



Aswan University

**Electrical Engg. Department
Third Year, 1st Semester
Electrical Testing 3A**



Faculty of Engineering

Digital Clock

Course:

Electrical Testing 3A

Edited by:

Moaaz Mahmoud

Presented to:

Eng. Abeer FathAllah

Supervised by:

Dr. Mahmoud A. Saber

1. 24-Hour Digital Clock Circuit Diagram

Fig. 1. shows a schematic for the digital clock.

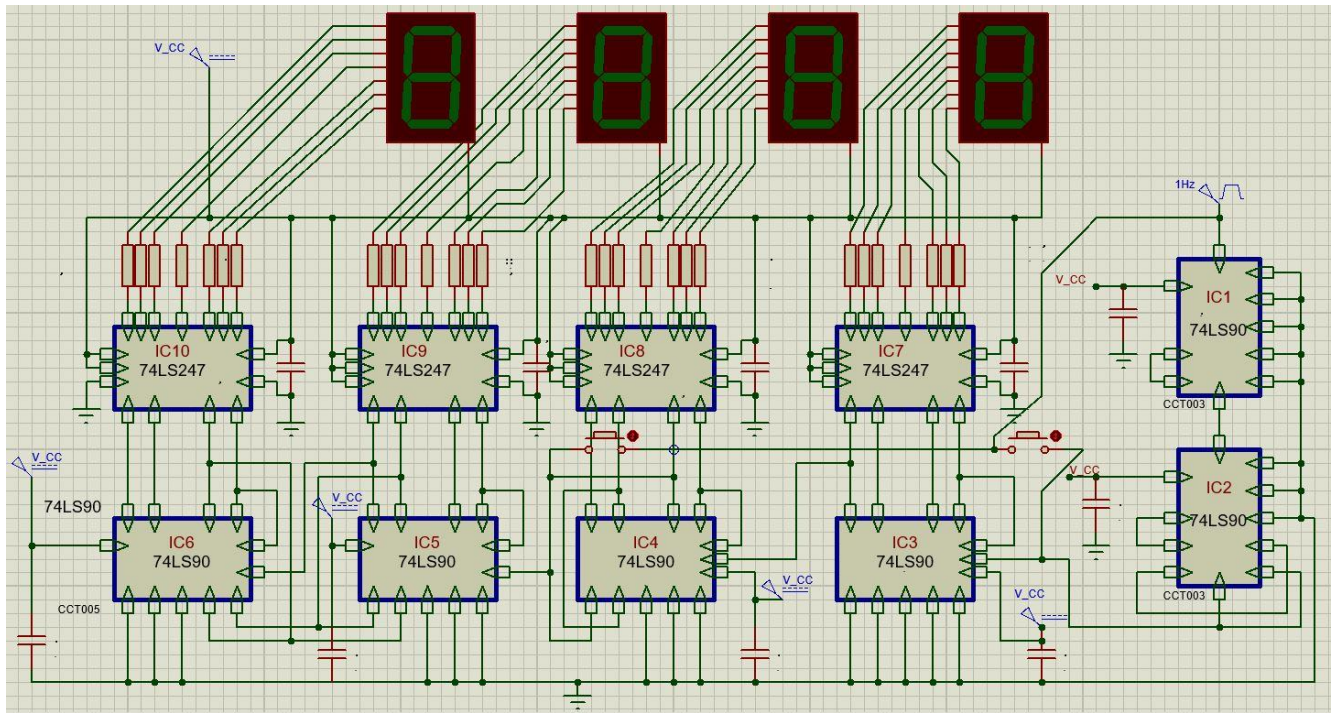


Fig. 1. The schematic of the digital clock.

2. Individual Components Functions

The functions the components in the circuit are listed below.

