Assignment 2

Multi-Mode-Counter

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Code: 1900802

Section : 2

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Verification

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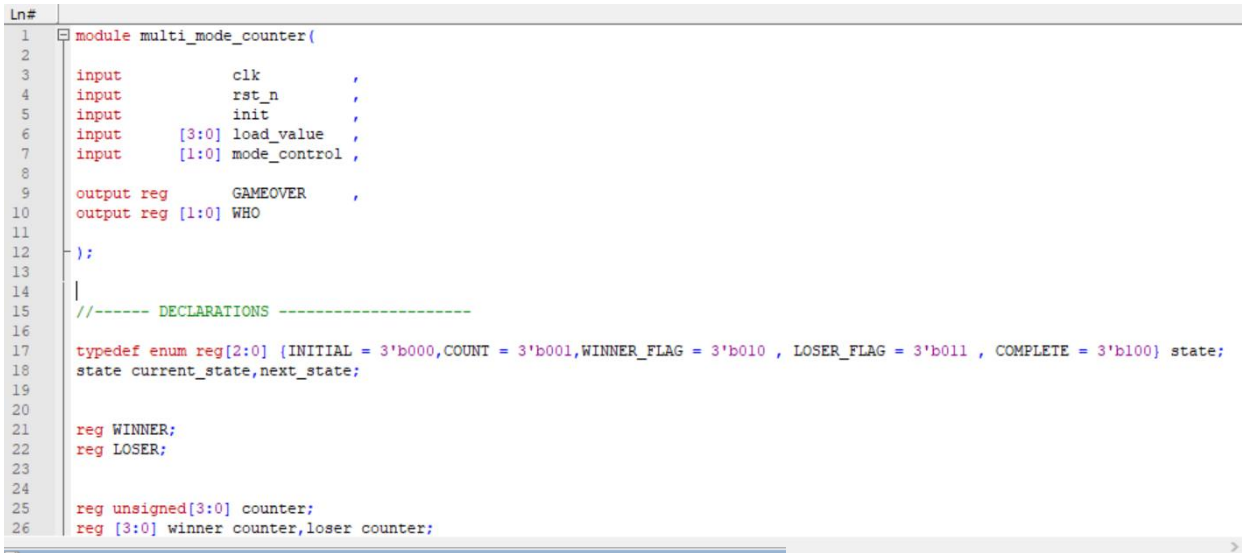
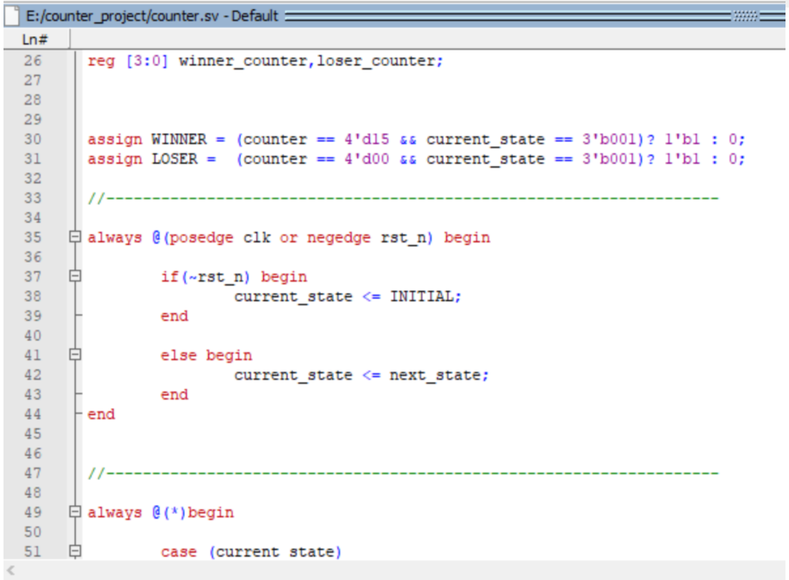
Dr. Ayman Wahba

