EAST WEST UNIVERSITY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Project: Final Report

DNA sequence: Searching from a database

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Course: Digital Logic Design

Course Code: EEE 205

Group: 03

Submission: **28-08-2023**

DNA sequence: Searching from a database

Genomics is the study of the structure, function, evolution, and mapping of genomes, which are the complete set of DNA in an organism. DNA is composed of four types of nucleotides: adenine (A), thymine (T), cytosine (C), and guanine (G). These nucleotides form long strings of ATCG that encode the genetic information for different traits and functions.

- Here we are representing 'A' as 00, 'T' as 01, 'C' as 10 and 'G' as 11 corresponding to the binary system.

The database we are given is,

C	A	A	A	T	T	T	C	G	C	C	A	C	C	T	G

This database represents a DNA sequence of 16 characters. From this sequence we need to find a specific 3-character sequence which is our query sequence. In this case our query sequence is,

T	C	G

- Our database string is 32 bits long and we want to read a single character that means two bits per clock pulse which refers to the fact that we want to read the database string serially.
- Our database provides a single character that means 2 bits per clock pulse, so we must need two input pins which will provide us data and the comparable circuit will receive and check for the sequence match. As the comparable circuit finds the match it will immediately stop the clock and a counter will show the match position for the query sequence as an output. For showing output we have used a 7-segment display.

  Input Parameters:

  I. Clock
  II. Two 16-to-1 line Multiplexer which acts as a database and selects the appropriate data in each clock pulse
  III. D flip-flops
  IV. Logical gates
  V. Counter

Output Parameters:

I. Led to indicate if the match is found or not.
II. 7 segment display to show the match position

- For finding the match for the sequence we made a comparator circuit which compares if the two bits are equal to the desired two bits. Our query sequence's length is 3 character or 6 bits. So, for checking each character we have a separate block. Here our query sequence is TCG, the comparator circuit's first block will first try to find T and it will wait for 2 clock pulse if it finds a match for T as the sequence is of 3 clock pulse. In the meantime, if the first block finds T the second block of the comparator circuit will try to find C and if it finds C it will wait for another clock pulse so that the third block can operate sequentially. After finding TC the third block will try to find G and if it finds G all the blocks will give 1 as output at the same time. All the outputs will be AND gated and that is our match result for the sequence. The truth table for the comparator circuit is given below.

Inputs		**Outputs (checking for equality)**		
A	B	T	C	G
0	0	0	0	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

We can get the equation for T,C and G with the help of SOP.

Equation:

- $T = A'B$
- $C = AB'$
- $G = AB$

We need to store the output of T for two clock pulse for that we connected two D flip-flops serially. Like that we used a single flip-flop to store the output of G for 1 clock pulse. These three flip flop will help to check the 3-character sequence sequentially.

