Gowin Analyzer Oscilloscope

User Guide

SUG114-3.4E,06/27/2025

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Revision History

Date	Version	Description
06/17/2021	2.4E	Dynamic BSRAM Usage and Capture Utilization in the Standard/Lite Mode GAO window can display the maximum amount of BSRAM supported by the device.
11/02/2021	2.5E	● The shortcuts for Start, Auto Run, Force Trigger, and Stop added in waveform capture window, and they are F1, F2, F3, and F4 in order. ● The shortcuts for Zoom In, Zoom Out, and Zoom Fit modified to F8, F7, and F6 in order in waveform capture window. ● Trigger signals and capture signals that do not exist in the netlist are highlighted in red in the configuration window. ● Waveform color can be modified. ● The description of importing vcd to ModelSim added.
12/16/2022	2.5.1E	GWU2X added in Cable option in GAO capture window.
05/25/2023	2.5.2E	● GWU2X updated to Gowin USB Cable (GWU2X) in Cable option in GAO capture window. ● "Save As" function added in GAO capture window.
08/18/2023	2.6E	● The default Cable in GAO Capture Window updated from FT2CH to GWU2X. ● The same signal can not be added repeatedly in Trigger Ports and Capture Signals. ● The Value of Match Unit supports right-click menu, including the values X, 0, 1, R, F, B, N. ● Bar chart and line chart display of waveform supported. ● The right-click menu of the signals on waveform interface support the display in ASCII, Real, and Signed Magnitude formats.
11/30/2023	2.7E	● GAO capture interface supports automatic recognition of Cable type. ● When selecting "Dynamic" for "Expression", SSRAM and REG implementations added. ● SSRAM and REG added in "Capture GAO Implementation". ● GAO configuration interface's Capture Signal right-click menu supports enabling and disabling signals. ● GAO Programmer supports specifying the frequency for tck when Cable is FT2CH. ● "Long Name", "Short Name", "New Divider", and "Delete Divider" options added in signal right-click menu on GAO capture interface.
02/02/2024	2.8E	● "Save" and "Save As" buttons removed from GAO capture window toolbar, and these two functions added to the "Export". ● 4, 8, 16, 32, 64, 128 depths added to Standard GAO Storage Size. ● "Windows Number" updated to "Segments Number", with the value range changing from 1~8 to 1~Storage Size/4. ● Standard GAO supports capturing trigger events occurring after the device is programmed or reset but before GAO is manually started.
03/29/2024	2.9E	● When GAO capture interface waveform contains multiple segments, each segment is updated from counting from 0 to a consecutive count from the end of the previous segment. ● A cursor will be generated at the left mouse click position in the

Date	Version	Description
		waveform. ● GAO capture interface has new function buttons for waveform operations, and the difference between markers can be displayed at the bottom of the waveform.
06/28/2024	3.0E	Joint debugging with GAO and GVIO supported.
10/25/2024	3.1E	● "WINUSB" added in the "Cable" option in GAO capture interface. ● Descriptions of using the command line to start the GAO capture interface added.
11/08/2024	3.1.1E	Descriptions of Capture Signals Configuration modified.
12/31/2024	3.2E	Remote programming and debugging supported.
02/28/2025	3.3E	Descriptions of the Target Jtagserver configuration updated.
06/27/2025	3.4E	● The "Search Nets" interface optimized. ● The "New GAO Wizard" dialog box supports the selection of the configuration file path and provides an option to add the configuration file to the current project.

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1 About This Guide

1.1 Purpose

This manual describes Gowin Analyzer Oscilloscope (GAO). It introduces GAO configuration file (.gao) and GAO usage so as to improve the efficiency of design analysis. The software screenshots in this manual are based on 1.9.11.03. 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 Related Documents

The latest user guides are available on our Website www.gowinsemi.com:

- SUG100, Gowin Software User Guide
- SUG918, Gowin Software Quick Start Guide
- SUG1189, Gowin Virtual Input Output User Guide
- SUG502, Gowin Programmer User Guide

1.3 Terminology and Abbreviations

Table 1-1 shows the abbreviations and terminology that are used in this manual.

Table 1-1 Terminology and Abbreviations

Terminology and Abbreviations	Meaning
AO Core	Analysis Oscilloscope Core
BSRAM	Block Static Random Access Memory
FPGA	Field Programmable Gate Array
GAO	Gowin Analyzer Oscilloscope
GVIO	Gowin Virtual Input Output
JTAG	Joint Test Action Group
REG	Register
SSRAM	Shadow Static Random Access Memory

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

E-mail:support@gowinsemi.com

2 Introduction

GAO is a digital signal analyzer that is designed in-house by Gowin. It helps you more easily analyze the signal timing, quickly perform system analysis and fault location so as to improve design efficiency.

The GAO operates on the following basic principle: When operating, FPGA saves the signal in real time to memory according to the trigger conditions set by you. It reads the signal and displays it on the software GUI via JTAG. GAO includes the signal configuration window and waveform display window. The signal configuration window is mainly used to configure location in the design, and the location is based on the sampling clock, trigger unit, and trigger expression. The waveform display window connects to Gowin Software and target hardware via JTAG.

GAO supports RTL-level and post-synthesis netlist signal capture, and provides Standard Mode and Lite Mode. Standard Mode GAO can support up to 16 AOs, each of which can be configured with one or more trigger ports, supporting multi-level static or dynamic trigger expressions, and capturing trigger events that occur between the time the device is programmed and the time the GAO is manually activated. Lite Mode GAO is easy to configure, and you do not need to set trigger conditions. Lite GAO can also capture the initial value of the signal, which is convenient for you to analyze the state of power on.

The GAO has the following features:

- Supports up to 16 AOs
- Each AO supports one or more port trigger
- Each AO supports one or more trigger levels
- Each trigger port supports one or more match units
- Each match unit supports six types of trigger match
- Supports static or dynamic trigger expressions setting
- Can capture signals before or after RTL synthesis
- AO uses segment capture, which supports one or more segment captures
- Supports four kinds of waveform file: csv, vcd, prn, and gwd

- Uses data ports to save resources

3 GAO Config File

The GAO consists of two parts: Control Core and AO Core. The Control Core is the communication controller of all AOs and JTAG scanning circuits. AO Core is used for configuring trigger signals, capturing and storing data. The Control Core connects the master and the AO Core. It receives instructions and sends them to the AO Core during configuration. It also transmits the data captured by the AO Core to the master. The AO Core directly communicates with Control Core, receives instructions from Control Core, captures and transmits data according to the instructions.

GAO Config window is used to configure AO Core and the Control Core. It helps you quickly and easily analyze data signals after synthesis, placement and routing. For a simple GAO example, see *SUG918, Gowin Software Quick Start Guide*.

3.1 GAO Config File in Standard Mode

3.1.1 Start Standard Mode GAO

You first need to create or load the config file (.gao/.rao) before start Standard Mode GAO, including "For RTL Design" and "For Post-Synthesis Netlist". The "For RTL Design" is used to capture RTL signal before synthesis with extension .rao. The "For Post-Synthesis Netlist" is used to capture the netlist signal after synthesis with extension .gao. For the two types of Standard Mode GAO configuration are similar, the following will take "For Post-Synthesis Netlist" in standard mode as an example.

Create GAO Config File in Standard Mode

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 "GAO Config File" and click "OK". The "New GAO Wizard" dialog box opens, as shown in Figure 3-2. select "Standard", and then click "Next".
3. Enter the config file name in "Name" editing box, select an appropriate path in the "Create in" path selection box, then click "Next", as shown in Figure 3-3.

4. Check the GAO config. file mode and path, as shown in Figure 3-4. Click "Finish". You can see the config file in "GAO Config Files" view.

Figure 3-1 Create a GAO Config File in Standard Mode

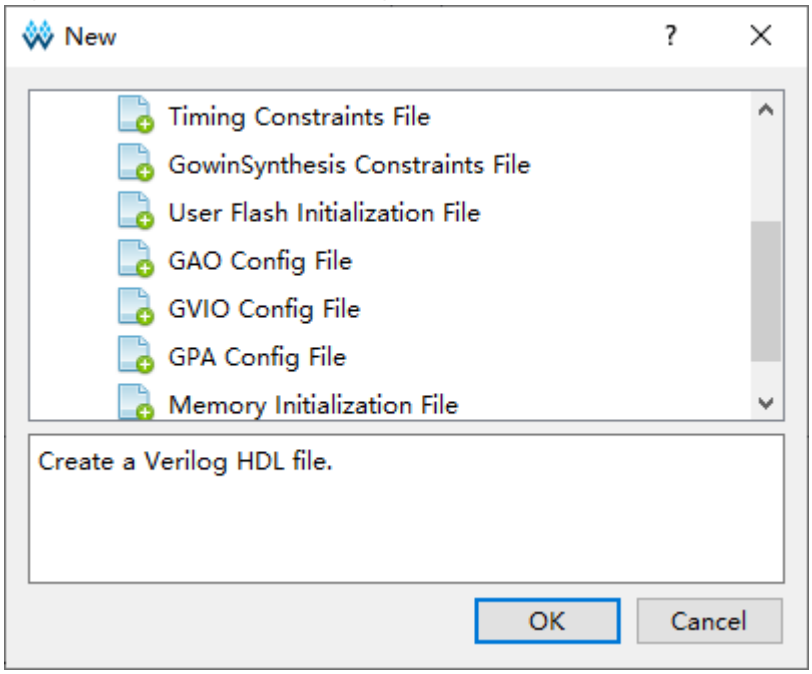


Figure 3-2 New GAO Wizard (Standard Mode)

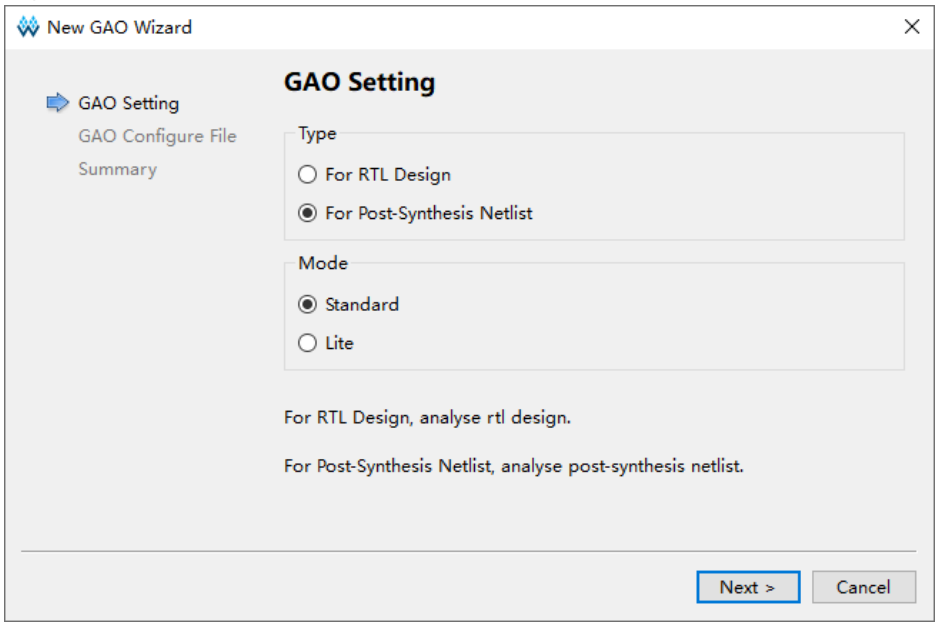


Figure 3-3 File Name

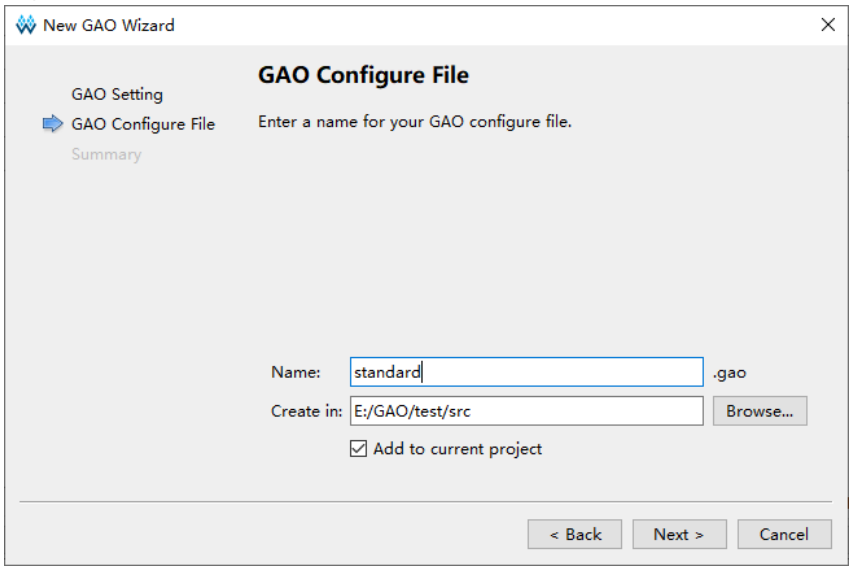
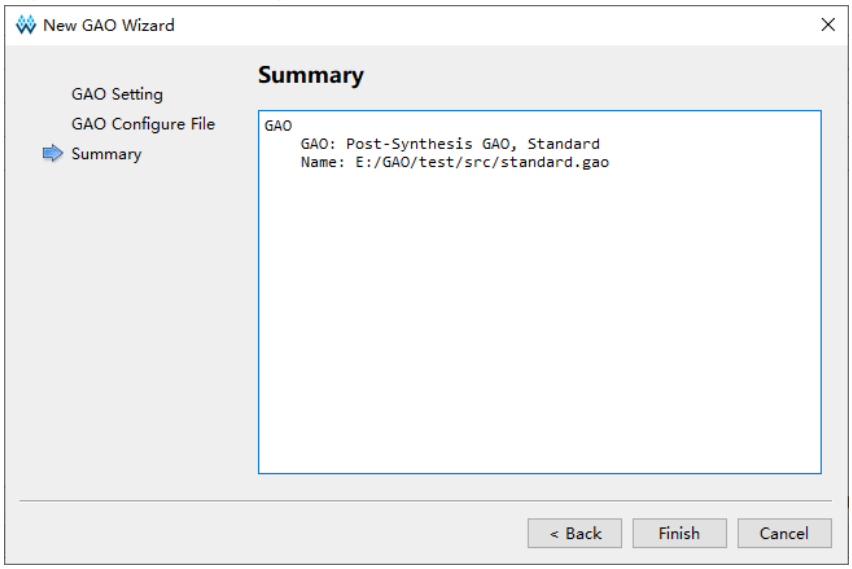


Figure 3-4 GAO Config File Mode and Path (Standard Mode)



Load Standard Mode GAO File

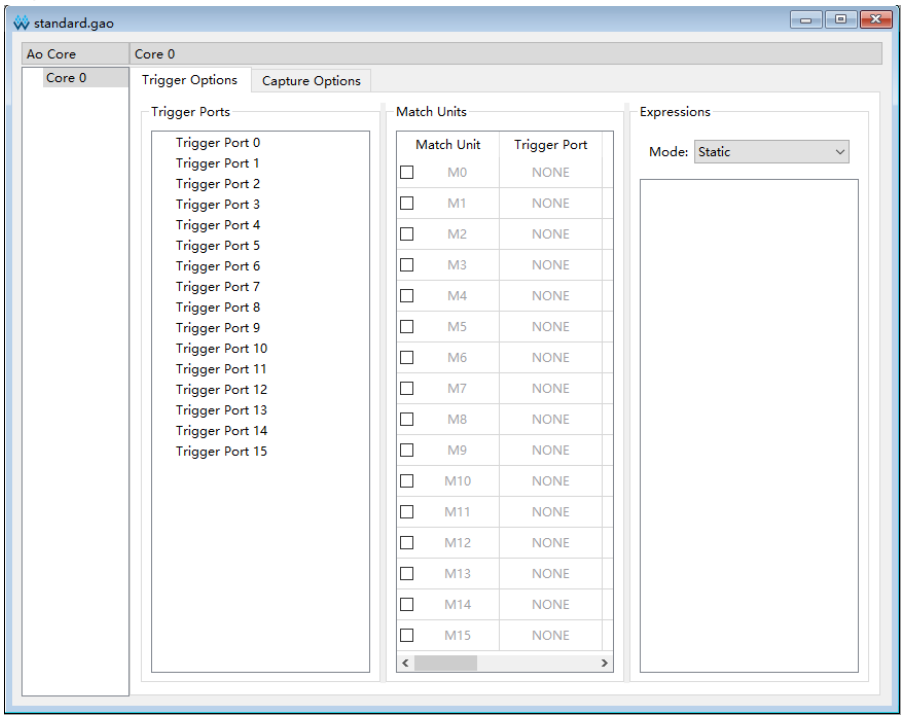
The steps are as follows:

1. In the "Design" view, right-click and select "Add Files...", the "Select Files" dialog box opens.
2. Select the config file (.gao) and load it to the project.

Start Standard Mode GAO

Double-click the configuration file (.gao) in the "Design" view. The "GAO Config View" will open, as shown in Figure 3-5. If the project has not synthesized, double-clicking on the .gao configuration file will bring up a warning box. GAO configuration window includes AO Core, Trigger Options, and Capture Options.

Figure 3-5 Gowin GAO Window (Standard Mode)



3.1.2 Standard Mode GAO Configuration

GAO includes AO Core, Trigger Options, and Capture Options.

AO Core Configuration

The AO Core is used to display and configure the number of AO used by current project, as shown in Figure 3-6. The AO Core only includes Core0 by default, and it can support up to 16 cores. The following operations can be performed:

1. Right click anywhere in the AO Core view and click "Add" to add new AO Core.
2. Select and right click a core in AO Core view and click "Remove" to remove core.
3. When a core is deleted, the subsequent core number decreases successively, and the core number increases continuously.
4. Select a core, and the core configuration view will be displayed on the right, as shown in Figure 3-7. For example, when Core2 is selected in AO Core, on the right is the Core2 configuration.

Note!

- When there is only one core in the AO Core, it is not allowed to delete it. If you select the core and click "Remove", the prompt will pop up.
- 16 cores are supported at most. When there are more than 16 cores, an error prompt will pop up.