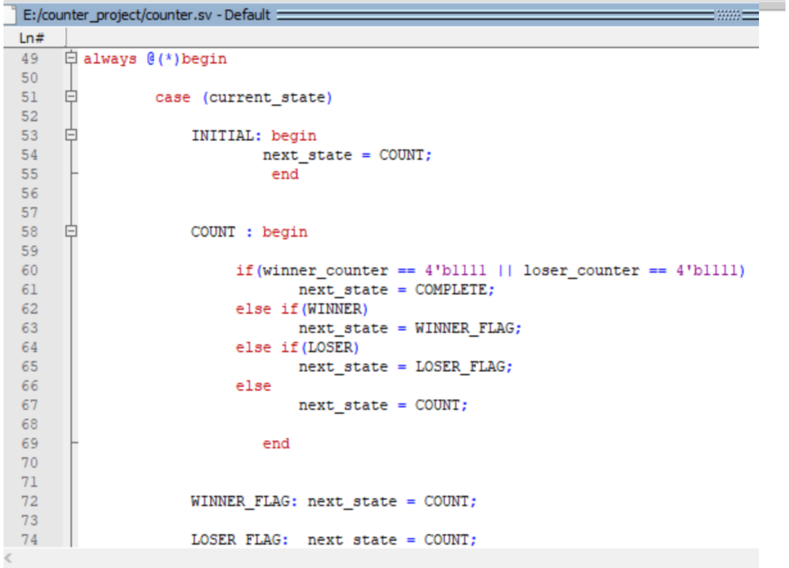
CODE



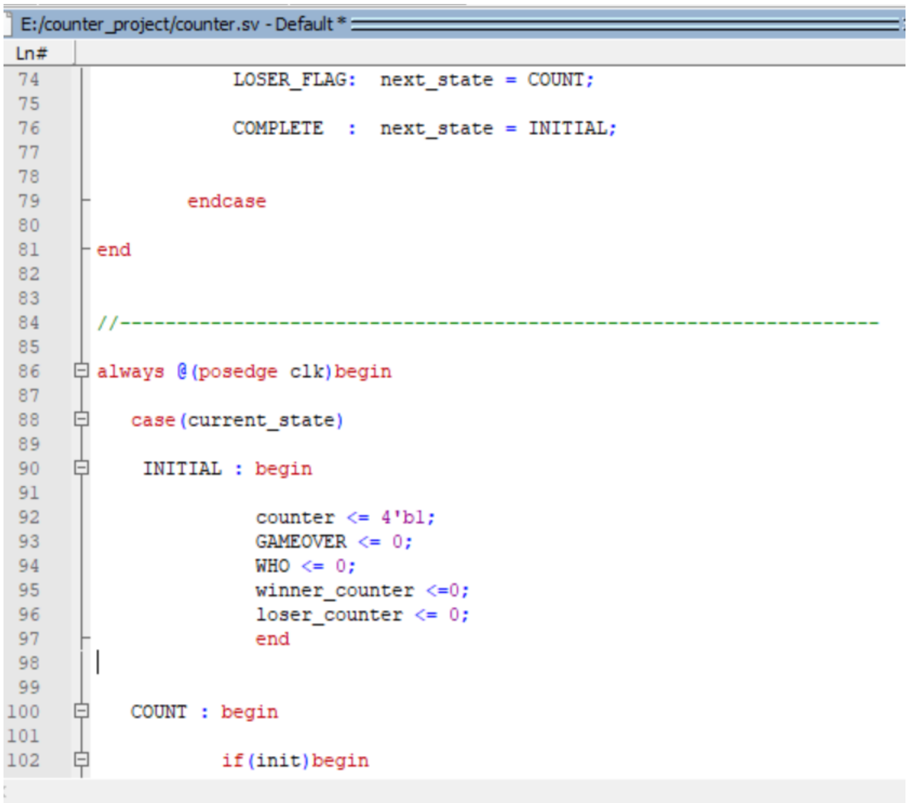
```
module multi_mode_counter(

input            clk         ,
input            rst_n       ,
input            init        ,
input      [3:0] load_value  ,
input      [1:0] mode_control ,

output reg       GAMEOVER    ,
output reg [1:0] WHO

);


//------ DECLARATIONS ---------------------

typedef enum reg[2:0] {INITIAL = 3'b000,COUNT = 3'b001,WINNER_FLAG = 3'b010 , LOSER_FLAG = 3'b011 , COMPLETE = 3'b100} state;
state current_state,next_state;


reg WINNER;
reg LOSER;


reg unsigned[3:0] counter;
reg [3:0] winner_counter,loser_counter;
```



