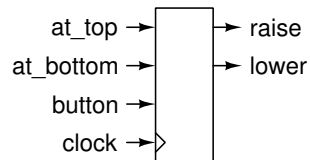


Practice Quiz 3 - State Machines

Question 1: Garage Door Opener

Description

The controller for a garage door opener:



has two active-high outputs:

- **raise** causes the door to move upwards while it is asserted
- **lower** causes the door to move downwards while it is asserted

and three active-high inputs:

- **button** indicates the user wants the door raised or lowered
- **at_top** indicates the door is fully raised
- **at_bottom** indicates the door is fully lowered

The controller operates as follows:

- If the door is at the top and the button is pushed the door starts moving down.
- If the door is at the bottom and the button is pushed the door starts moving up.
- If the door is not at the top or bottom and the button is pushed the direction reverses.
- If the door is not at the top or bottom and the button is not pushed the door continues moving in the same direction.
- If the door is at the top or bottom and the button is not pushed the door does not move.

You may assume button presses are synchronized to the clock and last exactly one clock period.

Question

- Choose an appropriate number of states and a name for each state.
- Draw the state transition diagram. Label each state and draw a directed edge (line with an arrow) between the required state transitions. On each edge write the input condition required for that state condition as an equation (e.g. $at_top=1$ and $button=0$). The expression must be unambiguous (e.g. a VHDL expression). If there isn't enough space, number the transitions and list the expressions elsewhere.
- Write expressions for each of the outputs as a function of the state and the inputs (e.g. $state=foo$ or $button=1$).
- (Optional) Draw a schematic of the controller using the schematic symbols used in the course (e.g. as in Quiz 2).

Hint: Follow the design procedure described in the lecture notes.