



Gowin AEAWB IP

User Guide

IPUG782-1.0E, 06/10/2021

Copyright © 2021 Guangdong Gowin Semiconductor Corporation. All Rights Reserved.

GOWIN, , Gowin, GowinSynthesis and GOWINSEMI are trademarks of Guangdong Gowin Semiconductor Corporation and are registered in China, the U.S. Patent and Trademark Office, and other countries. All other words and logos identified as trademarks or service marks are the property of their respective holders. No part of this document may be reproduced or transmitted in any form or by any denotes, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of GOWINSEMI.

Disclaimer

GOWINSEMI assumes no liability and provides no warranty (either expressed or implied) and is not responsible for any damage incurred to your hardware, software, data, or property resulting from usage of the materials or intellectual property except as outlined in the GOWINSEMI Terms and Conditions of Sale. All information in this document should be treated as preliminary. GOWINSEMI may make changes to this document at any time without prior notice. Anyone relying on this documentation should contact GOWINSEMI for the current documentation and errata.

Revision History

Date	Version	Description
06/10/2020	1.0E	Initial version published.

Contents

Contents	i
List of Figures.....	iii
List of Tables.....	iv
1 About This Guide	1
1.1 Purpose	1
1.2 Related Documents	1
1.3 Terminology and Abbreviations.....	2
1.4 Support and Feedback	2
2 Overview.....	3
2.1 Gowin AEAWB IP Introduction.....	3
2.2 Features.....	3
2.3 Max. Frequency	4
2.4 Latency	4
2.5 Resource Utilization.....	4
3 Functional Description	5
3.1 System Block Diagram	5
3.2 Algorithm Introduction	6
3.3 Gowin AEAWB IP Registers	7
4 Port Description.....	9
5 Timing Description	11
5.1 Timing Description	11
5.2 Timing Description	12
6 Call and Configure IP	13
7 Reference Design	16

8 File Delivery	17
8.1 Document	17
8.2 Reference Design	17

List of Figures

Figure 3-1 Gowin AEAWB IP Block Diagram	5
Figure 3-2 Window Divided	6
Figure 4-1 Ports Diagram of Gowin AEAWB IP	9
Figure 5-1 Gowin AEAWB IP Timing Diagram	11
Figure 5-2 Write Timing Diagram	12
Figure 5-3 Read Timing Diagram.....	12
Figure 6-1 Open GUI via Icon	13
Figure 6-2 Gowin AEAWB IP Configuration	14

List of Tables

Table 1-1 Terminology and Abbreviations	2
Table 2-1 Gowin AWAWB IP	3
Table 2-2 Resource Utilization (GW2A-18 C8/I7)	4
Table 3-1 Gowin AEAWB IP Registers.....	7
Table 4-1 Ports List of Gowin AEAWB IP	9
Table 6-1 Gowin AEAWB IP Configuration Option.....	15
Table 8-1 Document List	17
Table 8-2 Ref. Design Folder Contents.....	17

1 About This Guide

1.1 Purpose

The purpose of Gowin AEAWB IP User Guide is to help you learn the features and usage of this product by providing the descriptions of functions, ports, timing, GUI and reference design.

1.2 Related Documents

The latest user guides are available on the GOWINSEMI Website. You can find the related documents at www.gowinsemi.com:

- [DS100](#), GW1N series of FPGA Products Data Sheet
- [DS117](#), GW1NR series of FPGA Products Data Sheet
- [DS102](#), GW2A series of FPGA Products Data Sheet
- [DS226](#), GW2AR series of FPGA Products Data Sheet
- [DS971](#), GW2AN series of FPGA Products Data Sheet
- [DS961](#), GW2ANR series of FPGA Products Data Sheet
- [SUG100](#), Gowin Software User Guide

1.3 Terminology and Abbreviations

The terminology and abbreviations used in this manual are as shown in Table 1-1.

Table 1-1 Terminology and Abbreviations

Terminology and Abbreviations	Meaning
FPGA	Field Programmable Gate Array
IP	Intellectual Property
DSP	Digital Signal Processing
SRAM	Static Random Access Memory
BSRAM	Block Static Random Access Memory
ISP	Image Signal Processing
AE	Auto Exposure
AWB	Auto White Balance
RGB	R(Red) G(Green) B(Blue)

1.4 Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly by the following ways.

