Hardware Design and Lab

Lab_5 Group Report

Name: 林奕為

Vending Machine

Contents

Vending Machine

How do I design the module:

This design employs the concept of Finite State Machine, the vending machine has 7 states, and they are INSERT, INSERT_MAX, IS_COFFEE, IS_COKE, IS_OOLONG, IS_WATER, CANCEL respectively, the current money which is denoted by total_money will be displayed using 7_segment LED light.

The one_second_decrement submodule handle the decrement of the total_money, the input value will be decremented by $5 each second using a counter counting to 1M times under the 1Mhz clk signal generated by BASYS3 FPGA board.

The definition of states:

INSERT:

The initial state, only during this state can the user insert money into the machine, and at any time the state will enter INSERT if rst_n signal is triggered.

After examining the current total_money, if the total_money is greater than the price of the beverage (coffee = $80, coke = $30, oolong = $25, water = $20), the corresponding LED will be turn on, and if the key on the keyboard belong to that beverage is press down, it will enter next state depending on the item the user bought.

If total_money >= $100, enter state INSERT_MAX.

INSERT_MAX:

Under this state, the user cannot insert money anymore, but the user can still buy the beverages.

IS_COFFEE:

If the a key on the keyboard is press down and the total_money >= $80, enter this state, then the total_money will become total_money - $80 instantly, and in each second afterward, total_money will be decremented by $5 until it becomes $0 by means of one_second_decrement module, and eventually enter INSERT state again.

IS_COKE:

Like IS_COFFEE, but the price is $30, and the corresponding key on the keyboard is s.

IS_OOLONG:

Similar to IS_COFFEE, but the price is $25, and the corresponding key on the keyboard is s.

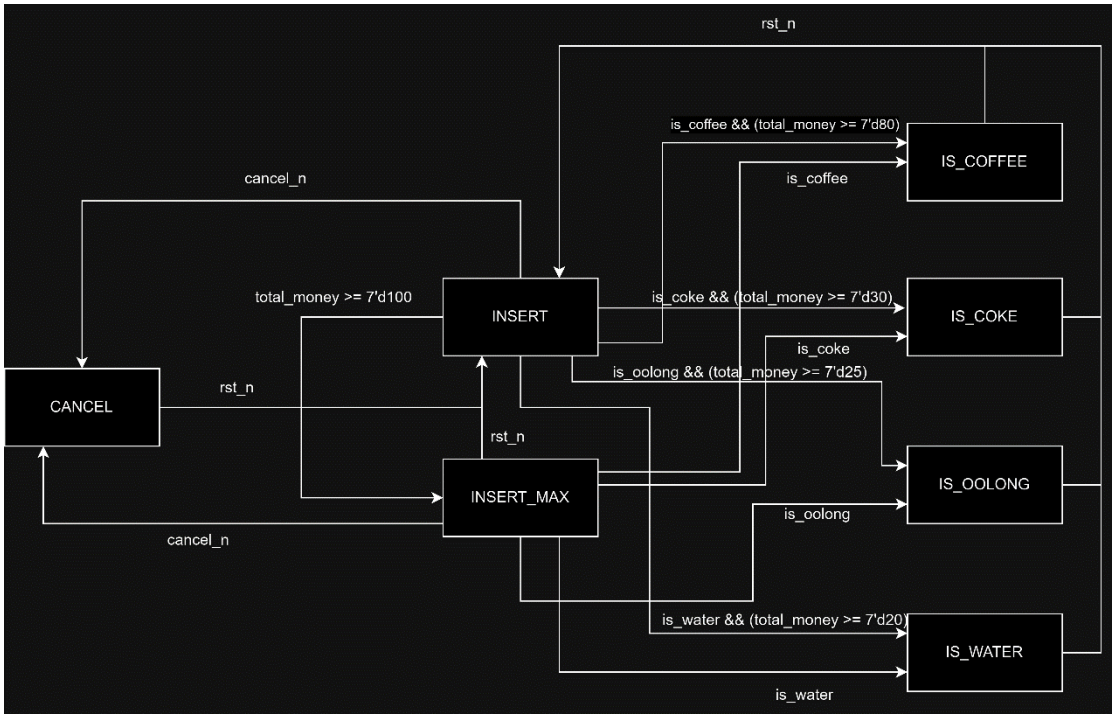
IS_WATER:

Similar to IS_COFFEE, but the price is $20, and the corresponding key on the keyboard is s.

CANCEL:

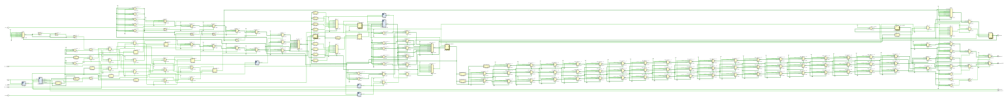
Upon hitting btn_down on the FPGA the state will become CANCEL, and the total_money will be decremented by $5 each second until $0, eventually enter INSERT state again.