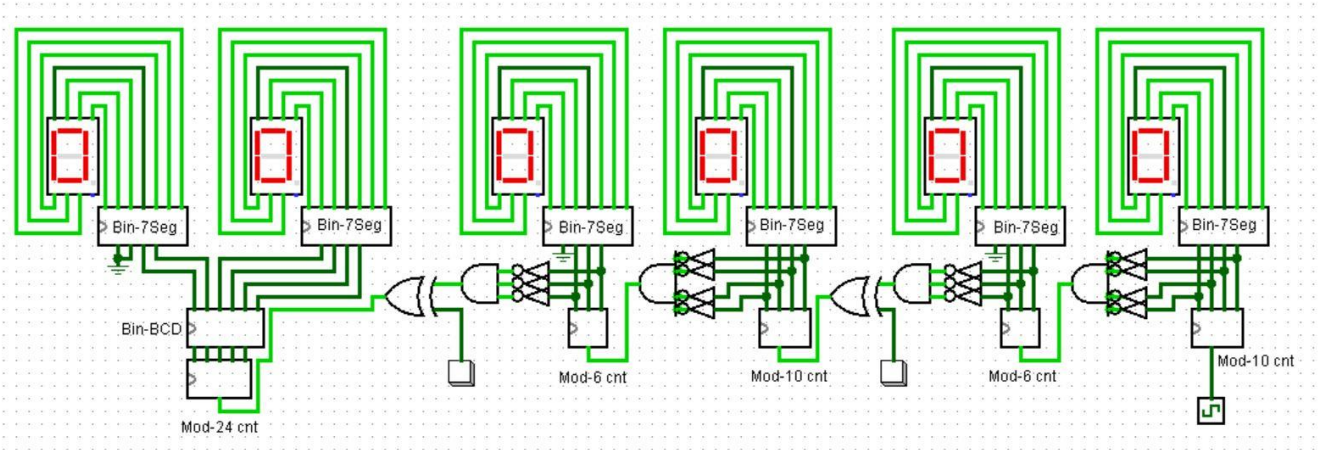
- The pulse generator: provides a 1-Hz pulse signal
- IC1-IC6: decade counters
- IC7-IC10: 7-segment display drivers
- All capacitors: decoupling
- Push-buttons: for quick adjustment of minutes and hours

3. 24-Hour Digital Clock Circuit Diagram (with Seconds)

A digital clock can be implemented by means of an asynchronous BCD ripple counter and can be driven with a 1-Hz pulse generator.

The basic idea of this implementation is that the pulse generator drives the first counter (mod-10) at 1Hz, causing a change in its state every second. The bits of the state of the first counter are inverted and ANDed such that the output of the final AND gate is equal to 1 whenever the state of the counter is 0 and 0 otherwise. The goal of this is that the output of the AND gate changes from 0 to 1 during the transition of the state of the counter from 9 to 0, triggering the next (second) counter. The second counter, in turn,

has its state inverted and ANDed so as to trigger the third counter during the transition from the maximum state to the zero state. The same idea applies to the rest of the counters.