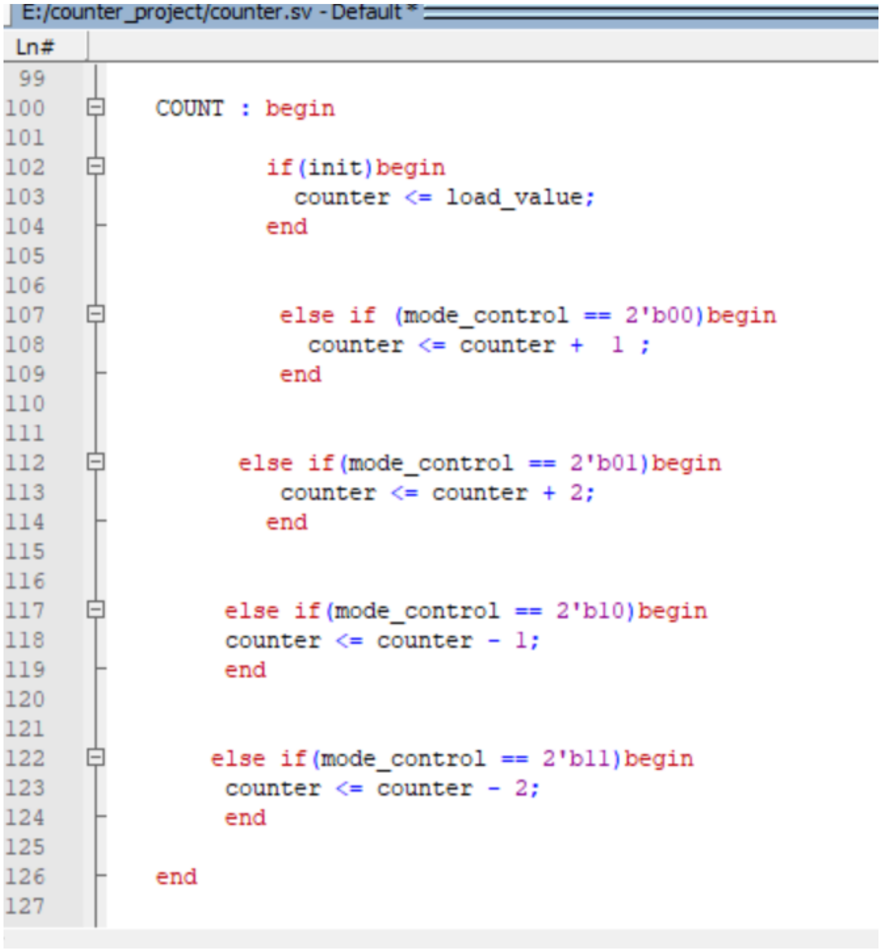
```
reg [3:0] winner_counter,loser_counter;



assign WINNER = (counter == 4'd15 && current_state == 3'b001)? 1'b1 : 0;
assign LOSER =  (counter == 4'd00 && current_state == 3'b001)? 1'b1 : 0;

//-------------------------------------------------------------------

always @(posedge clk or negedge rst_n) begin

        if(~rst_n) begin
                current_state <= INITIAL;
        end

        else begin
                current_state <= next_state;
        end
end


//-------------------------------------------------------------------

always @(*)begin

        case (current_state)
```



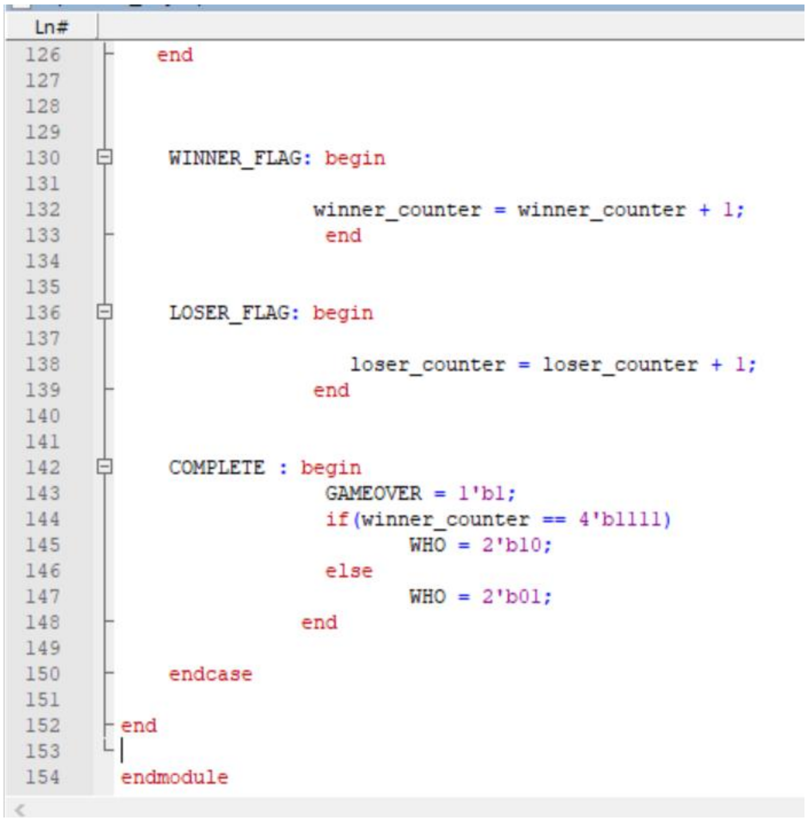
```
always @(*)begin

        case (current_state)

            INITIAL: begin
                    next_state = COUNT;
                     end


            COUNT : begin

                 if(winner_counter == 4'b1111 || loser_counter == 4'b1111)
                        next_state = COMPLETE;
                 else if(WINNER)
                        next_state = WINNER_FLAG;
                 else if(LOSER)
                        next_state = LOSER_FLAG;
                 else
                        next_state = COUNT;

                    end


            WINNER_FLAG: next_state = COUNT;

            LOSER_FLAG:  next_state = COUNT;
```



```
              LOSER_FLAG:  next_state = COUNT;

              COMPLETE   :  next_state = INITIAL;


          endcase

end


//--------------------------------------------------------------------

always @(posedge clk)begin

   case(current_state)

    INITIAL : begin

                counter <= 4'b1;
                GAMEOVER <= 0;
                WHO <= 0;
                winner_counter <=0;
                loser_counter <= 0;
                end


   COUNT : begin

            if(init)begin
```

