

EE/CS120A Logic Design
Department of Electrical Engineering
University of California – Riverside

Laboratory #2
EE/CS 120 A
Fall 2024

LABORATORY # 2

Combinatorial Logic Using EDA Playground

Objectives

Lab 2 contains a group design of a programming combinatorial logic for a BCD to 7 Segment LED Display. Its purposes are to get familiar with:

1. Synthesis and Implementation of combinatorial logic applications using EDA Playground.
2. Study the 7-segment LED display and LED decoder.
3. Build a basic project with behavior design, which uses switches to control the LED display.
4. Write a testbench to test your design.
5. Analyze the simulation results.

Equipment

- PC or compatible

Software

- EDA Playground

Parts

N/A

Introduction

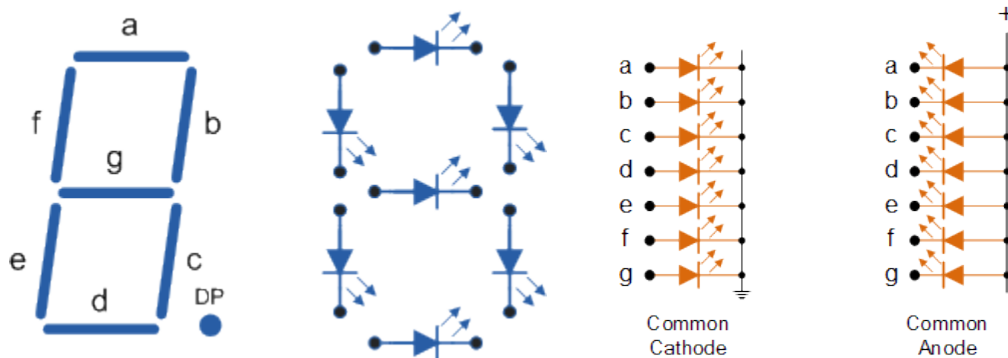


Figure1: (Left) Display image of a 7-segment LED design. (Right) Image of the common cathode and common anode configurations.

Please read and learn the 7-segment LED display from this link:

https://www.electronics-tutorials.ws/combinational/comb_6.html

Briefly speaking, the 7-segments display consists of 7 independent LEDs (If you count the DP in, that will be 8 independent LEDs). You can control the combination in display numbers through 0-9.

In our lab, the 7-segment LEDs are common Anode, which means $a=0$ is light on, $a=1$ is light off. If you want to display number “1”, the combination should be $abcdefg = 4'b1001111$, only segment b and segment c are light on.