4. Hardware Connections

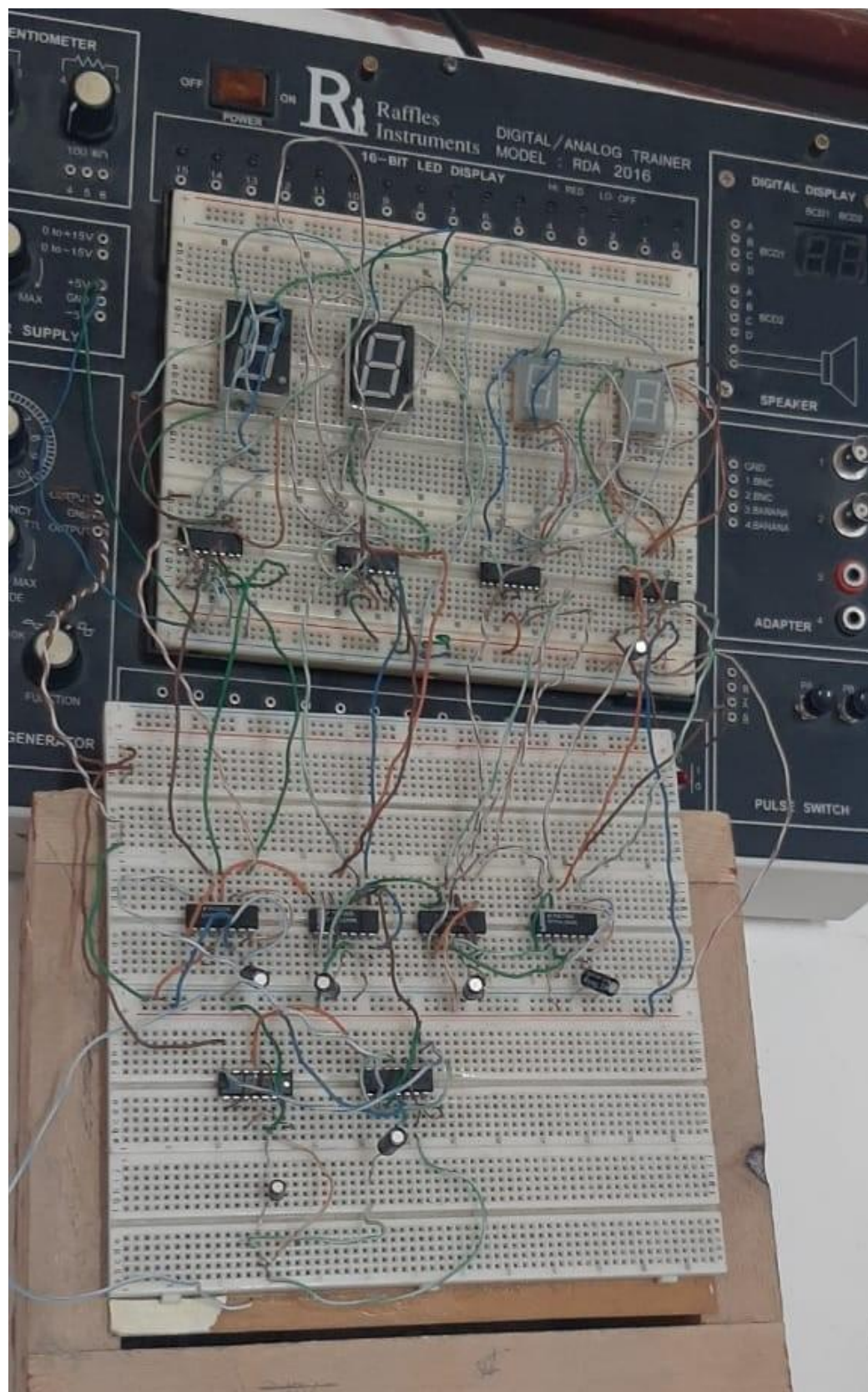


Fig. 3. The physical prototype of the digital clock built in lab.

5. 12-Hour Digital Clock Circuit Diagram (Extended)

We can obtain a 12-hour digital clock with AM/PM, days, and months by modifying the circuit in Fig. 2. In particular, we can replace the mod-24 counter with a mod-12 one and add a mod-2 counter for the AM/PM, a mod-30 counter for the days, and a mod-12 counter for months. For the days and months counters, 1 has to be added to state of each of them before displaying. That way, the values for the days and months will be from 1 to 30 and from 1 to 12 respectively. The circuit diagram for this implementation is shown in Fig. 4.