Figure 3-6 AO Core View

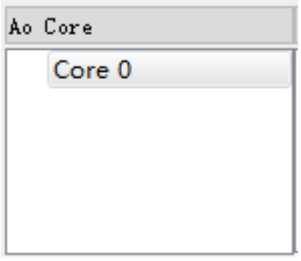
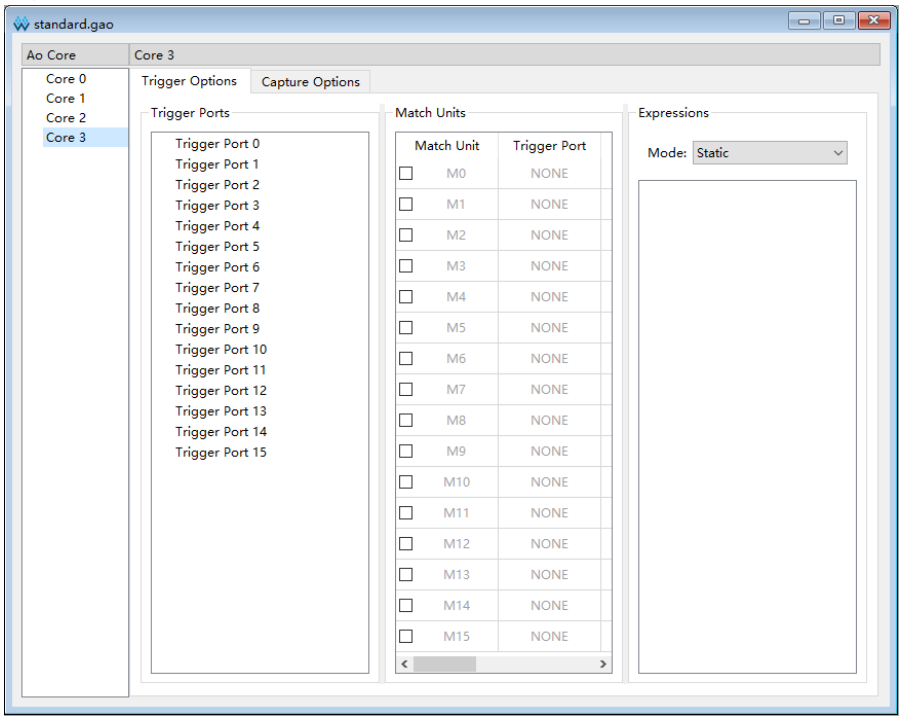


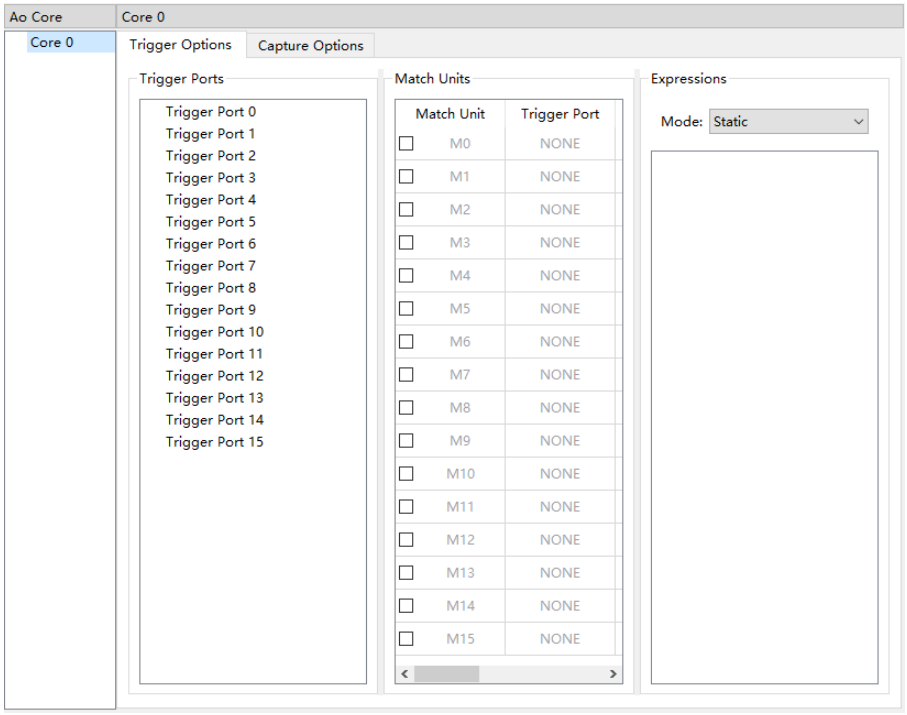
Figure 3-7 Select a Core



Trigger Options

Trigger options are used to configure signal trigger conditions, as shown in Figure 3-8. The Trigger Options view includes Trigger Ports, Match Units and Expressions.

Figure 3-8 Trigger Options View



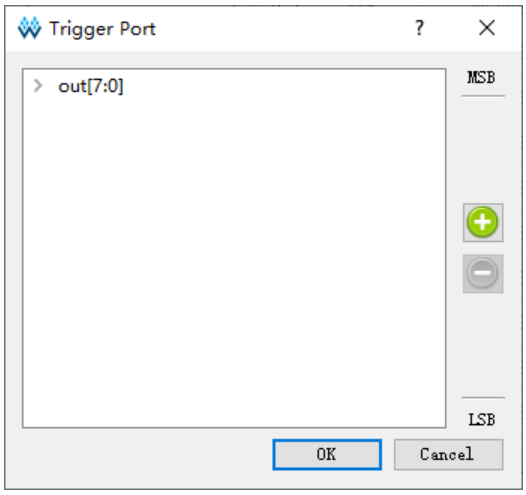
Trigger Ports Configuration

The Trigger Ports is used to configure the AO trigger ports; there are 16 trigger Ports (Trigger Port 0 ~ Trigger Port 15), and each trigger port width range is from 1 to 64. The steps are as follows:

1. Double-click on trigger port. The dialog box will pop up, as shown in Figure 3-9.
2. Click " " and the "Search Nets" dialog box opens. Click "Search", as shown in Figure 3-10. The signals grayed out are not available.
3. Select the trigger signals. As shown in Figure 3-10, the left side shows the filtered signals, and the right side displays the selected signals. You can use the "Add" or "Add all" buttons to move signals from the left to the right. Click “OK” to complete the trigger signal selection.

After the netlist is updated, if the signal that has been selected in the "Trigger Port" dialog box does not exist in the netlist, the trigger signal is highlighted in red, and this function is currently only supported in For Post-Synthesis Netlist GAO, not in For RTL Design GAO.

Figure 3-9 Trigger Port Dialog Box



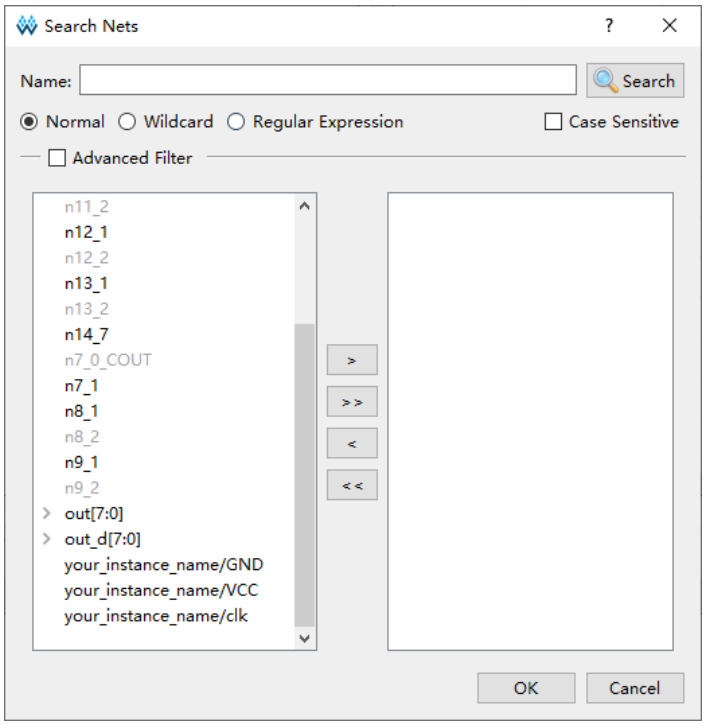
Note!

MSB and LSB in Figure 3-9 indicate the most and least bit of the trigger port.

You can perform the following operations:

- You can select signals by left-click, shift+left click, Ctrl+left to delete them by clicking "".
- You can select signals by left-click, shift+left click, Ctrl+left to sort by dragging.
- The same signal may not be added repeatedly in the same Trigger Port, and the rule is:
  - If an individual signal is added repeatedly, the addition fails.
  - If a sub signal of a Bus signal has already been added, when this Bus signal is added again, the added sub signal is deleted and the Bus signal is retained.
  - If a Bus signal has already been added, the addition fails when its sub signal is added.

Figure 3-10 Search Nets Dialog Box



Normal, Wildcard, and Regular Expression are mutually exclusive.

- Normal means searching in a normal way. Click "Search" to match the string in "Name" text box, as shown in Figure 3-11.
- Wildcard means searching with wildcard. Click "Search" to match the string in "Name" text box. The string contains wildcards (*,?) , as shown in Figure 3-12.
- Regular expression means searching with a regular expression. Click "Search" to match the string in "Name" text box. The string contains regular expression, as shown in Figure 3-13.
- If "Case Sensitive" is checked, the case-sensitive rule will be applied during signal matching. The signals area in the Search Nets dialog box supports left-click, Shift + left and Ctrl + left.

Figure 3-11 Normal Mode

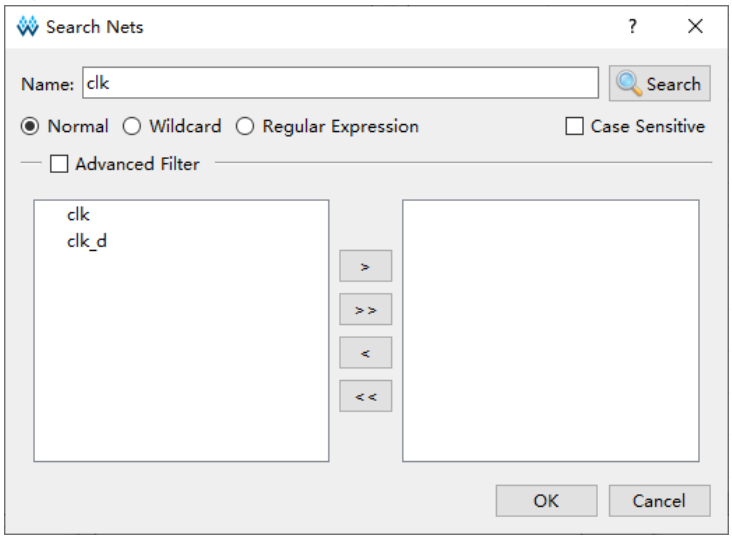


Figure 3-12 Wildcard Mode

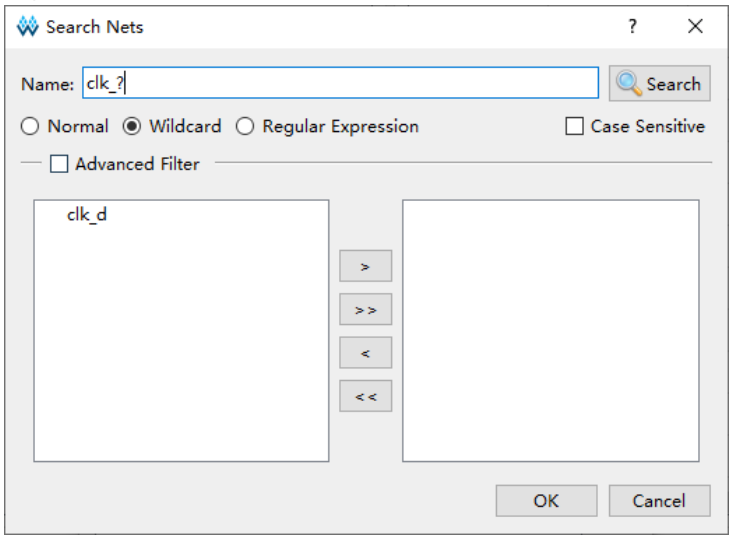
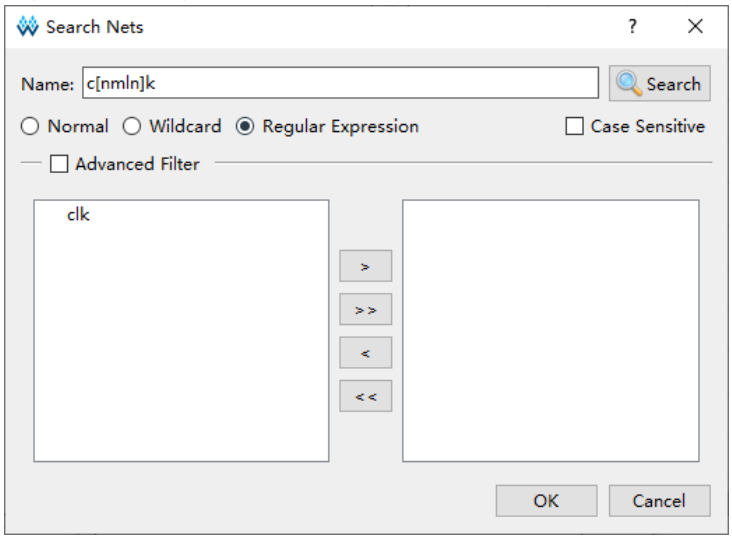


Figure 3-13 Regular Expression Mode

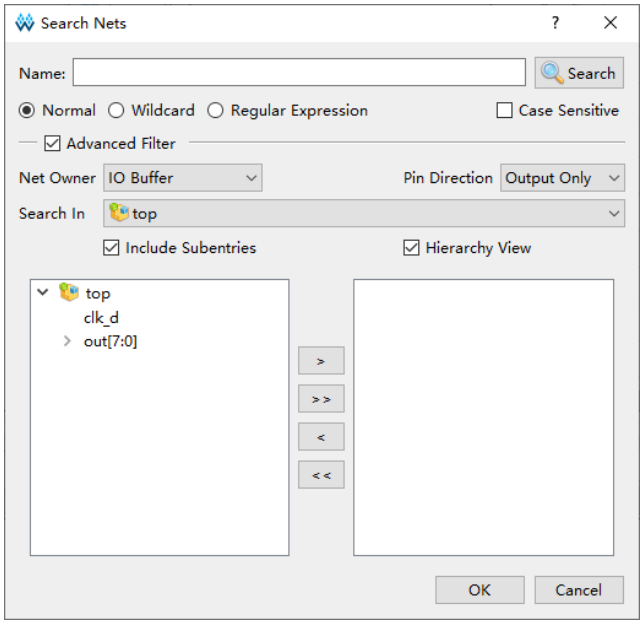


Select the "Advanced Filter" to further define filter conditions to search the required signals more specifically. Among them:

- The Net Owner is used to set the type of module where the signal belongs to. You can select a module or all.
- The Pin Directions is used to set whether the signal is Output only, Input only or All Directions.
- The Search In is used to set which module to filter signals from.
- The "Include Subentries" is used to set whether to filter the signal from the submodule.
- Hierarchy View is used to display signals in hierarchical structure.

As shown in Figure 3-14, the "Net Owner" selects IO_Buffer, "Pin Directions" selects "Output Only", "Search In" selects "top", and selects "Include Subentries" and "Hierarchy View". Click "Search" to display all output signals associated with IO_Buffer in top modules and their sub-modules in hierarchical structure.

Figure 3-14 Advanced Filter



Match Units Configuration

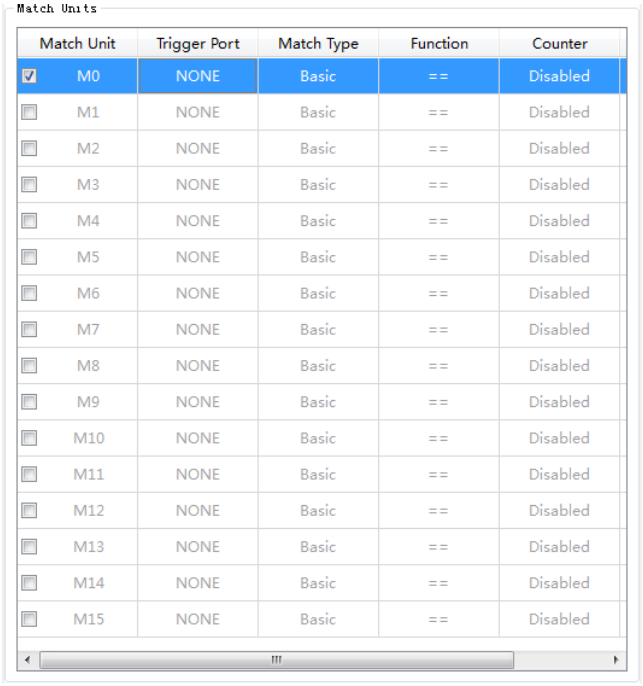
The match units option is used to configure the match unit of trigger ports. There are up to 16 trigger match units, which range from M0-M15. Match unit is the minimum unit required by GAO to achieve trigger conditions. AO processes the trigger port signals designed by the user by the match unit and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

A trigger port can use one or more trigger match units, but a trigger match unit can only belong to one trigger port. The number of Match Units that can be used is related to the trigger expression. Select "Static" in "Expressions", up to16 trigger match units can be used; and select

"Dynamic" in "Expressions", up to10 trigger match units can be used.

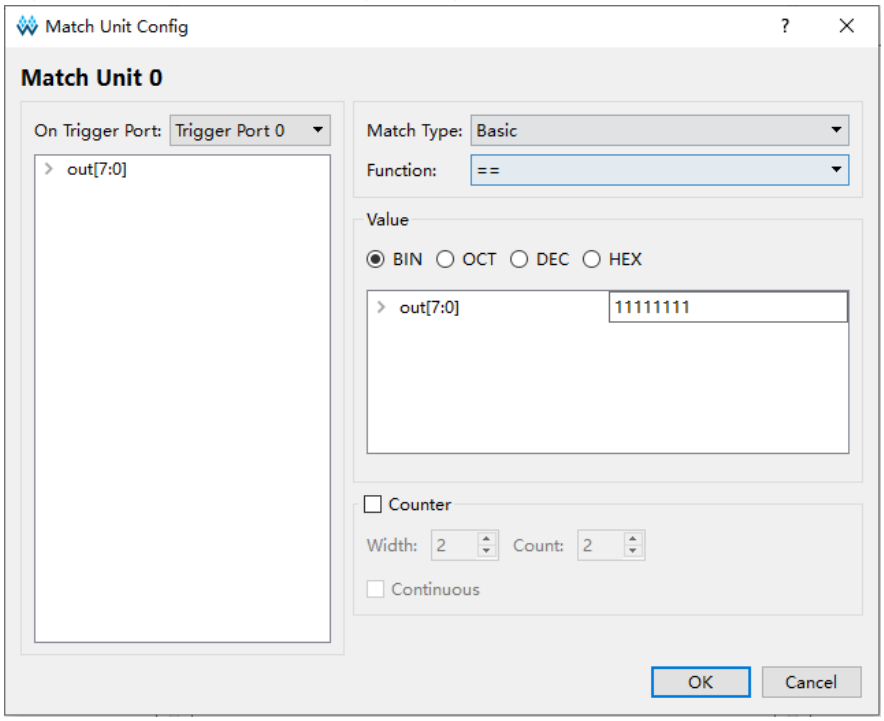
1. In Match Units view, check the "Match Units" to the select trigger match unit, as shown in Figure 3-15.

Figure 3-15 Match Units View



2. Double-click one match unit to open "Match Unit Config" dialog box and configure the trigger conditions, as shown in Figure 3-16.

Figure 3-16 Match Unit Config Dialog Box



3. Click "On Trigger Port" drop-down list and select the trigger port.

4. Select the match type and function from the "Match Type" and "Function" drop-down lists respectively. The details are as follows:
   - Basic: Execute "= =" and "! = "operations, which are used for general signal comparison, and it save resource.
   - Basic w/edges: Execute "= =" and "! = "and the jump test operations for control signal jump.
   - Extended: Execute ″==″、″!=″、″>″、″>= ″、″<″、and ″<= ″ operations for the value of address or data signal.
   - Extended w/edges: Execute ″==″、″!=″、″>″、″>= ″、″<″、″<= ″ and jump test operations for the value of address or data signal or signal jump.
   - Range: Execute ″==″、″!=″、″>″、″>= ″、″<″、″<= ″, in/out of the range detection operations for the value of specific address or data signal.
   - Range: Execute ″==″、″!=″、″>″、″>= ″、″<″、″<= ″, in/out of the range detection and jump test operations for the value of specific address, data signal and signal jump.

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, hexadecimal, and octal forms.