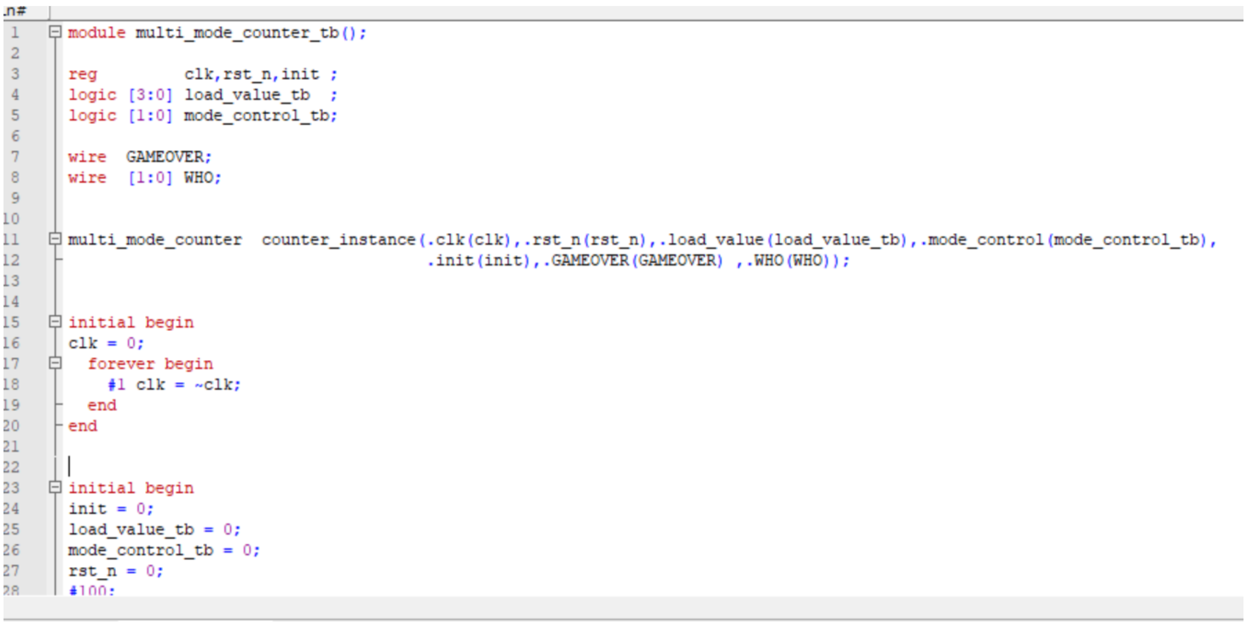


```

   COUNT : begin

            if(init)begin
              counter <= load_value;
            end


             else if  (mode_control == 2'b00)begin
               counter <= counter +   1 ;
             end


          else if(mode_control == 2'b01)begin
             counter <= counter + 2;
            end


         else if(mode_control == 2'b10)begin
         counter <= counter - 1;
         end


        else if(mode_control == 2'b11)begin
         counter <= counter - 2;
         end

   end

```

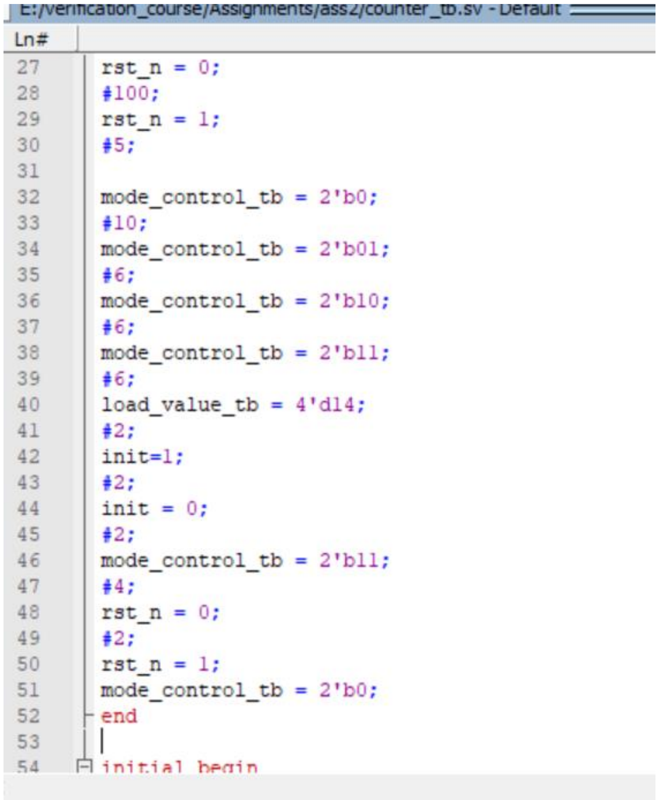


```
   end


    WINNER_FLAG: begin

                winner_counter = winner_counter + 1;
                 end


    LOSER_FLAG: begin

                   loser_counter = loser_counter + 1;
                end


    COMPLETE : begin
                 GAMEOVER = 1'b1;
                 if(winner_counter == 4'b1111)
                        WHO = 2'b10;
                 else
                        WHO = 2'b01;
               end

    endcase

end

endmodule
```

