# Lab Assignment 3

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# 8 Hour Clock

## Introduction

In this Experiment we have to build a 8 hour clock using flip flops, bcd to seven segment decoder, 7 segment display and nand gates, etc.

## Equipments required

- IC for D flip flop(8 to 9).
- SN47LS47N(BCD to seven segment decoder)(6).
- Seven Segment Display(6).
- Arduino UNO.
- Nand Gates.
- Jumper Wires.

### 7474 IC

In this experiment, we have used 7474 ic's for making counters, it is a dual D-type flip flop with Asynchronous Clear and Set inputs and complementary $(Q, \overline{Q})$ outputs.
We are making 1 MOD8, 1 MOD6 and 2 MOD10 asynchronous counters using D flip flop in this experiment.

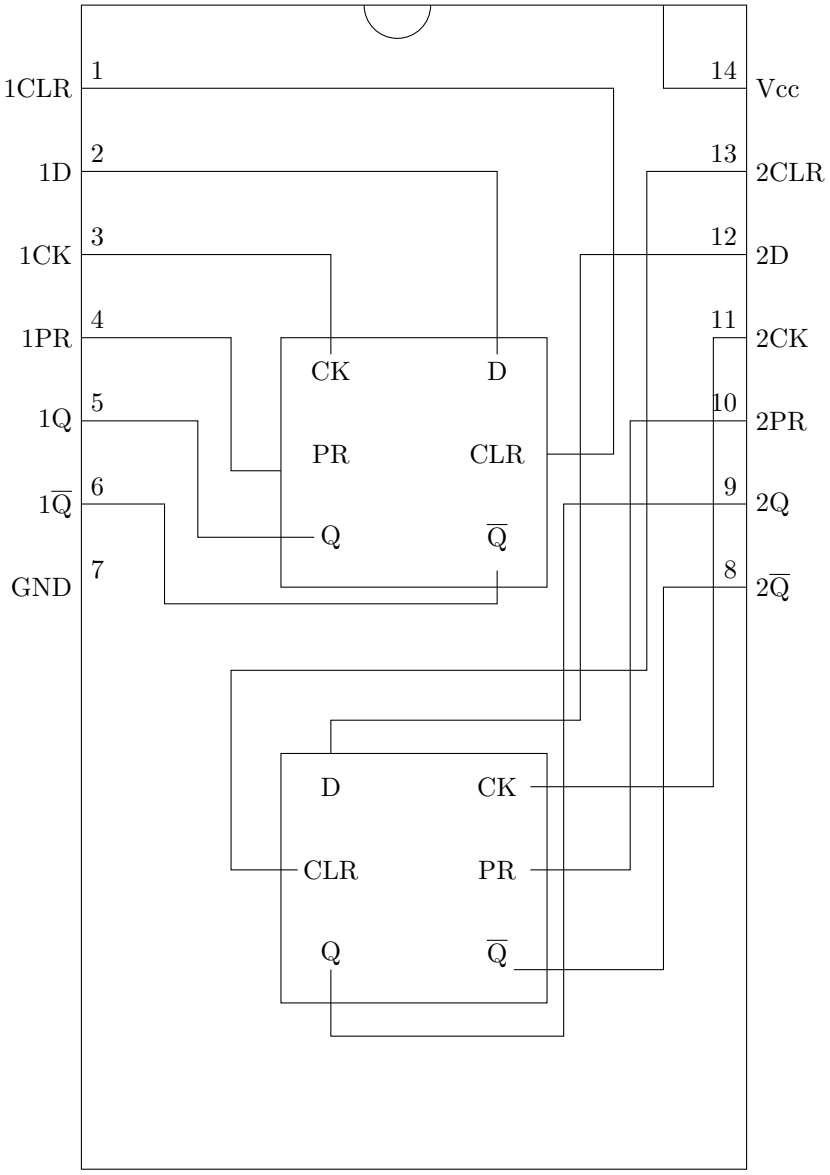


Figure 1: 7474

## SN47LS47N

The SN47LS47N is a BCD to seven segment decoder, it takes BCD input and decodes it in 7 segments which decides the digits display on the seven segment display.

