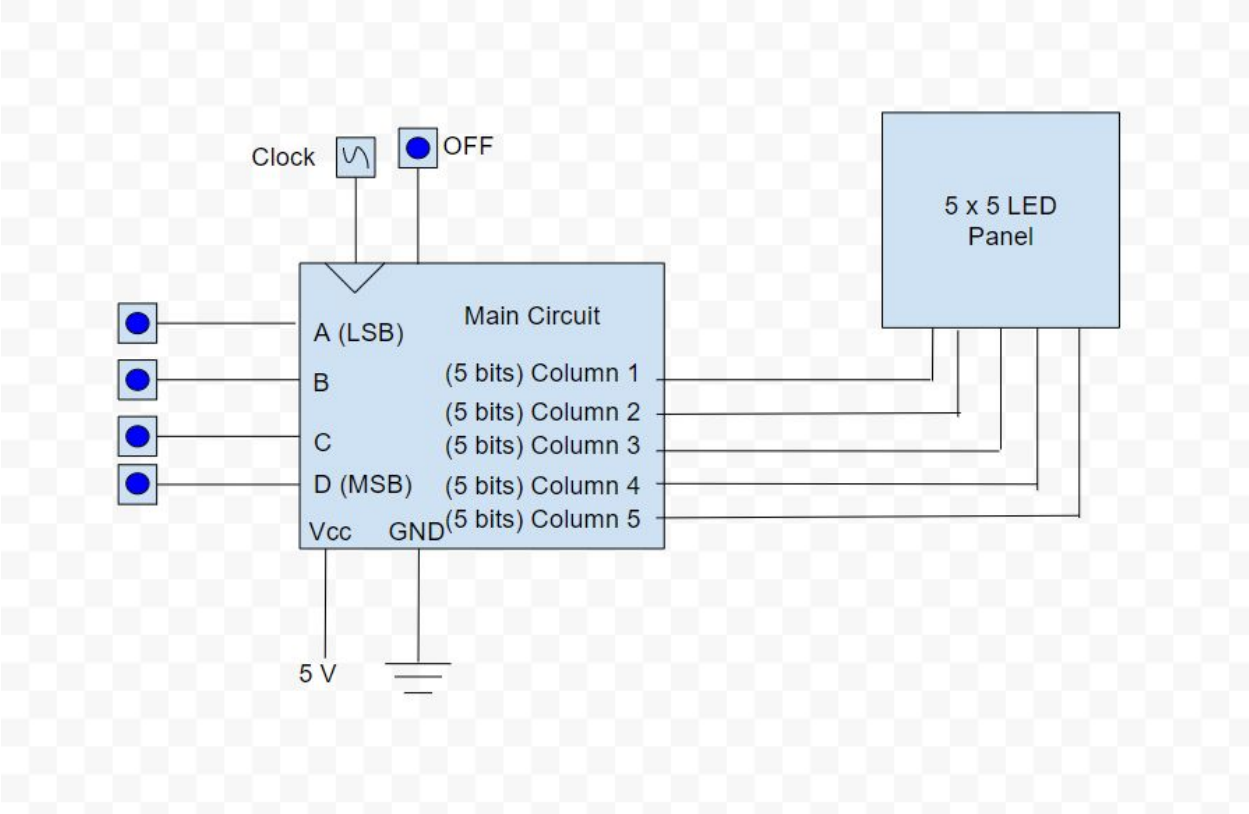
Digital Design Project Report Group 104

Top Level Block Diagram:

