w]

Bit	Function	Description	Default
B[6]	PLL2 Enable	This bit should be enabled for PLL operation.	0b
B[5]	PLL1 Enable	This bit should be enabled after PLL mode is set	0b
B[4:3]	PLL Bias	Recommended value is 0x00	00b
B[2:0]	PLL Mode	PLL mode should be set before enabling PLL. Select output clock of PLL. The output clock of PLL is multiple of external main clock 010: 1.5x, 011: 2x, 100: 2.5x, 101: 3x, 110: 3.5x, 111: 4X.	011b

0x0F[page mode 0]: PLLCTL2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:5]	PLL	PLL locking time. For PLL operation, users should wait over this time after enable PLL. B[7:5] * 512 * MCLK's period. Recommend value is over the 10msec.	000b
B[4:0]		Option of PLL	0_0000b

5.2. Device Identification

0x04 [page mode 0]: DEVID [default=0x92, r]

Bit	Function	Description	Default
B[7:0]	Device ID	Device ID to define YACE4B1S	1001_0010b

5.3. Image Size / Windowing / HSYNC / VSYNC[Type1]

0x10 [page mode 0]: VDOCTL1 [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	Hbin	When this bit is selected, horizontal binning mode is activated.	0b
B[6]		Reserved	0b
B[5:4]	Sub-sampling	This function reduces image output resolution by skipping the number of rows and columns, while maintaining the same view and frame rate. 00: No sub-sampling(UXGA), 01: 1/2 sub-sampling(skipping 2pixels,SVGA), 10: 1/4 sub-sampling(skipping 4pixels, QSVGA), 11: Reserved	00b
B[3]	VSYNC Type	0 : HSYNC doesn't overlap with VSYNC [Type1] 1 : HSYNCs are in the VSYNC [Type2]. Refer to the timing description.	0b
B[2:1]		Reserved	00b
B[0]	Preview1	When this bit is selected, sensor skips two pixels every two rows. Frame rate of preview1 is two times faster than that of full size.(0:OFF, 1:ON)	0b

Note) Refer to 4.16 [Timing Description]

0x11 [page mode 0]: VDOCTL2 [default=0x90, r/w]

Bit	Function	Description	Default
B[7]	Windowing	Users changes image size by setting WINROW[0x13,0x14:P0], WINCOL [0x15,0x16:P0], WINHGT [0x17,0x18:P0] and WINWID[0x19,0x1A:P0]. (0:OFF, 1:ON)	1b
B[6:4]	Bad Frame Skip	It is used to skip bad frames when image size is changed. 001: Skip 1frame. 010: Skip 2frames, 011: Skip 3frames 100: Skip 4frame, 101: Skip 5frame. 110: Skip 6frames, 111: Skip 7frames Note) Do not set 0.	001b
B[3]	Strobe	Strobe function Enable(0: OFF, 1: ON). Refer to STRCTL[0x30:P0] and STRWID[0x31:P0]	0b
B[2]	Fixed Frame Rate	Set frame time to be constant, regardless of the change of exposure time. (0:OFF, 1:ON) Refer to 4.17 [Fixed Frame Rate Timing]	0b
B[1]	Y Flip	Vertical Flip Function (0:OFF, 1:ON)	0b
B[0]	X Flip	Horizontal Flip Function (0:OFF, 1:ON)	0b

0x12 [page mode 0]: SYNCCTL [default=0x04, r/w]

Bit	Function	Description	Default
B[7:6]		Reserved	00b
B[5]	VSYNC Polarity	Select polarity of VSYNC[Type1]. 0 : When VSYNC[Type1] is high, there are no valid HSYNCs When VSYNC[Type2] is high, there are valid HSYNCs 1 : When VSYNC[Type1] is low, there are no valid HSYNCs When VSYNC[Type2] is low, there are valid HSYNCs	0b
B[4]	HSYNC Polarity	Select polarity of HSYNC. 0: Active High : When HSYNC is high, image data is valid. 1: Active Low : When HSYNC is low, image data is valid.	0b
B[3]	VSYNC Clipping	Clip VSYNC[Type1]. Refer to VSCLIP[0x1F:P0] (0:OFF, 1:ON)	0b
B[2]	Clock Inversion	Select phase of PCLK 0: D[7:0] are synchronized at rising edge of PCLK 1: D[7:0] are synchronized at falling edge of PCLK	1b
B[1:0]	Clock Divider	Divides the frequency of internal CLOCK 00:1x, 01:1/2x, 10: 1/4x. 11: 1/8x	00b

0x13 [page mode 0]: HREFCTL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:5]		Reserved	00b
B[4]	HSYNC Margin	Select margin of HSYNC for lack HSYNC. 0: No Operation 1: HSYNC Add 2 line for Y-Flip.	0b
B[3]	VSYNC Margin	Shift the VSYNC. (if you need to shift VSYNC in HREF Mode, can set the register 0x4A & 0x4B[page mode0])	0b

B[2:1]	HREF Odd Case	Select the sync margin of HREF start or end number 00:All Even Cases, 01:Start an Odd Case, 10: End an Odd Case. 11: All Odd Cases	00b
B[0]	HREF Selection	Enable HREF. 0 : Normal HSYNC Output 1 : HREF Output	0b

0x20[page mode 0]: WINROWH [default=0x00, r/w]

Bit	Function	Description	Default
B[7:3]	Windowing	Reserved	0000_0b
B[2:0]		High byte of row start point for windowing WINROW[10:0]={WINROWH[2:0], WINROWL[7:0]}. Both WINROWH and WINROWL should be updated when WINROW is changed. Refer to 4.12[Windowing] for recommended setting value	000b

0x21[page mode 0]: WINROWL [default=0x0A, r/w]

Bit	Function	Description	Default
B[7:0]	Windowing	Low byte of row start point for windowing	0000_1010b

0x22[page mode 0]: WINCOLH [default=0x00, r/w]

Bit	Function	Description	Default
B[7:3]	Windowing	Reserved	0000_0b
B[2:0]		High byte of column start point for windowing WINCOL[10:0]={WINCOLH[2:0], WINCOLL[7:0]} Both WINCOLH and WINCOLL should be updated when WINCOL is changed. Refer to 4.12[Windowing] for recommended setting value	000b

0x23[page mode 0]: WINCOLL [default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	Windowing	Low byte of column start point for windowing	0000_1100b

0x24[page mode 0]: WINHGTH [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	Windowing	High byte of height for windowing WINHGT[10:0]={WINHGTH[2:0], WINHGTL[7:0]}. Both WINHGTH and WINHGTL should be updated when WINHGT is changed. Refer to 4.12[Windowing] for recommended setting value	0000_0100b

0x25[page mode 0]: WINHGTL [default=0xB0, r/w]

Bit	Function	Description	Default
B[7:0]	Windowing	Low byte of height for windowing	1011_0000b

0x26[page mode 0]: WINWIDH [default=0x06, r/w]

Bit	Function	Description	Default
B[7:3]	Windowing	Reserved	0000_0b
B[2:0]		High byte of width for windowing WINWID[10:0]={WINWIDH[2:0], WINWIDL[7:0]}. Both WINWIDH and WINWIDL should be updated when WINWID is changed. Refer to 4.12[Windowing] for recommended setting value	110b

0x27[page mode 0]: WINWIDL [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	Windowing	Low byte of width for windowing	0100_0000b

0x40[page mode 0]: HBLANKH [default=0x01, r/w]

Bit	Function	Description	Default
B[7:4]	HBLANK	Reserved	0000b
B[3:0]		High byte of horizontal blanking time. Unit of HBLANK is OPCLK's period HBLANK[11:0] = {HBLANKH[3:0], HBLANKL[7:0]} . HBLANK is interval between continuous image data lines(HSYNC). HBLANK should be greater than 224 and should be multiple of 4. Both HBLANKH and HBLANKL should be updated when HBLANK is changed. Refer to 4.13[Frame Structure] and 4.16[Timing Description] We recommend that HBLANK is set to meet following equation. 1) (EXP100[0x8B,8C:P20] * 8 * TOPCLK) / (Data Width + HBLANK) should be integer for 100Hz flicker cancellation 2) (EXP120[0x8D,8E:P20] * 8 * TOPCLK) / (Data width + HBLANK) should be integer for 120Hz flicker cancellation (Data Width =1640) Note1) When auto-flicker cancellation(100Hz/120Hz) is enabled, HBLANK should be set to meet 1) and 2). Note2) HBLANK should be greater than 256.	0001b

0x41[page mode 0]: HBLANKL [default=0x68, r/w]

Bit	Function	Description	Default
B[7:0]	HBLANK	Low byte of horizontal blanking time	0110_1000b

0x42[page mode 0]: VSYNCH [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC	High byte of duration for vertical synchronization[Type1] VSYNC is interval between continuous image frames. VSYNC[15:0] = {VSYNCH[7:0], VSYNCL[7:0]} Unit of VSYNC is one line processing time (Data Width + HBLANK). (Data Width =1640) Both VSYNCH and VSYNCL should be updated when VSYNC is changed. Refer to 4.13[Frame Structure] and 4.16[Timing Description] Note) VSYNC should be greater than 4line.	0000_0000b

0x43[page mode 0]: VSYNCL [default=0x14, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC	Low byte of duration for vertical synchronization[Type1]	0001_0100b

0x44[page mode 0]: VSCLIP [default=0x09, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC	VSCLIP is clipping line in VSYNC[Type1] when enabling bit[3] of SYNCCTL[0x12:P0]. When the interval between last HSYNC and VSYNC[Type1] should be controlled, VSCLIP is used to adjust the interval. Unit of VSYNC is one line processing time (Data Width + HBLANK) Refer to 4.13[Frame Structure] and 4.16[Timing Description] Note) VSCLIP should be under VSYNC	0000_1001b

0x45[page mode 0]: VSCTL1 [default=0x04, r/w]

Bit	Function	Description	Default
B[7:4]	VSYNC	High 4bits of start row position for vertical synchronization(Type2)	0000b
B[3:0]	[Type2]	High 4bits of stop row position for vertical synchronization(Type2)	0100b

0x46[page mode 0]: VSCTL2 [default=0x18, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC [Type2]	Low byte of start row position for vertical synchronization(Type2) Vertical start row position = VSCTL1[7:4] * 256 + VSCTL2[7:0] Unit of Vertical start(stop) row position is one line processing time (Data Width + HBLANK). (Data Width =1640) VSYNC[Type2] duration = Vertical stop row position - Vertical start row position Refer to 4.13[Frame Structure] and 4.16[Timing Description] Note) Vertical start row position should not be under 4.	0001_1000b

0x47[page mode 0]: VSCTL3 [default=0x18, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC [Type2]	Low byte of stop row position for vertical synchronization(Type2) Vertical stop row position = VSCTL1[3:0] * 256 + VSCTL3[7:0] Note) When preview1 mode is used, vertical stop row position should be changed.	0001_1000b

0x48[page mode 0]: HREF1 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	HREF START	HREF Start Region Value Note) When preview, HBIN, sub-sample mode is used, value should be changed.	0000_0000b

0x49[page mode 0]: HREF2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	HREF END	HREF End Region Value Note) When preview, HBIN, sub-sample mode is used, value should be changed.	0000_0000b

0x4A[page mode 0]: VSYNC DELAY1 [default=0x00, r/w]

Bit	Function	Description	Default
B[4]	VSYNC DELAY1	VSYNC delay counter. (Option)	0b
B[3:0]		reserved	0000b

0x4B[page mode 0]: VSYNC DELAY2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	VSYNC DELAY2	VSYNC delay counter. Counter Value = {VSYNC DELAY1[4], VSYNC DELAY2[7:0]}	0000_0000b

5.4. Black Level Calibration

0x80[page mode 0]: BLCCTL [default=0x08, r/w]

Bit	Function	Description	Default
B[7:4]	BLC	Reserved.	0000b
B[3]		Enable Black Level Calibration. (0: OFF, 1: ON)	1b
B[2]		Reserved	0b
B[1]		Enable additional black level at dark-light	0b
B[0]		Enable additional black level.	0b

0x90[page mode 0]: BLCTIMETHON [default=0x07, r/w]

Bit	Function	Description	Default
B[5:0]	BLC	Exposure time threshold to enable additional BLC	00_0111b

0x91[page mode 0]: BLCTIMETHOFF [default=0x08, r/w]

Bit	Function	Description	Default
B[7:0]	BLC	Exposure time threshold to disable additional BLC	0000_1000b

0x92[page mode 0]: BLCAGTHH [default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	BLC	AG threshold to enable additional BLC	0110_0000b

0x93[page mode 0]: BLCAGTHL [default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	BLC	AG threshold to disable additional BLC	0110_0000b

0x94[page mode 0]: BLCDGH [default=0xC8, r/w]

Bit	Function	Description	Default
B[7:0]	BLC	Digital gain threshold to enable additional BLC	1100_1000b

0x95[page mode 0]: BLCDGL [default=0xC0, r/w]

Bit	Function	Description	Default
B[7:0]	BLC	Digital gain threshold to disable additional BLC	1100_0000b

0xA0[page mode 0]: BLCOFSDB [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	BLC	Reserved.	0b
B[6]		0 = Plus offset, 1 = Minus offset	0b
B[5:0]		Blue color offset for additional black level	00_0000b

0xA2[page mode 0]: BLCOFSDGB [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	BLC	Reserved.	0b
B[6]		0 = Plus offset, 1 = Minus offset	0b
B[5:0]		Green color in Gb line offset for additional black level	00_0000b

0xA4[page mode 0]: BLCOFSDR [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	BLC	Reserved.	0b
B[6]		0 = Plus offset, 1 = Minus offset	0b
B[5:0]		Red color offset for additional black level	00_0000b

0xA6[page mode 0]: BLCOFSDGR [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	BLC	Reserved.	0b
B[6]		0 = Plus offset, 1 = Minus offset	0b
B[5:0]		Green color in Gr line offset for additional black level	00_0000b

5.5. Strobe

0xC0[page mode 0]: STRCTL[default=0x09, r/w]

Bit	Function	Description	Default
B[7]	Strobe	Single XENON strobe pulse is generated, when this bit is enabled. (0:OFF, 1:ON)	0b
B[6]		Adaptive LED Strobe (0:OFF, 1:ON) When this bit is enabled, strobe pin is active according to exposure time. Because exposure time is changed by light environment, strobe pin goes to high at dark side and goes to low at bright side. 1) Exposure time > bit[7:4] * STRTIME[0xC2:P0] * 1/100sec(1/120sec), Strobe pin is high. 2) Exposure time < bit[3:0] * STRTIME[0xC2:P0] * 1/100sec(1/120sec), Strobe pin is low.	0b

B[5]		Continuous LED strobe (0:OFF, 1:ON) When this bit is enabled, strobe pin is always high regardless of exposure time.	0b
B[4]		Continuous XENON strobe (0:OFF, 1:ON) When this bit is enabled and exposure time is over the frame time, there is a period that all pixels are exposed at the same time. Strobe pin goes to high in a moment.	0b
B[3]		When XENON(bit[7] or bit[4]) is selected, sensor controls the width of strobe pulse. 0 : Constant pulse width of XENON strobe 1: Programmable pulse width of XENON strobe(Refer to STRWID[0xC1:P0])	1b
B[2]		Polarity of strobe. 0: High active, 1: Low active	0b
B[1]		When this bit is enabled, MRGAIN[0xB2:P22] and MBGAIN[0xB3:P22] are used for white balance	0b
B[0]		When this bit is enabled, XENON strobe pulse is generated in active VSYNC (0:OFF, 1:ON)	1b

0xC1[page mode 0]: STRWID[default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	**Strobe**	Strobe Pulse Width = b[7:0] * 128 * OPCLK. It is used in XENON strobe.	0000_1100b

