Gowin Analyzer Oscilloscope

User Guide

SUG114-2.0E, 11/28/2019

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Revision History

Date	Version	Description
02/20/2017	1.0E	Initial version published.
01/30/2018	1.2E	● GW1NR-4、GW1N-6、GW1N-9、GW1NR-9 supported; ● Gowin GAO configuration tool interface and Gowin Analyzer Oscilloscope tool interface updated; ● Gowin Analyzer Oscilloscope's tool operation and diagram updated.
08/152018	1.3E	● The function of outputing waveform data added. ● Blank if the Expression window on the STD configuration interface, double-clicking to pop up the formula editing window; ● The daisy chain settings supported;
10/262018	1.4E	GW1NS-2, GW1NZ-1, and GW1NSR-2C supported.
11/15/2018	1.5E	● Supporting GW1NSR-2; ● GW1N-6ES, GW1N-9ES and GW1NR-9ES devices removed;
01/26/2019	1.6E	● The default path for Bitstream files changed.
02/26/2019	1.7E	● Auto run function added in Gowin Analyzer Oscilloscope; ● GOwin Analyzer Oscilloscope added the saving function and generated the project file with the suffix of. Analyzer_prj. ● Improved the Bus signal display status on the Windows interface of Gowin Analyzer Oscilloscope.
05/30/2019	1.8E	● New device supported: GW1N-1S, FN32; ● The “GAO” icon added on the tool bar; ● GAO supports to sort trigger signals and sampling signals by dragging and dropping; ● “Value” in the “Match Unit” configuration view of GAO supports decimal numbers; ● GAO wave display interface supports full screen display and the “Ctrl+F” shortcut.
08/15/2019	1.9E	● GW1N-4S and GW1NS-4 supported. ● GW1NSE-2C supported. ● GAO configuration is supported and it does not resynthesize GAO when Device is not modified. ● GAO supports multiple AO Cores. ● GAO configuration interface supports displaying the number of BSRAM used by current AO Core. ● Capture Signals in GAO configuration interface supports signals Group, Ungroup, Rename and Restore Original Name. ● GAO waveform display interface integrates Programmer download function. ● GAO waveform display interface signals support Rename and Restore Original Name. ● The GAO capture interface is not closed for repeated triggering, and the waveform display window size remains the same as the last time. ● Waveform data file exported by GAO waveform display interface supports binary, octal, decimal and hexadecimal.
11/28/2019	2.0E	● GW1NRF-4B, GW1NSER-4C supported and GW1N-4S removed; ● Capture signal supports Rename and Restore of Bus signal; ● Merge Programmer and Device in GAO; ● The column width of Name and Value in waveform display

		interface can be adjusted by dragging, and the adjustment remains unchanged when it is triggered again.

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1 About This Guide

1.1 Purpose

The guide describes the operation flow of the Gowin Analyzer Oscilloscope (GAO). The purpose of this document is to familiarize users with the use of the GAO configuration file (.gao) and GAO interface as a means of improving the efficiency of design analysis. The software interface screenshots and the supported products list in this guide are based on the version Windows 1.9.3Beta. As the software is subject to change without notice, some information may not remain relevant and may need to be adjusted according to the software that is in use.

1.2 Supported Products

The information presented in this guide applies to the following products:

- GW1N series of FPGA Products: GW1N-1, GW1N-1S, GW1N-2,GW1N-2B,GW1N-4,GW1N-4B, GW1N-6,GW1N-9
- GW1NR series of FPGA products: GW1NR-4, GW1NR-4B, GW1NR-9
- GW2A series of FPGA products: GW2A-18 and GW2A-55
- GW2AR series of FPGA products: GW2AR-18
- GW1NS series of FPGA products: GW1NS-2, GW1NS-2C, GW1NS-4
- GW1NSE series of FPGA products：GW1NSE-2C
- GW1NZ series of FPGA products: GW1NZ-1
- GW1NSR series of FPGA products: GW1NSR-2C, GW1NSR-2, GW1NSR-4, GW1NSR-4C
- GW1NRF series of FPGA products: GW1NRF-4B
- GW1NSER series of FPGA products: GW1NSER-4C

1.3 Related Documents

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

1. SUG100, Gowin YunYuan Software User Guide

1.4 Terminology and Abbreviations

Table 1-1 shows the abbreviations and terminology that is used in this guide.

Table 1-1 Abbreviations and Terminology

Terminology and Abbreviations	Full Name
FPGA	Field Programmable Gate Array
JTAG	Joint Test Action Group
GAO	Gowin Analyzer Oscilloscope
AO	Analysis Oscilloscope
IO	Input/Output

1.5 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

E-mail: support@gowinsemi.com

Tel: +86 755 8262 0391

2 Introduction

GAO is a digital signal analyzer that was independently designed by Gowin. It is created to help users analyze the timing relationships, make a system analysis and find fault location more easily to improve design efficiency.

The GAO operates on the following basic principle: When in operation, the FPGA saves the signal in real time to memory according to the trigger conditions set by the user. It reads the signal state and displays it on the GUI through the JTAG interface in real-time. The GAO includes the signal configuration interface and the waveform display interface. The signal configuration interface is used to insert position information into the design, which is predominantly based on the sampling clock, trigger unit, and trigger expression. The waveform display interface connects software and target hardware through the JTAG interface, and visually displays the data for the sampled signal set by signal configuration interface with waveform.

The GAO has the following features:

- Up to 16 AOs supported.
- Each AO supports one or more port triggering.
- Each AO supports one or more trigger levels.
- Each trigger port supports one or more matching units.
- Each matching unit supports six types of trigger matching.
- AO uses window collection mode, which supports the collection of one or more windows.
- Use data ports to save device resources.

3 GAO Config File

The AO of GAO consists of two parts: AO Control and AO. The AO Control is the communication controller of all AO and JTAG scanning circuits. AO is used for configuring trigger signals and collecting and storing data. The AO Control connects the upper computer and the AO. It receives instruction and sends it to the AO during configuration. It also transmits the data collected by the AO to GUI as the data is being read. The AO directly communicates with and receives commands from the AO_Control, and collects and transfers data according to the instructions provided by the user.

GAO Config View is used to configure and change the AO_Control and its parameters. It helps users quickly and easily analyze data signals after synthesis, placement and routing. It also improves timing analysis efficiency.

3.1 Standard Mode GAO Configuration File

3.1.1 Start Standard Mode GAO Configuration File Interface

Before starting the Standard Mode GAO Config interface, you first need to create or load the configuration file (.gao).

Create Standard Mode GAO Configuration File

The steps are as follows:

1. In the "Design" view, right-click and select "New File..."
   The "New" dialog box will open, as show in Figure 3-1.
2. Select the "GAO Config File" and click "OK".
   The "New GAO Wizard" dialog box opens, as shown in Figure 3-2 select "Standard Mode", and then click "Next".
3. Enter the config file name in "New", as shown in Figure 3-3, and then click "Next".
4. Check the GAO config file mode and path, as shown in Figure 3-4. Click "Finish" to complete the configure file creation. Please refer to "GAO Config Files" in Design View for the GAO configuration file.

Figure 3-1 Creating Standard Mode GAO Configuration File (Standard Mode)

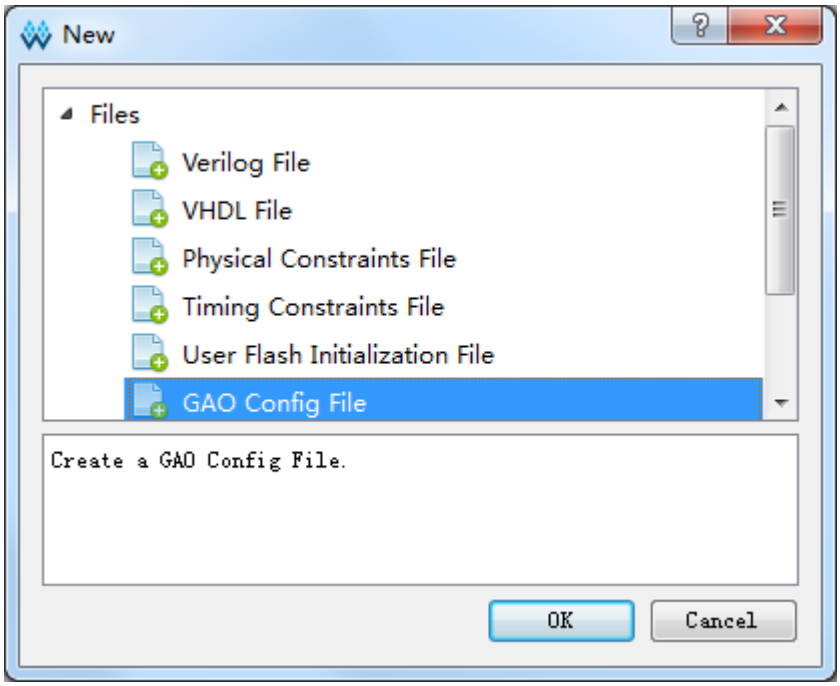


Figure 3-2 New GAO Wizard (Standard Mode)

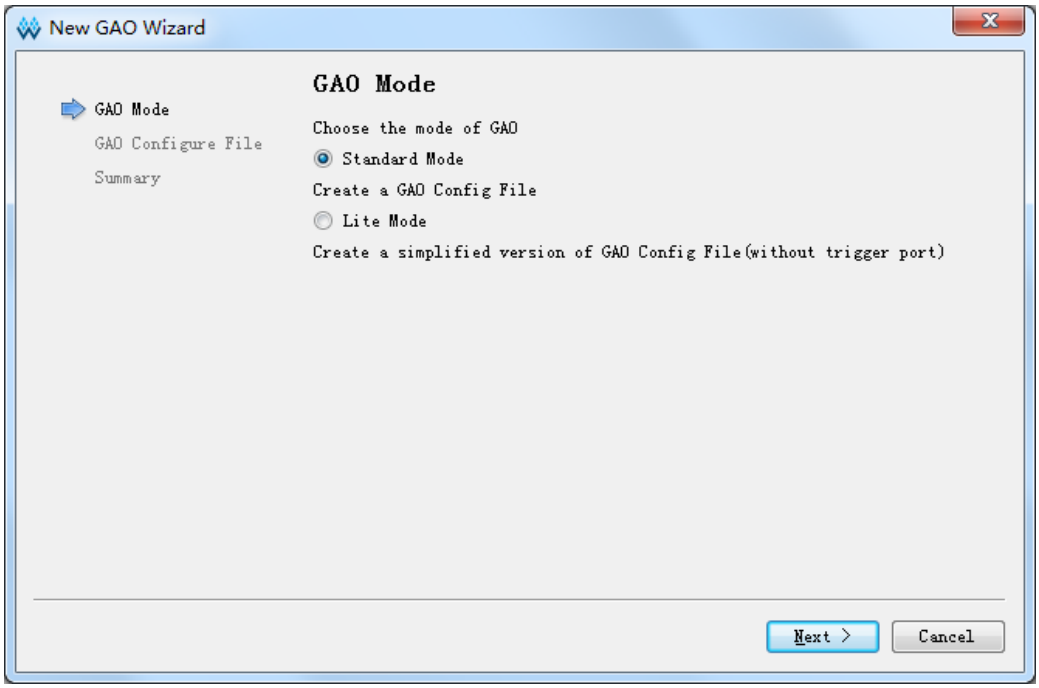


Figure 3-3 Mode GAO Configuration File Name

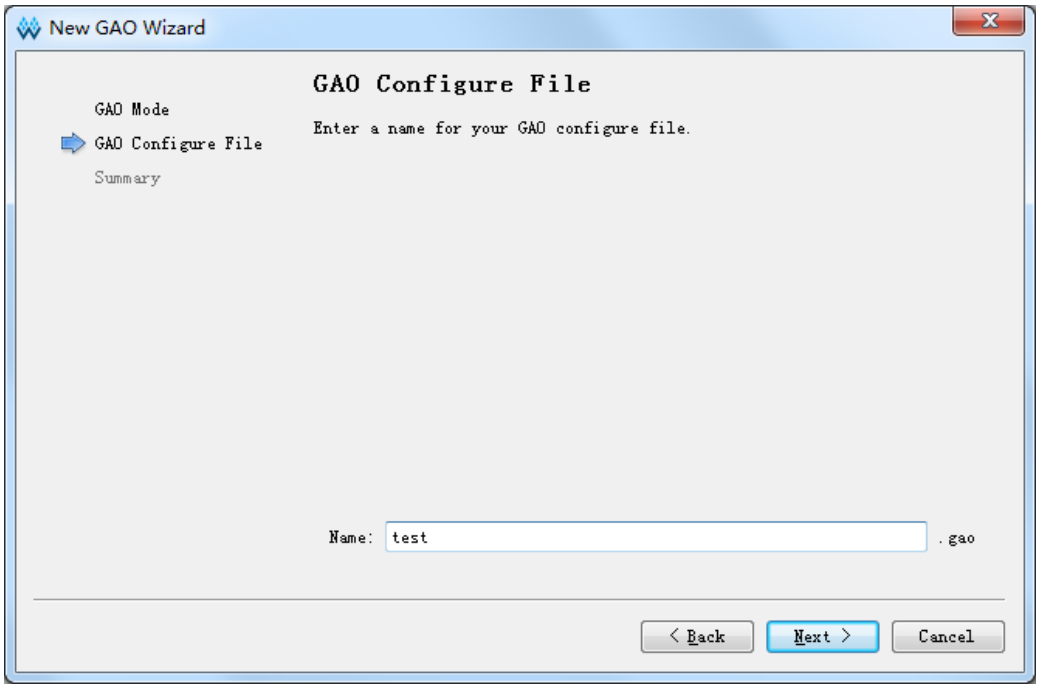
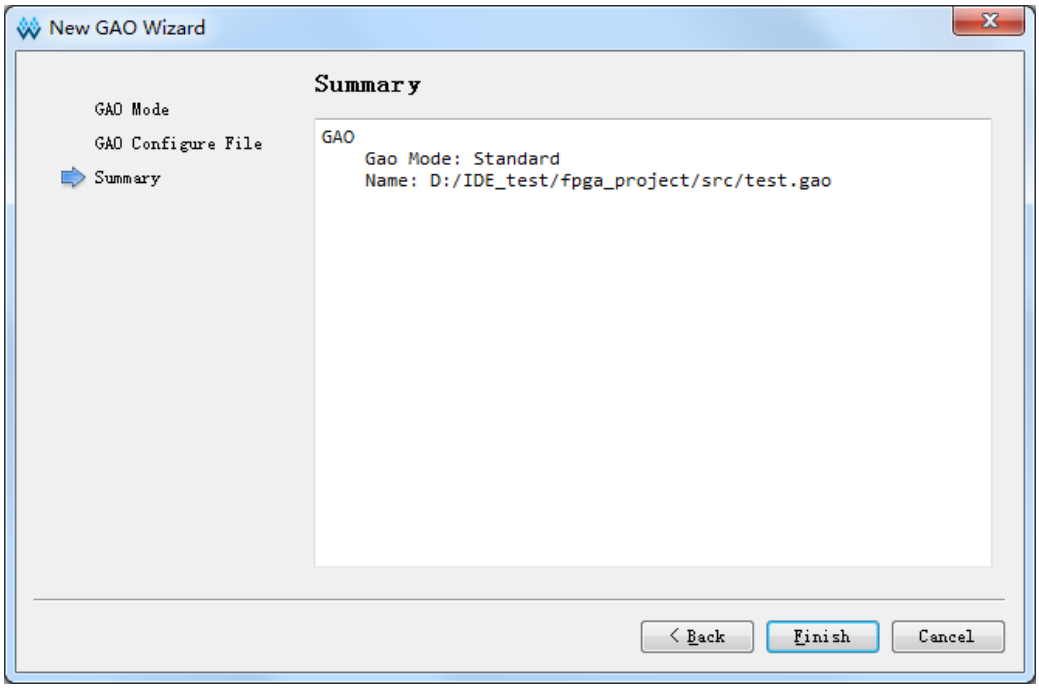


Figure 3-4 GAO Configuration File Mode and Path (Standard Mode)



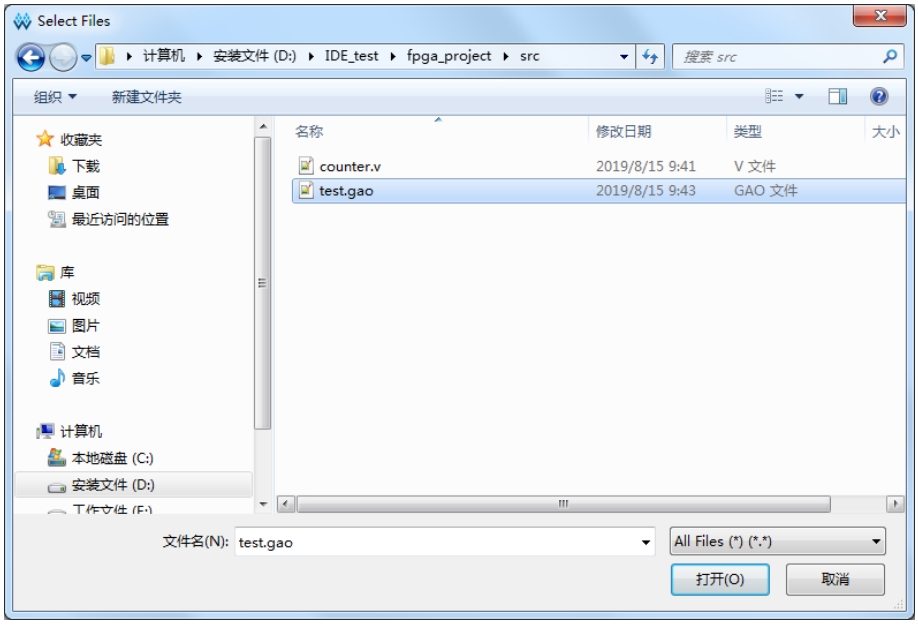
Creat a Standard Mode GAO Configuration File

The steps are as follows:

1. In the "Design" view, right click and select "Add Files..."
   The "Select Files" dialog box opens.
2. Select the existing standard mode configuration file (.gao), as shown in Figure 3-5.

