XMAS LIGHTING SYSTEM DESIGNS

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Introduction to Electronics

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Executive Summary

The goal of this study is to sketch out the design of a Christmas light system. It is made up of eight schemes that are controlled by a single button. The paper focuses on the lighting system's design and operation.

Introduction

During term two, as part of the Introduction to Electronics program, you must construct a Christmas lighting design. These had to be completed and submitted prior to the May tests. This lighting system is based on the Proteus program. Eight independent lighting systems were to be devised, built on Proteus, and then integrated into one huge lighting system. This system is to be operated by a single button and a single clock source.

Each week, we presented our designs to our lecturer in our laboratories to demonstrate how the concept worked and explain how it functioned. The first lighting design was shown to us in class to demonstrate how a simple lighting scheme works. The role of the common components were outlined in class.

Lighting Schemes

Walking One

The walking one is a simple design that turns on each light one after the other from top to bottom.

Components

- Clock
- 74LS193 counter
- 74LS138 decoder (3 to 8 decoder)
- 8 LED's
- 8 330Ω Resistors

The clock was tied to the Up wire of the 74LS193 counter (U1) to count up from binary 0 to 7. The output of the counter was connected to the input of the 74LS138 decoder (U2) and the select lines of the decode were enabled causing the decoder to move down the output. The decoder is an active low decoder, so all the output is 1 by default and each output turns to zero one at a time and that forward biases the LED allowing current to flow through it and turning it on.

Truth Table

COUNTER **Q2, Q1, Q0**	**DECODER** **Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7**	**LED** **ACTIVATED**
0 0 0	0 1 1 1 1 1 1 1	LED 1
0 0 1	1 0 1 1 1 1 1 1	LED 2
0 1 0	1 1 0 1 1 1 1 1	LED 3
0 1 1	1 1 1 0 1 1 1 1	LED 4
1 0 0	1 1 1 1 0 1 1 1	LED 5
1 0 1	1 1 1 1 1 0 1 1	LED 6
1 1 0	1 1 1 1 1 1 0 1	LED 7
1 1 1	1 1 1 1 1 1 1 0	LED 8

Alternate Walking One

This light scheme is just like the walking one but instead of going from LED 1 to 8 it goes odd numbers first then even numbers, that is it goes through LED 1, 3, 5, 7 then 2, 4, 6, 8.

Components:

- Clock
- 74LS193 counter
- 74LS138 decoder (3 to 8 decoder)
- 8 LED's

- 8 330Ω Resistors

This is created by connecting the wire accordingly in the order we want the LEDs to light up like the first output goes to LED 1 and the second goes to LED 3 and so on.

Truth Table

COUNTER Q2, Q1, Q0	DECODER Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	LED ACTIVATED
0 0 0	0 1 1 1 1 1 1 1	LED 1
0 0 1	1 0 1 1 1 1 1 1	LED 3
0 1 0	1 1 0 1 1 1 1 1	LED 5
0 1 1	1 1 1 0 1 1 1 1	LED 7
1 0 0	1 1 1 1 0 1 1 1	LED 2
1 0 1	1 1 1 1 1 0 1 1	LED 4
1 1 0	1 1 1 1 1 1 0 1	LED 6
1 1 1	1 1 1 1 1 1 1 0	LED 8

Reverse Walking One

The reverse walking one is just like the walking one but the light moves from bottom to top instead of top to bottom and this is possible by connecting the clock to the down wire of the counter instead of up like we did in the walking one.

Components

- Clock
- 74LS193 counter
- 74LS138 decoder (3 to 8 decoder)
- 8 x LED red
- 8 x 330Ω Resistors

Truth table

COUNTER Q2, Q1, Q0	DECODER Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	LED ACTIVATED
1 1 1	1 1 1 1 1 1 1 0	LED 8
1 1 0	1 1 1 1 1 1 0 1	LED 7
1 0 1	1 1 1 1 1 0 1 1	LED 6
1 0 0	1 1 1 1 0 1 1 1	LED 5
0 1 1	1 1 1 0 1 1 1 1	LED 4
0 1 0	1 1 0 1 1 1 1 1	LED 3
0 0 1	1 0 1 1 1 1 1 1	LED 2
0 0 0	0 1 1 1 1 1 1 1	LED 1

Waterfall

Components

- Clock
- 74LS193 counter
- 74LS138 decoder (3 to 8 decoder)
- 8 x LED red
- 8 x 330Ω Resistors
- 2 x 74276 (4 in 1) jk flipflop
- Not gate

The waterfall is like a walking one but with the introduction of a 74276 4 in 1 JK flip flop which stores the logic state of the LED that's on or off that is if the decoder is enabling the wires from top to bottom and turning on the LEDs, unlike the walking one the LEDs stays on until they are all on and the counter restarts then the flipflop changing the logic state to the opposite of what it was and stores it, in this case turning them off and the cycle continues.

Accordion

The Accordion consists of eight LEDs. It would start with LED 1 and LED 8 lighting, then LED 2 and 7 lighting, LED 3 and 6 lighting, then LED 4 and 5 would light that's the middle then it reverses the pattern starts from the middle (LED 4 and 5) and moves to the ends (LED 1 and 8).

Components:

- Clock
- 74LS193 counter
- 74LS138 decoder (3 to 8 decoder)
- 8 x LED red
- 8 x 330Ω Resistors
- 4 x EXNOR gate

To make the accordion circuit a counter was connected to a 3 to 8 decoder and the outputs of the decoder were paired the same way the LEDs were paired and connected to an EXNOR gate each (that is 4 EXNOR gates). So, if any of the outputs in a pair has a state of zero (because the decoder is an active low decoder, and the outputs are enabled one at a time) the EXNOR gate outputs a one and turns on the light it's connected to.