0xC2[page mode 0]: STRTIME[default=0x43, r/w]

Bit	Function	Description	Default
B[7:4]	**Strobe**	Strobe time high threshold = bit[7:4] * 4/100sec(4/120sec) It is threshold to enable adaptive LED strobe pulse.	0100b
B[3:0]		Strobe time low threshold = bit[3:0] * 4/100sec(4/120sec) It is threshold to disable adaptive LED strobe pulse.	0011b

5.6. Image Output Format and Image Effect

0x10[page mode 10]: ISPCTL1[default=0x03, r/w]

Bit	Function	Description	Default
B[7:4]	**Data Format**	0000: YUV4:2:2 8bit, 0100: RGB5:6:5 8bit, 0111: RGB4:4:4	0000b
B[3]		Reserved	0b
B[2]	**ITU656**	ITU656-like(0:OFF, 1:ON)	0b
B[1]	**Y Phase**	Select U/V(R/B) and Y(G) phase for output data. 0: UYVY …. for U Phase is ON, VYUY…. for U Phase is OFF 1: YUYV …. for U Phase is ON, YVYU…. for U Phase is OFF	1b
B[0]	**U Phase**	Select U(B) and V(R) phase for output data. 0: VYUY… for Y Phase is OFF, YVYU…. for Y Phase is ON 1: UYVY… for Y Phase is OFF, YUYV…. for Y Phase is ON	1b

0x11[page mode 10]: ISPCTL2[default=0x03, r/w]

Bit	Function	Description	Default
B[7]	**Byte Swap**	Byte Swap	0b
B[6]		Reserved.	0b
B[5]	**Embossing**	Embossing Effect (0:OFF, 1:ON)	0b
B[4]	**Sketch**	Sketch Effect (0:OFF, 1:ON)	0b
B[3]	**Solarization1**	Solarization Effect1 is controlled by adjusting SOLARI[0x46:P10]. (0:OFF, 1:ON)	0b
B[2]	**Solarization2**	Solarization Effect2 is controlled by adjusting SOLARI[0x46:P10]. (0:OFF, 1:ON)	0b
B[1]	**Color Space Conversion**	Color space conversion is done by enabling this bit. (0:OFF, 1:ON) RGB => YUV (Refer to 4.6[Color Space Conversion])	1b
B[0]	**Color Interpolation**	Because the raw data of the pixel array has only one of R, G or B for each pixel, sensor should perform color interpolation to recover the missing color component for each pixel. Color interpolation is done, by enabling this bit. (0:OFF, 1:ON)	1b

0x12[page mode 10]: ISPCTL3[default=0x00, r/w]

Bit	Function	Description	Default
B[7]	V OFFSET	Control V by adding or subtracting VOFS[0x43:P10]. (0:OFF, 1:ON)	0b
B[6]	U OFFSET	Control U by adding or subtracting UOFS[0x42:P10]. (0:OFF, 1:ON)	0b
B[5]	DYOFFSET	Control Y by adding DYOFS[0x41:P10] at dark environment. (0:OFF, 1:ON)	0b
B[4]	Y OFFSET	Control Y by adding or subtracting YOFS[0x40:P10]. (0:OFF, 1:ON)	0b
B[3]	Negative	Enable Negative effect	0b
B[2]	Color Inversion	U' = V, V' = U (0:OFF, 1:ON)	0b
B[1]	V Constant	This bit makes the output of V constant. Users can get mono, sepia and other special image by setting VCON[0x45:P10]. (0:OFF, 1:ON)	0b
B[0]	U Constant	This bit makes the output of U constant. Users can get mono, sepia and other special image by setting UCON[0x44:P10]. (0:OFF, 1:ON)	0b

0x13[page mode 10]: ISPCTL4[default=0x00, r/w]

Bit	Function	Description	Default
B[7:5]		Reserved	000b
B[4]	Negative Option	When Negative Effect is enabled, users can select effect1 or effect2. 0: Negative Effect1, 1: Negative Effect2	0b
B[3:2]		Reserved	00b
B[1]	Contrast Effect	Enable Contrast Effect. (0:OFF, 1:ON) Users can control contrast effect by adjusting CONTRAST[0x48:P10].	0b
B[0]	Binary Effect	Enable Binary Effect. (0:OFF, 1:ON) Users can control binary effect by adjusting BINARY[0x47:P10].	0b

0x14[page mode 10]: ISPCTL5 [default=0x02, r/w]

Bit	Function	Description	Default
B[7:1]	Luminance gain	Reserved	0000_001b
B[0]		Enable Y(luminance) gain. (0: OFF, 1: ON).	0b

0x20[page mode 10]: ITUCTL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:5]	ITU656	Reserved.	000b
B[4]		BLANK code word (0: 0x8010, 1: 0x0000)	0b
B[3]		Reserved.	0b
B[2]		0:YUV 0~255, 1: Y=16~236 U/V=16~240	0b
B[1]		Reserved.	0b
B[0]		Enable SOF and EOF code word.(0: OFF, 1: ON)	0b

0x24[page mode 10]: ITUSOF [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	ITU656	Start of frame data for ITU656-like mode	0010_0000b

0x25[page mode 10]: ITUSOL [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	ITU656	Start of line data for ITU656-like mode	0001_0000b

0x26[page mode 10]: ITUEOF [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	ITU656	End of frame data for ITU656-like mode	0000_0001b

0x27[page mode 10]: ITUEOL [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	ITU656	End of line data for ITU656-like mode	000_0010b

0x40[page mode 10]: YOFS [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Luminance offset	Luminance offset(Brightness function) is controlled by the following equation and bit[4] of ISPCTL3[0x12:P10]. Y' = Y + YOFS[6:0], for YOFS[7] = 0 = Y - YOFS[6:0], for YOFS[7] = 1	0000_0000b

0x41[page mode 10]: DYOFS [default=0x00, r/w]

Bit	Function	Description	Default
B[7:6]		Reserved	00b
B[5:0]	Luminance offset	Luminance offset coefficient at dark condition. When AG[0xB0:P20] is greater than AGBRT[0x50:P10] at dark environment by auto exposure control, sensor controls luminance by following equation Y' = Y + DYOFS[5:0] for AG > AGBRT = Y elsewhere	00_0000b

0x42[page mode 10]: UOFS [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	U offset	U chrominance offset coefficient. U chrominance offset is controlled by the following equation and bit[6] of ISPCTL3[0x12:P10]. U' = U + UOFS[6:0], for UOFS[7] = 0 = U - UOFS[6:0], for UOFS[7] = 1	0000_0000b

0x43[page mode 10]: VOFS [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	V offset	V chrominance offset coefficient. V chrominance offset is controlled by the following equation and bit[7] of ISPCTL3[0x12:P10]. V' = V + VOFS[6:0], for VOFS[7] = 0 = V - VOFS[6:0], for VOFS[7] = 1	0000_0000b

0x44[page mode 10]: UCON [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Chrominance Constant	UCON makes the output of U constant and VCON makes the output of V constant. Users can get mono, sepia and other special image by controlling these values and bit[1:0] of ISPCTL3[0x12:P10]. Example) Mono: UCON=0x80 and VCON=0x80	1000_0000b

0x45[page mode 10]: VCON [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Chrominance Constant	UCON makes the output of U constant and VCON makes the output of V constant. Users can get mono, sepia and other special image by controlling these values and bit[1:0] of ISPCTL3[0x12:P10]. Example) Mono: UCON=0x80 and VCON=0x80	1000_0000b

0x46[page mode 10]: SOLARI [default=0xF0, r/w]

Bit	Function	Description	Default
B[7:0]	Solarization Effect1/2	Solarization effect1. 0x00(more solarization) ~ 0xFF(normal image) Solarization effect2. 0x00(normal image) ~ 0xFF(more solarization)	1111_0000b

0x47[page mode 10]: BINARY [default=0x7F, r/w]

Bit	Function	Description	Default
B[7:0]	Binary Effect	Threshold of Binary Effect.	0111_1111b

0x48[page mode 10]: CONTRAST [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Contrast Effect	Parameter for Contrast Effect. Programmable range is from 0x80 (1x) to from 0xFF(1.99x)	1000_0000b

0x50[page mode 10]:AGBRT [default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	Auto Bright	When AG is greater than AGBRT at dark environment by auto exposure control, sensor controls luminance by enabling bit[5] of ISPCTL2[0x12:P10] and setting DYOFS[0x41:P10].	0110_0000b

0x70[page mode 10]:LGRATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Luminacnce gain	Luminance coefficient gain. 0x80(1x) ~ 0xFF(1.99x)	1000_0000b

0x71[page mode 10]:LGOFS [default=0x00, r/w]

Bit	Function	Description	Default
B[7]	Luminacnce gain	0: Plus 1: Minus	0b
B[6:0]		Luminance gain offset.	000_0000b

5.7. Color Saturation

0x60[page mode 10]: SATCTL[default=0x01, r/w]

Bit	Function	Description	Default
B[7:4]		Option for color saturation.	0000b
B[3:2]	Suppression Ratio	Suppression ratio in auto color saturation. 00 ~ 11(more suppression)	00b
B[1]	Auto Color Saturation	Enable auto color saturation. As AG[0xB0:P20] is increased, the more color noise is occurred in image. To suppress the color noise, color saturation is decreased as AG (0:OFF, 1:ON)	0b
B[0]	Manual Color Saturation	When this bit is enabled, SATB[0x61:P10] and SATR[0x62:P10] are multiplied to U and V. (0:OFF, 1:ON)	1b

0x61[page mode 10]: SATB [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Saturation B Gain	Blue color saturation coefficient. SATB is gain of color difference signal U. It is enabled by bit[0] of SATCTL[0x60:P10]. 0x00 ~ 0xFF(more U color saturation)	1000_0000b

0x62[page mode 10]: SATR [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Saturation R Gain	Red color saturation coefficient. SATR is gain of color difference signal V. It is enabled by bit[0] of SATCTL [0x60:P10]. 0x00 ~ 0xFF(more V color saturation)	1000_0000b

0x63[page mode 10]:AGSAT [default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	Color Saturation	When AG is greater than AGSAT, auto color de-saturation is performed by setting bit[3:2] of SATCTL[0x60:P10]. AGSAT = 0.5 + B[7:0]/32.	0110_0000b

0x66[page mode 1]: SATTIMETH [default=0xF4, r/w]

Bit	Function	Description	Default
B[7:4]	Color Saturation	Threshold to define bright condition	1111b
B[3:0]		Maximum threshold for bright color saturation	0100b

0x67[page mode 1]: SATOUTDEL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:4]	Color Saturation	Amount of U-chrominance to adjust color saturation at bright condition	0000b
B[3:0]		Amount of V-chrominance to adjust color saturation at bright condition	0000b

0x6A[page mode 10]: UPOSSAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Saturation	Positive coefficient of color saturation U. 0x00 ~ 0x7F(more color saturation)	1000_0000b

0x6B[page mode 10]: UNEGSAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Saturation	Negative coefficient of color saturation U. 0x00 ~ 0x7F(more color saturation)	1000_0000b

0x6C[page mode 10]: VPOSSAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Saturation	Positive coefficient of color saturation V. 0x00 ~ 0x7F(more color saturation)	1000_0000b

0x6D[page mode 10]: VNEGSAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Saturation	Negative coefficient of color saturation V. 0x00 ~ 0x7F(more color saturation)	1000_0000b

5.8. D-LPF(Noise Reduction)

0x10[page mode 11]: DLPFCTL1[default=0x00, r/w]

Bit	Function	Description	Default
B[7:6]	D-LPF	Reserved	00b
B[5]		Enable D-LPF under outdoor2 mode. (0: OFF, 1: ON).	0b
B[4]		Enable D-LPF under outdoor1 mode (0: OFF, 1: ON).	0b
B[3]		Enable D-LPF under indoor mode.r(0: OFF, 1: ON).	0b
B[2]		Enable D-LPF under dark1 mode (0: OFF, 1: ON).	0b
B[1]		Enable D-LPF under dark2 mode (0: OFF, 1: ON).	0b
B[0]		Enalbe D-LPF under dark3 mode (0: OFF, 1: ON).	0b

0x11[page mode 11]: DLPFCTL2 [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Option for D-LPF	0100_0000b

0x20[page mode 11]: DLPFAUTOCTL1 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Option for D-LPF	0000_0000b

0x21[page mode 11]: DLPFAUTOCTL2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Option for D-LPF	0000_0000b

0x26[page mode 11]: LPFAGTHL [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of Low threhold between Indoor mode and Dark1 mode	0011_0000b

0x27[page mode 11]: LPFAGTHH [default=0x38, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of High threhold between Indoor mode and Dark1 mode	0011_1000b

0x28[page mode 11]: LPFOUTTHL [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of Low threhold between outdoor2 mode and outdoor1 mode	0001_0000b

0x29[page mode 11]: LPFOUTTHH [default=0x0F, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of High threhold between outdoor2 mode and outdoor1 mode	0000_1111b

0x2B[page mode 11] : LPFYMEANTHL [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of high threhold value between dark2 mode and dark3 mode. When average luminance value in frame is lower than LPFYMEANTHL, dark 3 mode is ON	0100_0000b

0x2C[page mode 11]: LPFYMEANTHH [default=0x42, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Hysteresis of low threhold value between dark2 mode and dark3 mode. When average luminance value in frame is higher than LPFYMEANTHH, dark 2 mode is ON	0100_0010b

0x30[page mode 11] : OUT2YBOUNDH [default=0xBA, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under outdoor2 mode.	1011_1010b

0x31[page mode 11]: OUT2YBOUNDL[default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under outdoor2 mode	0001_0000b

0x32[page mode 11] : OUT2RATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under outdoor2 mode.	1000_0000b

0x33[page mode 11]: OUT2THH [default=0x08, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under outdoor2 mode 0x00 ~ 0xFF(more suppress noise)	0000_1000b

0x34[page mode 11] : OUT2THM [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under outdoor2 mode 0x00 ~ 0xFF(more suppress noise)	0000_0010b

0x35[page mode 11]: OUT2THL [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under outdoor2 mode 0x00 ~ 0xFF(more suppress noise)	0000_0001b

0x36[page mode 11] : OUT1YBOUNDH [default=0xB0, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under outdoor1 mode.	1011_0000b

0x37[page mode 11]: OUT1YBOUNDL[default=0x18, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under outdoor1 mode	0001_1000b

0x38[page mode 11] : OUT1RATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under outdoor1 mode.	1000_0000b

0x39[page mode 11]: OUT1THH [default=0x0A, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under outdoor1 mode 0x00 ~ 0xFF(more suppress noise)	0000_1010b

0x3A[page mode 11] : OUT1THM [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under outdoor1 mode 0x00 ~ 0xFF(more suppress noise)	0000_0100b

0x3B[page mode 11]: OUT1THL [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under outdoor1 mode 0x00 ~ 0xFF(more suppress noise)	0000_0010b

0x3C[page mode 11] : INYBOUNDH [default=0xA0, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under indoor mode.	1010_0000b

0x3D[page mode 11]: INYBOUNDL[default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under indoor mode	0010_0000b

0x3E[page mode 11] : INRATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under indoor mode.	1000_0000b

0x3F[page mode 11]: INTHH [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under indoor mode 0x00 ~ 0xFF(more suppress noise)	0001_0000b

0x40[page mode 11] : INTHM [default=0x08, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under indoor mode 0x00 ~ 0xFF(more suppress noise)	0000_1000b

0x41[page mode 11]: INTHL [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under indoor mode 0x00 ~ 0xFF(more suppress noise)	0000_0100b

0x42[page mode 11] : DARK1YBOUNDH [default=0x98, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under dark1 mode.	1001_1000b

