GC5605 COB

1/4.7’’ 5Mega CMOS Image Sensor

Datasheet Preliminary

V0.5

2024-12-16

Ordering Information

◆ **GC5605-WA1XA**

(Colored, 150um)

GENERATION REVISION HISTORY

Version.	Effective Date	Description of Changes	Prepared by
V0.0	2024-09-11	Document Preliminary	DSC-AE Dept.
V0.1	2024-09-12	Document Preliminary	DSC-AE Dept.
V0.2	2024-10-17	Updata Pin Descriptions	DSC-AE Dept.
V0.3	2024-10-30	Updata Figure 4: Pad Size and Aperture	DSC-AE Dept.
V0.4	2024-12-06	Updata 3. Pad Configuration	DSC-AE Dept.
V0.5	2024-12-16	Updata Pixel size	DSC-AE Dept.

Galaxycore Incorporation

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1. Sensor Overview

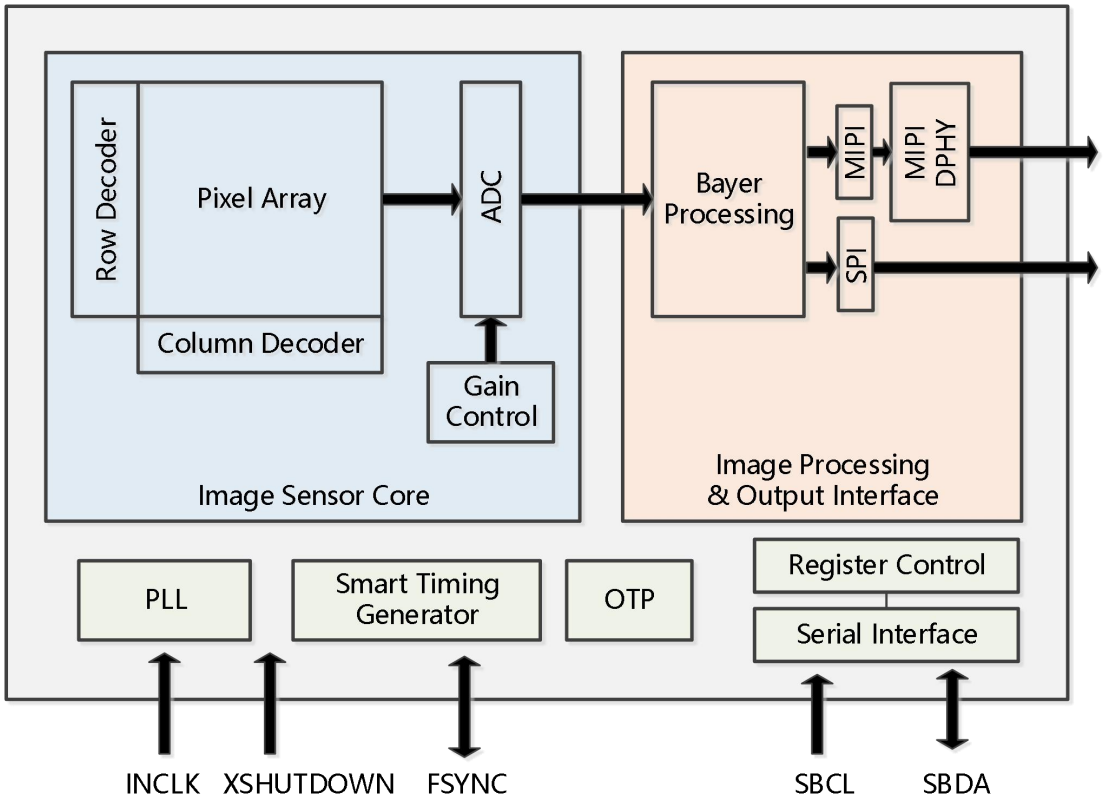
1.1 General Description

GC5605 is a high quality 5Mega CMOS image sensor, for cellular phone camera, PC multimedia, tablets. The total active pixel array size is 2888 x 1808 to meet with the 1/4.7-inch optical format. GC5605 has image signal process functions (static DD, dynamic DD, black level calibration, etc.) to achieve high speed image capturing and high quality image.

GC5605 is suitable for fast yet low power consumption application with power supply of AVDD(2.8V)/IOVDD(1.8V/1.2V)/DVDD(1.2V), which is useful in extending the battery life of tablet PCs and a variety of other mobile products.It provides raw8/raw10/raw12 data formats with MIPI/SPI interface.

1.2 Block Diagram

Figure 1: Block Diagram



1.3 Features

- Optical size: 1/4.7 inch
- Pixel size: 1.116μm x 1.116μm BSI
- Active image size: 2888 x 1808
- Color Filter: RGB Bayer
- Output formats: Raw 10/12 DAG HDR Tone Mapping
  Raw 10 Stagger HDR
  Raw 8/10 linear
- Interface: MIPI @Full Size
  MIPI/SPI @AO Mode
- Power supply requirement: AVDD: 2.7~2.9V (Typ. 2.8V)
  DVDD: 1.15~1.25V (Typ. 1.2V)
  IOVDD: 1.15-1.25V/1.7~1.9V
  (Typ. 1.2V/1.8V)
- Power Consumption: TBD
- Max Frame rate: 60fps@Full Size
- PLL support
- Frame sync support (master/slave)
- Windowing support
- Mirror and Flip support
- Binning Mode support
- OTP support: TBD
- Analog Gain: 16x(Max)
- Sensitivity: TBD
- Dynamic range: TBD
- MAX SNR: TBD
- Dark Current: TBD
- Operation Temperature: -30~85℃
- Stable Image temperature: 0~60℃
- Storage temperature: -40~125℃
- Package: COB
- Micro lens chief ray angle (CRA): 34.68°

2. Electrical Characteristics

2.1 Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings

Description	Symbol	Rating	Unit	Note
Analogue absolute max	V_{AVDD_MAX}	-0.3~3.9	V	Refer to GND
Digital absolute voltages	V_{DVDD_MAX}	-0.3~1.8	V	
IO absolute max	V_{IOVDD_MAX}	-0.3~3.6	V	
Digital input voltages	V_{IF_MAX}	-0.3~V_{IOVDD}+0.3	V	

Note: Digital input voltage: XCLK, SBCL, SBDA, XSHUTDOWN, FSYNC

2.2 Operation Conditions

Table 2: Operation Conditions

Description	Symbol	Min.	Typical	Max.	Unit
Analog power supply	V_{AVDD}	2.7	2.8	2.9	V
Digital power supply	V_{DVDD}	1.15	1.2	1.25	V
IO power supply	V_{IOVDD}	1.7/1.15	1.8/1.2	1.9/1.3	V
Digital input voltages	V_{IF}	0		IOVDD	V
Test temperature	T_{TEST}	21	25	27	℃

Note: 1. Digital input voltage: XCLK, SBCL, SBDA, XSHUTDOWN, FSYNC.
2. Test temperature: image quality test condition.

