

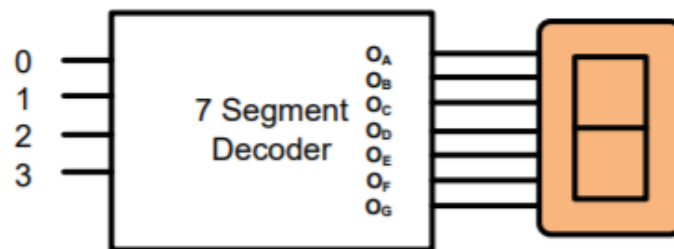
## Seven-Segment Display

### Objective

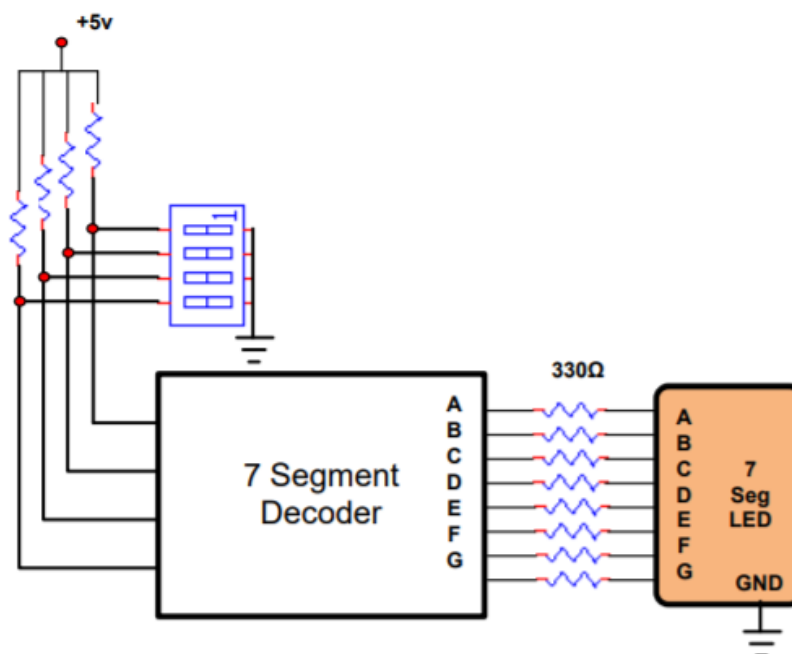
The objective of this project is to experiment the design and implementation of a combinational circuit using Verilog.

### Project Description

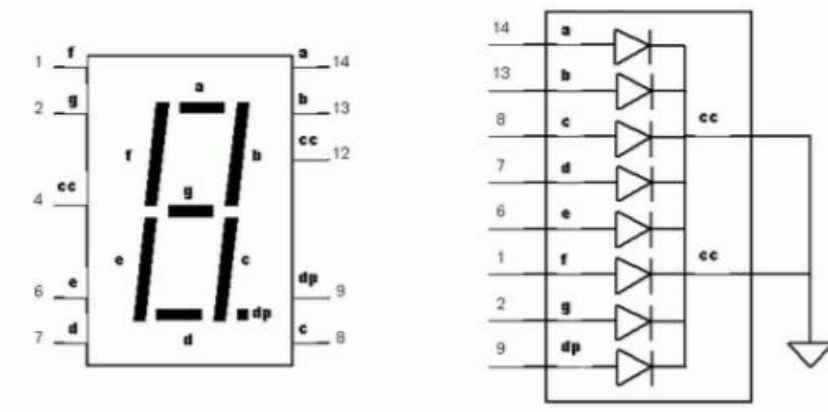
Alarm clocks and old-time calculator used seven-segment LED displays to display digits and sometimes letters. For this project, you will design a combinational logic circuit using Verilog which will accept a four-bit binary number as input and display the decimal value up to 9, and the letter “H” if the decimal value exceeds 9. In other words, the first ten permutations, 0000 – 1001 should be interpreted as decimal digits and the remaining permutations 1011-1111 should correspond to “H”, indicating Hexadecimal. You are to design the combinational circuit of the 7-Segment decoder. Your design should have seven outputs – one for each segment of a display digit as follows.



The designed logic can be verified using the following setup.



You should have MAN74 7-segment display in your box. The embedded LEDs in the MAN74 are designed to operate at 20 mA. Therefore, choose any resistor values between 250  $\Omega$  and 1K $\Omega$  to limit current through the LED. Connect the "CC" terminals (Common Cathode) on the MAN74 to ground. "DP" is the decimal point, which we do not need.



In order to unify the display of all decimal digits, the following figure shows what LED's need to turn on for each digit. Please note that '1' is displayed with the right-most LED's, and the '9' needs to have bottom LED turned on for its base. The output of your testbench should be similar to the following table:

Decimal Digit	Input lines				Output lines							Display pattern
	A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	1	0	1	1	0	0	0	0	1
2	0	0	1	0	1	1	0	1	1	0	1	2
3	0	0	1	1	1	1	1	1	0	0	1	3
4	0	1	0	0	0	1	1	0	0	1	1	4
5	0	1	0	1	1	0	1	1	0	1	1	5
6	0	1	1	0	1	0	1	1	1	1	1	6
7	0	1	1	1	1	1	1	0	0	0	0	7
8	1	0	0	0	1	1	1	1	1	1	1	8
9	1	0	0	1	1	1	1	1	0	1	1	9

## **Data Sheets**

- The data sheet for 7-seg LED can be found here:  
<http://pdf1.alldatasheet.com/datasheetpdf/view/89363/ETC/TOS5121.html>. For the MAN074, the datasheet can found on  
[http://www.eng.auburn.edu/~niuguof/2210lab/data%20sheets/MAN74A\\_7seg\\_display.pdf](http://www.eng.auburn.edu/~niuguof/2210lab/data%20sheets/MAN74A_7seg_display.pdf)
- The difference between Anode and Cathode based LEDs will be explained in the lab discussion.

## **To Do**

- The designed logic should have minimum number of gates, try to simplify so that it will help you implement the design using Verilog.
- The design should be verified using a test bench covering all the test cases.
- The Verilog should be designed in 'structural model', using only 2-, 3- and 4-input.