0x43[page mode 11]: DARK1YBOUNDL[default=0x28, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under dark1 mode.	0010_1000b

0x44[page mode 11] : DARK1RATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under dark1 mode.	1000_0000b

0x45[page mode 11]: DARK1THH [default=0x12, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under dark1 mode 0x00 ~ 0xFF(more suppress noise)	0001_0010b

0x46[page mode 11] : DARK1THM [default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under dark1 mode 0x00 ~ 0xFF(more suppress noise)	0000_1100b

0x47[page mode 11]: DARK1THL [default=0x08, r/w

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under dark1 mode 0x00 ~ 0xFF(more suppress noise)	0000_1000b

0x48[page mode 11] : DARK2YBOUNDH [default=0x90, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under dark2 mode.	1001_0000b

0x49[page mode 11]: DARK2YBOUNDL[default=0x2A, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under dark2 mode.	0010_1010b

0x4A[page mode 11] : DARK2RATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under dark2 mode.	1000_0000b

0x4B[page mode 11]: DARK2THH [default=0x14, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under dark2 mode 0x00 ~ 0xFF(more suppress noise)	0001_0100b

0x4C[page mode 11] : DARK2THM [default=0x0E, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under dark2mode 0x00 ~ 0xFF(more suppress noise)	0000_1110b

0x4D[page mode 11]: DARK2THL [default=0x0E, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under dark2mode 0x00 ~ 0xFF(more suppress noise)	0000_1110b

0x4E[page mode 11] : DARK3YBOUNDH [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	High luminance boundary under dark3 mode.	1000_0000b

0x4F[page mode 11]: DARK3YBOUNDL[default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Low luminance boundary under dark3 mode.	0011_0000b

0x50[page mode 11] : DARK3RATIO [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	D-LPF ratio under dark3 mode.	1000_0000b

0x51[page mode 11]: DARK3THH [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in high luminance region under dark3 mode 0x00 ~ 0xFF(more suppress noise)	0010_0000b

0x52[page mode 11] : DARK3THM [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in middle luminance region under dark3 mode 0x00 ~ 0xFF(more suppress noise)	0001_0000b

0x53[page mode 11]: DARK3THL [default=0x12, r/w]

Bit	Function	Description	Default
B[7:0]	D-LPF	Noise reduction threshold of D-LPF in low luminance region under dark3 mode 0x00 ~ 0xFF(more suppress noise)	0001_0010b

5.9. YC-LPF(Noise Reduction)

0x20[page mode 12]: YCLPFCTL1 [default=0x02, r/w]

Bit	Function	Description	Default
B[7:3]	YC-LPF	Reserved	0000_0b
B[2:1]		Option of Y-LPF.	01b
B[0]		Enable Y- LPF (0: OFF, 1: ON).	0b

0x21[page mode 12]: YCLPFCTL2 [default=0x06, r/w]

Bit	Function	Description	Default
B[7:4]	YC-LPF	Reserved	0000b
B[3]		C-LPF auto enable (0:OFF, 1:ON)	0b
B[2:1]		Reserved	11b

B[0]		Enable C- LPF (0: OFF, 1: ON).	0b

0x23[page mode 12]: YCLPFCTL4 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Option for YC-LPF	0000_0000b

0x30[page mode 12]: YCPRWTH [default=0x58, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for Texture region 0x00 ~ 0xFF(more blur)	0101_1000b

0x31[page mode 12]: YCUNI1TH [default=0x16, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for uniform1 region 0x00 ~ 0xFF(more blur)	0001_0110b

0x32[page mode 12]: YCUNI2TH [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for uniform2 region 0x00 ~ 0xFF(more blur)	0011_0000b

0x33[page mode 12]: YCUNI3TH [default=0x3A, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for uniform3 region 0x00 ~ 0xFF(more blur)	0011_1010b

0x34[page mode 12]: YCNOR1TH [default=0x3A, r/w

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for normal1 region 0x00 ~ 0xFF(more blur)	0011_1010b

0x35[page mode 12]: YCNOR2TH [default=0x64, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for normal2 region 0x00 ~ 0xFF(more blur)	0110_0100b

0x36[page mode 12]: YCNOR3TH [default=0x96, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Threshold for normal3 region 0x00 ~ 0xFF(more blur)	1001_0110b

0x40[page mode 12]: YCOUT2THH [default=0xB8, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under outdoor2 mode.	1011_1000b

0x41[page mode 12]: YCOUT2THL [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under outdoor2 mode.	0010_0000b

0x42[page mode 12]: YCOUT2STDH [default=0xA7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under outdoor2 mode 0x00 ~ 0xFF(more blur)	1010_0111b

0x43[page mode 12]: YCOUT2STDM [default=0xA7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in middle luminance region under outdoor2 mode 0x00 ~ 0xFF(more blur)	1010_0111b

0x44[page mode 12]: YCOUT2STDL [default=0xA7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under outdoor2 mode 0x00 ~ 0xFF(more blur)	1010_0111b

0x45[page mode 12]: YCOUT2RAT [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y- LPF under outdoor2 mode. 0x00 ~ 0xFF(more blur)	0100_0000b

0x46[page mode 12]: YCOUT1THH [default=0xB0, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under outdoor1 mode.	1011_0000b

0x47[page mode 12]: YCOUT1THL [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under outdoor1 mode.	0010_0000b

0x48[page mode 12]: YCOUT1STDH [default=0xAF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under outdoor1 mode 0x00 ~ 0xFF(more blur)	1010_1111b

0x49[page mode 12]: YCOUT1STDM [default=0xAF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in middle luminance region under outdoor1 mode 0x00 ~ 0xFF(more blur)	1010_1111b

0x4A[page mode 12]: YCOUT1STDL [default=0xAF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under outdoor1 mode 0x00 ~ 0xFF(more blur)	1010_1111b

0x4B[page mode 12]: YCOUT1RAT [default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y-lpf under outdoor1 mode. 0x00 ~ 0xFF(more blur)	0110_0000b

0x4C[page mode 12]: YCINTHH [default=0xB0, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under indoor mode.	1011_0000b

0x4D[page mode 12]: YCINTHL [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under indoor mode.	0011_0000b

0x4E[page mode 12]: YCINSTDH [default=0xB7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under indoor mode 0x00 ~ 0xFF(more blur)	1011_0111b

0x4F[page mode 12]: YCINSTDM [default=0xB7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y-lpf in middle luminance region under indoor mode 0x00 ~ 0xFF(more blur)	1011_0111b

0x50[page mode 12]: YCINSTDL [default=0xB7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under indoor mode 0x00 ~ 0xFF(more blur)	1011_0111b

0x51[page mode 12]: YCINRAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y- LPF under indoor mode. 0x00 ~ 0xFF(more blur)	1000_0000b

0x52[page mode 12]: YCDARK1THH [default=0xA8, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under dark1 mode.	1010_1000b

0x53[page mode 12]: YCDARK1THL [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under dark1 mode.	0011_0000b

0x54[page mode 12]: YCDARK1STDH [default=0xC7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under dark1 mode 0x00 ~ 0xFF(more blur)	1100_0111b

0x55[page mode 12]: YCDARK1STDM [default=0xC7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y-lpf in middle luminance region under dark1 mode 0x00 ~ 0xFF(more blur)	1100_0111b

0x56[page mode 12]: YCDARK1STDL [default=0xC7, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under dark1 mode 0x00 ~ 0xFF(more blur)	1100_0111b

0x57[page mode 12]: YCDARK1RAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y- LPF under dark1 mode. 0x00 ~ 0xFF(more blur)	1000_0000b

0x58[page mode 12]: YCDARK2THH [default=0xA0, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under dark2 mode.	1010_0000b

0x59[page mode 12]: YCDARK2THL [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under dark2 mode.	0100_0000b

0x5A[page mode 12]: YCDARK2STDH [default=0xDF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under dark2 mode 0x00 ~ 0xFF(more blur)	1101_1111b

0x5B[page mode 12]: YCDARK2STDM [default=0xDF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in middle luminance region under dark2 mode 0x00 ~ 0xFF(more blur)	1101_1111b

0x5C[page mode 12]: YCDARK2STDL [default=0xDF, r/w]]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under dark2 mode 0x00 ~ 0xFF(more blur)	1101_1111b

0x5D[page mode 12]: YCDARK2RAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y-lpf under dark2 mode. 0x00 ~ 0xFF(more blur)	1000_0000b

0x5E[page mode 12]: YCDARK3THH [default=0xA0, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	High luminance boundary under dark3 mode.	1010_0000b

0x5F[page mode 12]: YCDARK3THL [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Low luminance boundary under dark3 mode.	0100_0000b

0x60[page mode 12]: YCDARK3STDH [default=0xEF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in high luminance region under dark3 mode 0x00 ~ 0xFF(more blur)	1110_1111b

0x61[page mode 12]: YCDARK3STDM [default=0xEF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in middle luminance region under dark3 mode 0x00 ~ 0xFF(more blur)	1110_1111b

0x62[page mode 12]: YCDARK3STDL [default=0xEF, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	Noise reduction threshold of Y- LPF in low luminance region under dark3 mode 0x00 ~ 0xFF(more blur)	1110_1111b

0x63[page mode 12]: YCDARK3RAT [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	YC-LPF	The ratio of Y- LPF under dark3 mode. 0x00 ~ 0xFF(more blur)	1000_0000b

5.10. Dead Pixel Concealment

0x90[page mode 12]: DPCCTL[default=0x5D, r/w]

Bit	Function	Description	Default
B[7:1]	DPC	Reserved.	0101_110b
B[0]		Enable DPC [0:OFF, 1:ON]	1b

5.11. Edge Enhancement

0x10[page mode 13]: EDGECTL1 [default=0x28, r/w]

Bit	Function	Description	Default
B[7]	Edge Enhancement	Enable auto adjustment of edge gain according with AG(0: OFF, 1: ON). The adjustment ratio is relavive with B[3:1] of 0x11:Page13	0b
B[6:4]		Filter ratio 0 ~ 4(more edge)	010b
B[3:1]		Low clip ratio 0 ~ 7(more detail)	100b
B[0]		Enable edge enhancement(0: OFF, 1: ON).	0b

0x11[page mode 13]: EDGECTL2[default=0x17, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Option of edge enhancement.	0001_0111b

0x12[page mode 13]: EDGECTL3 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:1]	Edge Enhancement	Reserved.	0000_000b
B[0]		Filter type (0: detail edge, 1: thick edge but less noise)	0b

0x14[page mode 13]: EDGECTL5 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:6]	Edge Enhancement	Reserved.	00b
B[5:3]		Ratio for edge gain as AG	000b
B[2:0]		Ratio for edge gain as exposure time	000b

0x20[page mode 13]: EDGENGAIN[default=0x08, r/w]

Bit	Function	Description	Default
B[7:6]	Edge Enhancement	Reserved.	00b
B[5:0]		Edge gain to emphasize negative edge data. 0x00~ 0x3F(more edge)	00_1000b

0x21[page mode 13]: EDGEPGAIN[default=0x08, r/w]

Bit	Function	Description	Default
B[7:6]	Edge Enhancement	Reserved.	00b
B[5:0]		Edge gain to emphasize positive edge data. 0x00~ 0x3F(more edge)	00_1000b

0x23[page mode 13]: EDGEHCLIP1TH [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold of high clip1 This value should be lower than EDGEHCLIP2TH[0x24:page13]	0000_0110b

0x24[page mode 13]: EDGEHCLIP2TH [default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold of high clip2	0000_1100b

0x25[page mode 13]: EDGELCLIPTH [default=0x08, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold of low clip	0000_1000b

0x26[page mode 13]: EDGELCLIPLMT [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Limit of low clip	0011_0000b

0x29[page mode 13]: EDGETIMETH [default=0x10]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold of Exposure time for automatic edge enhancement.	0001_0000b

0x2A[page mode 13]: EDGEAGTH [default=0x30]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold of AG for automatic edge enhancement.	0011_0000b

0x80[page mode 13]: EDGE2DCTL1[default=0x00, r/w]

Bit	Function	Description	Default
B[7]	Edge Enhancement	Reserved.	0b
B[6:4]		Option for 2nd edge enhancement.	000b
B[3:1]		Ratio of low clip in 2nd edge enhancement	000b
B[0]		Enable 2nd edge enhancement	0b

0x81[page mode 13]: EDGE2DCTL2[default=0x07, r/w]

Bit	Function	Description	Default
B[7:5]	Edge Enhancement	Reserved.	000b
B[4:0]		Option for 2nd edge enhancement.	0_0111b

0x82[page mode 13]: EDGE2DCTL3[default=0x06, r/w]

Bit	Function	Description	Default
B[7:4]	Edge Enhancement	Reserved.	0000b
B[3:0]		Option of 2nd edge enhancement	0110b

0x83[page mode 13]: EDGE2DCTL4[default=0x21, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Option of 2nd edge enhancement	0010_0001b

0x85[page mode 13]: EDGE2DCTL6[default=0x00, r/w]

Bit	Function	Description	Default
B[6:4]	Embossing	Option of embossing effect	000b
B[3]		Embossing effect (0:OFF, 1:ON)	0b

B[2:1]	Sketch	Option of sketch effect	00b
B[0]		Sketch effect (0:OFF, 1:ON)	0b

0x90[page mode 13]: EDGE2DNGAIN[default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Edge gain to emphasize negative edge data for 2nd edge enhancement. 0x00~ 0xFF(more edge)	0011_0000b

0x91[page mode 13]: EDGE2DPGAIN[default=030, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Edge gain to emphasize positive edge data for 2nd edge enhancement. 0x00~ 0xFF(more edge)	0011_0000b

0x93[page mode 13]: EDGE2DLCLIPLMT [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Limit of low clip in 2nd edge enhancement.	0011_0000b

0x94[page mode 13]: EDGE2DHCLIP1TH [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Threshold1 of high clip This value should be higher than EDGE2DHCLIP2TH[0x95:page13]	0000_0110b

0x95[page mode 13]: EDGE2DHCLIP2TH [default=0x1E, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under outdoor2 mode.	0001_1110b

0xA0[page mode 13]: EDGE2DLCOUT2N [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under outdoor2 mode.	0000_0000b

0xA1[page mode 13]: EDGE2DLCOUT2P [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under outdoor2 mode	0000_0000b

0xA2[page mode 13]: EDGE2DLCOUT1N [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under outdoor1 mode	0000_0001b

0xA3[page mode 13]: EDGE2DLCOUT1P [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under outdoor1 mode.	0000_0010b

0xA4[page mode 13]: EDGE2DLCINN [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under indoor mode	0000_0010b

0xA5[page mode 13]: EDGE2DLCINP [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under indoor mode	0000_0100b

0xA6[page mode 13]: EDGE2DLCD1N [default=0x03, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under dark1 mode.	0000_0011b

0xA7[page mode 13]: EDGE2DLCD1P [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under dark1 mode.	0000_0110b

0xA8[page mode 13]: EDGE2DLCD2N [default=0x03, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under dark2 mode.	0000_0011b

0xA9[page mode 13]: EDGE2DLCD2P [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under dark2 mode	0000_0110b

0xAA[page mode 13]: EDGE2DLCD3N [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Negative threshold of low clip under dark3 mode	0000_0100b

0xAB[page mode 13]: EDGE2DLCD3P [default=0x08, r/w]

Bit	Function	Description	Default
B[7:0]	Edge Enhancement	Positive threshold of low clip under dark3 mode	0000_1000b

5.12. Lens Shading Correction

0x10[page mode 14]: LENSCTL1[default=0x00, r/w]

Bit	Function	Description	Default
B[7:1]	Lens Shading Correction	Option for lens shading correction	0000_000b
B[0]		Enable lens shading correction (0:OFF, 1:ON)	0b

