State Editor Lab

State Editor Lab

Introduction

This lab will enable the user to create the STOPWTCH macro using the Foundation State Editor. This macro can then be added to the top-level schematic in Foundation. The STOPWTCH macro is a small state machine necessary to control the counters (refer to Appendix). HDLs lend themselves well to generating large state machines easily. However, state machines can be difficult to debug if a bubble diagram representing the design is not drawn. Foundation contains an effective bubble diagrammer that enables users to debug their logic effectively, while still having the power of an HDL synthesizer. By using the state editor effectively, small and large state machines can be designed quickly and with little effort.

Objectives

In this lab, it will be shown:

- How to create a symbol using the Foundation Symbol Wizard
- How to create a state machine bubble diagram in the Foundation State Editor
- How to check and synthesize VHDL code in the Foundation State Editor
- How to enter a state machine macrofunction into a project using the Foundation Schematic Editor
- How to edit a symbol using the Foundation Symbol Editor

Procedure

Creating the STOPWTCH symbol in the State Editor

1) Open the Foundation State Editor from within the Foundation Project Manager by clicking on the icon.

2) Once the State Editor has started, the "**State Editor**" dialog box will open (see Figure 1). Click on the "**Use HDL Design Wizard**" bubble and click on "**OK**".

3) The HDL Design Wizard enables the user to enter basic features and specify the ports for a new macrofunction. Click on "**Next**".

4) The State Editor can create designs using either ABEL or VHDL design languages. In the "**Languages**" dialog box, select "**VHDL**" and click on the "**Next**" pushbutton.

5) In the "**Name**" dialog box, enter "**STOPWTCH**", and <u>click</u> on the "**Next**" pushbutton.
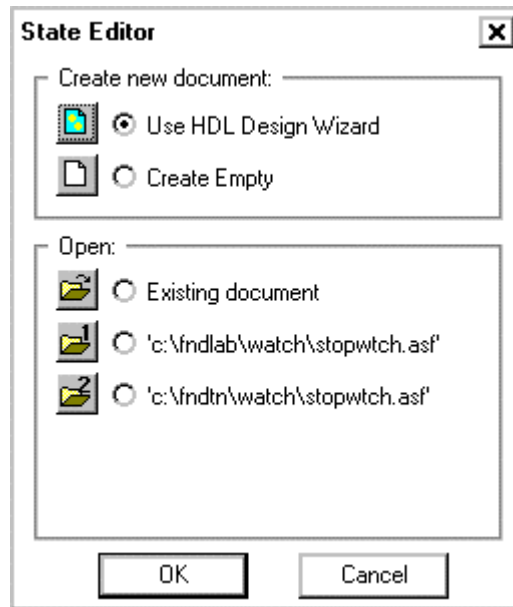

Figure 1. The State Editor dialog box.

6) The "**Port**" window allows the user to create input and output ports and to specify attributes for each port. <u>Click</u> on "**New**", and select a direction of "**Input**". Since there are no input buses, enter the name "**CLK**" and do not specify a bus width (see Figure 2). After entering this, <u>click</u> on "**New**". Enter the "**RESET**" and "**STRTSTOP**" input ports in the same manner.

7) After all the input ports have been entered, <u>click</u> on "**New**", and select a direction of "**Output**". Since there are no output busses, enter the name "**CLKOUT**" and do not specify a bus width. After entering this, <u>click </u>on "**New**". Enter the "**RST**" output port in the same manner.

8) After all the ports have been entered correctly, the "**Ports**" window should look like Figure 3. When the "**Ports**" window has been checked, click on the "**Next**" pushbutton.