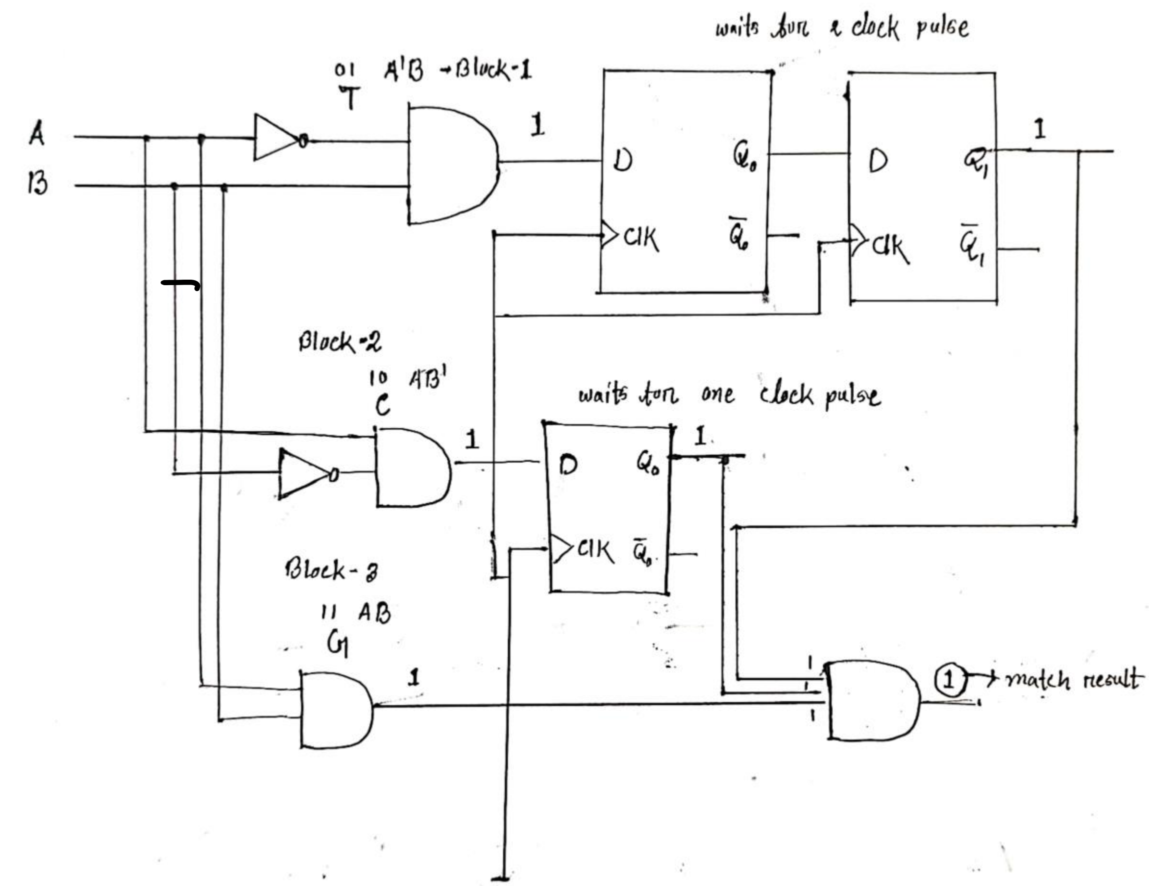


Fig 01: Circuit diagram for the comparator logic circuit

Part A Q/A

I. Once the matching process starts, the system will stop once a match is found. You should also output the match-position in the database string.

Answer: So, after once the matching process starts, the system will try to find the query sequence TCG. When the comparable circuit finds the match, it'll immediately stop the clock and a counter will show the match position for the query sequence as an output. The system won't stop until a match is found.

II. A start switch to begin the process – until start is pressed, the system should remain idle.

Answer: Yes, we use a start switch to begin the process. The start switch is situated at the bottom part of the clock in the circuit. After starting the simulation, we need to press the start switch to begin the process. Until the start switch is pressed, the system will remain idle.

III. A reset switch that will set the system to initial condition and stop all matching processes.

Answer: The MR pin on the 74193 IC stands for "Master Reset". This pin is used to reset the counter to a specific value when a reset signal is applied. When a high signal (logic level 1) is applied to the MR pin, it clears the counter and sets all its outputs to the initial state (usually all zeros).

We've used PROTEUS software to simulate our design.

