# **ECE241 Digital Systems Final Project Report**

**Project:** The Typist

**Teaching Assistant:** David Han

**Team Members & Student Number:**

Lisa Yoneyama

Kung Lim Siew Jin 1001511287

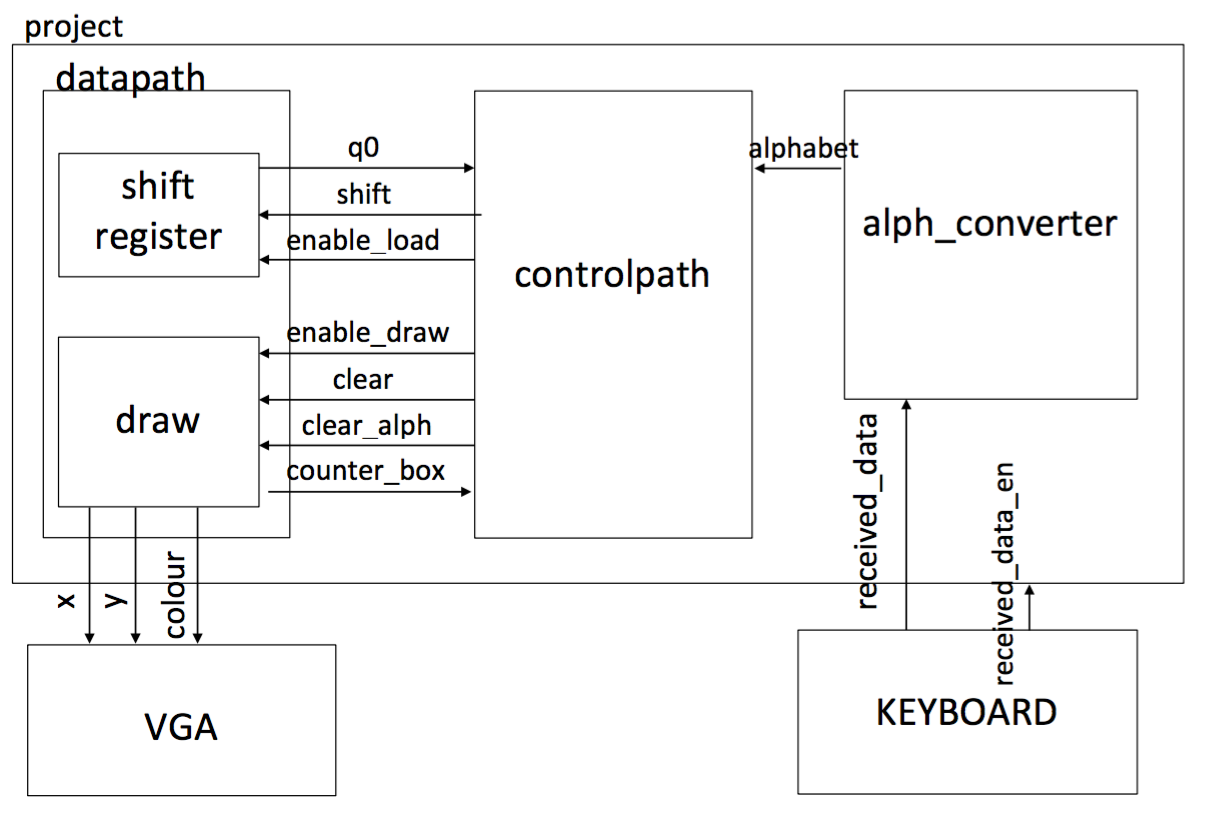
# Introduction

For the final project in the ECE241 Digital Systems course, we designed a circuit to implement a typing game that is projected onto a monitor via VGA. The user would then type the letters on the screen with a PS2 keyboard to “delete” or shift characters until all the characters have been “deleted”.

We had several goals when we started working on the project. The milestones listed are in chronological order of completion:

* Drawing a single letter on the monitor
* Drawing an entire sentence on the monitor
* Shifting the characters on the screen via FPGA KEY press
* Shifting the characters via PS2 keyboard
* Drawing the background to suit the game

# The Design



Project - This module contains two main modules: the control path and the data path. It is also where the VGA and Keyboard inputs/outputs are derived.

Datapath - The datapath consists of two modules: the shift register module and the draw module. It takes shift, enable\_load, enable\_draw, clear, clear\_alph and counter\_box as inputs from the control path.

Controlpath - The control path module consists of 28 different states: a reset state, register state, a state for each letter on the screen (twenty-four letters), a wait state and a shift state. The reset state restarts the game. The register state is a delay state that allows the letters from the shift register to register in the twenty-four D-Flip Flops for each letter on the screen. The draw states will draw the twenty-four letters on the screen from left to right. Each one going to the next state when the previous letter is finished drawing and counter\_box is incremented. Once all the letters are on the screen the control path will go to the wait state and stay in the wait state until the user inputs the first letter on the screen correctly via keyboard. The shift state will shift the shift register exactly one time so that the second letter is now in the very left of the screen.

Alph\_converter - The alph\_converter module takes input from the PS2 Keyboard and converts the hex numbers to binary parameters we have assigned to each letter.

Shiftregister - The shift register module contains the hard coded sentences, each letter registered in a D-Flip flop.

Draw - The draw module draws a single letter on the screen. It reads the colour stored in the rom memory and draws each pixel while counter\_alphabet is incrementing to thirty. The start point for each letter is taken in as an input from the datapath module and changes when counter\_box is incremented.

# Report on Success

Our final project performed as planned except for a minor bug, which causes the first pixel out of 30 pixels drawn for each character to be overwritten by a differently specified colour. We speculate this to be a timing issue due to the complexity of the circuit, as some variations of the code did not have this anomaly. All the characters shifted to the left when the leftmost character on the monitor was “deleted” while the rightmost character was drawn onto the monitor. The characters displayed on the monitor are preloaded into a series of shift registers. Although we only hard coded 2 sentences into the shift registers, we could have added many more. The game starts automatically and is reset to the image shown below when KEY[0] is pressed.



# 4. What We Would Do Differently

Some of the challenges we faced while working on this project was time management which resulted in a mad rush to complete the project before the deadline. Although we mostly worked together which avoided the problem of putting separate modules together, it was highly inefficient and therefore, more time consuming than it had to be. We spent the majority of our time on this project debugging instead of writing code or figuring out game logic, thus wasting plenty of time for compilation to happen as ModelSIM was a less than ideal method of debugging our circuit due to usage of a VGA and monitor.

We would have broken down the parts suggested as per our TA’s recommendation, as some parts of the circuit could have been done separately and put together easily. We would allocate more time to debugging our code.