9) The "**Machines"** window allows the user to insert more than one state machine in the same symbol. <u>Click </u>on "**1**", and then <u>click</u> on "**Finish**".
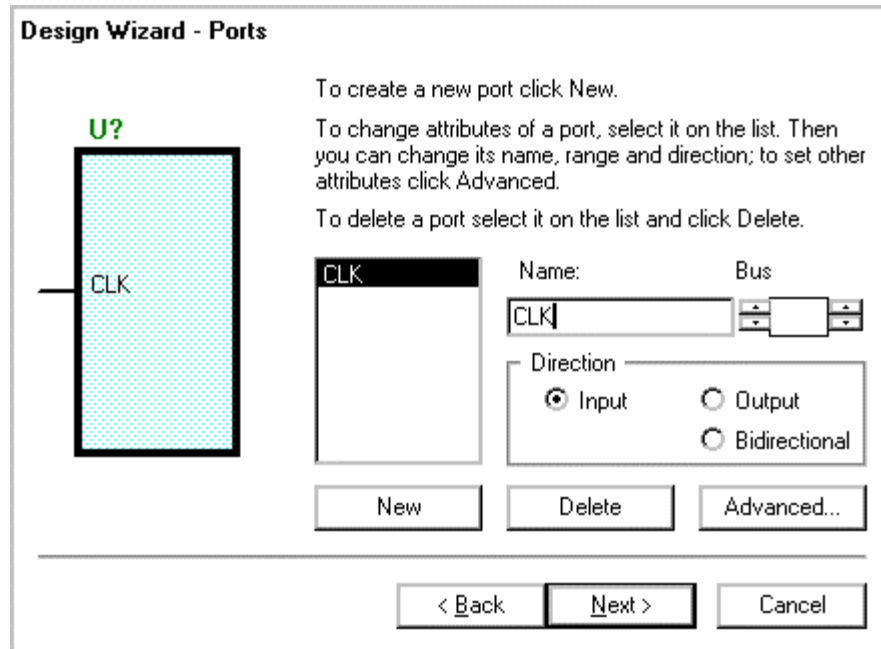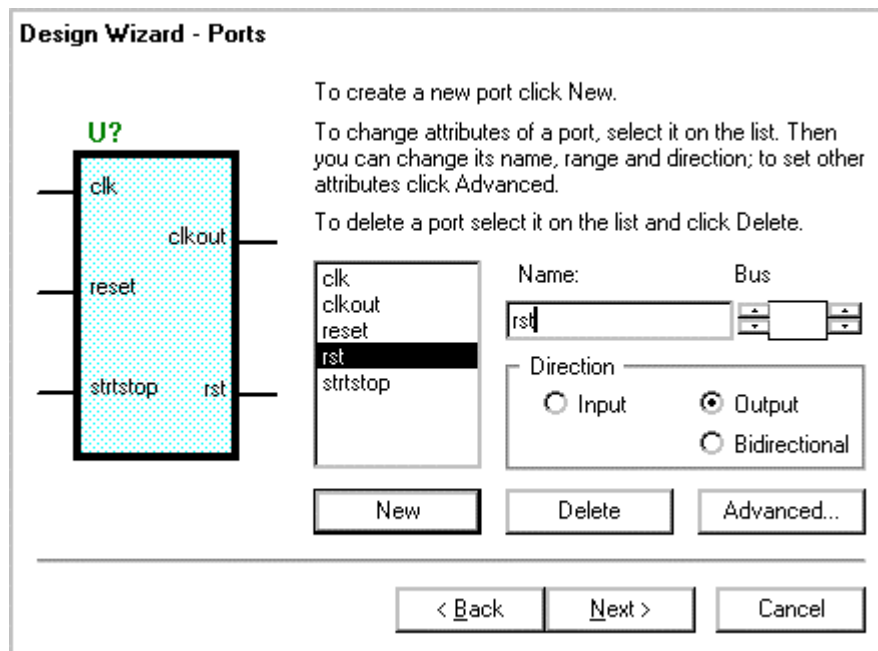
Figure 2. The "Ports" window.

Figure 3. The "Ports" window with the ports correctly entered.