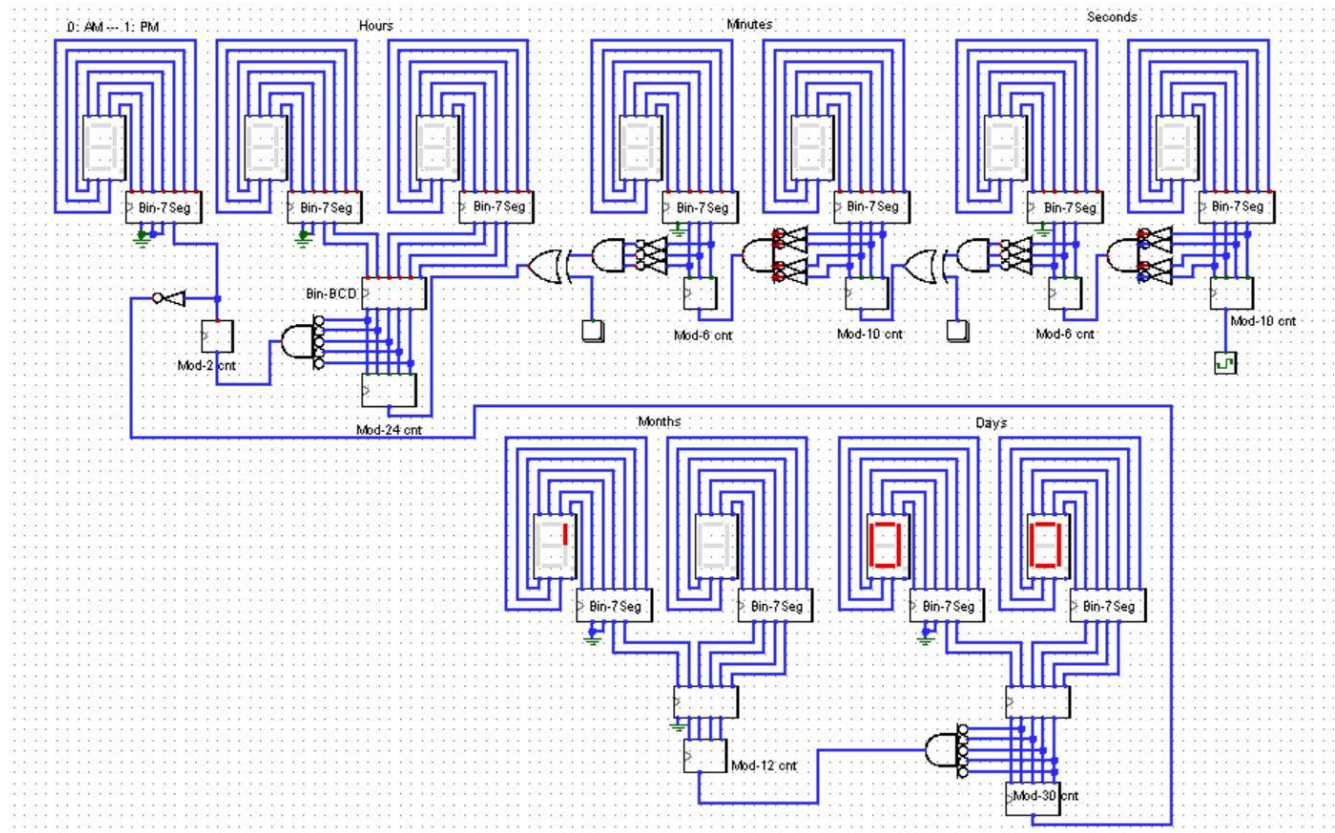


Fig. 4. The extended digital clock implementation.

6. Counters Internal Connections

A modulo- n counter can be implemented using a number of D-type flip-flops. In order to create a counter whose state goes inclusively from 0 to, say m , we first need to align n flip-flops as in Fig. 5 to obtain a $2^n - 1$ counter. n should be chosen so as to be the minimum value that satisfies $2^n - 1 \geq m$.