0x11[page mode 14]: LENSCTL2[default=0x0B, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Option for Lens Shading Correction (0:OFF, 1:ON)	0000_1011b

0x14[page mode 14]: Gb_XCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on x-axis of pixel array to compensate lens shading. Optical center on x-axis = 672+ b[7:0]	1000_0000b

0x15[page mode 14]: Gb_YCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on y-axis of pixel array to compensate lens shading. Optical center on y-axis = 472 + b[7:0]	1000_0000b

0x16[page mode 14]: R_XCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on x-axis of pixel array to compensate lens shading. Optical center on x-axis = 672+ b[7:0]	1000_0000b

0x17[page mode 14]: R_YCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on y-axis of pixel array to compensate lens shading. Optical center on y-axis = 472 + b[7:0]	1000_0000b

0x18[page mode 14]: B_XCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on x-axis of pixel array to compensate lens shading. Optical center on x-axis = 672+ b[7:0]	1000_0000b

0x19[page mode 14]: B_YCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on y-axis of pixel array to compensate lens shading. Optical center on y-axis = 472 + b[7:0]	1000_0000b

0x20[page mode 14]: XCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on x-axis of pixel array to compensate lens shading. Optical center on x-axis = 672+ b[7:0]	1000_0000b

0x21[page mode 14]: YCEN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	It indicates optical center point on y-axis of pixel array to compensate lens shading. Optical center on y-axis = 472 + b[7:0]	1000_0000b

0x22[page mode 14]: LENSRGAIN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Global Gain for Red pixel	1000_0000b

0x23[page mode 14]: LENSGGAIN[default=0x80, r/w

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Global Gain for Green Pixel	1000_0000b

0x24[page mode 14]: LENSBGAIN[default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Global Gain for Blue Pixel	1000_0000b

0x25[page mode 14]: LAGOFF[default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	When AG is over LAGOFF and bit[1] of LENSCTL1 is enabled, lens shading correction is disabled automatically.	0110_0000b

0x26[page mode 14]: LAGON[default=0x60, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	When AG is under LAGON and bit[1] of LENSCTL1 is enabled, lens shading correction is enabled automatically.	0110_0000b

0x28[page mode 14]: LENSSTEP[default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Incremental step for lens shading correction	0010_0000b

0x40[page mode 14]: LENSRP0[default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Gain Parameter0 for Red Pixel	0000_0000b

0x50[page mode 14]: LENSGrP0[default=0x00, r/w

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Gain Parameter0 for Gr Pixel	0000_0000b

0x60[page mode 14]: LENSBP0[default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Gain Parameter0 for Blue Pixel	0000_0000b

0x70[page mode 14]: LENSGbP0[default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Lens Shading Correction	Lens Shading Correction Gain Parameter0 for Gb Pixel	0000_0000b

5.13. Color Correction

0x10[page mode 15]: CMCCTL[default=0x0F, r/w]

Bit	Function	Description	Default
B[7:4]		Reserved	0000b
B[3]	CMC 1x double	0 : The range of CMC11, CMC12, CMC13 = -1.99 ~ 1.99 1 : The range of CMC11, CMC12, CMC13 = -3.99 ~ 3.99	1b
B[2]	CMC 2x Double	0 : The range of CMC21, CMC22, CMC23 = -1.99 ~ 1.99 1 : The range of CMC21, CMC22, CMC23 = -3.99 ~ 3.99	1b
B[1]	CMC 3x Double	0 : The range of CMC31, CMC32, CMC33 = -1.99 ~ 1.99 1 : The range of CMC31, CMC32, CMC33 = -3.99 ~ 3.99	1b
B[0]	CMC ON	Enable color correction (0:OFF, 1:ON)	1b

0x14[page mode 15]: CMCOFSGH [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	High threshold of color offset gain	0100_0000b

0x15[page mode 15]: CMCOFSGM [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Middle threshold of color offset gain	0011_0000b

0x16[page mode 15]: CMCOFSGL [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Low threshold of color offset gain	0010_0000b

0x16[page mode 15]: CMCOFSGL [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Low threshold of color offset gain	0010_0000b

0x17[page mode 15]: CMCSIGN [default=0x2F, r/w]

Bit	Function	Description	Default
B[7:6]	Color Correction	Reserved	00b
B[5]		Sign of CMC12, 0: + , 1: -	1b
B[4]		Sign of CMC13, 0: + , 1: -	0b
B[3]		Sign of CMC21, 0: + , 1: -	1b
B[2]		Sign of CMC23, 0: + , 1: -	1b
B[1]		Sign of CMC31, 0: + , 1: -	1b
B[0]		Sign of CMC32, 0: + , 1: -	1b

0x30[page mode 15]: CMC11 [default=0x4C, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient11. 0x00(0) ~ 0xFF(1.99) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(3.99) for bit[3] of CMCCTL[0x10:P15] = 1	0100_1100b

0x31[page mode 15]: CMC12 [default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient12. Bit[5] of CMC_SIGN[0x17:P15] = 0 and bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[5] of CMC_ SIGN[0x17:P15] = 1 and bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[5] of CMC_ SIGN[0x17:P15] = 0 and bit[3] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[5] of CMC_ SIGN[0x17:P15] = 1 and bit[3] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	0000_1100b

0x32[page mode 15]: CMC13 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient13. Bit[4] of CMC_ SIGN[0x17:P15] = 0 and bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[4] of CMC_ SIGN[0x17:P15] = 1 and bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[4] of CMC_ SIGN[0x17:P15] = 0 and bit[3] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[4] of CMC_ SIGN[0x17:P15] = 1 and bit[3] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	0000_0000b

0x33page mode 15]: CMC21 [default=0x26, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient21 Bit[3] of CMC_ SIGN[0x17:P15] = 0 and bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[3] of CMC_ SIGN[0x17:P15] = 1 and bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[3] of CMC_ SIGN[0x17:P15] = 0 and bit[2] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[3] of CMC_ SIGN[0x17:P15] = 1 and bit[2] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	0010_0110b

0x34[page mode 15]: CMC22 [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient22. 0x00(0) ~ 0xFF(1.99) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(3.99) for bit[2] of CMCCTL[0x10:P15] = 1	1000_0000b

0x35[page mode 15]: CMC23 [default=0x1A, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient23. Bit[2] of CMC_ SIGN[0x17:P15] = 0 and bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[2] of CMC_ SIGN[0x17:P15] = 1 and bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[2] of CMC_ SIGN[0x17:P15] = 0 and bit[2] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[2] of CMC_ SIGN[0x17:P15] = 1 and bit[2] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	0001_1010b

0x36[page mode 15]: CMC31 [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient31. Bit[1] of CMC_ SIGN[0x17:P15] = 0 and bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[1] of CMC_ SIGN[0x17:P15] = 1 and bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[1] of CMC_ SIGN[0x17:P15] = 0 and bit[1] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[1] of CMC_ SIGN[0x17:P15] = 1 and bit[1] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	0010_0000b

0x37[page mode 15]: CMC32 [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient32. Bit[0] of CMC_ SIGN[0x17:P15] = 0 and bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(1.99), Bit[0] of CMC_ SIGN[0x17:P15] = 1 and bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(-1.99), Bit[0] of CMC_ SIGN[0x17:P15] = 0 and bit[1] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(3.99), Bit[0] of CMC_ SIGN[0x17:P15] = 1 and bit[1] of CMCCTL[0x10:P15] = 1 0x00(0) ~ 0xFF(-3.99)	1000_0000b

0x38[page mode 15]: CMC33 [default=0xE0, r/w]

Bit	Function	Description	Default
B[7:0]	Color Correction	Color correction coefficient33. 0x00(0) ~ 0xFF(1.99) for bit[0] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0xFF(3.99) for bit[0] of CMCCTL[0x10:P15] = 1	1110_0000b

0x40[page mode 15]: CMCOFSL11 [default=0x12, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL11, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC11 for low color temperature. Absolute value of CMCOFSL11. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	001_0010b

0x41[page mode 15]: CMCOFSL12 [default=0xA0, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL12, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC12 for low color temperature. Absolute value of CMCOFSL12. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	010_0000b

0x42[page mode 15]: CMCOFSL13 [default=0x0E, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL13, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC13 for low color temperature. Absolute value of CMCOFSL13. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	000_1110b

0x43[page mode 15]: CMCOFSL21 [default=0x84, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL21, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC21 for low color temperature. Absolute value of CMCOFSL21. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_0100b

0x44[page mode 15]: CMCOFSL22 [default=0x08, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL22, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC22 for low color temperature. Absolute value of CMCOFSL22. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_1000b

0x45[page mode 15]: CMCOFSL23 [default=0x84, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL23, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC23 for low color temperature. Absolute value of CMCOFSL23. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_0100b

0x46[page mode 15]: CMCOFSL31 [default=0x8A, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL31, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC31 for low color temperature. Absolute value of CMCOFSL31. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_1010b

0x47[page mode 15]: CMCOFSL32 [default=0x02, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL32, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC32 for low color temperature. Absolute value of CMCOFSL32. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_1000b

0x48[page mode 15]: CMCOFSL33 [default=0x08, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSL33, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC33 for low color temperature. Absolute value of CMCOFSL33. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_0010b

0x50[page mode 15]: CMCOFSH11 [default=0x12, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH11, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC11 for high color temperature. Absolute value of CMCOFSH11. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	001_0010b

0x51[page mode 15]: CMCOFSH12 [default=0xA0, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH12, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC12 for high color temperature. Absolute value of CMCOFSH12. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	010_0000b

0x52[page mode 15]: CMCOFSH13 [default=0x0E, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH13, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC13 for high color temperature. Absolute value of CMCOFSH13. 0x00(0) ~ 0x7F(0.1245) for bit[3] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[3] of CMCCTL[0x10:P15] = 1	000_1110b

0x53[page mode 15]: CMCOFSH21 [default=0x84, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH21, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC21 for high color temperature. Absolute value of CMCOFSH21. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_0100b

0x54[page mode 15]: CMCOFSH22 [default=0x08, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH22, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC22 for high color temperature. Absolute value of CMCOFSH22. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_1000b

0x55[page mode 15]: CMCOFSH23 [default=0x84, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH23, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC23 for high color temperature. Absolute value of CMCOFSH23. 0x00(0) ~ 0x7F(0.1245) for bit[2] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[2] of CMCCTL[0x10:P15] = 1	000_0100b

0x56[page mode 15]: CMCOFSH31 [default=0x8A, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH31, 0: + , 1: -	1b
B[6:0]		It is color offset coefficient of CMC31 for high color temperature. Absolute value of CMCOFSH31. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_1010b

0x57[page mode 15]: CMCOFSH32 [default=0x02, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH32, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC32 for high color temperature. Absolute value of CMCOFSH32. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_0010b

0x58[page mode 15]: CMCOFSH33 [default=0x08, r/w]

Bit	Function	Description	Default
B[7]	Color Correction	Sign of CMCOFSH33, 0: + , 1: -	0b
B[6:0]		It is color offset coefficient of CMC33 for high color temperature. Absolute value of CMCOFSH33. 0x00(0) ~ 0x7F(0.1245) for bit[1] of CMCCTL[0x10:P15] = 0 0x00(0) ~ 0x7F(0.2490) for bit[1] of CMCCTL[0x10:P15] = 1	000_1000b

5.14. Gamma Correction

0x10[page mode 16]: GMACTL [default=0x01, r/w]

Bit	Function	Description	Default
B[7:1]	Gamma Correction	Option for gamma correction.	0000_000b
B[0]		Enable Gamma Correction	1b

0x30[page mode 16]: GGMA0 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 0(0)code in 10(8)bit linear input	0000_0000b

0x31[page mode 16]: GGMA1 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 16(4)code in 10(8)bit linear input	0001_0101b

0x32[page mode 16]: GGMA2 [default=0x1F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 32(8)code in 10(8)bit linear input	0001_1111b

0x33[page mode 16]: GGMA3 [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 64(16)code in 10(8)bit linear input	0011_0000b

0x34[page mode 16]: GGMA4 [default=0x49, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output at 128(32)code in 10(8)bit linear input	0100_1001b

0x35[page mode 16]: GGMA5 [default=0x5D, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 192(48)code in 10(8)bit linear input	0101_1101b

0x36[page mode 16]: GGMA6 [default=0x6F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 256(64) 10(8)bit linear input	0110_1111b

0x37[page mode 16]: GGMA7 [default=0x7F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 320(80)code in 10(8)bit linear input	0111_1111b

0x38[page mode 16]: GGMA8 [default=0x8E, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 384(96)code in 10(8)bit linear input	1000_1110b

0x39[page mode 16]: GGMA9 [default=0x9B, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 448(112)code in 10(8)bit linear input	1001_1011b

0x3A[page mode 16]: GGMA10 [default=0xA8, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 512(128)code in 10(8)bit linear input	1010_1000b

0x3B[page mode 16]: GGMA11 [default=0xB5, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 576(144)code in 10(8)bit linear input	1011_0101b

0x3C[page mode 16]: GGMA12 [default=0xC1, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 640(160)code in 10(8)bit linear input	1100_0001b

0x3D[page mode 16]: GGMA13 [default=0xCC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 704(176)code in 10(8)bit linear input	1100_1100b

0x3E[page mode 16]: GGMA14 [default=0xD7, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 768(192)code in 10(8)bit linear input	1101_0111b

0x3F[page mode 16]: GGMA15 [default=0xE2, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 832(208)code in 10(8)bit linear input	1110_0010b

0x40[page mode 16]: GGMA16 [default=0xEC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 896(224)code in 10(8)bit linear input	1110_1100b

0x41[page mode 16]: GGMA17 [default=0xF6, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 960(240)code in 10(8)bit linear input	1111_0110b

0x42[page mode 16]: GGMA18 [default=0xFF, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of green pixel at 1023(255)code in 10(8)bit linear input	1111_1111b

0x50[page mode 16]: RGMA0 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 0(0)code in 10(8)bit linear input	0000_0000b

0x51[page mode 16]: RGMA1 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 16(4)code in 10(8)bit linear input	0001_0101b

0x52[page mode 16]: RGMA2 [default=0x1F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 32(8)code in 10(8)bit linear input	0001_1111b

0x53[page mode 16]: RGMA3 [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 64(16)code in 10(8)bit linear input	0011_0000b

0x54[page mode 16]: RGMA4 [default=0x49, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 128(32)code in 10(8)bit linear input	0100_1001b

0x55[page mode 16]: RGMA5 [default=0x5D, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 192(48)code in 10(8)bit linear input	0101_1101b

0x56[page mode 16]: RGMA6 [default=0x6F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 256(64) 10(8)bit linear input	0110_1111b

0x57[page mode 16]: RGMA7 [default=0x7F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 320(80)code in 10(8)bit linear input	0111_1111b

0x58[page mode 16]: RGMA8 [default=0x8E, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gmma corrected output of red pixel at 384(96)code in 10(8)bit linear input	1000_1110b

0x59[page mode 16]: RGMA9 [default=0x9B, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 448(112)code in 10(8)bit linear input	1001_1011b

0x5A[page mode 16]:R GMA10 [default=0xA8, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 512(128)code in 10(8)bit linear input	1010_1000b

0x5B[page mode 16]: RGMA11 [default=0xB5, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 576(144)code in 10(8)bit linear input	1011_0101b

0x5C[page mode 16]: RGMA12 [default=0xC1, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 640(160)code in 10(8)bit linear input	1100_0001b

0x5D[page mode 16]: RGMA13 [default=0xCC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 704(176)code in 10(8)bit linear input	1100_1100b

0x5E[page mode 16]: RGMA14 [default=0xD7, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 768(192)code in 10(8)bit linear input	1101_0111b