2.3 DC Characteristics

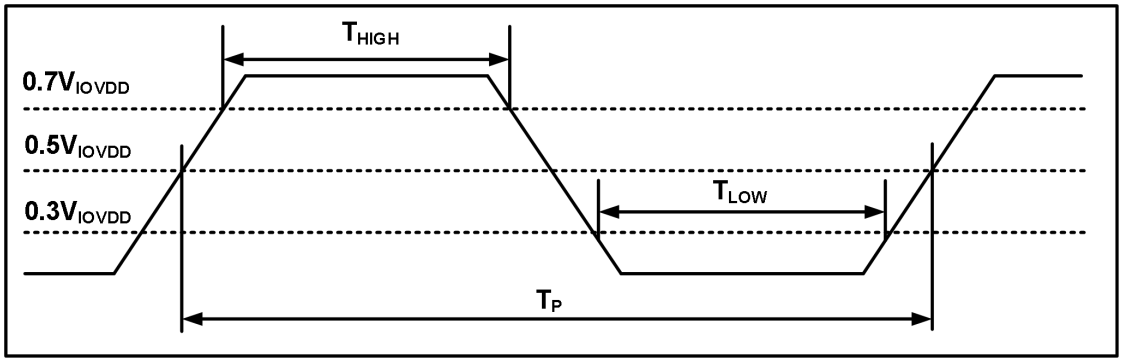
Table 3: DC Characteristics

Characteristics	Symbol	Min.	Typical	max	Unit
Input voltage HIGH	V_{IH}	0.7 x V_{IF}	-	-	V
Input voltage Low	V_{IL}	-	-	0.3 x V_{IF}	V
Output voltage HIGH	V_{OH}	0.7 x V_{IOVDD}	-	-	V
Output voltage LOW	V_{OL}	-	-	0.3 x V_{IOVDD}	V

Note: Input voltage apply to XCLK, SBCL, SBDA, XSHUTDOWN, FSYNC.

2.4 AC Characteristics

Figure 2: AC Characteristics



INCLK is the input clock to sensor. Table 2-4 shows some detailed parameters of INCLK square waveform specifications.

Table 4: AC Characteristics

Item	Symbol	Min.	Typ.	max	unit
Frequency	f_{SCK}	6	24	36	MHz
jitter (period, peak-to-peak)	T_{jitter}			600	ps
High level width	T_{HIGH}	0.4tp		0.6tp	ns
Low level width	T_{LOW}	0.4tp		0.6tp	ns
Duty Cycle	f_{DUTY}	40		60	%

2.5 Power Consumption

Table 5: Power Consumption

Item	Symbol	Min	Typ	Max	Unit
Full size @30fps MIPI 2lane	I_{AVDD}	-	TBD	TBD	mA
	I_{DVDD}	-	TBD	TBD	mA
	I_{IOVDD}	-	TBD	TBD	mA
Standby current	I_{AVDD}	-	TBD	TBD	μA
	I_{DVDD}	-	TBD	TBD	μA
	I_{IOVDD}	-	TBD	TBD	μA
Power off current	I_{total}	-	-	0	μA

Note: 1. All operate current are measured at 24MHz XCLK.
2. Standby current is measured at XSHUTDOWN = L, XCLK=24MHz.
3. We recommend that power should be turned off, when lower power consumption is required.