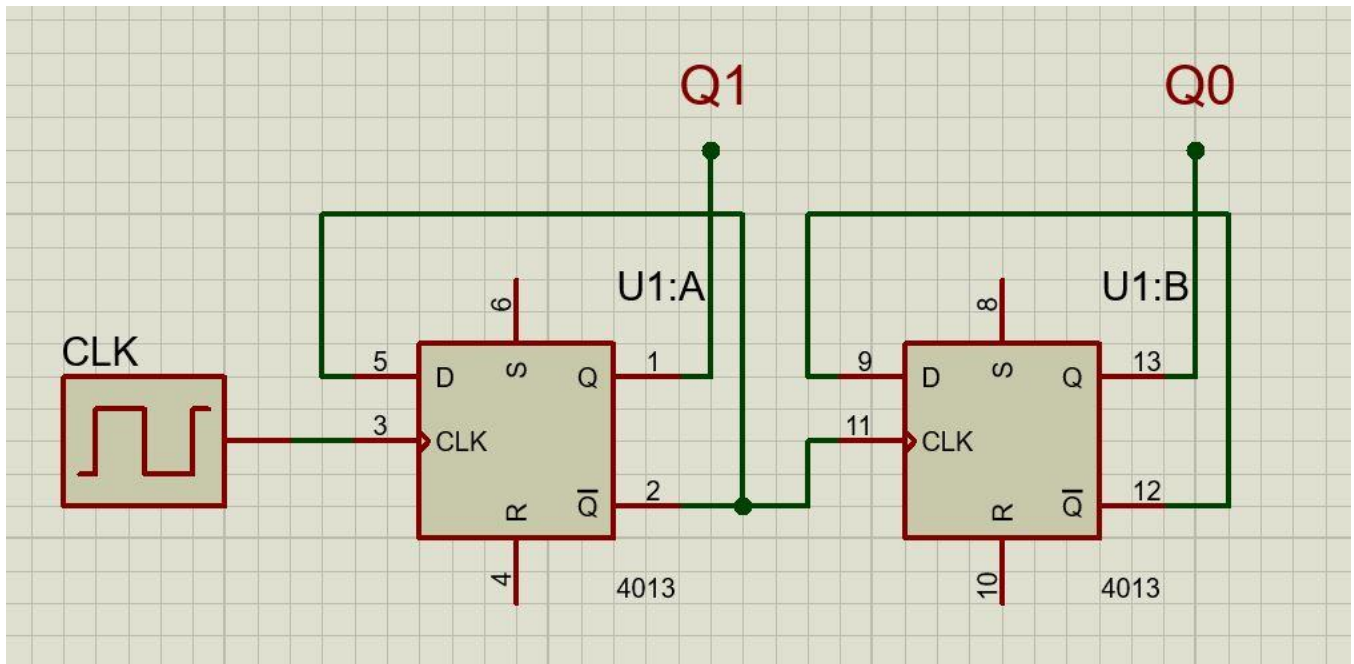


Fig. 5. The flip-flop alignment.

If m is equal to $2^n - 1$, then we're done! But if this is not the case, we will have to select the bits from right to left (or flip-flops from left to right) that have their state equal to 1 when the state of the whole counter is equal to m (the maximum desired value for the counter), AND them together, and feed them to the reset of the flip-flops. For example, if $m = 6$ (110 in binary), the second and third flip-flops will be ANDed and fed to the reset. This particular example is demonstrated in Fig. 6.

