TimingAnalyzer User Manual

version 0.954

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Contents

User Manual

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Introduction

Drawing Timing Diagrams -- The Basics

The most common way to draw timing diagrams is by using the Graphical User Interface (GUI). There are example timing diagrams in the examples directory and there are also step-by-step examples in this document. You can also draw timing diagrams using Python scripts. There are examples of Python scripts in the scripts directory.

The basic procedure for drawing timing diagrams:

Add a clock (Add Menu -> Clock)

When the Clock panel is displayed, set the options to the desired values and then hit the add button. The clock will be displayed immediately in the timing diagram.

Add other signals (Add Menu -> Signal or Bus)

Set the options to the desired values and hit the "Add" button. The signal or bus will be displayed below the last signal added.

Add pulses synchronized to the clock above (Add Menu -> Pulse)

When the pulse panel is displayed, set the state of the new pulse and then select "Rising Edge", "Falling Edge", or "Rising and Falling Edge" to synchronize the pulse to the clock above. Click in the signal during the clock cycle to add the pulse. There are options to automatically increment or decrement bus values so you click in a signal quickly multiple times to show a counter.

The pulses that have been added are not connected to the clock signal. So if you change the frequency of the clock signal, the pulses in the signals will not adjust to the new position of the clock edges. When the pulses were added, the clock cycle time was used in order to calculate the time of the edges in the pulses. In order to have the pulse edge times follow any change in frequency of the synchronizing clock, you have add Delays between Clock Edges and Edges in the Pulses. Delays represent actual hardware delays like combinatorial delays tphl, tplh, or tcomb, as well as synchronous delays like register CLK-to-Q output delays.

Working with Signals

Adding

You can add signals using the Add Menu or the Ctrl key shortcuts.

```
Digital Clock    - Add Menu -> Clock   - Ctrl 1
Digital Signal   - Add Menu -> Signal  - Ctrl 2
Digital Bus      - Add Menu -> Bus     - Ctrl 3
```

The signal panel is displayed on the left of the timing diagram. After entering all the paramenters, hit the "Add" Button. This new signal will appear in the timing diagram below the last signal. You can position the signal in the diagram, moving it up to the preferred position.

Selecting and Deselecting

• To select, click in the signal name or right click in signal waveform and choose select from the popup-menu.

• To select multiple signals, hold down the Shft key and click in the signal names.

- To deselect, hold down the Shft key and click in the selected name or right click in the signal waveform and choose deselect from the popup-menu.
- You can also just click in the diagram in an empty area to deselect all the selected items or use the "Esc" key.

Changing Parameters

- Double click in the signal name or select the signal then right click and choose edit from the popup-menu.
- The signal panel is displayed on the left of the diagram. Change the required parameters then click the "Update" button.
- Changes occur immediately after clicking update.

Moving

- Select the signals to be moved.
- Use the up and down arrow keys.

Deleting

- Select the signals to be deleted.
- Use the *delete* key

Working with Edges

The Edge Defined

An edge occurs when there is the transition from one state to another state. In the program, three points in time are saved for each edge. Point 1 is the very beginning of the edge transition or the 0% point. Point 2 is commonly set to the mid point of the edge transition or the 50% point but this point can be changed when specifying Delays and Constraints. Sometimes its necessary to make calculations from the 10% or 90% positions in the edge transition. This value can be set by the user to any value between 5% and 95%. Point 3 is the very end of the edge transition.

Selecting and Deselecting

select

1. Click in an edge to select.
2. Hold down the Shft key and click in other edges to select multiple edges.

deselect

1. Click in an empty area of the timing diagram to deselect all objects.
2. Hit the esc key to deselect all objects.
3. Hold down the Shft key and click in the selected edges.

Showing Margins

This shows the uncertainty in time it could take to change states. The area the min and max edge is filled gray.

1. Select the edge.

2. Click right mouse button to bring up pop-up menu. Select Add Margins

Moving

Use the left and right arrows keys at the same time with Ctrl and Shft key to precisely position the edge. If multiple edges are selected, they will all move together keeping the timing relationships.

```
Shft - Left/Right    - time per division        - 100ns
Left/Right           - time per division / 10   - 10ns
Ctrl - Left/Right    - time per division / 100  - 1ns
```

You can also move the edges by dragging the mouse.

Aligning

You can use "Align Edge" from the "Edit Menu" to align edges in different signals. "Align Left" aligns all the selected edges to the edge that occurs first in time. "Align Right" aligns all the selected edges to the edge that occurs last in time. "Align First" aligns all the selected edges to the first edge selected.