3. Click "open" button, and the "GAO Config Files" column is in the Design window for the loaded GAO configuration files.

Figure 3-5 Load the Standard Mode GAO configuration file

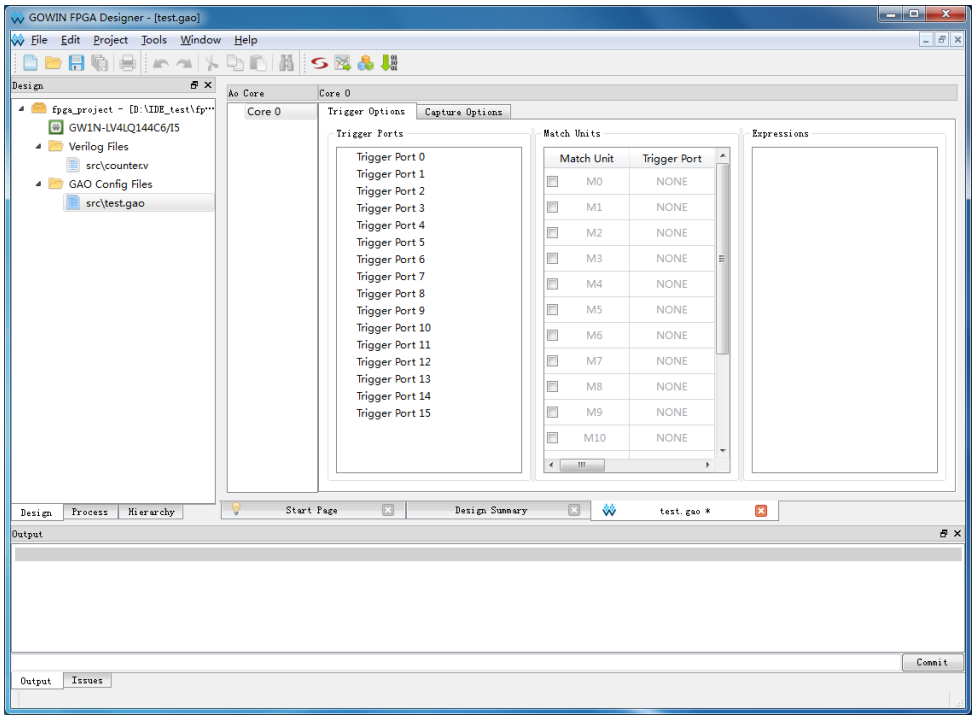


Start Standard Mode GAO Configuration File Interface

Double click the configuration file (.gao) in "Design". The "GAO Config" will open in the Gowin YunYuan main window, as shown in Figure 3-6.

"GAO Config" includes AO Core for configuring the number of AO, Trigger Options for configuring Trigger conditions and Capture Options for configuring signals sampling criteria.

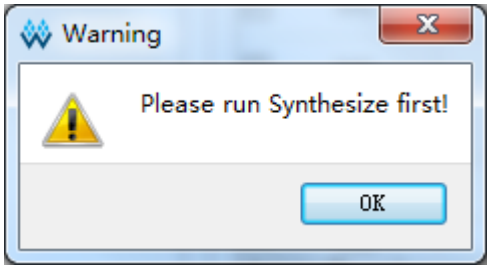
Figure 3-6 Gowin GAO Configuration Tool Interface (Standard Mode)



Note!

If the project fails to synthesize, when the user double click the configuration file (.gao), the "Warning" prompt box will pop up, as shown in Figure 3-7.

Figure 3-7 Compile Netlist Prompt Box (Standard Mode)



3.1.2 Configure Standard Mode GAO

The "GAO Config" is used to configure the number of AO, signal triggering conditions and signal sampling conditions.

The Number of AO Configuration

The AO Core is used to display and manage the number of AO used by current project, as shown in Figure 3-8. The AO Core only contains Core0 by default, and it can support up to 16 cores. The following operations can be performed in the order from Core0 to Core15.

1. Right click anywhere in the AO Core view to pop up the menu, click "Add" to add new AO Core.
2. Right click a Core in AO Core view and click "Remove" to remove the corresponding Core.
3. When the Core number is deleted, the subsequent Core number decreases successively, and the Core number increases continuously.
4. Left click to select a Core, and the menu of corresponding Core will be displayed on the right, as shown in Figure 3-9. For example, when Core2 is selected in AO Core, the menu of Core2 will be displayed on the right.

Note!

- When the AO Core view contains only one Core, it is forbidden to delete it. If the Core is selected and click "Remove", the prompt box will pop up, as shown in Figure 3-10.
- 16 cores are supported at most. When more than 16 cores are added, Error prompt box will pop up, as shown in Figure 3-11.

Figure 3-8 AO Core

Figure 3-9 Configuration View of A Selected Core

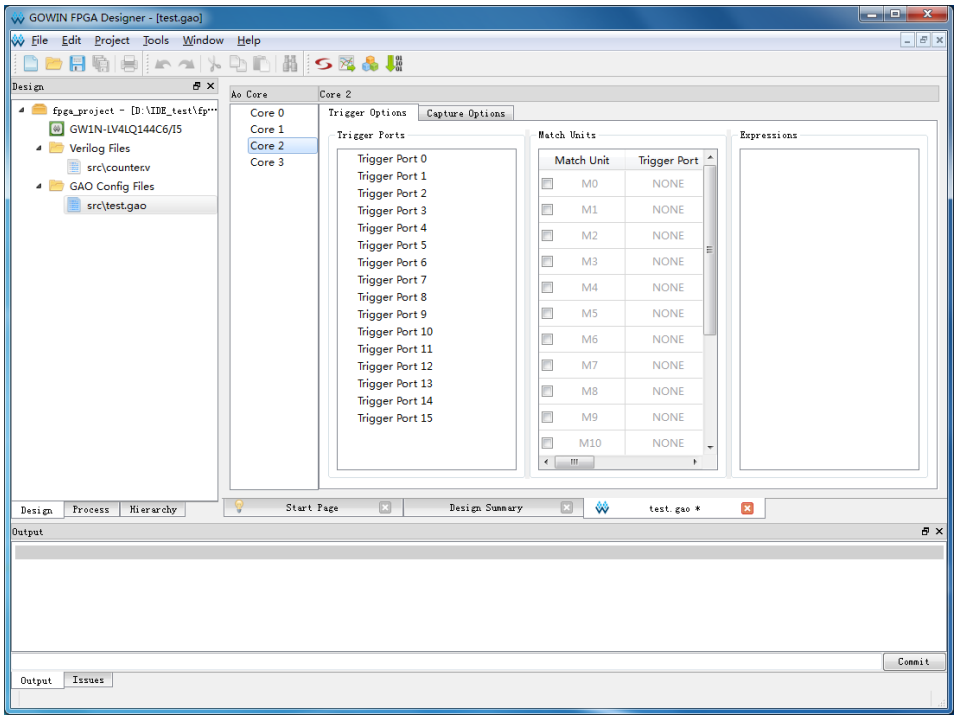


Figure 3-10 Prompt Box When Deleting the Only Core

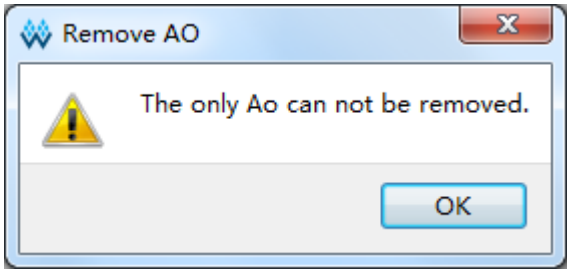
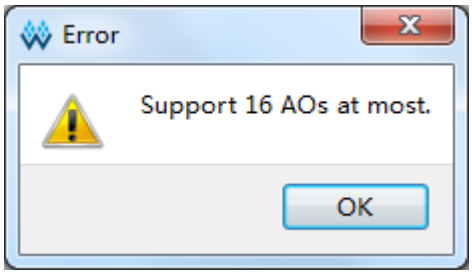


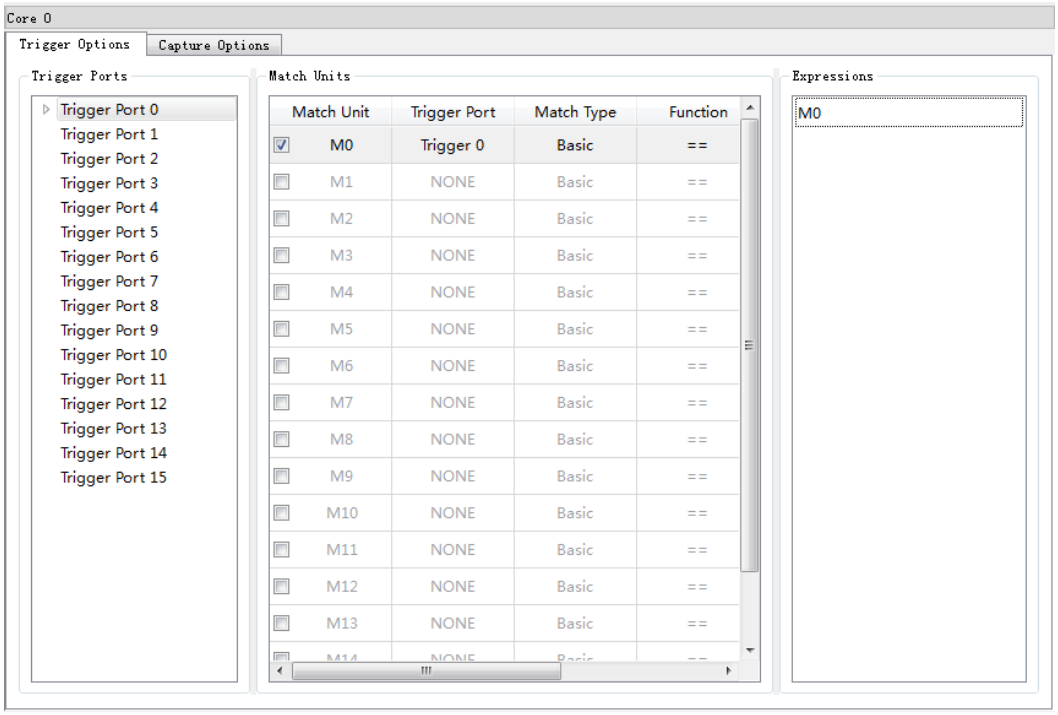
Figure 3-11 Upper Limit Prompt Box



Trigger Condition Configuration

Trigger options are used to configure signal trigger conditions, as shown in Figure 3-12. The upper left corner shows the currently configured AO Core. The Trigger Ports view is used to configure AO Trigger Ports, the Match Units view is used to configure the Trigger matching Units, and the Expressions view is used to configure the Trigger expressions.

Figure 3-12 Trigger Options View



Trigger Ports Configuration

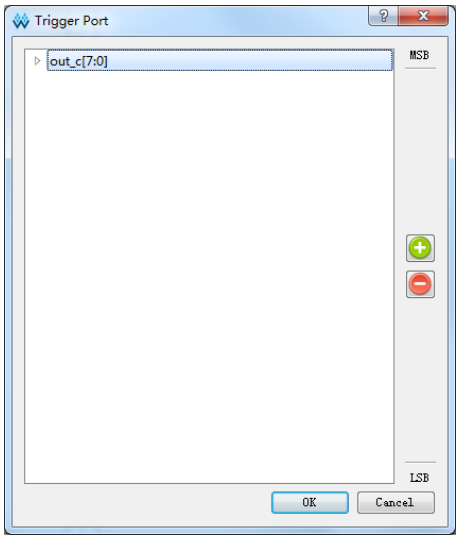
The Trigger Ports view is used to configure the AO Trigger ports in following steps:

1. Double-clicking on trigger port. The dialog box will open, as shown in Figure 3-13.
2. Click on the " " icon. The "Search Nets" dialog box will pop up. Click "Search", as shown in Figure 3-14.
3. Select trigger signal and click "OK" to finish selecting the trigger signal.

Note!

There are 16 Trigger Ports (Trigger Port 0 ~ Trigger Port 15), and each trigger port width is from 1 to 64.

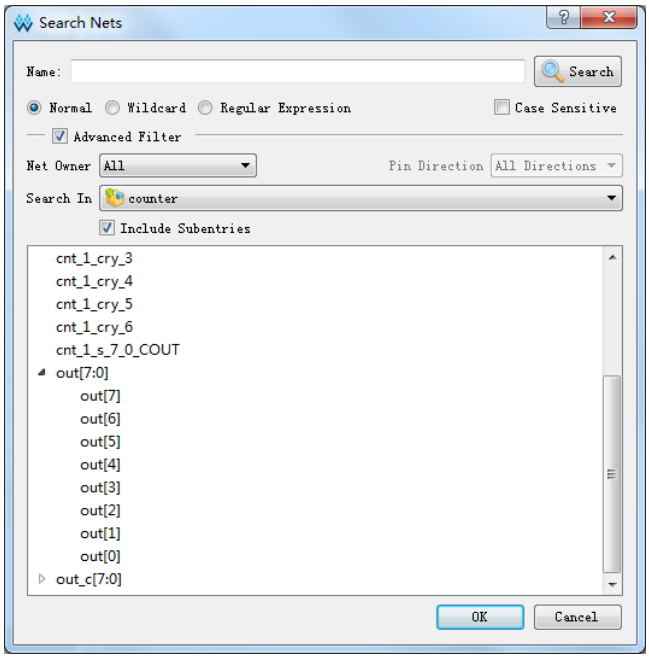
Figure 3-13 Trigger View



Note!

- MSB and LSB in Figure 3-13 indicate the high and low significant bit of trigger ports.
- To delete the trigger signal, left click to select the trigger signal, or use Shift + left and Ctrl + left to select multiple trigger signals, and then click the " " icon to delete.
- Signals can be sorted by dragging and dropping. Users can click the left button to select one signal or select multiple signals by Shift+left button or Ctrl+left button, and then drag and drop to sort the signals.

Figure 3-14 Search Nets Dialog Box



Normal, Wildcard, and Regular Expression are mutually exclusive.

- Normal means setting in the normal mode. Click "Search" to match all the character string in the name text box, as shown in Figure 3-15.
- Wildcard means setting in the wildcard. Click "Search" to match all the character string in the name text box. The string contains wildcards (*,?), as shown in Figure 3-16.

- Regular expression means setting with a regular expression. In this mode, click "Search" to match all the character string in the name text box. The string contains Regular Expression.
- If "Case Sensitive" is checked, the case-sensitive rule will be applied during signal matching.

The signal area in the "Search Nets" dialog box supports left-click, Shift + left and Ctrl + left.