Table 3-1 Match Type Supported By Trigger Match Unit

Type	Bit Values	Matching Function	Description
Basic	0, 1, X	==,!=	Used for general signal comparison, and it can save resource.
Basic w/edges	0, 1, X, R, F, B, N	= =,! =, jump detection	Used to control signal jump.
Extended	0, 1, X	==,!=,>,>=,<, <=	Used for the value of address or data signal.
Extended w/edges	0, 1, X, R, F, B, N	==,!=,>,>=,<,<=, jump detection	Used for the value of address or data signal and jump signal.
Range	0, 1, X	==,!=,>,>=,<,<=, in/out of the range detection.	Used for the value of address or data signal in specific range.
Range w/edges	0, 1, X, R, F, B, N	==,!=,>,>=,<,<=, in/out of the range detection, jump detection	Used for the value of address or data signal in specific range and jump detection.

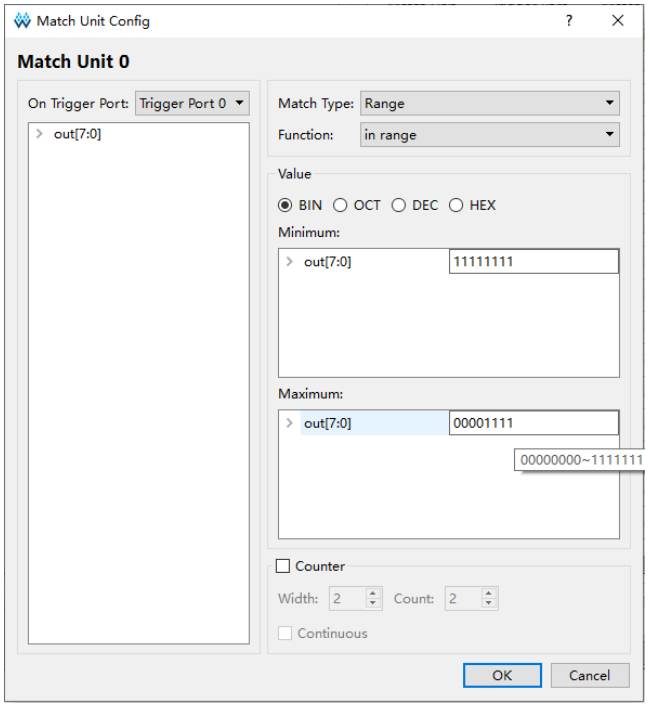
Note!

In Bit Values:
- "0" means low level.
- "1" means high level.
- "X" means either of them.
- "R" indicates rising edge 0->1.
- "F" indicates falling edge 1->0.

- "B" indicates rising or falling edge transition.
- "N" means no logical level transition.

5. If selecting "Range" or "Range w/edges" in "Match Type", and selecting in range or not in range in "Function", the value in the "Minimum" is the lower limit value, and the value in "Maximum" is the upper limit value, as shown in Figure 3-17. If the minimum is greater than the maximum, the "Value Invalid" prompt will pop up.
6. When the cursor is hovering over the "Value" input box, the Value range will be displayed, as shown in Figure 3-17.

Figure 3-17 Minimum/Maximum in/not in Range



7. The rule for configuring Value are as follows:
   - There are three types of signals: Bus, sub signal and single signal. Bus is the signal of Bus, sub signal is the sub signal of Bus signal, and single signal is the separate signal not belonging to sub signal.
   - Bus, sub signal and single signal add right-click menu, including seven values X, 0, 1, R, F, B, N.
   - For Bus, single signal, you can enter values via right-click menu or manually, while for sub signal, you can only enter values via right-click menu.
   - The value selected by the right-click menu for Bus signals is valid for all sub signals.
8. Each trigger match 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, capture data after matching 1 time by default.

- Check "Counter" and enter value in "Width", and modify or add/remove data in the box by clicking the up and down buttons on the right or using the mouse wheel.
- The range of the counter width is [1, 16], which determines the maximum value of the counter.
- If the counter width is set to 3, the maximum value is 2^3.
- Enter n in "Count". This triggers after matching n times. If the check "Continuous" is checked, enter value n in the "Count". This triggers after matching n times.

Note!

- If the error prompt pops up, click the "Hide Details" to show the details.
- When config file (.gao) is saved, if the number of signal trigger unit changes, but the match unit is not modified accordingly, the error prompt box will open, as shown in Figure 3-18.
- If the trigger port belonging to the match unit is not configured, the error prompt box will open when the .gao is saved, as shown in Figure 3-19.

Figure 3-18 Error Prompt

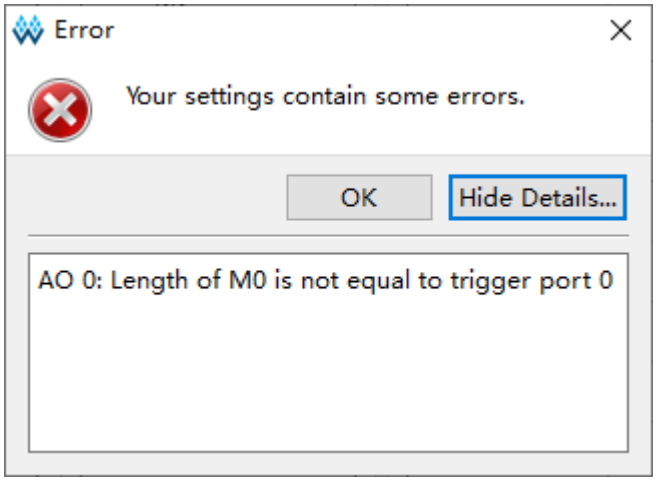
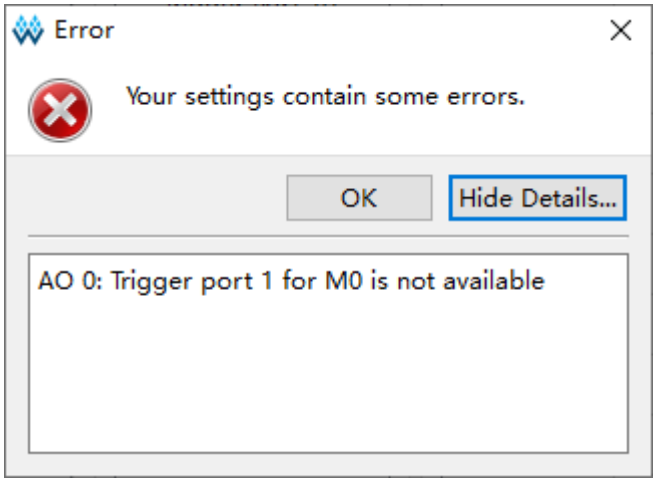


Figure 3-19 Prompt



Trigger Expressions Configuration

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

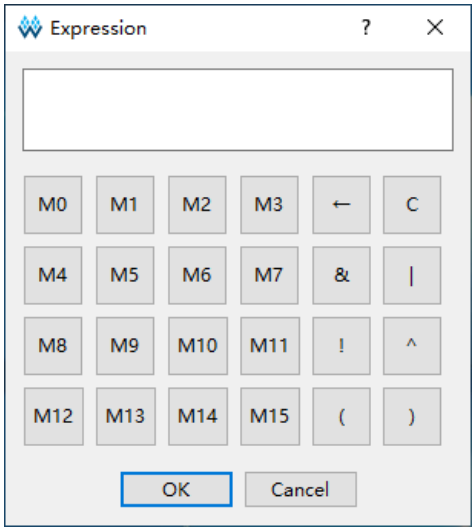
trigger expressions at most.

In the "Expressions" view, the trigger expressions are sorted in order from Expression0~Expression15.

The related operations are as follows:

- Select "Static" from the Mode drop-down list, and the number of Match Unit used is 16, but it cannot dynamically modify the trigger expression.
- Select "Dynamic" from the Mode drop-down list, and the number of Match Unit used is10. It can dynamically modify the trigger expression without re-synthesis and PnR. When the "Dynamic" type is selected, the implementation type of the trigger expression can be selected from the Implementation drop-down list, including BSRAM, SSRAM and REG, and the SSRAM option will not be displayed when there is no SSRAM resource in the device used.
- Double-click any trigger expression to edit.
- Right-click anywhere in Expressions, and select "Add" to add expression.
- The Expression dialog box will open, as shown in Figure 3-20. You can configure the trigger expressions in the dialog box. If the wrong syntax exists in the expression, the error will pop up when you click "OK" to save.
- Select the expression that you need to delete, right-click and select "Remove" to remove the trigger expression.

Figure 3-20 Expression Dialog Box



When "Static" is selected, the number of match unit that can be edited is 16, that is, M0~M15. When "Dynamic" is selected, the number of match unit that can be edited is 10, that is, M0~M9, and the M10~M15 are grayed out, as shown in Figure 3-20.

Expression 0 ~ Expression 15 correspond to Level 0 ~ Level 15. When setting the AO trigger conditions, the minimum trigger Level is one (Level 0), and the maximum is 16 (Level 0 to Level15). The trigger level corresponds

to the number of trigger expressions. If the trigger level is N and the first level trigger condition is met, the second level trigger condition will be estimated, and so on, until the Level. The final trigger signal is generated, and AO begins to capture data.

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

- Supports &, | and !. Supports logical operators, and "()".
- 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 call the same trigger match unit, or the same number or a different number of trigger match units.

For example, if you set eight match units M0-M7, for each level of trigger expressions, any number of the match units from these eight can be logically combined. For example:

M0&M1

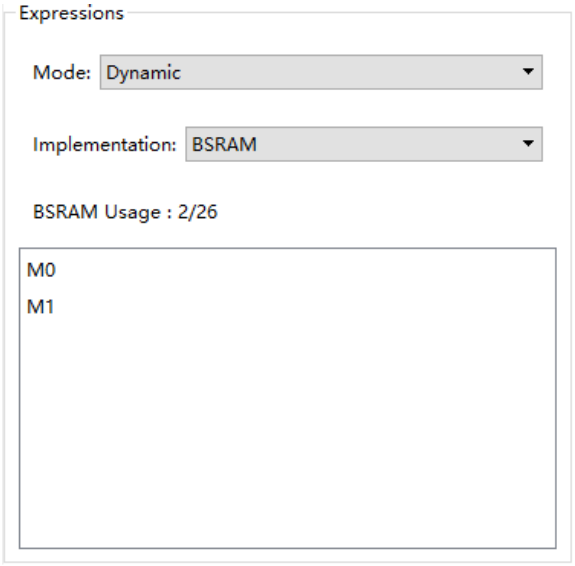
!M4&(M3|M6)

……

Configure an expression by double-clicking the text box in the expression dialog. Click "OK" to finish.

If "Dynamic" is checked, the resource usage of the triggering expression will change according to the Implementation, for example, when BSRAM is selected for the Implementation, BSRAM Usage will be displayed; when SSRAM is selected, SSRAM Usage will be displayed. As shown in Figure 3-21, it indicates that the Dynamic Expression occupies 2 BSRAM resources.

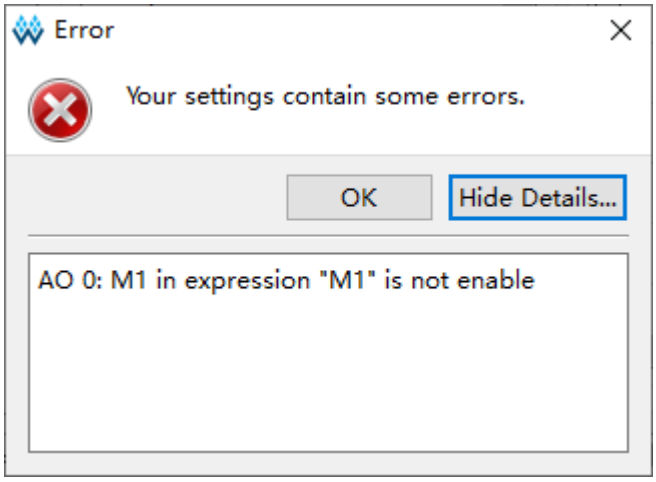
Figure 3-21 Select Dynamic



Note!

- When the configuration file (.gao) is saved, the prompt will pop up if the unselected match units are used in expressions, as shown in Figure 3-22.
- An AO can add up to 16 expressions. If more than 16 expressions are added, an error prompt will pop up.

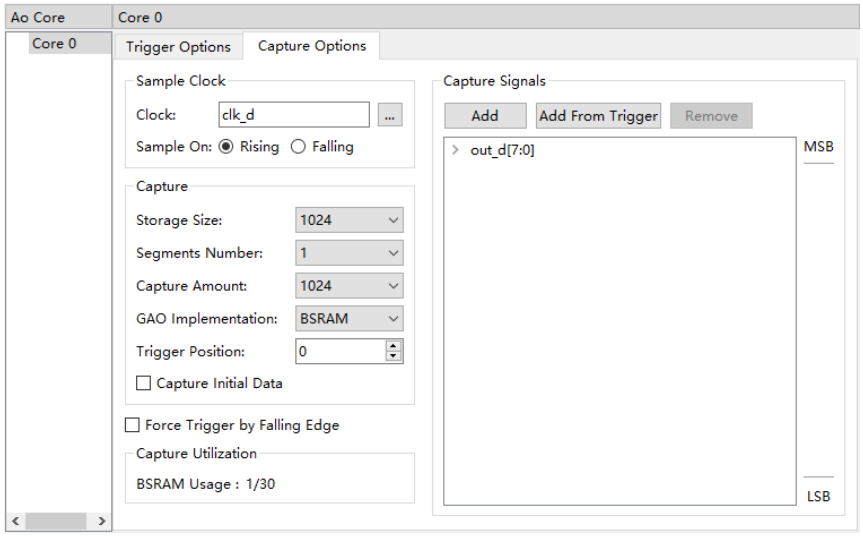
Figure 3-22 Error Prompt



Capture Conditions Configuration

As shown in Figure 3-23, the Capture Options is mainly used to configure signal sampling information such as "Sample Clock", "Storage Size", "GAO Implementation", "Trigger Position", "Capture Initial Data", "Force Trigger by Falling Edge", and "Capture Signals", etc. and it also displays the number of resources occupied by the current AO Core's Capture Signals to store data.

Figure 3-23 Capture Options



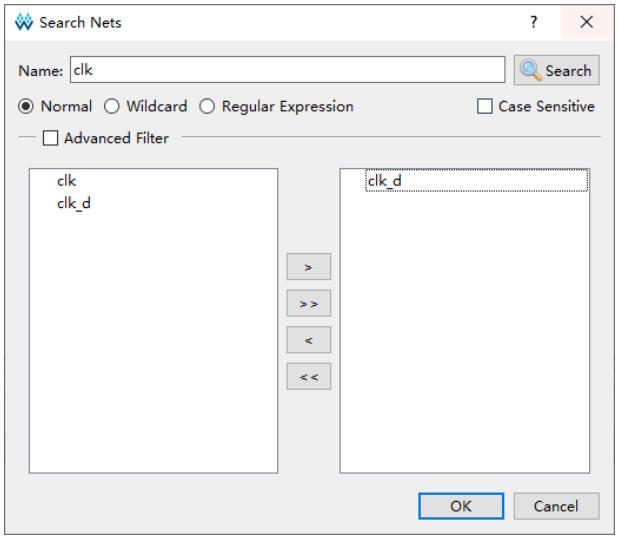
Sample Clock Configuration

You can select the clock in the user design or other clocks as the sample. 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. The sample clock supports sampling on rising edge and falling edge.

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

- Enter the sample clock name in the "Sample Clock" text box.
- Click the "..." next to the "Sample Clock" text field and the "Search Nets" dialog box will pop up to select the sample clock signal, as shown in Figure 3-24. Click "OK" to add the signal.

Figure 3-24 Search Nets Dialog Box (Standard 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 3-25.

- If there is no sample clock, the error dialog box, an error prompt will appear, as shown in Figure 3-26.

Figure 3-25 Error Prompt

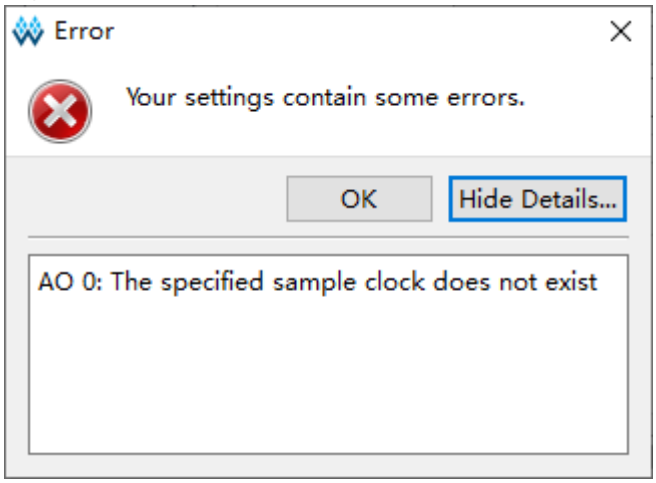
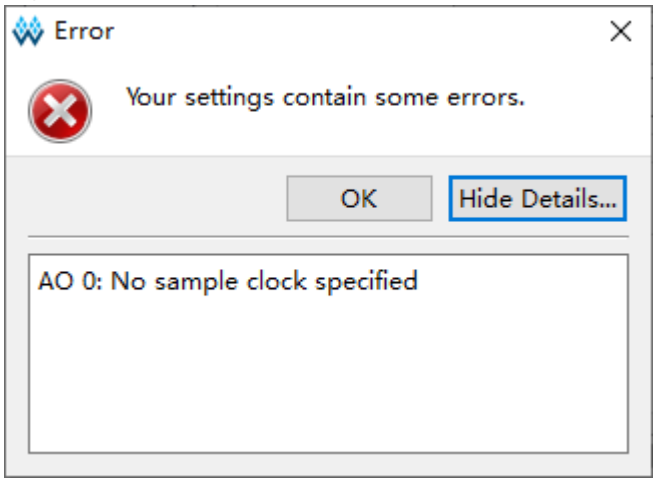


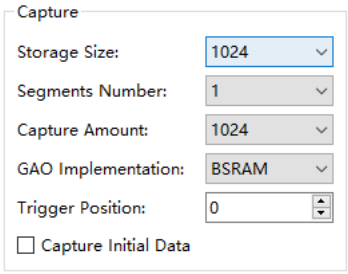
Figure 3-26 Error Prompt



Storage Configuration

As shown in Figure 3-27, it is mainly used to configure the "Storage Size", "Segments Number", "Capture Amount", "GAO Implementation", "Trigger Position", and "Capture Initial Data".

Figure 3-27 Capture Configuration



- "Storage Size" is the memory address depth for data capture. Click the "Storage Size" drop-down list and select the required size: 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536.
- "Segments Number" is the number of capture segments. AO uses the segment capture mode. The capture buffer is divided into one or more segments that have the same or multiple sizes. Each AO supports Storage Size/4 segments at most, and one segment at least. Select the number of segments number from the drop-down list.
- Capture Amount: The address depth of the memory being used on each capture buffer segment. Each capture segment has the same capture amount, and the total capture amount can not be more than the configured storage size. Select the capture amount from the drop-down list.
- GAO Implementation: Means sampled signal data storage method. Sampled signals can use BSRAM, SSRAM or REG resources to store the data, and you can select through the drop-down list. It should be noted that REG can be selected only when Storage Size*(Capture Signals + 1)<=512.
- "Trigger Position" is the capture data position in memory when triggering. Enter or select the required value in the "Trigger Position" text box. The address starts from 0.
- Capture Initial Data: Used for trigger events occurring after power-up or reset but before manually starting the GAO.