0x5F[page mode 16]: RGMA15 [default=0xE2, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 832(208)code in 10(8)bit linear input	1110_0010b

0x60[page mode 16]: RGMA16 [default=0xEC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output at 896(224)code in 10(8)bit linear input	1110_1100b

0x61[page mode 16]: RGMA17 [default=0xF6, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 960(240)code in 10(8)bit linear input	1111_0110b

0x62[page mode 16]: RGMA18 [default=0xFF, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of red pixel at 1023(255)code in 10(8)bit linear input	1111_1111b

0x70[page mode 16]: BGMA0 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 0(0)code in 10(8)bit linear input	0000_0000b

0x71[page mode 16]: BGMA1 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 16(4)code in 10(8)bit linear input	0001_0101b

0x72[page mode 16]: BGMA2 [default=0x1F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 32(8)code in 10(8)bit linear input	0001_1111b

0x73[page mode 16]: BGMA3 [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Ggamma corrected output of blue pixel at 64(16)code in 10(8)bit linear input	0011_0000b

0x74[page mode 16]: BGMA4 [default=0x49, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 128(32)code in 10(8)bit linear input	0100_1001b

0x75[page mode 16]: BGMA5 [default=0x5D, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 192(48)code in 10(8)bit linear input	0101_1101b

0x76[page mode 16]: BGMA6 [default=0x6F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 256(64) 10(8)bit linear input	0110_1111b

0x77[page mode 16]: BGMA7 [default=0x7F, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 320(80)code in 10(8)bit linear input	0111_1111b

0x78[page mode 16]: BGMA8 [default=0x8E, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 384(96)code in 10(8)bit linear input	1000_1110b

0x79[page mode 16]: BGMA9 [default=0x9B, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 448(112)code in 10(8)bit linear input	1001_1011b

0x7A[page mode 16]: BGMA10 [default=0xA8, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 512(128)code in 10(8)bit linear input	1010_1000b

0x7B[page mode 16]: BGMA11 [default=0xB5, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 576(144)code in 10(8)bit linear input	1011_0101b

0x7C[page mode 16]: BGMA12 [default=0xC1, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 640(160)code in 10(8)bit linear input	1100_0001b

0x7D[page mode 16]: BGMA13 [default=0xCC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 704(176)code in 10(8)bit linear input	1100_1100b

0x7E[page mode 16]: BGMA14 [default=0xD7, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 768(192)code in 10(8)bit linear input	1101_0111b

0x7F[page mode 16]: BGMA15 [default=0xE2, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 832(208)code in 10(8)bit linear input	1110_0010b

0x80[page mode 16]: BGMA16 [default=0xEC, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 896(224)code in 10(8)bit linear input	1110_1100b

0x81[page mode 16]: BGMA17 [default=0xF6, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 960(240)code in 10(8)bit linear input	1111_0110b

0x82[page mode 16]: BGMA18 [default=0xFF, r/w]

Bit	Function	Description	Default
B[7:0]	Gamma Correction	Gamma corrected output of blue pixel at 1023(255)code in 10(8)bit linear input	1111_1111b

5.15. Auto Flickers Cancellation

0xC0[page mode 17]: FLKMODE [default=0x01, r/w]

Bit	Function	Description	Default
B[7:2]	Auto Flicker Cancellation	Reserved	0000_00b
B[1:0]		Number of skipped frames in Auto flicker cancellation. 00: Reserved, 01: 1 frame, 10: 2frame, 11: 3frame Note) Do not select 0 for auto flicker cancellation	01b

0xC4[page mode 17]: FLK200 [default=0x3C, r/w]

Bit	Function	Description	Default
B[7:0]	Auto Flicker Cancellation	Number of horizontal line for 1/200sec. FLK200 = (1/200sec) / horizontal line time , where horizontal line time= (1640 + HBLANK) * OPCLK's period for full size and preview1 When auto-flicker cancellation is enabled, HBLANK should be set to meet that FLK200 and FLK240 are integer.	0011_1100b

0xC5[page mode 17]:FLK240 [default=0x32, r/w]

Bit	Function	Description	Default
B[7:0]	Auto Flicker Cancellation	Number of horizontal line for 1/240sec FLK240 = integer [(1/240sec) / horizontal line], where horizontal line = (1640 + HBLANK) * OPCLK's period for full size and preview1 When auto-flicker cancellation is enabled, HBLANK should be set to meet that FLK200 and FLK240 are integer.	0011_0010b

0xC6[page mode 17]: FLKTH1 [default=0x02, r/w]

Bit	Function	Description	Default
B[7:0]	Auto Flicker Cancellation	Low Threshold to find flicker condition. When internal calculated value is over FLKTH1 and under FLKTH2, sensor can detect flicker noise(banding noise) on image.	0000_0010b

0xC7[page mode 17]: FLKTH2 [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	Auto Flicker Cancellation	High threshold to find flicker condition. When internal calculated value is over FLKTH1 and under FLKTH2, sensor can detect flicker noise(banding noise) on image.	0010_0000b

5.16. Image Scaling

0x10[page mode 18]: ZOOMCTL1 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:2]	Image Scaling	Reserved	0000_00b
B[1]		Enable windowing after image scaling. (0:OFF, 1:ON)	0b
B[0]		Enable image scaling. (0:OFF, 1:ON).	0b

0x11[page mode 18]: ZOOMCTL2 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:1]	Image Scaling	Reserved	0000_000b
B[0]		Zoom output clock select 0 : PCLK(1x), maximum of ZOUTWID is 1600 1 : PCLK(1/ 2x), maximum of ZOUTWID is 800	0b

0x20[page mode 18]: ZOUTWIDH [default=0x05, r/w]

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of image width for image scaling ZOUTWID [10:0]={ZOUTWIDH[2:0], ZOUTWIDL[7:0]}.	101b

0x21[page mode 18]: ZOUTWIDL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of image width for image scaling ZOUTWID [10:0]={ZOUTWIDH[2:0], ZOUTWIDL[7:0]}.	0000_0000b

0x22[page mode 18]: ZOUTHGTH [default=0x04, r/w]

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of image height for image scaling ZOUTHGT [10:0]={ZOUTHGTH[2:0], ZOUTHGTL[7:0]}.	100b

0x23[page mode 18]: ZOUTHGTL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of image height for image scaling ZOUTHGT [10:0]={ZOUTHGTH[2:0], ZOUTHGTL[7:0]}.	0000_0000b

0x24[page mode 18]: ZWINSTXH [default=0x00, r/w]

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of column start x address for windowing after image scaling ZWINSTX [10:0]={ZWINWINSXTH[2:0], ZWINWINSTXL[7:0]} + 1.	000b

0x25[page mode 18]: ZWINSTXL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of column start x address for windowing after image scaling ZWINSTX [10:0]={ZWINSTXH[2:0], ZWINSTXL[7:0]} + 1.	0000_0000b

0x26[page mode 18]: ZWINSTYH [default=0x00, r/w

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of row start y address for windowing after image scaling ZWINSTY[10:0]={ZWINSTYH[2:0], ZWINSYTL[7:0]} + 1	000b

0x27[page mode 18]: ZWINSTYL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of row start y address for windowing after image scaling ZWINSTY [10:0]={ZWINSTYH[2:0], ZWINSTYL[7:0]} + 1.	0000_0000b

0x28[page mode 18]: ZWINENXH [default=0x05, r/w]

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of column end x address for windowing after image scaling ZWINENX [10:0]={ZWINENXH[2:0], ZWINENXL[7:0]}.	0000_0101b

0x29[page mode 18]: ZWINENXL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of column end x address for windowing after image scaling ZWINENX [10:0]={ZWINENXH[2:0], ZWINENXL[7:0]}.	0000_0000b

0x2A[page mode 18]: ZWINENYH [default=0x04, r/w]

Bit	Function	Description	Default
B[7:3]	Image Scaling	Reserved	0000_0b
B[2:0]		High byte of row end y address for windowing after image scaling ZWINENY [10:0]={ ZWINEYH[2:0], ZWINENYL[7:0]}.	100b

0x2B[page mode 18]: ZWINENYL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of row end y address for windowing after image scaling ZWINENY [10:0]={ZWINEYH[2:0], ZWINENYL[7:0]}.	0000_0000b

0x2C[page mode 18]: ZVERSTEPH [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	High byte of vertical increment step for vertical image scaling ZVERSTEP[15:0]={ZVERSTEPH[7:0], ZVERSTEPL[7:0]}. ZVERSTEP[15:11] = Integer step, ZVERSTEP[10:0] = floating step ZVERSTEP = (Image Height / ZOUTHGT) * 2048, , where Image Height is WINHGT[0x24, 0x25:P0] for full size. Image Height is WINHGT [0x24, 0x25:P0] /2 for preivew1	0001_0000b

0x2D[page mode 18]: ZVERSTEPL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of vertical increment step for vertical image scaling ZVERSTEP[15:0]={ZVERSTEPH[7:0], ZVERSTEPL[7:0]}. ZVERSTEP[15:11] = Integer step, ZVERSTEP[10:0] = floating step ZVERSTEP = (Image Height / ZOUTHGT) * 2048, where Image Height is WINHGT[0x24, 0x25:P0] for full size. Image Height is WINHGT[0x24, 0x25:P0] /2 for preivew1	0000_0000b

0x2E[page mode 18]: ZHORSTEPH [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	High byte of horizontal increment step for vertical image scaling ZHORSTEP[15:0]={ZHORSTEPH[7:0], ZHORSTEPL[7:0]}. ZHORSTEP[15:11] = Integer step, ZHORSTEP[10:0] = floating step ZHORSTEP = (Image Width / ZOUTWID) * 2048, Image Width is WINWID[0x26, 0x27:P0].	0001_0000b

0x2F[page mode 18]: ZHORSTEPL [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	Low byte of horizontal increment step for vertical image scaling ZHORSTEP[15:0]={ZHORSTEPH[7:0], ZHORSTEPL[7:0]}. ZHORSTEP[15:11] = Integer step, ZHORSTEP[10:0] = floating step ZHORSTEP = (Image Width / ZOUTWID) * 2048, Image Width is WINWID[0x26, 0x27:P0].	0000_0000b

0x30[page mode 18]: ZFIFODLY [default=0x55, r/w]

Bit	Function	Description	Default
B[7:0]	Image Scaling	FIFO delay step for image scaling. It depends on the bit[0] of ZOOMCTL2[0x11:P18] Case1) Bit[0] of ZOOMCTL2[0x11:P18] is 0, Zoom output clock is PCLK(1x) ZFIFODLY = {[(Niw – (Now * ZCLK)) * (Now * ZCLK)] / Niw + 5} / 4 Case2) Bit[0] of ZOOMCTL2[0x11:P18] is 1, Zoom output clock is PCLK(1/2x) ZFIFODLY = {[(Niw – (Now * ZCLK)) * (Now * ZCLK)] / Niw + 5} / (4 * ZCLK) + 1 Niw = WINWID[0x26,0x27:P0], Now = ZOUTWID[0x20,0x21:P18]. ZCLK = 1 for PCLK(1x), 2 for PCLK(1/2x)	0101_0101b

5.17. Auto Exposure

0x10[page mode 20]: AECTL1[default=0x0C, r/w]

Bit	Function	Description	Default
B[7]	AE Enable	Enable auto exposure. (0:OFF, 1:ON) When this bit is disabled, AFC(Auto Flicker Cancellation) operation is also disabled.	0b
B[6]	Auto Anti-Flicker	Sensor detects the frequency of fluorescent lamp(100Hz/120Hz) and adjusts exposure time to multiple of period of the frequency automatically. (0:OFF, 1:ON)	0b
B[5]		Reserved	0b
B[4]	120Hz/100Hz	On canceling flicker manually, users should select the frequency of a fluorescent lamp. 0: 120Hz, 1: 100Hz	0b
B[3:0]		Reserved.	1100b

0x11[page mode 20]: AECTL2[default=0x0C, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE	0000_1100b

0x20[page mode 20]: AEFRAMECTL [default=0x01, r/w]

Bit	Function	Description	Default
B[7:1]		Reserved	0000_000b
B[0]	AE WEIGHT	Enable AE weight (0:OFF, 1:ON), Refer to AEWGT1[0x60:P20] ~ AEWGT16[0x6F:P20]	1b

0x28[page mode 20]:AEFINECTL1[default=0x87, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	1000_0111b

0x29[page mode 20]: AEFINECTL2 [default=0xA5, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	1010_0101b

0x2A[page mode 20]: AEFINECTL3 [default=0x3F, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0011_1111b

0x2B[page mode 20]: AEFINECTL4 [default=0x34, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0011_0100b

0x2C[page mode 20]: AEFINECTL5 [default=0x23, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0010_0011b

0x2D[page mode 20]: AEFINECTL6 [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0000_0000b

0x2E[page mode 20]: AEFINECTL7 [default=0x03, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0000_0011b

0x2F[page mode 20]: AEFINECTL8 [default=0x0b, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Option of AE fine control	0000_1011

0x60[page mode 20]: AEWGT1 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R1 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R2 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R3 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R4 : 0 ~ 3(more weight)	01b

0x61[page mode 20]: AEWGT2 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R5 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R6 : 0 ~ 3(more weight)	01b

B[3:2]		AE weight for R7 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R8 : 0 ~ 3(more weight)	01b

0x62[page mode 20]: AEWGT3 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R9 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R10 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R11 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R12 : 0 ~ 3(more weight)	01b

0x63[page mode 20]: AEWGT4[default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R13 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R14 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R15 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R16 : 0 ~ 3(more weight)	01b

0x64[page mode 20]: AEWGT5 [default=0x5F, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R17 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R18 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R19 : 0 ~ 3(more weight)	11b
B[1:0]		AE weight for R20 : 0 ~ 3(more weight)	11b

0x65[page mode 20]: AEWGT6 [default=0xF5, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R21 : 0 ~ 3(more weight)	11b
B[5:4]		AE weight for R22 : 0 ~ 3(more weight)	11b
B[3:2]		AE weight for R23 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R24 : 0 ~ 3(more weight)	01b

0x66[page mode 20]: AEWGT7 [default=0x5F, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R25 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R26 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R27 : 0 ~ 3(more weight)	11b
B[1:0]		AE weight for R28 : 0 ~ 3(more weight)	11b

0x67[page mode 20]: AEWGT8[default=0xF5, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R29 : 0 ~ 3(more weight)	11b
B[5:4]		AE weight for R30 : 0 ~ 3(more weight)	11b
B[3:2]		AE weight for R31 : 0 ~ 3(more weight)	01b

B[1:0]		AE weight for R32 : 0 ~ 3(more weight)	01b

0x68[page mode 20]: AEWGT9 [default=0x5F, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R33 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R34 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R35 : 0 ~ 3(more weight)	11b
B[1:0]		AE weight for R36 : 0 ~ 3(more weight)	11b

0x69[page mode 20]: AEWGT10 [default=0xF5, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R37 : 0 ~ 3(more weight)	11b
B[5:4]		AE weight for R38 : 0 ~ 3(more weight)	11b
B[3:2]		AE weight for R39 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R40 : 0 ~ 3(more weight)	01b

0x6A[page mode 20]: AEWGT11 [default=0x5F, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R41 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R42 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R43 : 0 ~ 3(more weight)	11b
B[1:0]		AE weight for R44 : 0 ~ 3(more weight)	11b

0x6B[page mode 20]: AEWGT12 [default=0xF5, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R45 : 0 ~ 3(more weight)	11b
B[5:4]		AE weight for R46 : 0 ~ 3(more weight)	11b
B[3:2]		AE weight for R47 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R48 : 0 ~ 3(more weight)	01b