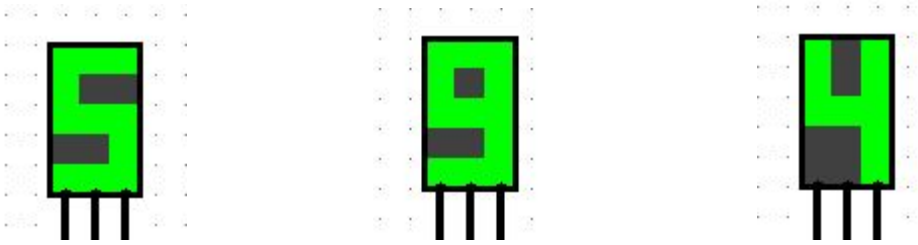


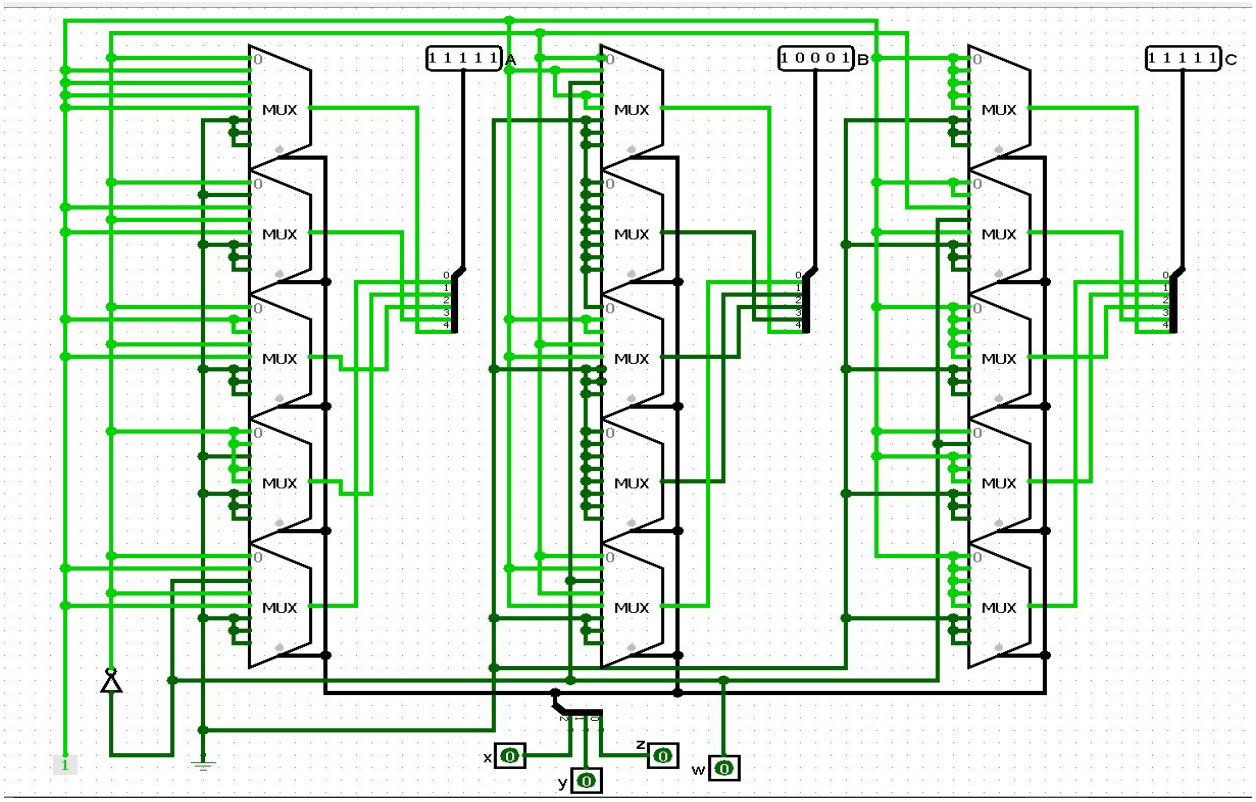
Assumptions:

The initial assumption while making the design was that the 4-bit input to the circuit is to be changed only when either the number in the output display has scrolled more than halfway across the panel or it has completely vanished. However, this assumption has been tackled in the additional functionalities implemented.

Design Methodology:

- The input for our circuit includes 4 bits - A, B, C, D, representing the numbers (0-9) and we have decided to show the output via a (5 x 5) LED panel. The inputs to the LED matrix are given column wise, each column receiving a bit string of length 5 respectively.
- First, we have implemented a function that takes a 4-bit binary number and generates its corresponding display on a (5-3) LED panel. Now, observe that there are 15 LEDs in the above panel. Each LED was assigned a label, and it's behaviour was noted in the form of a truth table.
- 15 - (8 x 1) multiplexers were used with x, y, z as the select lines to implement the logic of each of the 15 LEDs of the panel. Examples are shown below along with a snapshot of the implementation.





