Hardware Experiment of Digital Clock

Murra Rajesh Kumar Reddy - EE24BTECH11043

1. Abstract

This project demonstrates the implementation of a digital clock using an Arduino Uno, six seven-segment displays, and a 7447 BCD to 7-segment decoder IC. The clock displays time in HH:MM:SS format and uses multiplexing to drive the display. The system maintains accurate time and includes buttons for setting hours, minutes, and seconds.

2. Introduction

A digital clock is a fundamental electronic project that displays real-time information using seven-segment displays. The aim of this project is to build a simple digital clock with six seven-segment displays controlled by an Arduino Uno and a 7447 BCD to 7-segment decoder IC. The system updates the time every second and provides push buttons to adjust the time settings.

3. Components Required

The following components are required to build the digital clock:

1) Arduino Uno (1x)
2) 7-Segment Display (Common Anode or Common Cathode) (6x)
3) 7447 BCD to 7-Segment Decoder IC (1x)
4) Resistors (330Î©) (6x)
5) Push Buttons (4x)
6) Connecting Wires
7) Breadboard and Power Supply

4. Circuit Diagram and Connections

The Arduino controls the seven-segment displays using multiplexing. The 7447 IC converts the BCD inputs from the Arduino into corresponding seven-segment patterns.

4-A. Arduino Pin Configuration

Arduino Pin	**Connected To**
PD2 - PD5	7447 BCD Inputs (A, B, C, D)
PD6, PD7	Hour Display Control
PB0, PB1	Minute Display Control
PB2, PB3	Second Display Control
PC0, PC1, PC2	Buttons for setting time
PC3	Reset Button

TABLE I
PIN CONNECTIONS

Circuit Diagram of Aurdino to 7447 IC

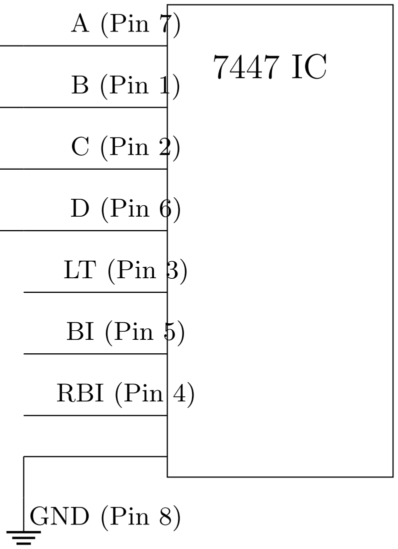


Figure 1: Connections between Arduino and 7447 BCD to 7-Segment Decoder

4-B. Connections from 7447 to 7-Segment Display

7447 Pin	Function	7-Segment Display Pin
13	Segment 'a'	Connected to segment 'a'
12	Segment 'b'	Connected to segment 'b'
11	Segment 'c'	Connected to segment 'c'
10	Segment 'd'	Connected to segment 'd'
9	Segment 'e'	Connected to segment 'e'
15	Segment 'f'	Connected to segment 'f'
14	Segment 'g'	Connected to segment 'g'
Common Anode (CA)	Power for segments	Connected to VCC

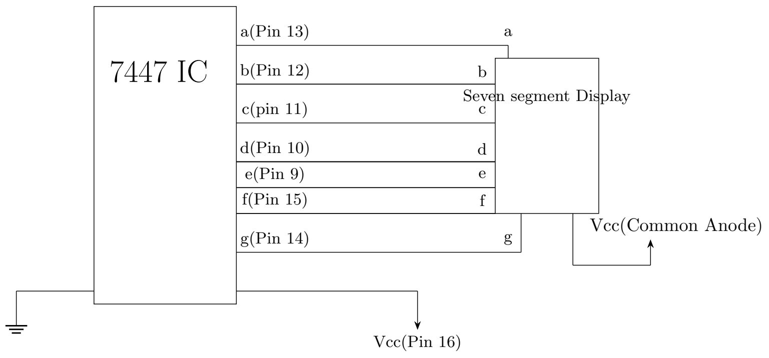
TABLE II
7447 to 7-Segment Display Pin Mapping

Additional 7447 Pin Connections

7447 Pin	Function	Connection
16	VCC (Power)	+5V
8	GND (Ground)	GND
3	LT (Lamp Test)	Connected to +5V (Disable Test Mode)
5	BI (Blanking Input)	Connected to +5V (Enable Display)
4	RBI (Ripple Blanking Input)	Connected to +5V (Disable Blanking)

TABLE III
Additional 7447 Pin Connections

Circuit Diagram of 7447 Ic to Seven segment



5. Code Implementation

The following code is used to control the digital clock. The code includes functions for timekeeping, multiplexing, and handling button inputs.

```
// BCD Output Pins
#define A PD2
#define B PD3
#define C PD4
#define D PD5

// Common Display Pins
#define H1 PD6
#define H2 PD7
#define M1 PB0
#define M2 PB1
#define S1 PB2
#define S2 PB3

// Button Pins
#define SET_HOUR PC1
#define SET_MIN PC2
#define SET_SEC PC0
#define RESET_BTN PC3

// Global BCD digits for the clock
volatile uint8_t h1 = 0, h2 = 0, m1 = 0, m2 = 0, s1 = 0, s2 = 0;
volatile uint32_t millis_count = 0, last_second = 0;
uint8_t current_digit = 0;
const uint8_t mux_interval = 2;
const uint16_t debounce_interval = 200;

void init_timer0() {
    TCCR0A |= (1 << WGM01);
    TCCR0B |= (1 << CS01) | (1 << CS00);
    OCR0A = 249;
    TIMSK0 |= (1 << OCIE0A);
    sei();
}

ISR(TIMER0_COMPA_vect) {
    millis_count++;
}

uint32_t millis() {
    uint32_t ms;
    cli();
    ms = millis_count;
    sei();
    return ms;
}

uint8_t bcdIncrement(uint8_t bcd, uint8_t max) {
    if (bcd == max) return 0;
    return bcd + 1;
}

void updateTime() {
    if (millis() - last_second >= 1000) {
        last_second += 1000;
        s2 = bcdIncrement(s2, 9);
        if (s2 == 0) {
            s1 = bcdIncrement(s1, 5);
            if (s1 == 0) {
                m2 = bcdIncrement(m2, 9);
                if (m2 == 0) {
                    m1 = bcdIncrement(m1, 5);
                    if (m1 == 0) {
                        h2 = bcdIncrement(h2, 9);
                        if (h2 == 0) {
                            h1 = bcdIncrement(h1, 2);
                            if (h1 == 2 && h2 > 3) {
                                h1 = h2 = 0;
                            }
                        }
                    }
                }
            }
        }
    }
}

void setup() {
    DDRD |= 0xFC;
    DDRB |= 0x0F;
    DDRC &= ~0x0F;
    PORTC |= 0x0F;
    init_timer0();
    last_second = millis();
}

int main(void) {
    setup();
    while (1) {
        updateTime();
    }
    return 0;
}
```

6. Results and Observations

1) The clock successfully displays real-time hours, minutes, and seconds.
2) Time increments every second and rolls over correctly at 23:59:59.
3) The push buttons allow manual time adjustments.
4) The multiplexing approach ensures efficient display updates with minimal flicker.

7. Conclusion

This project successfully implemented a ”Digital clock” using an ”Arduino Uno, six seven-segment displays, and a 7447 (BCD to 7-segment decoder) IC”. The use of multiplexing allowed for efficient display control while minimizing pin usage. The system accurately keeps track of time and allows manual adjustments via push buttons. This project serves as a foundation for advanced embedded systems applications involving real-time display control.

8. References

1) CHAT gpt