Lab 5: Ticket Machine

Due: 18:30, November 1st, 2016

Objective

- To be familiar with modeling finite state machines with Verilog.

Action Item

Design a controller for a ticket machine. The controller has the following input ports:

```
input   clk;
input   reset;
input   money_5;
input   money_10;
input   cancel;
input   business_ticket;
input   general_ticket;
```

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 presseing a ticket button, and then the two leftmost 7-segment displays will show the ticket price (the price of a business ticket is NT$ 75 and the price of a general ticket is NT$ 55). If the buyer wants to buy a business ticket, he/she presses the business_ticket button; if the buyer wants to buy a general ticket,

he/she presses the general_ticket button.

- Next, the buyer may deposit a number of coins. Every time after a buyer deposits a coin (NT$ 10 or NT$ 5), the two rightmost 7-segment displays will show the total amount of money that has been deposited so far. If the buyer wants to deposit NT$ 5, he/she presses the money_5 button; if the buyer wants to deposit NT$ 10, he/she presses the money_10 button.

- 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 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 selecte a ticket again. (Note: The money_5 button and the money_10 button are invaild 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 invaild while the machine is dropping the ticket or returning the change.)

- Cancel mode: The buyer presses the cancel button 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 clk/(2^25)**) until the two rightmost 7-segment displays show "00" or "05". If less than NT$ 10 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 (**with the frequency of clk/(2^25)**).

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 **SW0**). When reset is enabled, the numbers being shown on the four 7-segment displays are set to 0.
- **cancel**: the cancel signal which is generated from a onepulse circuit whose input comes from the output of a debouncer; the data input of the debouncer is the pushbutton **BTNC**.
- **business_ticket**: the business_ticket signal which is generated from a onepulse circuit whose input comes from the output of a debouncer; the data input of the debouncer is the pushbutton **BTNR**.
- **general_ticket**: the general_ticket signal which is generated from a onepulse circuit whose input comes from the output of a debouncer; the data input of the debouncer is the pushbutton **BTNL**.
- **money_5**: the money_5 signal which is generated from a onepulse circuit whose input comes from the output of a debouncer; the data input of the debouncer is the pushbutton **BTND**.
- **money_10**: the money_10 signal which is generated from a onepulse circuit whose input comes from the output of a debouncer; the data input of the debouncer is the pushbutton **BTNU**.
- **DISPLAY**: signal to show the money that has been deposited so far, or the money to be returned.
- **DIGIT**: signal 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 signal (connected to **LD6 ~ LD15**).

Notes:

1. The clock frequency of each debouncer or onepulse circuit is clk/(2^16)

2. The clock frequency of the seven-segment display controller is clk/(2^13)