3. Pad Configuration

Figure 3: Pad Configuration

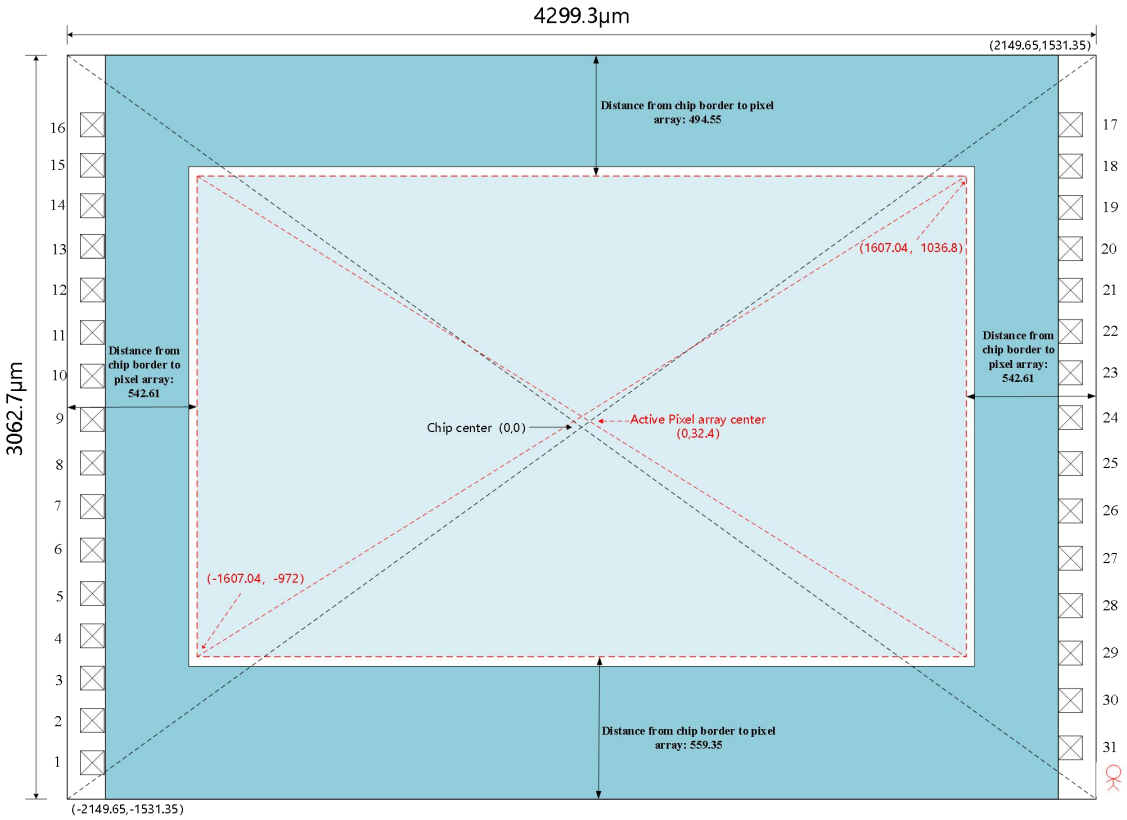


Figure 4: Pad Size and Aperture

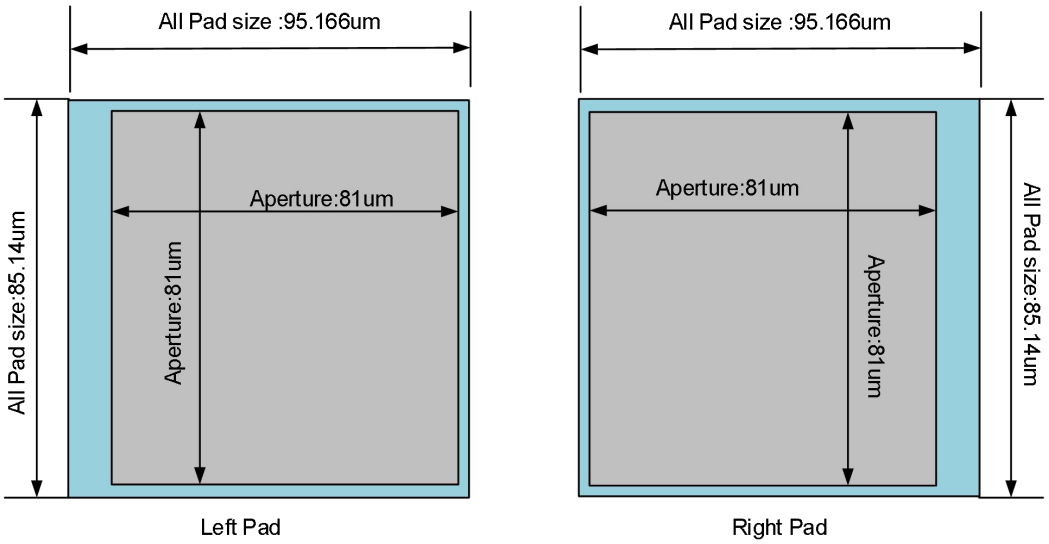


Table 6 : Package Information

Die size	Without Scribe Lane: 4299.3μm x 3062.7μm With Scribe Lane: 4379.3μm x 3142.7μm
Pad Pitch	See Table 7
Bonding Pad Open size	81 μm x 81 μm
Total number of pads	31ea (w/o dummy PADs)
Total number of bonding pads	31ea
Optical Center	(0μm, 32.4μm)

3.1 Pin Descriptions

Table 7: Pin Descriptions

Pin	X(μm)	Y(μm)	Name	Type	A/D	Description
1	-2054.826	-1372.140	DVDD12	Power	D	Digital power supply: 1.2V
2	-2054.826	-1213.740	DGND	Ground	D	Ground for Digital.
3	-2054.826	-1054.440	TXLOW	Power	A	Internal power supply.
4	-2054.826	-877.590	VREF	Power	A	Internal power supply.
5	-2054.826	-700.740	SCK	Output	D	SPI clock lane
6	-2054.826	-518.940	SDO	Output	D	SPI data lane
7	-2054.826	-337.140	SBCL	Input	D	I2C clock lane
8	-2054.826	-155.340	SBDA	I/O	D	I2C data lane
9	-2054.826	26.460	IN_CLK	Input	D	Sensor input clock
10	-2054.826	208.260	VDDIO	Power	D	IO power supply:1.8/1.2V
11	-2054.826	390.060	FSYNC	I/O	D	Frame sync control
12	-2054.826	567.810	XSHUTDOWN	Input	D	Sensor power down control: (Floating forbidden) 0: reset & standby; 1: normal work
13	-2054.826	750.510	AVDD28	Power	A	Analog power supply: 2.8V
14	-2054.826	919.710	AGND	Ground	A	Ground for Analog
15	-2054.826	1088.910	SGND	Ground	D	Ground for digital
16	-2054.826	1258.110	SVDD	Power	D	Digital power supply:1.2V

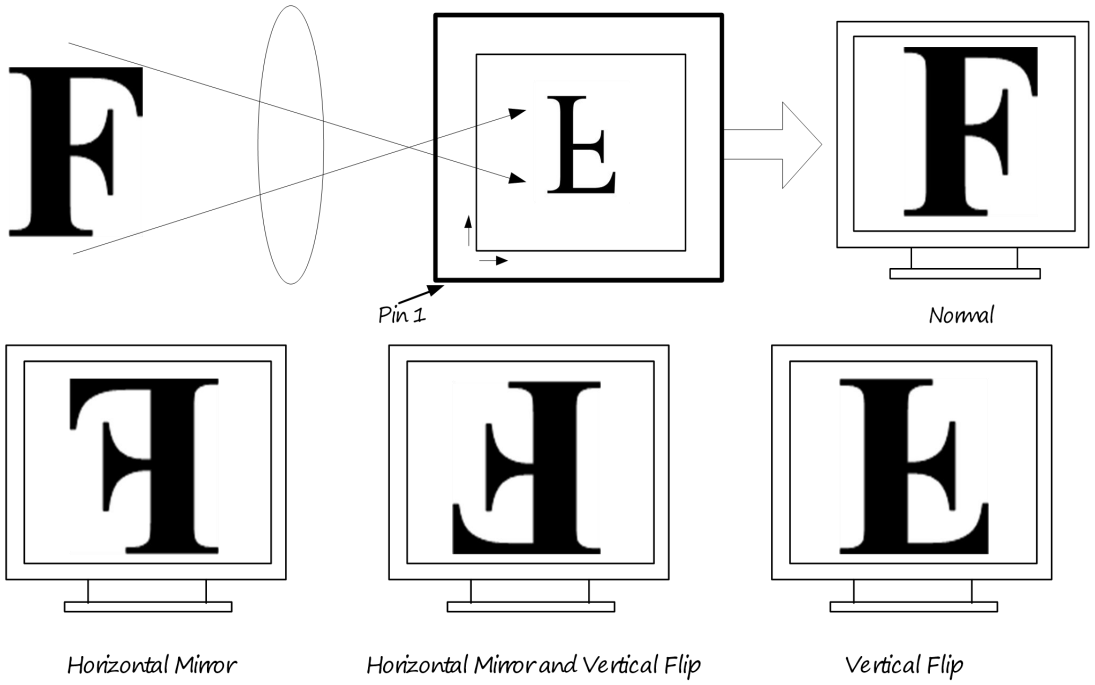
17	2054.826	1208.142	AGND	Ground	A	Ground for Analog
18	2054.826	1035.342	VOTP	Power	D	OTP power supply: TBD (floating available)
19	2054.826	862.542	PLLVSS	Ground	D	Ground for PLL
20	2054.826	689.742	VDDIO	Power	D	IO power supply: 1.8V/1.2V
21	2054.826	516.942	I2C_ID_SEL	Input	D	ID_SEL(floating forbidden)
22	2054.826	344.142	DVDD12	Power	D	Digital power supply: 1.2V
23	2054.826	171.342	DGND	Ground	D	Ground for Digital.
24	2054.826	8.271	MD1N	Output	D	MIPI data <1> (+)
25	2054.826	-189.729	MD1P	Output	D	MIPI data <1> (-)
26	2054.826	-387.729	MVDD	Power	D	MIPI Power supply: 1.2V
27	2054.826	-585.729	MGND	Ground	D	Ground for Digital.
28	2054.826	-783.729	MCN	Output	D	MIPI clock (-)
29	2054.826	-981.729	MCP	Output	D	MIPI clock (+)
30	2054.826	-1179.729	MD0N	Output	D	MIPI data <0> (+)
31	2054.826	-1377.729	MD0P	Output	D	MIPI data <0> (-)

4. Optical Specifications

4.1 Readout Position

GC5605 default status is readout from the lower left corner with pin 1 located in the upper left corner. The image is inverted vertically and horizontally by the lens, so proper image output results when Pin 1 is located in the upper left corner.

Figure 5: Readout Position



Readout direction can be set by the registers.