# Appendix

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Module:       ECE241 Typing Project

Description:

This module was made by Siew Jin Kung Lim & Lisa Yoneyama.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

module project(

       CLOCK\_50,                       //  On Board 50 MHz

       // Your inputs and outputs here

       KEY,

       SW,

 PS2\_CLK,

 PS2\_DAT,

 LEDR,

 HEX0,

 HEX1,

 HEX2,

 HEX3,

 HEX4,

 HEX5,

       // The ports below are for the VGA output.  Do not change.

       VGA\_CLK,                        //  VGA Clock

       VGA\_HS,                         //  VGA H\_SYNC

       VGA\_VS,                         //  VGA V\_SYNC

       VGA\_BLANK,                      //  VGA BLANK

       VGA\_SYNC,                       //  VGA SYNC

       VGA\_R,                          //  VGA Red[9:0]

       VGA\_G,                          //  VGA Green[9:0]

       VGA\_B                           //  VGA Blue[9:0]

   );

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                           Parameter Declarations                          \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                             Port Declarations                             \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

input           CLOCK\_50;               //  50 MHz

   // Declare your inputs and outputs here

input   [3:0]   KEY;

input   [9:0]   SW;

inout PS2\_CLK, PS2\_DAT;

output [9:0]LEDR;

output [6:0] HEX0, HEX1, HEX2, HEX3, HEX4, HEX5;

   // Do not change the following outputs

   output          VGA\_CLK;                //  VGA Clock

   output          VGA\_HS;                 //  VGA H\_SYNC

   output          VGA\_VS;                 //  VGA V\_SYNC

   output          VGA\_BLANK;              //  VGA BLANK

   output          VGA\_SYNC;               //  VGA SYNC

   output  [9:0]   VGA\_R;                  //  VGA Red[9:0]

   output  [9:0]   VGA\_G;                  //  VGA Green[9:0]

   output  [9:0]   VGA\_B;                  //  VGA Blue[9:0]

   wire resetn;

   assign resetn = KEY[0];

   // Create the colour, x, y and writeEn wires that are inputs to the controller.

   wire [2:0] colour;

   wire [7:0] x;

   wire [6:0] y;

   wire writeEn;

wire shift, clear;

wire [7:0] received\_data;

wire received\_data\_en;

wire [5:0]q0;

wire[5:0]d0;

wire[5:0] alphabet;

wire [2:0] y\_cord;

wire clear\_alph, enable\_draw;

wire [4:0]counter\_alphabet;

wire [4:0] counter\_box;

wire [14:0] counter\_black;

wire enable\_load;

wire [3:0]time\_counter;

reg [7:0]last\_data\_received;

   // Create an Instance of a VGA controller - there can be only one!

   // Define the number of colours as well as the initial background

   // image file (.MIF) for the controller.

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                              Internal Modules                             \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Instance of VGA

   vga\_adapter VGA(

           .resetn(resetn),

           .clock(CLOCK\_50),

           .colour(colour),

           .x(x),

           .y(y),

           .plot(writeEn),

           /\* Signals for the DAC to drive the monitor. \*/

           .VGA\_R(VGA\_R),

           .VGA\_G(VGA\_G),

           .VGA\_B(VGA\_B),

           .VGA\_HS(VGA\_HS),

           .VGA\_VS(VGA\_VS),

           .VGA\_BLANK(VGA\_BLANK),

           .VGA\_SYNC(VGA\_SYNC),

           .VGA\_CLK(VGA\_CLK));

       defparam VGA.RESOLUTION = "160x120";

       defparam VGA.MONOCHROME = "FALSE";

       defparam VGA.BITS\_PER\_COLOUR\_CHANNEL = 1;

       defparam VGA.BACKGROUND\_IMAGE = "Background.mif";

//Instance of keyboard

PS2\_Controller KEYBOARD (

.CLOCK\_50(CLOCK\_50),

.reset(~resetn),

//.the\_command(),

//.send\_command(),

.PS2\_CLK(PS2\_CLK),

.PS2\_DAT(PS2\_DAT),

//.command\_was\_sent(),

//.error\_communication\_timed\_out,

.received\_data(received\_data),

.received\_data\_en(received\_data\_en)

);

// keyboard conversion

alph\_converter u0(alphabet, last\_data\_received);

   // Instanciate datapath

datapath u1 (x, y, colour, counter\_box, counter\_black, q0, d0, enable\_draw, writeEn, shift, clear, CLOCK\_50, clear\_alph, enable\_load);

   // Instanciate FSM control

controlpath u2(clear\_alph, LEDR, enable\_draw, enable\_load, shift, writeEn, clear, alphabet, received\_data\_en, q0, CLOCK\_50, SW[0], counter\_box, SW[1], SW[2], KEY[1], counter\_black, KEY[2], resetn, HEX2, HEX3, HEX4, HEX5);

time\_counter u3(time\_counter, CLOCK\_50);

seg7 u4 (HEX0, time\_counter);

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                             Sequential logic                              \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

always @(posedge CLOCK\_50)//clk

begin

if (received\_data\_en == 1'b1)

last\_data\_received <= received\_data;

//else

//last\_data\_received <= 7'b0;

end

endmodule

//datapath module

module datapath (x, y, colour, counter\_box, counter\_black, q0, d0, enable\_draw, writeEn, shift, clear, clk, clear\_alph, enable\_load);

input shift, writeEn, clear, clk, enable\_draw, clear\_alph;

input enable\_load;

output [4:0]counter\_box;

output [14:0] counter\_black;

output [5:0]q0;

output [5:0]d0;

output [2:0]colour;

output [7:0]x;

output [6:0]y;

reg [5:0] letter;

wire [4:0]counter\_box;

wire [4:0]counter\_box\_1;

reg [7:0]x\_start;

reg [6:0]y\_start;

wire [2:0] x\_cord, y\_cord;

wire [5:0]q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12, q13, q14, q15, q16, q17, q18, q19, q20, q21,

q22, q23, q24, q25, q26, q27, q28, q29;

parameter A = 6'b0, B = 6'b000001, C = 6'b000010, D = 6'b000011, E = 6'b000100, F = 6'b000101, G = 6'b000110,

H = 6'b000111, I = 6'b001000, J = 6'b001001, K = 6'b001010, L = 6'b001011, M = 6'b001100, N = 6'b001101,

O = 6'b001110, P = 6'b001111, Q = 6'b010000, R = 6'b010001, S = 6'b010010, T = 6'b010011, U = 6'b010100,