Website: www.gowinsemi.com/en

E-mail: support@gowinsemi.com

2 Overview

2.1 Gowin AEAWB IP Introduction

Gowin AEAWB IP is applied for auto exposure and auto white balance. This IP collects statistical information about images, calculates the required gain, and outputs the adjusted images.

Table 2-1 Gowin AEAWB IP

Gowin AEAWB IP	
IP Core Application	
Logic Resource	Please refer to Table 2-2.
Delivered Doc.	
Design Files	Verilog (encrypted)
Reference Design	Verilog
TestBench	Verilog
Test and Design Flow	
Synthesis Software	GowinSynthesis®
Application Software	Gowin Software (V1.9.7.05Beta)

2.2 Features

- Supports 8x8~4320x7680 pixels of input images.
- Supports 8, 10, 12, 16 bits data width of input images.
- Supports 8, 10, 12, 16 bits data width of output images.
- Supports the mean output of R, G, B, and Y color channels.

2.3 Max. Frequency

The maximum frequency of Gowin AEAWB IP is mainly determined by the speed grade of the devices and configuration parameters. For example, when GW2A-18 series of devices used, the system clock can reach a maximum frequency of 95M.

2.4 Latency

Gowin AEAWB IP latency is usually three clock cycles.

2.5 Resource Utilization

Gowin AEAWB IP resource utilization mainly depends on the size of image, etc. The resource utilization may be different with different devices.

Taking GW2A-18 series of FPGA as an example, Gowin AEAWB IP resource utilization is shown in Table 2-2.

Table 2-2 Resource Utilization (GW2A-18 C8/I7)

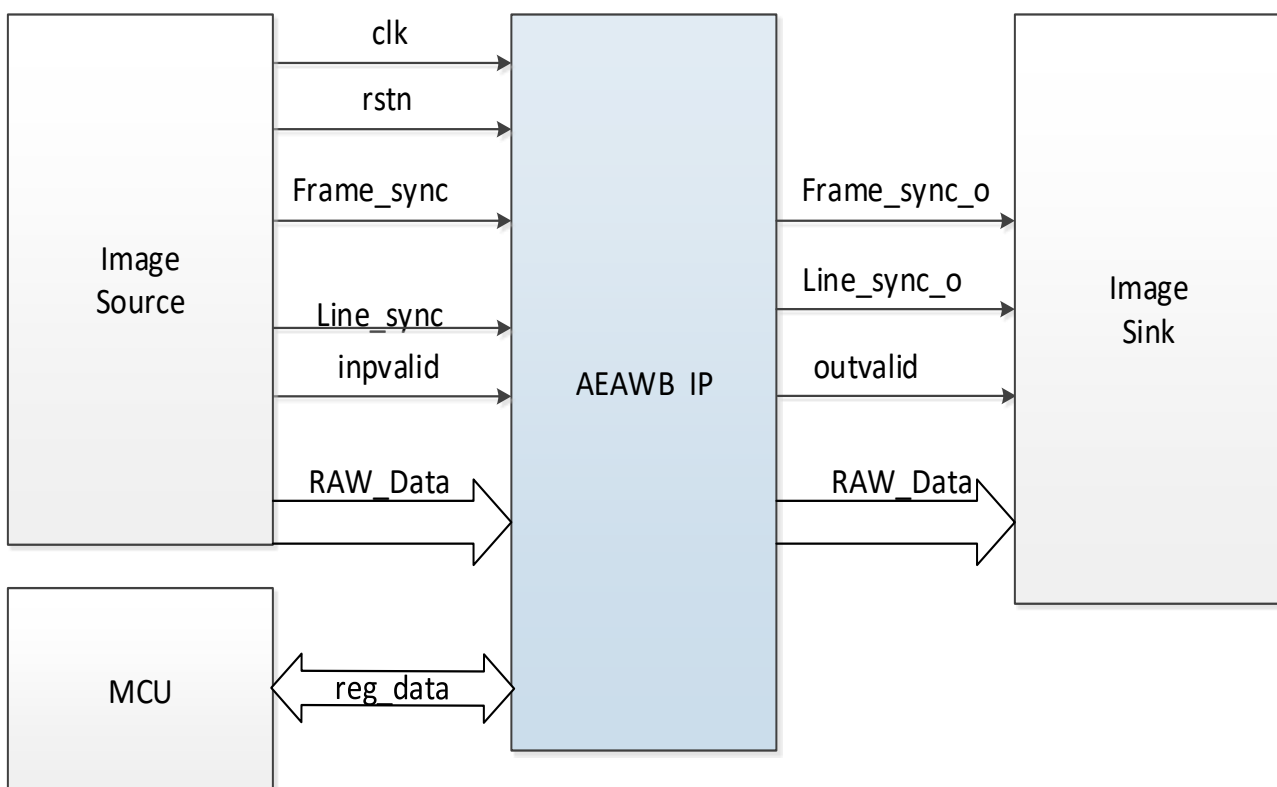
Frame Size	Data Width	LOGIC	REG	DSP Macro	BSRAM
640*480	8	4490	2703	16	7