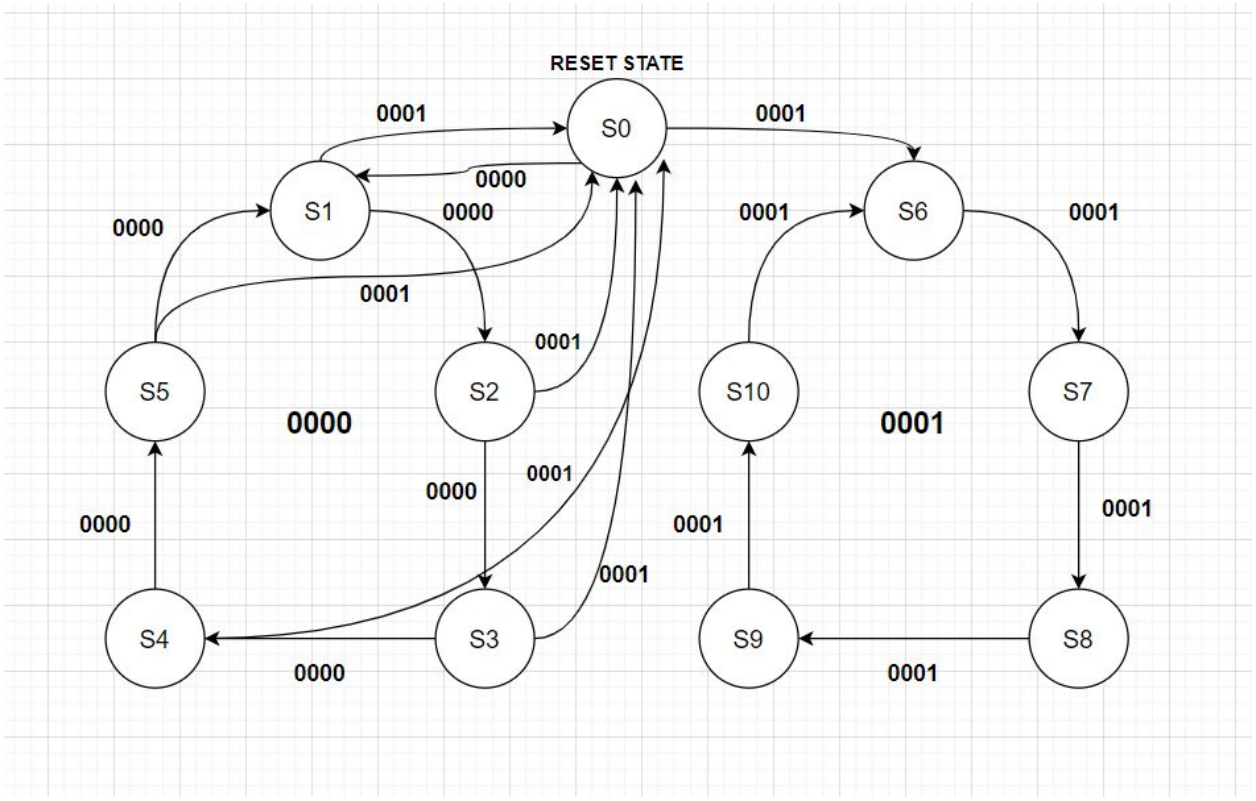
- Note in above that each column of multiplexers gives input to one column in the (5 x 3) LED panel. It is these three columns that will be scrolled across the (5 x 5) LED panel in the final output. --------> [1]
- To implement the scrolling action, we used one (8 x 1) multiplexer (5 data bit input), one 4-bit binary counter and one 5 bit 5 stages shift register.
- The 4-bit binary counter was used as a 3-bit binary counter by making the connections as specified in the datasheet. (This is shown in the pin out diagram of the counter)
- The shift register was a custom component that we made using 25 D - flip flops. It was designed to accept a 5 bit input and shift all the five bits together as a single entity to the next stage. Every stage was designed to retain and shift 5 bits of data.
- Now the three columns of outputs of [1] containing 5 bits each were fed into the multiplexer as input 0, 1 and 2. The rest of its inputs were made 0.
- The select line of the multiplexer was connected to the output of the counter. The output of the multiplexer was connected to the input of the register to be shifted into the first stage.
- 'and' logic of the 'clock' and the 'OFF' input was fed as a common clock input to the register and the counter. The output lines of the 5 stages of the register were connected to the 5 columns of the (5 x 5) LED panel.
- The 'OFF' input is also connected to the 'clear' of the register and the counter, and its complement is connected to the 'enable' of the counter and the shift register.