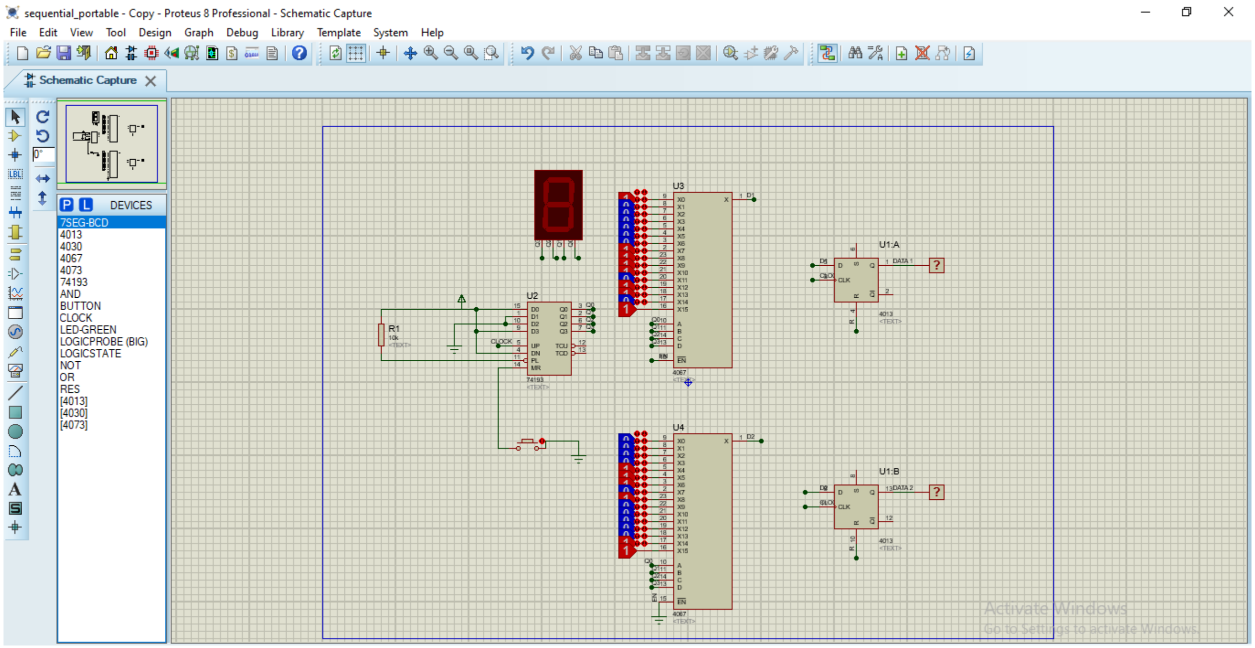


Figure : Input memory block of the circuit

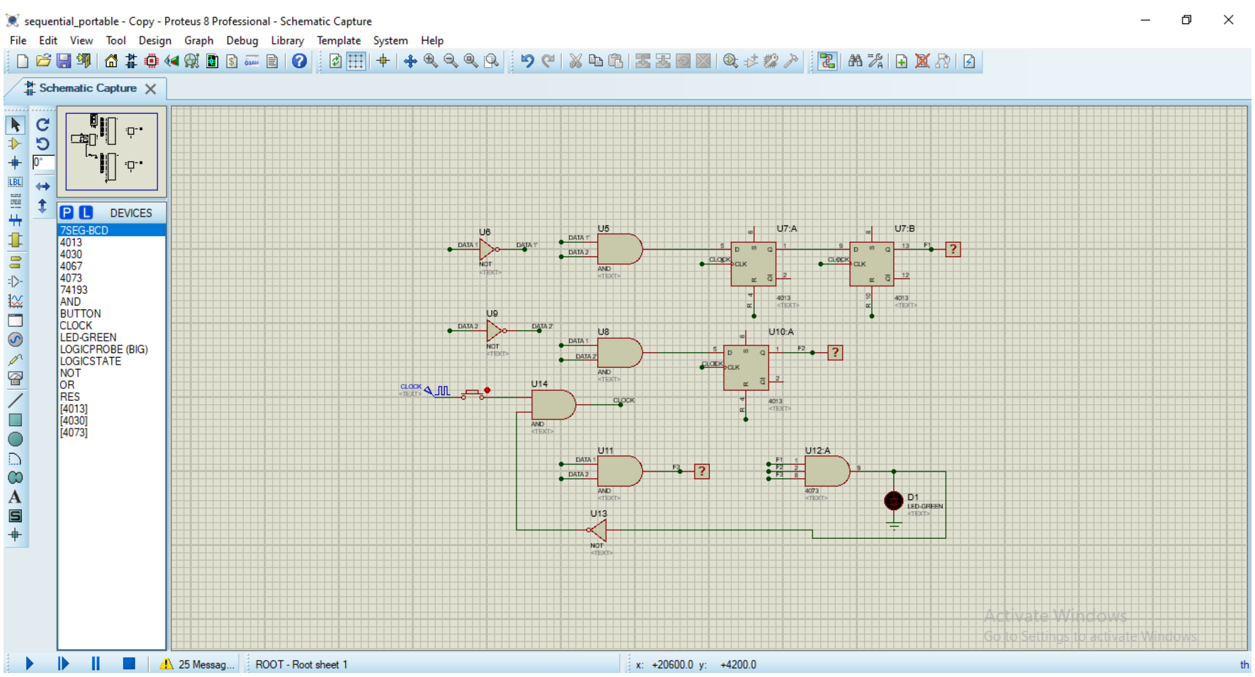