0x6C[page mode 20]: AEWGT13 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R49 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R50 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R51 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R52 : 0 ~ 3(more weight)	01b

0x6D[page mode 20]: AEWGT14 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R53 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R54 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R55 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R56 : 0 ~ 3(more weight)	01b

0x6E[page mode 20]: AEWGT15 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R57 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R58 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R59 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R60 : 0 ~ 3(more weight)	01b

0x6F[page mode 20]: AEWGT16 [default=0x55, r/w]

Bit	Function	Description	Default
B[7:6]	AE Weight	AE weight for R61 : 0 ~ 3(more weight)	01b
B[5:4]		AE weight for R62 : 0 ~ 3(more weight)	01b
B[3:2]		AE weight for R63 : 0 ~ 3(more weight)	01b
B[1:0]		AE weight for R64 : 0 ~ 3(more weight)	01b

0x70[page mode 20]:YLVL [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AE	YLVL is luminance level to converge in AE operation.	0101_0000b

0x78[page mode 20]:YTH1 [default=0x22, r/w]

Bit	Function	Description	Default
B[7:4]	AE	Marginal range of Y convergence level in AE operation.	0010b
B[3:0]		Hysteresis range1 in AE operation.	0010b

0x79[page mode 20]:YTH2HI [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Hysteresis High range2 in AE operation.	0101_0000b

0x7C[page mode 20]:YTH2LOW [default=0x28, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Hysteresis of Low range2 in AE operation.	0010_1000b

0x80[page mode 20]: EXPINTH [r]

Bit	Function	Description	Default
B[7:0]	AE	High byte of internal exposure time EXPINT[23:0] = {EXPINTH[7:0], EXPINTM[7:0], EXPINTL[7:0]} EXPINT is internal exposure time in current frame. Example) EXPINTH=0x01, EXPINTM=0x86, EXPINTL=0xA0, period of OPCLK=41.666ns (MCLK=48MHz, OPCLK=24MHz) EXPTIME = 0x01_86_A0 = 100000 decimal. Exposure time = 100,000 * 8 * 41.666ns = 33.333ms	RO

0x81[page mode 20]: EXPINTM [r]

Bit	Function	Description	Default
B[7:0]	AE	Middle byte of internal exposure time	RO

0x82[page mode 20]: EXPINTL [r]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of internal exposure time	RO

0x83[page mode 20]: EXPTIMEH [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	AE	High byte of manual exposure time EXPTIME[23:0] = {EXPTIMEH[7:0], EXPTIMEM[7:0], EXPTIMEL[7:0]} EXPTIME is exposure time that makes pixel element to accumulate photons and convert electrons. Since the brightness of image may change by amount of exposure time, users should control the exposure time adequately. However, users does not need to control exposure time on auto exposure. The unit of exposure time is 8 times of OPCLK's period. Example) EXPINTH=0x00, EXPINTM=0xC3, EXPINTL=0x50, period of OPCLK=41.666ns (MCLK=48MHz, OPCLK=24MHz) EXPTIME = 0x00_C3_50 = 50,000 decimal. Exposure time = 50,000 * 8 * 41.666ns = 16.666ms	0000_0001b

0x84[page mode 20]: EXPTIMEM [default=0x86, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Middle byte of manual exposure time	1000_0110b

0x85[page mode 20]: EXPTIMEL [default=0xA0, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of manual exposure time	1010_0000b

0x86[page mode 20]: EXPMINH [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	AE	High byte of minimum exposure time EXPMIN = {EXPMINH, EXPMINL} EXPMIN is minimum time of EXPTIME in AE operation. Users should set EXPTIME[0x83, 0x84, 0x85:P20] over EXPMIN and EXPMIN should be greater than (1640+HBLANK) / 4 Unit is 8 OPCLK's period.	0000_0001b

0x87[page mode 20]: EXPMINL [default=0xF4, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of minimum exposure time	1111_0100b

0x88[page mode 20]: EXPMAXH [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	AE	High byte of maximum exposure time EXPMAX[23:0] = {EXPMAXH[7:0], EXPMAXM[7:0], EXPMAXL[7:0]} EXPMAX is maximum time of EXPTIME in AE operation. Example) EXPMAXH=0x04, EXPMAXM=0x93, EXPMAXL=0xE0, period of OPCLK=41.666ns MCLK=48MHz, OPCLK=24MHz) EXPMAX = 0x04_93_E0 = 300,000 decimal. Maximum exposure time = 300,000 * * 41.666ns = 100msec	0000_0100b

0x89[page mode 20]: EXPMAXM [default=0xB8, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Middle byte of maximum exposure time	1011_1000b

0x8A[page mode 20]: EXPMAXL [default=0xD8, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of maximum exposure time	1101_1000b

0x8B[page mode 20]: EXP100H [default=0x75, r/w]

Bit	Function	Description	Default
B[7:0]	AE AFC (Auto Flicker Cancellation)	High byte of exposure time for 1/100sec EXP100[15:0] = {EXP100H[7:0], EXP100L[7:0]} EXP100 is anti-flickering exposure time step for 100Hz. The unit of exposure time is 8 times of OPCLK's period (1 pixel clock period). Example) EXP100 = anti-flickering exposure time step for 100Hz / (8 * period of OPCLK), = 10ms / (8 * 41.666ns) = 30000(decimal)= 0x7530 where MCLK = 48MHz and OPCLK =24MHz	0111_0101b

0x8C[page mode 20]: EXP100L [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	AE/AFC	Low byte of exposure time for 1/100sec	0011_0000b

0x8D[page mode 20]: EXP120H [default=0x61, r/w]

Bit	Function	Description	Default
B[7:0]	AE/AFC	High byte of exposure time for 1/120sec EXP120[15:0] = {EXP120H[7:0], EXP120L[7:0]} EXP120 is anti-flickering exposure time step for 120Hz. The unit of exposure time is 8 times of OPCLK's period (1 pixel clock period). Example) EXP120 = anti-flickering exposure time step for 120Hz / (8 * period of OPCLK), = 8.3333ms / (8 * 41.666ns) = 25000(decimal)= 0x61A8 where MCLK = 48MHz and OPCLK =24MHz	0110_0001b

0x8E[page mode 20]: EXP120L [default=0xA8, r/w]

Bit	Function	Description	Default
B[7:0]	AE/AFC	Low byte of exposure time for 1/120sec	1010_1000b

0x91[page mode 20]: EXPFIXH [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	FFR (Fixed Frame Rate)	High byte of exposure time for fixed frame rate EXPFIX[23:0]= {EXPFIXH[7:0], EXPFIXM[7:0], EXPFIXL[7:0]} EXPFIX makes Frame Time constant by enabling bit[2] of VDOCTL2[0x11:P0] regardless of the change of exposure time . Frame Time = EXPFIX Duration + VSYNC Duration Example) EXPFIXH=0x06, EXPFIXM=0x06, EXPFIXL=0xF0, period of OPCLK=41.666ns (MCLK=48MHz, OPCLK=24MHz) EXPFIX = 0x06_06_F0 = 394.992 decimal. Exposure time for fixed frame rate= 394,992 * 8 * 41.666ns = 131.664msec	0000_0110b

0x92[page mode 20]: EXPFIXM [default=0x06, r/w]

Bit	Function	Description	Default
B[7:0]	FFR	Middle byte of exposure time for fixed frame rate	0000_0110b

0x93[page mode 20]: EXPFIXL [default=0xF8, r/w]

Bit	Function	Description	Default
B[7:0]	FFR	Low byte of exposure time for fixed frame rate	1111_1000b

0x98[page mode 20]: EXPOUT1 [default=0x9A, r/w]

Bit	Function	Description	Default
B[7:4]	AE	Threshold of exposure time to enter into bright condition	1001b
B[3:0]		Threshold of exposure time to escape from bright condition	1010b

0x99[page mode 20]: EXPOUT2 [default=0x46, r/w]

Bit	Function	Description	Default
B[7:4]	AE	Threshold of exposure time to enter into very bright condition	0100b
B[3:0]		Threshold of exposure time to escape from very bright condition	0110b

0x9C[page mode 20]: EXPLMTH [default=0x09, r/w]

Bit	Function	Description	Default
B[7:0]	AE	High byte of exposure time for low limit. EXPLMT[15:0] = {EXPLMTH[7:0], EXPLMTL[7:0]}	0000_1001b

0x9D[page mode 20]: EXPLMTL [default=0xC4, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of exposure time for low limit.	1100_0100b

0x9E[page mode 20]: EXPUNITH [default=0x01, r/w]

Bit	Function	Description	Default
B[7:0]	AE	High byte of unit step of EXPLMT. EXPUNIT = {EXPUNITH[7:0], EXPUNITL[7:0]} It should be (1640+HBLANK)/4.	0000_0001b

0x9F[page mode 20]: EXPUNITL [default=0xF4, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Low byte of unit step of EXPLMT	1111_0100b

0xB0[page mode 20]:AG [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AG is common gain for R, G and B channel and is used for AE operation. AG = 0.5 + B[7:0]/32. 0x00(0.5x) ~ 0xFF(8.5x)	0001_0000b

0xB1[page mode 20]:AGMIN [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AGMIN is minimum AG in AE operation. AGMIN should be under the AGTH1[0xB4:P20].	0001_0000b

0xB2[page mode 20]:AGMAX [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AGMAX is maximum AG in AE operation. AGMAX should be over the AGTH2[0xB5:P20].	1000_0000b

0xB3[page mode 20]:AGLVLH [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AGLVLH is target of AG to converge on abrupt transition.(Outdoor -> Indoor)	0001_0000b

0xB4[page mode 20]:AGTH1 [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AGTH1 is lower limit of AG, when exposure time is from 1/100sec(1/120sec) to EXPMAX.	0001_0000b

0xB5[page mode 20]:AGTH2 [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	AE	AGTH2 is upper limit of AG, when exposure time is from 1/100sec(1/120sec) to EXPMAX	0011_0000b

0xB6[page mode 20]: AGBTH1 [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold1 of Adaptive AG in AE.	0010_0000b

0xB7[page mode 20]: AGBTH2 [default=0x1B, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold2 of Adaptive AG in AE.	0001_1011b

0xB8[page mode 20]: AGBTH3 [default=0x18, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold3 of Adaptive AG in AE.	0001_1000b

0xB9 [page mode 20]: AGBTH4 [default=0x16, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold4 of Adaptive AG in AE.	0001_0110b

0xBA[page mode 20]: AGBTH5 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold5 of Adaptive AG in AE.	0001_0101b

0xBB[page mode 20]: AGBTH6 [default=0x14, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold6 of Adaptive AG in AE.	0001_0100b

0xBC[page mode 20]: AGBTH7 [default=0x13, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold7 of Adaptive AG in AE.	0001_0011b

0xBD[page mode 20]: AGBTH8 [default=0x12, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold8 of Adaptive AG in AE.	0001_0010b

0xC0[page mode 20]: AGSKY[default=0x14, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold of AG at very bright condition	0001_0100b

0xC4[page mode 20]: AGTIMETH [default=0x04, r/w]

Bit	Function	Description	Default
B[7:0]	AE	Threshold of Band time for Adaptive AG	0000_0100b

0xC8[page mode 20]: DGMAX [default=0xFF, r/w]

Bit	Function	Description	Default
B[7:0]	AE	It is maximum of digital gain for AE, 0x80(1x) ~ 0xFF(1.99x)	1111_1111b

0xC9[page mode 20]: DGMIN [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	AE	It is minimum of digital gain for AE. , 0x80(1x) ~ 0xFF(1.99x)	1000_0000b

0xD3[page mode 20]: YAVG[r]

Bit	Function	Description	Default
B[7:0]	AE	Average of luminance in frame.	RO

5.18. Auto White Balance

0x10[page mode 22]: AWBCTL1[default=0x6B, r/w]

Bit	Function	Description	Default
B[7]	AWB	Enable Automatic White Balance (0: OFF, 1: ON)	0b
B[6:4]		The update speed of AWB (slow) 000 ~ 111 (fast)	110b
B[3:0]		Option for speed of AWB	1011b

0x11[page mode 22]: AWBCTL2[default=0x28, r/w]

Bit	Function	Description	Default
B[7:3]	AWB	Reserved	0010_1b
B[2]		Use the relation of RGAIN and BGAIN (0:OFF, 1:ON)	0b
B[1]		Change the boundary of RGAIN and BGAIN at bright condition (0:OFF, 1:ON)	0b
B[0]		Enable manual white balance (0:OFF, 1:ON)	0b

0x30[page mode 22]: ULVL [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	U chrominance level to converge in AWB.	1000_0000b

0x31[page mode 22]: VLVL [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	V chrominance level to converge in AWB.	1000_0000b

0x38[page mode 22]: UVTH1 [default=0x13, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	Marginal range of white U/V convergence level in AWB operation	0001b
B[3:0]		Hysteresis range1 of white U/V in AWB operation	0011b

0x39[page mode 22]: UVTH2 [default=0x66, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	B[7:4] * 2 is Hysteresis range2 of white U/V in AWB operation	0110b
B[3:0]		B[3:0] * 8 is Hysteresis range3 of white U/V in AWB operation	0110b

0x40[page mode 22]: YRANGE [default=0x88, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	YMAX is maximum luminance to find white pixel. YMAX = 128 + B[7:4] * 8.	1000b
B[3:0]		YMIN is minimum luminance to find white pixel. YMIN = B[3:0] * 8.	1000b

0x41[page mode 22]: CDIFF [default=0x88 r/w]

Bit	Function	Description	Default
B[7:4]	AWB	It is high threshold of the difference between U and V and is used to find the white pixel	1000b
B[3:0]		It is low threshold of the difference between U and V and is used to find the white pixel	1000b

0x42[page mode 22]: CSUM2 [default=0x66, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	It is high threshold of the 2 domain summation of U and V and is used to find the white pixel.	0110b
B[3:0]		It is low threshold of the 2 domain summation of U and V and is used to find the white pixel.	0110b

0x46[page mode 22]: WHTPXLTH [default=0x0A, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold of white pixels in frame.	0000_1010b

0x80[page mode 22]: RGAIN [default=0x30, r/w]

Bit	Function	Description	Default
B[7]		Reserved	0b
B[6:0]	AWB	RGAIN (Red Color Gain) = 0.5 + B[6:0]/64 (0.5 ~ 2.5x) Sensor has red, green, and blue color gain respectively. Users can control white balance manually by setting these value and bit[7] of AWBCTL1[0x10:P22]=OFF.	011_0000b

0x81[page mode 22]: GGAIN [default=0x20, r/w]

Bit	Function	Description	Default
B[7]		Reserved	0b
B[6:0]	AWB	GGAIN (Green Color Gain) = 0.5 + B[6:0]/64(0.5 ~ 2.5x) Sensor has red, green, and blue color gain respectively. Users can control white balance manually by setting these value and bit[7] of AWBCTL1[0x10:P22]=OFF.	010_0000b

0x82[page mode 22]: BGAIN [default=0x38, r/w]

Bit	Function	Description	Default
B[7]		Reserved	0b
B[6:0]	AWB	BGAIN (Blue Color Gain) = 0.5 + B[6:0]/64(0.5 ~ 2.5x) Sensor has red, green, and blue color gain respectively. Users can control white balance manually by setting these value and bit[7] of AWBCTL1[0x10:P22]=OFF.	011_1000b

0x83[page mode 22]: RMAX [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of RGAIN.	0101_0000b

0x84[page mode 22]: RMIN [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of RGAIN.	0010_0000b

0x85[page mode 22]: BMAX [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of BGAIN.	0101_0000b

0x86[page mode 22]: BMIN [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of BGAIN.	0010_0000b

0x87[page mode 22]: RMAXM [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of RGAIN at a littel bright condition..	0101_0000b