TestBench

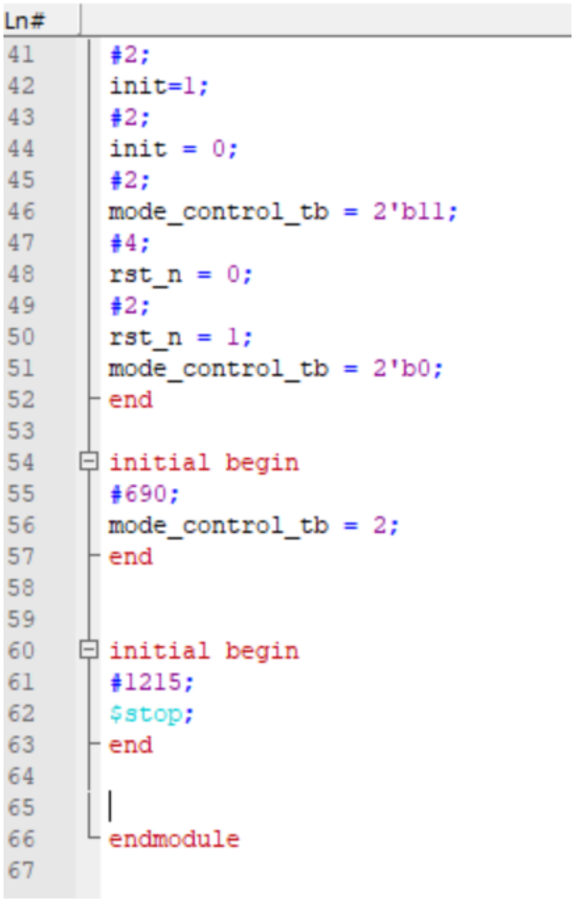


```
module multi_mode_counter_tb();

reg         clk,rst_n,init ;
logic [3:0] load_value_tb  ;
logic [1:0] mode_control_tb;

wire  GAMEOVER;
wire  [1:0] WHO;


multi_mode_counter  counter_instance(.clk(clk),.rst_n(rst_n),.load_value(load_value_tb),.mode_control(mode_control_tb),
                                     .init(init),.GAMEOVER(GAMEOVER) ,.WHO(WHO));


initial begin
clk = 0;
  forever begin
    #1 clk = ~clk;
  end
end


initial begin
init = 0;
load_value_tb = 0;
mode_control_tb = 0;
rst_n = 0;
#100;
```



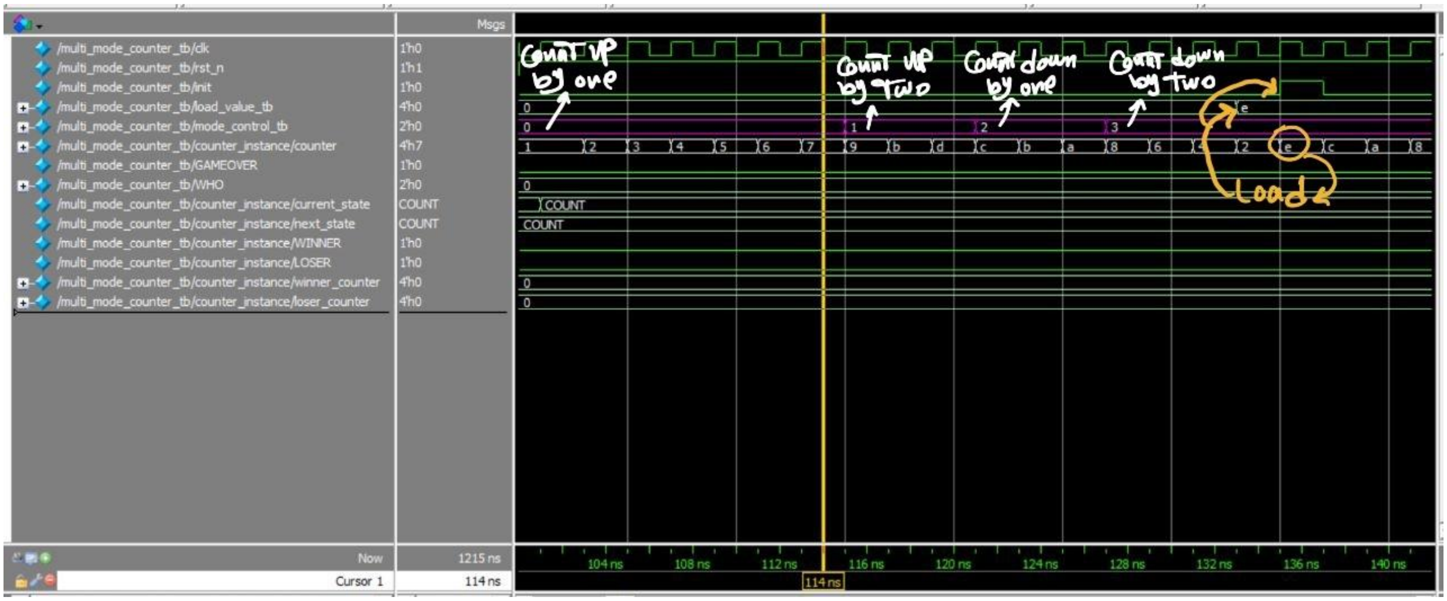
E:/verification_course/Assignments/ass2/counter_tb.sv - Default

```
rst_n = 0;
#100;
rst_n = 1;
#5;

mode_control_tb = 2'b0;
#10;
mode_control_tb = 2'b01;
#6;
mode_control_tb = 2'b10;
#6;
mode_control_tb = 2'b11;
#6;
load_value_tb = 4'd14;
#2;
init=1;
#2;
init = 0;
#2;
mode_control_tb = 2'b11;
#4;
rst_n = 0;
#2;
rst_n = 1;
mode_control_tb = 2'b0;
end

initial begin
```