Figure : Comparator block of the circuit

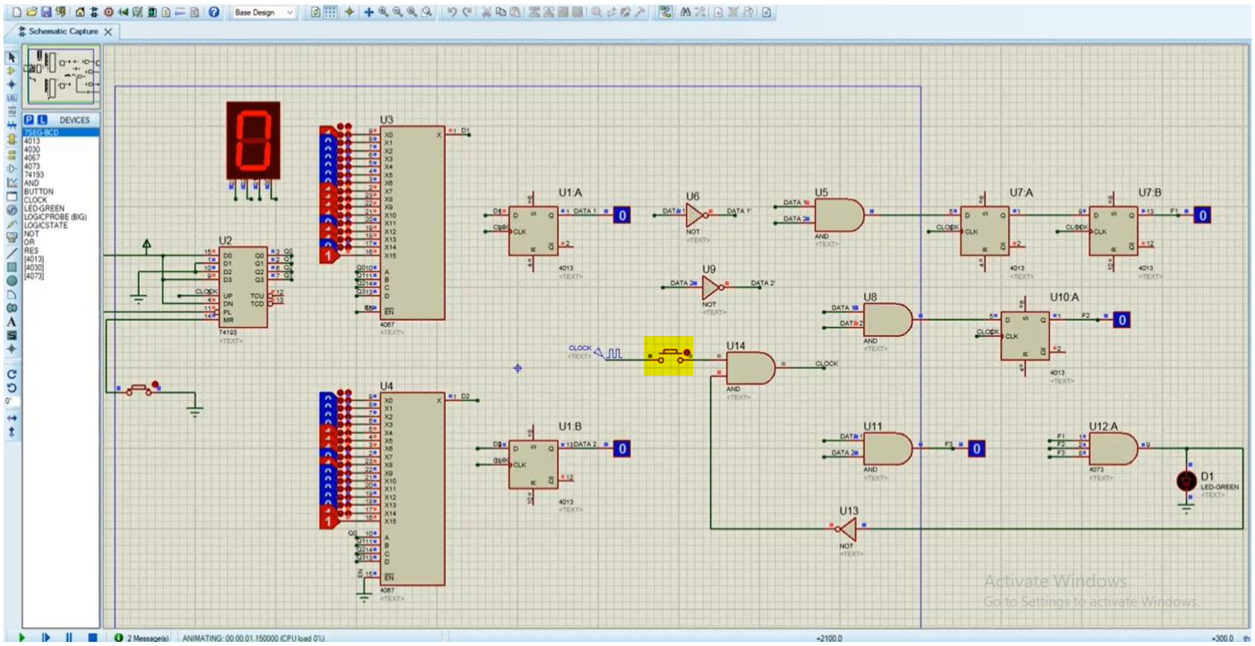


Figure : Total