10) The Design Wizard creates the "**STOPWTCH**" symbol and opens the "**State Editor**" with the necessary input and output ports entered (see Figure 4).
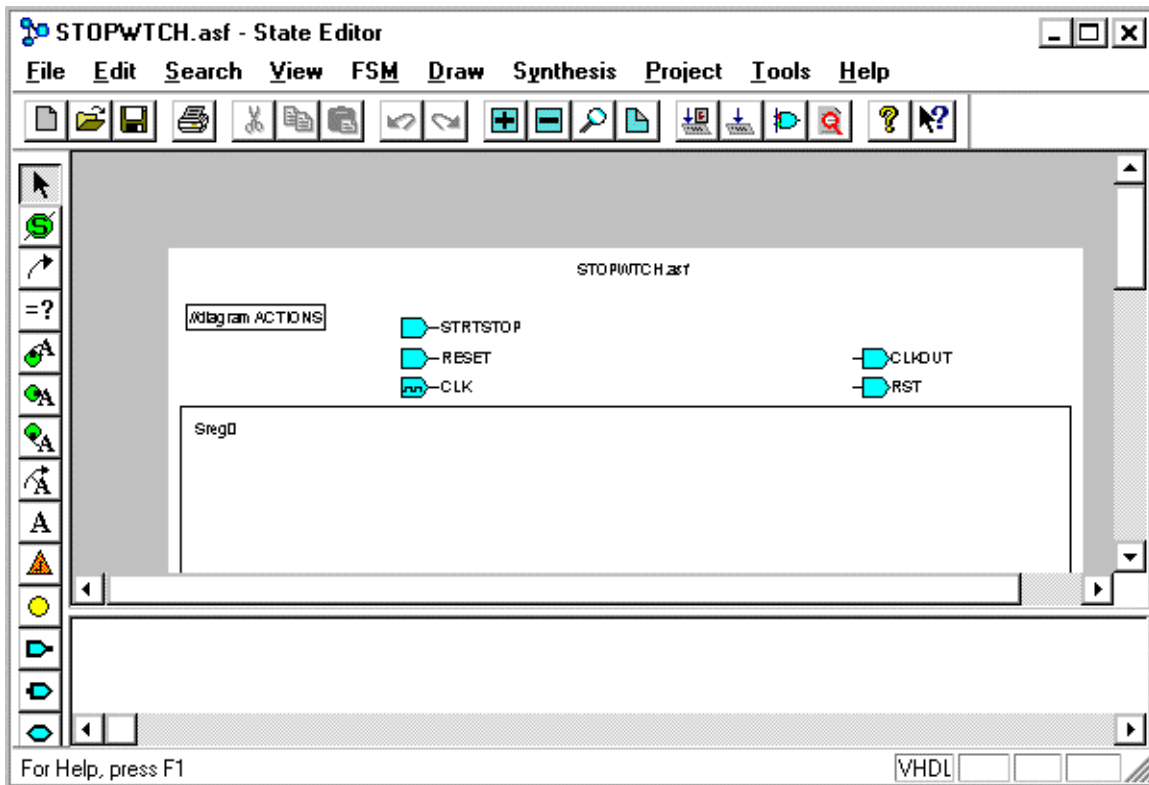

Figure 4. The State Editor with the necessary ports entered

Creating the STOPWTCH bubble diagram

1) To enter states into the state machine, <u>click</u> on the "**State**" button   and place it by

<u>clicking</u> on the left mouse button. If the state symbol needs to be moved again, <u>click</u> on the symbol and drag it to a new location. Enter six states into the diagram (refer to Appendix).

2) After entering the states, change the names of each state by <u>clicking</u> on the state name a second time.

3) Enter transitions by <u>clicking</u> on the "**Transition**" button.   To place a transition,

click once on the **starting location**, and then <u>click</u> a second time at the **destination** of the transition. After doing this, the arrow between the states will be drawn and the arrow can be moved or bent to suit the users needs. Enter the transitions necessary for STOPWTCH by reviewing the diagram in the appendix.

4) To create a transition condition, <u>click</u> on the "**Condition**" button.   To place the

condition, <u>click</u> once on a transition that has been entered into the bubble diagram. Once this has been done, a little box will open for entering the HDL syntax for a condition statement. Enter the conditions necessary for the STOPWTCH state machine.

5) <u>Click</u> on the "**State Action**" button   to generate outputs from the state machine at

each state. After clicking on this button, <u>click</u> on the state the action is to be associated. After doing this, a little box will open for the HDL syntax to be entered for an action. Enter the necessary actions into the STOPWTCH state machine. Note that for proper machine design, every output should be defined for every state. Otherwise the synthesizer can generate erroneous results that meet the required conditions.

6) Add the **Reset** condition by clicking on the "**Reset**" button.   After this has been

placed in the diagram, add the reset condition on the RESET input as shown in the appendix. This will assure that whenever the reset input goes high, the machine will automatically be transitioned to this state. To select this as an asynchronous reset open the "**Machine Properties**" dialog box by using the menu command: *FSM>Machines>Sreg0*. <u>Click</u> on the "**Reset**" tab, and select Asynchronous as the reset type. <u>Click</u> on the "**OK**" button.

Generating and sythesizing the STOPWTCH macro's VHDL code

1) After entering the state machine into the state editor, <u>click</u> on the menu command: *Synthesis>HDL Code Generation*. This will enable the State Editor to create the VHDL code. After the code is generated the State Editor asks the user if they want to view the code. Feel free to observe the state machine generated. After viewing, close the HDL Editor window and get back to the State Editor window.