3 Functional Description

3.1 System Block Diagram

In Gowin AEAWB IP, the data comes from RAW data of the image source, and the output is from the selected coefficient matrix and offset operation. The block diagram is shown Figure 3-1.

Figure 3-1 Gowin AEAWB IP Block Diagram



3.2 Algorithm Introduction

AEAWB, or auto exposure/auto white balance. It is mainly used for image information statistics and adjusting image exposure and white balance.

1. Mean Statistics

The mean reflects the brightness of the image. The larger the mean is, the greater the brightness of the image is, and vice versa.

$$\bar{Y} = \frac{1}{MN} (0.299 * \sum_{i=1}^M \sum_{j=1}^N R_{ij} + 0.587 * \sum_{i=1}^M \sum_{j=1}^N G_{ij} + 0.144 * \sum_{i=1}^M \sum_{j=1}^N B_{ij})$$

Where M and N are the number of vertical and horizontal pixels of the image respectively, R, G and B are the three color channels respectively, and Y is the mean grayscale value.

2. Window Statistics

Due to the uncertainty of light source distribution, window statistics are added. A window of a certain size is set in the image, and it is evenly divided into 16 zones, and the weight of each zone can be set flexibly, as shown in Figure 3-2.

Figure 3-2 Window Divided



$$\bar{Y}_k = \frac{1}{MN} \left(0.299 * \sum_{i=1}^M \sum_{j=1}^N R_{ij} + 0.587 * \sum_{i=1}^M \sum_{j=1}^N G_{ij} + 0.144 * \sum_{i=1}^M \sum_{j=1}^N B_{ij} \right)$$

$$\bar{Y} = \frac{1}{16} \sum_{k=1}^{16} (W_k * \bar{Y}_k)$$

Where M and N are the number of vertical and horizontal pixels of the image respectively, R, G and B are the three color channels respectively, W_k is the weight of each zone, and Y is the mean grayscale value.

1. White Balance Correction

The gray world is used to improve the image quality.

$$\begin{cases} R_{out} = \frac{R_{in} * Grey}{R_{over}} \\ G_{out} = \frac{G_{in} * Grey}{G_{over}} \\ B_{out} = \frac{B_{in} * Grey}{B_{over}} \end{cases}$$

Where (R_{in}, G_{in}, B_{in}) and $(R_{out}, G_{out}, B_{out})$ are the values of the original image and the corrected image R, G, and B channels, and $\frac{Grey}{over}$ is the white balance correction gain.

2. Exposure Correction

$$Data_{out} = Data_{in} * AE_Gain$$

Where $Data_{in}$ and $Data_{out}$ are the original image and the corrected image, and AE_Gain is the exposure correction gain.

3.3 Gowin AEAWB IP Registers

Gowin AEAWB IP parameters can be read or rewritten by accessing specific registers, and the details are as shown in Table 3-1.

Table 3-1 Gowin AEAWB IP Registers

Name	Address (8 bits)	Type	Description
Window_Top	0x20	Write-only	Write window top
Window_Left	0x24	Write-only	Write window left
Window_Height	0x28	Write-only	Write window height
Window_Width	0x2C	Write-only	Write window width
AWB_Gain_R	0x30	Read-only	Read AWB statistic gain of channel R
AWB_Gain_G	0x34	Read-only	Read AWB statistic gain of channel G
AWB_Gain_B	0x38	Read-only	Read AWB statistic gain of channel B
AE_Gain	0x3C	Read-only	Read AE statistic gain
Mean_R	0x40	Read-only	Read mean of channel R
Mean_G	0x44	Read-only	Read mean of channel G
Mean_B	0x48	Read-only	Read mean of channel B
Mean_Y	0x4C	Read-only	Read mean of Y (Brightness)
Window_Mean_R	0x50	Read-only	Read mean of channel R in the window
Window_Mean_G	0x54	Read-only	Read mean of channel G in the

Name	Address (8 bits)	Type	Description
			window
Window_Mean_B	0x58	Read-only	Read mean of channel B in the window
Window_Mean_Y	0x5C	Read-only	Read mean of Y (Brightness) in the window
Target_Y	0x60	Write-only	Write target Y (Brightness) in the window
Window_Weight	0xAx	Write-only	Write the weight of 0~15 zones

4 Port Description

The IO ports of Gowin AEAWB IP are shown in Figure 4-1. For the details, you can see Table 4-1.