Figure 3-15 Normal Mode

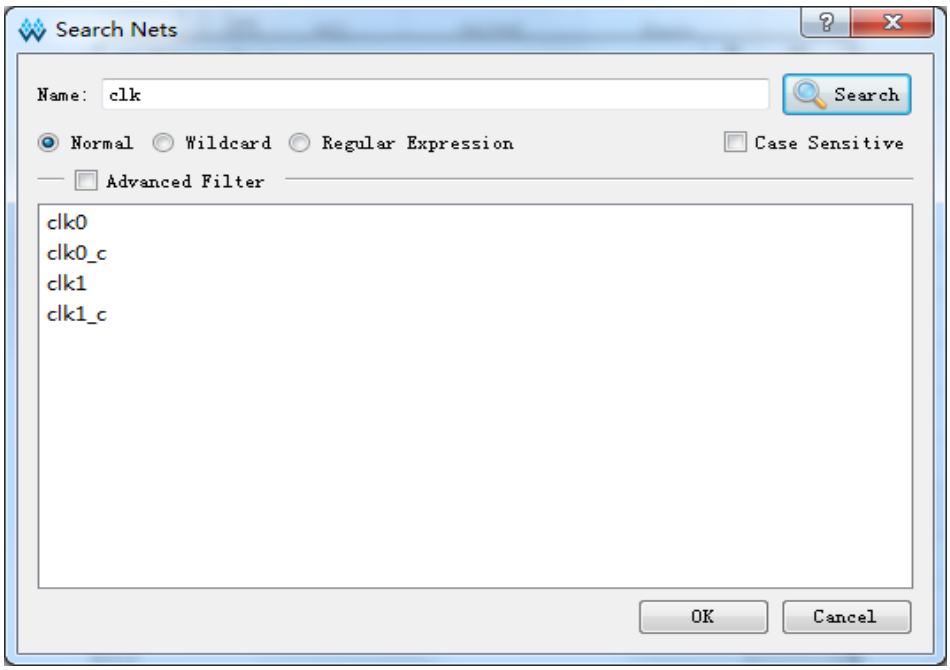
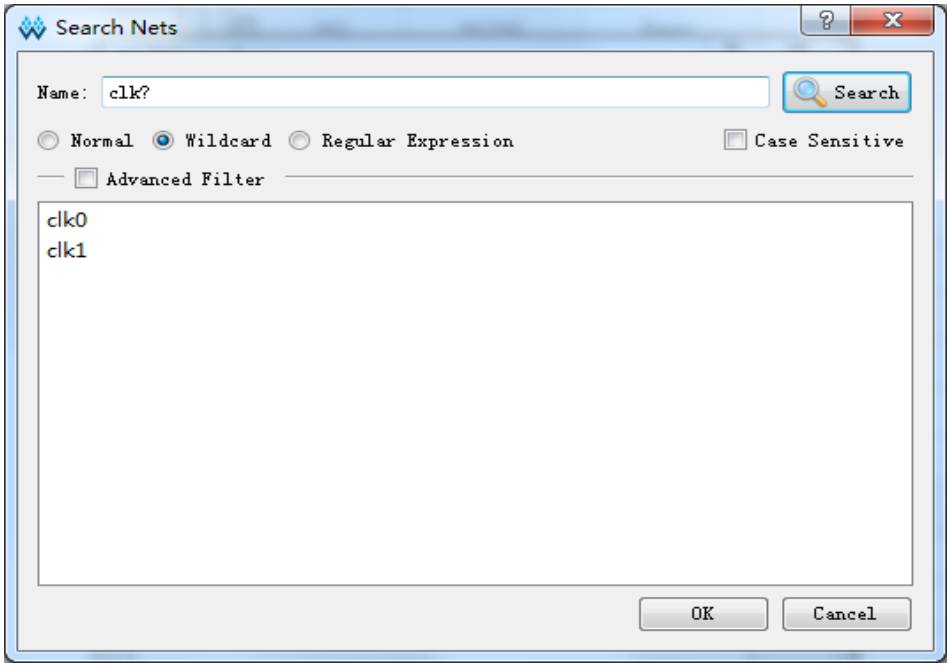


Figure 3-16 Wildcard Mode



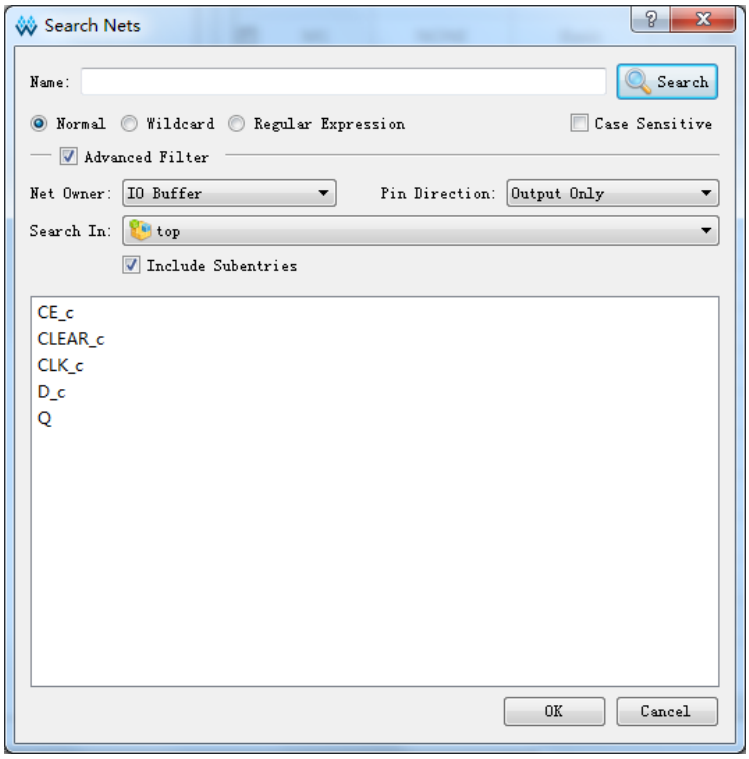
Select the "Advanced Filter" checkbox to further define filter conditions as a means of more specifically searching the required signals. Among

them:

- The "Net Owner" option is used to set the type of module which the signal belongs to. The user can select one or all.
- The "Pin Directions" option is used to set whether the signal is output only, input only or all directions.
- The "Search In" option is used to set module where signals are filtered.
- The "Include Subentries"option is used to set whether to filter the signal from the submodule.

As shown in Figure 3-17, the "Net Owner" selects IO_Buffer, "Pin Directions" selects Output Only, "Search In" selects Top, and selects Include Subentries. Click "Search" to display all output signals associated with the top modules and their sub-modules.

Figure 3-17 Advanced Filtering



Match Unit Configuration

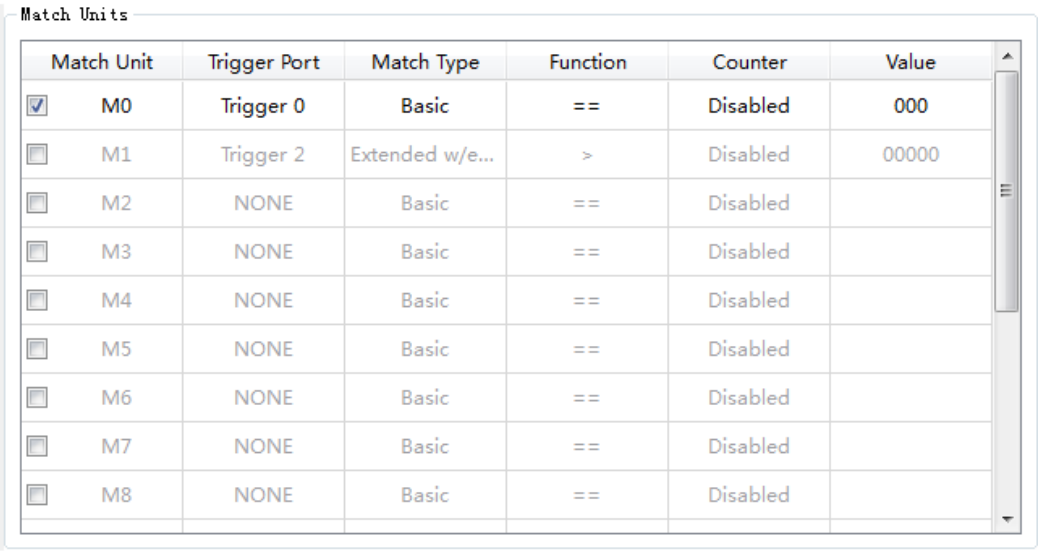
The match units view is used to configure the matching unit of trigger ports. There are up to 16 trigger match units, which range from M0-M15. Match unit is the minimum unit required for the GAO to achieve trigger conditions. AO sets the trigger port signals designed by the user through the matching unit and realizes the trigger if the trigger signal port signals meet the requirements.

Note!

- A trigger port can use one or more trigger match units, but a trigger match unit can only belong to one trigger port;
- Up to16 trigger match units can be used for all trigger ports.

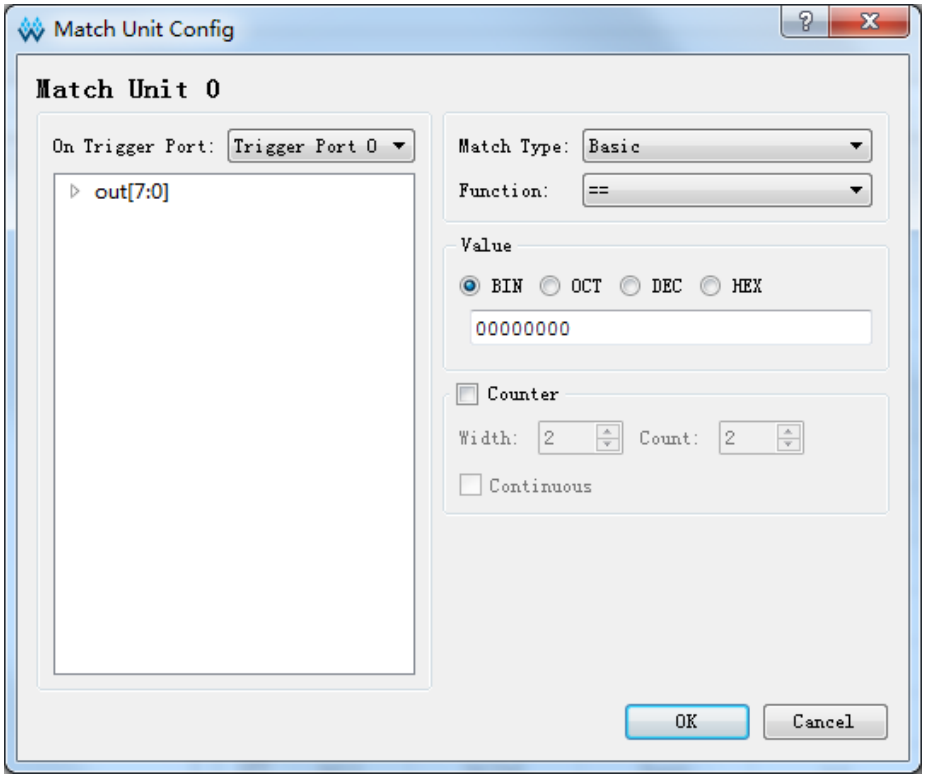
1. In the Match Units view, check the "Match Units" checkbox to the select trigger matching unit, as shown in Figure 3-18.

Figure 3-18 Match Units View



2. Double-click on one match unit to open the "Match Unit Config" dialog box and configure the trigger conditions, as shown in Figure 3-19.

Figure 3-19 Match Unit Config Dialog Box



3. Click "On Trigger Port" drop-down list and select the trigger port from the drop-down list.
4. Select the match type and function from the up to16 trigger match units "Match Type" and "Function" drop-down lists respectively. The available options are as follows:
   - Basic: Execute "= =" and "! = "operation, which are used for general signal comparison, and are a form of economical resource;

- Basic w/edges: Execute "= =" and "! = "and the jump test operation for control signal jumping;
- Extended: Execute operation “==”, ”!=”, ”>”, ” >=”, ”<”, and “<=” for the value of address or data signal;
- Extended w/edges: Execute operation “==”, ”!=”, ”>”, ”>=”, ”<”, ”<=” for the value of address or data signal or signal jumping;
- Range: Execute “==”, ”!=”, ”>”, ”>=”, ”<”, ”<=”, detect outside and inside of the range for the value specific range of addresses or data signals
- Range w/edges: execute “==”, ”!=”, ”>”, ”>=”, ”<”, ”<=”, detect outside and inside of the range, and signal jumping for the value specific range of addresses or data signals and signal jumping.

Value is used to set the bit value that correlates with the match type, as shown in Table 3-1. The bit value currently supports binary, octal, decimal and hexadecimal.

Table 3-1 Match Type Supported By Trigger Match Unit

Type	Bit Values	Matching Function	Description
Basic	0, 1, X	==,!=	Use for general signal comparison. Is a form of economical resource;
Basic w/edges	0, 1, X, R, F, B, N	= =,! =, jump detection	Use for control signal jumping;
Extended	0, 1, X	==,!=,>,>=,<, <=	Use for the value of address or data signal;
Extended w/edges	0, 1, X, R, F, B, N	==,!=,>,>=,<, <=, jumping detection	Use for the value of address or data signal and jumping signal;
Range	0, 1, X	==,!=,>,>=,<, <=, detection inside or outside of range	Use for the value of address or data signal in particular range;
Range w/edges	0, 1, X, R, F, B, N	==,!=,>,>=,<, <=, detection inside or outside of range, jumping detection	Use for the value of address or data signal in particular range and jumping detection;

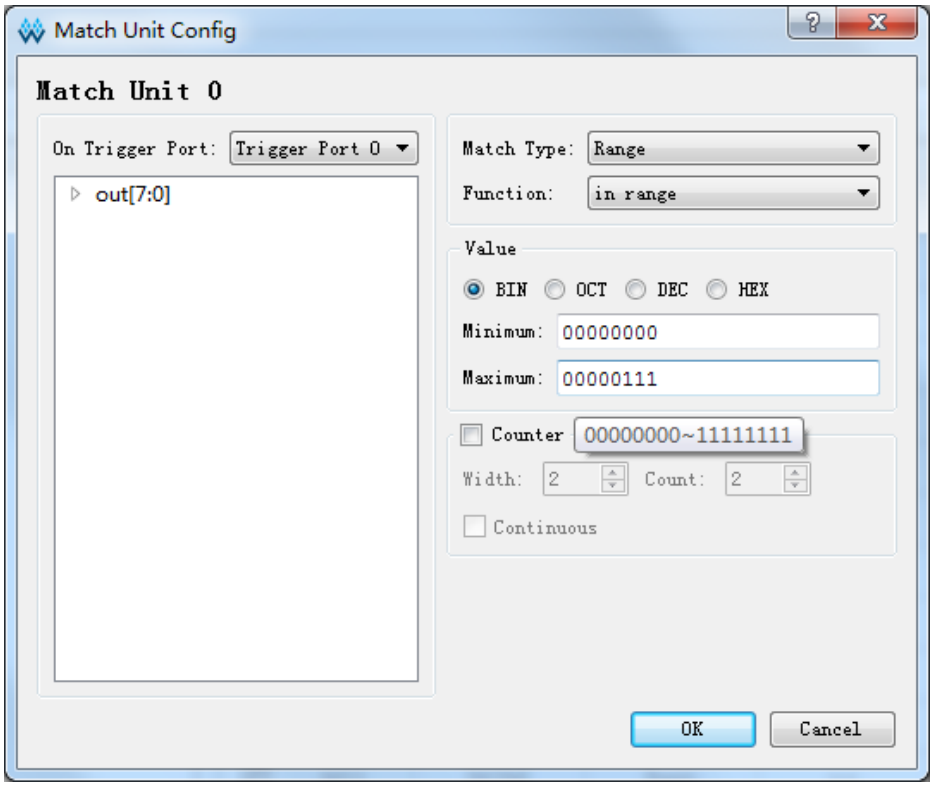
Note!

In Bit Values:

- "0" means low level 0.
- "1" means high level 1.
- "X" means both.
- "R" indicates the change in rising edge 0->1.
- "F" indicates the change in falling edge 1->0.
- "B" indicates transition in upward or downward edge.
- "N" means no logical level conversion.

5. If Match Type selects Range or Range w/edges, and Function selects Range or not in Range, the value specified in the "Minimum" field is the lower limit value, and the value in the "Maximum" field is the upper limit value, as shown in Figure 3-20.

Figure 3-20 Minimum/Maximum Setting for Detection in/not in Range



Each trigger matching unit has a counter for sampling data after the trigger conditions are met N times, where N is the counter value.

- Check "Counter" to set and use the counter. If the counter is unused, collect data after matching 1 time by default.
- Check "Counter", enter the value directly in "Width", and modify or add/remove data in the box by clicking the up and down buttons on the right or using the scrolling wheel in the middle of the mouse.
- The effective range of the counter width is [1, 16], which determines the maximum value that the counter allows.
- If the counter width is set to 3, the maximum value is 23.
- Input n in "Count". This triggers after matching n times. If the check Continuous checkbox is checked, enter value n in the Count field. This triggers after matching n times.

Note!

- When the configuration file (.gao) is saved, if the number of the signal trigger unit changes, but the match unit is not modified accordingly, the error prompt box will open, as shown in Figure 3-21.
- If the error prompt is displayed, click the "Hide Details" to display the error description.
- If the trigger port belonging to the match unit is not configured, the error prompt box will open when the gao configuration is saved, as shown in Figure 3-22.
- When the Function of the matching unit is specified as being out of range or within range, if the minimum is greater than the maximum, the “Value Invalid” dialog box will appear, as shown in Figure 3-23.
- When you move the cursor to the input box of Value, the configurable range of Value will be displayed, as shown in Figure 3-20.