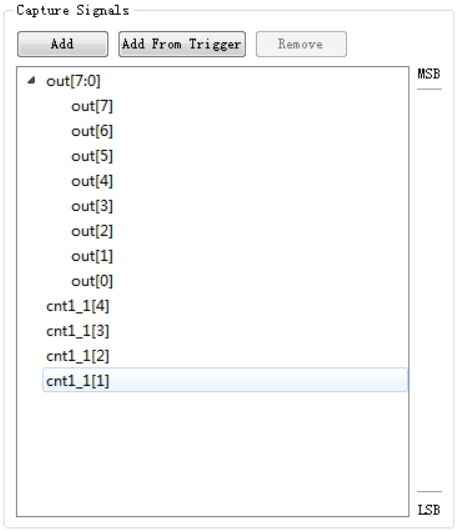
Force Trigger by Falling Edge Configuration

When Force Trigger by Falling Edge is checked, you can modify some internal registers in GAO IP driven by the rising edge of the TCK clock to be driven by the falling edge, which is used to improve the timing of the TCK, and the default is unchecked.

Capture Signals Configuration

The "Capture Signals" in Figure 3-28 can be used to configure capture signals. The data port signal is the input signal of the data port specified in the user design.

Figure 3-28 Capture Signal



- "Add" is used to select the signal. click "Add", and "Search Nets" dialog box pops up, then select your required data port signal, click "OK" to finish. Bus signals can also be added, such as ". [7:0]", as shown in Figure 3-28.
- You can use trigger signal as the capture signal if selecting "Add From Trigger". One or more trigger ports can be selected in the "Add From Trigger" list, as shown in Figure 3-29.
- You can delete signal by clicking "Remove".
- You can select signals by left-click, shift+left click, Ctrl+left to sort by dragging.
- Right-click the signal, and you can select Group, Ungroup, Rename, Restore Original Name, Reverse, Enable and Disable from the pop-up menu. As shown in Figure 3-30, after the signal Disable is grayed out and can not be captured, Enable the signal can be captured.
- After the netlist is updated, if the signal that has been selected in the Trigger window does not exist in the netlist, you can see Trigger Ports Configuration for details.
- The same signal may not be added repeatedly in the same Trigger Port, and you can see Trigger Ports Configuration for details.

Figure 3-29 Add From Trigger

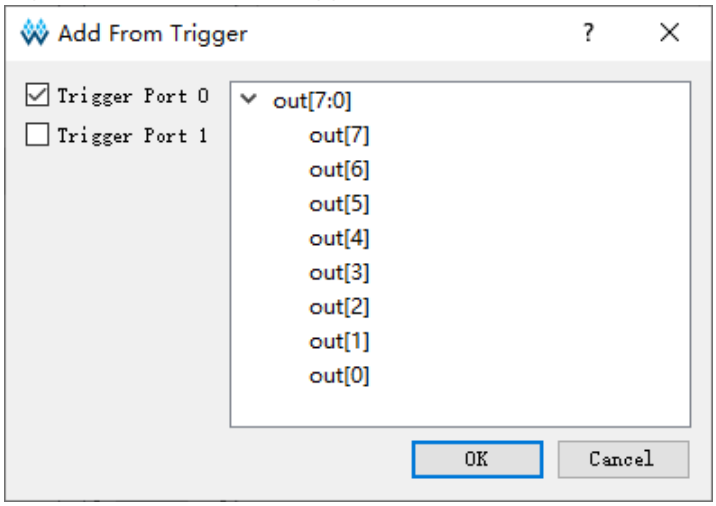
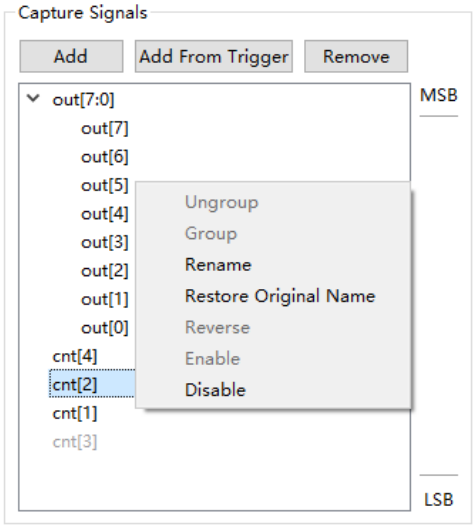


Figure 3-30 Signal Right-Click Menu



Resources Used by Capture Signals

The number of BSRAM, SSRAM, or REG resources used by the current AO Core "Capture Signals" can be displayed, and it is related to the GAO Implementation. As shown in Figure 3-31, when BSRAM is selected for GAO Implementation, the number of BSRAM resources used by AO Core Capture Signals is displayed.

Figure 3-31 Resources Used by AO Core Capture Signals

3.1.3 Generate Bitstream File

After GAO files configuration, double-click "Place & Route" in the "Process" to run PnR. Generate a bitstream file containing user designs and GAO configuration. The files are named after the AO name by default, such as "ao_0.fs", and they are stored in the project path "/impl/pnr/" by

default.

3.2 GAO Config File in Lite Mode

3.2.1 Start Lite Mode GAO

You first need to create or load the configuration file (.gao/.rao) before start, including "For RTL Design" and "For Post-Synthesis Netlist". The "For RTL Design" is used to capture RTL signal before synthesis with extension .rao. The 'For Post-Synthesis Netlist' is used to capture the netlist signal after synthesis with extension .gao. For the two types of Lite Mode GAO configuration are similar, the following will take "For Post-Synthesis Netlist" in Lite Mode GAO as an example.

Create GAO Config File in Lite Mode

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 3-32.
2. Select the "GAO Config File" and click "OK". The "New GAO Wizard" dialog box will open, as shown in Figure 3-33. Select "Lite", and then click "Next".
3. Enter the config file name in the "Name" editing box, select an appropriate path in the "Create in" path selection box as shown in Figure 3-34, and then click "Next".
4. Check the GAO config. file mode and path, as shown in Figure 3-35 . Click "Finish". You can see the config file in "GAO Config Files" view.

Figure 3-32 Create GAO Config File (Lite Mode)

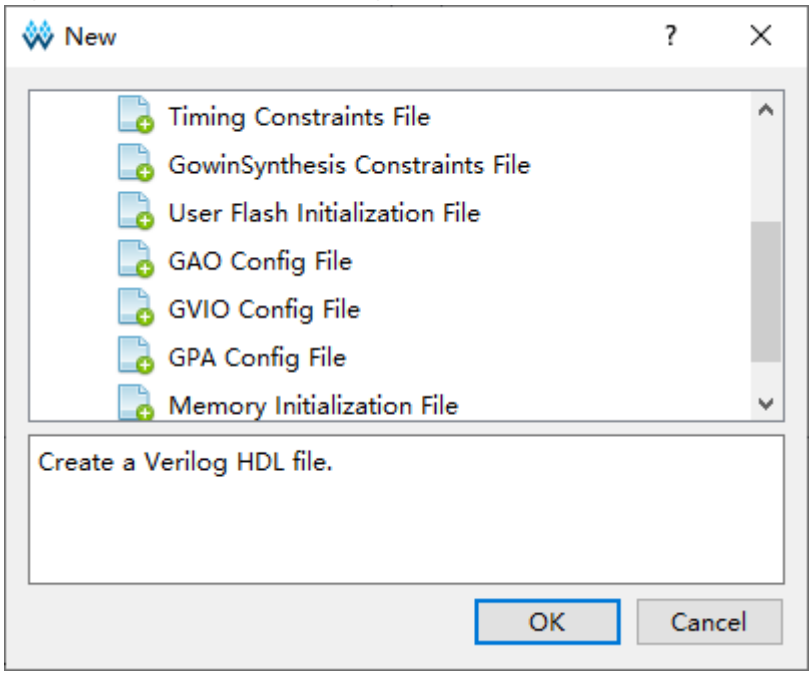


Figure 3-33 New GAO Wizard (Lite Mode)

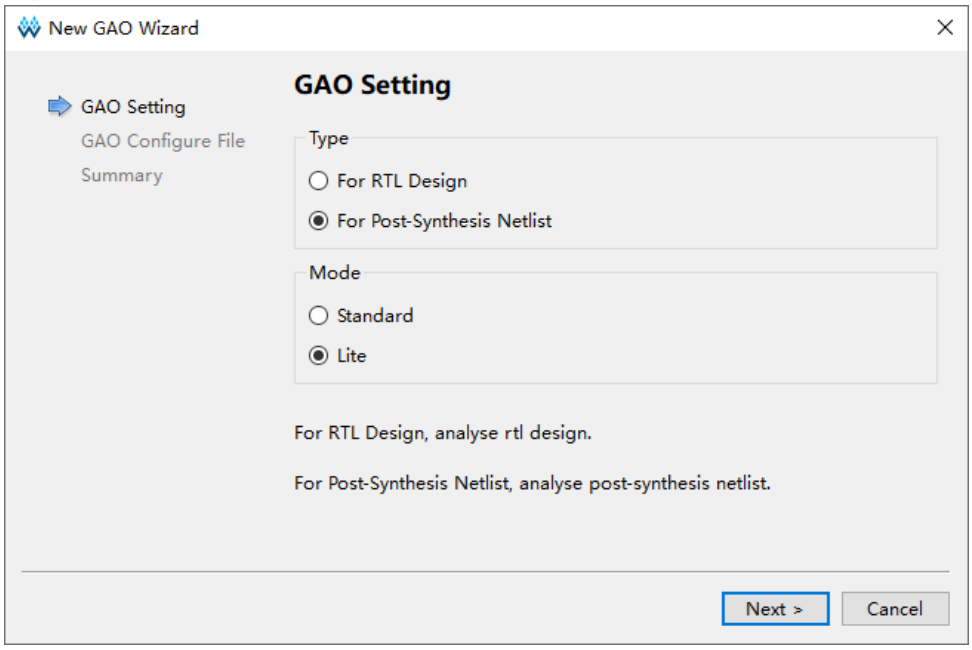


Figure 3-34 GAO Config File Name (Lite Mode)

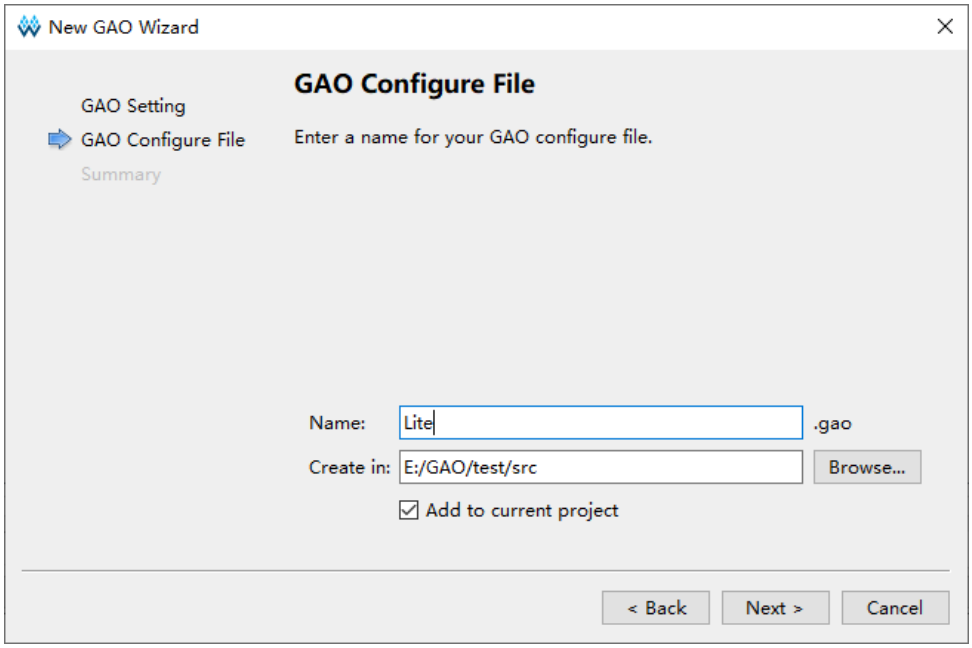
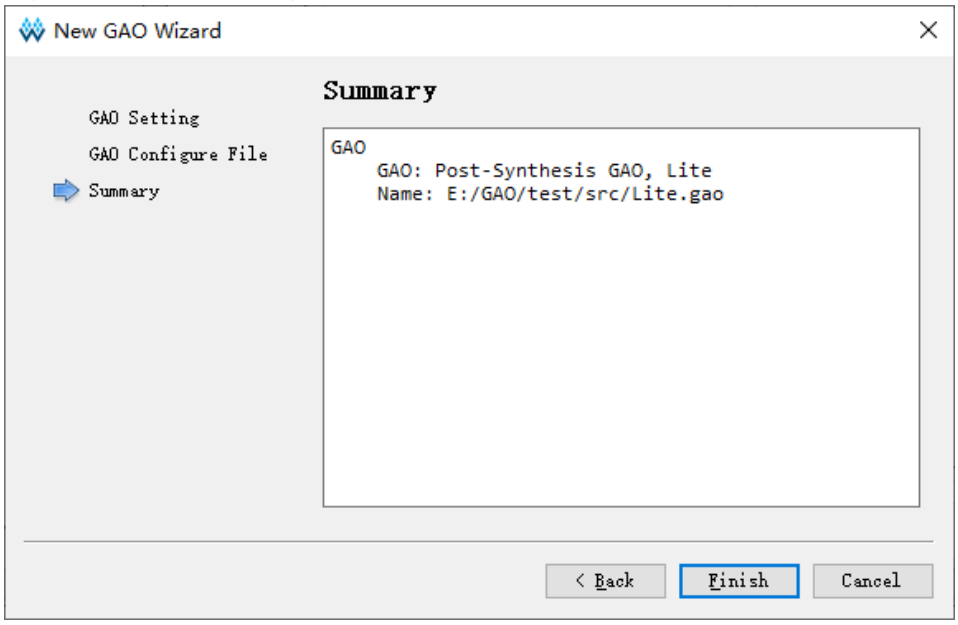


Figure 3-35 GAO Config File Mode and Path (Lite Mode)



Load GAO Config File

The steps are as follows:

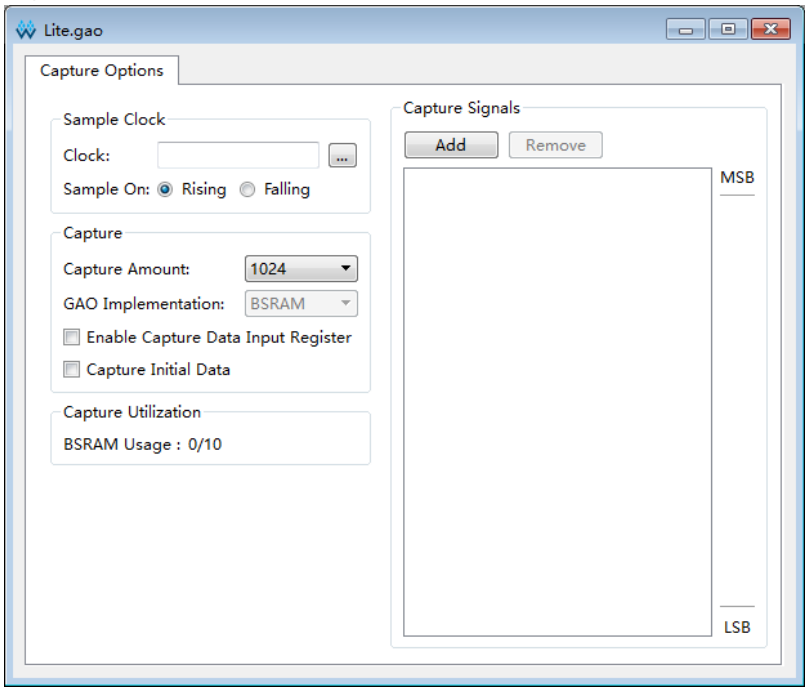
1. In the "Design" view, right-click and select "Add Files..."; the "Select Files" dialog box opens.
2. Select the config file (.gao) and load it to the project.

Start Lite Mode GAO

Double-click the configuration file (.gao) in the "Design" window. The "GAO Config" will open, as shown in Figure 3-36. If the project is without synthesis, when user double-clicks the config file (.gao), the "Warning" prompt will pop up.

The GAO configuration window displays the capture options.

Figure 3-36 Gowin GAO (Lite Mode)



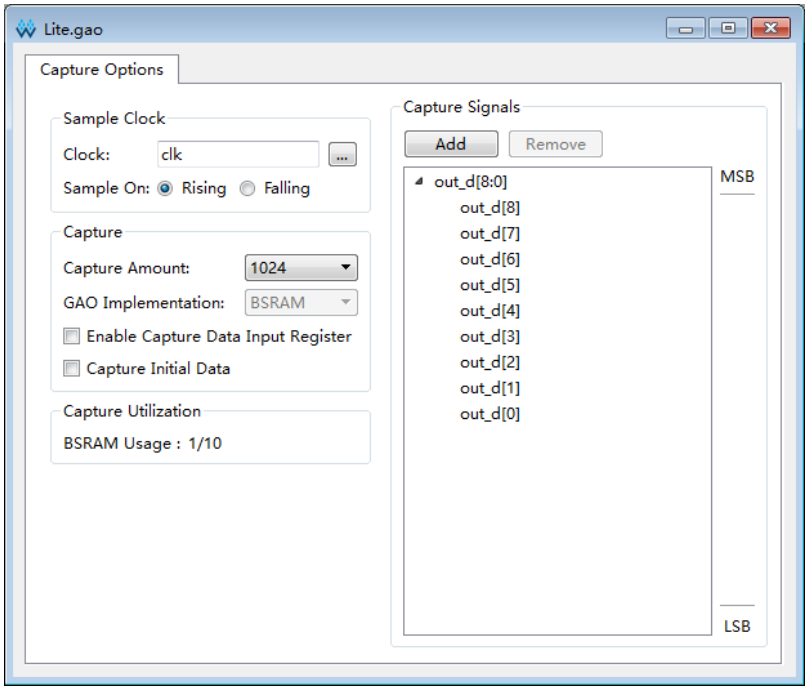
3.2.2 Lite Mode GAO Configuration

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

Capture Signals Configuration

As shown in Figure 3-37, the "Capture Options" includes the "Sample Clock", "Capture Signals", "Capture" and "Capture Utilization".

Figure 3-37 Capture Options (Lite Mode)



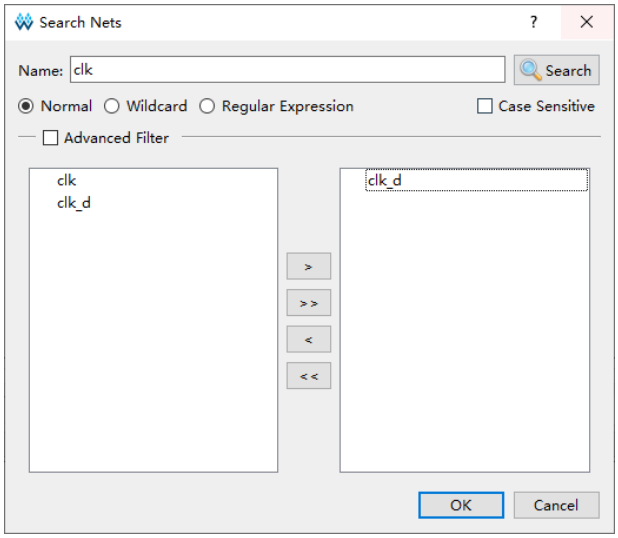
You can select the clock in the user design or other clocks as the

sample. The sample clock supports sampling on rising edge and falling edge.

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

- Enter the sample clock name in the "Sample Clock" text box.
- Click the "..." next to the right of the "Sample Clock" text box and the "Select Nets" dialog box will pop up to select the sample clock signal, as shown in Figure 3-38. Click "OK" to add the signal.