Table 8: Mirror and Flip Information

TBD

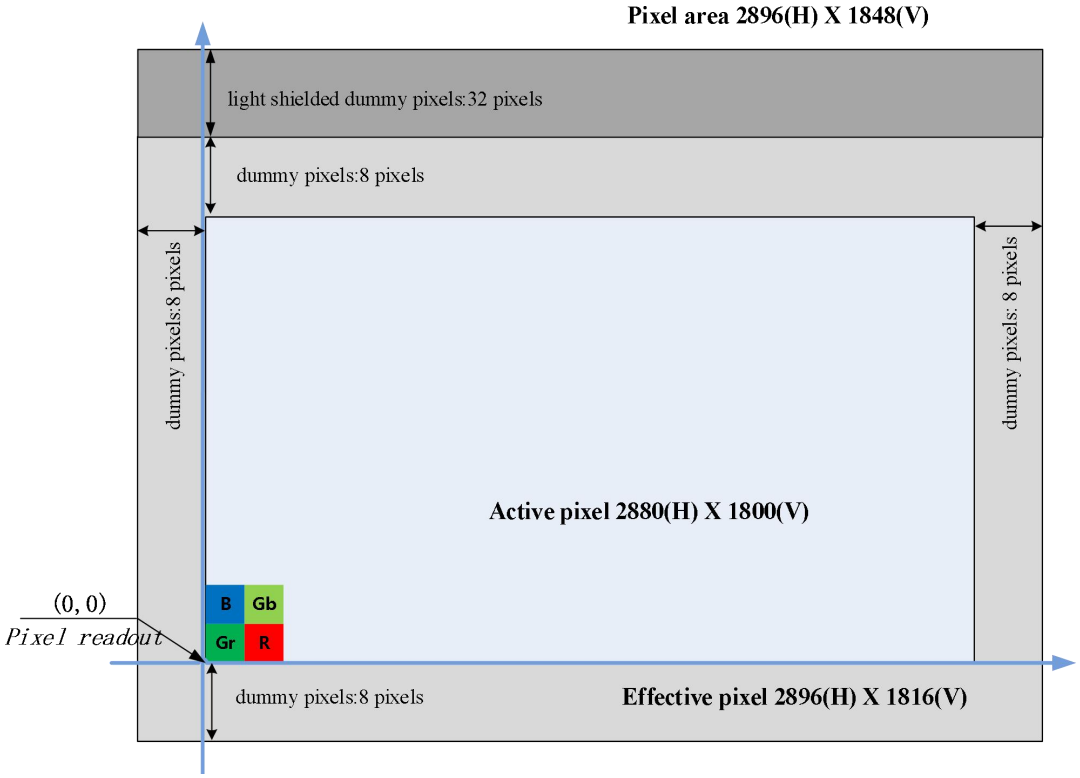
4.2 Pixel Array

Pixel array is covered by Bayer pattern color filters. The primary color GR/BG array is arranged in line-alternating way.

If no flip in column, column is read out from 0 to 2879. If flip in column, column is read out from 2879 to 0.

If no flip in row, row is read out from 0 to 1799.If flip in row, row is read out from 1799 to 0.

Figure 6: Pixel Array



4.3 Lens Chief Ray Angle (CRA)

Figure 7 CRA Information

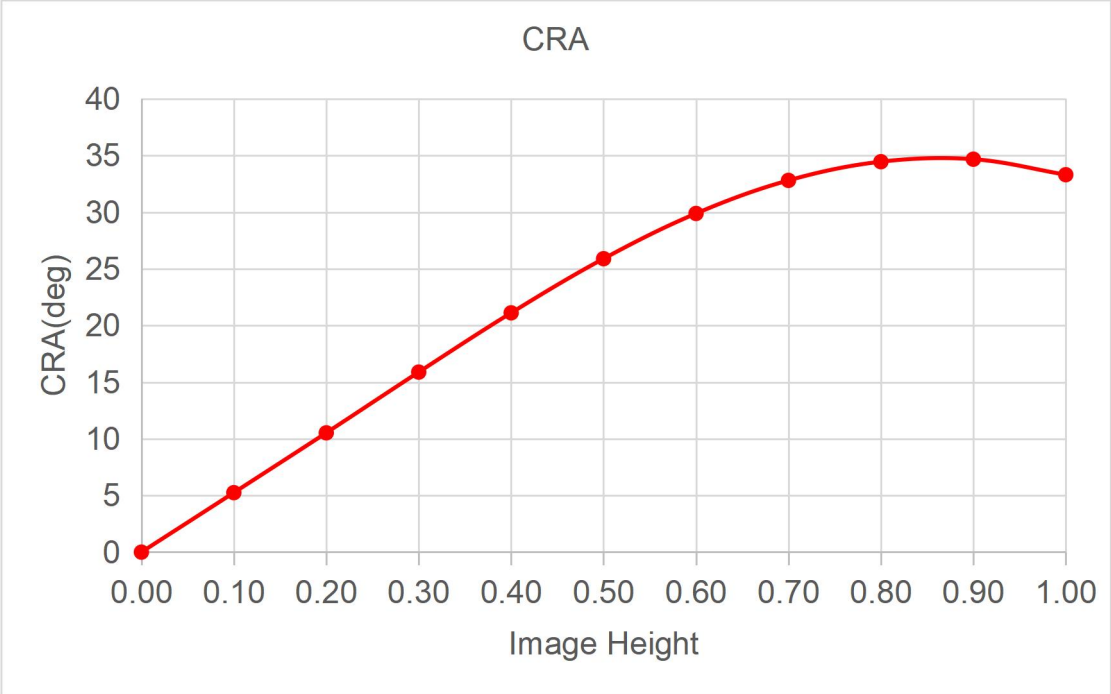


Table 9: CRA Information

Image Heigh (%)	Image Height (mm)	CRA (degree)
00	0.000	0.000
10	0.190	5.250
20	0.380	10.530
30	0.570	15.890
40	0.761	21.120
50	0.951	25.900
60	1.141	29.890
70	1.331	32.810
80	1.521	34.460
90	1.711	34.680
100	1.901	33.310

4.4 QE Spectral Characteristics

TBD

5. Two-wire Serial Bus Communication

GC5605 Device Address: TBD

5.1 Protocol

The host must perform the role of a communications master and GC5605 acts as either a slave receiver or transmitter. The master must do:

- Generate the **Start(S)/Stop(P)** condition
- Provide the serial clock on **SBCL**

Figure 9: Write operate (2 bytes address –1byte data format)