Figure 4-1 Ports Diagram of Gowin AEAWB IP

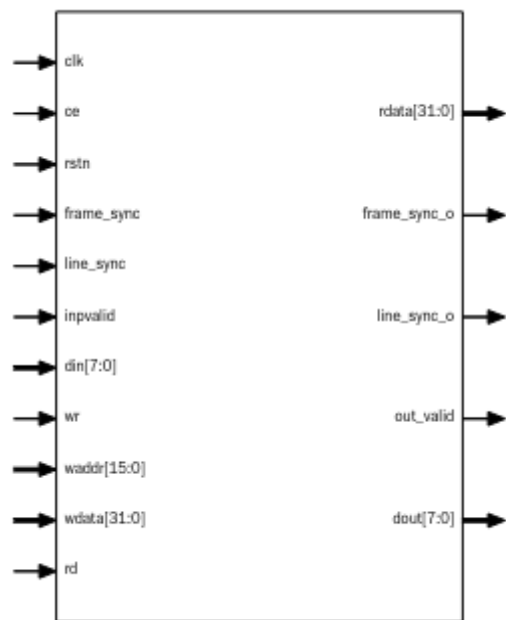


Table 4-1 Ports List of Gowin AEAWB IP

Signal	I/O	Data Width	Description
clk	I	1	Input clock signal
rstn	I	1	Reset signal, active-low.
ce	I	1	Enable Signal
frame_sync	I	1	Input frame synchronization signal
line_sync	I	1	Input line synchronization signal
inpvalid	I	1	Input data valid signal
din	I	Optional	Input image data signal
wr	I	1	Write signal
waddr	I	16	Write address signal
wdata	I	32	Write data signal

Signal	I/O	Data Width	Description
rd	I	1	Read signal
rdata	O	32	Read data signal
frame_sync_o	O	1	Output frame synchronization signal
line_sync_o	O	1	Output line synchronization signal
outvalid	O	1	Output valid signal, active-high.
dout	O	Optional	Output image data signal