Figure 3-38 Search Nets Dialog Box (Lite Mode)



Note!

- If the configured sample clock does not exist when the config file (.gao) is saved, the error prompt box will pop up, as shown in Figure 3-39.
- If there is no sample clock, the error dialog box, "No sample clock specified", will pop up, as shown in Figure 3-40.

Figure 3-39 Error Prompt

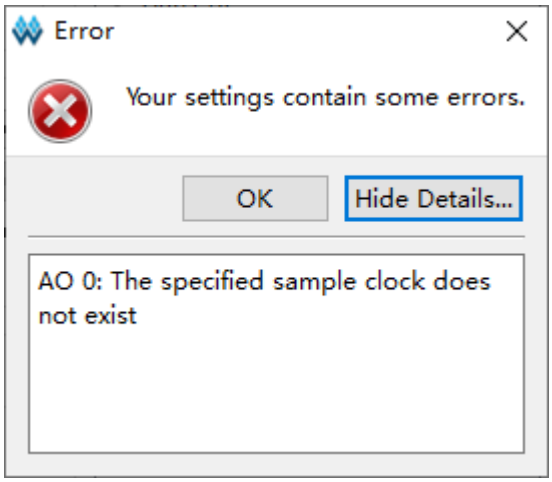
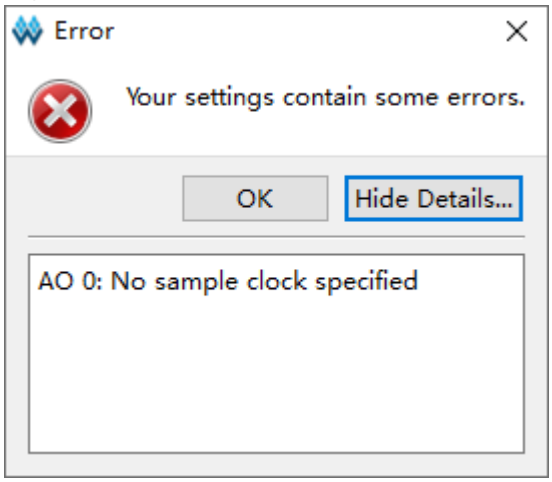


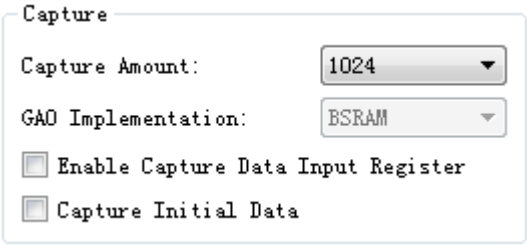
Figure 3-40 Error Prompt



Storage Configuration

As shown in Figure 3-41, it is used to configure "Capture Amount", "GAO Implementation", "Enable Capture Data Input Register", and "Capture Initial Data".

Figure 3-41 Capture Configuration (Lite Mode)

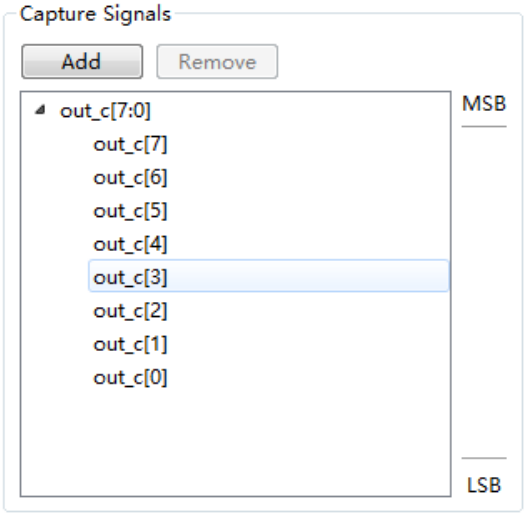


- Capture Amount: The address depth of the memory being used on each capture buffer page.
- GAO Implementation: Means sampled signal data storage method. Sampled signals can use BSRAM, SSRAM or REG resources to store the data, and you can select through the drop-down list. It should be noted that REG can be selected only when Storage Size*(Capture Signals + 1)<=512.
- Enable Capture Data Input Register: Adjust timing. If there is a delay from the clk to BSRAM, you can select this option to adjust the timing to add a layer of reg for capture signal.
- Capture Initial Data: Samples data during the FPGA power-up initialization period.

Capture Signals Configuration

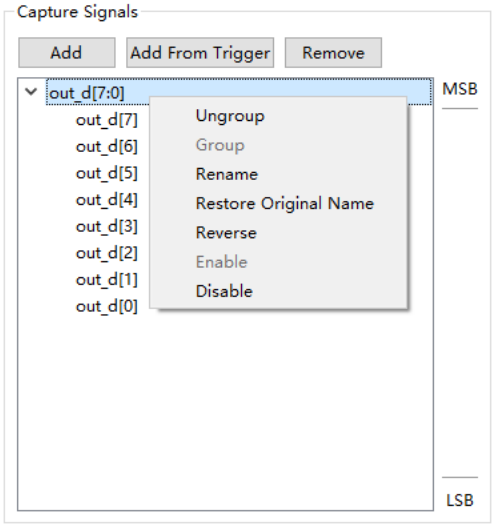
The "Capture Signals" in Figure 3-42 can be used to configure capture signals. The data port signal is the input signal of the data port specified in the user design.

Figure 3-42 Capture Signals



- "Add" is used to select the signal. Click "Add", and "Search Nets" dialog box pops up, then select your required data port signal, click "OK" to finish. Bus signals can also be added, such as out[7:0] as shown in Figure 3-42.
- You can delete signal by clicking "Remove".
- You can select signals by left-click, shift+left click, Ctrl+left to sort by dragging.
- When a signal is selected and right-click on it, in the pop-up menu, there are operations such as Group, Ungroup, Rename, Restore Original Name, Reverse, Enable, and Disable, as shown in Figure 3-43. A disabled signal is grayed out and cannot be captured, while an enabled signal can be captured.
- After the netlist is updated, if the signal that has been selected in the "Capture Signals" view does not exist in the netlist, the capture signal is highlighted in red, and this function is currently only supported in For Post-Synthesis Netlist GAO, not in For RTL Design GAO.

Figure 3-43 Signal Right-click Menu



Resources Used by Capture Signals

It is used to display the number of BSRAM, SSRAM, or REG resources used by the current AO Core "Capture Signals", and it is related to the GAO Implementation. As shown in Figure 3-44, when BSRAM is selected for GAO Implementation, the number of BSRAM resources used by the AO Core Capture Signals is displayed.

Figure 3-44 BSRAM Used by GAO

3.2.3 Generate Bitstream File

After GAO files configuration, double-click "Place & Route" in the "Process" to run PnR. Generate a bitstream file containing user designs and GAO configuration. The files are named after the AO name by default, such as "ao_0.fs", and they are stored in the project path "/impl/pnr" by default.

4 GAO Usage

GAO is used to display the capture signal waveform. It can also be used to configure the AO capture segment number, capture amount, and match conditions for match units via the JTAG. It helps you to observe data signals much more directly and visually. For a simple GAO example, see *SUG918, Gowin Software Quick Start Guide*.

For RTL Design GAO (.rao), joint debugging with GVIO is supported. For Post-Synthesis Netlist GAO (.gao), this is not allowed. For more details, you can see *SUG1189, Gowin Virtual Input Output User Guide*.

4.1 GAO Usage in Standard Mode

4.1.1 Start GAO in Standard Mode

Gowin Software can create either "For RTL Design" Standard Mode GAO config file with extension .rao or the "For Post-Synthesis Netlist" Standard Mode GAO config file with extension .gao, which has the same capture window. Therefore, the capture interface for loading the .gao configuration file is described here.

The steps are as follows:

1. Select "Tools" from the menu bar.
2. Select "Gowin Analyzer Oscilloscope" from the pull-down list to start GAO and the .gao file can be loaded automatically. Or click "Open" to select Standard Mode config file (.gao) or waveform file (.gwd/.analyzer_prj) that you require.
3. According to "Static" and "Dynamic" in 3.1.2 Standard Mode GAO Configuration > Trigger Expressions Configuration, the capture windows after loading the .gao config file are different. When "Static" is configured, the capture interface is as shown in Figure 4-1. When "Dynamic" is configured, the capture window is shown in Figure 4-2. The difference is whether the trigger expression of the capture window can be dynamically edited, so only the capture window when the trigger expression is configured as "Dynamic" is described.

You can also click " " to start GAO. In addition, GAO config file with the extension .rao can also be loaded. For the configuration of the .gao/.rao config file, see 3.1.1 Start Standard Mode GAO.

Note!

Under the IDE installation path /IDE/bin, the GAO capture interface can be started from the command line, and the executable program is gao_analyzer.exe, whose command parameters include:

- -gao: Specifies .gao or .rao file, and it is an optional command.
- -dir: Specifies the path that the "Open" button in the GAO capture interface will open, and it is an optional command.
- -family: Specifies the chip series, and it is a mandatory command.
- -device: Specifies the device type, and it is a mandatory command.
- -fs: Specifies the fs file loaded by GAO-Programmer, and it is an optional command.

Figure 4-1 Gowin Analyzer Oscilloscope (Static Standard Mode)

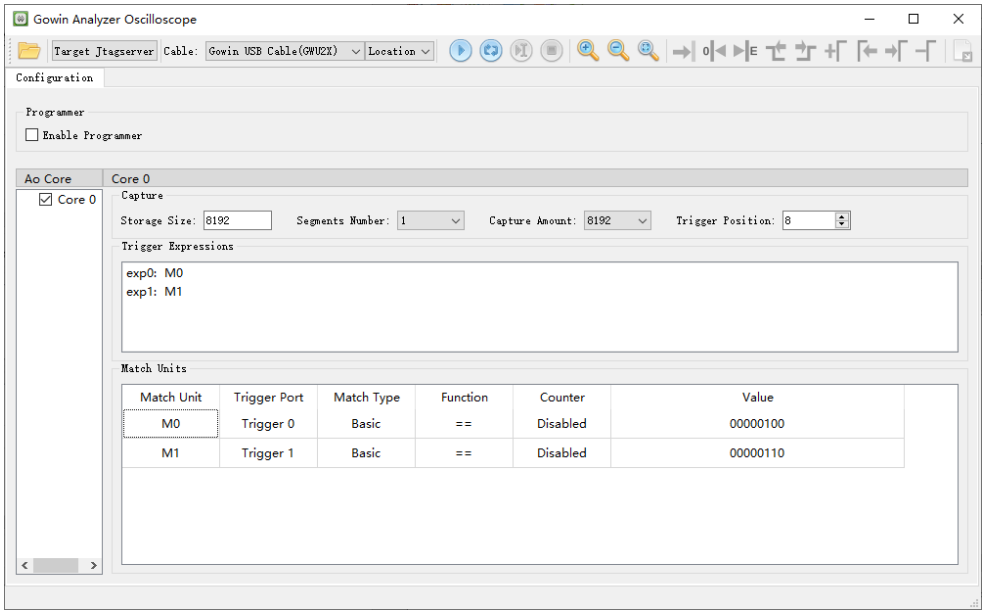
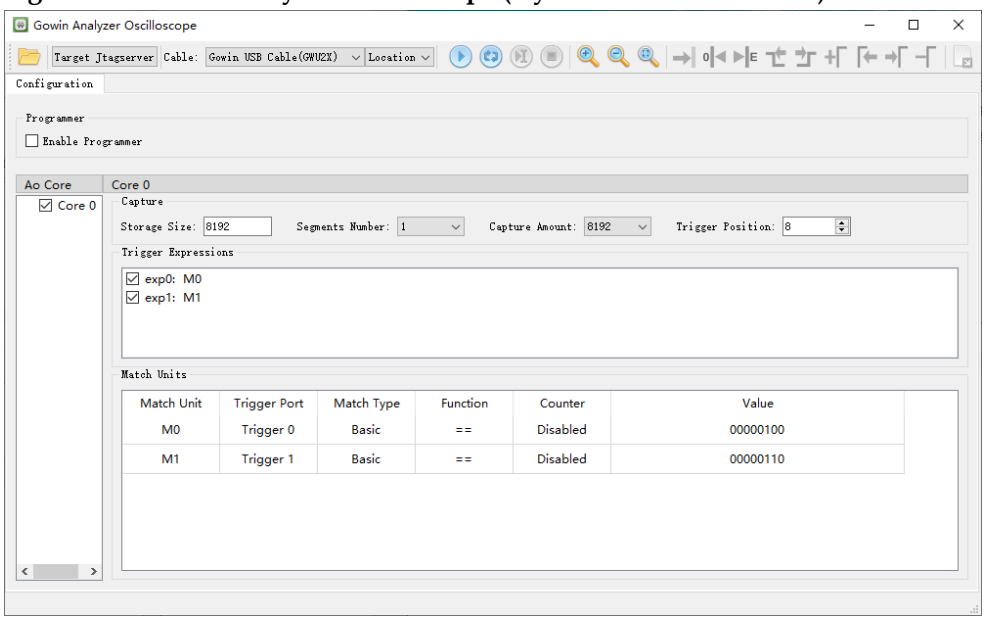


Figure 4-2 Gowin Analyzer Oscilloscope (Dynamic Standard Mode)



4.1.2 Run GAO

As shown in Figure 4-2, GAO window includes toolbar, Configuration view and Core Waveform view. The toolbar allows operations such as loading configuration files (.gao/.rao) or waveform files (.gwd/.analyzer_prj), setting the Target Jtagserver, and performing device initialization. The Configuration view is used to configure dynamic parameters of functional cores, and Core waveform view is used for waveform display.

Toolbar

GAO toolbar includes Open…, Target Jtagserver, Cable, Start/Stop control, Auto Run, Force Trigger, Zoom in/out, Go to Cursor, Go to Time 0, Go to Last Time, Previous Transition, Next Transition, Add Marker, Previous Marker, Next Marker, Delete All Markers, Export, etc., as shown in Figure 4-3.

Figure 4-3 Toolbar (Standard Mode)

The detailed description is as follows:

- " ": Open and load config files (.gao/.rao/.gwd/.analyzer_prj).
- Target Jtagserver: Used to connect GAO to a Local jtagserver or Remote jtagserver. As shown in Figure 4-4, click "Target Jtagserver", then the "Target Jtagserver Configuration" dialog box pops up, which includes:
  - The "Connect to" dropdown menu includes "Local jtagserver" and "Remote jtagserver" options. The default is Local server.
  - Connect to the Local jtagserver for local GAO debugging and local Programmer operations. Connect to the Remote server for remote GAO debugging and remote Programmer operations.
  - Before connecting to a Remote jtagserver, start the jtagserver on the remote device. For details on starting the jtagserver, see the Section 3.14 in *SUG502, Gowin Programmer User Guide*.
  - When selecting Remote jtagserver, configure the remote device's "Host Name/IP" and "Port", as shown in Figure 4-6. The Host Name/IP can directly specify the IP address of the remote device or its Host Name. If the Host Name resolves to multiple IP addresses, the first IP address is connected by default. The port defaults to 36548 but can be modified; it must match the port specified when starting the jtagserver on the remote device.
  - Clicking the "Connect" button initiates the connection to the jtagserver. If the connection fails, the "Connect to" dropdown will display "Local jtagserver connection failed" or "Remote jtagserver connection failed". If successful, it will display "Local jtagserver connection successful" or "Remote jtagserver connection successful".

- After successfully connecting to the Remote jtagserver, you can perform remote GAO debugging and remote Programmer operations, which are the same as those for the Local jtagserver.

Figure 4-4 Target Jtagserver Configuration

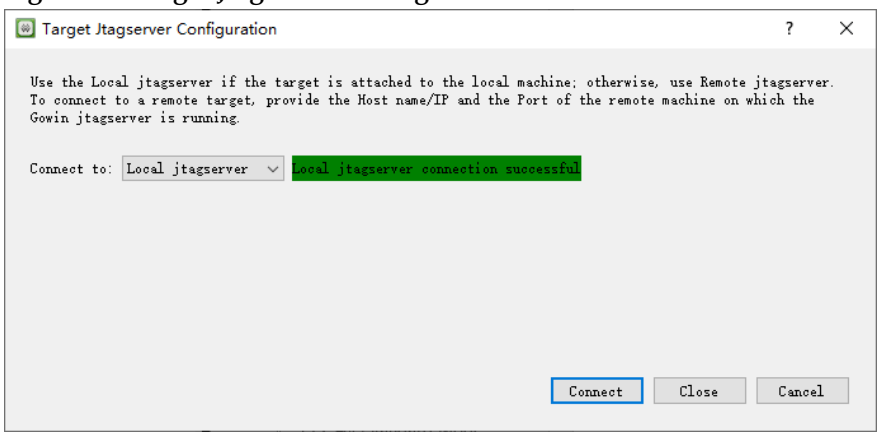
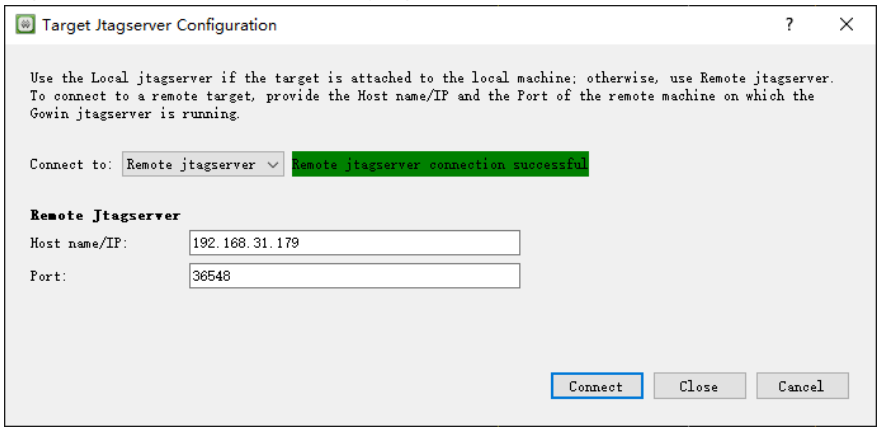
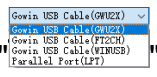


Figure 4-5 Start jtagserver

Figure 4-6 Connect to Remote jtagserver



- 

": Gowin USB Cable (GWU2X), Gowin USB Cable (FT2CH), Gowin USB Cable (WINUSB), and Parallel Port (LPT) can be selected from pull-down list. The Cable type is automatically scanned when the GAO Capture interface is opened, and the default is Gowin USB Cable (GWU2X). When using GAO Programmer to download Bitstream or use GAO to capture data, it is necessary to select the correct Cable type, otherwise there will be a Bitstream download failure or GAO can not be triggered.

- : Automatically scans the connected cable and displays the corresponding location parameter and SN code parameter. When connecting dual-channel cable or more than one cable, you can manually select the corresponding cable according to the parameter to perform Bitstream download operation or GAO capture data operation.
- " ", " ", " ", " ": Start, Auto Run, Force Trigger, and Stop. The shortcut keys are "F1", "F2", "F3" and "F4" in order.
  - Start means Analyzer will perform one data capture
  - Auto Run means Analyzer will loop and display the captured signal status in the Core waveform view until user clicks stop, and this function is only supported when the number of segment is 1
  - Force Trigger means to force Analyzer to complete the data capture when the trigger condition is not reached
  - Stop used to stop the data capture operation
- " ", " ", " ": Zoom in/out and fullscreen. The shortcut keys are "F8", F7" and "F6" in order.
- " ", " ", " ", " ", " ", " ", " ", " ", " "
  - " " Go to Cursor: Moves the view to the position of the cursor.
  - " " Go to Time 0: Moves the view to the position marked as 0 on the waveform view, i.e., the leftmost position of the waveform.
  - " " Go to Last Time: Moves the view to the position marked with the highest number on the waveform view, i.e., the rightmost position of the waveform.
  - " " Previous Transition: Searches backward from the current cursor position for the occurrences of a transition in the selected signal values.
  - " " Next Transition: Searches forward from the current cursor position for the occurrences of a transition in the selected signal values.
  - " " Add Marker: Creates a marker at the cursor position.
  - " " Previous Marker: Searches backward from the current cursor position for a marker.
  - " " Next Marker: Searches forward from the current cursor position for a marker.
  - " " Delete All Markers: Deletes all markers.