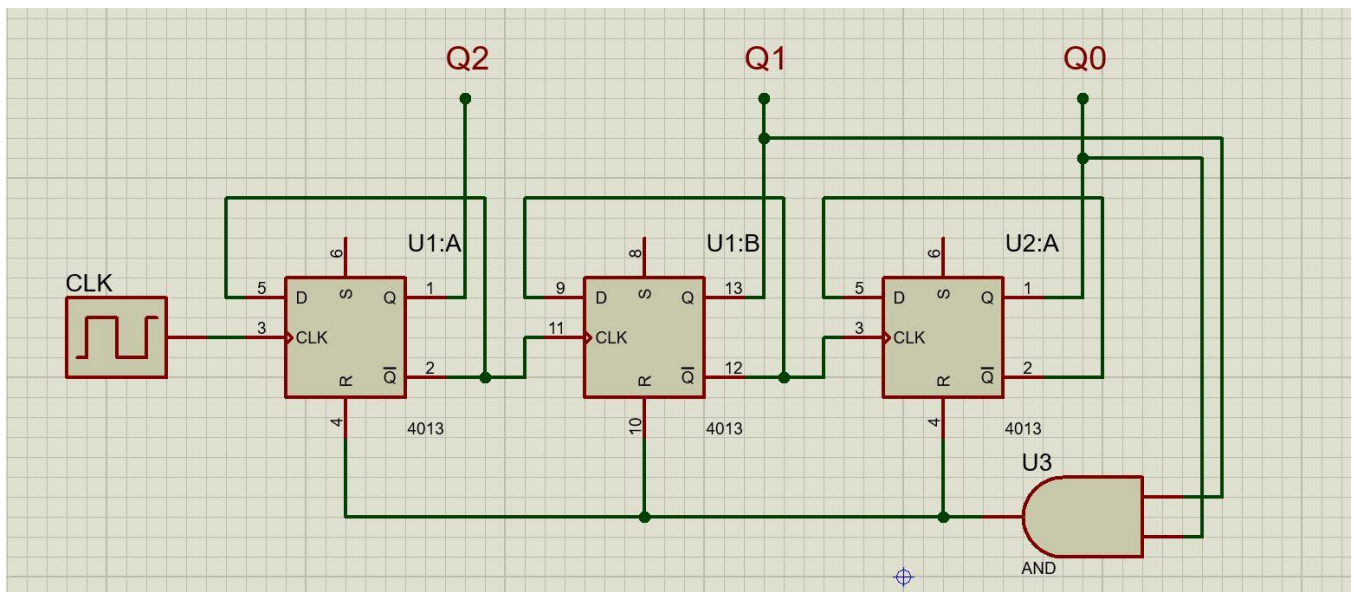


Fig. 6. Reducing the maximum state of a counter by ANDing.

6.1. Modulo-10 Counter

A modulo-10 counter using D flip-flops is shown in Fig. 7.

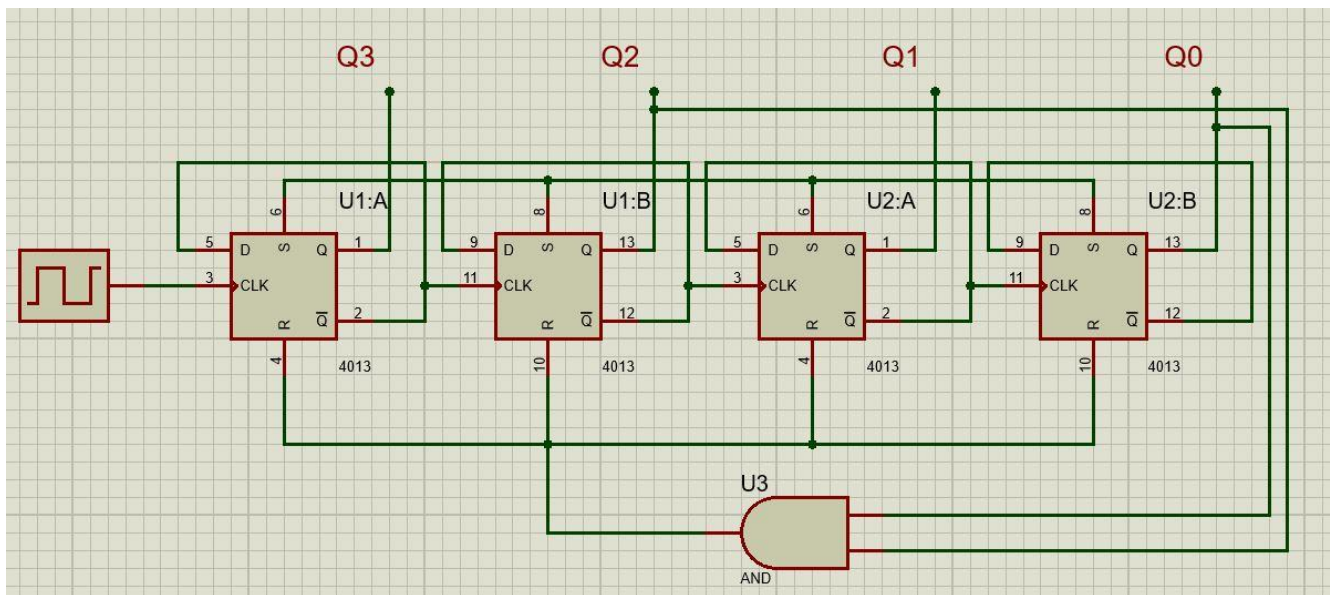


Fig. 7. Modulo-10 counter using D flip-flops.

6.2. Modulo-5 Counter

A modulo-5 counter using D flip-flops is shown in Fig. 8.