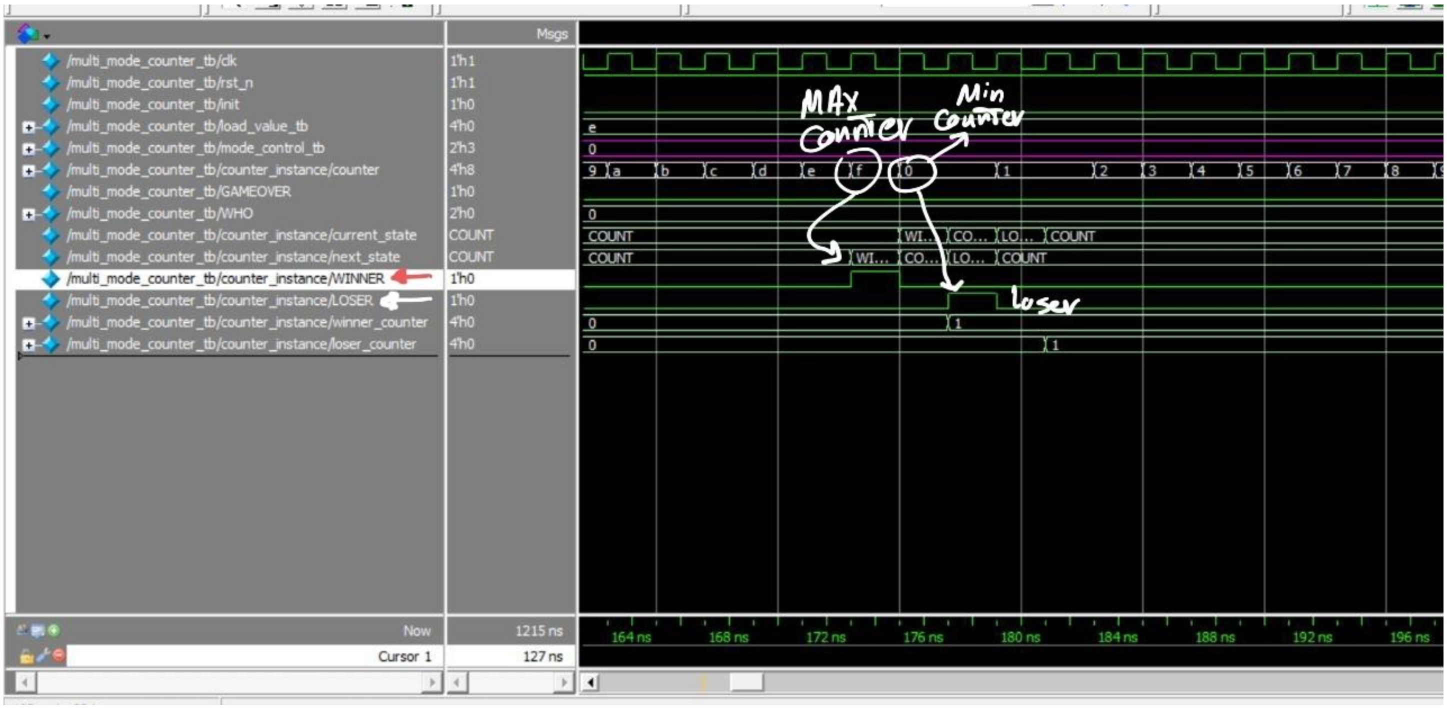


```
#2;
init=1;
#2;
init = 0;
#2;
mode_control_tb = 2'b11;
#4;
rst_n = 0;
#2;
rst_n = 1;
mode_control_tb = 2'b0;
end

initial begin
#690;
mode_control_tb = 2;
end


initial begin
#1215;
$stop;
end


endmodule
```