Note!

When a marker is selected, the other markers and cursors will use it as a reference and display the difference between them and the reference marker.

- " ": Export waveform data.

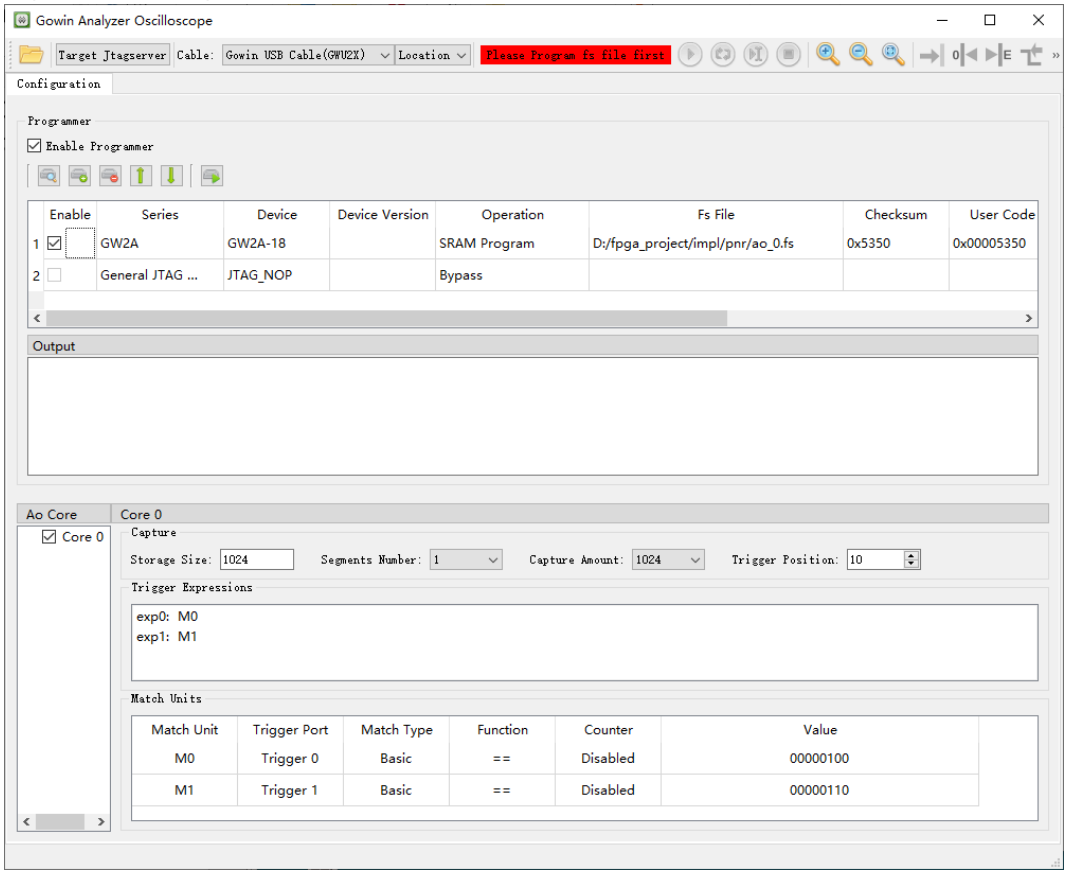
AO Configuration

AO Configuration has the following functions:

- Whether to use Programmer.
- Whether to use the device chain, you can select General JTAG device or Gowin device.
- Display AO sampling data, Expressions, and Match Unit.
- Modify configuration parameters.

Configuration view includes Programmer and AO Core (Capture, Trigger Expressions and Match Unit), as shown in Figure 4-7.

Figure 4-7 Configuration View



Programmer has the following functions:

- After Enable Programmer is checked, Programmer is supported. According to GAO Programmer requirements, only Access Mode and Operation are supported. For the usage, see *SUG502, Programmer User Guide*.
- When connecting to a remote device for programming operations, the Programmer needs to connect to the remote device's jtagserver. For

connection instructions, see the "Target jtagserver" descriptions in 4.1.2 Run GAO -> Toolbar.

- Click " " to scan device and display details, such as, Series, Device, Device Version, 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 you to select.
- Device chain function can be implemented. Click " " can add device. The default series is General JTAG Device (Non Gowin device). The default device is JTAG_NOP. Double-click Series and Device column of Device to pop up the drop-down list, you 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.
- Click " " to delete the selected device.
- Click " " to move up the selected device.
- Click " " to move down the selected device.
- Click " " to download bitstream file.
- Frequency can be used to select the frequency of the tck port when downloading Bitstream. Frequency can be selected when Cable is FT2CH or WINUSB, but not selected when Cable is GWU2X or LPT. Frequency defaults to 2.5 MHz, and the other options are 0.02 MHz, 0.1 MHz, 0.3 MHz, 0.4 MHz, 0.5 MHz, 0.75 MHz, 0.9 MHz, 1.1 MHz, 1.5 MHz, 2 MHz, 2.5 MHz, 10 MHz, 15 MHz.
- GAO can only capture the signal data of Gowin Device, but cannot capture the signal data of General JTAG Device, so you can only check Gowin Device in Enable column.
- Output view can display downloading information.

AO Core view includes Capture, Trigger Expressions, and Match Unit.

Capture has the following functions:

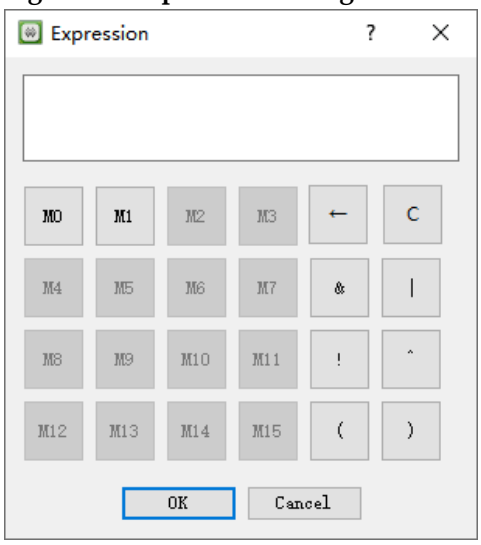
- Configure storage size, segment number, capture amount, and trigger position.
- Modify the above parameters. For the details, please refer to Storage Configuration.

Trigger Expressions has the following functions:

- After .gao file is loaded, all trigger expressions are checked by default on the capture window.
- Double-click any trigger expression to pop up the Expression dialog box, which can be edited. The Match Unit not checked will be grayed out, as shown in Figure 4-8.

- Trigger Expression can not be added.
- Any trigger is implemented when none of the trigger expressions is checked.

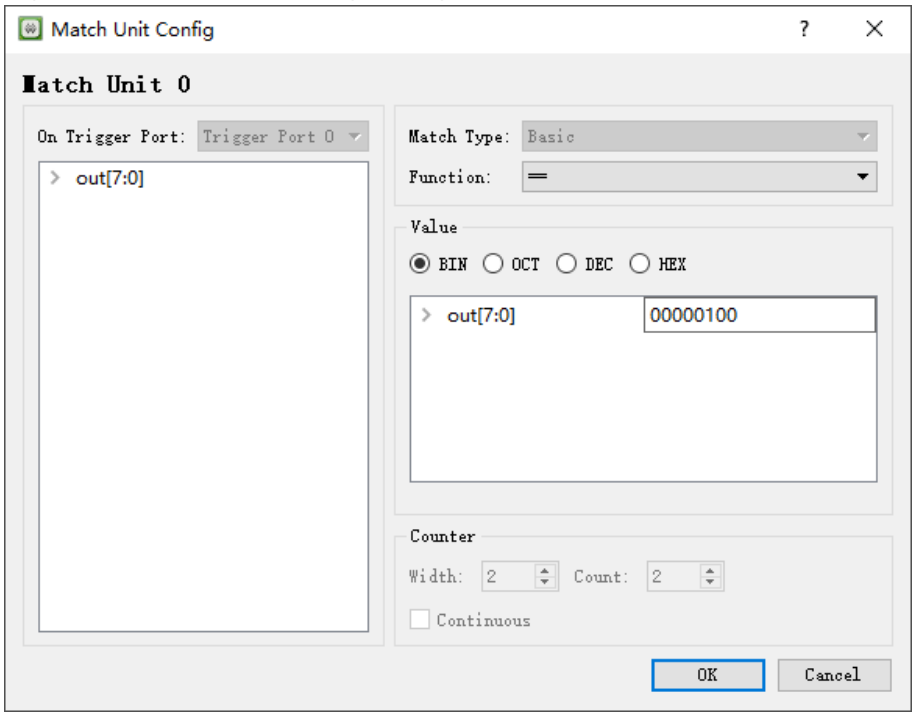
Figure 4-8 Expression Dialogue Box



Match Unit includes the following functions:

- Display the name, trigger port, and match type, etc.
- Double click the match unit, modify the match functions and Bit Value in "Match Unit Config" dialog box, such as, AO Counter, and match times, as shown in Figure 4-9. For the details, see 3.1.2 Standard Mode GAO Configuration.

Figure 4-9 Match Unit Config Dialog Box



Display Waveform

Core waveform view is used to display signal waveform and supports the following functions:

- Mark the position with marker.
- Display the segment number of the capture data
- Zoom in/out and fullscreen.
- Change the order of signals.
- Configure Group, Ungroup, Rename, Restore Original Name, Reverse, Long Name, Short Name, New Divider, and Delete Divider operations for signals, as well as Format conversions and Color modifications.

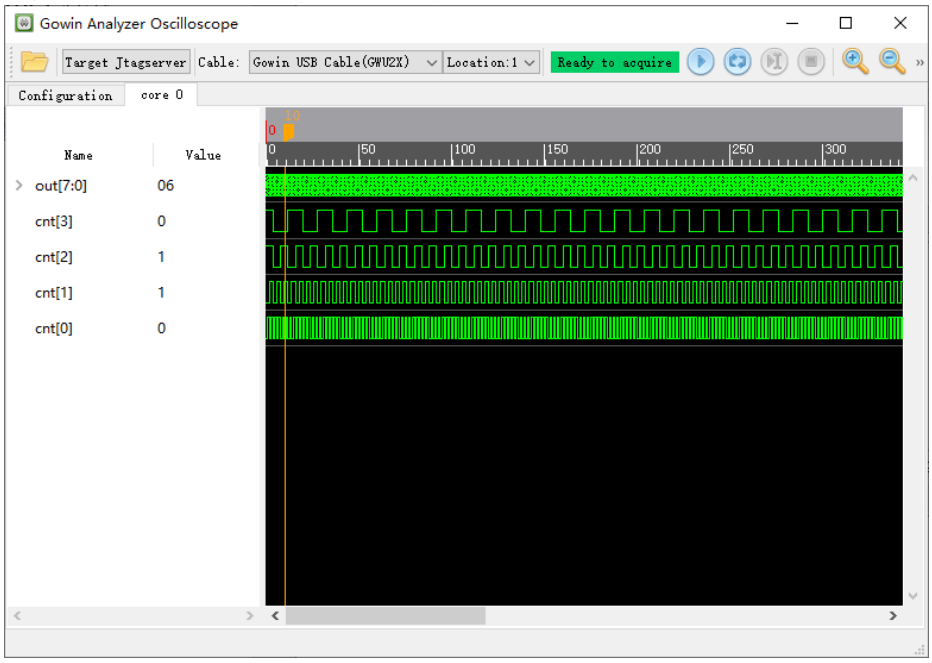
Click " " or use shortcut "F1" to run GAO. When the trigger conditions are met, GAO displays Core waveform view. Figure 4-10 shows capture signal name, Value, and waveforms.

If you click the " " and the trigger condition does not meet, you can click the " " or use "F3" to force the trigger; or click the " " or use shortcut "F4" to stop running.

In addition, click the " " or use shortcut "F2" to start the GAO Auto Run. At present, Auto Run is only supported when the number of Segments and AO Core is both 1. Analyzer will loop and display the captured signal in the Core waveform view in real time until you click stop.

Click " " or " ", GAO Programmer is grayed out.

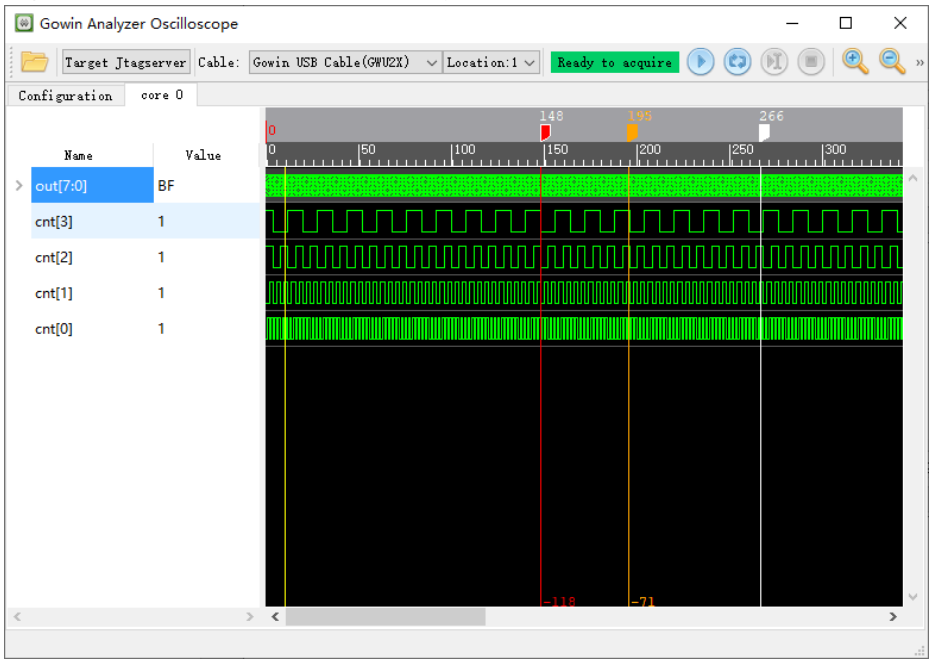
Figure 4-10 GAO Waveform Display (Standard Mode)



As shown in Figure 4-11, initial position of cursor is the trigger position

by default. The trigger point is marked with yellow line. Right-click the blank above the ruler to add a new marker. Move the mouse to a marker position, left-click and drag the marker. Additionally, right-click on the marker to select "Remove Marker" to delete the selected marker, or select "Remove All Markers" to delete all markers.

Figure 4-11 Ruler and Cursor Display (Standard Mode)



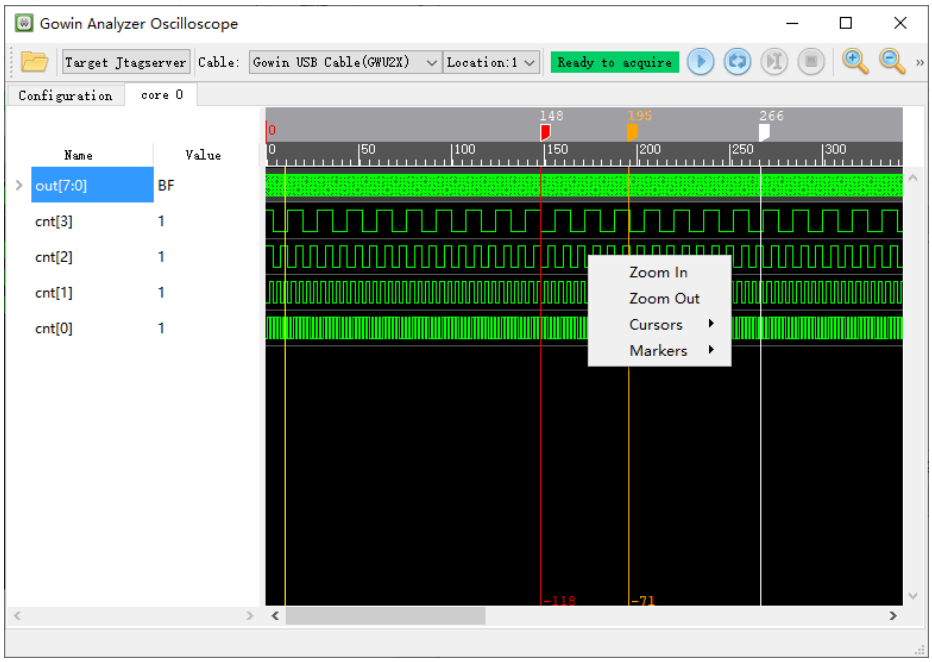
Right-click in the waveform display area to pop up the menu, as shown in Figure 4-12.

Click "Zoom In", "Zoom Out", or " ", or " ", or use the shortcut keys "F8", "F7", or Ctrl+ mouse wheel to zoom in/out the waveform. Click the " ", or use the shortcut key "F6" to display the waveform fullscreen.

The dropdown list on the right side of the Cursor includes five submenus: Go to Cursor, Go to Time 0, Go to Last Time, Previous Transition, and Next Transition.

The dropdown list on the right side of the Markers includes four submenus: Add Marker, Previous Marker, Next Marker, and Delete All Markers.

Figure 4-12 Right-click Menu (Standard Mode)

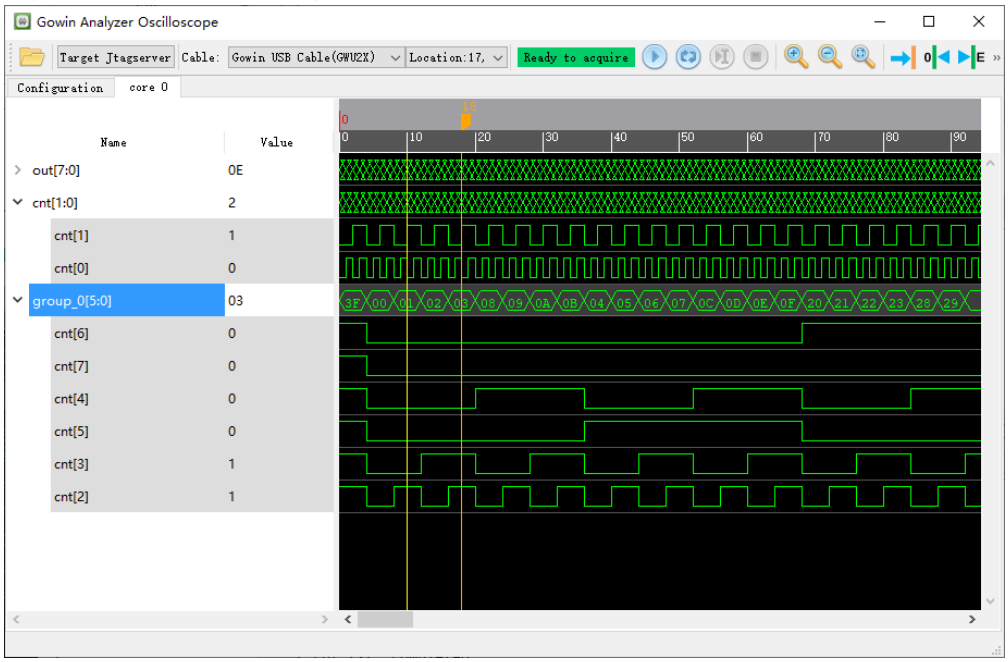


Change signals order by clicking signals in Name column.