Truth Table

COUNTER Q2, Q1, Q0	DECODER Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	LED ACTIVATED
0 0 0	0 1 1 1 1 1 1 0	LED 1 and 8
0 0 1	1 0 1 1 1 1 0 1	LED 2 and 7
0 1 0	1 1 0 1 1 0 1 1	LED 3 and 6
0 1 1	1 1 1 0 0 1 1 1	LED 4 and 5
1 0 0	1 1 1 0 0 1 1 1	LED 4 and 5
1 0 1	1 1 0 1 1 0 1 1	LED 3 and 6
1 1 0	1 0 1 1 1 1 0 1	LED 2 and 7
1 1 1	0 1 1 1 1 1 1 0	LED 1 and 8

Latched Accordion

Latched accordion is just like the first stage of an accordion from when the decoder is enabled and turns on the LEDs at the far end to when the two middle light comes on but the difference is the lights stays on until it comes to the middle and when it restarts the lights start to turn off and stays off and the cycle continues.

Components:

- Clock
- 74LS193 counter
- 74LS139 decoder (2 to 4 decoder)
- 8 x LED red
- 8 x 330Ω Resistors
- 74276 (4 in 1) jk flipflop

This is created with a 74LS139 decoder (2 to 4 lines) and 74276 (4 in 1) JK flipflop, the outputs of the decoder were connected to the inputs of the flip flop and the j and k wires were tied to logic 1 to enable the flip flops.

Knight rider

The Knight-rider consists of eight LEDs, one LED lighting at a time. This design is the combination of a walking one and a reverse walking One in the sense that it lights from top to bottom but instead of it to reset and starting from the top again it instead moves from the bottom to top.

Components

- Clock
- 74LS193 counter
- 74154 decoder (4 to 16 decoder)
- 8 x LED red
- 8 x 330Ω Resistors
- 8 x EXNOR gate

The circuit was designed using a 74154 decoder (4 to 16 decoder) so it can have the pattern of a walking one and reverse walking one at one go. The output lines were paired and sent to an EXNOR gate. The outputs were paired as follows output 0 and 15 connected to LED 1, 1 and 14 connected to LED 2, 2 and 13 connected to LED 3, and so on. The EXNOR gate made sure that if any of the pair was 0 the light it's connected to lights up

Truth Table

COUNTER **Q3, Q2, Q1, Q0**	**DECODER** **Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7**	**LED** **ACTIVATED**
0 0 0 0	0 1 1 1 1 1 1 1	LED 1
0 0 0 1	1 0 1 1 1 1 1 1	LED 2
0 0 1 0	1 1 0 1 1 1 1 1	LED 3
0 0 1 1	1 1 1 0 1 1 1 1	LED 4
0 1 0 0	1 1 1 1 0 1 1 1	LED 5
0 1 0 1	1 1 1 1 1 0 1 1	LED 6
0 1 1 0	1 1 1 1 1 1 0 1	LED 7
0 1 1 1	1 1 1 1 1 1 1 0	LED 8
1 0 0 0	1 1 1 1 1 1 1 0	LED 8
1 0 0 1	1 1 1 1 1 1 0 1	LED 7
1 0 1 0	1 1 1 1 1 0 1 1	LED 6
1 0 1 1	1 1 1 1 0 1 1 1	LED 5
1 1 0 0	1 1 1 0 1 1 1 1	LED 4
1 1 0 1	1 1 0 1 1 1 1 1	LED 3
1 1 1 0	1 0 1 1 1 1 1 1	LED 2
1 1 1 1	0 1 1 1 1 1 1 1	LED 1

ROM

ROM is a read-only memory. A memory that gives you permission to read but not write. The ROM can be used to execute any light scheme you just have to be able to write the scheme in a .BIN file and load it in the ROM.

Components

- Clock
- 74LS193 counter
- 27C512 ROM
- 8 LED's
- 8 330Ω Resistors

A counter was connected to the ROM to read the bin file in it and send the data to the output lines and it's connected to the resistors which are connected to the LEDs. Each data in a bin file is separated by either a space or a new line. I loaded the ROM with a Latched Knight rider scheme which turns on the LEDs and keeps it on from top to bottom and turns off the LEDs and keeps it off from bottom to top.

Combination Lighting Scheme

The combination lighting scheme involved combining all eight individual lighting schemes into one large lighting scheme. All Lighting schemes were copied onto an A2 landscape size ISIS schematic. The resistors, LEDs, clock, and logic states for each scheme were removed. Only eight resistors, eight LEDs, one clock, and two logic states (one 1 and 0) were used. I made sure the components were reduced to the minimum to make sure the circuit was neat and small, like using one counter for all the schemes and using one decoder for 4 different lighting schemes because it does the same thing for all the lighting schemes.

To combine all the lighting schemes, eight 74151 multiplexers (Fig 9.0) were used. The first lighting scheme, The Walking One had all its outputs on the decoder connected to the first input of each multiplexer, the second lighting scheme to the second, and so on. The output of each multiplexer was connected to the eight LEDs. I tied the A, B, and C inputs of each multiplexer together.

Control System

The control system is the part of the circuit That changes between the lighting schemes.

Components:

- Push button
- 7SEG-BCD-GRN Display

- Or gate
- Nor gate
- 74LS193 counter

The different lighting schemes had to be selected using two different push buttons tied to the up and down wire of a 74LS193 counter to count up and down, the preload was set to logic 1 because it is active low, and we don't need it. The Master reset wire was tied to Q3 because we don't want the counter to count over binary 7. The two push buttons was passed through a NOR gate each and the NOR gates was passed through an OR gate then the OR gate was connected to the master reset of every counter in the circuit to ensure the counter of the lighting schemes reset anytime any of the button is pushed. The push button is also connected to the R and S button of the flip-flop to reset it anytime the button is pushed. The control system can be seen in Fig.1.1.