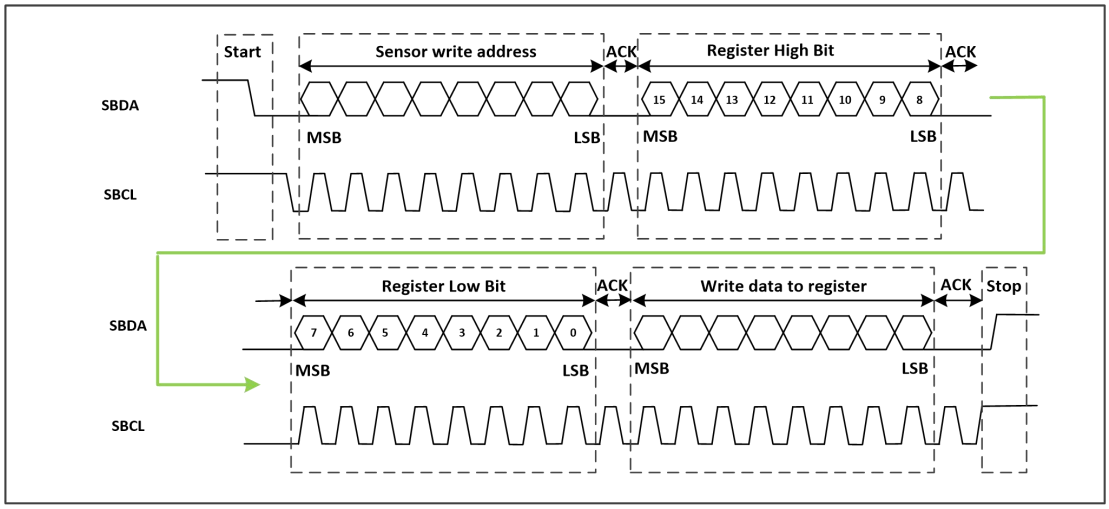
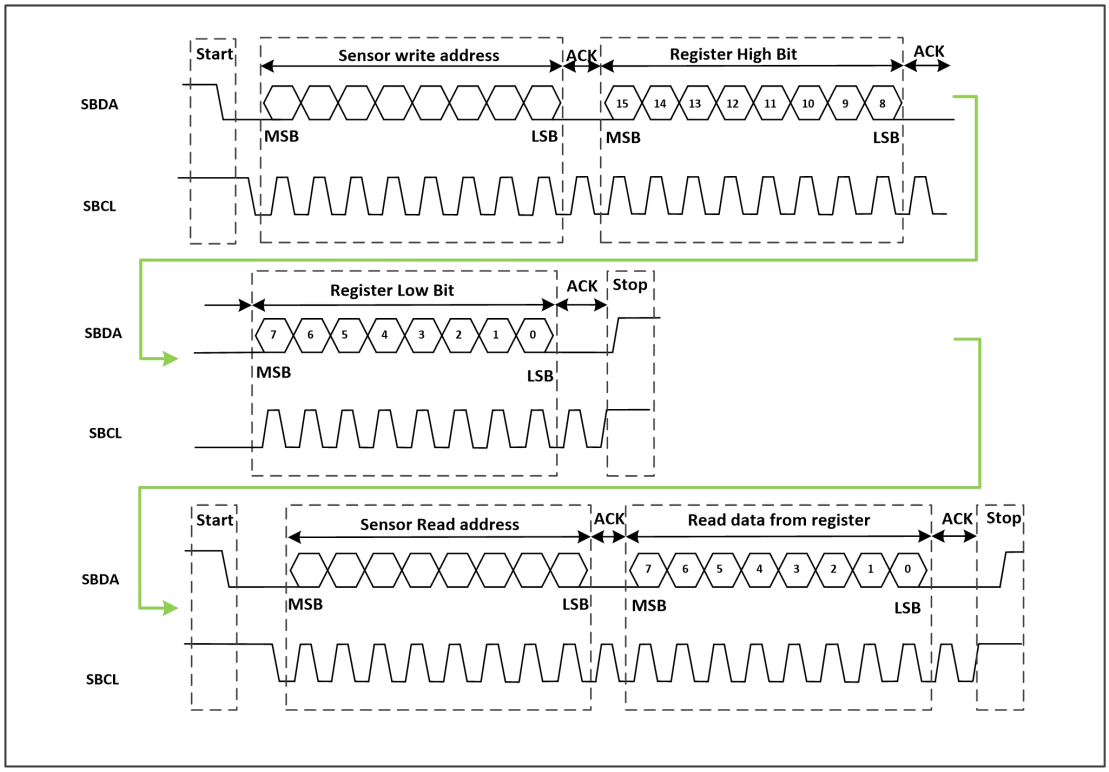


Figure 10: Read Operate (2 bytes address –1byte data format)



5.2 Serial Bus Timing

Figure 11: Serial Bus Timing

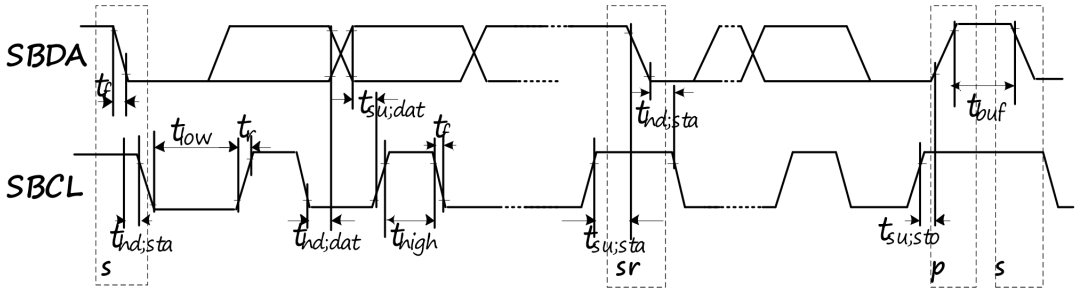


Table 11: Serial Bus Timing

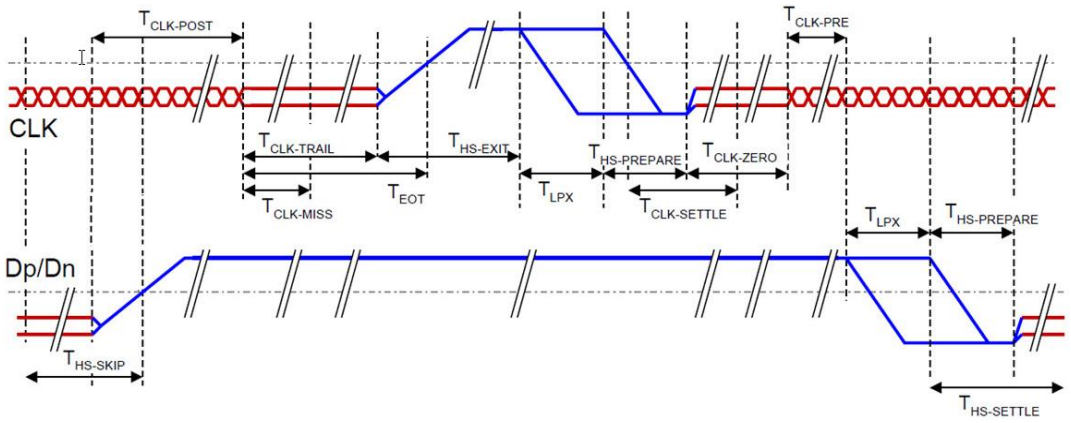
Parameter	Symbol	Min	Typ.	Max	Unit
SBCL clock frequency	F_{scl}	0	--	400	KHz
Bus free time between a stop and a start	t_{buf}	1.3	--	--	μs
Hold time for a repeated start	$t_{hd;sta}$	0.6	--	--	μs
LOW period of SBCL	t_{low}	1.3	--	--	μs
HIGH period of SBCL	t_{high}	0.6	--	--	μs
Set-up time for a repeated start	$t_{su;sta}$	600	--	--	ns
Data hold time	$t_{hd;dat}$	0	--	900	ns