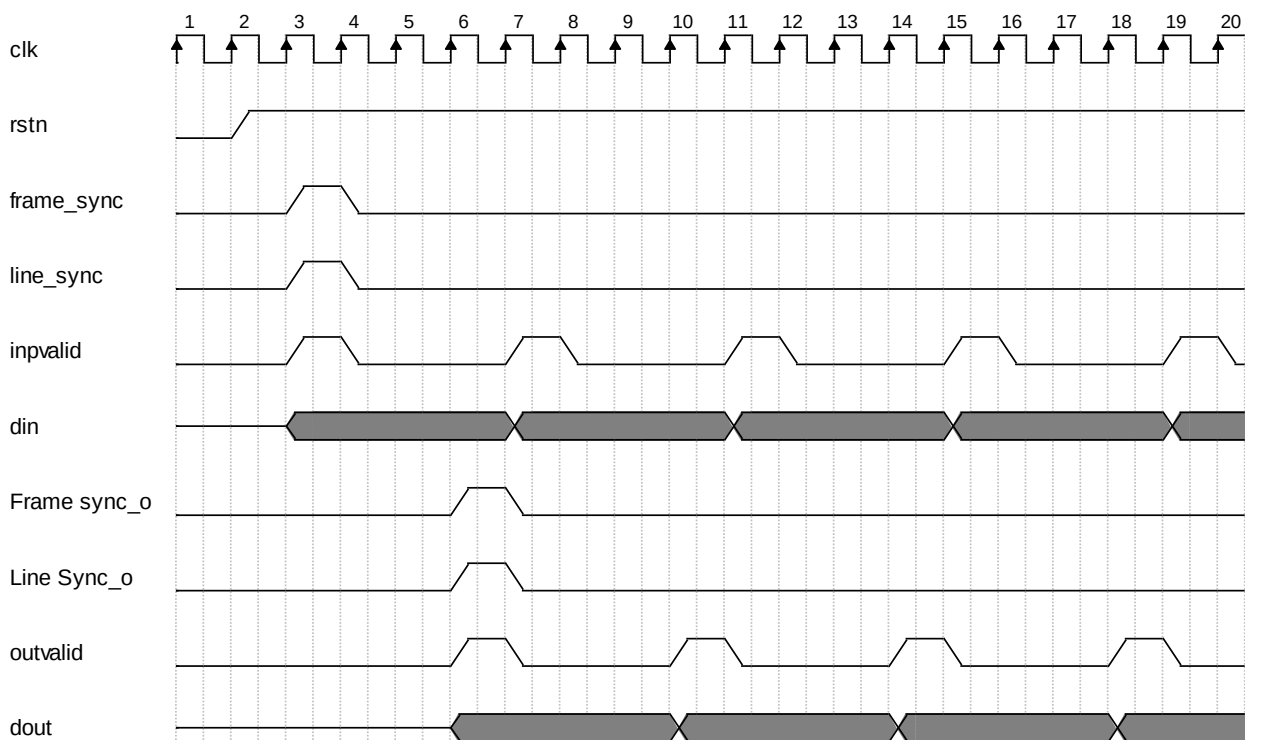
5 Timing Description

This chapter introduces the timing of Gowin AEAWB IP.

5.1 Timing Description

After the Gowin AEAWB IP operation, the data will be output with a latency of 3 clock cycles, and the IP timing is as shown in Figure 5-1.

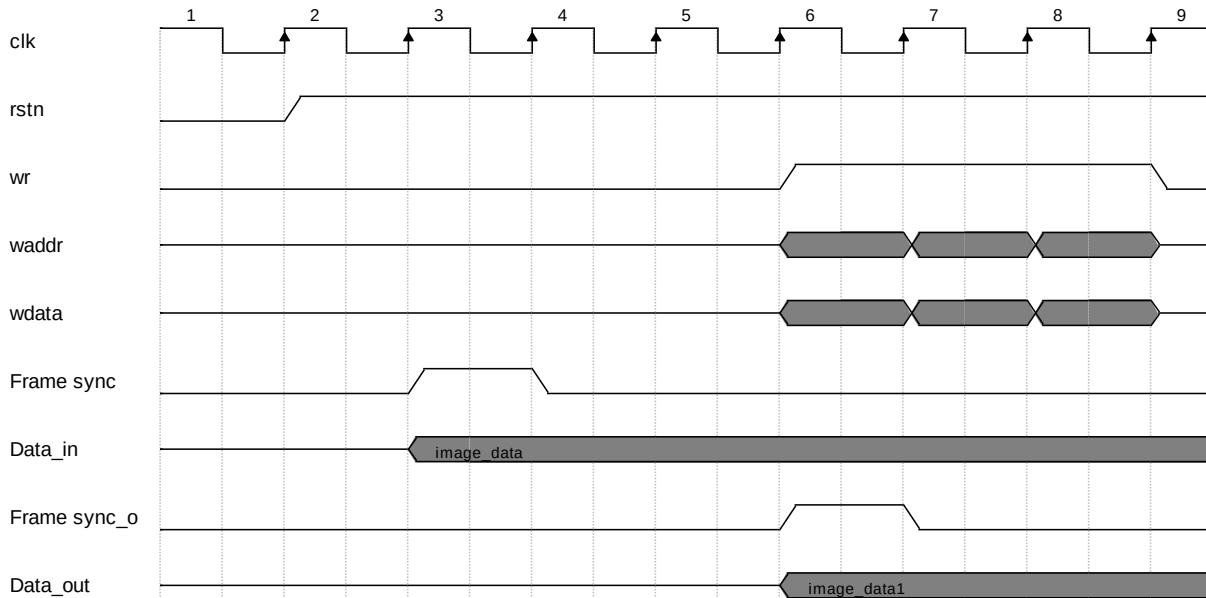
Figure 5-1 Gowin AEAWB IP Timing Diagram