Multiplexers

The Multiplexer is the main tool that combines the eight lighting schemes and sends them to the LED's. I used eight 8 to 1 multiplexers. Each multiplexer takes one leg of the output from each lighting scheme and sends it to the LED and the control system decides which lighting scheme is allowed through the multiplexer. The A, B, and C input of the multiplexer is connected to the Q0, Q1, and Q2 output of the controller U9 in the control system which lets it move up and down the lighting scheme while the enable wire of the multiplexers is set to 0 because it is active low.

Conclusion

After finishing this project, I gained a lot of new knowledge and got a lot of experience in the module "Introduction to Electronics". Throughout this task, there were several obstacles with each lighting scheme.

Learning the theory behind electronic components in lectures has given me a greater grasp of how each component operates and how to combine them into an electrical circuit.

Appendices

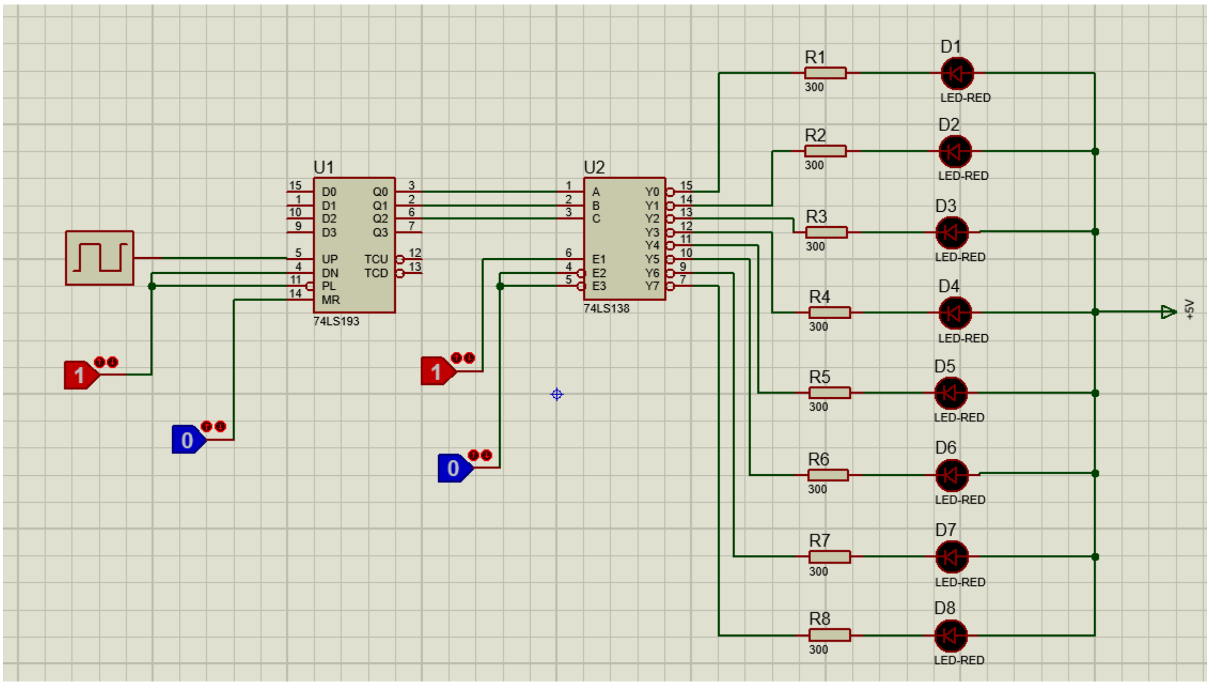


Fig.1.1 Walking one

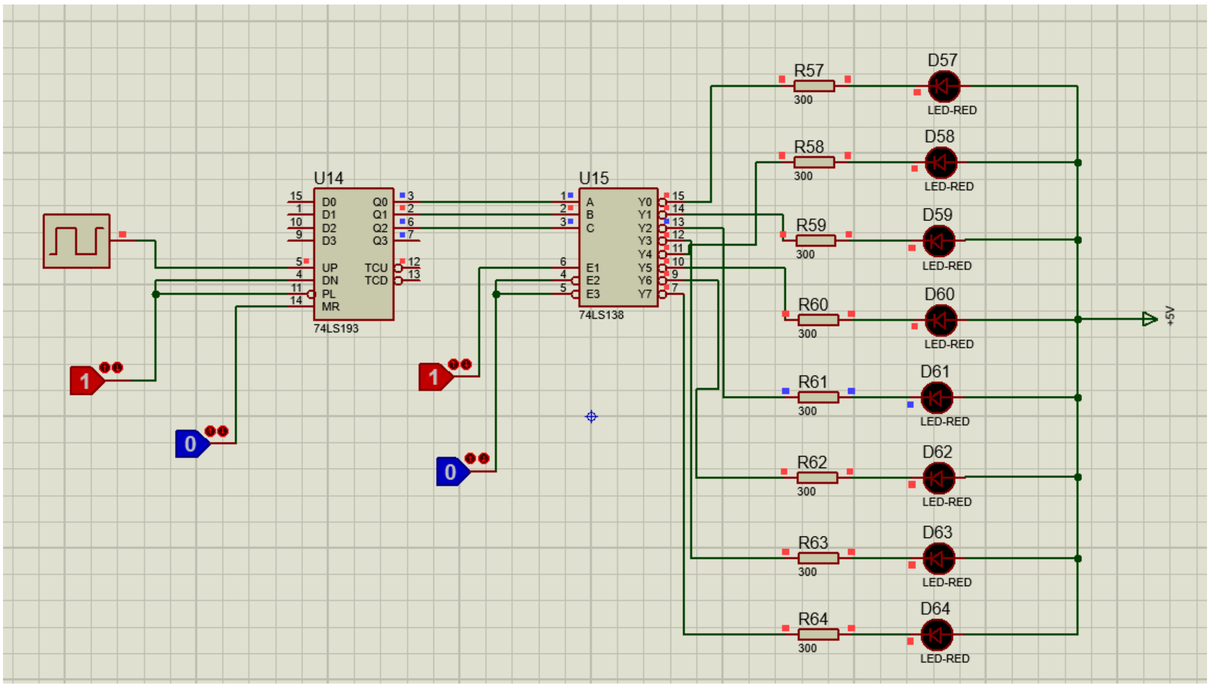


Fig.2.1 Alternate Walking one

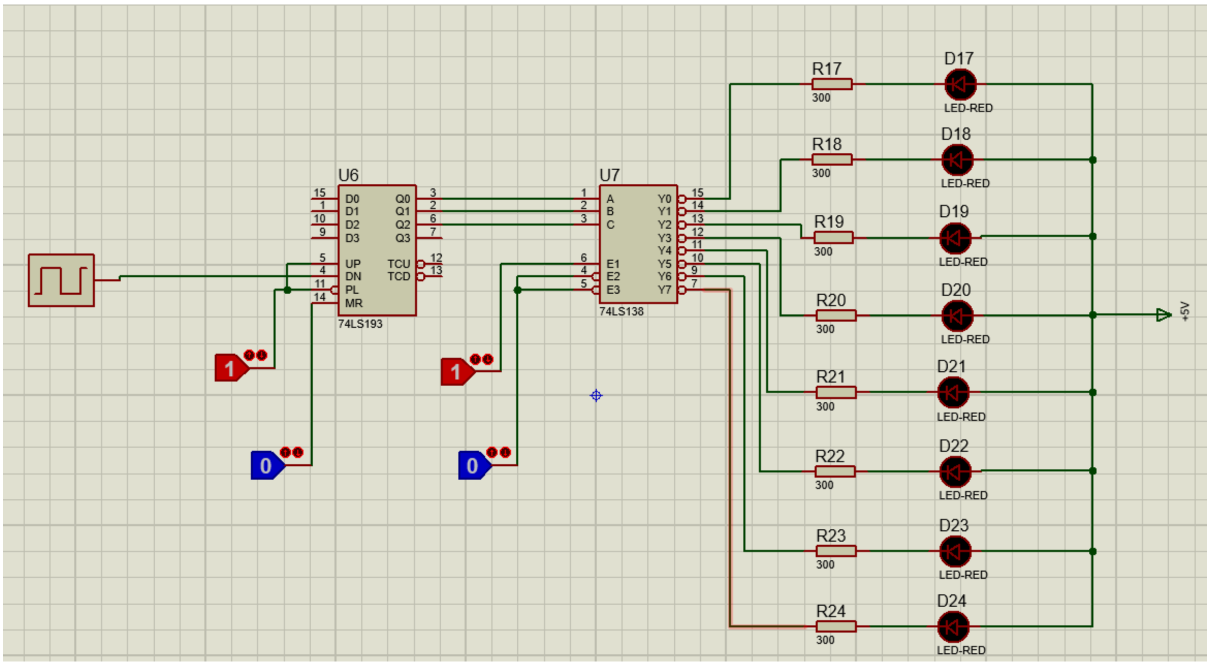


Fig.3.1 Reverse Walking one

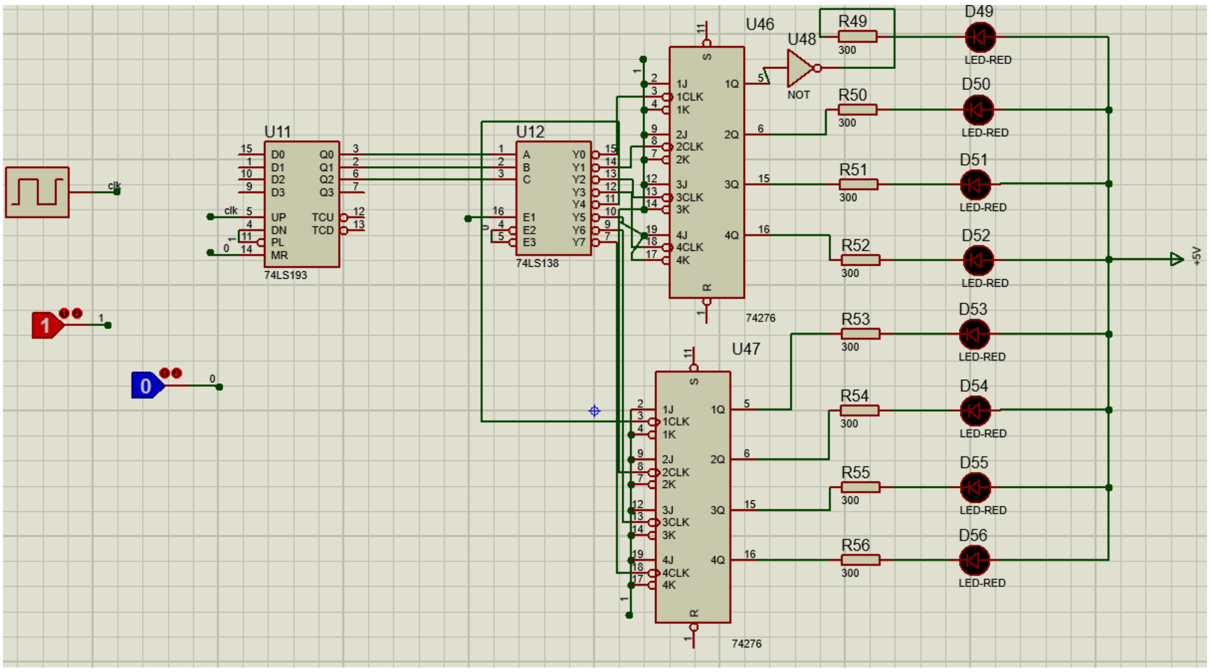


Fig.4.1 Waterfall