Data Set-up time	$t_{su;dat}$	100	--	--	ns
Rise time of SBCL, SBDA	t_r	--	--	300	ns
Fall time of SBCL, SBDA	t_f	--	--	300	ns
Set-up time for a stop	$t_{su;sto}$	0.6	--	--	μs
Capacitive load of bus line (SBCL, SBDA)	C_b	--	--	100	pf

6. MIPI Timing

6.1 Clock Lane Low-power

Figure 12: MIPI Clock Lane Time

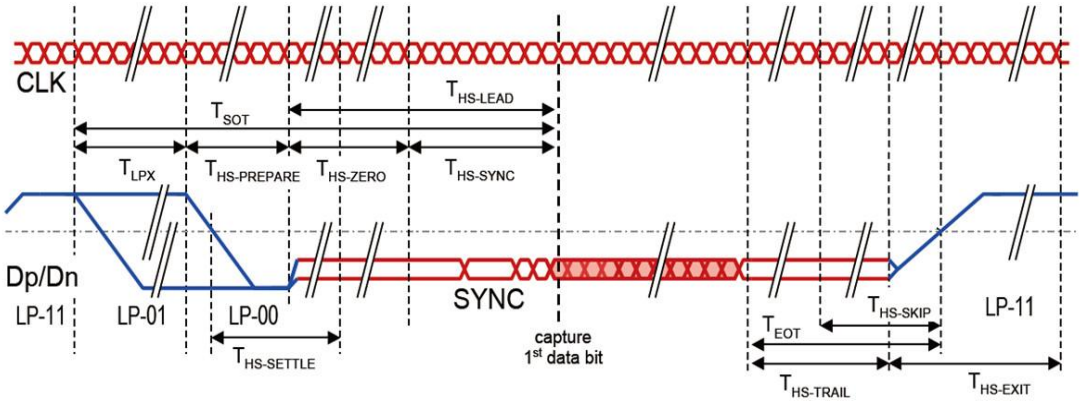


Notice:

- Clock must be reliable during high speed transmission and mode-switching.
- Clock can go to LP only if data lanes are in LP (and nothing relies on it).
- In Low-Power data lanes are conceptually asynchronous (independent of the high speed clock).

6.2 Data Burst

Figure 13: MIPI Data Lane Time



Notice:

- Clock keeps running and samples data lanes (except for lanes in LPS).
- Unambiguous leader and trailer sequences required to distill real bits.
- Trailer is removed inside PHY (a few bytes).
- Time-out to ignore line values during line state transition.

7. Function Description

7.1 Operation Mode

Figure 14: Operation Mode

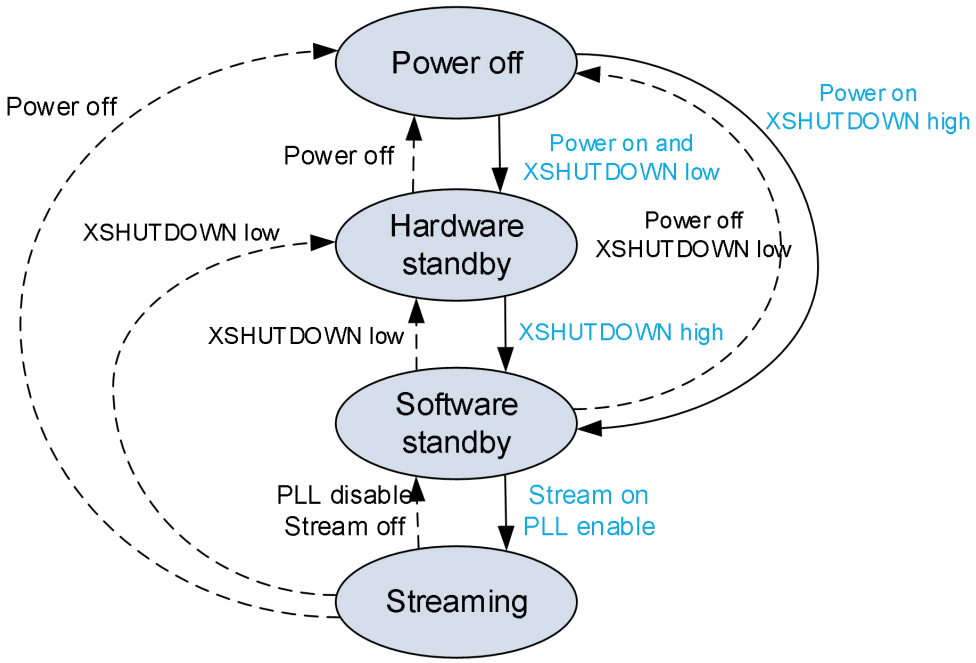


Table 12: Operate State

Power state	Description	Activate
Power off	Power supplies are turned off	None
Hardware standby	No communication with sensor, low level on XSHUTDOWN	XSHUTDOWN low
Software standby	Two- wire serial communication with sensor is possible, pll is ready for fast return to streaming mode	Stream mode off PLL disable XSHUTDOWN high
Streaming	Sensor is fully powered and streaming image data on the MIPI CSI-2 bus	All Pad Enabled