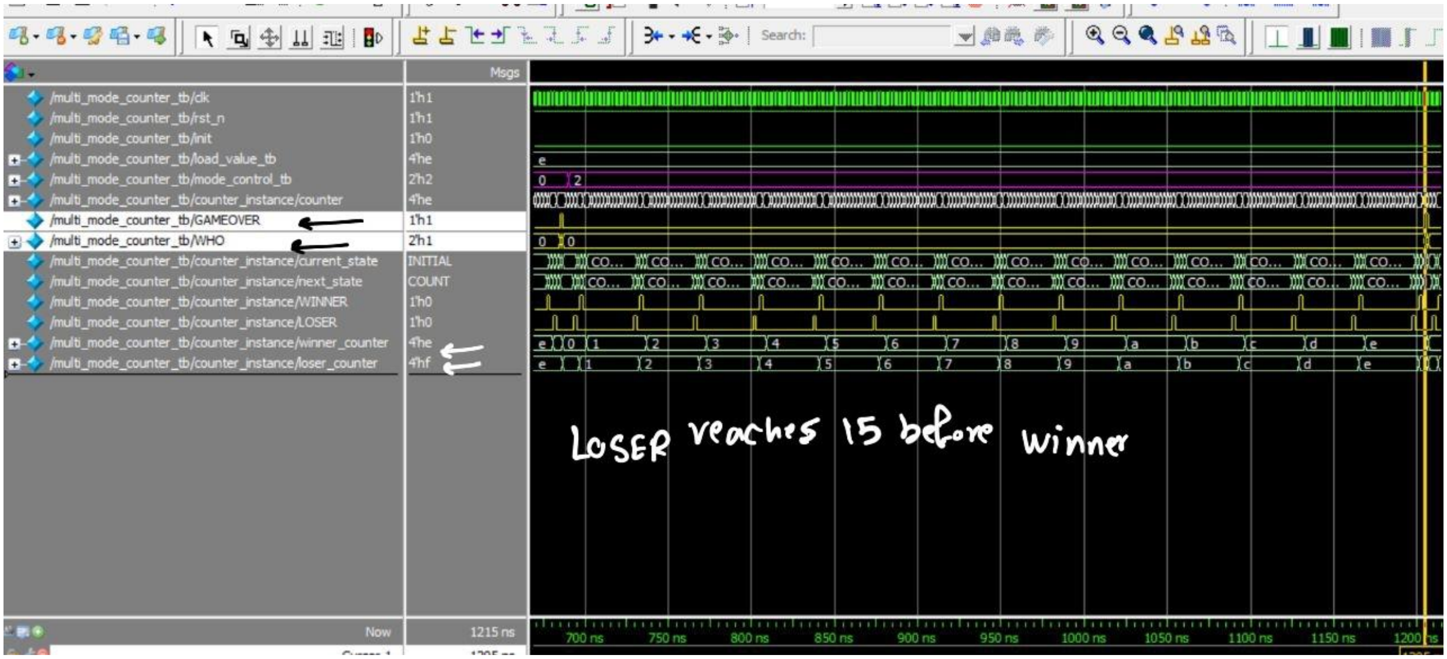
WaveForms



```
/multi_mode_counter_tb/clk                                  1'h0
/multi_mode_counter_tb/rst_n                                1'h1
/multi_mode_counter_tb/init                                 1'h0
/multi_mode_counter_tb/load_value_tb                        4'h0
/multi_mode_counter_tb/mode_control_tb                      2'h0
/multi_mode_counter_tb/counter_instance/counter             4'h7
/multi_mode_counter_tb/GAMEOVER                             1'h0
/multi_mode_counter_tb/WHO                                  2'h0
/multi_mode_counter_tb/counter_instance/current_state       COUNT
/multi_mode_counter_tb/counter_instance/next_state          COUNT
/multi_mode_counter_tb/counter_instance/WINNER              1'h0
/multi_mode_counter_tb/counter_instance/LOSER               1'h0
/multi_mode_counter_tb/counter_instance/winner_counter      4'h0
/multi_mode_counter_tb/counter_instance/loser_counter       4'h0

Now        1215 ns
Cursor 1   114 ns
```