The Name column and Value column width can be adjusted, and the adjustment made by you before the trigger is retained when triggered again.

In Name Column, you can select multiple signals. Right click and select Group in the pop-up menu to group Bus signals. For signals with the same name and continuous subscript, such as cnt[1], cnt[0], the grouped Bus signal name is cnt[1:0]. For signals with different names or same names but discontinuous subscriptions, the grouped Bus signal name defaults to group_index[n:0], index and n are integers greater than or equal to 0, as shown in Figure 4-13.

Figure 4-13 Group Bus Signal (Standard Mode)



The Core waveform view includes the following functions:

- Click " " again to capture sampling signals waveform. The Bus signal generated by "Group" still exists.
- Do not close the GAO capture window to trigger again, and the waveform display view size remains the same as last time.
- Right-click the Bus signal\ in "Name" column and select "Ungroup" in the pop-up menu to ungroup Bus signal.
- Bus signals generated through "Group" are not saved as a .gwd waveform file. When reopening with GAO, they needs to be regrouped, and the manually created Bus signals are retained when they are saved as a .gwd waveform file, and the .gwd file is loaded by GAO.
- Bus signals can be added together or individually in the Capture Signals of GAO configuration view. When they are added together, the waveform view will directly display as Bus Signals, such as "out [7:0]", as shown in Figure 4-13.
- It is not allowed to select some sub Bus signals to group a new Bus.

In Value area, select one signal and right-click to pop up the menu, as shown in Figure 4-14.

- You can rename the selected signal by clicking Rename.
- You can restore signals to netlist names by clicking Restore Original Name.
- You can reverse the selected signals by clicking Reverse.
- Long Name displays the name with the signal path.
- Short Name displays the name without the signal path.

- New Divider is used to add a signal divider.
- Delete Divider is used to delete a signal divider.
- Format includes two parts, as shown in Figure 4-14. One part is Binary, Octal, Signed Decimal, Unsigned Decimal, Signed Magnitude, Hexadecimal, ASCII, Real, used to set the way of displaying the Value of the sampled signal; and by default, the Value is displayed in hexadecimal. The other part is Unsigned Bar Chart, Unsigned Line Chart, Signed Bar Chart, Signed Line Chart, and Row Height Setting, used to set the display of waveforms in bar chart or line chart, and the pixel height of bar chart and line chart can be set. An example of Unsigned Bar Chart is shown in Figure 4-15 and an example of Unsigned Line Chart is shown in Figure 4-16.
  - The difference between Signed Decimal and Signed Magnitude is that Signed Decimal is the signed decimal two's complement representation, while Signed Magnitude is the signed decimal magnitude representation.
  - ASCII: Every 8-bit data is converted to one ASCII code; data in the range of 8'h00~8'h20h and 8'h7F corresponding to ASCII code is converted to space, while other data is converted to the corresponding ASCII code.
  - Real: Can be set to display as fixed point or floating point by the Type drop-down box, and the floating point includes single precision and double precision.
  - For the Real fixed point setting, as shown in Figure 4-17, the precision range of Binary Point can be set to 0-80, and when the value of Binary Point exceeds the bit width of Bus, the corresponding value will be converted to "NA".
  - For the Real Floating Point setting, as shown in Figure 4-18, Single Precision and Double Precision can be set, but it is required that the Bus bit width corresponding to Single Precision is 32 bits, and the Bus bit width corresponding to Double Precision is 64 bits; otherwise, the corresponding value will be converted to "NA"; for the converted infinity floating point number, it is "INF".
- You can modify the color of the selected signal by clicking color, including Green, Light Green, Dark Red, Red, Orange, Yellow, Blue, Light Blue, Dark Blue, Purple, and the waveform color is Green by default.

Figure 4-14 Signal Right-click Menu (Standard Mode)

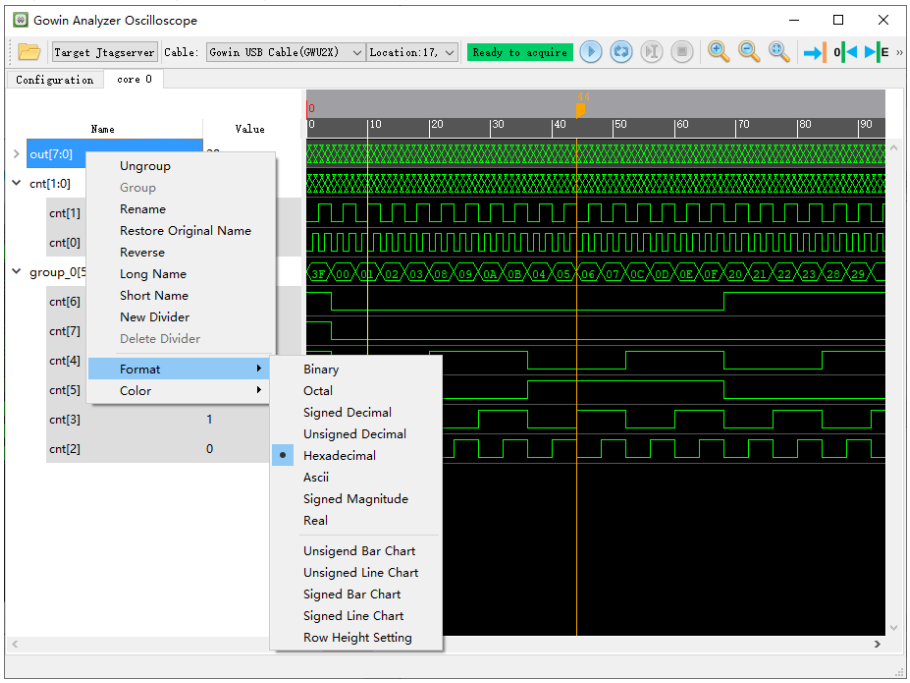


Figure 4-15 Unsigned Bar Chart

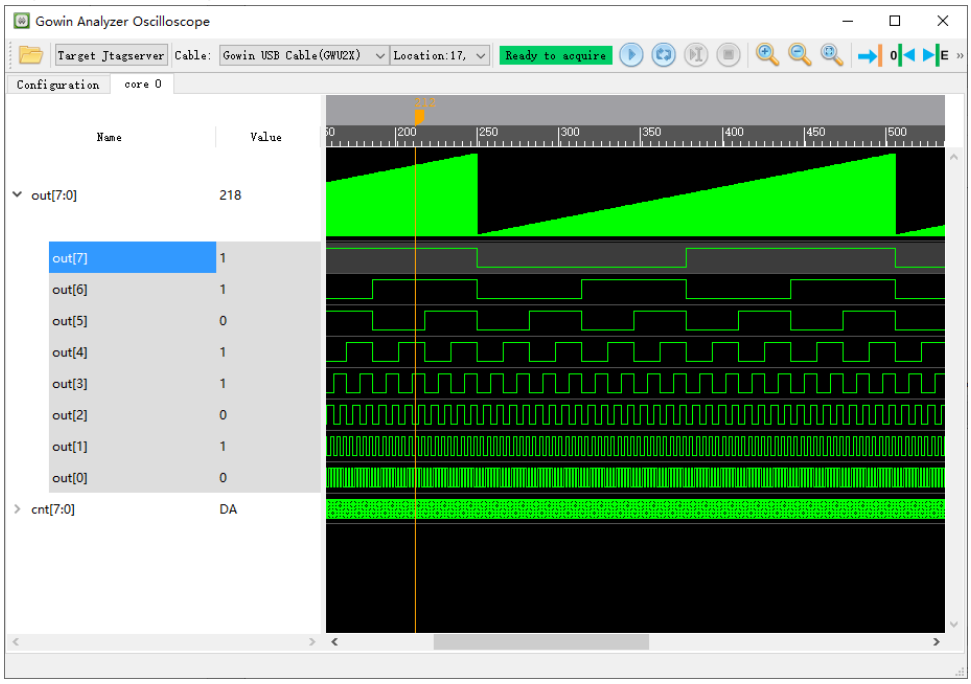


Figure 4-16 Unsigned Line Chart

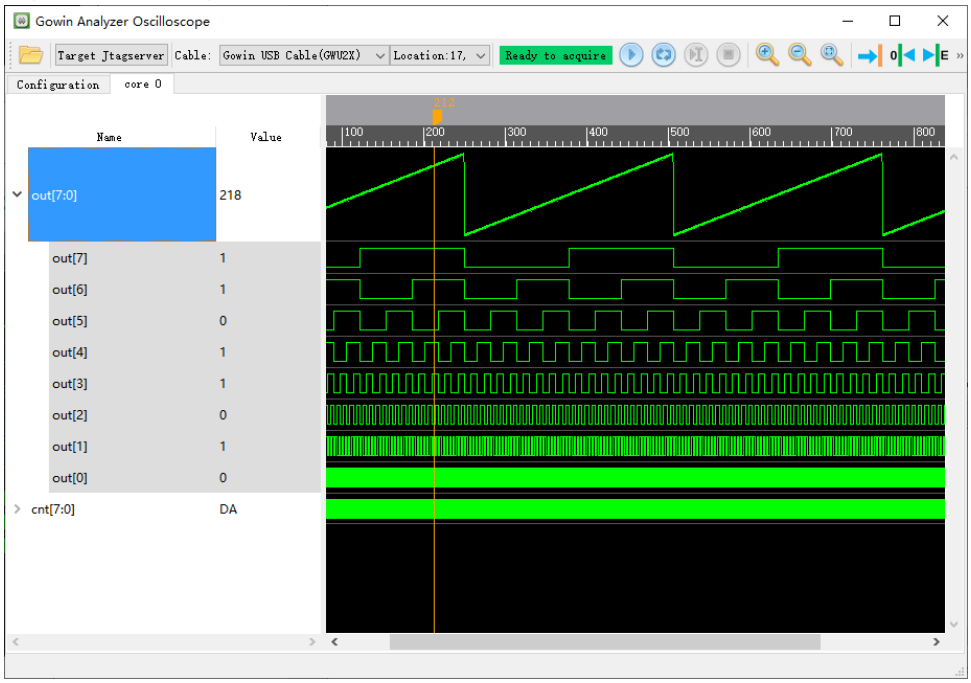


Figure 4-17 Fixed Point Setting

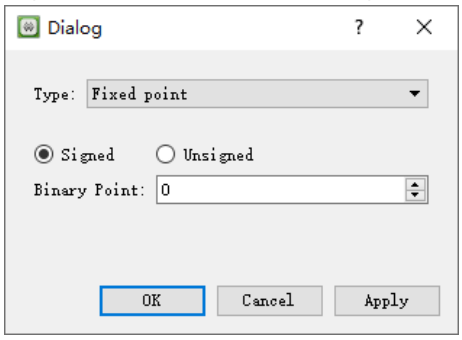
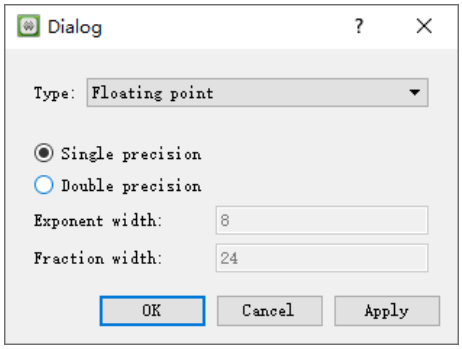


Figure 4-18 Floating Point Setting



Monitor File

GAO monitors whether the loaded .gao/.rao or .fs files are updated. If they have been upated, you will be prompted.

1. GAO Config files Updated
   After GAO config file is updated, if GAO does not capture data at this

time, the prompt will pop up immediately. Otherwise, the prompt will pop up after the data is captured, as shown in Figure 4-19. Click "Reload" to load the updated GAO config file. At the same time, GAO Programmer is updated to "Disable", and waveform view is closed, as shown in Figure 4-20.

Figure 4-19 Prompt

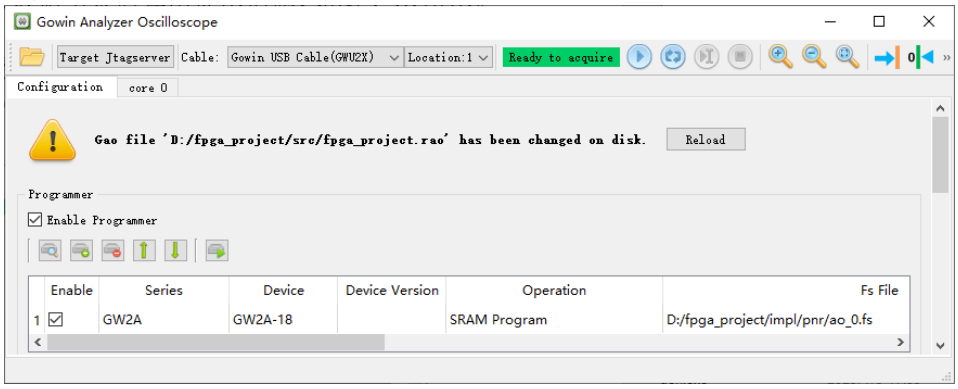
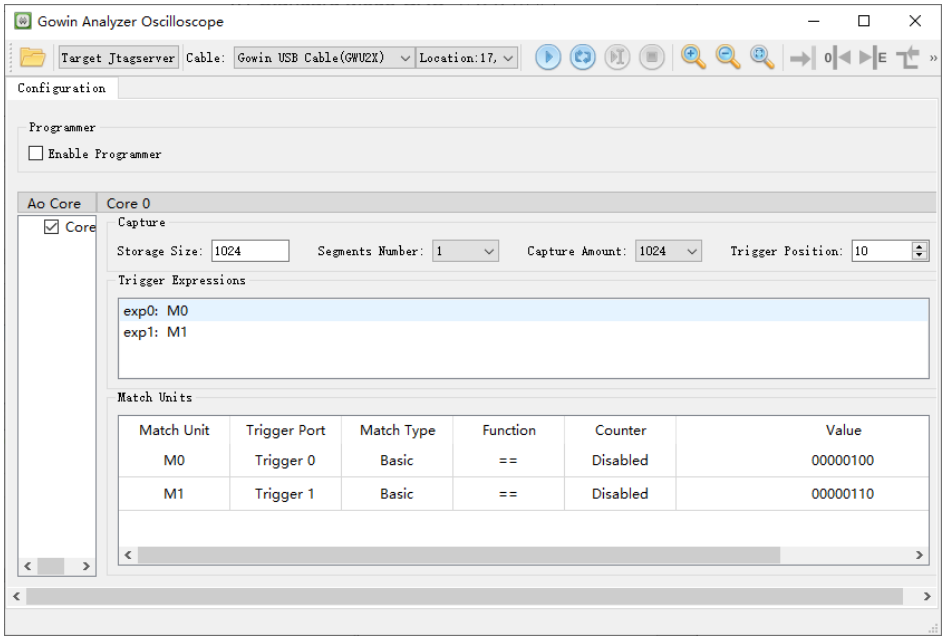
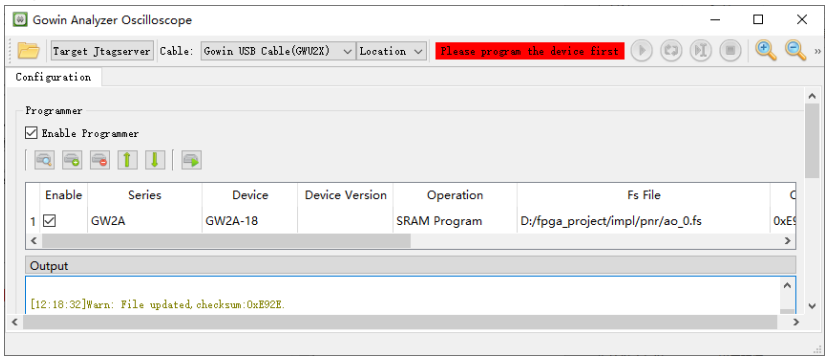


Figure 4-20 Reload Config File



2. Bitstream File Updated
   - If GAO prompts "Please program the device first", it will no longer prompt you to update the bitstream file.
   - If GAO prompts "Ready to acquire", it will prompt you to update the bitstream file. If GAO does not capture data at this time, prompt will pop up immediately in GAO Programmer Output; otherwise, prompt will pop up after the data is captured, and the prompt updates to "Please program the device first", as shown in Figure 4-21.

Figure 4-21 Prompt



4.1.3 Export Waveform

The steps are as follows:

1. Click the " " in the toolbar.
2. The Export dialog box pops up, specifying the wave file information, where the clock signal (Clock Signal) is the sampled clock signal specified in GAO and cannot be changed, as shown in Figure 4-22.

The GAO export file supports the following settings:

- AO core (Export Core) that specifies the waveform data to be exported is supported.
- The specified file export path (Export to) is supported. The default path is /impl/wave, and it allows to specify the relative path, where the base path is the path of the current project file .gprj.
- File Name defaults to the name of the GAO configuration file enabled in the current project.
- The specified file export format, including *.csv(Comma Separated Values), *.vcd(Value Change Dump), *.prn(Tab_delimited Text), and *.gwd(Gowin Waveform Data).
- The output waveform data file supports binary, octal, decimal and hexadecimal.
- The gwd file is used to save the waveform data of the current capture window and its corresponding .gao/.rao files, including the group information, rename information and data conversion information set by users.
- Tab_delimited Text- (*.prn) consists of three forms, "All Signals/Buses", "Waveform Signals/Buses" and Only Buses, as shown in Figure 4-23.
  - All Signals/Buses: The prn file will display all signals and buses signal, including the signals grouping the Buses.
  - Waveform Signals/Buses: The prn file will display all signals and buses signal data, but does not include the signals grouping the Buses.
  - Only Buses: The prn file will display only the Bus signal checked by the user, as shown in Figure 4-24.

- Clock period supports us, ns and ps. Since the GAO waveform interface's scale only indicates the position of captured data without reflecting the period, you can specify the clock period through Clock period.

