

ENGG 125.03 Laboratory Activity 7: Basketball Scoring System

Activity Sheet; Submitted: 17 May 2021

Mallari, Kevin Luis T.
BS Computer Engineering
Electronics, Computer, and Communications Engineering
Ateneo de Manila University
Philippines

Abstract—The laboratory activity is about simulating basketball scoring and timer system. The system includes the scores for the both the teams in the game, and a shot clock and game timer. Different virtual push buttons and switches are used in the project. One push button was used as a master reset. The other push buttons were used to increment or decrement the scores of the teams. The switches were used to enable and disable certain functions of the system. Some switches were used in resetting the values of the timers.

Keywords - Basketball Scoring, ModelSim, Quartus, Verilog

I. COMPUTATIONS AND SOLUTIONS

The basketball scoring system consists of multiple buttons and switches which do different things. The table in figure 1 shows and explains what each button and switch does.

Button	Function
PB0	Master Reset
PB1	Increments Team 1's Score
PB2	Decrements Team 1's Score
PB3	Increments Team 2's Score
PB4	Decrements Team 2's Score
LEDs	Function
SW1	Resets timer and shot clock
SW2	Activates game timer
SW3	Resets shot clock
SW4	Activates shot clock

Fig. 1. Virtual Buttons and LEDs Functions

II. HDL CODE

This section shows and explains the code made for the activity.

```
`timescale 1ms/1ms
module basketball_system(
    score1, score2,
    clock, PB0, PB1, PB2, PB3, PB4, SW1, SW2,
    SW3, SW4,
```

```
seconds, minutes, shotclock);

    output reg[7:0] score1, score2; // 8-bit
    for a score up to 255
    input clock;
    input PB0; // master reset switch
    input PB1, PB2; // up-down buttons for
    first team
    input PB3, PB4; // up-down buttons for the
    second team

    // variables for minutes and seconds
    output reg [5:0] seconds; // = d59
    output reg [3:0] minutes; // = d12
    output reg [4:0] shotclock; // = d24

    input SW1; // resets general timer to 12
    mins if on
    // also resets shot clock to 24
    secs

    input SW2; // if on, counts down time. if
    off, pauses timer
    input SW3; // if on, resets shot clock to
    24 secs
    input SW4; // if on, counts down shot
    clock
    // if off, pauses shot clock

    always @(posedge clock or posedge PB0)
    begin
        if (PB0 == 1) begin
            // master reset. resets original
            value of shotclock,
            // seconds, minutes, and scores
            shotclock = 5'b11000;
            seconds = 8'b00111011;
            minutes = 4'b1100;
```

```

        score1 = 8'b0000_0000;
        score2 = 8'b0000_0000; // resets
scores
    end else begin
        // if both buttons are pressed or
not pressed,
        // nothing will happen.
        if (PB1 == 1 && PB2 == 0) score1
<= score1 + 1;
        else if (PB1 == 0 && PB2 == 1)
begin
            if (score1 != 8'b0000_0000)
score1 <= score1 - 1; // prevents overflow
            end
            // if both buttons are pressed or
not pressed,
            // nothing will happen.
            if (PB3 == 1 && PB4 == 0) score2
<= score2 + 1;
            else if (PB3 == 0 && PB4 == 1)
begin
                if (score2 != 8'b0000_0000)
score2 <= score2 - 1; // prevents overflow
            end
            // resets timer values
            if (SW1 == 1) begin
                minutes <= 4'b1100; // sets
game minutes to 12
                seconds = 6'b111011; // sets
the game seconds back to 59
                shotclock = 5'b11000; // sets
shotclock to 24
            end

            // starts the countdown timer
            if (SW2 == 1) begin
                // when seconds == 0, that
means that a minute has passed.
                // therefore, the value of
seconds is reset and the value
                // of minutes is decremented
by 1.
                if (seconds == 0) begin
                    seconds = 8'b00111011;
                    if (minutes != 0) minutes
<= minutes - 1;
                end
                // decrements the value of
seconds. decrements the value of
                // the shotclock if SW4 is on.