- Select one Edge in each signal. Do not select multiple Edges in one signal.
- From popup-menu or Edit → Edge menu, select the alignment operation.

Deleting

- Select the edge. Use "delete" key to remove the edge. If the edge is not the last edge in the signal, the following will be removed as well. This is same as deleting a pulse.
- Select multiple edges and then use the "delete" key to remove them all at one time.

Working with Pulses

Adding

Set the new state using the pulse panel buttons, 1 0 Z or X, or you can set a signal value if the signal value button is selected. If the "Auto Increment" equals 1 or more , the signal value is automatically incremented every time you add a pulse. Just click in the signal during a clock cycle to add the pulse. Add pulses quickly by clicking in the signal during the next clock cycle for each new pulse.

Click in the signal between the clock edges and the pulse appears. Keep clicking to add new pulses or extend a pulse value. A clock should be above the signals being edited. You can select "Rising Edge", "Falling Edge", or "Rising and Falling Edge" synchronous.

If a clock does not exist, the pulse is put in the signal between division markers in the time ruler.

Time Offset

The pulse offset entry in the pulse panel is used to specify an offset in time. When adding pulses, edges are added at the time of the clock edge plus the offset.

For example: If the clock edges occur at 25ns and 50ns and the offset is 2 ns, the pulse will be added with edges at 27ns and 52ns.

Moving

Select the pulse by selecting both edges. Use the left or right arrow keys with Ctrl and Shft key combination to move the pulse. The distance its move depends on the time per division settinsg as shown below.

```
Shft - Left/Right    - time per division        - 100ns
Left/Right           - time per division / 10   - 10ns
```

```
Ctrl - Left/Right   - time per division / 100   - 1ns
```

You can also just dray the mouse to move the pulse.

Moving Synchronously

- Select the pulse by dragging the mouse so the pulse is contained in the select rectangle.
- Hold down the Alt key and use the left or right arrow keys to move the pulse synchronously with respect to a clock. The clock must be above the signal that has the pulse being moved.

Working with Delays

About User Delays

User delays are entered in the "User Delay Panel" and represent actual part delays specified by the manufacturer. A "User Delay" needs to specified before adding a delay in the diagram.

Adding New Delays

1. Select 2 edges. The first edge selected should occur in time before the second.
2. Add Menu -> Delay or Ctrl 7 or pop-up menu -> Add Delay
3. Enter user delay parameters in the "User Delay Panel" if this is the first time defining this delay. If the user delay has already been defined, skip this step.
4. Enter the delay parameters in the "Delay Panel" and hit the "Add" button.

Adding Previously Used Delays

1. Select 2 edges. The first edge selected should occur in time before the second.
2. Pop-up menu, select "Add Used Delay"

Selecting and Deselecting

select

1. Drag the mouse so the select rectangle contains the delays
2. Hold down the Shft key and click on the delay names

deselect

1. Click in empty area in timing diagram. This deselects all objects.
2. Hold down the Shft key and click on the delay namesf

Moving

1. Select the delays.
2. Use Alt and left key to move the delays back one half clock cycle
3. Use Alt and right key to move the delays forward one half clock cycle.

Moving the Text Labels

horizontally

1. Select the delay.

2. Use left or right key to move the label to the left, right, or center position.

vertically

1. Select the delays.

2. Use up and down keys to move the label. Use the Shft or Alt key with the up and down key to precisely position the text. You can select multiple delays and move all the labels at the same time.

Deleting Delays

1. Select the delays.

2. Use the delete key.

Working with Constraints

About User Constraints

User constraints are entered in the "User Constraint Panel" and represent actual part constraint specified by the manufacturer. A "User Constraint" needs to specified before adding a constraint in the diagram.

Adding New Constraints

1. Select 2 edges. The first edge selected should occur in time before the second.

2. Add Menu -> Constraint or Ctrl 8 or pop-up menu -> Add Constraint

3. Enter user constraint parameters in the "User Constraint Panel" if this is the first time defining this constraint. If the user constraint has already been defined, skip this step.

4. Enter the constraint parameters in the "Constraint Panel" and hit the "Add" button.

Time Calculations

Constraints are used to specified parameters like setup and hold times and pulse width min and max times. When specifying a constraint, the constraint type allows you specify how the time is calculated between two edges.

- Max-Min – measured from source edge max time to the destination edge min time.

- Max-Max – measured from source edge max time to the destination edge max time.

- Min-Max – measured from source edge min time to the destination edge max time.

