Practical Session – Processors

26-11-2018

The following assignment is to be done during the practical of Processors as an introduction to the HADES tool and its library of components. You do *not* have to submit your answers. Instead, you will be able to see yourself whether you have a correct answer.

1. Build a half adder, with inputs A and B, and outputs S and C. Use an `Ipin` for each input, and an `Opin` for each output. These pins and the required logic gates can be found in the component browser, which is accessible via "Edit", "Open component browser", or via the context menu (right-click), "create", "browse…".

   All predefined components are under `built-in.hades.models`. For this assignment, you will need components from the subdirectories `io`, `gates`, `rtlib.io`, and `rtlib.arith`. Several commonly used components can also be accessed from the context menu, under "create". You can rename components by using "name" in the context menu.

2. Store the half adder as a component. First, define a name for the design: "Edit", "Set design name…". Then save the file, with the extension `.hds`. Finally, choose "Edit", "Create symbol". This last step must be repeated each time you change the inputs or outputs of the component.

3. Use the half adder to build a full adder, with inputs A, B, and C_IN and outputs S and C. The half adder component can be inserted by "Create Subdesign..." in the context menu. To see the names of the ports of the half adder, turn on "Layers", "port labels" (these correspond to the names of the `Ipins` and `Opins` of the subdesign). Again, store the full adder as a component.

4. HADES has a built-in component `ADDC` which is a full adder, in the subdirectory `rtlib.arith`. Make a circuit, with inputs A, B, and C_IN and one output E. The circuit contains your own full adder component and the `ADDC` component. The inputs of the circuit are connected to the inputs of both your full adder and the `ADDC` component of HADES' library. Output E should return true, if and only if: the S output of both adders are equal *and* the C output of both adders are equal.

5. Verify that your full adder is correct. If your full adder is correct, then output E should be true for any inputs A, B, and C_IN. You can thus verify your full adder by checking for all $2^3 = 8$ possible inputs whether output E is true.

Hints and Comments

- You can find the circuits of the half adder and the full adder in the slides of Lecture 2.
- There are two ways to create a connection between wires. To *start* a wire on another wire, press "w" when the mouse is over the existing wire. To *end* a wire on another wire, use "shift-left click" on the existing wire.
- The `ADDC` uses n-bit *vectors* as input. In this case, you want to set the number of bits to 1. The component `ExpandBit` expands a wire to a vector. Conversely, `Expander` expands a vector to wire(s).
- Please use common sense when designing your circuits, such as
  - Use meaningful names for all components, especially inputs and outputs
  - Use straight lines with 90 degree angles
  - Employ a clear (not a "spaghetti") layout
  - Use labels to clarify your structure