```

```

        if (SW4 == 1 && shotclock !=
0) shotclock = shotclock - 1;
        seconds = seconds - 1;
    end
    // resets the value of the
shotclock
    if (SW3 == 1) shotclock <=
5'b11000;
end
endmodule

module tb_basketball();

    reg clock, PB0, PB1, PB2, PB3, PB4, SW1,
SW2, SW3, SW4;
    wire [7:0] score1, score2;
    wire [5:0] seconds;
    wire [4:0] shotclock;
    wire [3:0] minutes;

    basketball_system dut(
        score1, score2,
        clock, PB0, PB1, PB2, PB3, PB4, SW1,
SW2, SW3, SW4,
        seconds, minutes, shotclock);

    always #10 clock = ~clock;

    initial begin
        #1 clock = 0; #0 PB0 = 1; PB1 = 0; PB2
= 0; PB3 = 0; PB4 = 0; SW1 = 0; SW2 = 0; SW3 =
0; SW4 = 0;

        #5 PB0 = 0;

        #50 PB1 = 1; // adds to the score of
team 1
        #100 PB2 = 1; #100 PB1 = 0; // removes
a score from team 1
        #150 PB2 = 0;

        #150 PB3 = 1; // adds to the score of
team 2
        #200 PB4 = 1; #100 PB3 = 0; // removes
a score from team 2
        #250 PB4 = 0;

        #300 SW2 = 1; // turns on the game
timer
        #300 SW4 = 1; // turns on the

```

```

shotclock
    #800 SW3 = 1; // resets shot clock to
24s
    #900 SW3 = 0; // allows shot clock to
work
    #1000 SW2 = 0; // pauses the timer
    #1000 SW4 = 0; // pauses the shotclock

    #1050 SW1 = 1; // resets timer to 12
mins and shot clock to 24 secs
    #1100 SW1 = 0; // allows timer to
start again

    #1200 $stop;
end
endmodule

```

Fig. 2. Circuit for the Basketball Scoring System

The code follows the functions of the push buttons and switches shown in figure 1. It was determined that the outputs should be score1, score2, seconds, minutes, and shotclock. All the push buttons and switches are made to be inputs.

At the beginning of the always statement, a conditional statement where PB0 is the condition. If PB0 is 1, then it resets the values of all the outputs. This also effectively initializes the values of the outputs. The initial value of minutes is 12 since we want to count down from 12 minutes. The initial value of seconds is 59, since we want to count down from that value. It starts at 59 because it goes down until 0. The shot clock is set at 24 since this is the duration of the shot clock in a game.

If PB is 0, then the other push buttons and switches can be used. If PB1 is pressed and PB2 is not, then score1 will increment by one. If PB2 is pressed and PB1 is not, then score1 will decrement by one. The same is true for PB3 and PB4 when it comes to score2. If none of the push buttons are pressed, or if they are pressed at the same time, nothing happens to the score. The scores will only decrement if their value is not zero. This is because if the score is zero, it will overflow back to 1111_1111 if it is decremented. The same is done with the seconds, minutes, and shotclock outputs.

SW1 resets the values of the timers, which includes the seconds, minutes, and shot clock outputs. SW4 on the other hand, just resets the value of the shot clock.

If SW2 is on, then the timers will start. Both the game timers and shot clock timer can start. However, the shot clock is dependent on SW4. If SW4 is high, that is the only time that the shot clock will be counted down.