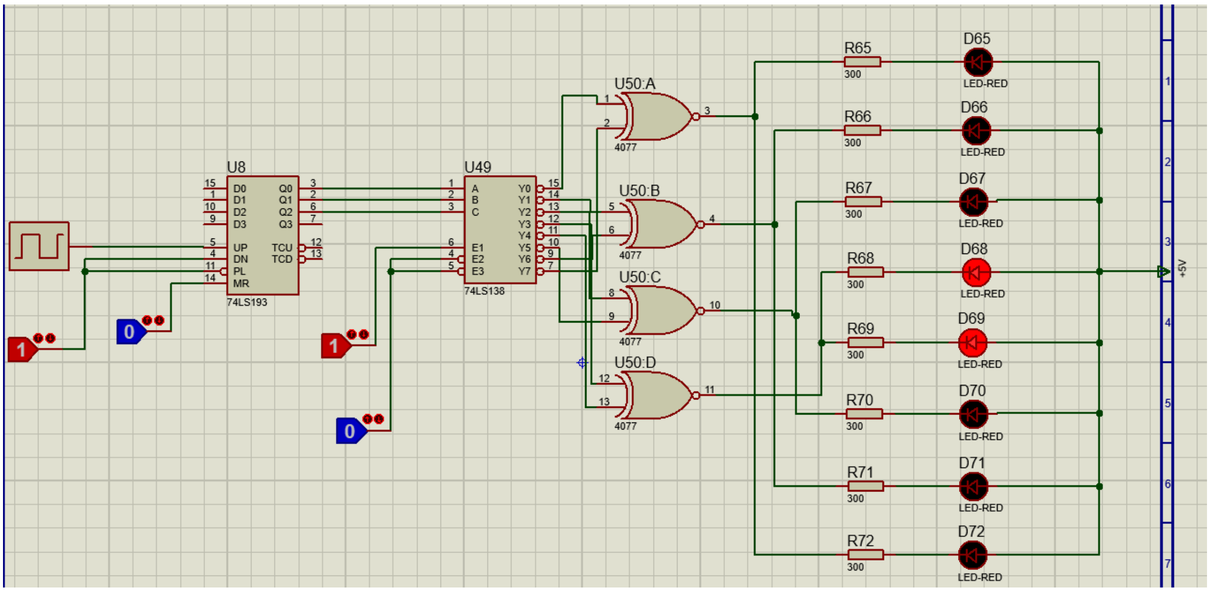


Fig.5.1 Accordion

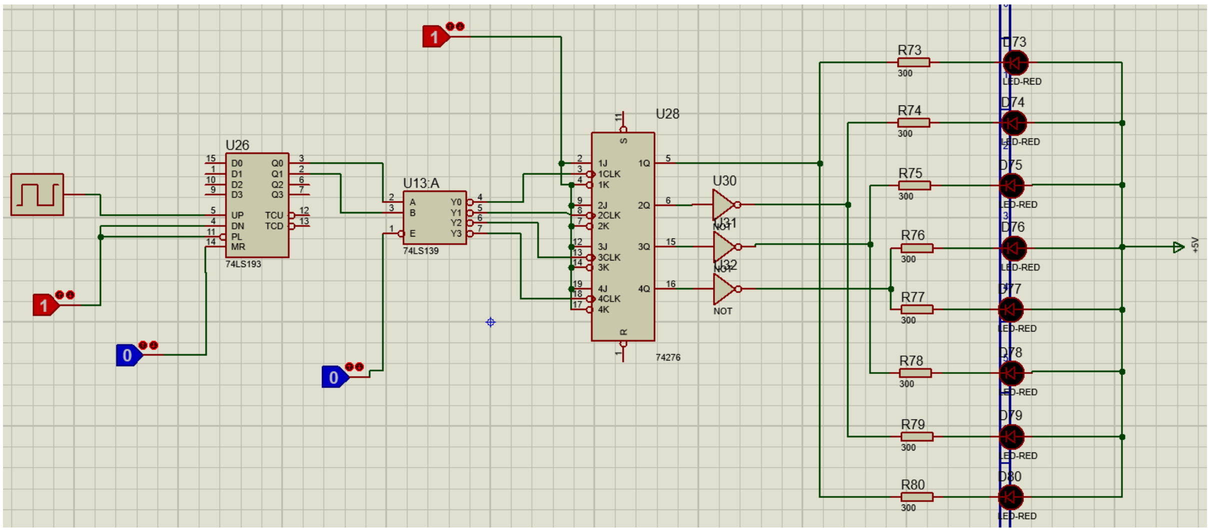


Fig.6.1 Latched Accordion

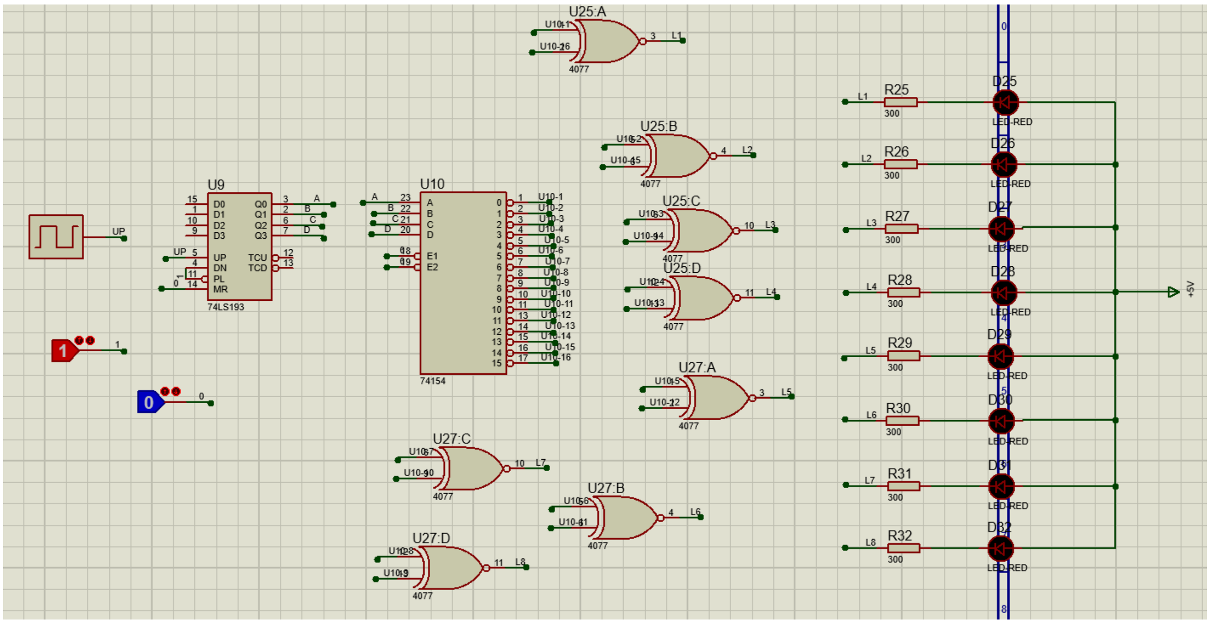


Fig.7.1 Knight rider

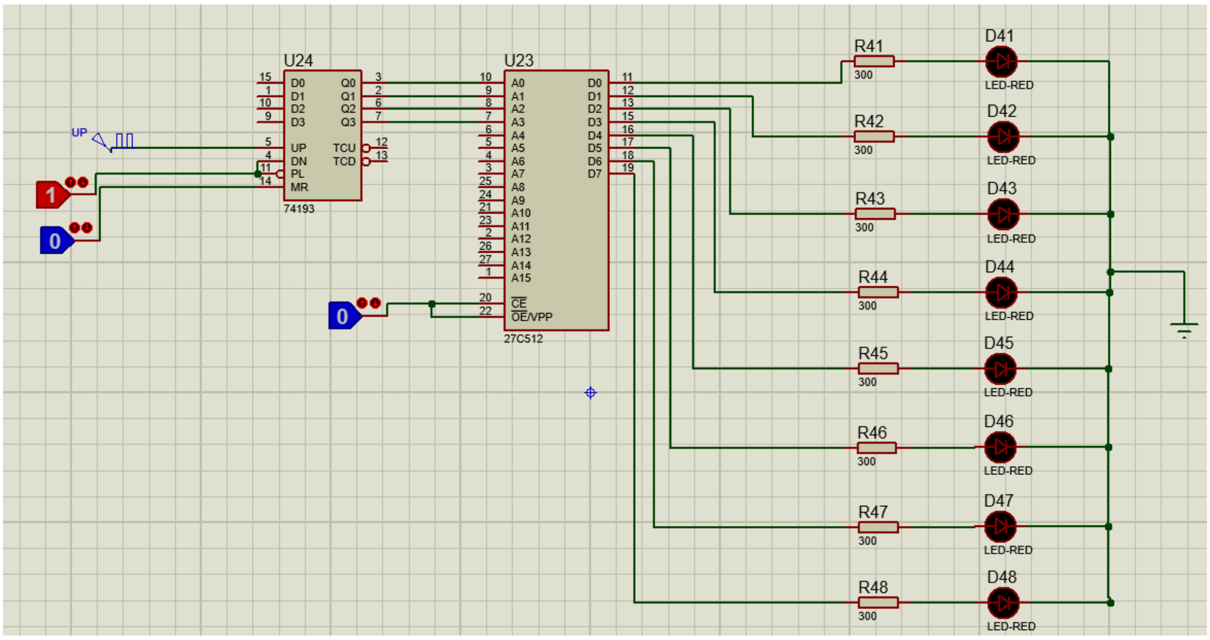
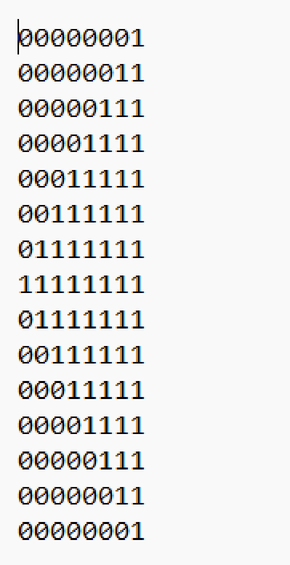


Fig..8.1 ROM



```
00000001
00000011
00000111
00001111
00011111
00111111
01111111
11111111
01111111
00111111
00011111
00001111
00000111
00000011
00000001
```