State Diagram:

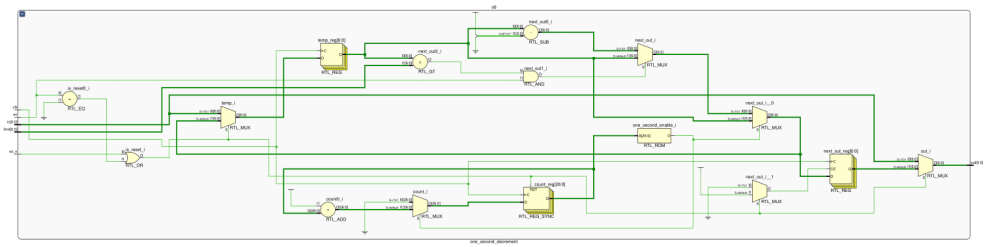


Block Diagram:

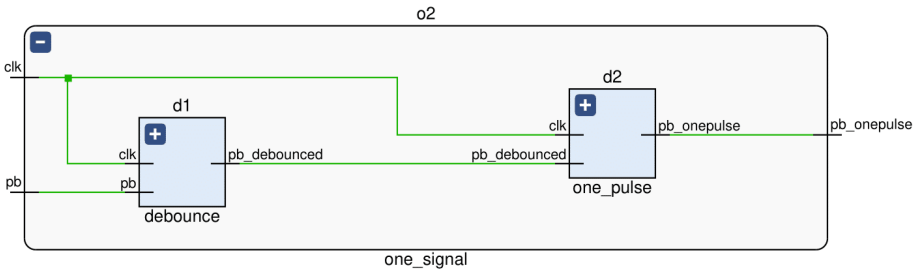
Global_schematic:



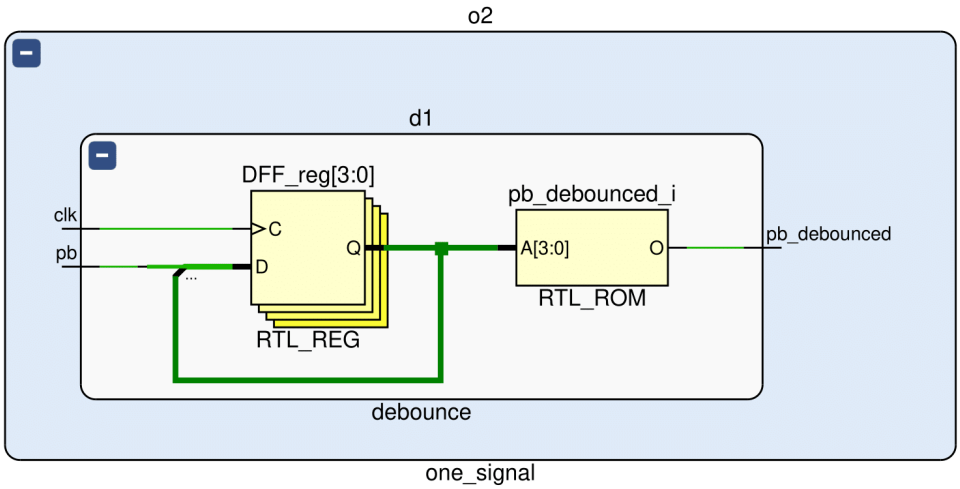
One_second_decrement:



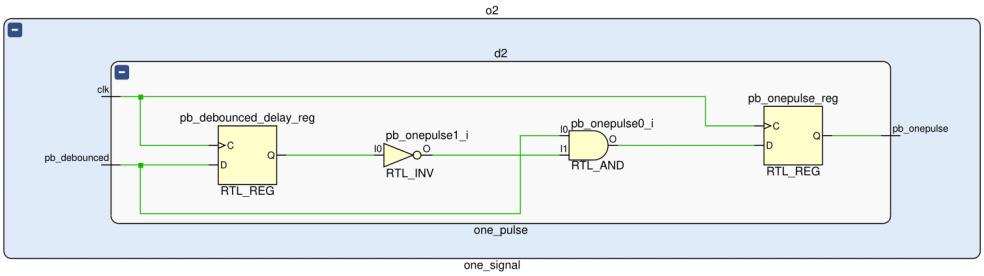
One_signal:


o2
clk
d1
clk
pb
pb
pb_debounced
debounce
d2
clk
pb_debounced
pb_onepulse
one_pulse
pb_onepulse
one_signal

Debounce:


o2
d1
DFF_reg[3:0]
clk
pb
C
D
Q
RTL_REG
pb_debounced_i
A[3:0]
O
RTL_ROM
pb_debounced
debounce
one_signal

One_pulse:


o2
d2
clk
pb_debounced
pb_debounced_delay_reg
C
D
Q
RTL_REG
pb_onepulse1_i
I0
O
RTL_INV
pb_onepulse0_i
I0
I1
O
RTL_AND
pb_onepulse_reg
C
D
Q
RTL_REG
pb_onepulse
one_pulse
one_signal