III. OUTPUT CIRCUIT

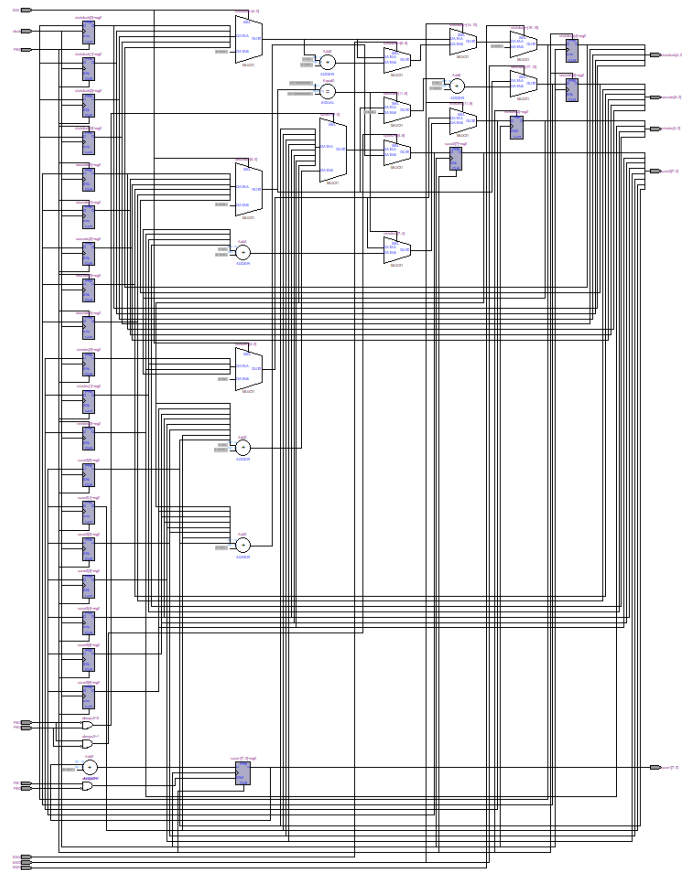


Fig. 3. Circuit for the Basketball System

The circuit generated by the code can be seen in figure 3. As seen, the size of the circuit is relatively bigger compared to previous activities. This is because there are more factors and variables included in the system than the other activities. The whole circuit consists of registers, multiplexers, logic gates, adders, and equals operators.

IV. Screenshot(s) of Simulations and VWF file

The screenshots of the simulations are presented below. The simulations of the different outputs produced by the system are shown. Multiple possible outputs are shown in all of the figures.

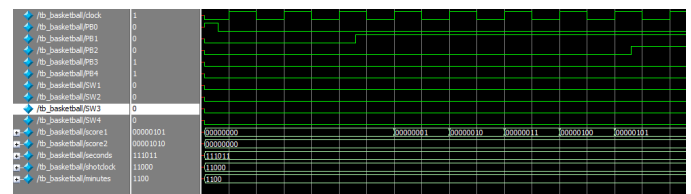


Fig. 4. score1 incrementing.

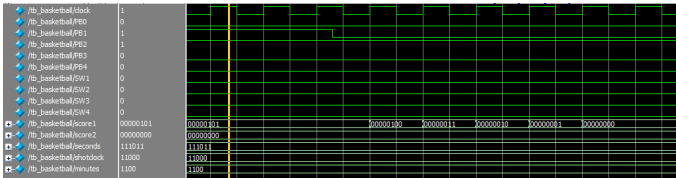


Fig. 5. score1 decrementing.

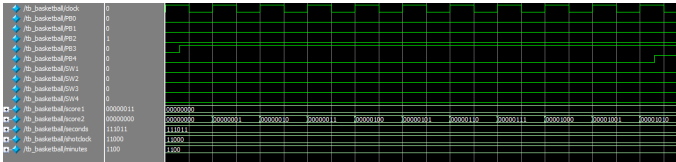


Fig. 6. score 2 incrementing.

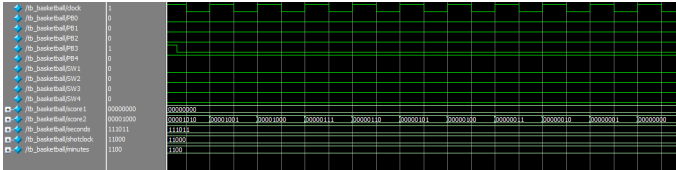


Fig. 7. score2 decrementing.

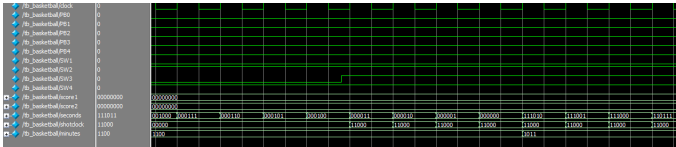


Fig. 8. Timers (seconds, minutes, shotclock) counting down.