

Digital Clock Implementation using Arduino with Multiplexing and Editing Features

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Introduction

- Digital clock system with editing features using Arduino
- Multiplexing six 7-segment displays using minimal I/O pins
- Pause/play functionality and digit-by-digit editing
- Boolean logic for increment/decrement and constraints for each digit

Components List

| Component | Value | Quantity |
|-----------------------|----------------|----------|
| Arduino Uno | | 1 |
| USB Cable | Type B | 1 |
| Seven Segment Display | Common Cathode | 6 |
| Push Buttons | | 4 |
| IC 7447 | | 1 |
| Jumper Wires | M-M | 16 |
| Breadboard | | 1 |
| Resistors | 220 Ω | 7 |
| Resistors | 10k Ω | 4 |

Arduino Pin Connections

| Item | Arduino Pin | Function |
|---------------|-------------|----------------------|
| Button 1 | D10 | Edit Mode Toggle |
| Button 2 | D11 | Next Digit Selection |
| Button 3 | D12 | Increment Digit |
| Button 4 | D13 | Decrement Digit |
| IC 7447 Pin 7 | D0 | BCD Bit 0 (A) |
| IC 7447 Pin 1 | D1 | BCD Bit 1 (B) |
| IC 7447 Pin 2 | D2 | BCD Bit 2 (C) |
| IC 7447 Pin 6 | D3 | BCD Bit 3 (D) |
| Display 1 | D4 | Hours Tens Digit |
| Display 2 | D5 | Hours Units Digit |
| Display 3 | D6 | Minutes Tens Digit |
| Display 4 | D7 | Minutes Units Digit |
| Display 5 | D8 | Seconds Tens Digit |
| Display 6 | D9 | Seconds Units Digit |

Multiplexing

- All BCD inputs shared among six 7-segment displays
- Arduino controls enable pins D4-D9
- Each digit displayed for 1ms \rightarrow appears continuous
- Saves I/O pins, enables six-digit display

Editing System

- 1 PAUSE button toggles run/edit mode
- 2 NEXT button selects which digit to edit
- 3 INC button increments selected digit (rollover constraints)
- 4 DEC button decrements selected digit (rollunder constraints)
- 5 Selected digit blinks every 500ms

Digit Constraints

- Seconds/Minutes Ones: 0–9
- Seconds/Minutes Tens: 0–5
- Hours Ones: 0–9 (if tens = 0/1), 0–3 (if tens = 2)
- Hours Tens: 0–2

Seconds / Minutes / Hours (Tens= 0/1) Ones (0-9)

| Z | Y | X | W | D | C | B | A |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

$$A = W'_1$$

$$B = (W_1 X'_1 Z'_1) + (W'_1 X_1)$$

$$C = (X'_1 Y_1) + (W'_1 Y_1) + (W_1 X_1 Y'_1)$$

$$D = (W'_1 Z_1) + (W_1 X_1 Y_1)$$

Seconds / Minutes Tens (0-5)

| Z | Y | X | W | D | C | B | A |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

$$A = W'_2$$

$$B = (W_2 X'_2 Y'_2) + (W'_2 X_2)$$

$$C = (W_2 X_2) + (W'_2 X'_2 Y_2)$$

$$D = 0$$

Hours Ones (Tens = 2 \rightarrow 0-3)

| X | W | D | C | B | A |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 |

$$A = W'_5$$

$$B = (W_5 X'_5) + (W'_5 X_5)$$

$$C = 0$$

$$D = 0$$

Hours Tens (0-2)

| X | W | D | C | B | A |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |

$$A = W'_6 X'_6$$

$$B = W_6 X'_6$$

$$C = 0$$

$$D = 0$$

Seconds / Minutes / Hours(Tens = 0/1) Ones (0-9)

| Z | Y | X | W | D | C | B | A |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

$$A = W'_1$$

$$B = (X'_1 W'_1 ((Z'_1 Y_1) + (Z_1 Y'_1))) + (Z'_1 W_1 X_1)$$

$$C = (Z'_1 Y_1 (X_1 + W_1)) + (Z_1 X'_1 W'_1 Y'_1)$$

$$D = X'_1 Y'_1 ((Z_1 W_1) + (Z'_1 W'_1))$$

Seconds / Minutes Tens (0-5)

| Z | Y | X | W | D | C | B | A |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |

$$A = W'_2$$

$$B = (Y_2 X'_2 W'_2) + (Y'_2 X_2 W_2)$$

$$C = X'_2((Y_2 W_2) + (Y'_2 W'_2))$$

$$D = 0$$

Hours Ones (Tens = 2 \rightarrow 0-3)

| X | W | D | C | B | A |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 0 |

$$A = W'_5$$

$$B = (X_5 W_5) + (X'_5 W'_5)$$

$$C = 0$$

$$D = 0$$

Hours Tens (0-2)

| X | W | D | C | B | A |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 |

$$A = X_6 W'_6$$

$$B = X'_6 W'_6$$

$$C = 0$$

$$D = 0$$

Hardware Implementation

- Connect seven-segment displays to breadboard
- Connect all segment outputs together (through resistors)
- Make connections to IC7447 and buttons to Arduino
- Add current-limiting resistors for LEDs
- Add pull-down resistors for buttons

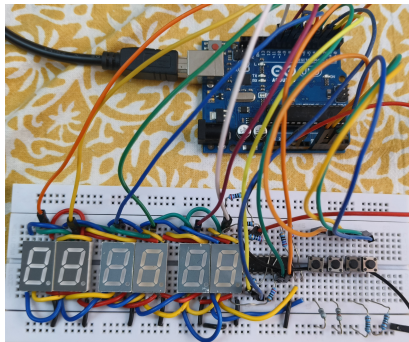
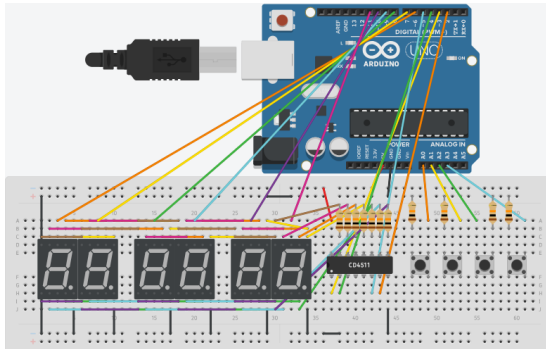


Figure: Final Arduino-based Clock Implementation

Tinkercad Simulation



Clock Tinkercad Simulation

Summary

- Successfully implemented digital clock with editing features
- Efficient multiplexing and minimal I/O usage
- Complete increment/decrement logic implemented via Boolean expressions
- Full digit-by-digit editing with constraints for hours, minutes, seconds

Acknowledgment

The complete source code and documentation can be found at:
<https://github.com/Dhawal24112006/projects.git>

Thank You!