0x88[page mode 22]: RMINM [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of RGAIN at a littel bright condition.	0011_0000b

0x89[page mode 22]: BMAXM [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of BGAIN at a littel bright condition.	0100_0000b

0x8A[page mode 22]: BMINM [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of BGAIN at a littel bright condition.	0010_0000b

0x8B[page mode 22]: RMAXB [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of RGAIN at bright condition.	0101_0000b

0x8C[page mode 22]: RMINB [default=0x3E, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of RGAIN at bright condition.	0011_1110b

0x8D[page mode 22]: BMAXB [default=0x2E, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is maximum of BGAIN at bright condition.	0010_1110b

0x8E[page mode 22]: BMINB [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	It is minimum of BGAIN at bright condition.	0010_0000b

0x8F[page mode 22]: BGAINPARA1 [default=0x50, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter1 of BGAIN.	0101_0000b

0x90[page mode 22]: BGAINPARA2 [default=0x4C, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter2 of BGAIN.	0100_1100b

0x91[page mode 22]: BGAINPARA3 [default=0x48, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter3 of BGAIN..	0100_1000b

0x92[page mode 22]: BGAINPARA4 [default=0x46, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter4 of BGAIN.	0100_0110b

0x93[page mode 22]: BGAINPARA5 [default=0x44, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter5 of BGAIN.	0100_0100b

0x94[page mode 22]: BGAINPARA6 [default=0x42, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter6 of BGAIN.	0100_0010b

0x95[page mode 22]: BGAINPARA7 [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter7 of BGAIN.	0100_0000b

0x96[page mode 22]: BGAINPARA8 [default=0x3E, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter8 of BGAIN.	0011_1110b

0x97[page mode 22]: BGAINPARA9 [default=0x3C, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter9 of BGAIN.	0011_1100b

0x98[page mode 22]: BGAINPARA10 [default=0x28, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter10 of BGAIN.	0010_1000b

0x99[page mode 22]: BGAINPARA11 [default=0x26, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter11 of BGAIN.	0010_0110b

0x9A[page mode 22]: BGAINPARA12 [default=0x24, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Parameter12 of BGAIN.	0010_0100b

0x9B[page mode 22]: BGAINBND1 [default=0x44, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	It is marginal range of BGAIN When RGAIN is over RGAINTH1	0100b
B[3:0]		It is marginal range of BGAIN When RGAIN is under RGAINTH1 and over RGAIN2	0100b

0x9C[page mode 22]: BGAINBND2 [default=0x44, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	It is marginal range of BGAIN When RGAIN is under RGAINTH2 and over RGAIN3	0100b
B[3:0]		It is marginal range of BGAIN When RGAIN is under RGAINTH3.	0100b

0x9D[page mode 22]: RAINTH1 [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold1 of RGAIN. RGAINTH1 = 0.5 + B[6:0]/64. Default is 1.5x	0100_0000b

0x9E[page mode 22]: RAINTH2 [default=0x30, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold2 of RGAIN. RGAINTH2 = 0.5 + B[6:0]/64. Default is 1.25x	0011_0000b

0x9F[page mode 22]: RAINTH3 [default=0x20, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold3 of RGAIN. RGAINTH3 = 0.5 + B[6:0]/64. Default is 1x	0010_0000b

0xA0[page mode 22]: RDELTA1 [default=0x04, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	The Increment delta value of red gain limit boundary from RMAXB.	0000b
B[3:0]		The decrement delta value of red gain limit boundary from RMINB.	0100b

0xA1[page mode 22]: BDELTA1 [default=0x60, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	The Increment delta value of blue gain limit boundary from BMAXB.	0110b
B[3:0]		The decrement delta value of blue gain limit boundary from BMINB.	0000b

0xA2[page mode 22]: RDELTA2 [default=0x22, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	The Increment delta value of red gain limit boundary from RMAXM.	0010b
B[3:0]		The decrement delta value of red gain limit boundary from RMINM.	0010b

0xA3[page mode 22]: BDELTA2 [default=0x42, r/w]

Bit	Function	Description	Default
B[7:4]	AWB	The Increment delta value of blue gain limit boundary from BMAXM.	0100b
B[3:0]		The decrement delta value of blue gain limit boundary from BMINM.	0010b

0xA4[page mode 22]: AWBEXPLMT1 [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold1 of unit of exposure time to adjust red and blue limit boundary automatically	0001_0000b

0xA5[page mode 22]: AWBEXPLMT2 [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold2 of unit of exposure time to adjust red and blue limit boundary automatically	0100_0000b

0xA6[page mode 22]: AWBEXPLMT3 [default=0x80, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	Threshold3 of unit of exposure time to adjust red and blue limit boundary automatically	1000_0000b

0xB2[page mode 22]: MRGAIN [default=0x48, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	When bit[0] AWBCTL2 is enabled, it is used for manual RGAIN in white balance. MRGAIN = 0.5 + B[6:0]/64. Default is 1.625x	0100_1000b

0xB3[page mode 22]: MBGAIN [default=0x40, r/w]

Bit	Function	Description	Default
B[7:0]	AWB	When bit[0] AWBCTL2 is enabled, it is used for manual BGAIN in white balance. MBGAIN = 0.5 + B[6:0]/64. Default is 1.5x	0100_0000b

0xD2[page mode 22]: UAVG [r]

Bit	Function	Description	Default
B[7:0]	AWB	U chrominance of white pixels in frame.	RO

0xD3[page mode 22]: VAVG [r]

Bit	Function	Description	Default
B[7:0]	AWB	V chrominance of white pixels in frame.	RO

5.19. Auto Focus, Anti-shaking

0x10[page mode 24]: AFCTL1[default=0x00, r/w]

Bit	Function	Description	Default
B[7:3]	AutoFocus Anti-Shaking	Reserved.	00000b
B[2:1]		Filter type for edge data1.	00b
B[0]		Enable AutoFocus value(0:OFF, 1: ON)	0b

0x12[page mode 24]: AFCTL2[default=0x00, r/w]

Bit	Function	Description	Default
B[7:6]	AutoFocus Anti-Shaking	Divide of data in region 1/3/5/7/9/11 0: 1x, 1:1/2x, 2:1/4x, 3:1/8x	00b
B[5:4]		Divide of data in region 2/4/6/8/10/12 0: 1x, 1:1/2x, 2:1/4x, 3:1/8x	00b
B[3:0]		Reserved.	0000b

0x13[page mode 24]: AFCTL3[default=0x00, r/w]

Bit	Function	Description	Default
B[7:4]	AutoFocus Anti-Shaking	Data type of region 1/3/5/7/9/11 0: edge data, 4: motion data1, 5: motion data2	0000b
B[3:0]		Data type of region 2/4/6/8/10/12 0: edge data, 4: motion data1, 5: motion data2	0000b

0x19[page mode 24]: AFCTL4 [default=0x10, r/w]

Bit	Function	Description	Default
B[7:4]	AutoFocus Anti-Shaking	Reserved.	0001b
B[3:2]		Sampling ratio of row data	00b
B[1:0]		Sampling ratio of column data	00b

0x40[page mode 24]: AFROWSTR1 [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row start of data region1/2/3/4 Auto Focus/Anti-shaking = B[7:0]*8	0001_0000b

0x41[page mode 24]: AFROWENR1 [default=0x11, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row end of data region1/2/3/4 Auto Focus/Anti-shaking = B[7:0]*8 + bit[7:6] of AFROWLSB [0x50:P24]*2	0001_0001b

0x42[page mode 24]: AFROWSTR2 [default=0x10, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row start of data region5/6/7/8 Auto Focus/Anti-shaking = B[7:0] * 8	0100_0000b

0x43[page mode 24]: AFROWENR2 [default=0x11, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row end of data region5/6/7/8 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[5:4] of AFROWLSB [0x50:P24] * 2	0001_0001b

0x44[page mode 24]: AFROWSTR3 [default=0x70, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row start of data region9/10/11/12 Auto Focus/Anti-shaking = B[7:0]*8	0111_0000b

0x45[page mode 24]: AFROWENR3 [default=0x71, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Row end of data region9/10/11/12 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[3:2] of AFROWLSB [0x50:P24] * 2	0111_0001b

0x48[page mode 24]: AFCOLSTR1 [default=0x14, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column start of data region1/5/9 Auto Focus/Anti-shaking = B[7:0] * 8	0001_0000b

0x49[page mode 24]: AFCOLENR1 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column end of data region1/5/9 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[7:6] of AFCOLLSB [0x51:P24] * 2	0001_0101b

0x4A[page mode 24]: AFCOLSTR2 [default=0x8C, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column start of data region2/6/10 Auto Focus/Anti-shaking = B[7:0] * 8	1000_1100b

0x4B[page mode 24]: AFCOLENR2 [default=0x8D, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column end of data region2/6/10 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[5:4] of AFCOLLSB [0x51:P24] * 2	1000_1101b

0x4C[page mode 24]: AFCOLSTR3 [default=0x90, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column start of data region3/7/11 Auto Focus/Anti-shaking = B[7:0] * 8	1001_0000b

0x4D[page mode 24]: AFCOLENR3 [default=0x15, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column end of data region3/7/11 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[3:2] of AFCOLLSB [0x51:P24] * 2	0001_0101b

0x4E[page mode 24]: AFCOLSTR4 [default=0x8C, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column start of data region4/8/12 Auto Focus/Anti-shaking = B[7:0] * 8	1000_1100b

0x4F[page mode 24]: AFCOLENR4 [default=0x8D, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Column end of data region4/8/12 Auto Focus/Anti-shaking = B[7:0] * 8 + bit[1:0] of AFCOLLSB [0x51:P24] * 2	1000_1101b

0x50[page mode 24]: AFROWLSB [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Control LSB of row address.	0000_0000b

0x51[page mode 24]: AFCOLLSB [default=0x00, r/w]

Bit	Function	Description	Default
B[7:0]	AutoFocus Anti-Shaking	Control LSB of column address	0000_0000b

0xA0[page mode 24]: AFDATAR1H[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region1	RO

0xA1[page mode 24]: AFDATAR1L[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region1	RO

0xA2[page mode 24]: AFDATAR2H[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region2	RO

0xA3[page mode 24]: AFDATAR2L[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region2	RO

0xA4[page mode 24]: AFDATAR3H[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region3	RO

0xA5[page mode 24]: AFDATAR3L[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region3	RO

0xA6[page mode 24]: AFDATAR4H[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region4	RO

0xA7[page mode 24]: AFDATAR4L[r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region4	RO

0xA8[page mode 24]: AFDATAR5H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region5	RO

0xA9[page mode 24]: AFDATAR5L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region5	RO

0xAA[page mode 24]: AFDATAR6H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region6	RO

0xAB[page mode 24]: AFDATAR6L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region6	RO

0xAC[page mode 24]: AFDATAR7H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region7	RO

0xAD[page mode 24]: AFDATAR7L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region7	RO

0xAE[page mode 24]: AFDATAR8H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region8	RO

0xAF[page mode 24]: AFDATAR8L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region8	RO

0xB0[page mode 24]: AFDATAR9H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region9	RO

0xB1[page mode 24]: AFDATAR9L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region9	RO

0xB2[page mode 24]: AFDATAR10H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region10	RO

0xB3[page mode 24]: AFDATAR10L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region10	RO

0xB4[page mode 24]: AFDATAR11H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region11	RO

0xB5[page mode 24]: AFDATAR11L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region11	RO

0xB6[page mode 24]: AFDATAR12H [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	High byte of auto focus data in region12	RO

0xB7[page mode 24]: AFDATAR12L [r]

Bit	Function	Description	Default
B[7:0]	AutoFocus	Low byte of auto focus data in region12	RO

0xB8[page mode 24]: ASDATAR1H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region1	RO

0xB9[page mode 24]: ASDATAR1L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region1	RO

0xBA[page mode 24]: ASDATAR2H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region2	RO

0xBB[page mode 24]: ASDATAR2L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 2	RO

0xBC[page mode 24]: ASDATAR3H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 3	RO

0xBD[page mode 24]: ASDATAR3L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 3	RO

0xBE[page mode 24]: ASDATAR4H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 4	RO

0xBF[page mode 24]: ASDATAR4L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 4	RO

0xC0[page mode 24]: ASDATAR5H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 5	RO

0xC1[page mode 24]: ASDATAR5L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 5	RO

0xC2[page mode 24]: ASDATAR6H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 6	RO

0xC3[page mode 24]: ASDATAR6L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 6	RO

0xC4[page mode 24]: ASDATAR7H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 7	RO

0xC5[page mode 24]: ASDATAR7L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 7	RO

0xC6[page mode 24]: ASDATAR8H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 8	RO

0xC7[page mode 24]: ASDATAR8L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 8	RO

0xC8[page mode 24]: ASDATAR9H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 9	RO

0xC9[page mode 24]: ASDATAR9L [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 9	RO

0xCA[page mode 24]: ASDATAR10H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 10	RO

0xCB[page mode 24]: ASDATAR10L[r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 10	RO

0xCC[page mode 24]: ASDATAR11H [r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 11	RO

0xCD[page mode 24]: ASDATAR11L[r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 11	RO

0xCE[page mode 24]: ASDATAR12H [r]

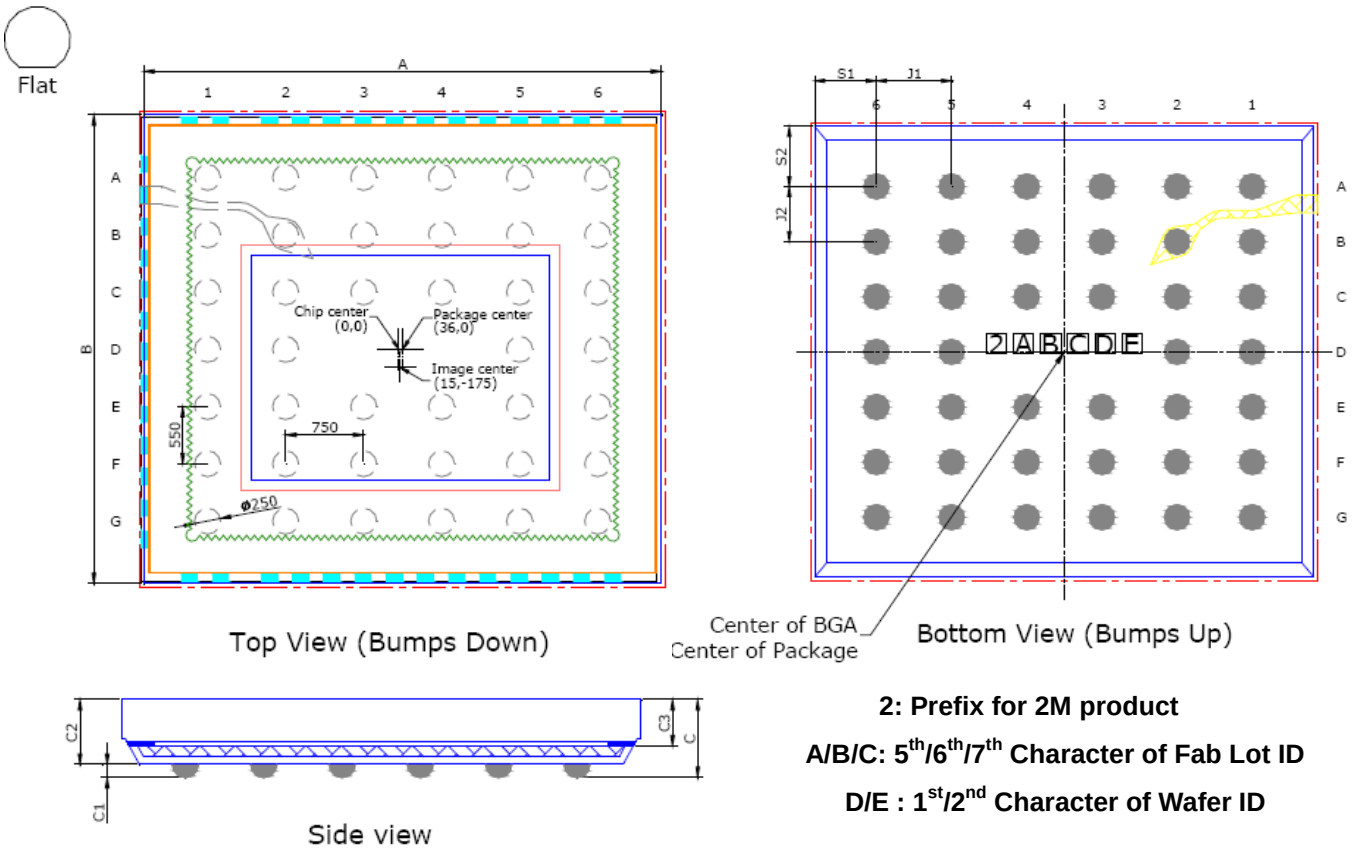
Bit	Function	Description	Default
B[7:0]	Anti-Shaking	High byte of anti-shaking data in region 12	RO