circuit diagram at Ideal position

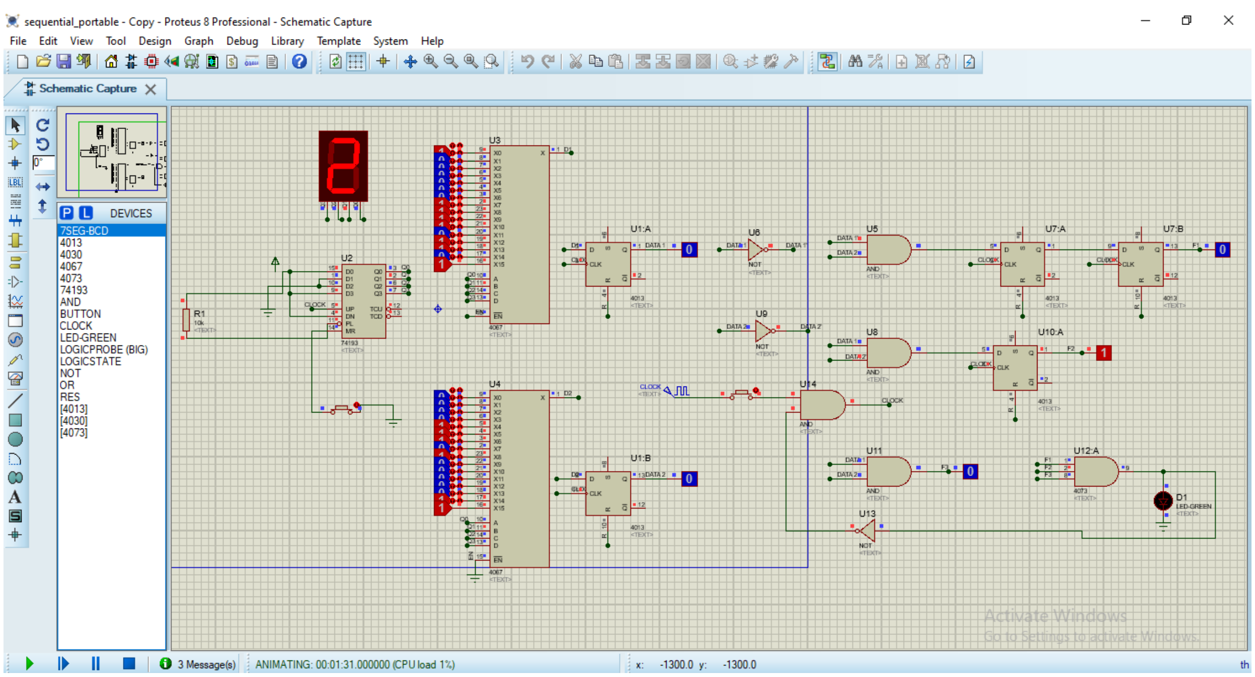
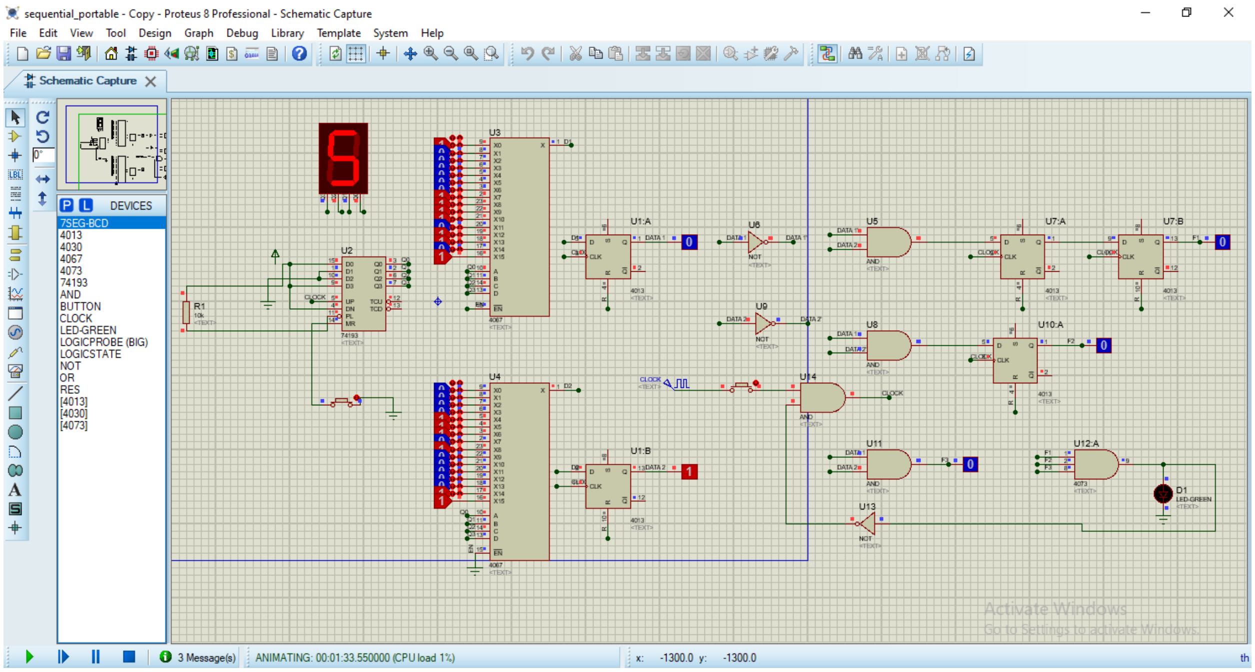