7.2 Power on Sequence

Figure 15: Power on Timing

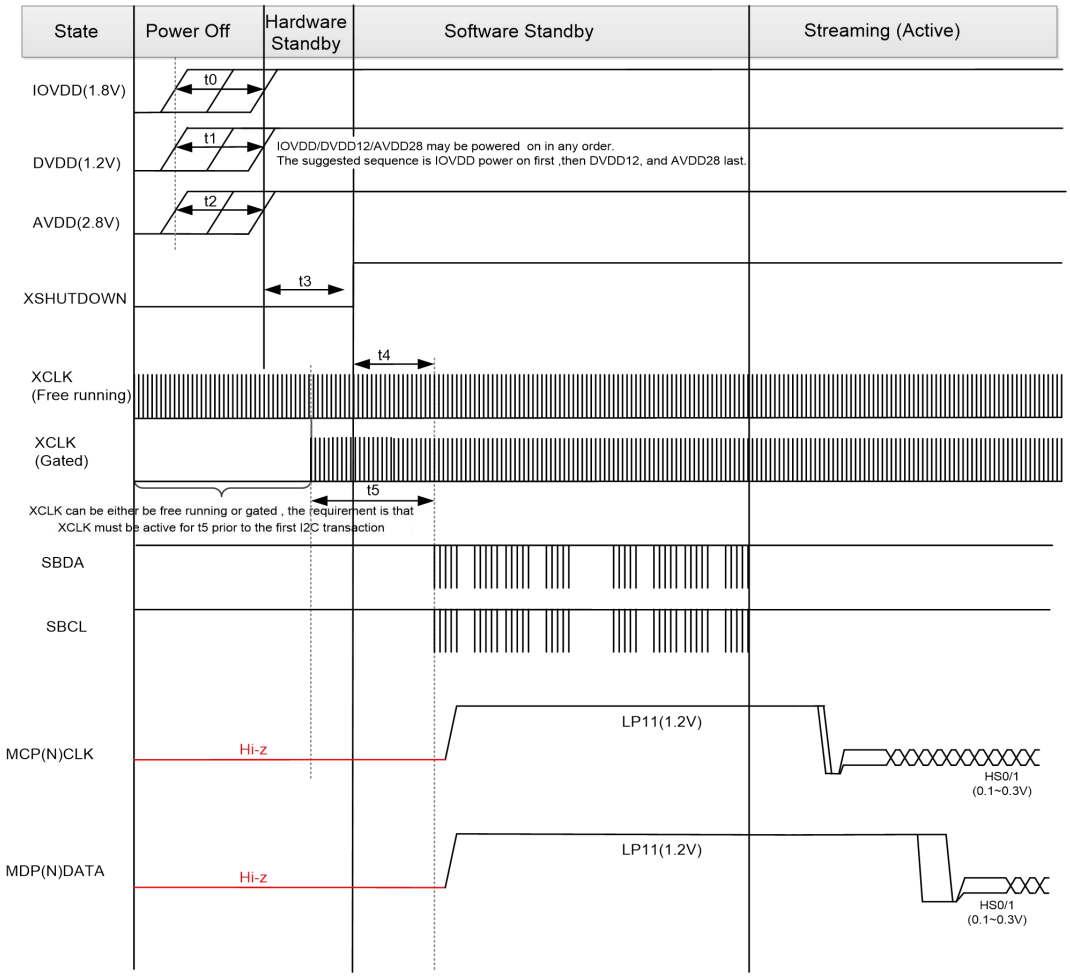


Table 13: Power on Timing

Parameter	Description	Min.	Max.	Unit
t0 t1 t2	IOVDD/DVDD12/AVDD28 may rise in any order. The rising separation can vary from 0μs to indefinite.	0	-	μs
t3	From power on to XSHUTDOWN pull high	0	-	μs
t4	XSHUTDOWN rising to first I2C transaction	50	-	μs
t5	Minimum No. of XCLK cycles prior to the first I2C transaction	1200	-	XCLK

Note: 1. IOVDD/DVDD12/AVDD28 may rise in any order.
2. The suggested sequence is IOVDD powered on first, then DVDD12, and AVDD28 last.
3. Register should be reloaded before works.

7.3 Power off Sequence

Figure 16: Power off Timing

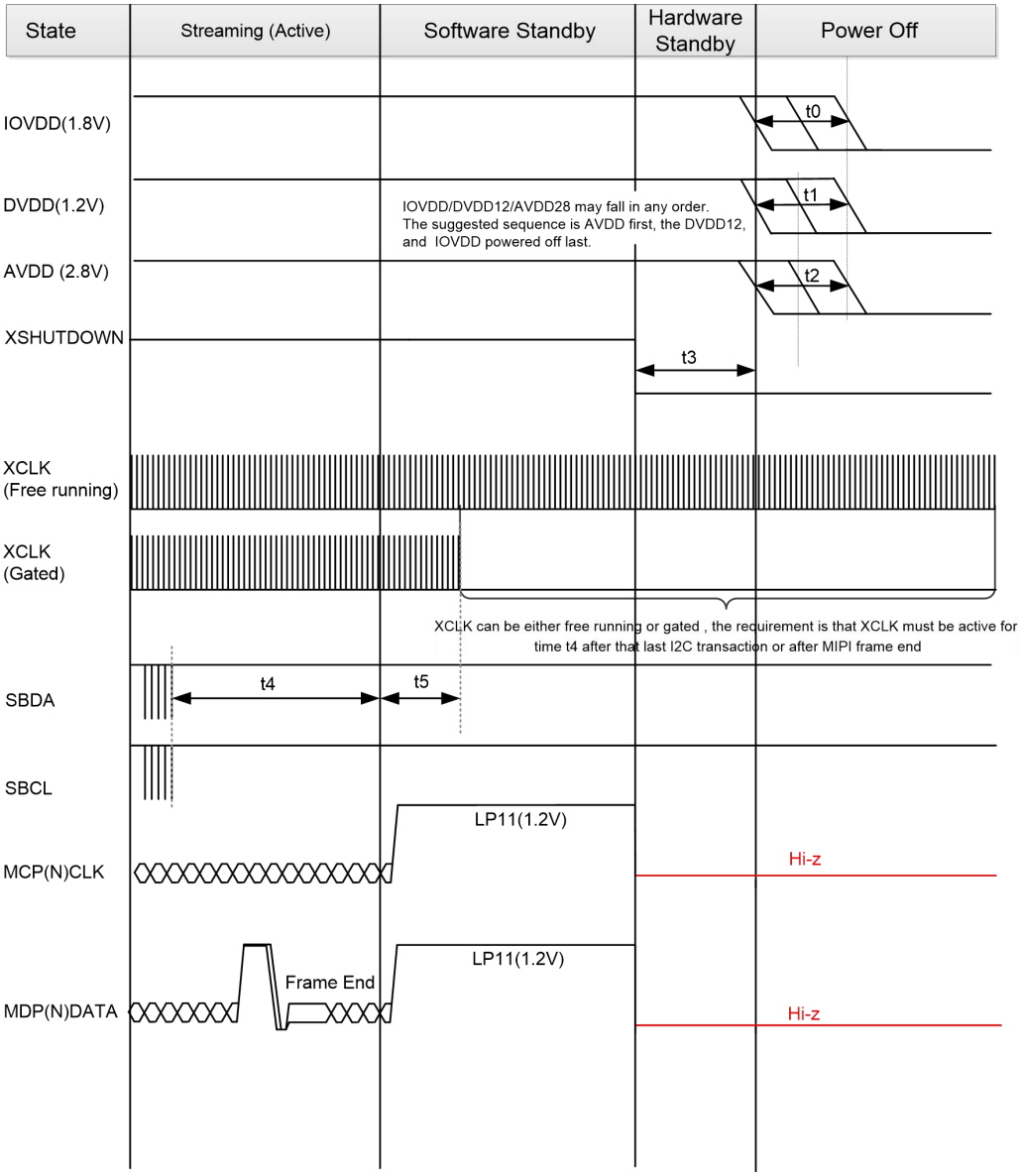


Table 14: Power off Timing

Parameter	Description	Min.	Max.	Unit
t0	IOVDD/DVDD12/AVDD28 may fall in any order. The fall separation can Vary from 0μs to indefinite.	0	-	μs
t1				
t2				
t3	From XSHUTDOWN pull down to power off	0		μs
t4	Enter Software Standby command – Device in Software Standby mode	0	-	μs
t5	Minimum number of XCLK cycles after the	2000		XCLK

	last transaction or MIPI frame end code.			

Note: 1. IOVDD/DVDD12/AVDD28 may fall in any order. The suggested sequence is AVDD first, the DVDD12, and IOVDD powered off last.
2. If the sensor’s power cannot be cut off, please keep power supply, then set XSHUTDOWN pin low. It will make sensor standby.
3. If the standby sequence needs to be modified, please contact FAE of *Galaxycore Inc*.

7.4 Black Level Calibration

Black level is caused by pixel characteristics and analog channel offset, which makes poor image quality in dark condition and color balance, to reduce these, sensor automatically calibrates the black level every frame with light shield pixel array.

7.5 Integration Time

The integration time is controlled by the shutter time registers. When you want to set an exposure value that is bigger than the current frame length value, you should first set a new frame length and make sure that it’s bigger than the exposure value you’d like to set.