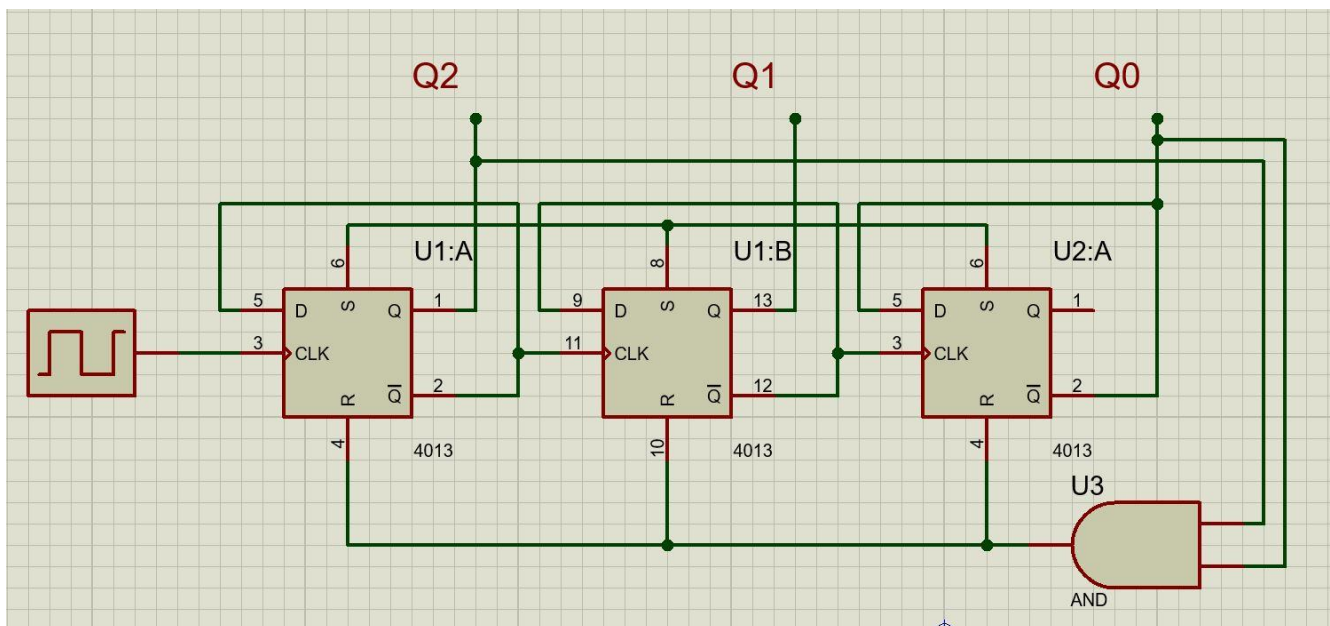


Fig. 8. Modulo-5 counter using D flip-flops.

6.3. Modulo-6 Counter

A modulo-6 counter using D flip-flops is shown in Fig. 9.