Figure : Different output figure for different clock pulses



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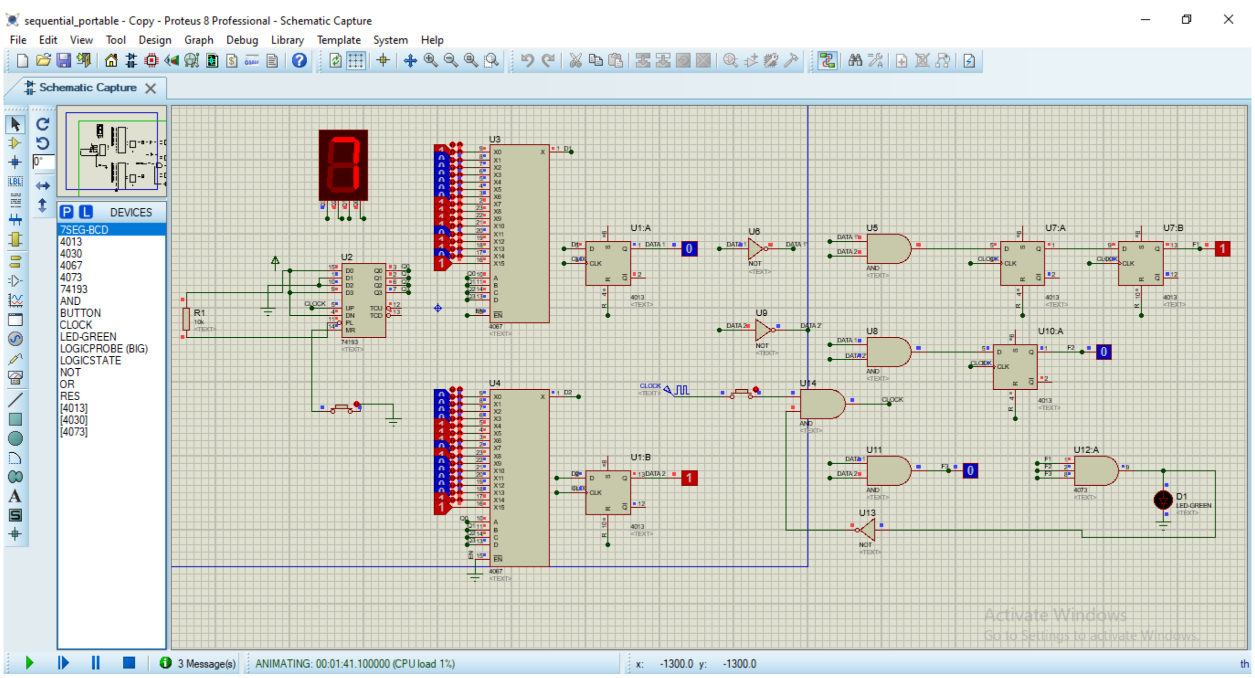

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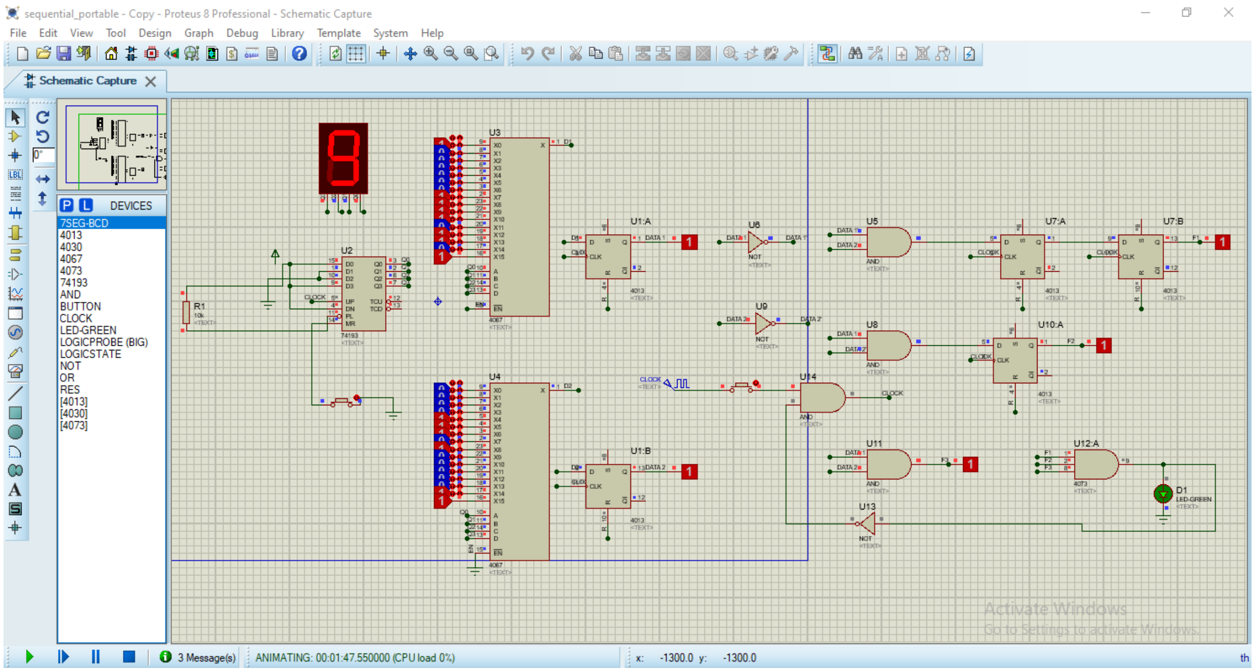

Figure : Figure for 9 number clock pulses (Match Result)