PRINCIPLES AND APPLICATION OF MICROCONTROLLERS
Arduino Lab2: Digital Watch

Introduction

In this lab, you are required to design and build a digital watch using an Arduino MCU. The digital watch you are required to build comprises two 7-segment LEDs that display time in second. The watch has two modes: a clock mode and a stopwatch mode. The watch has three keys: mode, adjust/start, and reset. After completing this lab you should be able to:

- Master in advanced Arduino programming
- Implement 7-segment LEDs

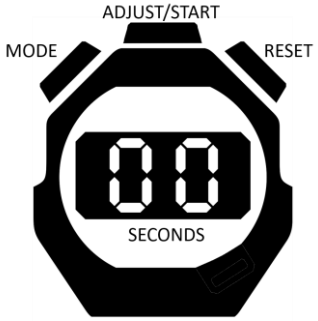

Figure 1: Digital watch

Parts List

- A breadboard
- An Arduino Uno MCU
- Resistors
- Buttons
- 7-segment LEDs

7-segment LED

A 7-segment LED (Fig. 2) is an electronic device for displaying decimal numerals. These displays are widely used in digital clocks, electronic meters, and basic calculators. In a typical 7-segment LED package, all of the cathodes or all of the anodes of the segment LEDs are connected to a common pin. This is referred to as a "common cathode" or "common anode" device. Table 1 lists the encodings for displaying digits.

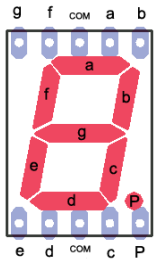

Figure 2: 7-segment LED

Table 1: Musical note frequency

Digit	a	b	c	d	e	f	g
0	on	on	on	on	on	on	off
1	off	on	on	off	off	off	off
2	on	on	off	on	on	off	on
3	on	on	on	on	off	off	on
4	off	on	on	off	off	on	on
5	on	off	on	on	off	on	on
6	on	off	on	on	on	on	on
7	on	on	on	off	off	off	off
8	on	on	on	on	on	on	on
9	on	on	on	on	off	on	on

Digital Watch

The digital watch you are asked to build has two modes: a clock mode and a stopwatch mode. The modes are switched using the button “mode” (Fig. 3). The digital watch is in the clock mode when powered on. In the clock mode, the watch counts the time continuously. The 7-segment LEDs display the time in second. The LEDs resets to zero when the time reaches 60 s.

In the stopwatch mode, the LEDs initialize with a number of 60. If the key "start" is hit once, the watch starts to count down the time from 60 s. The watch stops counting the time when it reaches zero, or when the key "start" is hit a second time. The watch time resets to 60 when the key "reset" is hit. The reset function should not work when the watch is counting down. Note that the watch keeps tracking the current time in both the clock mode and stopwatch mode. When the watch is switched to the stopwatch mode and later is switched back to the clock mode again, it keeps counting the time.

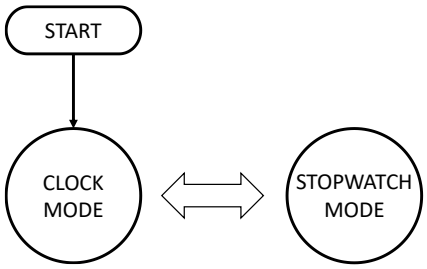

Figure 3: Modes of the digital watch

Procedure

Connect pins A2, A3, and A4 as the buttons (Fig. 2). Pin 2 through pint 8 are used as the outputs to the 7-segment that displays digit in ones. Pin 9 through pint 13 and pins A0 and A1 are used as the outputs to the 7-segment that displays digit in tens. Connect the pins as shown in Fig. 2. Write an Arduino program to function the digital watch.