V = 6'b010101, W = 6'b010110, X = 6'b010111, Y = 6'b011000, Z = 6'b011001, SPACE = 6'b011010, PERIOD = 6'b011011;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                             Sequential logic                              \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

always @ (\*)

begin

if (counter\_box == 5'd0)

begin

letter = q0;

x\_start = 8'd9;

y\_start = 7'd80;

end

else if (counter\_box == 5'd1)

begin

letter = q1;

x\_start = 8'd15;

y\_start = 7'd80;

end

else if (counter\_box == 5'd2)

begin

letter = q2;

x\_start = 8'd21;

y\_start = 7'd80;

end

else if (counter\_box == 5'd3)

begin

letter = q3;

x\_start = 8'd27;

y\_start = 7'd80;

end

else if (counter\_box == 5'd4)

begin

letter = q4;

x\_start = 8'd33;

y\_start = 7'd80;

end

else if (counter\_box == 5'd5)

begin

letter = q5;

x\_start = 8'd39;

y\_start = 7'd80;

end

else if (counter\_box == 5'd6)

begin

letter = q6;

x\_start = 8'd45;

y\_start = 7'd80;

end

else if (counter\_box == 5'd7)

begin

letter = q7;

x\_start = 8'd51;

y\_start = 7'd80;

end

else if (counter\_box == 5'd8)

begin

letter = q8;

x\_start = 8'd57;

y\_start = 7'd80;

end

else if (counter\_box == 5'd9)

begin

letter = q9;

x\_start = 8'd63;

y\_start = 7'd80;

end

else if (counter\_box == 5'd10)

begin

letter = q10;

x\_start = 8'd69;

y\_start = 7'd80;

end

else if (counter\_box == 5'd11)

begin

letter = q11;

x\_start = 8'd75;

y\_start = 7'd80;

end

else if (counter\_box == 5'd12)

begin

letter = q12;

x\_start = 8'd81;

y\_start = 7'd80;

end

else if (counter\_box == 5'd13)

begin

letter = q13;

x\_start = 8'd87;

y\_start = 7'd80;

end

else if (counter\_box == 5'd14)

begin

letter = q14;

x\_start = 8'd93;

y\_start = 7'd80;

end

else if (counter\_box == 5'd15)

begin

letter = q15;

x\_start = 8'd99;

y\_start = 7'd80;

end

else if (counter\_box == 5'd16)

begin

letter = q16;

x\_start = 8'd105;

y\_start = 7'd80;

end

else if (counter\_box == 5'd17)

begin

letter = q17;

x\_start = 8'd111;

y\_start = 7'd80;

end

else if (counter\_box == 5'd18)

begin

letter = q18;

x\_start = 8'd117;

y\_start = 7'd80;

end

else if (counter\_box == 5'd19)

begin

letter = q19;

x\_start = 8'd123;

y\_start = 7'd80;

end

else if (counter\_box == 5'd20)

begin

letter = q20;

x\_start = 8'd129;

y\_start = 7'd80;

end

else if (counter\_box == 5'd21)

begin

letter = q21;

x\_start = 8'd135;

y\_start = 7'd80;

end

else if (counter\_box == 5'd22)

begin

letter = q22;

x\_start = 8'd141;

y\_start = 7'd80;

end

else if (counter\_box == 5'd23)

begin

letter = q23;

x\_start = 8'd147;

y\_start = 7'd80;

end

else

begin

letter = SPACE;

x\_start = 8'd0;

y\_start = 7'd0;

   end

end

shiftRegister u1(d0, q0, q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12, q13, q14, q15, q16, q17, q18, q19, q20, q21, q22, q23, q24, q25, q26, q27, q28, q29, clk, shift, enable\_load);

draw draw0 (x, y, colour, counter\_alphabet, counter\_box, counter\_black, letter, x\_start, y\_start, enable\_draw, clk, LEDR, clear\_alph, clear);//12

endmodule

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                         Finite State Machine(s)                           \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

module controlpath (clear\_alph, LEDR, enable\_draw, enable\_load, shift, writeEn, clear, alphabet, received\_data\_en, q0, clk, next, counter\_box, asd, asdf, hi, counter\_black, hello, reset, HEX2, HEX3, HEX4, HEX5);

input clk, next, reset, received\_data\_en, asd, asdf, hi, hello;

output [6:0] HEX2, HEX3, HEX4, HEX5;

input [5:0]alphabet;

input [5:0]q0;

input [4:0] counter\_box;

input [14:0] counter\_black;

output reg enable\_load;

output reg enable\_draw;

//output reg [5:0]Sel;

output reg shift, writeEn, clear, clear\_alph;

output reg [5:0]LEDR;

//output reg [4:0] counter\_box;

reg [5:0]PresentState, NextState;

parameter RESET\_S = 6'b000000, REG\_S = 6'b000001, FIRST\_S = 6'b000010, SECOND\_S = 6'b000011,

THIRD\_S = 6'b000100, FOURTH\_S = 6'b000101, FIFTH\_S = 6'b000110, SIXTH\_S = 6'b000111, SEVENTH\_S = 6'b001000,

EIGHTH\_S = 6'b001001, NINTH\_S = 6'b001010, TENTH\_S = 6'b001011, ELEVENTH\_S = 6'b001100, TWELTH\_S = 6'b001101,

THIRTEENTH\_S = 6'b001110, FOURTEENTH\_S = 6'b001111, FIFTEENTH\_S = 6'b010000, SIXTEENTH\_S = 6'b010001,

SEVENTEENTH\_S = 6'b010010, EIGHTEENTH\_S = 6'b010011, NINETEETH\_S = 6'b010100, TWENTIETH\_S = 6'b010101,

TWENTYFIRST\_S = 6'b010110, TWENTYSECOND\_S = 6'b010111, TWENTYTHIRD\_S = 6'b011000, TWENTYFOURTH\_S = 6'b011001,

CLEAR\_S = 6'b011010, SHIFT\_S = 6'b011011, WAIT\_S = 6'b011100;

seg7 u5 (HEX2, alphabet[3:0]);//hex2

seg7 u6 (HEX3, alphabet[5:4]);//hex3

seg7 u7 (HEX4, q0[3:0]);//hex2

seg7 u8 (HEX5, q0[5:4]);//hex3

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*                             Sequential logic                              \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

//state table

   always@(\*)

   begin: state\_table

       case(PresentState)

RESET\_S:

begin

NextState = REG\_S;

end

REG\_S:

begin

NextState = FIRST\_S;

end

FIRST\_S:

if(counter\_box == 5'd1)

NextState = SECOND\_S;

else

NextState = FIRST\_S;

