

digital clock

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1 OBJECTIVE

The objective of this experiment is to design and implement a digital clock using an **Arduino** and the **7447 BCD to 7-segment decoder/driver IC**. The clock displays time in the **HH:MM:SS** format on six 7-segment displays. The Arduino generates the BCD (Binary-Coded Decimal) output, which is decoded by the 7447 IC to drive the 7-segment displays.

2 COMPONENTS REQUIRED

- Arduino Uno (or compatible board).
- Six 7-segment displays (common cathode or common anode).
- Six 7447 BCD to 7-segment decoder/driver ICs.
- Resistors (220Ω for current limiting in 7-segment displays).
- Breadboard and connecting wires.
- Power supply (5V DC from Arduino or external source).
- Push buttons (optional, for manual time setting).

3 CIRCUIT DESIGN

The digital clock is designed using the following components and connections:

3.1 Arduino to 7447 IC

- Connect the 4 BCD output pins of the Arduino (e.g., D2, D3, D4, D5) to the BCD input pins (A, B, C, D) of the 7447 IC.
- Connect the GND pin of the Arduino to the GND pin of the 7447 IC.

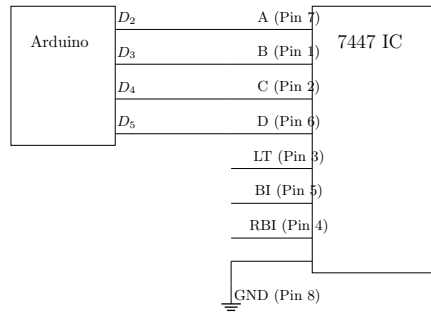
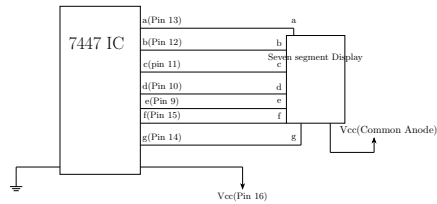


Figure 1: Connections between Arduino and 7447 BCD to 7-Segment Decoder

Fig. 1: Circuit Diagram

3.2 7447 IC to 7-Segment Displays

- Connect the output pins (a, b, c, d, e, f, g) of the 7447 IC to the corresponding segments of the 7-segment display.
- Use current-limiting resistors 200Ω between the 7447 outputs and the 7-segment display segments.
- Connect the common cathode (or anode) of the 7-segment display to GND (or VCC) depending on the type of display.



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Fig. 2: Circuit Diagram

3.3 Multiplexing

- Use six 7-segment displays for hours, minutes, and seconds.
- Use additional 7447 ICs for each digit (total of six 7447 ICs).
- Connect the BCD outputs of the Arduino to each 7447 IC in parallel, but use separate Arduino pins to control which digit is active at a time (multiplexing).
- Use Arduino digital pins (e.g., D6, D7, D8, D9, D10, D11) to control the common cathode (or anode) of each 7-segment display.

4 EXPERIMENTAL PROCEDURE

1) Circuit Connections:

- Connect the Arduino to the 7447 IC and 7-segment displays as described in the circuit design.
- Ensure proper current-limiting resistors are used for the 7-segment displays.

2) **Arduino Code:**

- Write and upload the provided Arduino code to implement the digital clock.

3) **Testing:**

- Power on the circuit and verify that the displays show the initial time (12:00:00).
- Observe the seconds incrementing every second.
- Check that the minutes and hours increment correctly.

4) **Optional Enhancements:**

- Add push buttons to manually set the hours, minutes, and seconds.
- Add an AM/PM indicator for a 12-hour format.