2) Next, synthesize the VHDL code by <u>clicking</u> on the menu command: *Synthesis>Synthesize*. This converts the VHDL code into an EDIF netlist that can be combined with the rest of a project. If no warnings or errors occur, <u>click</u> on "**OK**" when the synthesis is complete.

3) Finally, associate the symbol file and the EDIF netlist with the STOPWTCH macrofunction by <u>clicking</u> on the command: *Project>Create Macro*. After this is complete, <u>click</u> on "**OK**".

Adding the STOPWTCH macrofunction into the WATCH Project

1) After the macro has been created, it is associated with the current project and can be entered into the schematic. After exiting the State Editor, open the Foundation Project Manager and <u>click</u> on the "**Schematic Editor**" icon.
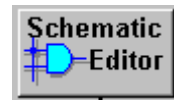
2) Once the program has started, <u>click</u> on the "**Symbols Toolbox**" icon on the vertical toolbar.   Find the STOPWTCH macro by entering its name at the bottom of the

"**SC Symbols**" box, and place it in the schematic as seen in Figure 5. After placing the symbol, enter "**Select and Drag**" mode by <u>clicking</u> on its icon.

Editing the STOPWTCH symbol with the Foundation Symbol Editor

1) To edit the ports attached to the STOPWTCH symbol, <u>double click</u> on the symbol in the schematic editor. After the "**Symbol Properties**" dialog box opens, <u>click</u> on the Symbol Editor button at the bottom of the window. This will open the "**Symbol Editor**" window (see Figure 6).

2) It is possible to modify the location of the STOPWTCH ports from within the Symbol Editor. To move the CLK port, simply <u>click</u> on its port and drag-and-drop it at its new location.
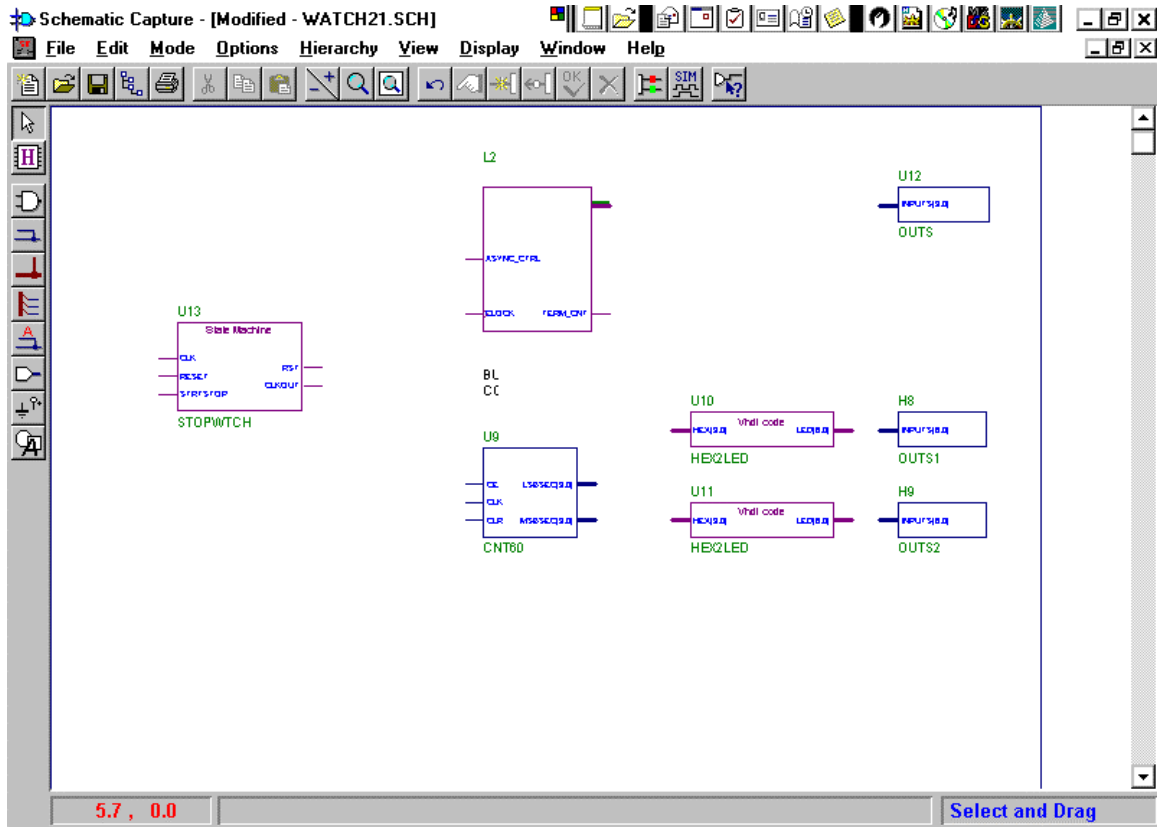
Figure 5. The WATCH Project with the STOPWTCH macrofunction.

