

Lab 5 : Vending machine

Finite state machines are at the heart of many designs, sequencing functions, controlling I/O, etc. For this lab, we will be designing an FSM that mimics a simple vending machine. In addition to the FSM, you will be drawing on your experience from previous labs to add the input total and control board LED's. **Note : For this assignment, you may use whatever arithmetic library you choose**

General Description

The top level to the vending machine is shown below:

```
entity lab5_top is
port (
    clk50 : in std_logic;
    pushbuttons : in std_logic_vector(3 downto 0);
    sliderswitches : in std_logic_vector(2 downto 0);
    Seg7 : out std_logic_vector(6 downto 0);
    Leds : out std_logic_vector(2 downto 0);
    anodes : out std_logic_vector(3 downto 0)
);
```

The functionality of the vending machine is as follows:

- 1) The three slider switches represent coins being placed into the machine: nickels for switch 0, dimes for switch 1, and quarters for switch 2. Toggling the switch from open to closed or closed to open simulates the entry of one coin. (Note that the switches exhibit switch bounce, so think of a simple strategy to fix this. Hint, a person can't move the switch at light speed)
- 2) As coins are entered, a running total is displayed in the two rightmost 7 segment LEDs. **This vending machine is not in the IEEE lounge, and as such, all values displayed should be in decimal.** When no money is in the machine, these two LEDs should read 0.
- 3) Push-buttons 0 through 2 dispense the three items in the machine. The cost for the push button 0 item is 55 cents, the pushbutton 1 item costs 70 cents, and the pushbutton 2 item costs 75 cents. Pressing the button once dispenses the appropriate item and flashes the corresponding LED (i.e. LED 0 for push button 0, etc.) three times at an approximately 1 second interval.
- 4) When an item has been dispensed, the two rightmost 7 segment LEDs return to 0 while the two leftmost 7 segment LEDs display the amount of change for approximately 5 seconds.
- 5) If there is not enough money in the machine to dispense the desired item, the two leftmost LEDs flash a '-' three times at an approximately 1 second interval.
- 6) Button 3 is a "coin return" button. It essentially resets the vending machine back to an empty state.

There should be a state machine that controls the operation of the state machine; however, a number of the other functions (such as 7 segment decoding and clock dividing) have been used before. In partitioning the functionality of your design, remember that it may be easiest to create some sub-blocks that perform the various operations. For instance, you may want to have separate clock generating, FSM, and 7 segment driving blocks (and maybe others). In the comments at the start of your top level file, include a brief description of your design's hierarchy to make it easier for a non-expert (such as the instructor) to figure out how your design works.

Implementation Notes

- 1) **A testbench is not required for this design, although you may find it handy to actually use one to debug your state machine.**
- 2) **As usual, submit via.web: lab5_yourlastname.zip (the zipfile of the entire project with any huge simulation files stripped out)**

Note : the vending machine does not accept pennies. For this reason, you will find it much easier to keep track of the total money deposited (and the costs) in units of nickels. This makes the display of total money much easier.

Think about it this way. If money_deposited is the count of nickels, then the lower digit of our display is always either 5 or 0, and that is just based on money_deposited(0). Then, the upper digit is simple too!

Upper_digit = total money / 10

Total money = money_deposited*5

So.

Upper_digit = money_deposited / 2, which is a simple shift.

Grading Sheet:

- 1) (10 points) : Switches are debounced correctly so that individual transitions add only 1 "coin"
- 2) (20 points) : running total of money deposited is correctly displayed on the 7 segment display
- 3) (10 points) : change is displayed when vending an item
- 4) (30 points) : dispensing of items gives the correct amount of change
- 5) (10 points) : pressing coin return brings total of money in machine to 0
- 6) (10 points) : machine will not vend if not enough money has been deposited
- 7) (10 points) : code quality