SECOND\_S:

if(counter\_box == 5'd2)

NextState = THIRD\_S;

else

NextState = SECOND\_S;

THIRD\_S:

if(counter\_box == 5'd3)

NextState = FOURTH\_S;

else

NextState = THIRD\_S;

FOURTH\_S:

if(counter\_box == 5'd4)

NextState = FIFTH\_S;

else

NextState = FOURTH\_S;

FIFTH\_S:

if(counter\_box == 5'd5)

NextState = SIXTH\_S;

else

NextState = FIFTH\_S;

SIXTH\_S:

if(counter\_box == 5'd6)

NextState = SEVENTH\_S;

else

NextState = SIXTH\_S;

SEVENTH\_S:

if(counter\_box == 5'd7)

NextState = EIGHTH\_S;

else

NextState = SEVENTH\_S;

EIGHTH\_S:

if(counter\_box == 5'd8)

NextState = NINTH\_S;

else

NextState = EIGHTH\_S;

NINTH\_S:

if(counter\_box == 5'd9)

NextState = TENTH\_S;

else

NextState = NINTH\_S;

TENTH\_S:

if(counter\_box == 5'd10)

NextState = ELEVENTH\_S;

else

NextState = TENTH\_S;

ELEVENTH\_S:

if(counter\_box == 5'd11)

NextState = TWELTH\_S;

else

NextState = ELEVENTH\_S;

TWELTH\_S:

if(counter\_box == 5'd12)

NextState = THIRTEENTH\_S;

else

NextState = TWELTH\_S;

THIRTEENTH\_S:

if(counter\_box == 5'd13)

NextState = FOURTEENTH\_S;

else

NextState = THIRTEENTH\_S;

FOURTEENTH\_S:

if(counter\_box == 5'd14)

NextState = FIFTEENTH\_S;

else

NextState = FOURTEENTH\_S;

FIFTEENTH\_S:

if(counter\_box == 5'd15)

NextState = SIXTEENTH\_S;

else

NextState = FIFTEENTH\_S;

SIXTEENTH\_S:

if(counter\_box == 5'd16)

NextState =  SEVENTEENTH\_S;

else

NextState = SIXTEENTH\_S;

SEVENTEENTH\_S:

if(counter\_box == 5'd17)

NextState = EIGHTEENTH\_S;

else

NextState = SEVENTEENTH\_S;

EIGHTEENTH\_S:

if(counter\_box == 5'd18)

NextState = NINETEETH\_S;

else

NextState = EIGHTEENTH\_S;

NINETEETH\_S:

if(counter\_box == 5'd19)

NextState = TWENTIETH\_S;

else

NextState = NINETEETH\_S;

TWENTIETH\_S:

if(counter\_box == 5'd20)

NextState = TWENTYFIRST\_S;

else

NextState = TWENTIETH\_S;

TWENTYFIRST\_S:

if(counter\_box == 5'd21)

NextState = TWENTYSECOND\_S;

else

NextState = TWENTYFIRST\_S;

TWENTYSECOND\_S:

begin

if(counter\_box == 5'd22)

NextState = TWENTYTHIRD\_S;

else

NextState = TWENTYSECOND\_S;

end

TWENTYTHIRD\_S:

begin

if(counter\_box == 5'd23)

NextState = TWENTYFOURTH\_S;

else

NextState = TWENTYTHIRD\_S;

end

TWENTYFOURTH\_S:

begin

if(counter\_box == 5'd24)

NextState = WAIT\_S;

end

CLEAR\_S:

begin

if(counter\_black == 15'd720)

NextState = WAIT\_S;

else

NextState = CLEAR\_S;

end

SHIFT\_S:

begin

NextState = FIRST\_S;

end

WAIT\_S:

begin

if(alphabet == q0)

//if(hello == 1'b0)

NextState = SHIFT\_S;

else

NextState = WAIT\_S;

end

default: NextState = RESET\_S;

endcase

end // state\_table

//state registers

   always@(posedge clk)

   begin: state\_FFs

       if(reset == 1'b0)

           PresentState <= RESET\_S;

       else

           PresentState <= NextState;

   end //state\_FFs

//output logic

   always@(\*)

   begin: output\_logic

       case(PresentState)

RESET\_S:

begin

shift = 0;

writeEn = 1;

clear = 1;

clear\_alph = 1;

enable\_draw = 0;

enable\_load = 1;

LEDR = RESET\_S;

end

REG\_S:

begin

shift = 0;

writeEn = 0;

clear = 1;

clear\_alph = 1;

enable\_draw = 0;

enable\_load = 1;

LEDR = REG\_S;

end

FIRST\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = FIRST\_S;

end

SECOND\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = SECOND\_S;

end

THIRD\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = THIRD\_S;

end

FOURTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = FOURTH\_S;

end

FIFTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = FIFTH\_S;

end

SIXTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = SIXTH\_S;

end

SEVENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = SEVENTH\_S;

end

EIGHTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = EIGHTH\_S;

end

NINTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = NINTH\_S;

end

TENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TENTH\_S;

end

ELEVENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = ELEVENTH\_S;

end

TWELTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWELTH\_S;

end

THIRTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = THIRTEENTH\_S;

end

FOURTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = FOURTEENTH\_S;

end

FIFTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = FIFTEENTH\_S;

end

SIXTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = SIXTEENTH\_S;

end

SEVENTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = SEVENTEENTH\_S;

end

EIGHTEENTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = EIGHTEENTH\_S;

end

NINETEETH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = NINETEETH\_S;

end

TWENTIETH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWENTIETH\_S;

end

TWENTYFIRST\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWENTYFIRST\_S;

end

TWENTYSECOND\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWENTYSECOND\_S;

end

TWENTYTHIRD\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWENTYTHIRD\_S;

end

TWENTYFOURTH\_S:

begin

shift = 0;

writeEn = 1;

clear = 0;

clear\_alph = 0;

enable\_draw = 1;

enable\_load = 0;

LEDR = TWENTYFOURTH\_S;

end

CLEAR\_S:

begin

shift = 0;

writeEn = 1;

clear = 1;

clear\_alph = 1;

enable\_draw = 0;

enable\_load = 0;

LEDR = CLEAR\_S;

end

SHIFT\_S:

begin

shift = 1;

writeEn = 0;

clear = 0;

clear\_alph = 1;

enable\_draw = 0;

LEDR = SHIFT\_S;

enable\_load = 1;

end

WAIT\_S:

begin

shift = 0;

writeEn = 0;

clear = 1;

clear\_alph = 1;

enable\_draw = 0;