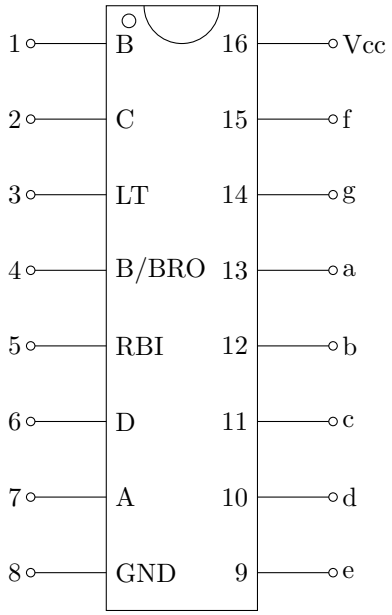


Figure 2: SN47LS47N

**Seven Segment Display**

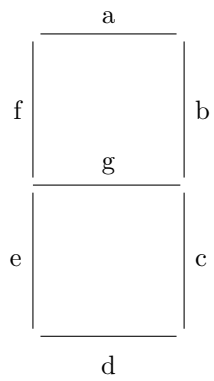


Figure 3: 7 Segment Display

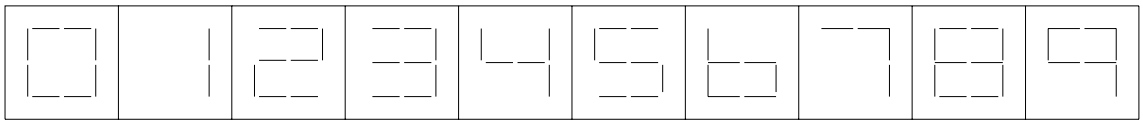

Figure 4: Numerical Desinations and resultant Display

| Function | D | C | B | A | | a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 1 | 0 | | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 3 | 0 | 0 | 1 | 1 | | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 4 | 0 | 1 | 0 | 0 | | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 5 | 0 | 1 | 0 | 1 | | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 6 | 0 | 1 | 1 | 0 | | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 7 | 0 | 1 | 1 | 1 | | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 1 | 0 | 0 | 1 | | 1 | 1 | 1 | 0 | 0 | 1 | 1 |

Table 1: Truth Table

### Arduino UNO

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs.
We are using it to generate a clock pulse for the D flip flop.

## Procedure

To make the clock first we have to make counters for unit, tenth place of seconds and minutes and than for unit place of hour, As we are making 8 hour clock we don't need to make counter for tenth place of hour.

### MOD10 counter

We require 2 MOD10 counters for unit place of minutes and seconds, which count from 0 to 9. For this we need 4 D flip flops to make MOD10 counter i.e 2 dual ff IC's.

Here is the detailed procedure how to make it

- Connect 2 7474 ICs(4 D flip flop) to breadboard and than connect the Clock pulse to PIN 3 of 1st D flip flop. Connect PIN2 and PIN 6.
- Connect PIN6 to PIN11 which is clock input for 2nd D flip flop then connect PIN12 and PIN 8.
- Connect PIN 8 of 1st IC to PIN 3 of 2nd IC which clock pulse input of 2nd IC than Connect PIN2 and and PIN 6 of 2nd IC.
- Connect PIN 6 to PIN 11 which is 4th D flip flop than connect PIN 12 to PIN 8 of 4th D flip flop.
- PIN 4 and PIN 10 of both ICs are Preset which we have to set high. PIN 1 and PIN 13 are clear if we put clear as 0 then counter will reset and start from 0 again. By this we can create MOD10 counter by taking NAND of outputs D and B of 4th, 2nd flip flop respectively and giving the feedback to reset pins of ICs.
- We are taking NAND of D and B only because we have to reset our flip flops when the binary output is 1010 which are output DCBA. Nand of D and B will become 0 at 1010, So it will reset from 10 and will become MOD10 counter.
- In our circuit we have taken clock input of flip flop from $Q'$ of previous flip flop thus making it a asynchronuous counter.