Fig.8.2 .BIN file

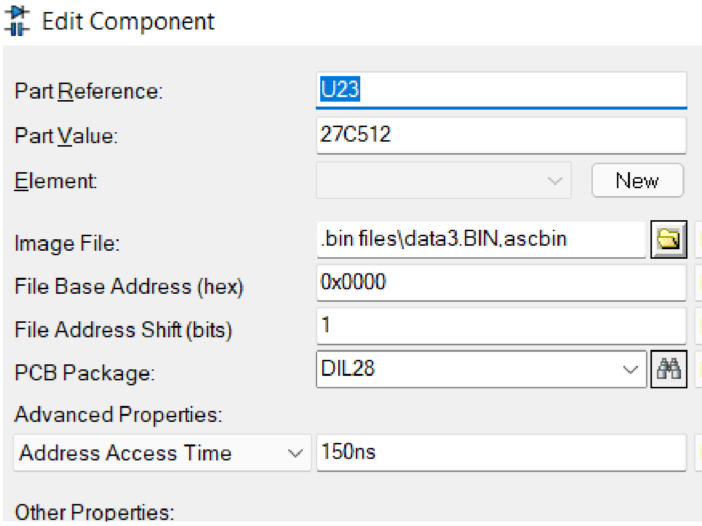


Fig.8.3 Loading the .BIN file

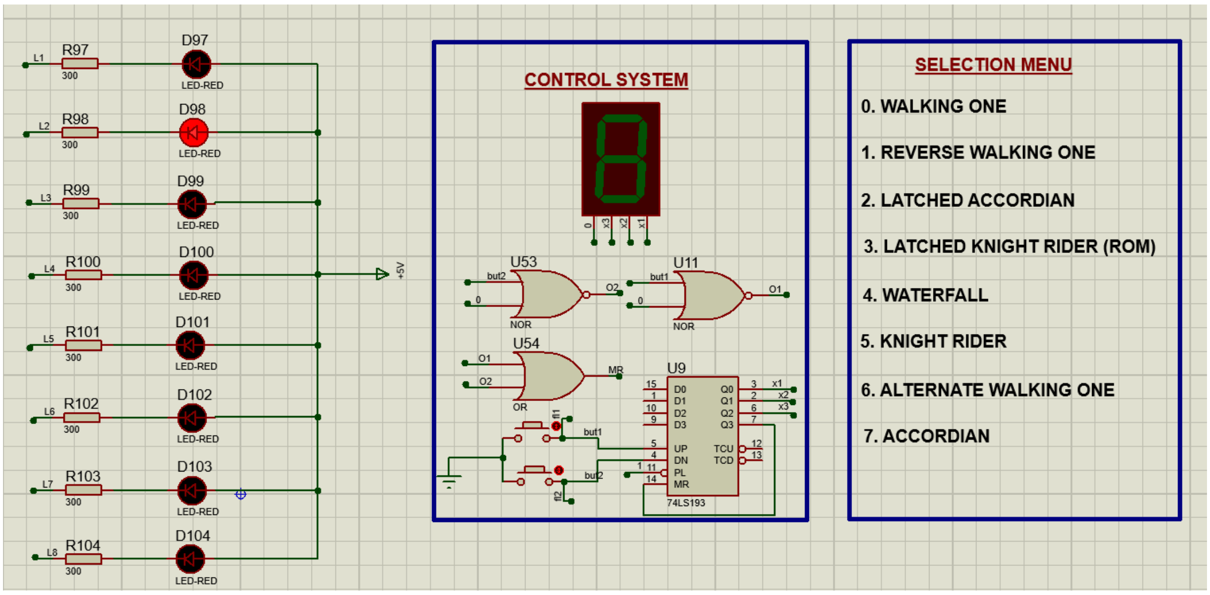


Fig.9.1 Control System

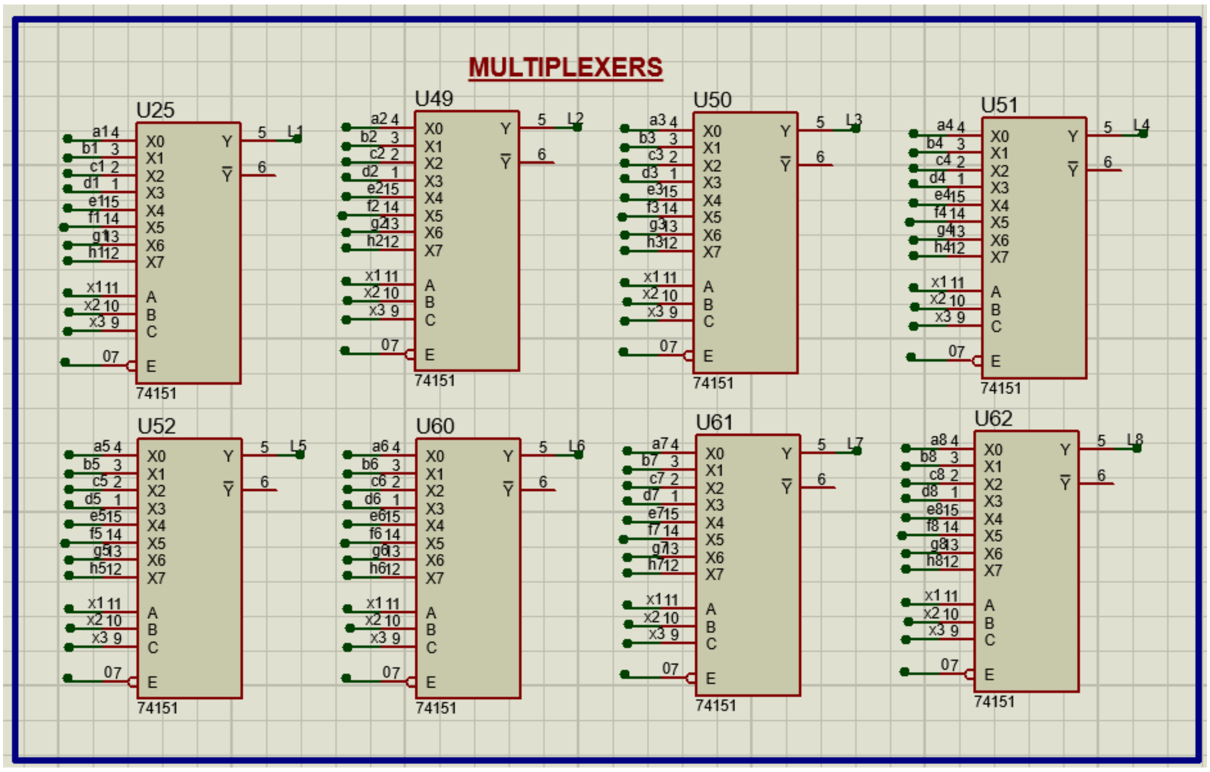
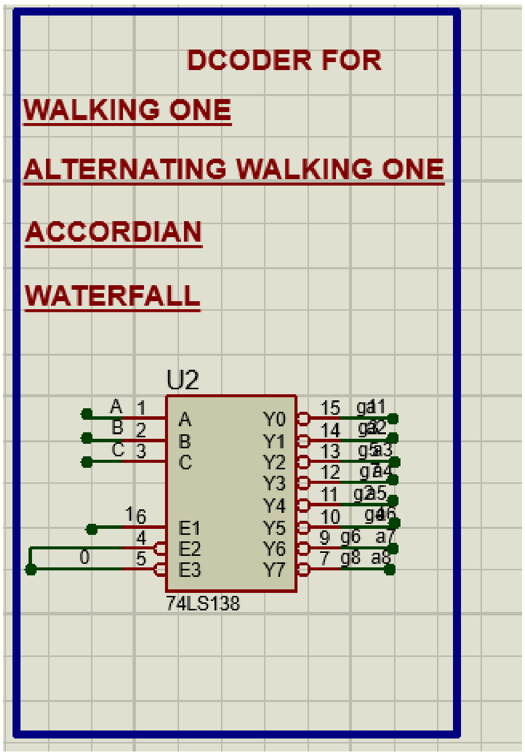