LEDR = WAIT\_S;

enable\_load = 0;

end

default:

begin

shift = 0;

writeEn = 0;

clear = 1;

enable\_draw = 0;

enable\_load = 0; //changed from 1 to 0

LEDR = 0;

end

 endcase

end

endmodule

module shiftRegister (d0, q0, q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12, q13, q14, q15, q16, q17, q18, q19, q20, q21,

q22, q23, q24, q25, q26, q27, q28, q29, clk, shift, enable\_load);

input clk, shift, enable\_load;

output [5:0] q0, q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12, q13, q14, q15, q16, q17, q18, q19, q20, q21,

q22, q23, q24, q25, q26, q27, q28, q29;

output [5:0]d0;

wire [5:0] d1, d2, d3, d4, d5, d6, d7, d8, d9, d10, d11, d12, d13, d14, d15, d16, d17, d18, d19, d20,

d21, d22, d23, d24, d25, d26, d27, d28, d29, d30, d31, d32, d33, d34, d35, d36, d37, d38, d39, d40, d41, d42, d43, d44, d45, d46, d47, d48, d49, d50, d51, d52, d53, d54, d55, d56, d57, d58, d59, d60, d61, d62, d63, d64, d65, d66,

   d67, d68, d69, d70, d71, d72, d73, d74, d75, d76, d77, d78, d79, d80, d81, d82, d83, d84, d85;

wire [5:0] q30, q31, q32, q33, q34, q35, q36, q37, q38, q39, q40, q41, q42, q43, q44, q45, q46, q47, q48, q49, q50,

q51, q52, q53, q54, q55, q56, q57, q58, q59, q60, q61, q62, q63, q64, q65, q66, q67, q68, q69, q70, q71, q72, q73, q74, q75, q76, q77, q78, q79, q80, q81, q82, q83, q84, q85;

parameter A = 6'b0, B = 6'b000001, C = 6'b000010, D = 6'b000011, E = 6'b000100, F = 6'b000101, G = 6'b000110,

H = 6'b000111, I = 6'b001000, J = 6'b001001, K = 6'b001010, L = 6'b001011, M = 6'b001100, N = 6'b001101,

O = 6'b001110, P = 6'b001111, Q = 6'b010000, R = 6'b010001, S = 6'b010010, T = 6'b010011, U = 6'b010100,

V = 6'b010101, W = 6'b010110, X = 6'b010111, Y = 6'b011000, Z = 6'b011001, SPACE = 6'b011010, PERIOD = 6'b011011;

  mux2to1 m85 (d85, PERIOD, SPACE, shift);

  D\_FF dff85 (q85, clk, enable\_load, d85);

mux2to1 m84 (d84, T, q85, shift);

  D\_FF dff84 (q84, clk, enable\_load, d84);

mux2to1 m83 (d83, I, q84, shift);

  D\_FF dff83 (q83, clk, enable\_load, d83);

mux2to1 m82 (d82, SPACE, q83, shift);

  D\_FF dff82 (q82, clk, enable\_load, d82);

mux2to1 m81 (d81, O, q82, shift);

  D\_FF dff81 (q81, clk, enable\_load, d81);

mux2to1 m80 (d80, D, q81, shift);

  D\_FF dff80 (q80, clk, enable\_load, d80);

mux2to1 m79 (d79, SPACE, q80, shift);

  D\_FF dff79 (q79, clk, enable\_load, d79);

mux2to1 m78 (d78, T, q79, shift);

  D\_FF dff78 (q78, clk, enable\_load, d78);

mux2to1 m77 (d77, S, q78, shift);

  D\_FF dff77 (q77, clk, enable\_load, d77);

mux2to1 m76 (d76, U, q77, shift);

  D\_FF dff76 (q76, clk, enable\_load, d76);

mux2to1 m75 (d75, J, q76, shift);

  D\_FF dff75 (q75, clk, enable\_load, d75);

mux2to1 m74 (d74, PERIOD, q75, shift);

  D\_FF dff74 (q74, clk, enable\_load, d74);

mux2to1 m73 (d73, S, q74, shift);

  D\_FF dff73 (q73, clk, enable\_load, d73);

mux2to1 m72 (d72, M, q73, shift);

  D\_FF dff72 (q72, clk, enable\_load, d72);

mux2to1 m71 (d71, A, q72, shift);

  D\_FF dff71 (q71, clk, enable\_load, d71);

mux2to1 m70 (d70, E, q71, shift);

  D\_FF dff70 (q70, clk, enable\_load, d70);

mux2to1 m69 (d69, R, q70, shift);

  D\_FF dff69 (q69, clk, enable\_load, d69);

mux2to1 m68 (d68, D, q69, shift);

  D\_FF dff68 (q68, clk, enable\_load, d68);

mux2to1 m67 (d67, SPACE, q68, shift);

  D\_FF dff67 (q67, clk, enable\_load, d67);

mux2to1 m66 (d66, E, q67, shift);

  D\_FF dff66 (q66, clk, enable\_load, d66);

mux2to1 m65 (d65, B, q66, shift);

  D\_FF dff65 (q65, clk, enable\_load, d65);

mux2to1 m64 (d64, SPACE, q65, shift);

  D\_FF dff64 (q64, clk, enable\_load, d64);

mux2to1 m63 (d63, S, q64, shift);

  D\_FF dff63 (q63, clk, enable\_load, d63);

mux2to1 m62 (d62, M, q63, shift);

  D\_FF dff62 (q62, clk, enable\_load, d62);

mux2to1 m61 (d61, A, q62, shift);

  D\_FF dff61 (q61, clk, enable\_load, d61);

mux2to1 m60 (d60, E, q61, shift);

  D\_FF dff60 (q60, clk, enable\_load, d60);

mux2to1 m59 (d59, R, q60, shift);

  D\_FF dff59 (q59, clk, enable\_load, d59);

mux2to1 m58 (d58, D, q59, shift);

  D\_FF dff58 (q58, clk, enable\_load, d58);

mux2to1 m57 (d57, SPACE, q58, shift);

  D\_FF dff57 (q57, clk, enable\_load, d57);

mux2to1 m56 (d56, R, q57, shift);

  D\_FF dff56 (q56, clk, enable\_load, d56);

mux2to1 m55 (d55, U, q56, shift);

  D\_FF dff55 (q55, clk, enable\_load, d55);

mux2to1 m54 (d54, O, q55, shift);

  D\_FF dff54 (q54, clk, enable\_load, d54);

mux2to1 m53 (d53, Y, q54, shift);

  D\_FF dff53 (q53, clk, enable\_load, d53);

mux2to1 m52 (d52, SPACE, q53, shift);