5.2 Timing Description

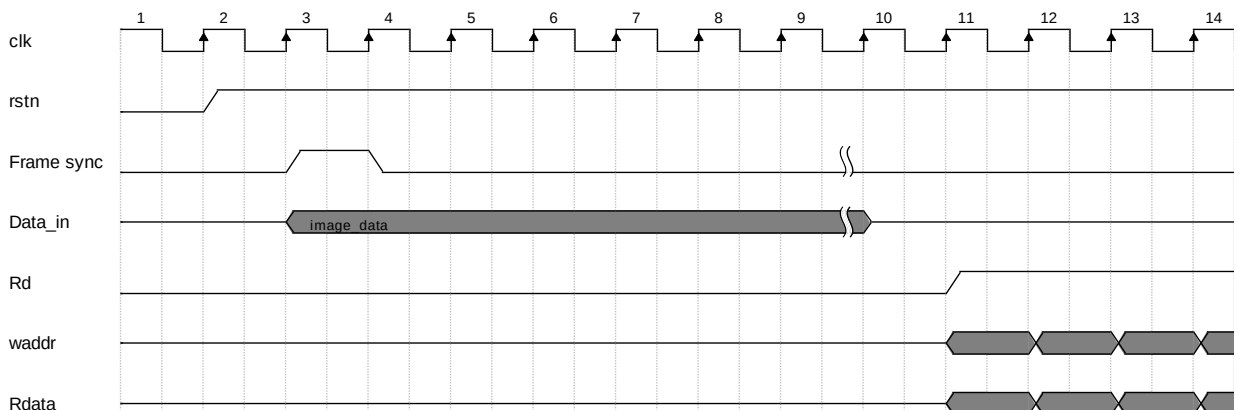
Some parameters of the Gowin AEAWB IP can be set through the GUI or written through registers while the IP is running, and the timing diagram is as shown in Figure 5-2.

Figure 5-2 Write Timing Diagram



The register read should be performed after a frame processing is completed, and the timing diagram is as shown in Figure 5-3.