Figure 3-21 Prompt Box "Match Unit and Trigger Port Mismatch"

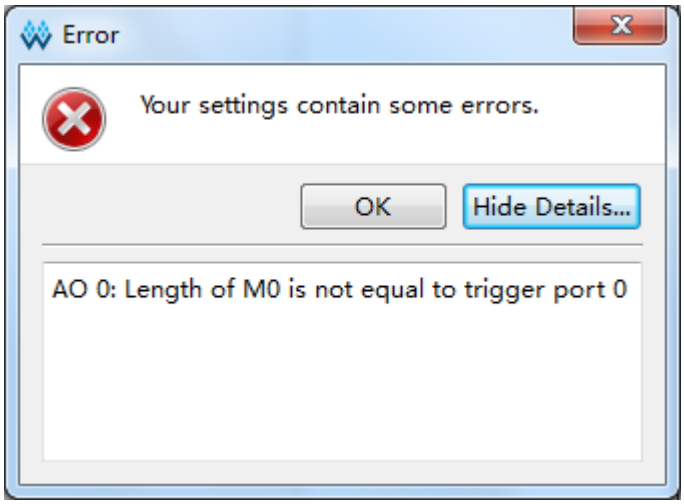


Figure 3-22 Prompt Box "Trigger Port Does Not Select Match Unit"

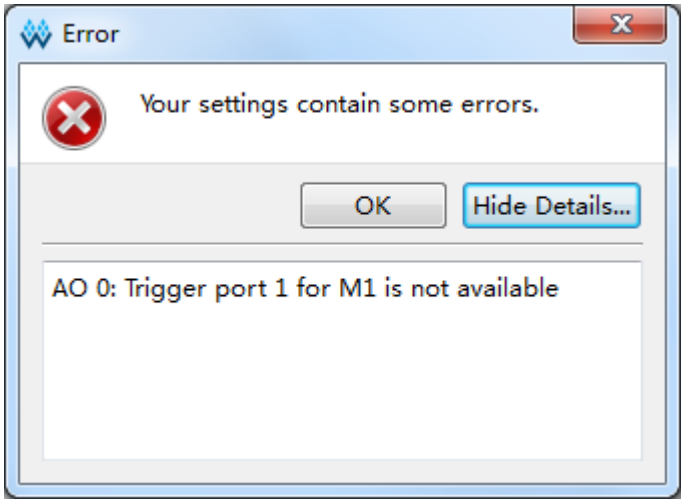
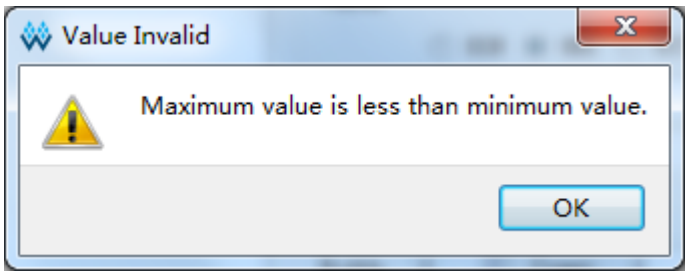


Figure 3-23 Value Invalid Prompt Box



Trigger Expression Configuration

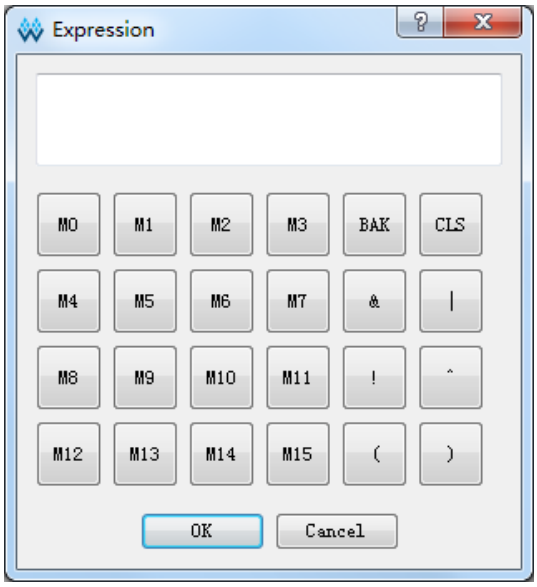
Expressions are used to set the trigger Expressions. An AO has 16 trigger expressions at most.

In "Expressions" view, the trigger expression is sorted by expression and ranges from M0-M15.

The related operations are as follows:

- Double or right click "Expressions", select "Add".The Expression dialog box will pop up, as shown in Figure 3-24. You can configure the trigger expressions in the dialog box;
- Select the expression you want to delete. Right click and select "Remove" to remove the trigger expression.

Figure 3-24 Expression View



Expression 0 to Expression 15 is corresponding to Trigger Level 0 to Trigger Level 15. When setting the AO trigger conditions, the minimum Trigger Level is Level 1 (Level 0), and the maximum is 16 (Level 0 to Level15). The Trigger Level series corresponds to the number of trigger expressions. If the Trigger Level is Level N and the Level 1 Trigger condition is met, the Level 2 Trigger condition will be estimated, and so on, until the Level N Trigger condition is met, the final trigger signal is generated, and AO begins to sample data.

Trigger expressions can logically combine one or more trigger match units, which follow these rules:

- Support with (&), or (|) and non-(!) Logical operators, and operators ().
- Trigger expression can only logically combine the selected trigger match units.
- The same trigger match unit can be used one or more times in a trigger expression.
- The logic combination that triggers match unit between different trigger expressions is not affected, and the same trigger match unit and operator can be used.
- Different expressions can invoke the same trigger match unit, or the same number or a different number of trigger match units.

For example, if the user sets eight match units, for each level of trigger expressions, any number of the matching units from these eight can be logically combined, and the form of each match unit is M (0 ~ 7). For example:

M0&M1

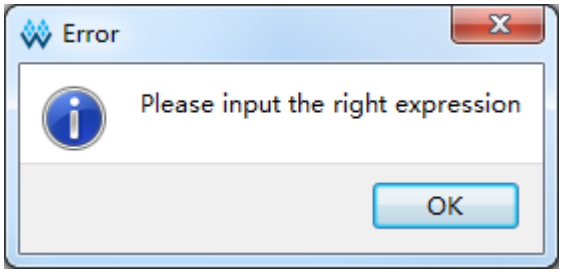
!M4&(M3|M6)

……

Configure an expression by double-clicking the text box in the expression dialog. Click "OK" after completing the configuration.

If the wrong syntax exists in the expression, the following message will be displayed when the user clicks "OK" to save: Please input the right expression, as shown in Figure 3-25.

Figure 3-25 Wrong Expression



Note!

- When the configuration file (.gao) is saved, the window depicted in Figure 3-26 will pop up to prompt the user the match the unit error if the unselected match units are used in expressions.
- An AO can add up to 16 expressions. If more than 16 expressions are added, an error dialog box will open, as shown in Figure 3-27.

Figure 3-26 Error

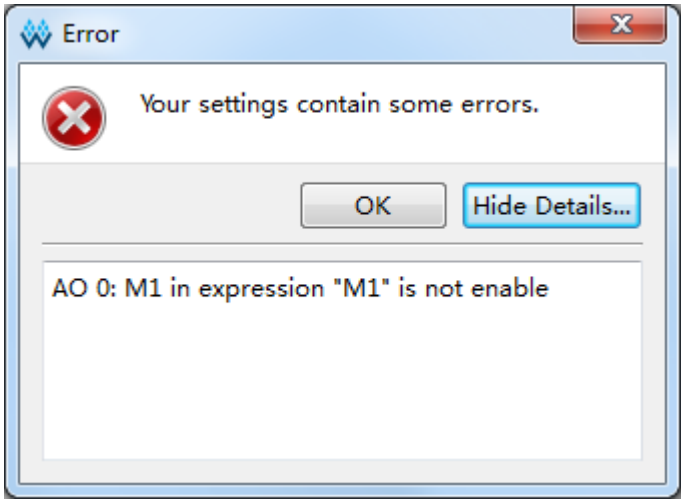
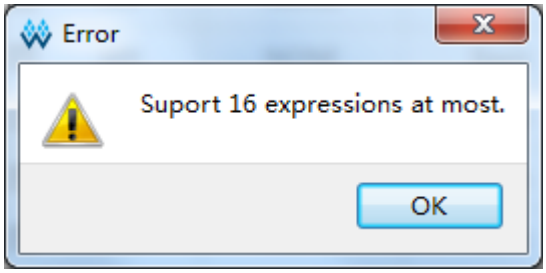


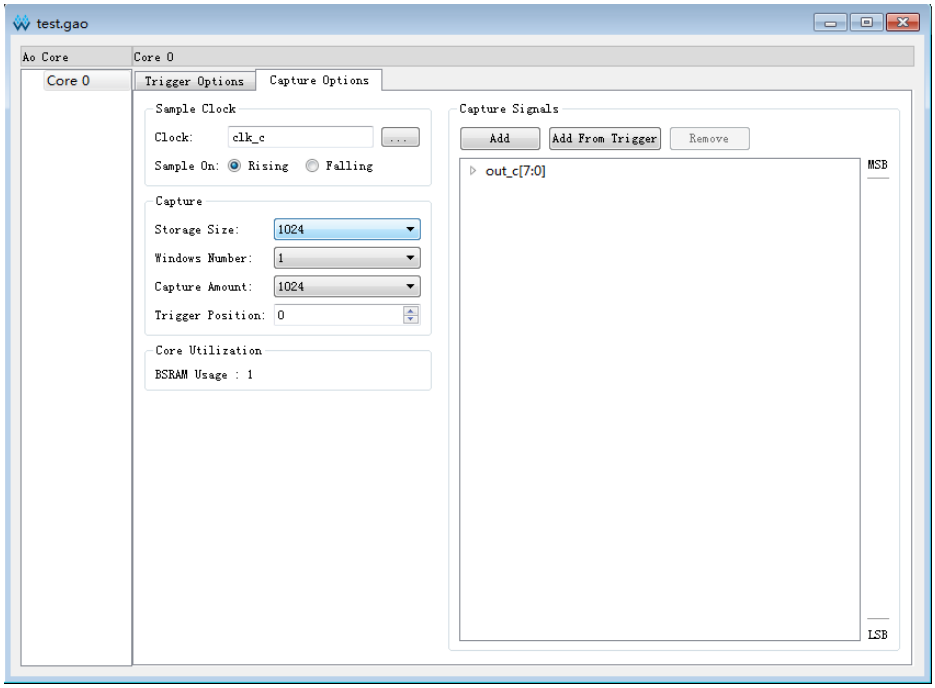
Figure 3-27 Upper Limit Error



Configure Sample Signals

As shown in Figure 3-28, the Capture Options view includes the Sample Clock, Storage Size, and Capture Signals settings, etc. And it also displays the number of BSRAM currently used by AO Core.

Figure 3-28 Capture Options

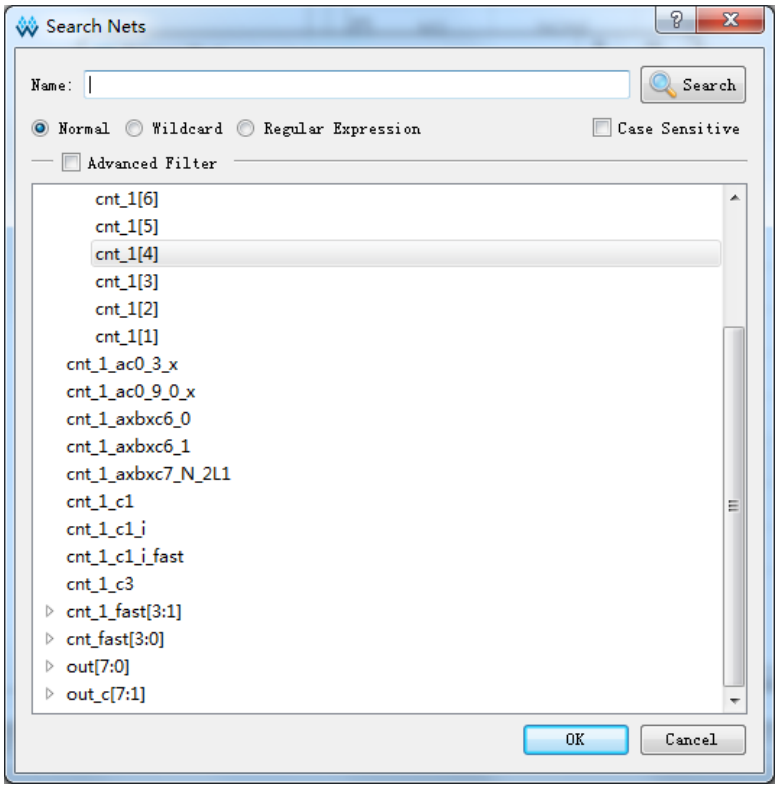


Users can use the Sample Clock to select the clock signal that is incorporated into their design. The other signals can also be refined. The sample clock supports sampling on rising edge and falling edge.

Users can employ the following two methods to add sample clock signals:

- Enter the sample clock name in the "Sample Clock" textbox.
- Click on the " " icon that is next to the "Sample Clock" textbox. The "Select Nets" dialog box will open. Select the required sample clock signal, as shown in Figure 3-29. Click "OK" to add the signal to the "Clock" textbox.

Figure 3-29 Select Nets Dialog Box



Note!

- The sample clock frequency should be double or above the frequency of the configured expression and the sample data signal. It is recommended that the configured expression and sample data signal belong to the same clock domain.
- If the configured sample clock does not exist when the configuration file (.gao) is saved, the error prompt box will appear, as shown in Figure 3-30.
- If there is no sample clock, the error dialog box, "No sample clock specified", will appear, as shown in Figure 3-31.

Figure 3-30 Error - Sample Clock Inexistence

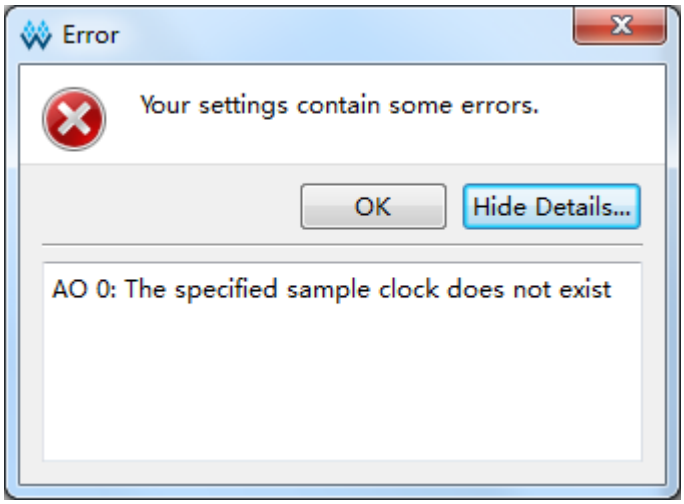
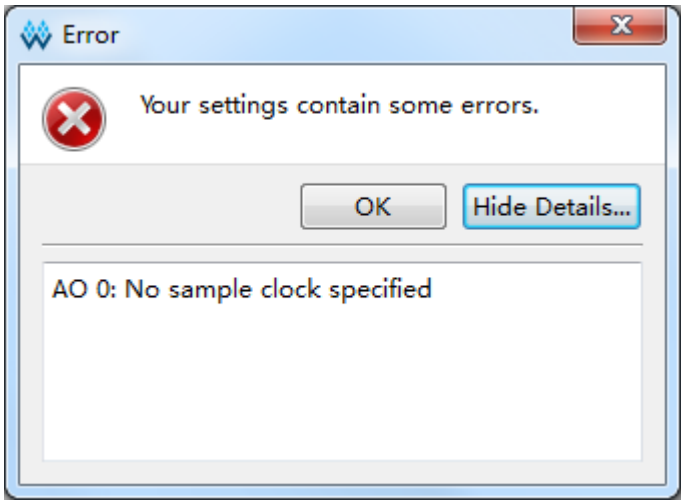


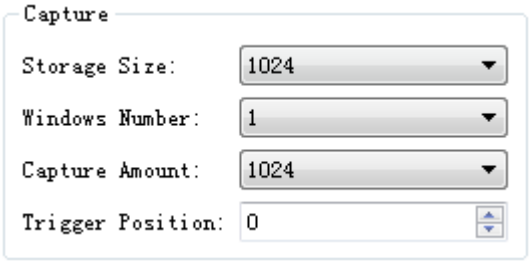
Figure 3-31 Error - No Sample Clock Specified



Configure Storage Info.

As shown in Figure 3-32, the storage info includes storage size, windows number, capture amount, and trigger position.

Figure 3-32 Capture Configuration

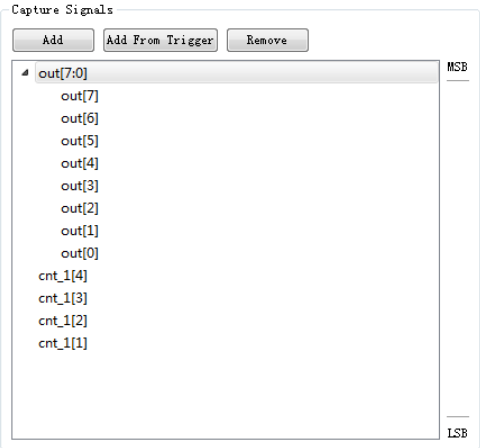


- Storage Size is the maximum storage size for data sampling.
  Click on the "Storage Size" drop-down list and select the required size from the list: 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, or 65536.
- Windows Number is the number of capture window, i.e., the number of page numbers in the capture buffer. AO uses the window collection mode, and the capture buffer is divided into one or more pages that have the same or multiple capacities. Each AO supports 8 windows at most and 1 window at least. Select the number of "Windows Number" from the drop-down list.
- Capture Amount: Capture length, i.e., the address length of the actual memory being used on each capture buffer page.
  Each capture window has the same capture amount, and the total capture size can not be more than the configured storage size. Select the capture amount from the "Capture Amount" drop-down list.
- Trigger Position is the sampling data in memory when triggering.
  Enter or select the required value in the "Trigger Position" text box. The storage address starts from 0.

Configure the sampled data signal

The Capture Signals view in Figure 3-33 can be used to configure capture signals. The data port signal is the input signal of the data port specified in the user's design.

