

Lab 6: Ticket Machine (2)

Due: 18:30, November 15, 2016

Objective

- Be familiar with Keyboard and FSM.

Action Item

Design a ticket machine. There will be some specific key combinations of the keyboard that represent the buttons of a ticket machine. **You can modify the code in Lab 5 to finish Lab 6.** The controller has the following input ports:

```
input  clk;
input  reset;
inout PS2_DATA;
inout PS2_CLK;
```

and the following output ports:

```
output [9:0] drop_money;
output drop_business_ticket;
output drop_general_ticket;
output [3:0] DIGIT;
output [6:0] DISPLAY;
```

The ticket machine behaves as follows

- After reset, the 7-segment displays will show "0000". The LEDs respectively corresponding to drop_business_ticket, drop_general_ticket and drop_money will not light up.
- First, a buyer selects one kind of ticket (business ticket or general ticket) by pressing a ticket button, and then the two leftmost 7-segment displays will show the ticket price (the price of a business ticket is **NT\$ 73** and the price of a general ticket is **NT\$ 66**). If the buyer wants to buy a business ticket, he/she presses **"shift + b" on the keyboard**; if the buyer wants to buy a general ticket, he/she presses **"shift + g" on the keyboard**.

- Next, the buyer may deposit a number of coins. Every time after a buyer deposits a coin (NT\$ 1, NT\$ 5 and NT\$ 10), the two rightmost 7-segment displays will show the total amount of money that has been deposited so far. If a buyer wants to deposit NT\$ 1, he/she presses “1” on the keyboard; if a buyer wants to deposit NT\$ 5, he/she presses “5” on the keyboard; if a buyer wants to deposit NT\$ 10, he/she presses “0” on the keyboard.
- When the money deposited so far is enough for the ticket price, the corresponding drop_business_ticket or drop_general_ticket LED will light up (to simulate dropping one ticket) for one clock cycle (**with the frequency of $\text{clk}/(2^{25})$**), and the two leftmost 7-segment displays will show "00" at the same time. After dropping the ticket, the machine will return the change (refer to the return change mode). When the change becomes "00", the buyer can select a ticket again. (Note: Pressing 1, 5 and 0 on the keyboard are invalid while the machine is dropping the ticket or returning the change.)
- The buyer can press the cancel button (refer to the cancel mode) after selecting one ticket and before depositing enough money for the ticket. (Note: The cancel button is invalid while the machine is dropping the ticket or returning the change.)
- Cancel mode: The buyer presses “Esc” on the keyboard and the two leftmost 7-segment displays will show "00" immediately. After that, the machine will return the change (refer to the return change mode) until the two rightmost 7-segment displays show "00".
- Return change mode: The two rightmost 7-segment displays will show the change to be returned to the buyer, and if there are more than or equal to NT\$ 10 to return, the change will be decremented by NT\$ 10 (to simulate dropping a coin of NT\$ 10) and the ten LEDs corresponding to the drop_money will light up at each clock cycle (**with the frequency of $\text{clk}/(2^{25})$**) until the two rightmost 7-segment displays show less than "10". If less than NT\$ 10 and more than NT\$ 4 are to be returned, it will be decremented by NT\$ 5 once and the five leftmost LEDs corresponding to the drop_money will light up for one clock cycle. If less than NT\$ 5

are to be returned, it will be decremented by NT\$ 1 and the leftmost LED corresponding to the drop_money will light up at each clock cycle (with the frequency of $\text{clk}/(2^{25})$) until the two rightmost 7-segment displays show "00".

More details about the I/O signals of the design are given below.

- **clk**: clock signal (which is connected to pin W5).
- **reset**: asynchronous active-high reset (connected to BTNC). When reset is enabled, the numbers being shown on the four 7-segment displays are set to 0.
- **PS2_CLK**: the clock signal for sending message between FPGA and keyboard (connected to C17).
- **PS2_DATA**: the data signal for sending message between FPGA and keyboard (connected to B17).
 - Press "1": means the buyer wants to deposit NT\$ 1.
 - Press "5": means the buyer wants to deposit NT\$ 5.
 - Press "0": means the buyer wants to deposit NT\$ 10.
 - Press "shift + g": means the buyer wants to buy a general ticket.
 - Press "shift + b": means the buyer wants to buy a business ticket.
 - Press "Esc": means the buyer wants to get the money back.
- **DISPLAY**: signals to show the money that has been deposited so far, or the money to be returned.
- **DIGIT**: signals to enable one 7-segment display.
- **drop_business_ticket**: the drop_business_ticket signal (connected to LD0).
- **drop_general_ticket**: the drop_general_ticket signal (connected to LD1).
- **drop_money**: the drop_money signals (connected to LD6 ~ LD15).

Notes:

- The clock frequency of the keyboard is clk (100MHz), but you have to slow down the signal of each pressed key to have the frequency $\text{clk}/(2^{16})$, in order to get the signal from the keyboard.
- Each pressed key is detected by the ticket machine controller

under the clock frequency $\text{clk}/(2^{16})$

- **The clock frequency of the seven-segment display controller is $\text{clk}/(2^{13})$**