- Min-Min – measured from source edge min time to the destination edge min time.

Adding Previously Used Constraints

1. Select 2 edges. The first edge selected should occur in time before the second.

2. Pop-up menu, select "Add Used Constraint"

Selecting and Deselecting

select

Moving

> 1. Drag the mouse so the select rectangle contains the constraints
>
> 2. Hold down the Shft key and click on the constraint names

deselect

> 1. Click in empty area in timing diagram. This deselects all objects.
>
> 2. Hold down the Shft key and click on the constraint names

Moving

1. Select the constraints.
2. Use Alt and left key to move the constraints back one half clock cycle
3. Use Alt and right key to move the constraints forward one half clock cycle.

Moving the Text Labels

horizontally

> 1. Select the constraints.
>
> 2. Use left or right key to move the label to the left, right, or center position.

vertically

> 1. Select the constraints.
>
> 2. Use up and down keys to move the label. Use the Shft or Alt key with the up and down key to precisely position the text. You can select multiple constraints and move all the labels at the same time.

Deleting

1. Select the constraints.
2. Use the delete key.

Working with StateBars

StateBars are used to add vertical line to any signal edge. The line can dashed or solid and given a label. StateBars could be added to the rising edges of a clock signal to show the state of processor transaction or maybe the state changes for a state machine. They are also very handy for aligning and moving edges.

Adding

- Select an edge.
- Add Menu -> StateBar or Ctrl-4 or pop-up menu → Add StateBar.
- Enter the parameters in the panel and then hit the "Add" button.

Selecting and Deselecting

select

> 1. Click in the StateBar name or on the line or drag the mouse so the select rectangle contains the StateBar.

2. Hold down the Shft key and click on the StateBar names or the line to select multiple StateBars. You can also drag the mouse so the select rectangle contains the StateBars.

deselect

1. Click in the diagram in an empty area. This deselects all the objects.

2. Use the "Esc" key. This also deselects all objects.

3. You can also hold down the Shft key and click in the StateBar name or line.

Editing

• Double click on StateBar label or select the StateBar then the "edit" from pop-up menu.

• Change the required parameters in the dialog and then hit the "Update" button.

Moving

• Select the StateBar. Click in the StateBar name.

• Use the Alt and left key combination to move the StateBar back one half cycle.

• Use the Alt and right key combination to move the StateBar right one half cycle.

Deleting

• Select the StateBar. Click in StateBar names.

• Delete key.

Working with Text Labels

Adding

• Add Menu → Text or use Ctrl-6.

• The text panel is displayed. Enter the text then change the options if desired. Then hit the "Add" button.

• Click in the timing diagram at the desired position to place the text.

Selecting and Deselecting

select

1. Click in the label name or drag the mouse so the select rectangle contains the label.

2. Hold down the Shft key and click in the labels. You can also drag the mouse so the select rectangle contains the labels.

deselect

1. Click in the diagram in an empty area. This deselects all objects.

2. Use the "Esc" key. This also deselects all objects.

3. Hold down the Shft key and click in the label.

Editing

• Double click in the text. The text dialog is displayed with the text to edited.

- Enter any text or option changes, then hit the "Update" button to change the text in the diagram.

Moving

- Select the text, click in the text label.
- Use the left and right arrows at the same time with the Alt key, Ctrl key, and the Shft key. If text labels are selected you can move all of them at the same time.

  Shft - Left/Right - time per division - 100ns Left/Right - time per division / 10 - 10ns Ctrl - Left/Right - time per division / 100 - 1ns
- Drag the text label using the mouse to the new desired location.

Moving Synchronously

- Select the text, click in the text label.
- Use the alt and left/right key combination to move the text label left or right one half clock cycle.

Aligning

- Select the text labels, click in the text labels with Ctrl key down.
- Edit menu → Text → Align Left or
- Edit menu → Text → Align Center or
- Edit menu → Text → Align Right or
- Edit menu → Text → Align Bottom

Deleting

- Select the text label. Click in text label.
- Delete key.

Working with Pulse Width Labels

Adding

- Select 2 edges. The first edge selected should occur in time before the 2nd edge selected.
- Add Menu → Pulse Width Label or Ctrl-5 or pop-up menu → Add Pulse Width Label.
- Enter the parameters in the panel and hit the "Add" button.

Selecting and Deselecting

Editing

select

1. Drag the mouse so the select rectangle contains the label name or click in the label name.
2. Hold down the Shft key and click in the label names or drag the mouse so the select rectangle contains the label names.

deselect

1. Click in the diagram in an empty area. This deselects all the objects.
2. You can also hold down the Shft key and click in the label.