<u>Explanation of working of the circuit:</u>

1. As soon as the input number is provided and OFF is logic 0, the function calculates the required display. The initial output of the counter is 0, thus the first column is selected by the multiplexer and is input to the register.
2. When the first clock pulse arrives, the 1st column is shifted to the first stage by the register, the counter outputs 1 and the multiplexer selects the 2nd column and inputs it to the register.
3. Step 2 keeps repeating and three columns of the display func are shifted across the register which gives a scrolling action in the final display.
4. When the counter reaches its maximum value, it again resets to 0 and repeats the whole process. Thus, this shows up in the final display as the number scrolls from left to right, then disappears at the right end and reappears at the left end.

5. When the ‘OFF’ input is made 1, the mux is disabled, the register and the counter are cleared and disabled asynchronously.

State Diagram:



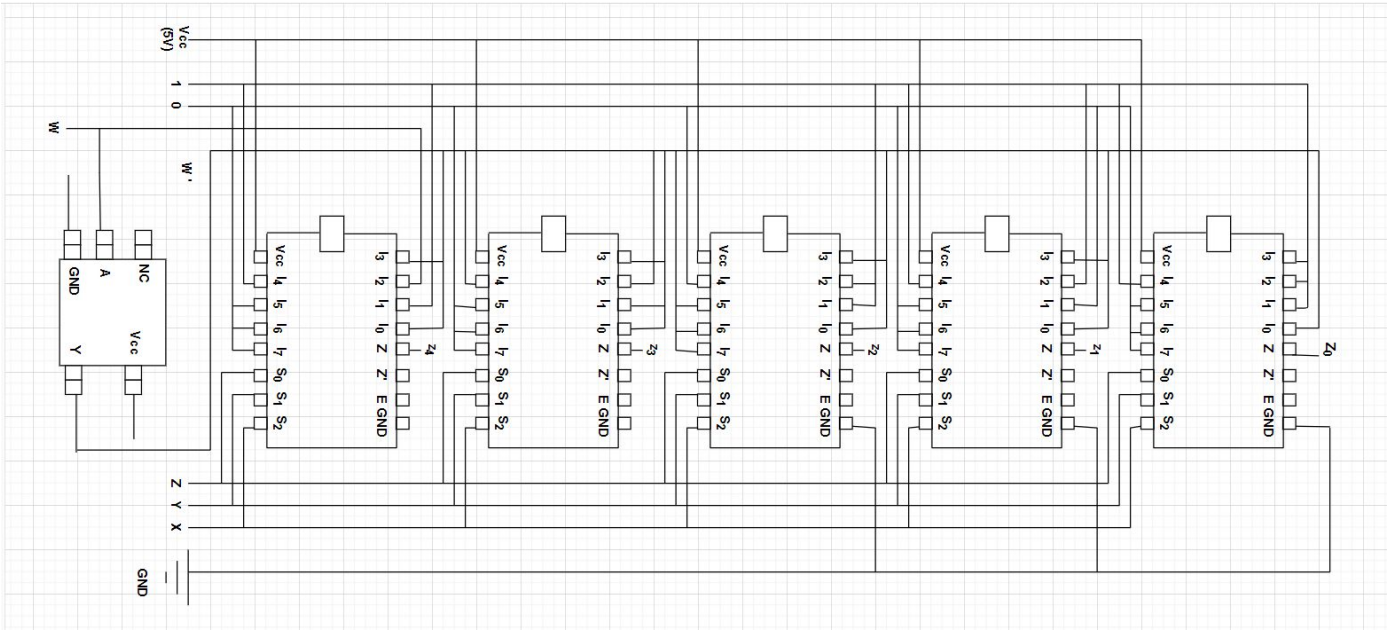
The above state diagram is shown for two specific input combinations - 0 and 1, out of the 10 possible combinations. Once a steady input of ‘0000’ is given, the circuit enters the cycle for display output of the number - ‘0’ until either the ‘OFF’ is made logic 1 or the input is changed to ‘0001’ and in this case the circuit immediately goes to the reset state and enters the cycle for display output of the number - ‘0001’. The vice-versa is also true but it hasn’t been shown in the above diagram as it would become cumbersome.