Figure 3-33 Capture Signal Configuration



- Add: Select the signal which needs AO to sample and store data as the sampled data signal; Click "Add", the Select Nets dialog box will pop up, Select the desired data port signal, and click "OK" to complete the configuration; Bus signals can also be added here, as shown in Figure 3-33 dout[7:0].
- Add From Trigger: Directly use the Trigger port to sample the Trigger signal as the sampled data signal. One or more Trigger ports can be selected in the "Add From Trigger" list, and use the selected trigger port signals as sample signals, as shown in Figure 3-34.
- Remove: Delete the selected signals.
- Signals can be sorted by dragging and dropping. Users can click the left button to select one signal or select multiple signals by Shift+left or Ctrl+left, and then drag and drop to sort the signals.
- Right click the signal, the options of Group, Ungroup, Rename and Restore Original Name can be set in the menu, as shown in Figure 3-35.

Figure 3-34 Select Add From Trigger

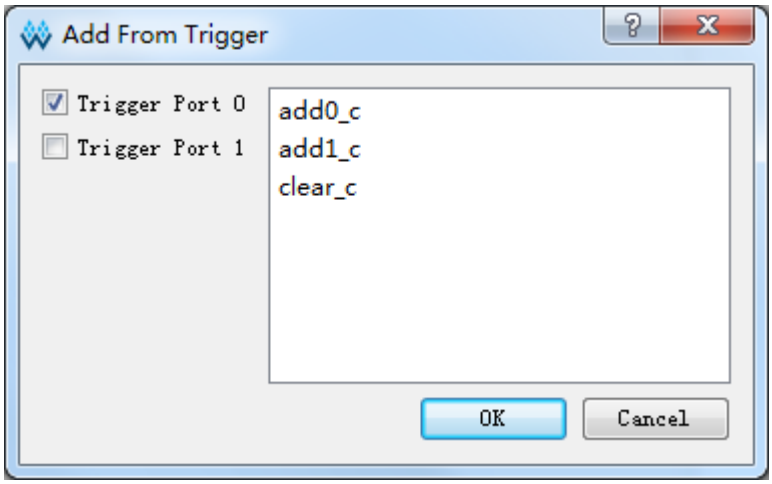
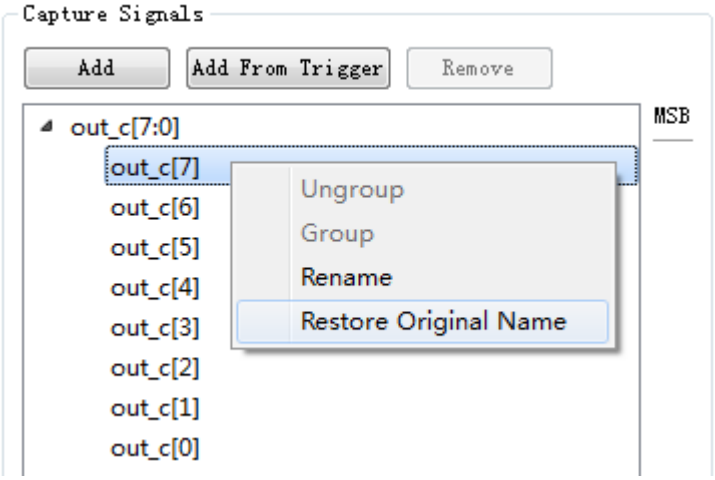


Figure 3-35 Right-click Menu



The Number of BSRAM Used by AO Core

It shows the number of BSRAM used by AO Core in Figure 3-36.

Figure 3-36 The Number of BSRAM Used by AO Core

3.1.3 Generate Bitstream File

After configuring the GAO files, double-click on "Place & Route" option in the "Process" view to perform placement & routing for the user design. Generate one bitstream file containing user designs and GAO configuration. The file name is ao_0.fs by default. They are stored in the project path /impl/pnr/ by default.

3.2 Lite Mode GAO Configuration File

3.2.1 Start Lite Mode GAO Configuration File Interface

Before starting the Lite Mode GAO Config View, it first needs to create or load the configuration file (.gao).

Create Lite Mode GAO Configuration File

The steps are as follows:

1. In the "Design" view, right click and select New File...The "New" dialog box will open, as show in Figure 3-37.
2. Select the "GAO Config File" and click "OK".
   The "New GAO Wizard" dialog box will open, as shown in Figure 3-38; select "Lite Mode", and then click "Next".
3. Enter the config file name in "Name", as shown in Figure 3-39, and then click "Next".
4. Check the GAO config. file mode and path, as shown in Figure 3-40. Click "Finish" to complete creation. Please refer to GAO Config Files in Design View for the GAO configuration file.

Figure 3-37 Create Lite Mode GAO Configuration File (Lite Mode)

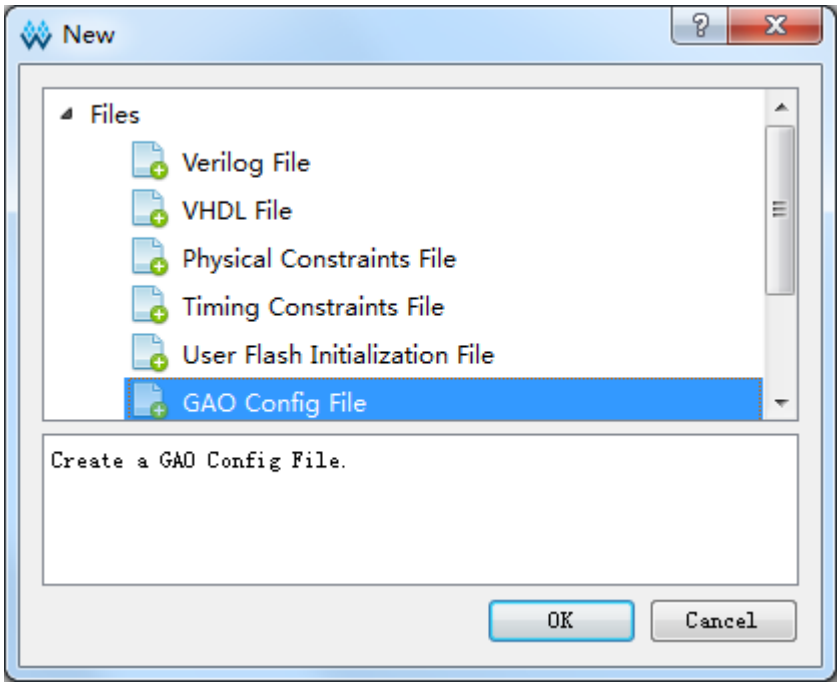


Figure 3-38 New GAO Wizard (Lite Mode)

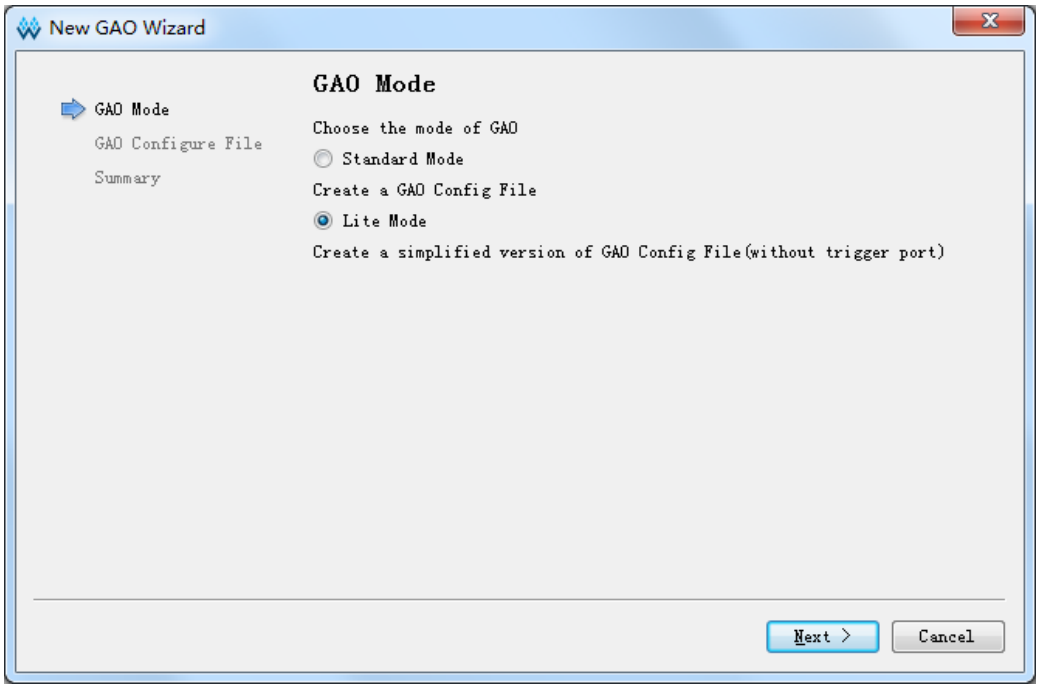


Figure 3-39 Lite Mode GAO Configuration File Name

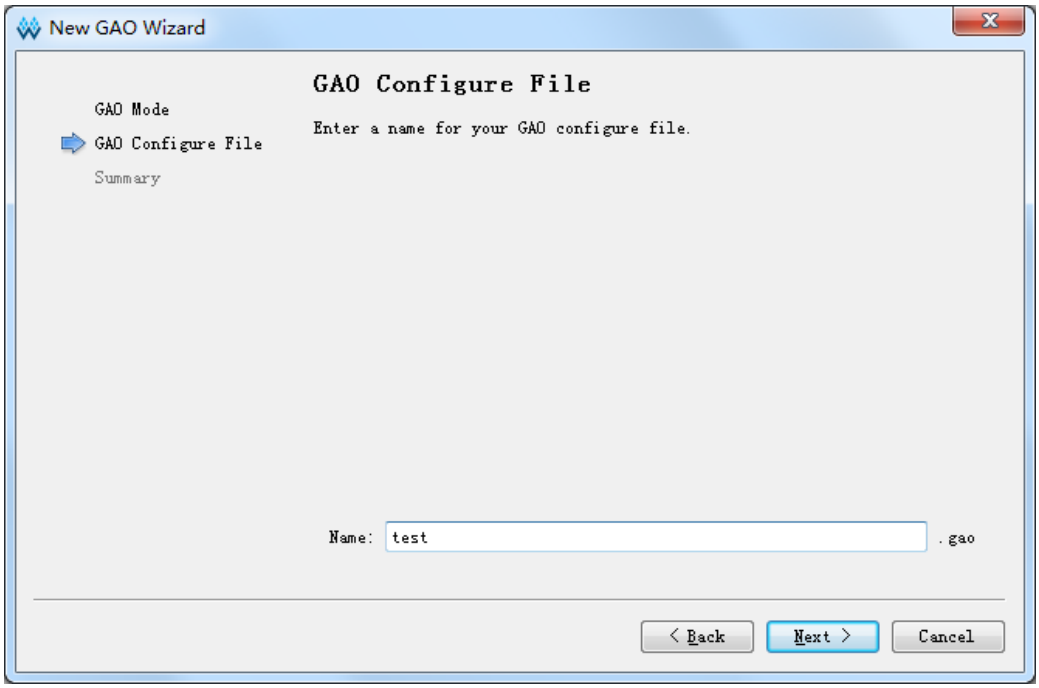
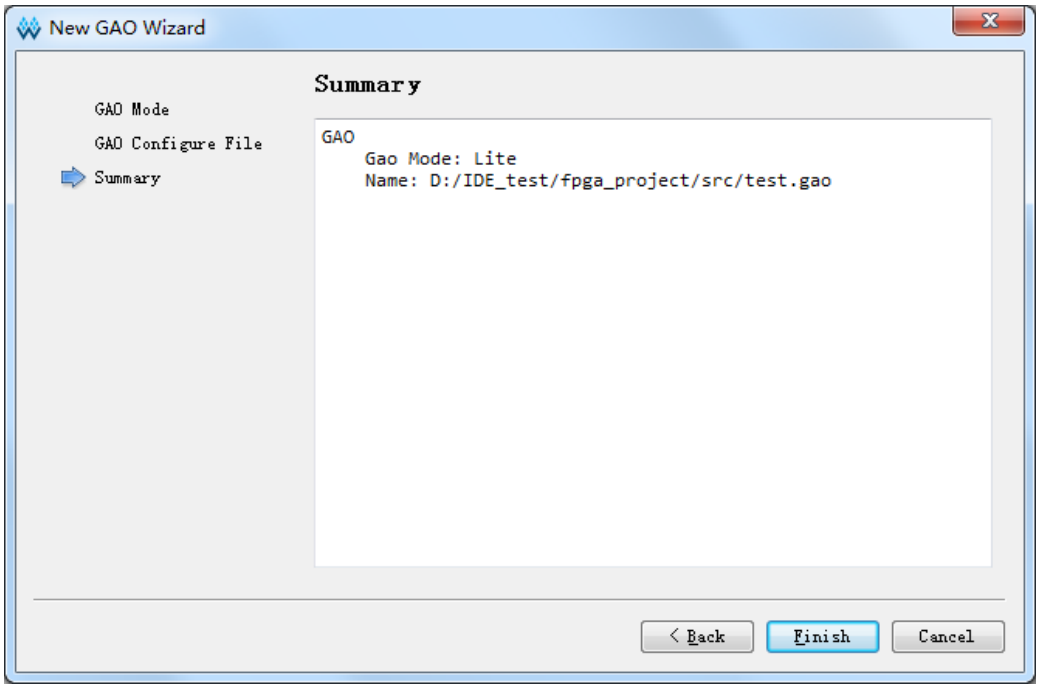


Figure 3-40 GAO Configuration File Mode and Path (Lite Mode)

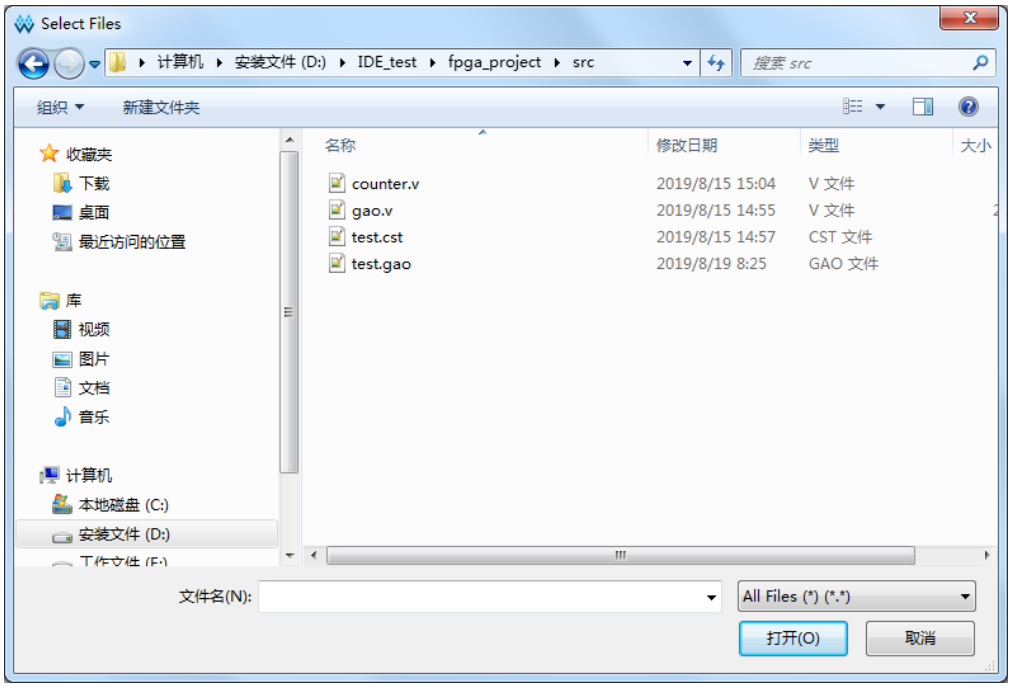


Add Lite Mode GAO Configuration File

The steps to create a standard mode GAO are as follows:

1. In the "Design" view, right-click and select "Add Files...". The "Select Files" dialog box opens.
2. Select the existing lite mode configuration file (.gao), as shown in Figure 3-41.
3. Click "Open". See the loaded "GAO configuration file" in "Design > GAO Config Files".

Figure 3-41 Lite Mode GAO Configuration File

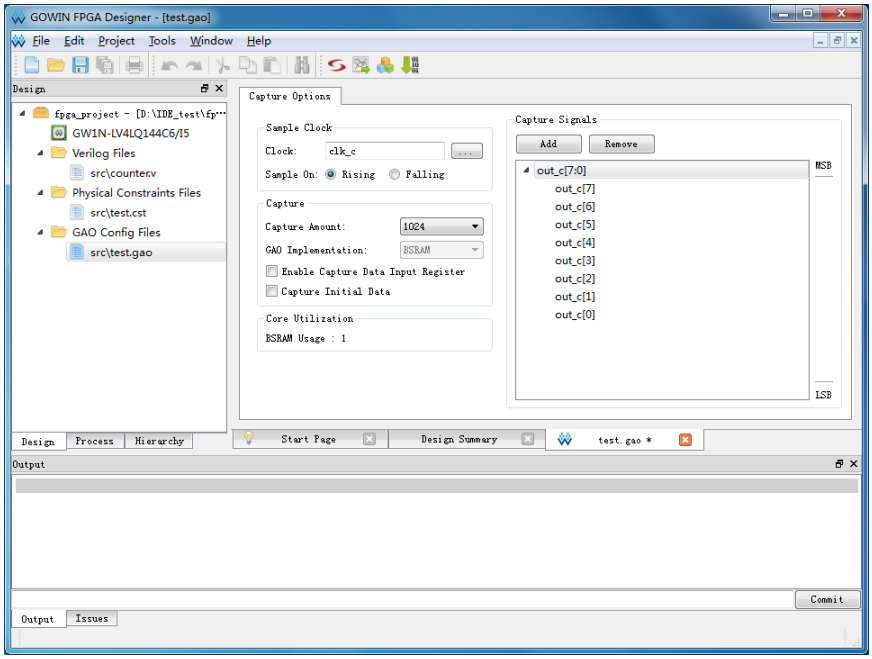


Start Lite Mode GAO Configuration File Interface

Double click configuration file (.gao) in the "Design" view. The "GAO Config View" will open in the Gowin YunYuan main window, as shown in Figure 3-42.