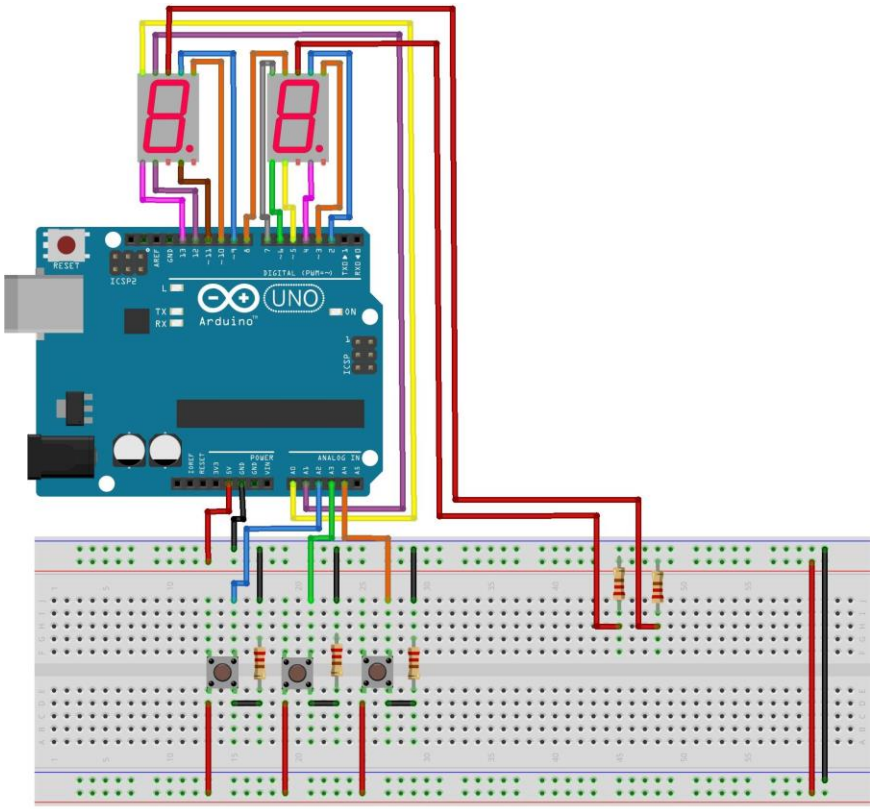

Figure 4: Circuit of the digital watch

Deliverables

Basic + advanced points (100%):

Demo your digital watch to the TAs, or record it in a video. Upload the followings to ceiba: 1) your Arduino scratch, 2) a photo of your physical circuit, and 3) contributions from each teammate to the lab. The contributions must include the information of the tasks each teammate has done and the contributions in percentage. The total percentage should be 100%. All the teammates have to agree with the contributions before they are uploaded.

Bonus

You will obtain a 20% bonus if you use a multiplexed 7-segment LED to display both minute and second of the watch.

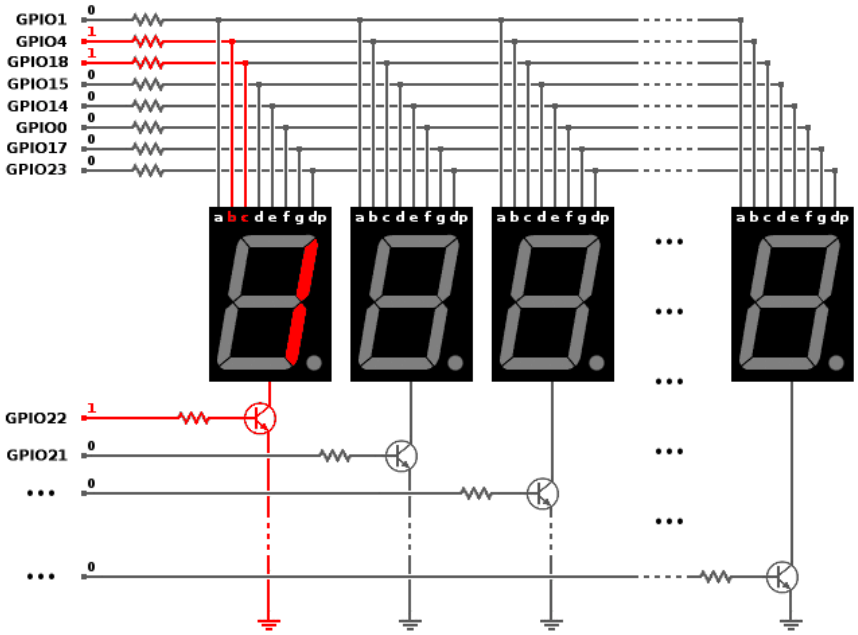

Figure 5: Multiplexed 7-segment LED