0xCF[page mode 24]: ASDATAR12L[r]

Bit	Function	Description	Default
B[7:0]	Anti-Shaking	Low byte of anti-shaking data in region 12	RO

6. CSP Package Information

<Figure 34. Package Drawing>

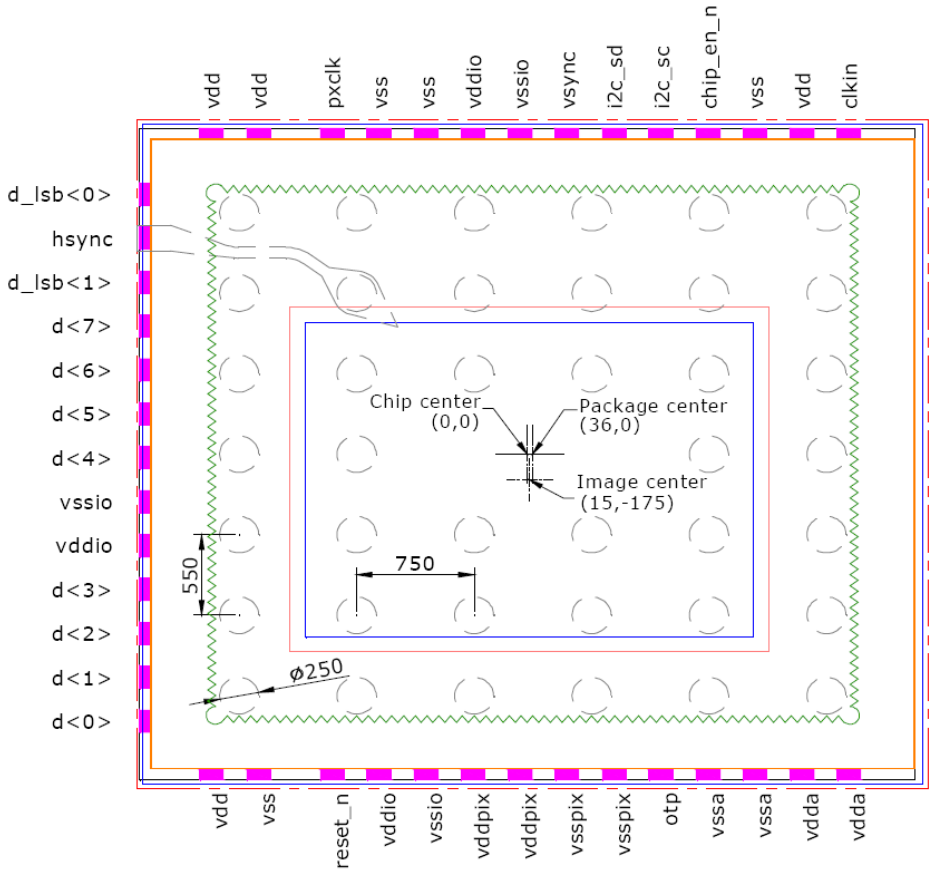


2: Prefix for 2M product

A/B/C: 5th/6th/7th Character of Fab Lot ID

D/E : 1st/2nd Character of Wafer ID

<Figure 35. Detailed View>



[Table 9. Package Dimensions]

Unit : um

	Symbol	Nominal	Min	Max
Package Body Dimension X	A	4980	4955	5005
Package Body Dimension Y	B	4500	4475	4525
Package Height	C	750	690	810
Ball Height	C1	130	100	160
Package Body Thickness	C2	620	575	665
Thickness of Glass surface to wafer	C3	445	425	465
Ball Diameter	D	250	220	280
Total Pin Count	N	40		
Pin Count X axis	N1	6		
Pin Count Y axis	N2	7		
Pins Pitch X axis	J1	750		
Pins Pitch Y axis	J2	550		
Edge to Pin Center Distance along X	S1	615	585	645
Edge to Pin Center Distance along Y	S2	600	570	630

[Table 10. Ball Matrix Table]

	1	2	3	4	5	6
A	d_lsb<0>	vdd	vss	vsync	i2c_sc	vdd
B	d_lsb<1>	hsync	pxclk	i2c_sd	chip_en_n	clkin
C	d<6>	d<7>	vddio	vssio	vss	vss
D	d<4>	d<5>			vssio	vss
E	vddio	d<3>	vdd	vddio	otp	vdda
F	d<2>	d<1>	reset_n	vddpix	vssa	vdda
G	d<0>	vss	vssio	vsspix	vssa	vdda

[Table 11. Pin Description]

Pin Number	Pin Name	Description	I/O Type	Remark
A1	d_lsb<0>	Strobe / YUV Control	OUT	
A2	vdd / vdd	Digital Core Circuit Power Supply	-	1.8V
A3	vss / vss	Digital Core Circuit Power GND	-	GND
A4	vsync	Vertical SYNC	OUT	
A5	i2c_sc	Serial Clock	IN	
A6	vdd	Digital Core Circuit Power Supply	-	1.8V
B1	d_lsb<1>	YUV Control	OUT	
B2	hsync	Horizontal SYNC	OUT	
B3	pxclk	PCLK	OUT	
B4	i2c_sd	Serial Data	INOUT	
B5	chip_en_n	Chip enable	IN	
B6	clkin	Master Clock	IN	
C1	d<6>	Parallel Data Output	OUT	
C2	d<7>	Parallel Data Output	OUT	
C3	vddio	I/O Circuit Power Supply	-	1.8 ~ 2.8V
C4	vssio	I/O Circuit Ground	-	GND
C5	vss	Digital Core Circuit Power GND	-	GND
C6	vss	Digital Core Circuit Power GND	-	GND
D1	d<4>	Parallel Data Output	OUT	
D2	d<5>	Parallel Data Output	OUT	
D5	vssio	I/O Circuit Ground	-	GND
D6	vss	Digital Core Circuit Power GND	-	GND
E1	vddio	I/O Circuit Power Supply	-	1.8 ~ 2.8V
E2	d<3>	Parallel Data Output	OUT	
E3	vdd	Digital Core Circuit Power Supply	-	1.8V
E4	vddio	I/O Circuit Power Supply	-	1.8 ~ 2.8V
E5	otp	Analog option pad	INOUT	Ext. Cap 0.1uF
E6	vdda / vdda	Analog Circuit Power Supply	-	2.8V
F1	d<2>	Parallel Data Output	OUT	
F2	d<1>	Parallel Data Output	OUT	
F3	reset_n	Hardware Reset. Active low	IN	
F4	vddpix / vddpix	Pixel Array Power Supply	-	2.8V
F5	vssa / vssa	Analog Circuit Ground	-	GND
F6	vdda / vdda	Analog Circuit Power Supply	-	2.8V
G1	d<0>	Parallel Data Output	OUT	

G2	vss	Digital Core Circuit Power GND	-	GND
G3	vssio	I/O Circuit Ground	-	GND
G4	vsspix / vsspix	Pixel Array Ground	-	GND
G5	vssa / vssa	Analog Circuit Ground	-	GND
G6	vdda / vdda	Analog Circuit Power Supply	-	2.8V

Note 1)

In case of outputting data in YUV format, d<0> ~ d<7> are used for output pin and A1 is used for strobe , B1 is NC

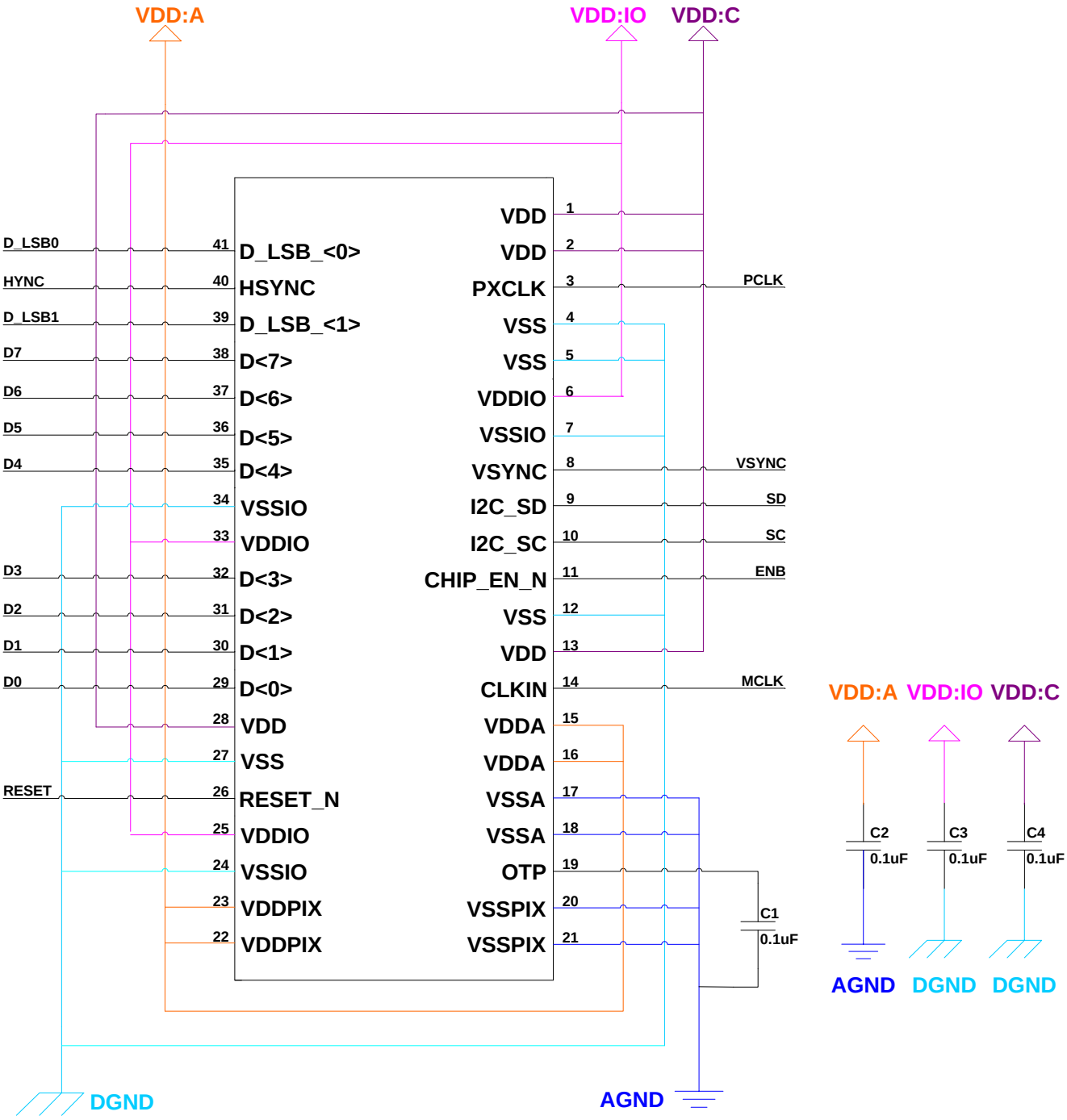
Note 2)

In case of outputting data in 10-bit Bayer format, d_lsb<0>, d_lsb<1>, d<0>~d<7> are used for output pin.

(d_lsb<0> → d<0>, d_lsb<1> → d<1>, d<0>~d<7> → d<2>~d<9>)

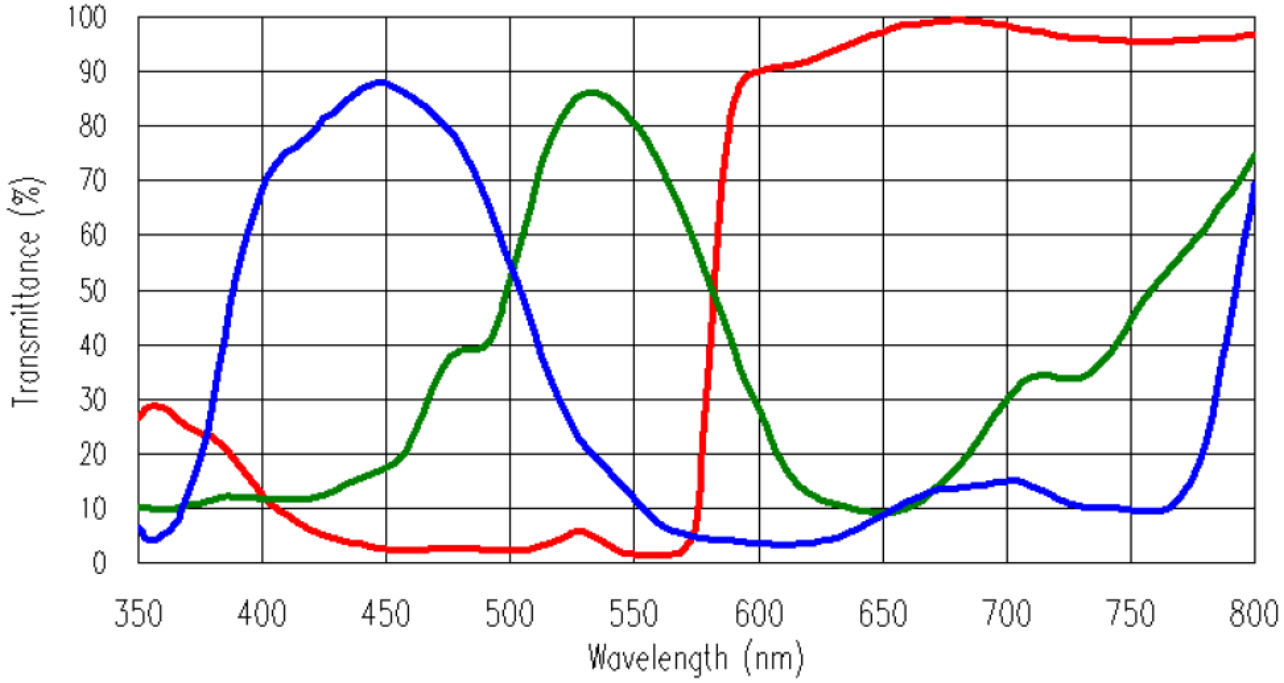
7. Reference Module Schematic

<Figure 36. Module Schematic>



8. Color Filter Characteristics

<Figure 37. Spectral Response>



9. Ordering Information

Product	Package Type
YACD511SBDDC-050A	CSP Package

*. Please contact the Hynix sales representatives for the detail information about 16th digit of the Ordering Code