The "GAO Config View" includes the capture options for configuring the signals sampling criteria.

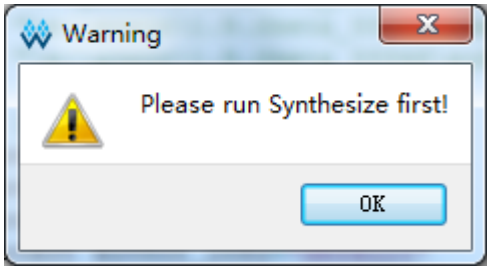
Figure 3-42 Gowin GAO Configuration Tool Interface (Lite Mode)



Note!

If the project to fail synthesis, when the user double clicks configuration file (.gao), the "Warning" prompt box will open, as shown in Figure 3-43.

Figure 3-43 Compile Netlist Prompt Box (Lite Mode)



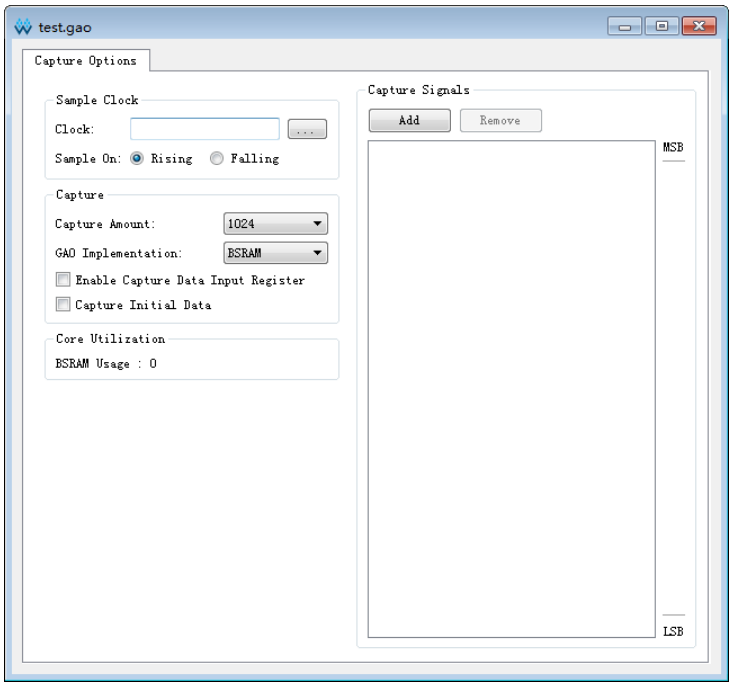
3.2.2 Configure Lite Mode GAO

The "Lite Mode GAO" is used to configure the signal sampling conditions.

Configure Capture Signals

As shown in Figure 3-44, the Capture Options view is used to configure the sampling clock, sampleing data signals and other sampling information, and it also displays the number of BSRAM currently used by GAO.

Figure 3-44 Capture Options (Lite Mode)

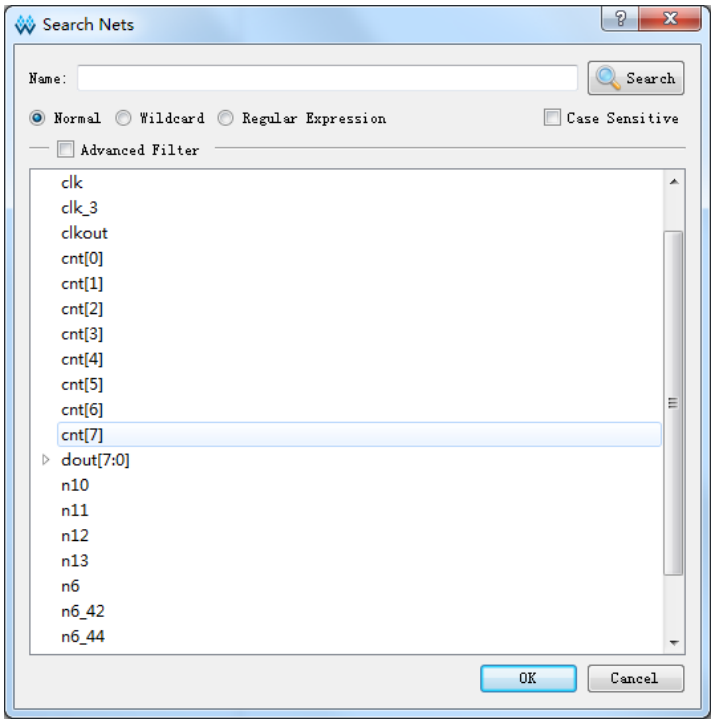


Users can use the Sample Clock to select the clock signal that is incorporated into their design. The other signals can also be refined. The sample clock supports sampling on rising edge and falling edge.

Users can employ the following two methods to add sample clock signals:

- Enter the sample clock name in the Sample Clock textbox.
- Click on the "..." icon that appears next to the Sample Clock textbox. The Select Nets dialog box will open. Select the required sample clock signal, as shown in Figure 3-45. Click OK to add the signal to the Clock textbox.

Figure 3-45 Select Nets Dialog Box (Lite Mode)



Note!

- If the configured sample clock does not exist when the configuration file (.gao) is saved, the error prompt box will appear, as shown in Figure 3-46.
- If there is no sample clock, the error dialog box, No sample clock specified will pop up, as shown in Figure 3-47.

Figure 3-46 Error - Sample Clock Inexistence (Lite Mode)

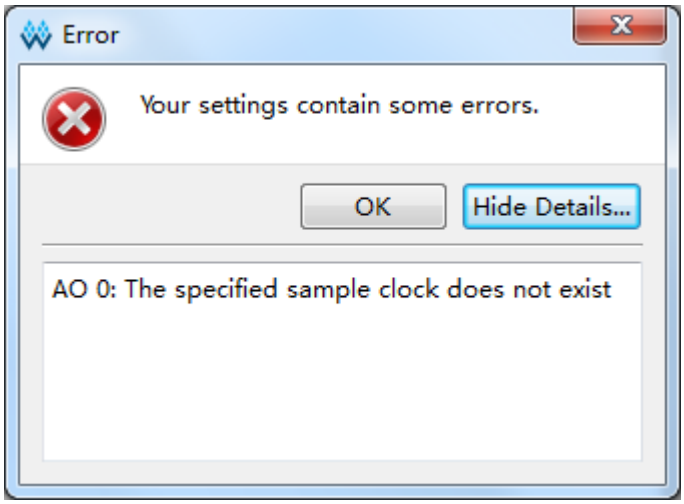
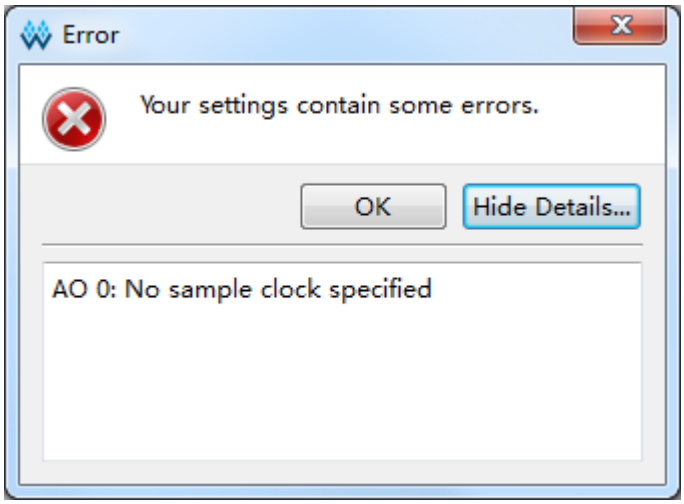


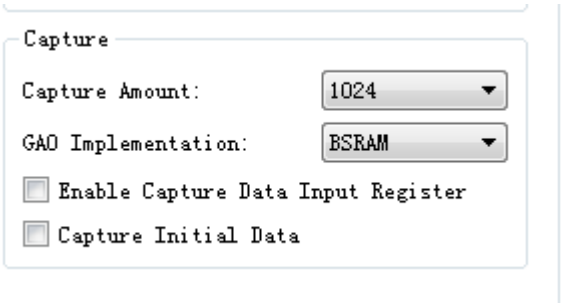
Figure 3-47 Error - No Sample Clock Specified (Lite Mode)



Configure Storage Info.

As shown in Figure 3-48, it is used to configure the sampling length of the sampling signal, the GAO implementation method, adjust the timing sequence, and capture the data of the power-on.

Figure 3-48 Capture Configuration View (Lite Mode)

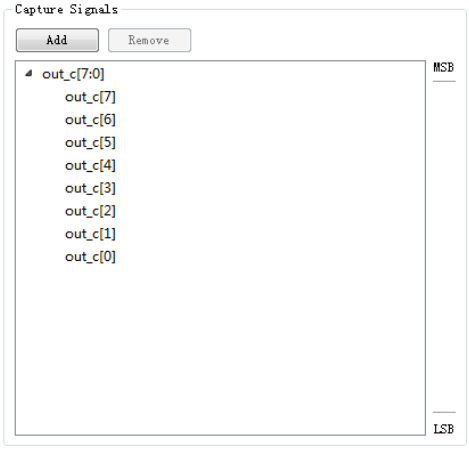


- Capture Amount: Capture length, i.e., the address length of the actual memory being used on each capture buffer page.
- GAO Implementation: Captured data signals storage mode. Captured data signals can use the BSRAM resource or logic resource. Users can select the storage resource from the "GAO Implementation" drop-down list.
- Enable Capture Data Input Register: Adjust timing.
  If your design has a delay from the clk to BSRAM in the GAO, you can select this option to adjust the timing to add a layer of reg for capturing data.
- Capture Initial Data: Capture the data of power-on.
  Select this option to capture the data of power-on.

Configure the sampled data signal

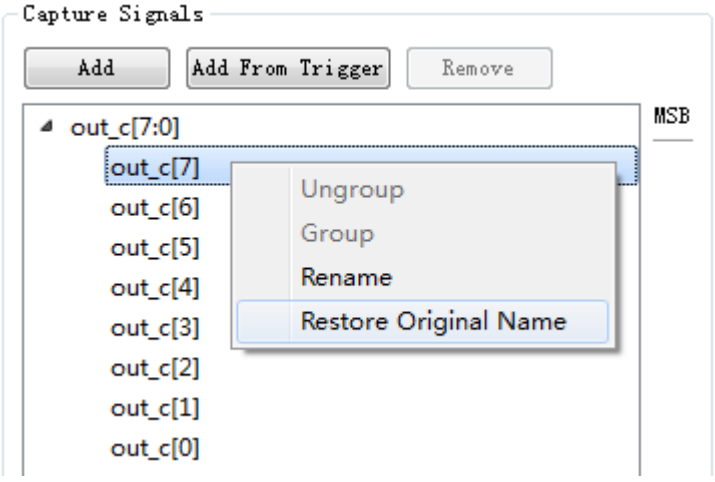
The "Capture Signals" view displayed in Figure 3-49 can be used to configure capture signals. The data port signal is the input signal of the data port specified in the user's design.

Figure 3-49 Capture Signal Configuration



- The "Add" is used to select the Nets; Click "Add", "Select Nets" dialog box pops up, and then select your required data port signal, click "OK" to finish configuration. Bus signals can also be added here, such as out_c[7:0];
- Remove: Delete the selected signals;
- Signals can be sorted by dragging and dropping. Users can click the left button to select one signal or select multiple signals by Shift+left or Ctrl+left, and then drag and drop to sort the signals.
- Right click the signal, the options of Group, Ungroup, Rename and Restore Original Name can be set in the menu, as shown in Figure 3-50.

Figure 3-50 Right-click Menu



The Number of BSRAM Used by GAO

It shows the number of BSRAM used by GAO in Figure 3-51.

Figure 3-51 The Number of BSRAM Used by GAO

3.2.3 Generate Bitstream File

After configuring the GAO files, double click "Place & Route"option in the "Process" view to conduct layout and wiring operations for the entire user design. Generate one bitstream file containing user designs and GAO configuration. The file name is ao_0.fs by default, and it is stored in the project path /impl/pnr by default.

4 GAO Usage

The GAO is used to display the capture signal waveform. It can also be used to reconfigure the AO capture window number, capture amount, and some matching conditions for match units through the JTAG interface. It helps users to observe data signals much more directly and visually.

4.1 Standard Mode GAO Operation

4.1.1 Start Standard Mode GAO

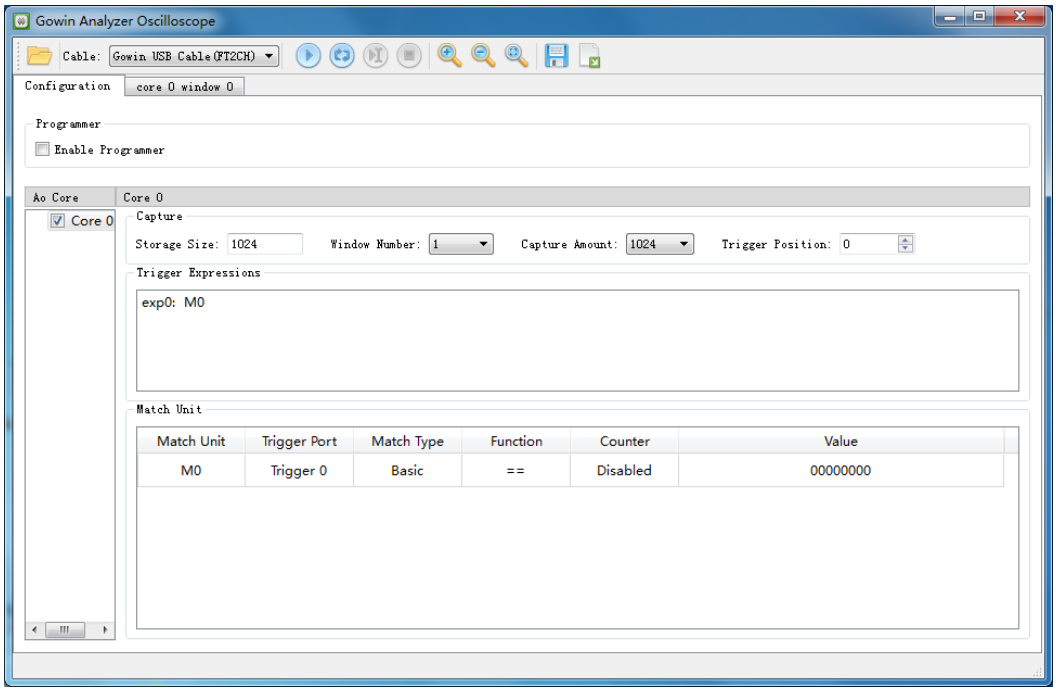
The following are the steps:

1. Select "Tools" from the menu.
2. Select Gowin Analyzer Oscilloscope from the pull-down list to start GAO. The GAO config. file in the project is loaded by default or click "Open" to select Standard Mode gao config. file (.gao) or Project file (.analyzer_prj) that you require , as shown in Figure 4-1.

   Note!

   You can also click the " " icon on the IDE tool bar to start GAO.

Figure 4-1 Gowin Analyzer Oscilloscope (Standard Mode)



4.1.2 Run GAO

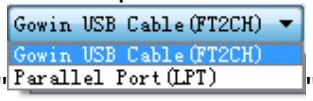
As shown in Figure 4-1, GAO view includes toolbar, Configuration View and Window View. The tool bar can be used for loading configuration files (.gao), Project file (.analyzer_prj) or device initialization, etc.; Configuration View is used for configuring dynamic parameters of AO; Window View is used for waveform display.

Tool Bar Operation

GAO tool bar includes "Open…", Cable, start/stop control, Auto Run, Force Triggering, Zoom In/Out/Full Screen, Save, Export, etc., as shown in Figure 4-2.