Table 15: Shutter Time Register

Addr.	Register name	Description
TBD	Shutter time	[5:0] shutter time[13:8]
TBD		[7:0] shutter time[7:0]

7.6 Windowing

GC5605 has a rectangular pixel array 2880 x 1800, it can be windowed by output size control, the output image windowing can be used to adjust output size, and it will affect field angle.

Figure 17: Windowing Mode

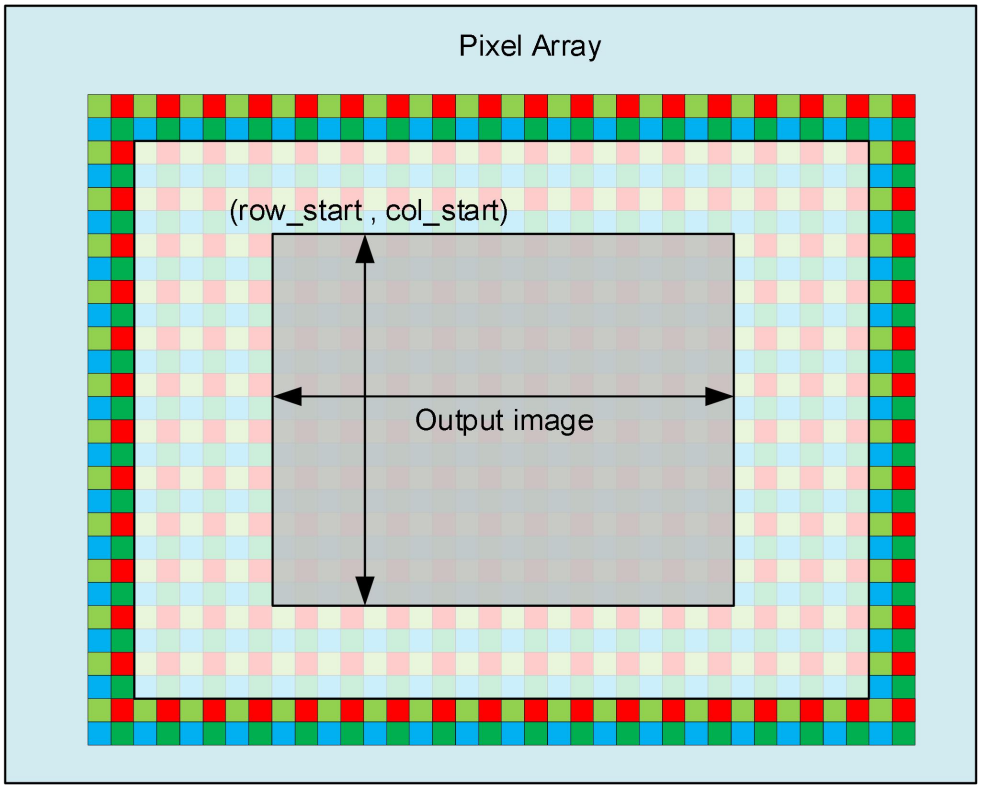


Table 16: Window Set Register

Addr.	Register name	Description
TBD	win_height	[2:0]win_height[10:8]
TBD		[7:0]win_height[7:0]
TBD	win_width	[3:0]win_width[11:8]
TBD		[7:0]win_width[7:0]
TBD	Row start	[2:0]row_start[10:8]
TBD		[7:0]row_start [7:0]

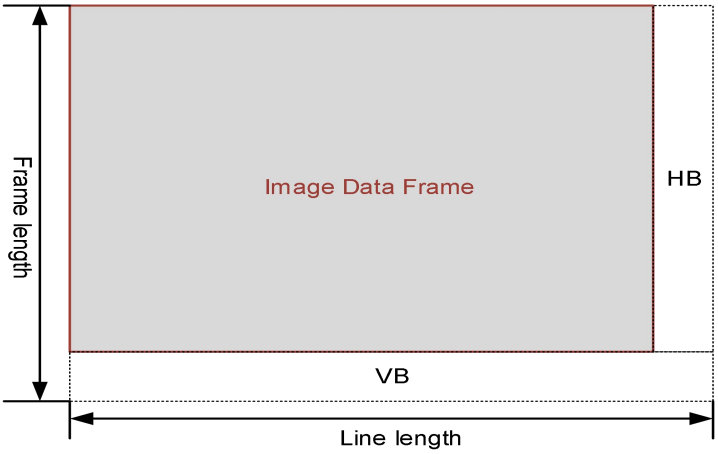
Table 17: Out Window Set Register

Addr.	Register name	Description
TBD	out_win_x1	[3:0] out_win_x1[11:8]
TBD		[7:0] out_win_x1[7:0]
TBD	out_win_y1	[7:0] out_win_y1[3:0]
TBD	out_win_width	[3:0] out_win_width[11:8]
TBD		[7:0] out_win_width[7:0]

7.7 Frame Sync Mode

GC5605 can support hardware frame sync for dual camera application. It can be set both master and slave sensor. When use this mode, the two sensor’s FSYNC pin must connect to each other.

Figure 18: Frame Sync Configuration



Master Mode:

When GC5605 operates as a master device, it controls vertical synchronous timings and outputs synchronous signal called Vsync signal or Fsync signal from the FSYNC pin.

Slave Mode:

GC5605 can be worked as a slave and automatically synchronized within a certain VSYNC time period. It is important to control two image sensors’ rolling shutters with the same timing.

7.8 Binning Mode

GC5605 has Binning mode which support a lower resolution output with high frame rate. The row or col can be independent controlled. However, only the row binning can increase frame rate.

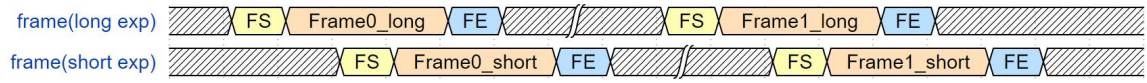
7.9 Stagger HDR mode

GC5605 has Stagger HDR function. If the function is enabled, by setting 2 different exposure times (always called long and short exposure), user can get 2 frame data in staggered output mode, and can combine two frames into one picture to improve dynamic range and avoid smearing.

When user choose MIPI protocol as output format, different exposure time line can be distinguished by virtual channel according to MIPI protocol. By default, long exposure line’ ID is 00, and short exposure line’s ID is 01.

The MIPI output timing as following (virtual channel mode):

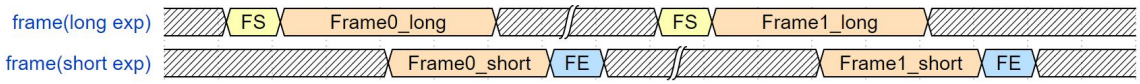
Figure 19: Virtual Channel Mode



Additionally, User can distinguish different exposure time line without virtual channel. In this mode, Short exposure time line has fixed offset lines with Long exposure time line.

The MIPI output timing as following (no virtual channel mode):

Figure 20: No Virtual Channel Mode



7.10 OTP memory

GC5605 sensor has 16K bits embedded OTP(One Time Programmable) memory which is used for store module calibration date, etc.