Pin Out Diagrams:

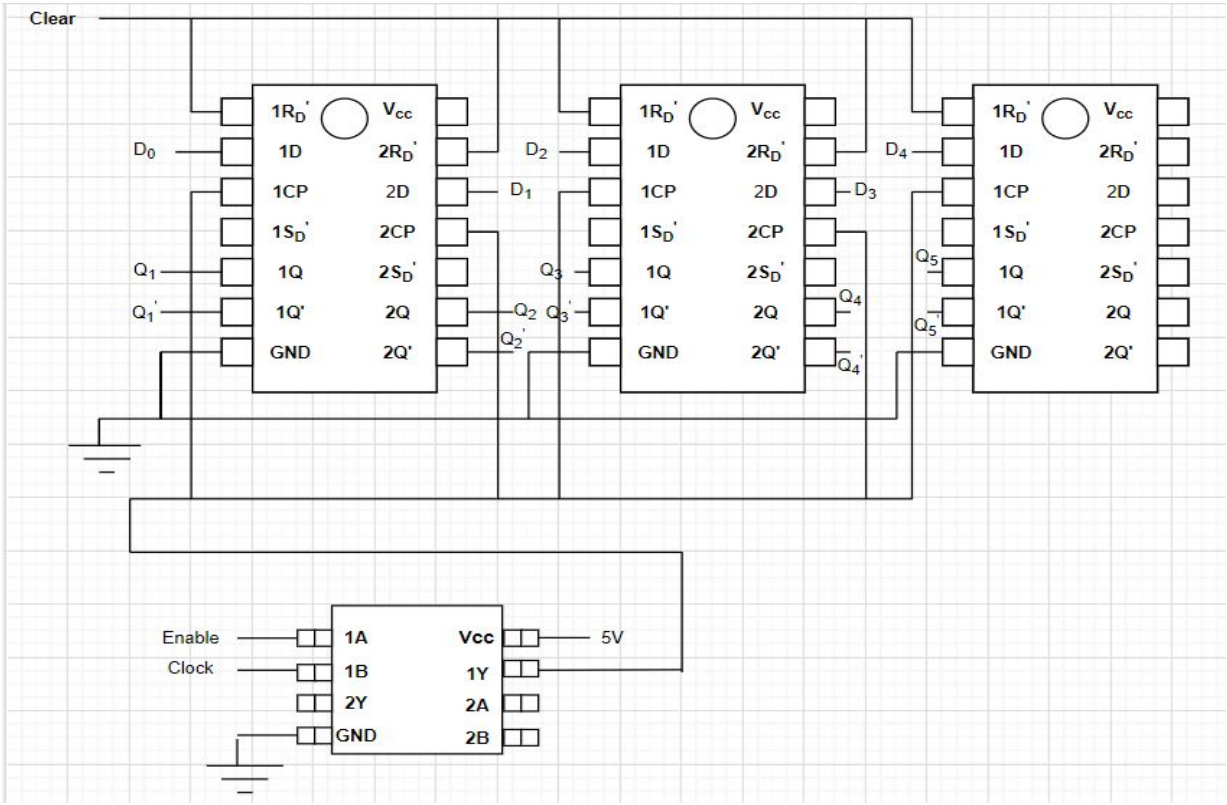
The pin out diagrams below are for parts of the circuit that are integral to the logic of the implementation.