Figure 4-2 Tool Bar (Standard Mode)

The detailed function description is as follows:

- " ": Open, add configuration files (.gao);
- " 

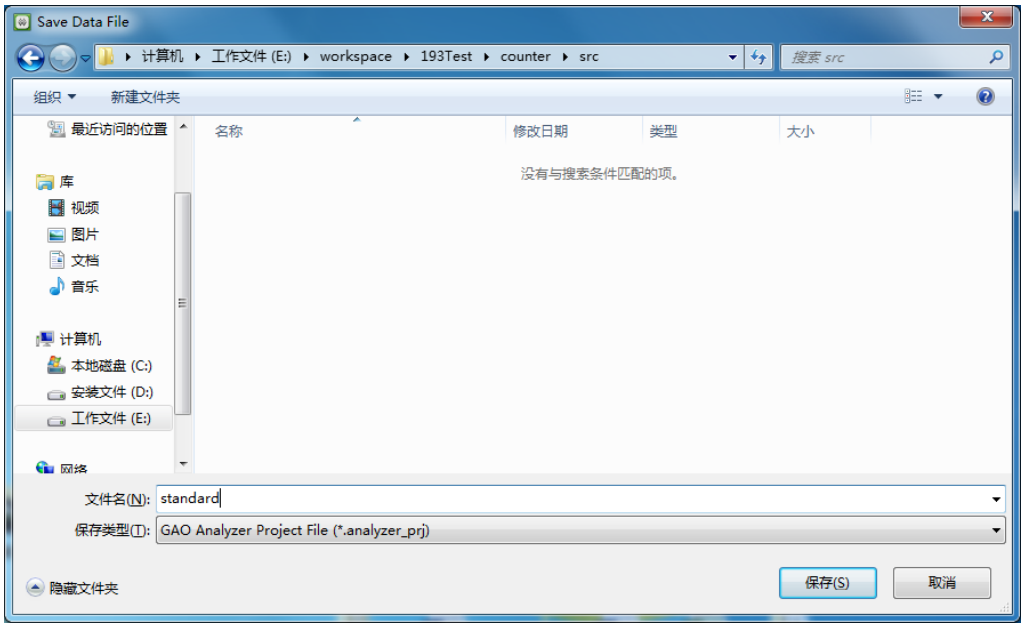
": The download line of waveform interface supports Gowin USB Cable and Parallel Port, which can be selected by pull-down list.
- " ", " ", " ", " ": Start, Auto Run, Force Trigger, Stop；
- " ", " ", " ": Zoom In/Zoom Out/Full Screen display of waveform;

- " ", " ": Save waveform data, output the waveform data;

Note!

- At present, Auto Run is only supported when the number of Windows is 1. Analyzer will loop through and display the signal status of match in the window in real time until the user clicks stop;
- The save button allows the user to save the current project data to a separate project file. The file suffix of the project is Analyzer_prj by default.
- When the back-end project is opened again, the user can manually choose to directly load the. Gao file or the previously saved. Analyzer_prj project file. Project file saves all current project data and its corresponding Gao file;
- If you choose to load the. Gao file, it will be handled according to the current process. When the window displays, there is no group information and base information set by the user.
- If you choose to load the. Analyzer_prj project file, the back-end program reads the project file and its corresponding Gao file and analyzes whether they match or not.
- If the Analyzer_prj project file data can match the Gao file data, the state of the saved project file will be restored; otherwise, the project file data will be ignored and step 4 will be performed.

Figure 4-3 Save as Analyzer_prj project file



AO Configuration

Configuration View contains the following functions:

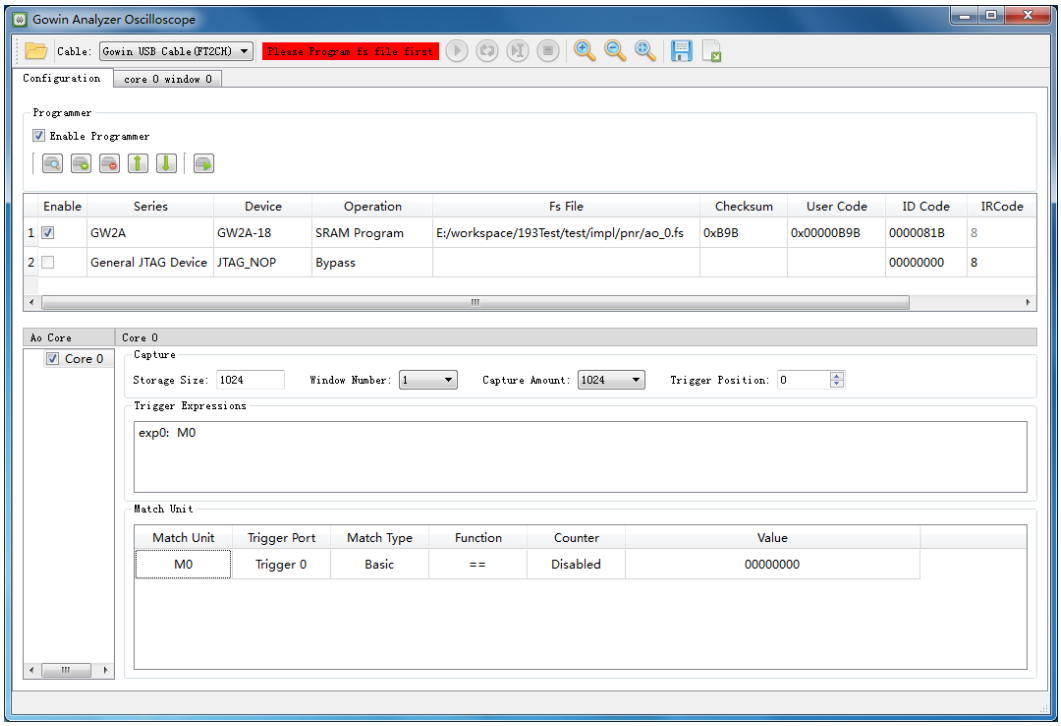
- Whether to set Programmer to integrate Programmer download function.
- Whether to use the device chain to set to select General JTAG Device or Gowin device.
- Display AO info, including the sampling data, Trigger Expressions, and Match Unit.
- Modify the sampling data info and match unit info.

Configuration View includes Programmer, Ao Core (Capture, Trigger Expressions, and Match Unit, as shown in Figure 4-4.

Note!

Ao Core includes Capture, Trigger Expressions and Match Unit.

Figure 4-4 Configuration Window



The Programmer includes the following functions:

- Check Enable Programmer, and Programmer download function is supported.
- Click " " to scan device and display details of the device, such as, Series, Device, Operation, ID Code and IRCode. If the ID code of the scaning device is the same as the one of other devices, the popover displays all the devices with the same ID code for users to select.
- Device chain function can be implemented. Clicking " " can add target device. The default series is General JTAG Device (Non-Gowin device). The default device is JTAG_NOP. Double-clicking on Series and Device column of Target Device to pop up the drop-down list, the users can select series and device as required. In addition, IRCode of General JTAG Device can be configured from 1 to 16. The IRCode of Gowin Device is 8 by default and can not be modified.
- Clicking " " to delete the device selected by users.
- Clicking " " to move up the device selected by users.
- Clicking " " to move down the device selected by users.
- Clicking " " to download bitstreams.
- GAO can only capture the signal data of Gowin Device, but cannot capture the signal data of General JTAG Device, so the Enable can only select Gowin Device.

Ao Core includes Capture, Trigger Expressions and Match Unit.

Capture includes the following functions:

- Display sampling storage depth, number of windows, length and trigger position.
- Modify number of windows, length and trigger position.

Note!

For the parameters configuration rules, please refer to Configure Sample Signals and Configure Storage Info.

Trigger Expressions shows the expressions for current AOs.

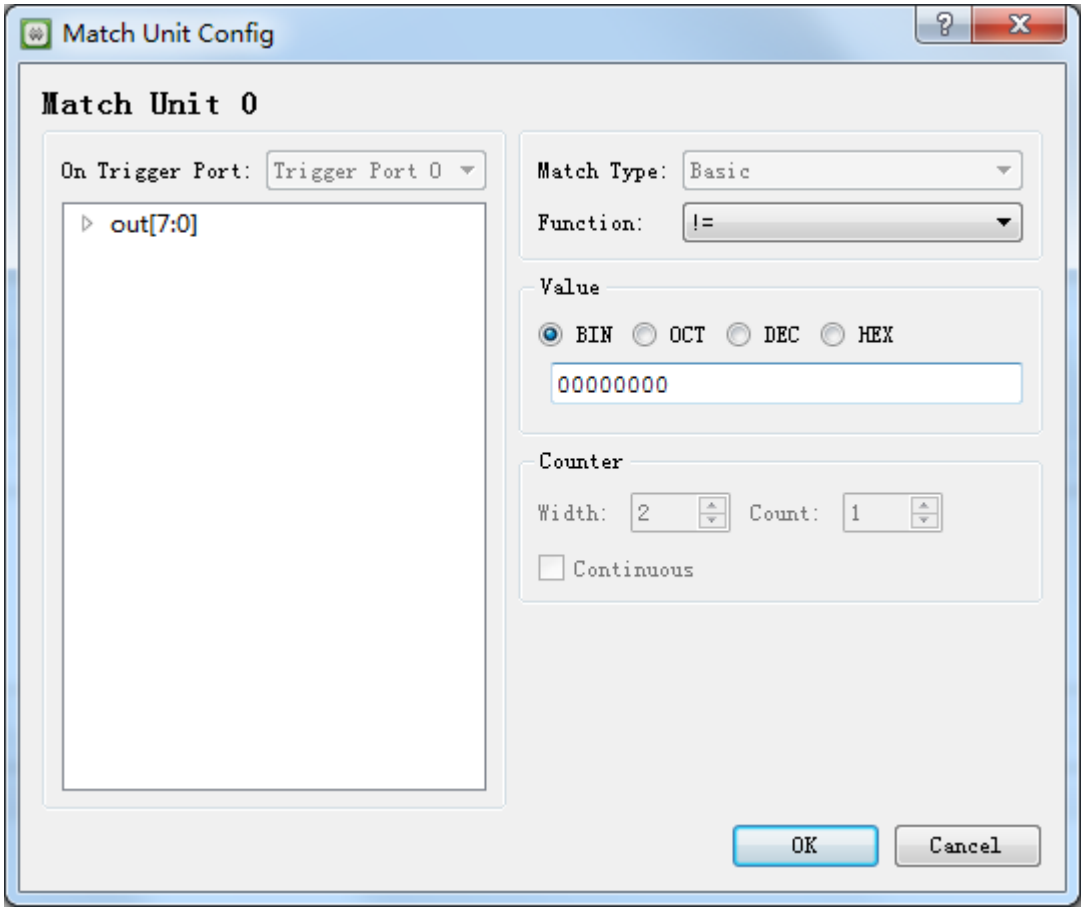
Match Unit includes the following functions:

- Display the name, trigger port, and match type, etc., of the match units for current AOs.
- Double click trigger matching Unit and modify the matching functions and Bit Value in the "Match Unit Config" dialog box, such as AO Counter or the matching times of Counter, as shown in Figure 4-5.

Note!

For the parameters configuration rules, please refer to 3.1.2>Configure Standard Mode GAO.

Figure 4-5 Match Unit Config Dialog Box



Display Waveform

Windows view is used to display the captured sampling signal waveform and supports the following functions:

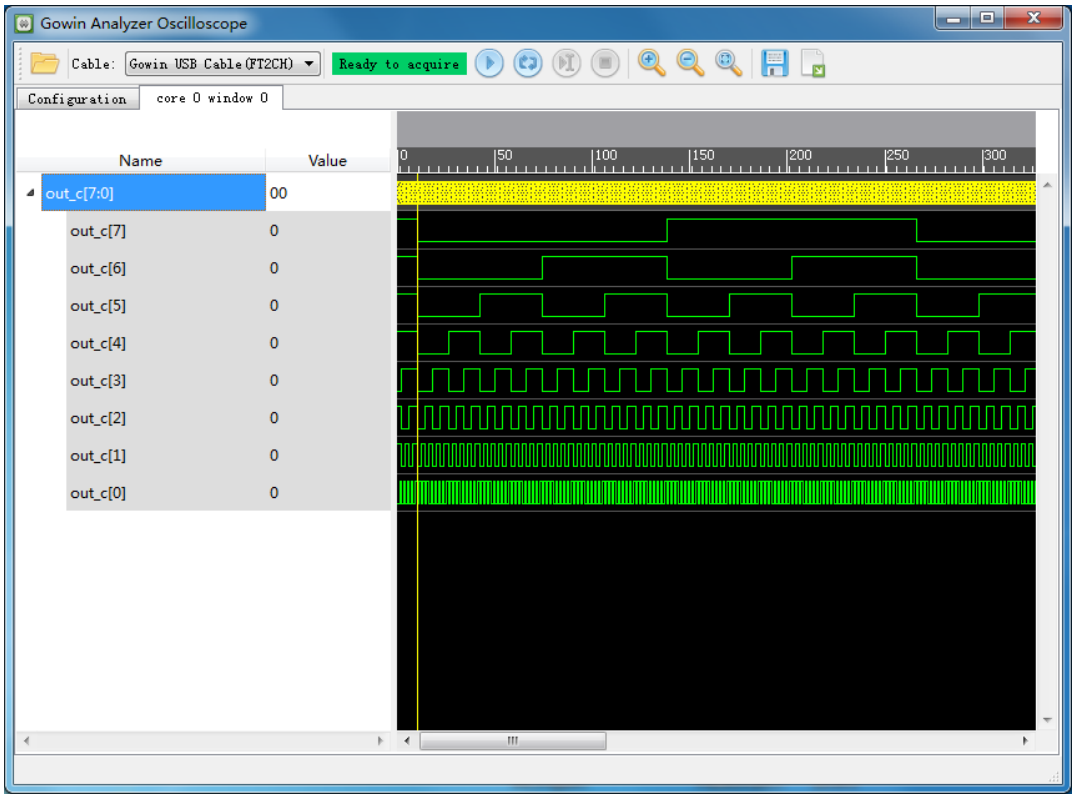
- Mark the position with nonius.
- Waveform zoom in/out/full screen display.

- Change the sort order of signals.
- Number systems conversion of "Group", "Ungroup", "Rename", "Restore Original Name" and "Format".

Click “ ” to run GAO. When the triggering conditions are met, GAO displays Windows number, and the windows number equals to the configured number of capture windows. Figure 4-6 shows capture signal name, value, and waveforms. Click one waveform, and it will highlight with yellow.

In addition, click the " " icon to start the GAO Auto Run. At present, Auto Run is only supported when the number of AO Core and window are both 1. Analyzer will loop through and display the signal status of match in the window in real time until the user clicks stop.

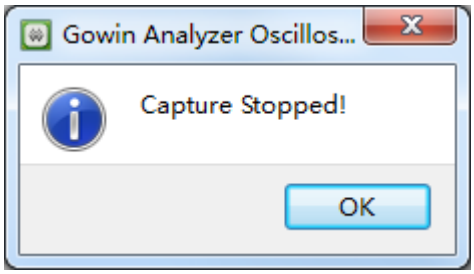
Figure 4-6 GAO Waveform Display of AO (Standard Mode)



Note!

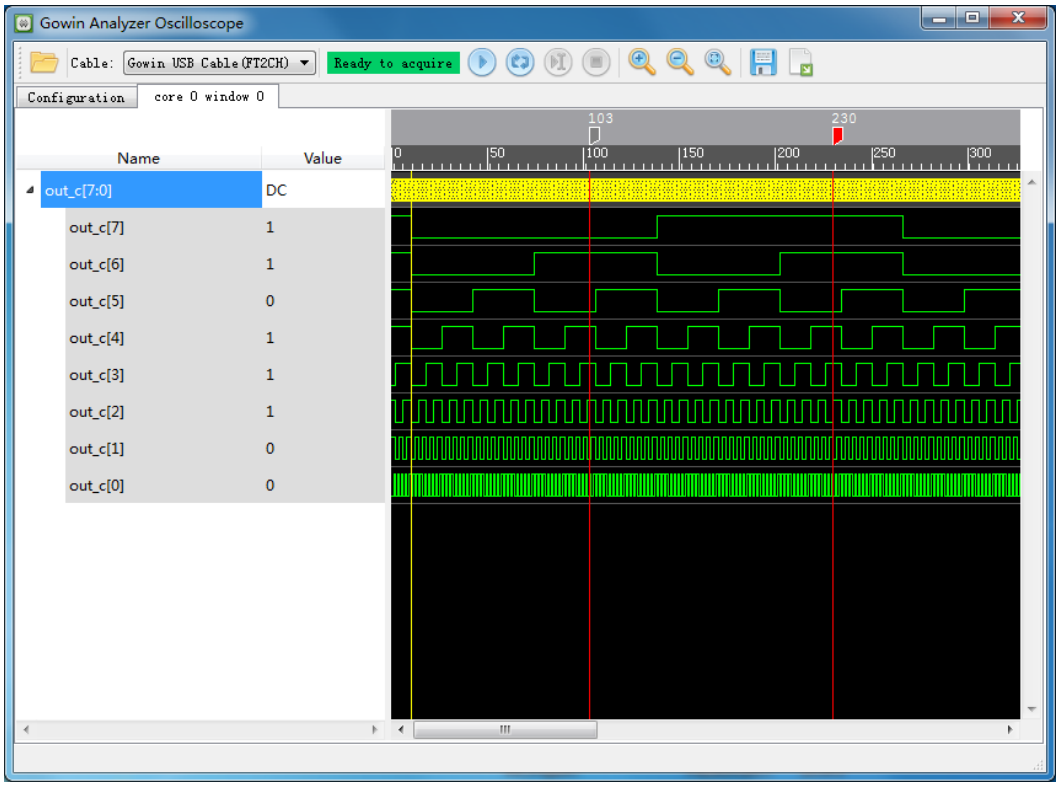
- If trigger conditions are not met, click " "to force triggering to display windows and the captured sampling signals waveform.
- If trigger conditions are not met, click " " to stop running, "Stop Capture" dialog box will pop up, as shown in Figure 4-7.