Editing

- Double Click in the label name or select the label and use the pop-up menu and choose "edit".
- The dialog is displayed. Change the label parameters in the dialog and hit the "Update" button. You wiil see the changes to the label immediately.

Resizing

- Select the label. Click in the label name.
- Select one of the edges that connects to the label.
- Use the left or right key move the label right one half cycle.

Moving Synchronously

- Select the label. Click in the label name.
- Use the Alt and left key combination to move the label back one half cycle.
- Use the Alt and right key combination to move the label right one half cycle.

Moving Label Position

horizontally

1. Select the label. Click in the label name.
2. Use the left or right key to move the text label to the left, center, or right position. If the label text does not fit between the vertical lines, the label can be set to only the left or right positions.

vertically

1. Select the label. Click in the label name.
2. Use the up or down key to move the text label up and down. Use the Shft or Alt key with the up and down keys to precisely position the label text. You can select multiple pulse width labels and move them at the same time.

Deleting

- Select the label. Click in label names.
- Use *delete* key.

Working with TimeWarps

Adding

Time Warps allow you to compress the diagram or skip periods of time. This is useful when you want to show transactions that are far apart in time.

Adding

- Select an edge at the start time and another edge at the end time of the new TimeWarp.
- Add Menu -> TimeWarp or Ctrl-0 or pop-up menu → Add TimeWarp.

Selecting and Deselecting

select

1. Click in the TimeWarp

deselect

1. Click in the diagram in an empty area. This deselects all the objects.
2. Use the "Esc" key. This also deselects all objects.
3. You can also hold down the Shft key and click in the TimeWarp.

Editing

- Currently, you can not edit a TimeWarp.

Moving

- Currently, you can not edit a TimeWarp.

Deleting

- Select the TimeWarp. Click in TimeWarp.
- Use *delete* key.

Working with VCD Files

Its very convenient to take simulation waveform diagrams and convert them to a timing diagram. If you create a VCD file while running simulations, just open the VCD file as you would a timing diagram file. The program will read and parse VCD file and convert it to a timing diagram automatically and save it in the same directory the VCD file is in.

Reading

Use File→open from the menu or toolbar button, and select *.vcd in the file filter in the dialog. Select the VCD file. The TimingAnalyzer reads the VCD file and automatically converts it to a timing diagram that is saved in the same directory the VCD file is in.

Writing

This option will be added. Saving diagrams as VCD files can be useful for simulation test vectors.

Bus Signals

Some VCD files don't seem to contain buses so there a function, "Bus Signals" that can be used to make buses from sequentially ordered signals like ADIO<31>, ADIO<30>, ADIO<29> …

If you want to bus signals, select the signals, click the right mouse button to bring up the pop-up menu, and select "Bus Signals". The new bus should appear above the most significant signal in the diagram.

Limitations

VCD files are commonly very large files when produced from simulators. The TimingAnalyzer does not handle large files very well at this time because it was original designed to work with small text timing diagram files, so I limited the file size to 100,000 lines. This is hardcoded in the VCD parser, so the first 100,000 lines of any VCD will be parsed and displayed. It is recommended to create smaller sized VCD files from simulations that contain just the transactions of interest that you want to convert to a timing diagram.

It is possible to run out of memory on the heap if there are lots of edges in the vcd file. If this happens, a java "OutOfMemory" error occurs. you can increase the memory limit allocated for the program by running the program from the command line as shown below

```
java -Xmx512m -jar TimingAnalyzer.jar
```

-Xmx512m specifies the maximum heap memory the program can use in MBytes, in this case 512M Bytes

User Support

Beta 0.947 is the first release with this feature. If you find a VCD file that is not loading properly, please send me a copy and I will do my best to fix asap.

Limitations

1. VCD $dumpvars is supported but not $dumpports. $dumpports includes port driver data and is used typically used to drive a tester.

2. The first 100,000 lines of a VCD file are parsed and converted to a timing diagram. All lines after are ignored.

3. If signal definitions take more than 100,000 lines, the VCD file will cause an "OutOfBounds" Exception. Close the empty tab window.

Testing (Request for VCD example files)

1. All VCD files tested use binary notations for signal values changes. Can anyone provide example VCD files that use hex notations for bus signals?

2. Scopes are added to the signal names to keep hierarchy information. Can anyone provide example VCD files that contain signal names with hierarchy?

- *search*