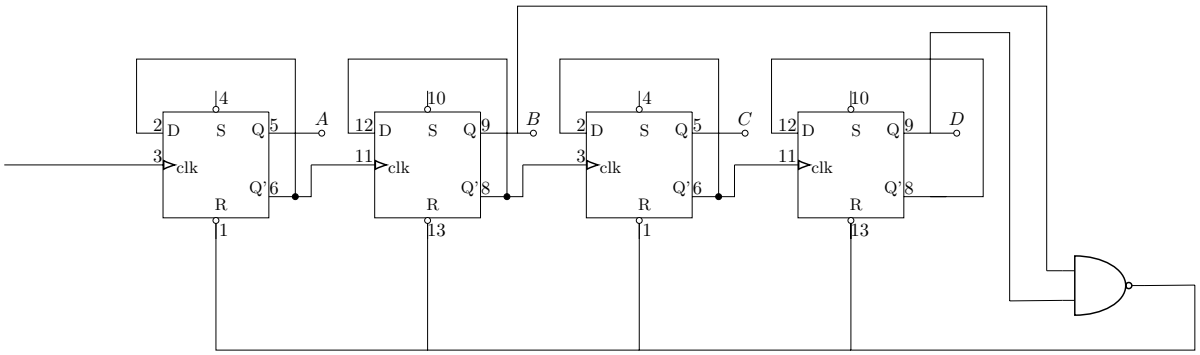


Figure 5: MOD10 Counter

## MOD6 Counter

We require 2 MOD6 counters for tenth place of minutes and seconds, which count from 0 to 5. for this we need 3 D flip flops.

The procedure to make it is same as of MOD10 counter we just have to use only 3 flip flops and take the NAND of outputs of 2nd and 3rd flip flop and connect it to the reset of all the flip flops.

Through this way we can make it count from 0 to 5.

It generates 3 bit number so we can take 4th bit as 0 for the input of BCD to Seven Segment Decoder.

## MOD8 Counter

We require 1 MOD8 counter to count from 0 to 7 for hour clock.

We can make it by using 3 D flip flop and setting the clear HIGH because 3 flip flops will already count from 0 to 7, So we don't need to take NAND.

It also generates 3 bit number so we can take 4th bit as 0 for the input of BCD to Seven Segment Decoder.

## BCD to Seven Segment Decoder

We have made counters for each Seven segment LED because we are using BCD to seven segment decoder, it takes BCD input and decodes it into binary outputs which decides the number on Seven Segment LED. So for it we need BCD input and as we know that a single digit number in binary is same as a BCD code.

Now just connect the output of our flip flops to the input A,B,C and D of Decoder respectively and then connect the output of the Decoder to the inputs of Seven segment Display.

## Clock Pulse

We generate a single clock pulse of 1 second time period for our flip flops by using Arduino UNO.

The code we used for it is given below:

```
#define CLOCK 6
#define PRESET 7
void setup() {
  Serial.begin(115200);
  pinMode(CLOCK,OUTPUT);
  pinMode(PRESET,OUTPUT);

  digitalWrite(PRESET,LOW);
  delay(100);
  digitalWrite(PRESET,HIGH);
}

void loop() {
  digitalWrite(CLOCK,LOW);
  delay(500);
  digitalWrite(CLOCK,HIGH);
  delay(500);
}
```

We connect the PIN6 of Arduino UNO to the PIN3 of 1st counter(unit place for seconds clock) now we just have to connect the Q' of last flip flop of each counter to the clock input of each counter.

So it was the whole procedure to build the clock on breadboard using D flip flop, BCD to Seven Segment Decoder, Seven segment Decoder, Arduino UNO etc.

## Conclusion

Through this experiment we have learnt about how flip flops work, how we can generate clock pulse using Arduino and how we can make counters using flip flops, we have specifically used D flip flop in this experiment we can do with J K flip flop also but it could be little more complicated.