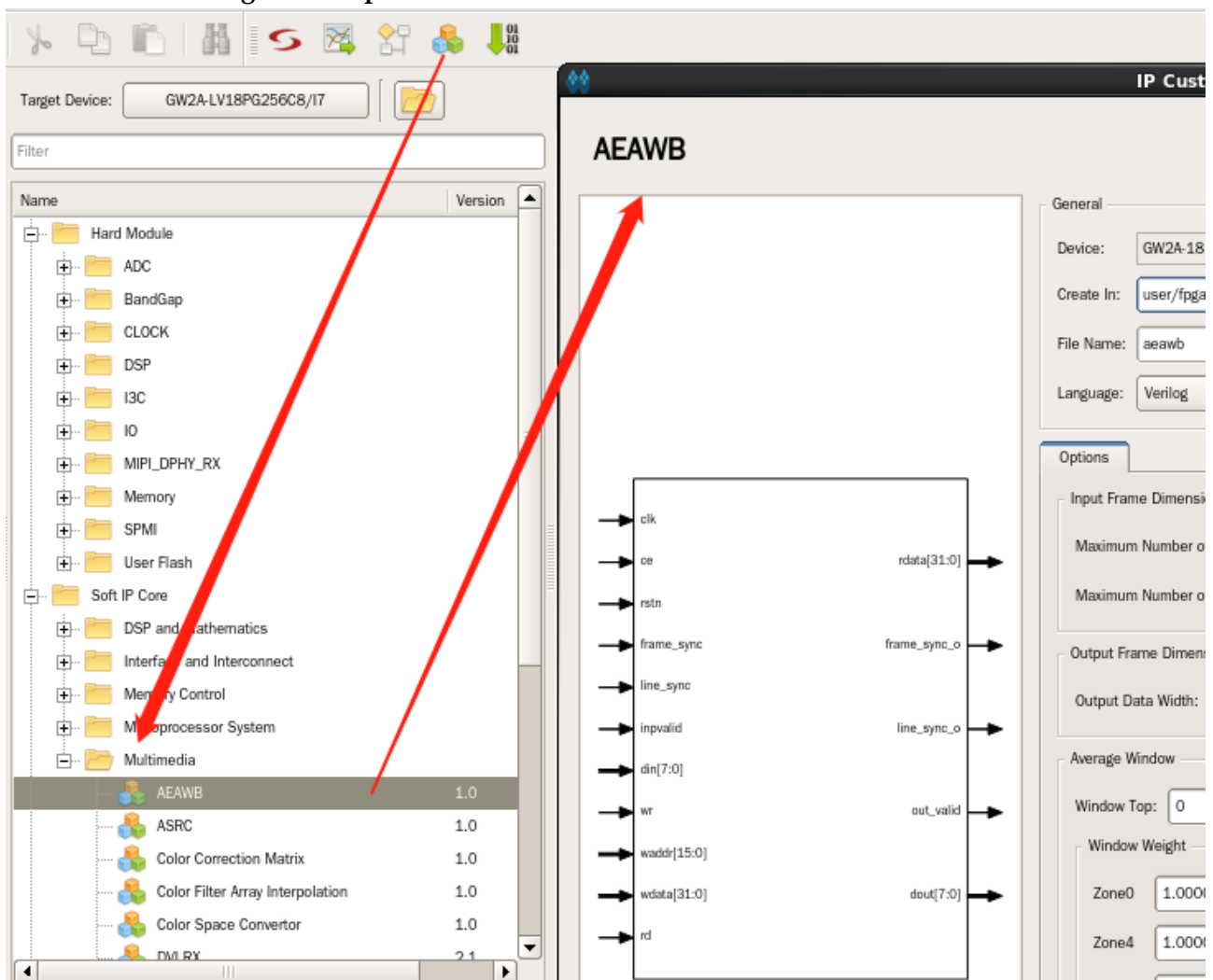
Figure 5-3 Read Timing Diagram



6 Call and Configure IP

Click "Tools > IP Core Generator > Multimedia > AEAWB" to call and configure Gowin AEAWB IP. Toolbar icon is also available as shown in Figure 6-1.

Figure 6-1 Open GUI via Icon



The Gowin AEAWB IP configuration interface is shown in Figure 6-2.

Figure 6-2 Gowin AEAWB IP Configuration

AEAwb

General

Device: GW2A-18 Part Number: GW2A-LV18PG256C8/I7

Create In: user/fpga_project/src/aeawb

File Name: aeawb Module Name: AEAwb_Top

Language: Verilog Synthesis Tool: GowinSynthesis

Options

Input Frame Dimension

Maximum Number of Columns: 8 (8-7680) Input Data Width: 8

Maximum Number of Rows: 8 (8-4320) Bayer Phase: RGGB

Output Frame Dimension

Output Data Width: 8

Average Window

Window Top: 0 Window Left: 0 Window Width: 0 Window Height: 0

Window Weight

Zone0: 1.000000	Zone1: 1.000000	Zone2: 1.000000	Zone3: 1.000000
Zone4: 1.000000	Zone5: 1.000000	Zone6: 1.000000	Zone7: 1.000000
Zone8: 1.000000	Zone9: 1.000000	Zone10: 1.000000	Zone11: 1.000000
Zone12: 1.000000	Zone13: 1.000000	Zone14: 1.000000	Zone15: 1.000000

Target Mean: 128

Generation Config

☒ Disable I/O Insertion

Help Cancel OK

- You can configure the generated file name by modifying the File Name.
- You can configure the module name by modifying the Module Name.
- You can configure IP working mode and other options by Options.

Gowin AEAwb IP parameter configuration is shown in Table 6-1.

Table 6-1 Gowin AEA WB IP Configuration Option

Option	Description
Maximum Number of Columns	Number of input image columns
Maximum Number of Rows	The number of input image rows
Input Data Width	Input data bit width, 8/ 12/16/2010 bits.
Output Data Width	Output data bit width, 8/10/12/16 bits.
Bayer Phase	Bayer Phase
Window Top	Write window top (No greater than the number of image rows)
Window Left	Write window top (No greater than the number of image columns)
Window Width	Window width setting
Window Height	Window height setting
Window Weight	Window weight setting (Each zone can be set independently)
Target Mean	Target mean setting

7 Reference Design

Please refer to the related test cases in RefDesign.

8 File Delivery

The delivery files for Gowin AEAWB IP include document and reference design.

8.1 Document

The document folder mainly contains the user guide in PDF.

Table 8-1 Document List

Name	Description
IPUG782, Gowin AEAWB IP User Guide	Gowin IP User Guide, namely this one.
Gowin AEAWB IP Release Note	—

8.2 Reference Design

The Ref. Design folder contains the netlist file, the user reference design, the constraints file, the top file, and the project folder, etc.

Table 8-2 Ref. Design Folder Contents

Name	Description
aeawb_exp.v	Top module and excitation generation module of reference design
aeawb.vo	Gowin AEAWB IP netlist file
demo.cst	AEAWB physical constraints File
fpga_project.gao	Capture output data of AEAWB
aeawb	AEAWB IP project folder