Figure 4-7 Stop Capture Warning (Standard Mode)



As shown in Figure 4-6, initial position of nonius is the trigger position by default. The trigger point is marked with yellow vertical line. Move the mouse cursor over the nonius, left-click the mouse to drag the nonius, and then right-click the mouse in the blank above the nonius to add a new nonius, as shown in Figure 4-8.

Figure 4-8 Nonius Display (Standard Mode)



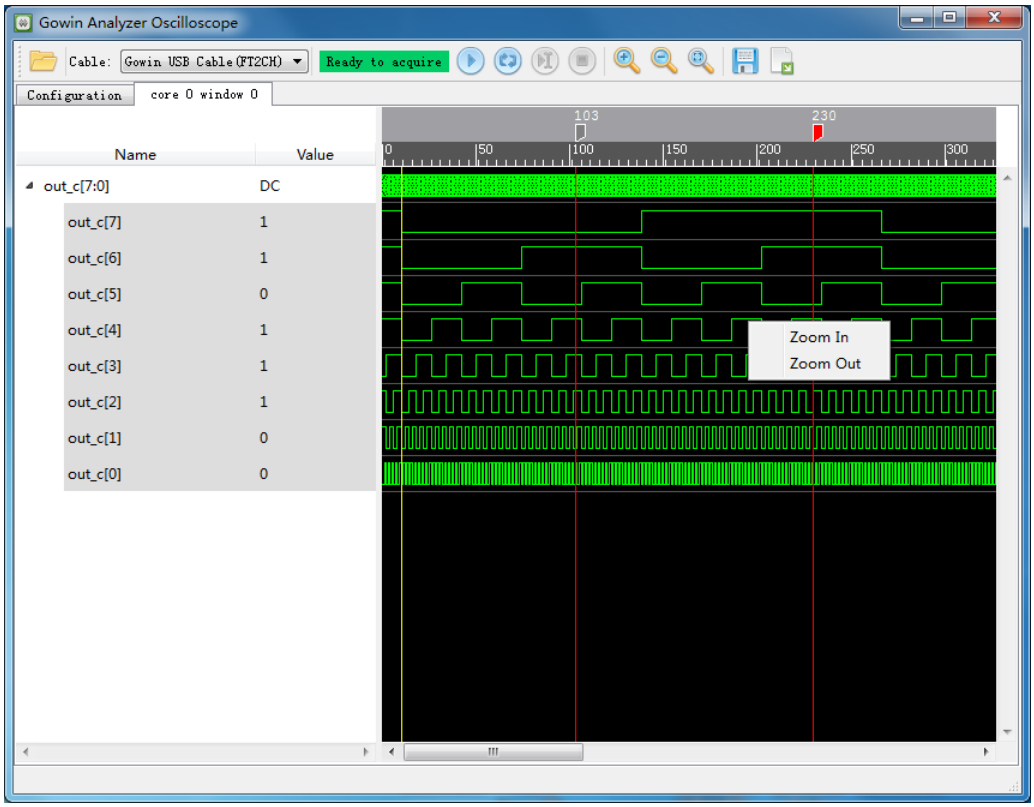
Note!

Select one nonius and right-click, and then select "Remove Marker" in the Pop-up menu to delete the nonius.

Right-click in the waveform display area to pop up the menu, as shown in Figure 4-9.

Click "Zoom In" or "Zoom Out", or click the " " or " " icon, or use the "Ctrl++" or "Ctrl+-" shortcuts, or press Ctrl+mouse wheel, to zoom in/out waveform; Click the " " icon or use the "Ctrl +F" shortcut to display the waveform in full screen.

Figure 4-9 Right-Clicking Menu of Zoom In/Out (Standard Mode)

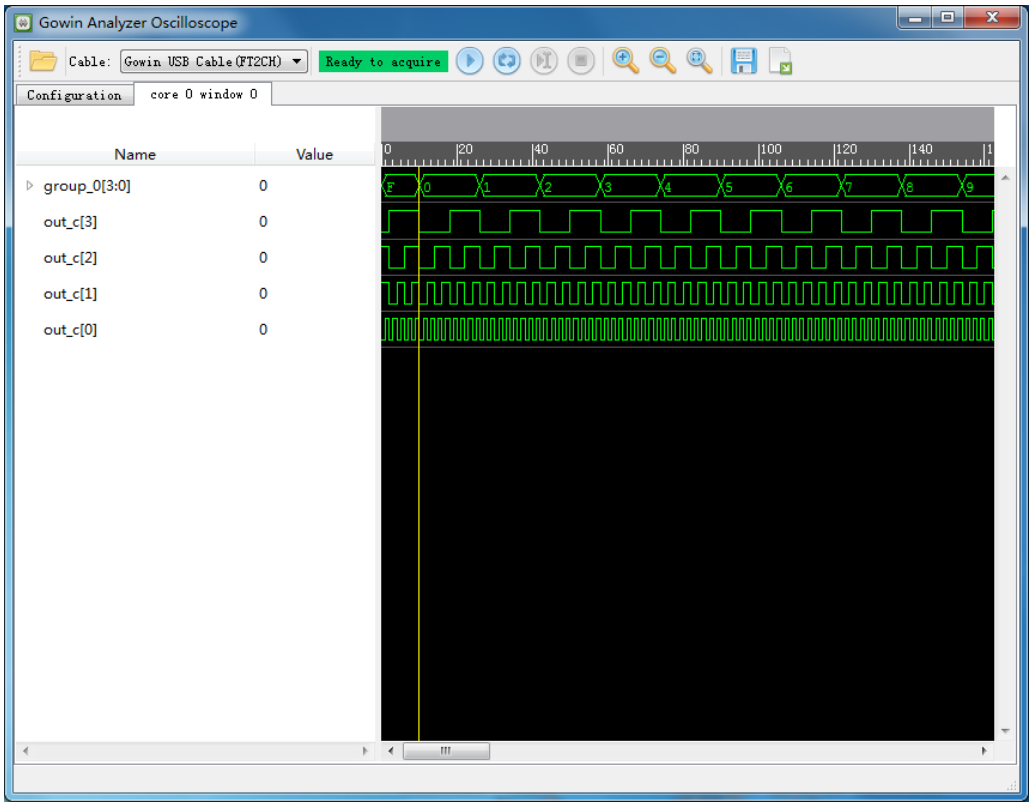


Change signals order by clicking signals name in "Name" column and pressing and dragging left mouse button or mouse wheel.

The width of "Name" and "Value" can be adjusted according to the display. The adjustment by users will be kept when it is triggered again.

In "Name" column, use Shift+left mouse button or Ctrl+left mouse button to select multiple signals. Right click and select "Group" in the pop-up menu to combine Bus signals. The name of the combined Bus signal is group_index[n:0] by dedault. Index and n are integers greater than or equal to 0, as shown in Figure 4-10.

Figure 4-10 Combined Bus Signal (Standard Mode)



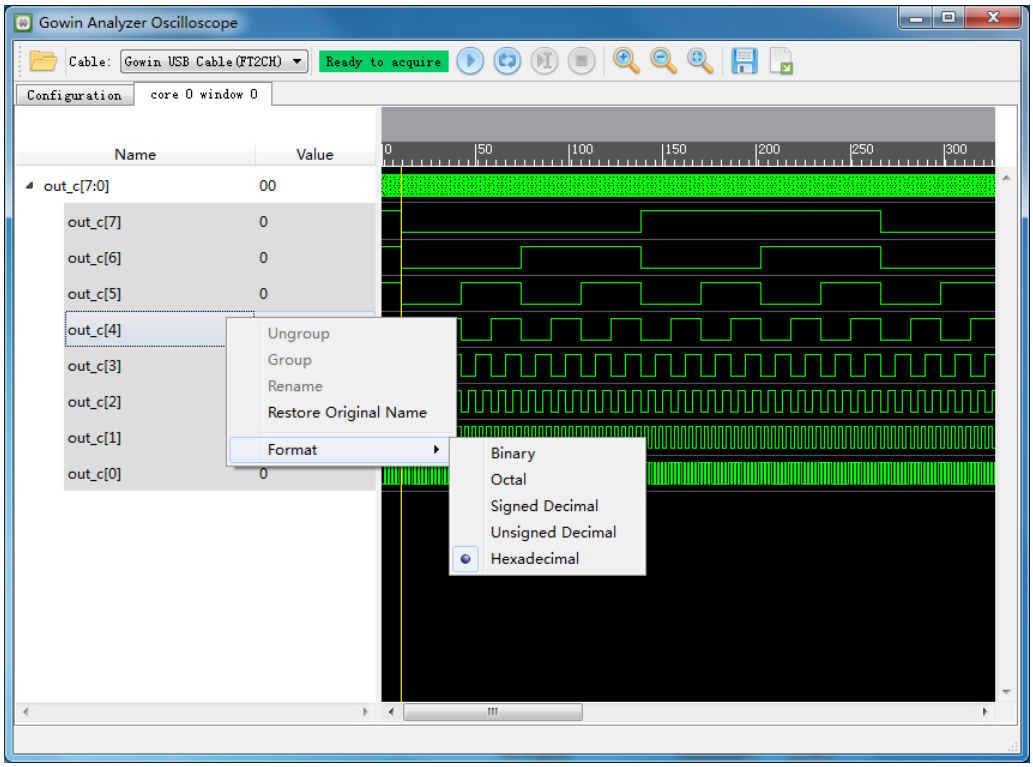
Note!

- Click " " again to capture sampling signals waveform, and Bus signal still exists.
- The GAO capture interface is not closed for repeated triggering, and the waveform display window size remains the same as the last time.
- Right-click the Bus signal name in Name column and select "Ungroup" in the pop-up menu to split Bus signal.
- Do not save the manually established Bus signal as the .analyzer_prj project file. When you reopen it using GAO, recombine it, save it as the .analyzer_prj project file, and load the .analyzer_prj file using GAO, then save the manually established Bus signal.
- Bus Signals can be added together or separately in the Capture Signals of GAO configuration page. When they are added together, the waveform window will directly display as Bus Signals, out [7:0] as shown in Figure 4-6.
- It is not possible to reconstitute some part of the Bus signal into a new Bus.

Select a signal and right click in the value display area, and the menu pops up, as shown in Figure 4-11.

"Rename" can rename the selected signal; "Restore Original Name" can restore the signal to the netlist name; "Format" includes Binary/Octal/Signed Decimal/Unsigned Decimal/Hexadecimal. Set the sampling signals value, and it's displayed as hexadecimal by default.

Figure 4-11 Right-click Menu of One Signal (Standard Mode)



4.1.3 Output Waveform Data

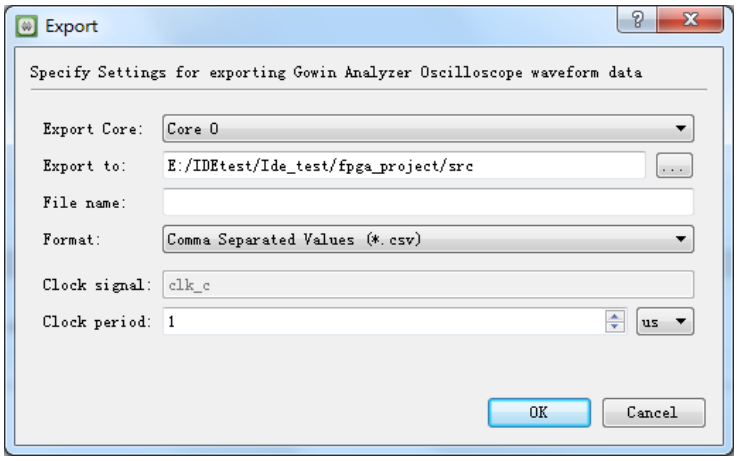
The steps to create a standard mode GAO are as follows:

1. Click the "Waveform Output" in the toolbar " ";
2. The waveform export dialog box will pop up. Specify the waveform file information including the "Export Core", "Export to", "File name", "Format", Clock Signal, Clock Period. The Clock Signal is the capture clock signal specified in GAO and cannot be changed; the export format (Format) supports the Comma Separated Values-(*.csv), Value Change Dump-(*.vcd); Clock period supports us , ns, ps, as shown in Figure 4-12.

Note!

Waveform data file exported by GAO waveform display interface supports binary, octal, decimal and hexadecimal.

Figure 4-12 Waveform Data Output View



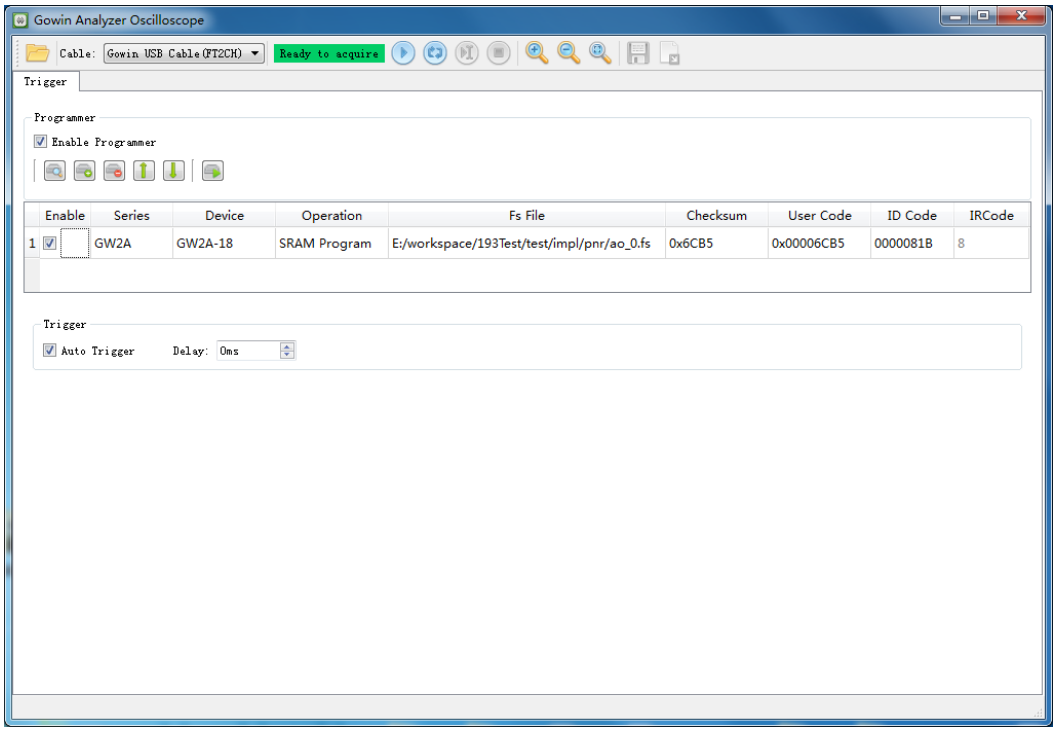
4.2 Lite Mode GAO Operation

4.2.1 Start Lite Mode GAO

The steps to create a standard mode GAO are as follows:

1. Select "Tools" from the menu bar.
2. Select "Gowin Analyzer Oscilloscope" from the pop-up pull-down list to start GAO. The gao config. file in the project is loaded by default or click "Open" to select Lite Mode gao config. file (.gao) or Project file you require, as shown in Figure 4-13.

Figure 4-13 Gowin Analyzer Oscilloscope Tool Interface (Lite Mode)



4.2.2 Run GAO

Tool Bar Operation

Please refer to 4.1.2 running the GAO > tool bar operations section for details.

Trigger View

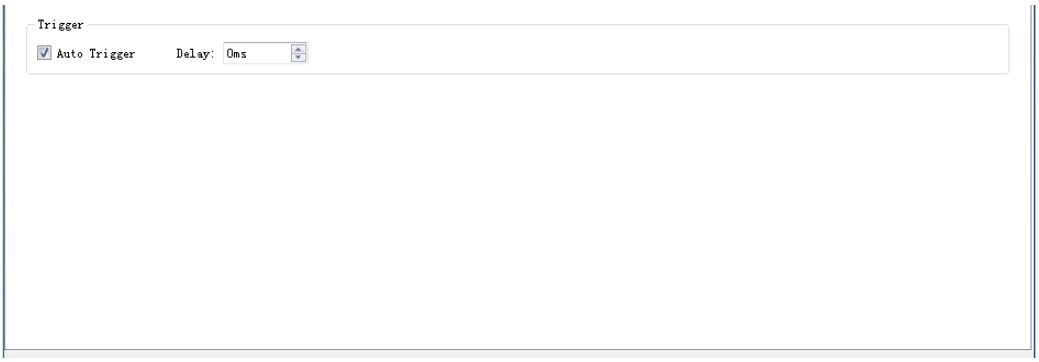
This section is a bit different from the section of Run GAO > AO Configuration in 4.1.2. Only the different sections are described here. For the rest, please refer to the section of Run GAO > AO Configuration in 4.1.2.

Some parts of Trigger are different between Figure 4-13 and Figure 4-14.

Trigger view is as shown in Figure 4-14. Its main functions are as follows:

- Auto Trigger: Click "Start" to trigger automatically when you select this option.
- Delay: Configure the trigger delay.

Figure 4-14 Trigger View



Display Waveform

Please refer to the section of 4.1.2 Run GAO > Display Waveform for details.

4.2.3 Output Waveform Data

Please refer to the section of 4.1.3 Output Waveform Data for details.

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