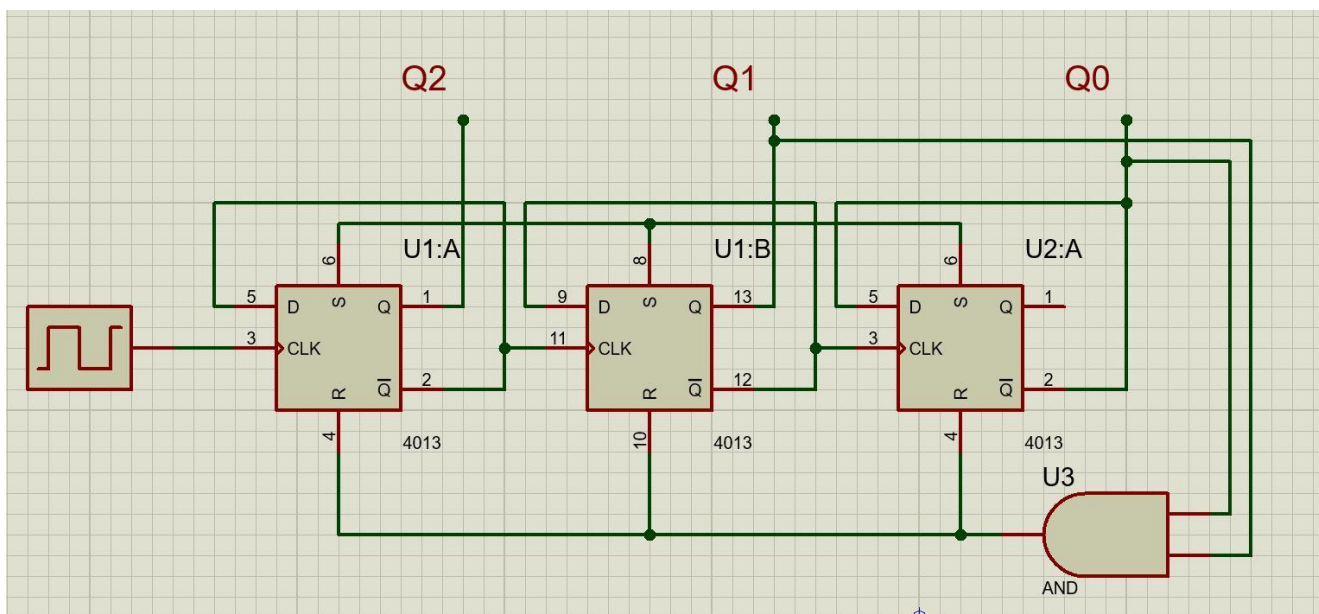


Fig. 9. Modulo-6 counter using D flip-flops.

6.4. Modulo-15 Counter

A modulo-15 counter using D flip-flops is shown in Fig. 10.

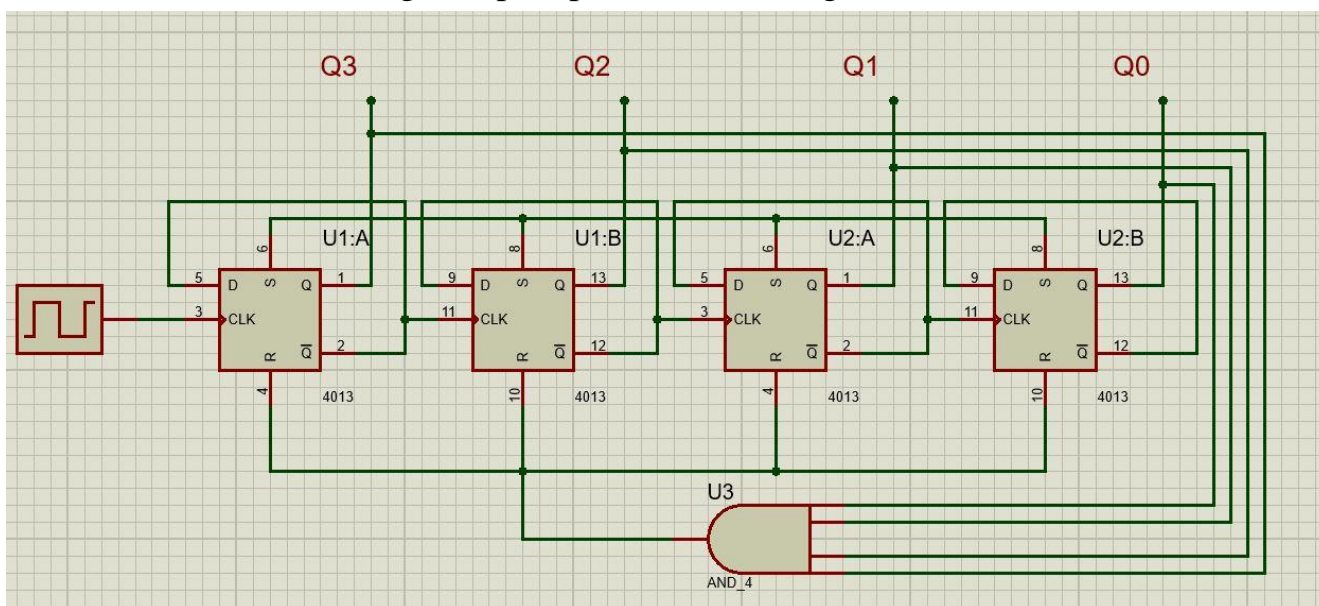


Fig. 10. Modulo-15 counter using D flip-flops.