Fig.10.1 Multiplexers



Fig,11.1

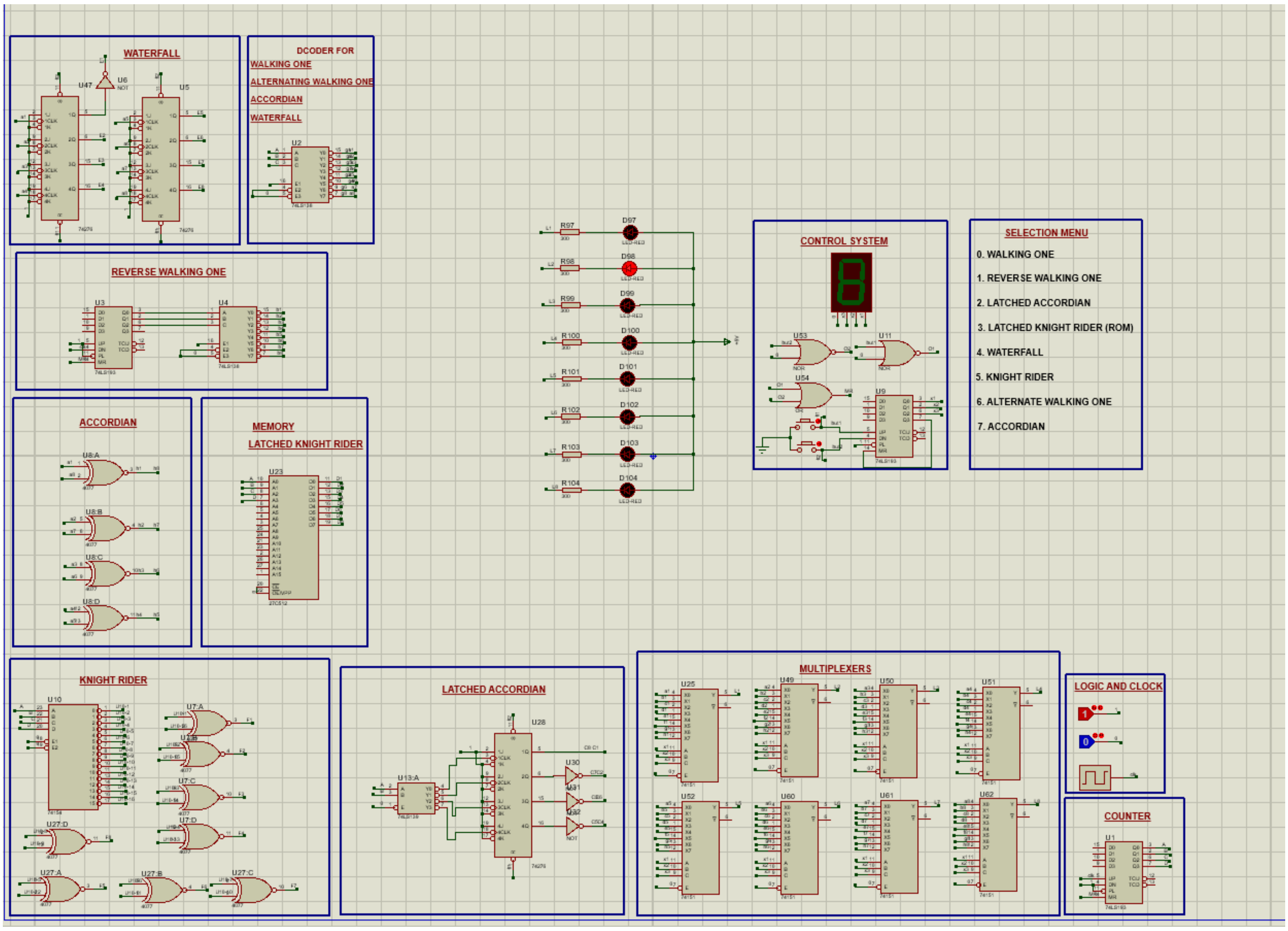


Fig.11.2 Combined lighting scheme