Figure 4-22 Export Dialog Box

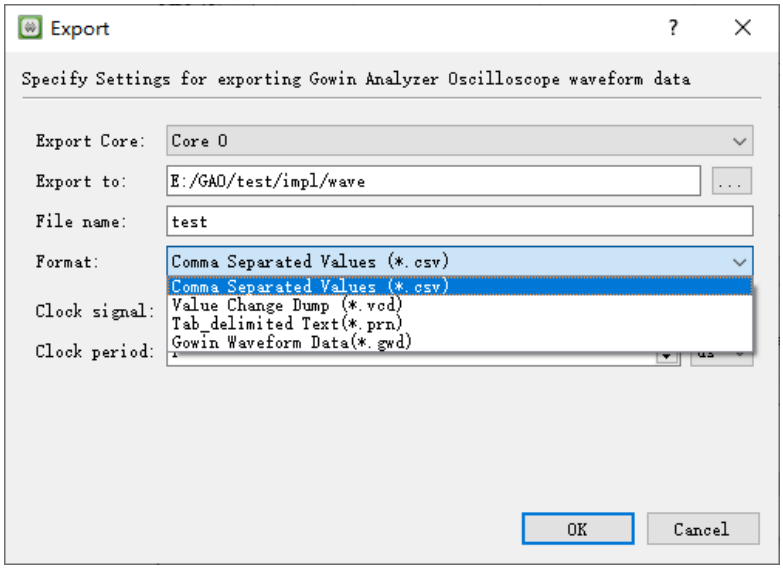


Figure 4-23 Export Tab_delimited Text (*.prn) File

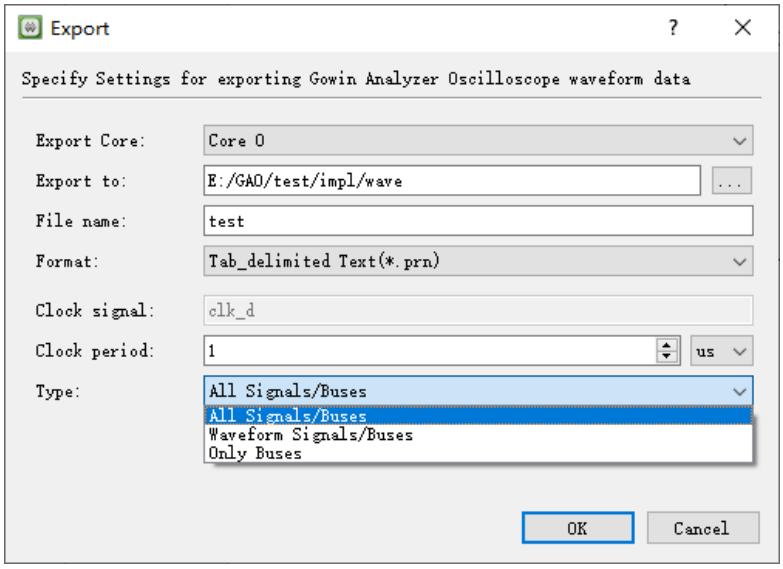
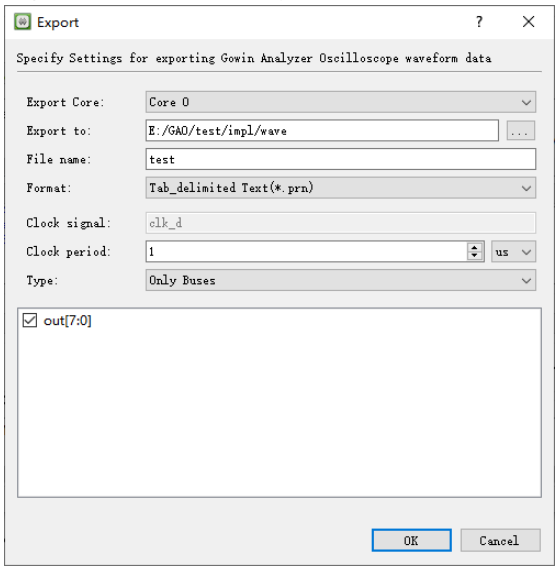


Figure 4-24 Export Only Buses prn File



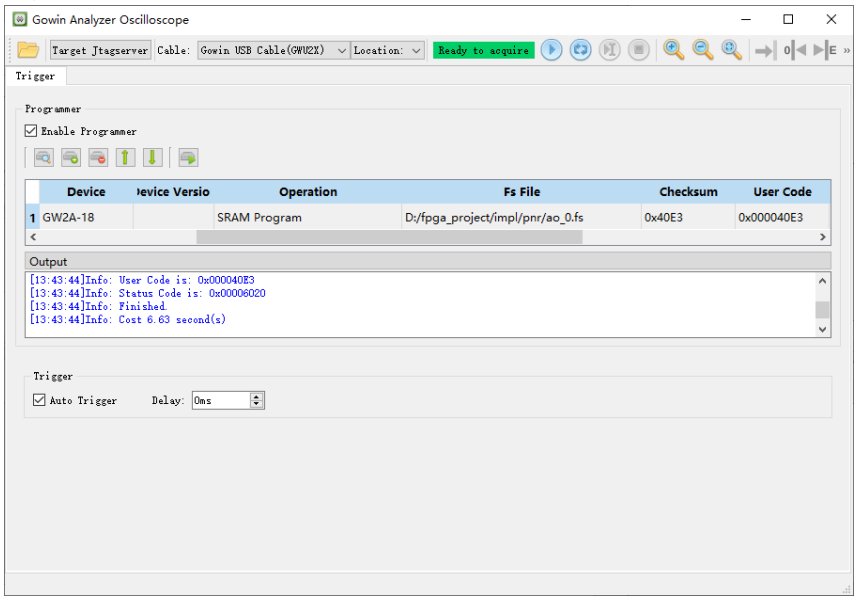
4.2 GAO Usage in Standard Mode

4.2.1 Start Lite Mode GAO

The steps are as follows:

1. Select "Tools" from the menu bar.
2. Select "Gowin Analyzer Oscilloscope" from the pull-down list to start GAO, click "Open" to select Lite Mode gao config file (.gao) or waveform file .gwd/.analyzer_prj you require, as shown in Figure 4-25.

Figure 4-25 Gowin Analyzer Oscilloscope Window (Lite Mode)



4.2.2 Run GAO

Toolbar

Please see 4.1.2 Run GAO > Toolbar for details.

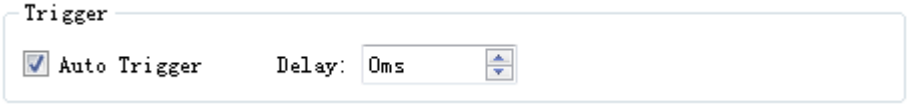
Trigger

This section is a bit different from 4.1.2 Run Gao > AO Configuration. Only the differences are described here. For other details, you can see 4.1.2 Run Gao > AO Configuration.

The differences are as follows: Lite GAO Trigger view is as shown in Figure 4-26. Its main functions are as follows:

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

Figure 4-26 Trigger View



Display Waveform

Please see 4.1.2 Run GAO > Display Waveform for details.

Monitor File

Please see 4.1.2 Run GAO > Monitor File for details.

4.2.3 Output Waveform

Please see 4.1.3 Export Waveform for details.

5 Import Waveform File

GAO supports csv, vcd, prn, and gwd. csv and prn can be imported to Matlab; vcd can be imported to ModelSim; gwd can be imported to GAO. For Matlab and ModelSim, you need a third-party license to open them.

5.1 Import csv to Matlab

To analyze the data easily, the data is imported to csv file in the form of Bus. The following is an example of importing the csv in decimal to Matlab.

The steps are as follows:

1. As shown in Figure 5-1, click "Import Data" to select the file to be imported.
2. Set the delimiter by clicking "Delimited". The content is separated by commas. Therefore, when importing csv file to Matlab, you need to set the delimiter as a comma. As shown in Figure 5-2, select "Comma" in "Delimited" drop-down list.
3. Save only the variable name and waveform data in csv, delete the header annotation. Or import the data to Matlab, select the data range to be imported by "Range". As shown in Figure 5-2, the range is A6:N1023, that is, import 14 columns and 1024 rows of data.
4. "Variable Names Row" can specify the row in which the variable name is in order to import the variable name. As shown in Figure 5-2, the row of the variable name is specified as the fourth.
5. Click "Import Selection" to import the selected variable name and data in matrix, as shown in Figure 5-3.

Figure 5-1 Matlab Import Data

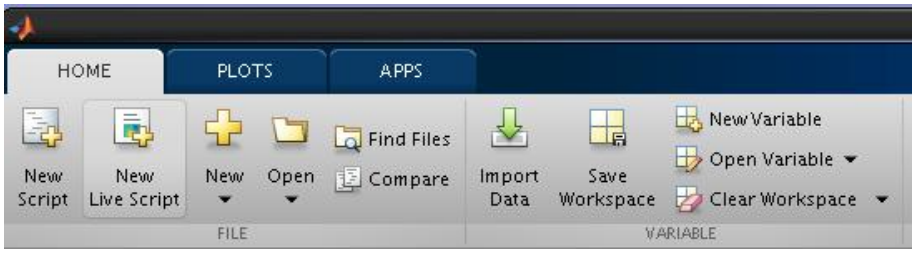


Figure 5-2 Import csv to Matlab

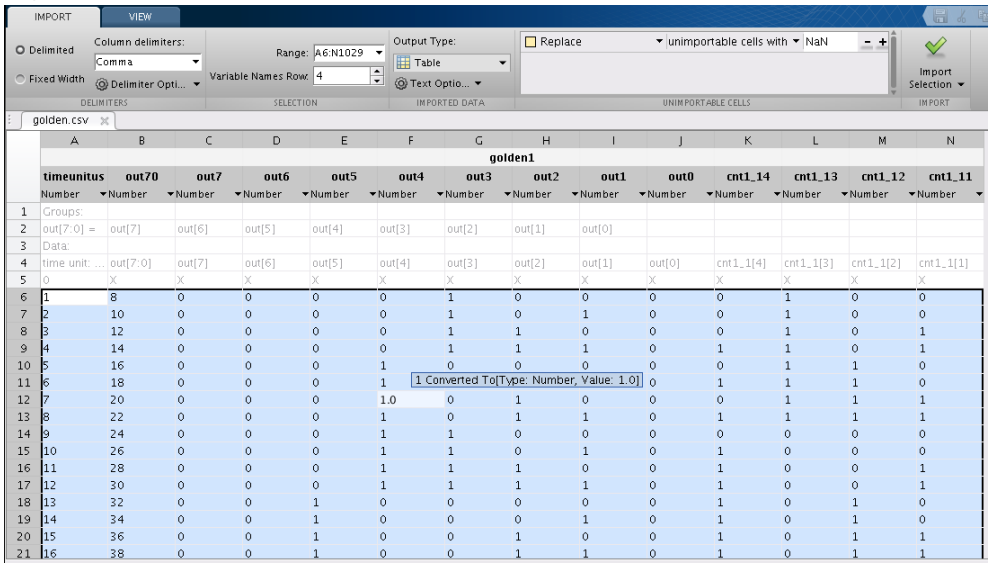
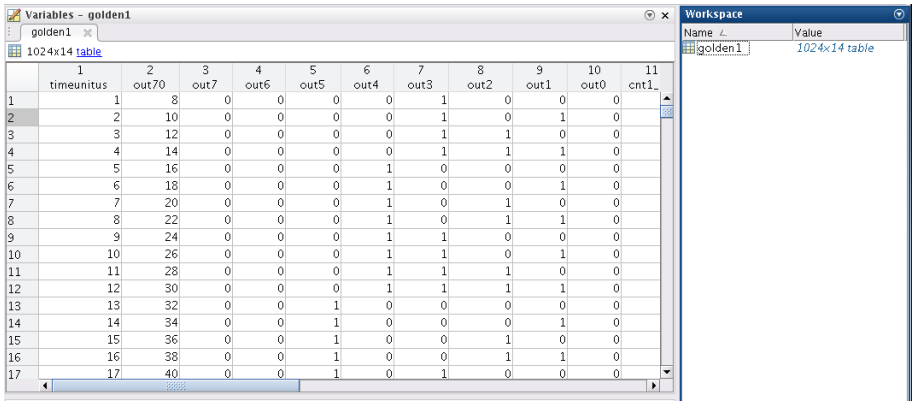


Figure 5-3 Import csv to Matlab in Matrix



5.2 Import prn to Matlab

To analyze the data easily, the data is usually exported to the prn file in Bus. Here the decimal prn file exported in "Only Buses" is used to import to the Matlab. The prn file only contains the Bus.

Similar to the step of importing the csv file to Matlab, since the prn file does not have the header annotation and the variable name defaults to the first row, you do not need to manually select the range and specify the row of the variable name. In addition, the prn file is a file with tab as a delimiter, so when you import the prn file, you do not need to select a delimiter, as shown in Figure 5-4.

The imported data displays in matrix, as shown in Figure 5-5.

Figure 5-4 Import prn to Matlab

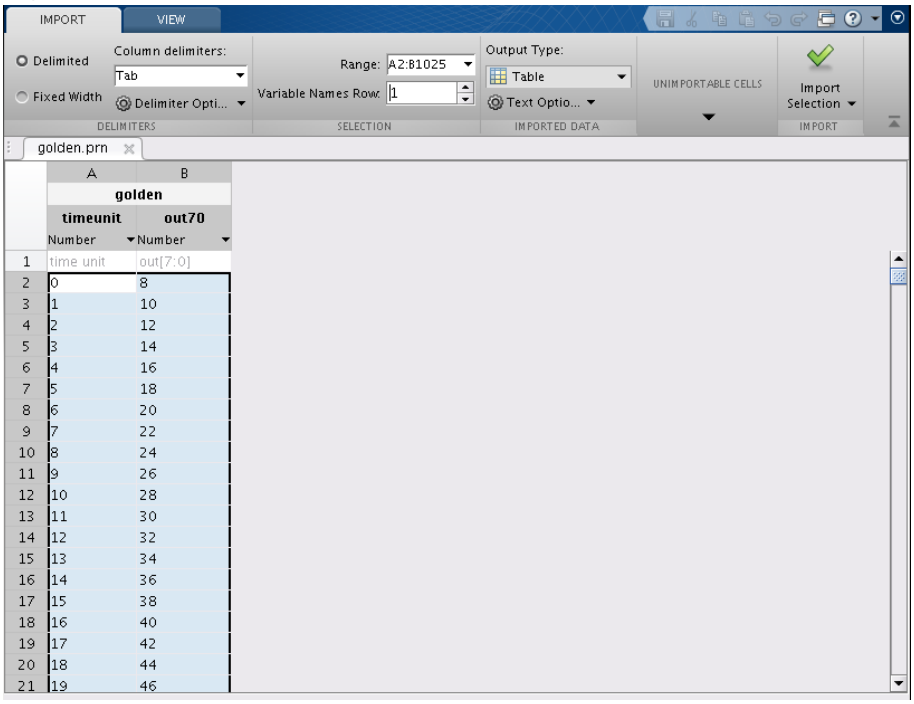
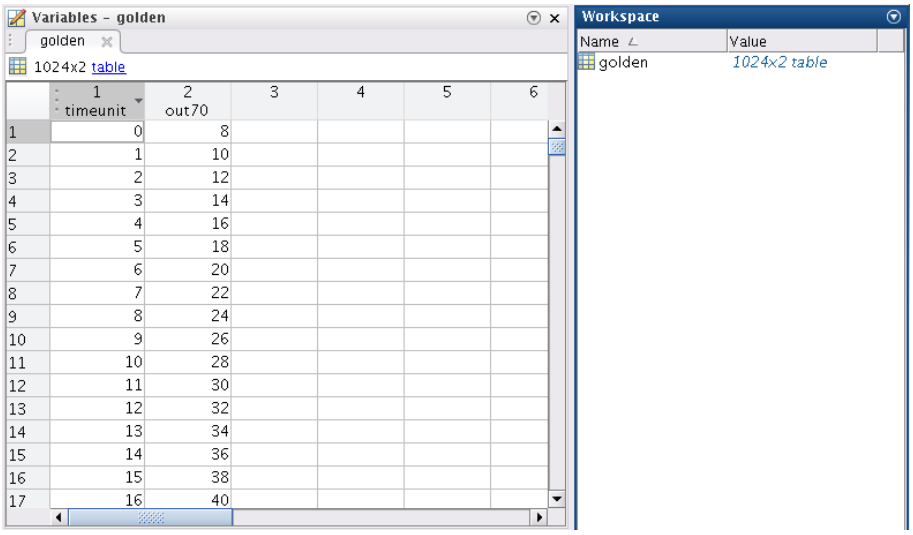


Figure 5-5 Import prn to Matlab in Matrix



5.3 Import vcd to ModelSim

The steps to open vcd waveform files with ModelSim are as follows.

1. In ModelSim, use the command "vcd2wlf test.vcd test.wlf" to convert vcd to wlf, as shown in Figure 5 6.
2. Use the command vsim -view test.wlf or click File > Open in the menu bar to open the wlf file; display the waveform in ModelSim through the right-click menu "Add Wave", as shown in Figure 5 7.

Figure 5-6 vcd to wlf

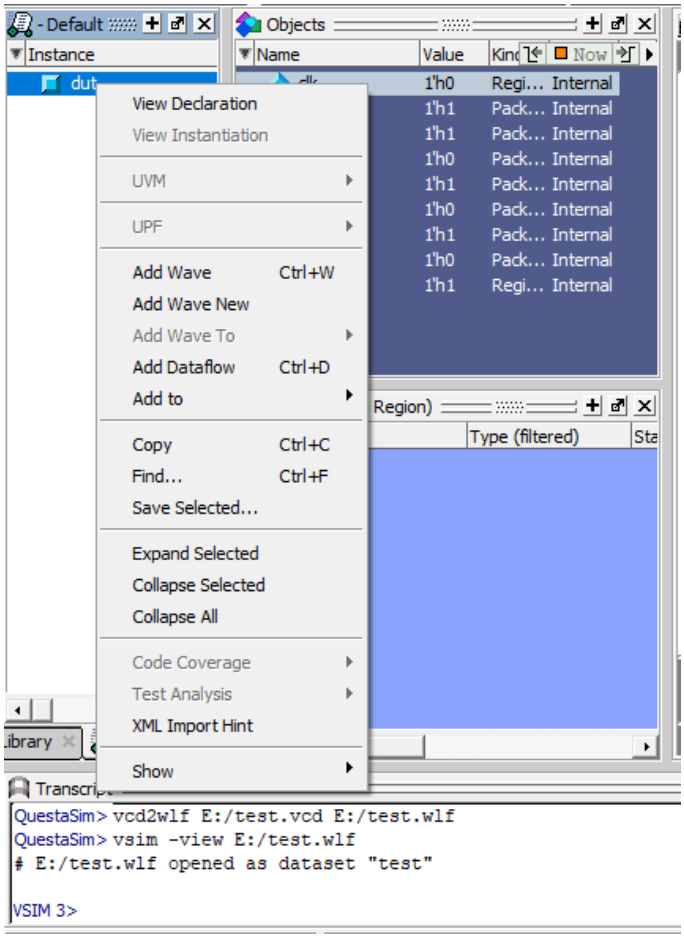
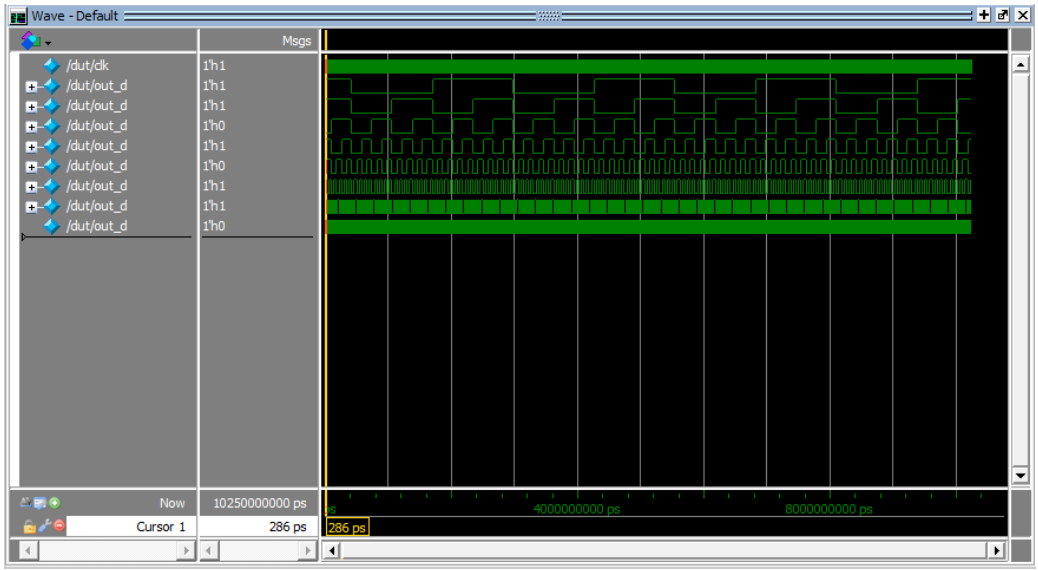


Figure 5-7 Open vcd Waveform with ModelSim



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