BCD to 7 Segment LED Display

Specification

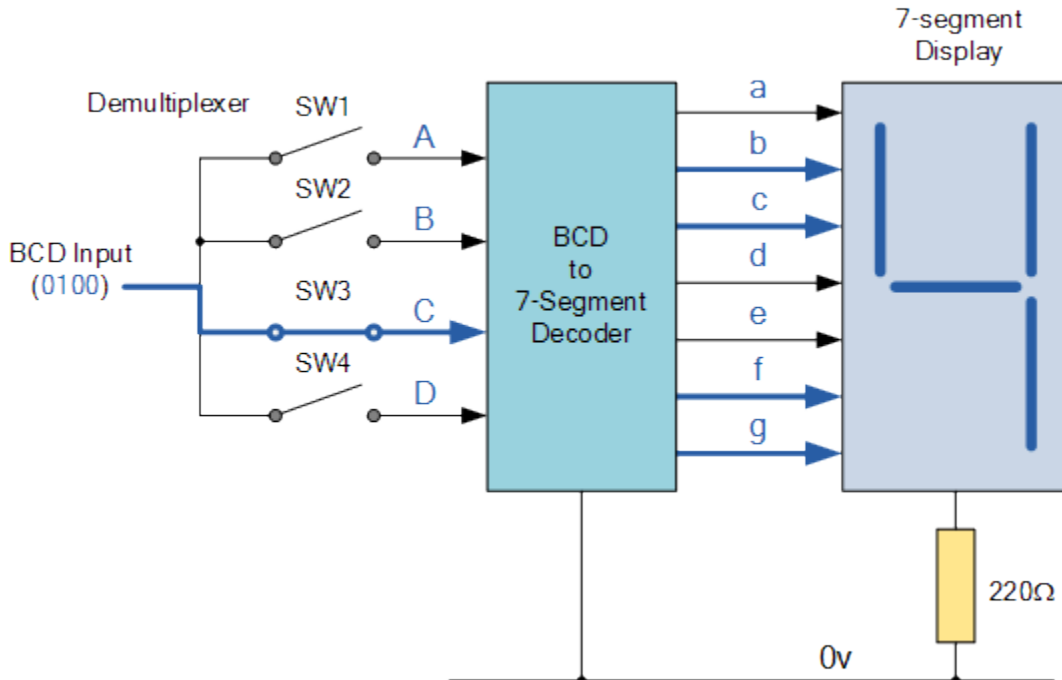


Figure 2: An example of the 4-bit BCD input (0100) representing the number “4”.

You are required to implement the structural (slow to code) **or** behavioral (faster to code) description of the BCD-to-7seg decoder described above. The module you are about to implement should have the set of input and output ports given in listing 3. In here, we have provided a basic template that can be used as a starting point for the behavioral description, and please complete the missing code.

Note, the 7-seg display is active low (0 = on, 1 = off)

Behavioral Model

```
`timescale 1ns / 1ps
module bcd_to_7led_bh (
  input wire sw0 , // Switches
```

```

input wire sw1 ,
input wire sw2 ,
input wire sw3 ,
output reg a , // LED segments
output reg b ,
output reg c ,
output reg d ,
output reg e ,
output reg f ,
output reg g
);

// Internal wire
wire [3:0] bundle ;
assign bundle = {sw3,sw2,sw1,sw0 } ;

always @(*) begin

    // Setting the segments signals (Initialize all to off/1)
    a = 1'b1 ;
    b = 1'b1 ;
    c = 1'b1 ;
    d = 1'b1 ;
    e = 1'b1 ;
    f = 1'b1 ;
    g = 1'b1 ;

    case ( bundle )

        4'b0000 : begin // 0
            a = 1'b0 ;
            b = 1'b0 ;
            c = 1'b0 ;
            d = 1'b0 ;
            e = 1'b0 ;
            f = 1'b0 ;
            g = 1'b1 ;    //(Don't need to explicitly state that g is off here since
                        // it is initialized to off already, but it doesn't hurt)
        end
        // Your code goes here for the other 8 numbers (1-9)

    endcase
end

```

```
endmodule
```

Listing 1. BCD-to-7seg decoder behavioral model

Test bench

```
`timescale 1ns / 1ps

// http://www.electronics-tutorials.ws/combinational/comb_6.html

module bcdtoled_tb;

    // Inputs
    reg sw0;
    reg sw1;
    reg sw2;
    reg sw3;

    // Outputs
    wire a;
    wire b;
    wire c;
    wire d;
    wire e;
    wire f;
    wire g;

    // Instantiate the Unit Under Test (UUT)
    // bcdto7led_st uut (
    bcd_to_7led_bh uut (
        .sw0(sw0),
        .sw1(sw1),
        .sw2(sw2),
        .sw3(sw3),
        .a(a),
        .b(b),
        .c(c),
        .d(d),
        .e(e),
        .f(f),
```

```

        .g(g)
    );

    initial begin

        $dumpfile("dump.vcd"); $dumpvars;

        // Initialize Inputs
        sw3 = 0;      sw2 = 0;      sw1 = 0;      sw0 = 0;
        #100;
        $display("TC10 ");
        if ( {a,b,c,d,e,f,g} != 7'b00000001 ) $display ("Result is wrong %b
", {a,b,c,d,e,f,g});

        // Your test cases go here (9 left)

    end
endmodule

```

Listing 2. Testbench for BCD-to-7seg decoder behavioral model

Demonstration

Provide the truth tables, circuit schematic and functionality of the design.

Presentation and Report

Must be presented according to the general EE/CS120A lab guidelines posted on iLearn.

Prelab

1. Familiarize yourself with the Lab3 manual posted on iLearn.
2. Review Lectures.
3. Try to answer all the questions, prepare logic truth tables, do all necessary computations.