  D\_FF dff52 (q52, clk, enable\_load, d52);

mux2to1 m51 (d51, T, q52, shift);

  D\_FF dff51 (q51, clk, enable\_load, d51);

mux2to1 m50 (d50, E, q51, shift);

  D\_FF dff50 (q50, clk, enable\_load, d50);

mux2to1 m49 (d49, L, q50, shift);

  D\_FF dff49 (q49, clk, enable\_load, d49);

mux2to1 m48 (d48, SPACE, q49, shift);

  D\_FF dff48 (q48, clk, enable\_load, d48);

mux2to1 m47 (d47, T, q48, shift);

  D\_FF dff47 (q47, clk, enable\_load, d47);

mux2to1 m46 (d46, N, q47, shift);

  D\_FF dff46 (q46, clk, enable\_load, d46);

mux2to1 m45 (d45, O, q46, shift);

  D\_FF dff45 (q45, clk, enable\_load, d45);

mux2to1 m44 (d44, D, q45, shift);

  D\_FF dff44 (q44, clk, enable\_load, d44);

mux2to1 m43 (d43, PERIOD, q44, shift); // input empty space for y

D\_FF dff43 (q43, clk, enable\_load, d43);

mux2to1 m42 (d42, G, q43, shift);

D\_FF dff42 (q42, clk, enable\_load, d42);

mux2to1 m41 (d41, O, q42, shift);

D\_FF dff41 (q41, clk, enable\_load, d41);

mux2to1 m40 (d40, D, q41, shift);

D\_FF dff40 (q40, clk, enable\_load, d40);

mux2to1 m39 (d39, SPACE, q40, shift);

D\_FF dff39 (q39, clk, enable\_load, d39);

mux2to1 m38 (d38, Y, q39, shift);

D\_FF dff38 (q38, clk, enable\_load, d38);

mux2to1 m37 (d37, Z, q38, shift);

D\_FF dff37 (q37, clk, enable\_load, d37);

mux2to1 m36 (d36, A, q37, shift);

D\_FF dff36 (q36, clk, enable\_load, d36);

mux2to1 m35 (d35, L, q36, shift);

D\_FF dff35 (q35, clk, enable\_load, d35);

mux2to1 m34 (d34, SPACE, q35, shift);

D\_FF dff34 (q34, clk, enable\_load, d34);

mux2to1 m33 (d33, E, q34, shift);

D\_FF dff33 (q33, clk, enable\_load, d33);

mux2to1 m32 (d32, H, q33, shift);

D\_FF dff32 (q32, clk, enable\_load, d32);

mux2to1 m31 (d31, T, q32, shift);

D\_FF dff31 (q31, clk, enable\_load, d31);

mux2to1 m30 (d30, SPACE, q31, shift);

D\_FF dff30 (q30, clk, enable\_load, d30);

mux2to1 m29 (d29, R, q30, shift);

D\_FF dff29 (q29, clk, enable\_load, d29);

mux2to1 m28 (d28, E, q29, shift);

D\_FF dff28 (q28, clk, enable\_load, d28);

mux2to1 m27 (d27, V, q28, shift);

D\_FF dff27 (q27, clk, enable\_load, d27);

mux2to1 m26 (d26, O, q27, shift);

D\_FF dff26 (q26, clk, enable\_load, d26);

mux2to1 m25 (d25, SPACE, q26, shift);

D\_FF dff25 (q25, clk, enable\_load, d25);

mux2to1 m24 (d24, S, q25, shift);

D\_FF dff24 (q24, clk, enable\_load, d24);

mux2to1 m23 (d23, P, q24, shift);

D\_FF dff23 (q23, clk, enable\_load, d23);

mux2to1 m22 (d22, M, q23, shift);

D\_FF dff22 (q22, clk, enable\_load, d22);

mux2to1 m21 (d21, U, q22, shift);

D\_FF dff21 (q21, clk, enable\_load, d21);

mux2to1 m20 (d20, J, q21, shift);

D\_FF dff20 (q20, clk, enable\_load, d20);

mux2to1 m19 (d19, SPACE, q20, shift);

D\_FF dff19 (q19, clk, enable\_load, d19);

mux2to1 m18 (d18, X, q19, shift);

D\_FF dff18 (q18, clk, enable\_load, d18);

mux2to1 m17 (d17, O, q18, shift);

D\_FF dff17 (q17, clk, enable\_load, d17);

mux2to1 m16 (d16, F, q17, shift);

D\_FF dff16 (q16, clk, enable\_load, d16);

mux2to1 m15 (d15, SPACE, q16, shift);

D\_FF dff15 (q15, clk, enable\_load, d15);

mux2to1 m14 (d14, N, q15, shift);

D\_FF dff14 (q14, clk, enable\_load, d14);

mux2to1 m13 (d13, W, q14, shift);

D\_FF dff13 (q13, clk, enable\_load, d13);

mux2to1 m12 (d12, O, q13, shift);

D\_FF dff12 (q12, clk, enable\_load, d12);

mux2to1 m11 (d11, R, q12, shift);

D\_FF dff11 (q11, clk, enable\_load, d11);

mux2to1 m10 (d10, B, q11, shift);

D\_FF dff10 (q10, clk, enable\_load, d10);

mux2to1 m9 (d9, SPACE, q10, shift);

D\_FF dff9 (q9, clk, enable\_load, d9);

mux2to1 m8 (d8, K, q9, shift);

D\_FF dff8 (q8, clk, enable\_load, d8);

mux2to1 m7 (d7, C, q8, shift);

D\_FF dff7 (q7, clk, enable\_load, d7);

mux2to1 m6 (d6, I, q7, shift);

D\_FF dff6 (q6, clk, enable\_load, d6);

mux2to1 m5 (d5, U, q6, shift);

D\_FF dff5 (q5, clk, enable\_load, d5);

mux2to1 m4 (d4, Q, q5, shift);

D\_FF dff4 (q4, clk, enable\_load, d4);

mux2to1 m3 (d3, SPACE, q4, shift);

D\_FF dff3 (q3, clk, enable\_load, d3);

mux2to1 m2 (d2, E, q3, shift);

D\_FF dff2 (q2, clk, enable\_load, d2);

mux2to1 m1 (d1, H, q2, shift);

D\_FF dff1 (q1, clk, enable\_load, d1);

mux2to1 m0 (d0, T, q1, shift);