3) Modify any of the macros in the WATCH project using the Symbol Editor to make it easier to draw and connect wires in the schematic editor. After making changes to any symbol, save the symbol file so it will be reflected in every instance of the symbol in the project.

4) Exit the "**Symbol Editor"** and the "**Symbol Properties**" dialog box. Save the WATCH Project within the Schematic Editor with the menu command: *File>Save*.
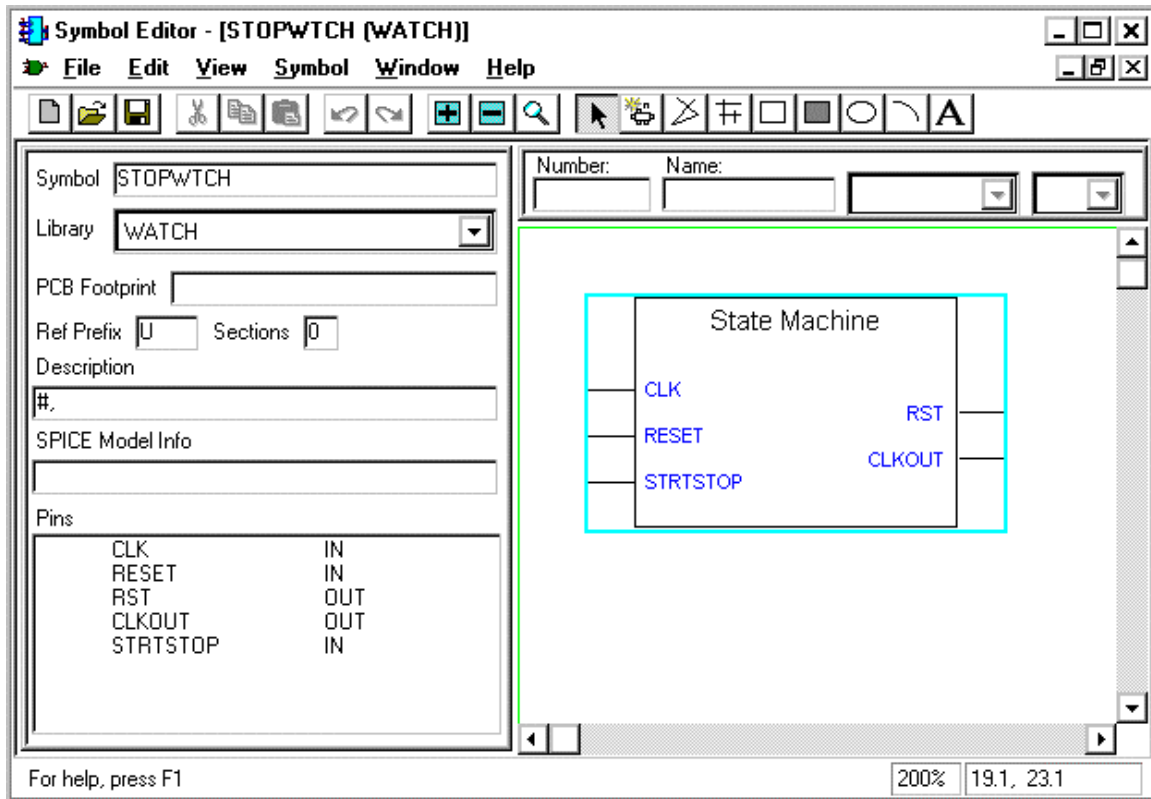
5) Exit the Schematic Editor by clicking on *File>Exit*.

Figure 6. The Symbol Editor.

Conclusion

In this laboratory, it was shown:

- The HDL Design Wizard is used to create a symbol that represents the VHDL code generated by the State Editor.
- Ports are automatically entered in the state diagram for the user after creating a symbol using the HDL Design Wizard.
- After entering the state diagram VHDL code must be generated and synthesized by the State Editor.
- After compilation, the STOPWTCH macro can be entered into the top-level schematic using the Schematic Editor and the Symbols Toolbox.

Questions

1) How can a synchronous reset be added to the state diagram?

2) What kind of Actions were used in the STOPWTCH macro?

3) How can a symbol be modified?