First column of the logic used in the display function:

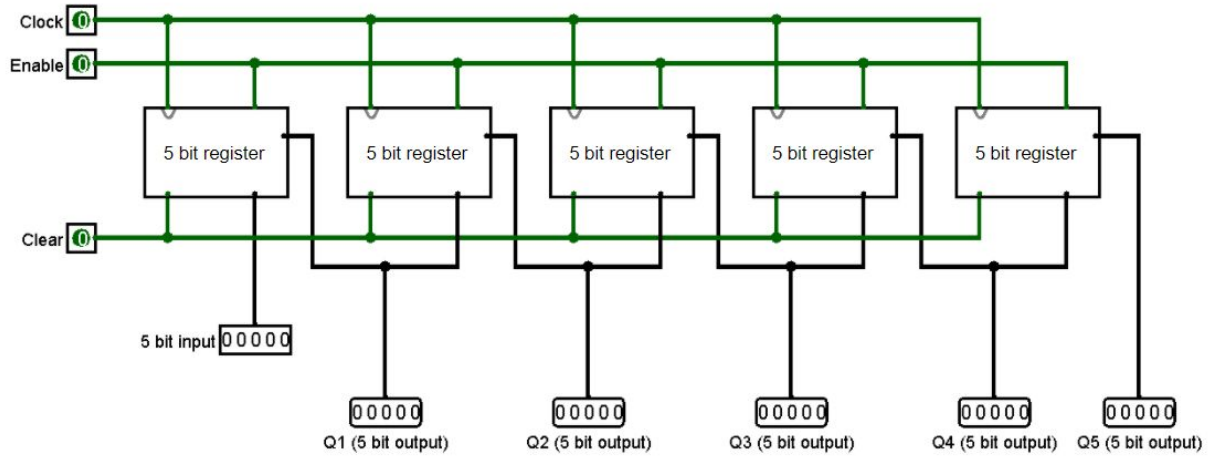
(A clear image of this diagram named as 'logic' is included in the zip file)



5-bit register implemented using Dual D-type Flip-Flops:

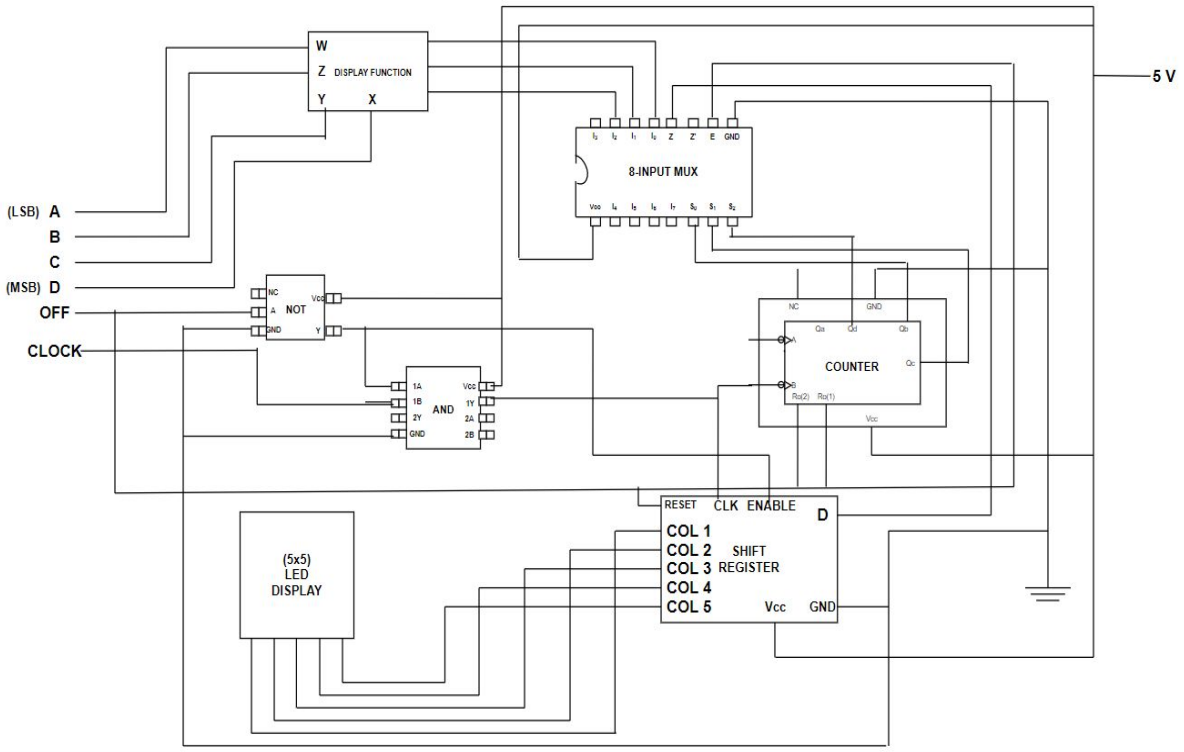


Implementation of multi-bit Shift Register using 5 bit Registers



Overview of the whole circuit:

(A clear image of this diagram named as ‘circuit’ is included in the zip file)



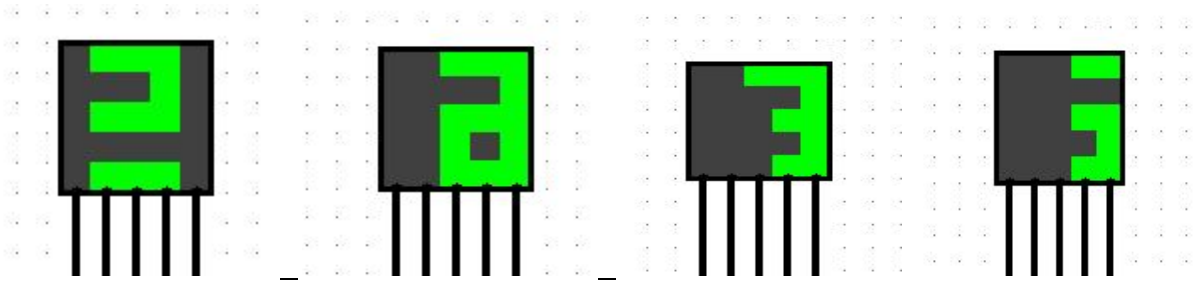
Sample Input/Output Combination:

As the output of the problem statement is dynamic in nature, a pictorial representation of the input/output combination cannot be given. This will be demonstrated during the viva.

Additional Functionalities:

(These have been implemented in the file named as "project_extra.circ")

1. Accepts extended inputs as the numbers 10 to 15 and in the output that number scrolls across the LED display.
2. The design has been made robust and error free by ensuring that any time the input is changed midway when a number is scrolling, incorrect displays such as the below are avoided.



3. Frequency adjustment inputs have been provided so that the parent can adjust the scrolling speed according to the comfort of the infant.
4. Asynchronous 'OFF' input is also provided that disables all the components and inhibits the clock pulse from reaching any of the components, thus reducing the power consumption of the device and also increasing the durability of its components.

List of Components required:	No.
1. 8 input multiplexer	16
2. Dual D-type Flip - Flop	13
3. Dual 2-input AND Gate	2
4. Single Inverter Gate	3
5. 4-bit Binary Counter	1
6. (5x5) LED panel	1

Appendix:

1. **8 input multiplexer -** https://drive.google.com/file/d/1iMKrUgTlC-OtdP5lEnLALaSnNpqxppYT/view?usp=sharing

2. **Dual D-type Flip - Flop -** https://drive.google.com/file/d/1r5gX-xiYwCqql-DaQEmHpELPdh1p7re7/view?usp=sharing

3. **Dual 2-input AND Gate -** https://drive.google.com/file/d/1Ey1mWktvPMjOAUH4xZnyw1vJjFXC_q7X/view?usp=sharing

4. **Single Inverter Gate -** https://drive.google.com/file/d/1F2CQF5hahSq235o8yhoOTZU9sitK9blS/view?usp=sharing

5. **4-bit Binary Counter -** https://drive.google.com/file/d/1J5FCL7pkTk7zx4PesuLRiBCXqn27asdN/view?usp=sharing

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