D\_FF dff0 (q0, clk, enable\_load, d0);

endmodule

module mux2to1(z, x, y, s);

input [5:0]x, y;

input s;

output [5:0]z;

assign z = s? y : x;

endmodule

module D\_FF (q, clk, enable, d);

   input clk, enable;

   input [5:0]d;

   output reg [5:0]q;

   always @ (posedge clk)

   begin

       if(enable)

           q <= d;

   end

endmodule

module upcount\_box (clear, counter\_alphabet, Clock, Q);

input Clock, clear;

input [4:0] counter\_alphabet;

  output reg [4:0] Q;

  always @(posedge Clock)

if(clear)

Q <= 1'b0;

else if(counter\_alphabet == 5'd28)

Q <= Q + 1'b1;

endmodule

module upcount\_alphabet (clear, enable, Clock, Q);

input clear, Clock, enable;

output reg [4:0] Q;

always @(posedge Clock)

if (clear)

Q <= 0;

else if (Q == 5'd29)

begin

Q <= 5'b0;

end

     else if (enable)

Q <= Q + 1'b1;

endmodule

module upcount\_X (clear, enable, Clock, counter\_alphabet, y\_cord, enable\_y, Q);

   input clear, enable, Clock;

input [4:0]counter\_alphabet;

input [2:0]y\_cord;

output reg enable\_y;

   output reg [2:0] Q;

   always @(posedge Clock)

begin

if (clear || counter\_alphabet == 5'd29)

begin

Q <= 3'd0;

enable\_y = 1'b0;

end

else if(Q == 3'd5)

begin

Q <= 3'b0;

enable\_y <= 1'b0;

end

else if (Q == 3'd4)

begin

Q <= Q + 1'b1;

enable\_y = 1'b1;

end

else if (enable)

begin

enable\_y <= 0;

Q <= Q + 1'b1;

end

end

endmodule

module upcount\_Y (clear, enable, Clock, counter\_alphabet, Q);

input Clock, enable, clear;

input [4:0]counter\_alphabet;

output reg [2:0] Q;

always @(posedge Clock)

if (clear || counter\_alphabet == 5'd29)

Q <= 1'b0;

else if (Q == 3'd5)

Q <= 3'd0;

     else if (enable)

Q <= Q + 1'b1;

endmodule

module upcount\_black\_X (clear, enable, Clock, enable\_y, Q);

   input clear, Clock, enable;

output reg enable\_y;

output reg [7:0] Q;

   always @(posedge Clock)

       if (~clear)

begin

           Q <= 1'b0;

enable\_y <= 1'b0;

end

else if (Q == 15'd142)

begin

Q <= 3'b0;

enable\_y <= 1'b0;

end

else if (Q == 15'd141)

begin

Q <= Q + 1'b1;

enable\_y <= 1'b1;

end

     else if (enable)

begin

           Q <= Q +1;

enable\_y <= 1'b0;

end

endmodule

module upcountblack\_Y (clear, enable, Clock, Q);

input Clock, enable, clear;

output reg [2:0] Q;

always @(posedge Clock)

if (~clear)

Q <= 1'b0;

else if (Q == 3'd5)

Q = 3'd0;

     else if (enable)

Q = Q + 1'b1;

endmodule

module upcount\_black (Clock, enable, Q);

input Clock, enable;

output reg [14:0] Q;

always @(posedge Clock)

if (Q == 14'd720)

Q <= 0;

     else if (enable)

Q <= Q + 1'b1;

endmodule

module draw (x\_out, y\_out, colour, counter\_alphabet, counter\_box, counter\_black, letter, x\_start, y\_start, enable\_draw, clk, LEDR, clear\_alph, clear);

input enable\_draw, clk;

input [5:0]letter;

input [7:0]x\_start;

input [6:0]y\_start;

input clear\_alph;

input clear;

output reg [7:0] x\_out;

output reg [6:0] y\_out;

output [4:0] counter\_alphabet;

output [4:0] counter\_box;

//output [4:0] counter\_box;

output reg [2:0] colour;

output [9:0] LEDR;

reg [9:0] memory;

//assign writeEn = 1'b1;

wire [2:0] x\_cord;

wire [2:0] y\_cord;

wire enable\_y;

wire [4:0]counter\_box\_1;

wire [7:0] counter\_black\_X;

wire[6:0]counter\_black\_Y;

wire [2:0]colour\_1;

output [14:0]counter\_black;

parameter A = 6'b0, B = 6'b000001, C = 6'b000010, D = 6'b000011, E = 6'b000100, F = 6'b000101, G = 6'b000110,

H = 6'b000111, I = 6'b001000, J = 6'b001001, K = 6'b001010, L = 6'b001011, M = 6'b001100, N = 6'b001101,

O = 6'b001110, P = 6'b001111, Q = 6'b010000, R = 6'b010001, S = 6'b010010, T = 6'b010011, U = 6'b010100,

V = 6'b010101, W = 6'b010110, X = 6'b010111, Y = 6'b011000, Z = 6'b011001, SPACE = 6'b011010, PERIOD = 6'b011011;

upcount\_X u0(clear\_alph, enable\_draw, clk, counter\_alphabet, y\_cord, enable\_y, x\_cord); //X coordinate to draw

upcount\_Y u1(clear\_alph, enable\_y, clk, counter\_alphabet, y\_cord); //Y coordinate to draw

//upXYcounter(enable\_draw, clear\_alph, clk, x\_cord, y\_cord);

//seg7 q0 (HEX0, {4'b0, x\_cord});

seg7 q1 (HEX1, {4'b0, y\_cord});

seg7 q2 (HEX2, {3'b0, counter\_alphabet[3:0]});

seg7 q3 (HEX3, {6'b0, counter\_alphabet[4]});

upcount\_black\_X upbx(clear, clear, clk, counter\_y\_en, counter\_black\_X);

upcountblack\_Y upy(clear, counter\_y\_en, clk, counter\_black\_Y);

upcount\_black upb(clk, clear, counter\_black);

always@(\*)

begin

if(clear)

begin

x\_out = 8'd9 + counter\_black\_X;

y\_out = 7'd80 + counter\_black\_Y;

//colour = 3'b000;

end

else

begin

x\_out = x\_start + {5'b0, x\_cord};

y\_out = y\_start + {4'b0, y\_cord};

end

end

upcount\_box upbox (clear, counter\_alphabet, clk, counter\_box);

//D\_FF upboxdelay (counter\_box, clk, clear, counter\_box\_1); // probably do not need this

//upcount u4(clear\_alph, enable\_draw, clk, x\_cord, y\_cord, counter\_alphabet);

upcount\_alphabet u2(clear\_alph, enable\_draw, clk, counter\_alphabet);

always@(\*)

begin

if(clear)

colour = 3'b000;

else

colour = colour\_1;

end

rom840x3 u3 (memory, clk, colour\_1);

seg7 u9 (HEX4, {3'b0, counter\_alphabet});

seg7 u10 (HEX5, {3'b0, counter\_box});

always@(\*)

begin

case(letter)