TABLE I: Arduino to 7-Segment Display Connections

Arduino Pin	7-Segment Display Pin
2	a
3	b
4	c
5	d
6	e
7	f
8	g
9	COM (1st Display)
10	COM (2nd Display)
11	COM (3rd Display)
12	COM (4th Display)
A0	COM (5th Display)
A1	COM (6th Display)

5 ARDUINO CODE

Below is the Arduino code used to implement the digital clock:

```

1 #include <stdint.h>
2 #include <stdbool.h>
3 #include <avr/io.h> // For AVR microcontrollers
4 #include <util/delay.h> // For delay functions
5
6 // Define BCD output pins
7 #define BCD_A 2
8 #define BCD_B 3

```

```

9  #define BCD_C 4
10 #define BCD_D 5
11
12 // Define digit control pins
13 const uint8_t digitPins[6] = {6, 7, 8, 9, 10, 11};
14
15 // Variables to store time
16 uint8_t hours = 12;
17 uint8_t minutes = 0;
18 uint8_t seconds = 0;
19
20 // Function to set a specific pin HIGH or LOW
21 void setPin(uint8_t pin, bool state) {
22     if (state) {
23         PORTB |= (1 << pin); // Set pin HIGH
24     } else {
25         PORTB &= ~(1 << pin); // Set pin LOW
26     }
27 }
28
29 // Function to display a digit on the 7-segment display
30 void displayDigit(uint8_t digit, uint8_t value) {
31     // Set the BCD output based on the value
32     setPin(BCD_A, value & 0x01);
33     setPin(BCD_B, (value >> 1) & 0x01);
34     setPin(BCD_C, (value >> 2) & 0x01);
35     setPin(BCD_D, (value >> 3) & 0x01);
36
37     // Turn on the corresponding digit
38     setPin(digitPins[digit], true);
39     _delay_ms(5); // Display for a short time
40     setPin(digitPins[digit], false); // Turn off the digit
41 }
42
43 // Function to update the time
44 void updateTime() {
45     seconds++;
46     if (seconds >= 60) {
47         seconds = 0;
48         minutes++;
49         if (minutes >= 60) {
50             minutes = 0;
51             hours++;
52             if (hours >= 24) {
53                 hours = 0;
54             }
55         }
56     }
57 }
58
59 int main(void) {
60     // Set BCD pins as output
61     DDRB |= (1 << BCD_A) | (1 << BCD_B) | (1 << BCD_C) | (1 << BCD_D);

```

```

62 // Set digit control pins as output
63 for (uint8_t i = 0; i < 6; i++) {
64     DDRB |= (1 << digitPins[i]);
65     setPin(digitPins[i], false); // Turn off all digits initially
66 }
67
68 // Main loop
69 while (1) {
70     // Update time every second
71     static uint32_t lastTime = 0;
72     uint32_t currentTime = millis(); // Implement millis() for your
73     platform
74     if (currentTime - lastTime >= 1000) {
75         lastTime = currentTime;
76         updateTime();
77     }
78
79     // Display hours, minutes, and seconds
80     displayDigit(0, hours / 10); // Tens place of hours
81     displayDigit(1, hours % 10); // Units place of hours
82     displayDigit(2, minutes / 10); // Tens place of minutes
83     displayDigit(3, minutes % 10); // Units place of minutes
84     displayDigit(4, seconds / 10); // Tens place of seconds
85     displayDigit(5, seconds % 10); // Units place of seconds
86 }
87
88 return 0;
89 }

```

Listing 1: Arduino Code for Digital Clock

6 OBSERVATIONS AND RESULTS

- The Arduino generated the correct BCD output for each digit.
- The 7447 IC successfully decoded the BCD signals and drove the 7-segment displays.
- The digital clock displayed the time accurately in the HH:MM:SS format.
- Multiplexing ensured that all digits were displayed clearly without flickering.

7 CONCLUSION

The digital clock was successfully implemented using an Arduino and the 7447 BCD to 7-segment decoder/driver IC. The circuit accurately displayed time in the HH:MM:SS format. Future enhancements could include adding an AM/PM indicator, alarm functionality, and manual time-setting buttons.