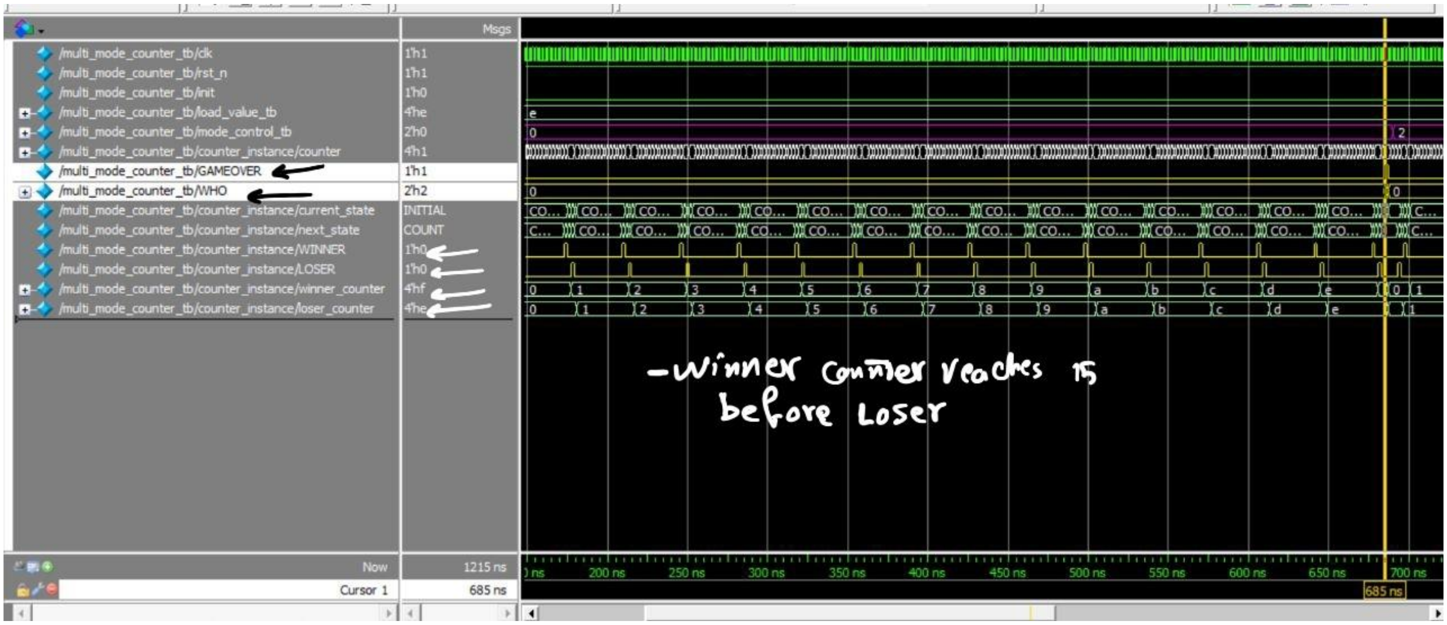


```
/multi_mode_counter_tb/clk                                  1'h1
/multi_mode_counter_tb/rst_n                                1'h1
/multi_mode_counter_tb/init                                 1'h0
/multi_mode_counter_tb/load_value_tb                        4'h0
/multi_mode_counter_tb/mode_control_tb                      2'h3
/multi_mode_counter_tb/counter_instance/counter             4'h8
/multi_mode_counter_tb/GAMEOVER                             1'h0
/multi_mode_counter_tb/WHO                                  2'h0
/multi_mode_counter_tb/counter_instance/current_state       COUNT
/multi_mode_counter_tb/counter_instance/next_state          COUNT
/multi_mode_counter_tb/counter_instance/WINNER              1'h0
/multi_mode_counter_tb/counter_instance/LOSER               1'h0
/multi_mode_counter_tb/counter_instance/winner_counter      4'h0
/multi_mode_counter_tb/counter_instance/loser_counter       4'h0

Now        1215 ns
Cursor 1   127 ns
```



	Msgs
/multi_mode_counter_tb/clk	1'h1
/multi_mode_counter_tb/rst_n	1'h1
/multi_mode_counter_tb/init	1'h0
/multi_mode_counter_tb/load_value_tb	4'he
/multi_mode_counter_tb/mode_control_tb	2'h2
/multi_mode_counter_tb/counter_instance/counter	4'he
/multi_mode_counter_tb/GAMEOVER	1'h1
/multi_mode_counter_tb/WHO	2'h1
/multi_mode_counter_tb/counter_instance/current_state	INITIAL
/multi_mode_counter_tb/counter_instance/next_state	COUNT
/multi_mode_counter_tb/counter_instance/WINNER	1'h0
/multi_mode_counter_tb/counter_instance/LOSER	1'h0
/multi_mode_counter_tb/counter_instance/winner_counter	4'he
/multi_mode_counter_tb/counter_instance/loser_counter	4'hf
Now	1215 ns

LOSER reaches 15 before winner



	Msgs
/multi_mode_counter_tb/clk	1'h1
/multi_mode_counter_tb/rst_n	1'h1
/multi_mode_counter_tb/init	1'h0
/multi_mode_counter_tb/load_value_tb	4'he
/multi_mode_counter_tb/mode_control_tb	2'h0
/multi_mode_counter_tb/counter_instance/counter	4'h1
/multi_mode_counter_tb/GAMEOVER	1'h1
/multi_mode_counter_tb/WHO	2'h2
/multi_mode_counter_tb/counter_instance/current_state	INITIAL
/multi_mode_counter_tb/counter_instance/next_state	COUNT
/multi_mode_counter_tb/counter_instance/WINNER	1'h0
/multi_mode_counter_tb/counter_instance/LOSER	1'h0
/multi_mode_counter_tb/counter_instance/winner_counter	4'hf
/multi_mode_counter_tb/counter_instance/loser_counter	4'he
Now	1215 ns
Cursor 1	685 ns

-winner counter reaches 15 before Loser

GitHub Link : https://github.com/HassanKhaled11/Multi_Mode_Counter.git