A:

begin

memory = {5'b0, counter\_alphabet} + 10'd1;

end

B:

begin

memory = {5'b0, counter\_alphabet} + 10'd31;

end

C:

begin

memory = {5'b0, counter\_alphabet} + 10'd61;

end

D:

begin

memory = {5'b0, counter\_alphabet} + 10'd91;

end

E:

begin

memory = {5'b0, counter\_alphabet} + 10'd121;

end

F:

begin

memory = {5'b0, counter\_alphabet} + 10'd151;

end

G:

begin

memory = {5'b0, counter\_alphabet} + 10'd181;

end

H:

begin

memory = {5'b0, counter\_alphabet} + 10'd211;

end

I:

begin

memory = {5'b0, counter\_alphabet} + 10'd241;

end

J:

begin

memory = {5'b0, counter\_alphabet} + 10'd271;

end

K:

begin

memory = {5'b0, counter\_alphabet} + 10'd301;

end

L:

begin

memory = {5'b0, counter\_alphabet} + 10'd331;

end

M:

begin

memory = {5'b0, counter\_alphabet} + 10'd361;

end

N:

begin

memory = {5'b0, counter\_alphabet} + 10'd391;

end

O:

begin

memory = {5'b0, counter\_alphabet} + 10'd421;

end

P:

begin

memory = {5'b0, counter\_alphabet} + 10'd451;

end

Q:

begin

memory = {5'b0, counter\_alphabet} + 10'd481;

end

R:

begin

memory = {5'b0, counter\_alphabet} + 10'd511;

end

S:

begin

memory = {5'b0, counter\_alphabet} + 10'd541;

end

T:

begin

memory = {5'b0, counter\_alphabet} + 10'd571;

end

U:

begin

memory = {5'b0, counter\_alphabet} + 10'd601;

end

V:

begin

memory = {5'b0, counter\_alphabet} + 10'd631;

end

W:

begin

memory = {5'b0, counter\_alphabet} + 10'd661;

end

X:

begin

memory = {5'b0, counter\_alphabet} + 10'd691;

end

Y:

begin

memory = {5'b0, counter\_alphabet} + 10'd721;

end

Z:

begin

memory = {5'b0, counter\_alphabet} + 10'd751;

end

SPACE:

begin

memory = {5'b0, counter\_alphabet} + 10'd781;

end

PERIOD:

begin

memory = {5'b0, counter\_alphabet} + 10'd811;

end

default: memory = {5'b0, counter\_alphabet} + 10'd781;

endcase

end

endmodule

module alph\_converter(alphabet, received\_data);

   input [7:0]received\_data;

   output reg [5:0]alphabet;

   parameter A = 6'b0, B = 6'b000001, C = 6'b000010, D = 6'b000011, E = 6'b000100, F = 6'b000101, G = 6'b000110,

   H = 6'b000111, I = 6'b001000, J = 6'b001001, K = 6'b001010, L = 6'b001011, M = 6'b001100, N = 6'b001101,

   O = 6'b001110, P = 6'b001111, Q = 6'b010000, R = 6'b010001, S = 6'b010010, T = 6'b010011, U = 6'b010100,

   V = 6'b010101, W = 6'b010110, X = 6'b010111, Y = 6'b011000, Z = 6'b011001, SPACE = 6'b011010, PERIOD = 6'b011011;

   always@(\*)

   begin

       if(received\_data == 8'h1C)

           alphabet = A;

       else if (received\_data == 8'h32)

           alphabet = B;

       else if (received\_data == 8'h21)

           alphabet = C;

       else if (received\_data == 8'h23)

           alphabet = D;

       else if (received\_data == 8'h24)

           alphabet = E;

       else if (received\_data == 8'h2B)

           alphabet = F;

       else if (received\_data == 8'h34)

           alphabet = G;

       else if (received\_data == 8'h33)

           alphabet = H;

       else if (received\_data == 8'h43)

           alphabet = I;

       else if (received\_data == 8'h3B)

           alphabet = J;

       else if (received\_data == 8'h42)

           alphabet = K;

       else if (received\_data == 8'h4B)

           alphabet = L;

       else if (received\_data == 8'h3A)

           alphabet = M;

       else if (received\_data == 8'h31)

           alphabet = N;

       else if (received\_data == 8'h44)

           alphabet = O;

       else if (received\_data == 8'h4D)

           alphabet = P;

       else if (received\_data == 8'h15)

           alphabet = Q;

       else if (received\_data == 8'h2D)

           alphabet = R;

       else if (received\_data == 8'h1B)

           alphabet = S;

       else if (received\_data == 8'h2C)

           alphabet = T;

       else if (received\_data == 8'h3C)

           alphabet = U;

       else if (received\_data == 8'h2A)

           alphabet = V;

       else if (received\_data == 8'h1D)

           alphabet = W;

       else if (received\_data == 8'h22)

           alphabet = X;

       else if (received\_data == 8'h35)

           alphabet = Y;

       else if (received\_data == 8'h1A)

           alphabet = Z;

       else if (received\_data == 8'h29)

           alphabet = SPACE;

       else if (received\_data == 8'h49)

           alphabet = PERIOD;

else

alphabet = X;

   end

endmodule

module seg7 (HEX0, SW);

input [7:0] SW;

output reg [6:0] HEX0;

always@(\*)

begin

case(SW)

0: HEX0 = 7'b1000000;

1: HEX0 = 7'b1111001;

2: HEX0 = 7'b0100100;

3: HEX0 = 7'b0110000;

4: HEX0 = 7'b0011001;

5: HEX0 = 7'b0010010;

6: HEX0 = 7'b0000010;

7: HEX0 = 7'b1111000;

8: HEX0 = 7'b0;

9: HEX0 = 7'b0010000;

10: HEX0 = 7'b0001000;

11: HEX0 = 7'b0000011;

12: HEX0 = 7'b1000110;

13: HEX0 = 7'b0100001;

14: HEX0 = 7'b0000110;

15: HEX0 = 7'b0001110;

default: HEX0 = 7'bx;

endcase

end

endmodule

module time\_counter (counter, clk);

   reg [26:0]out;

   input clk;

   output reg [3:0]counter;

   always@(posedge clk)

begin

if(out == 27'd49999999)

begin

out <= 1'b0;

counter <= counter + 1'b1;

end

else

out <= out + 1'b1;

     end

endmodule

