

CMPE 322: Micro-controllers and Interfacing

Lab #3

Due 11/08/2023 at 3:30pm

Fall 2023

Deliverables

- Code (C or assembly)
- Answer the questions and show your work (take pictures for the report)
- Demo to the instructor

Introduction and requirements

Our goal in this lab is to display numbers between 0 and 9 using one of the 7-segment displays on the Basys MX3. Note that the Basys MX3 has four displays. A 7-segment display consists of LEDs positioned in a specific configuration. Two formulations are possible: Common anode and common cathode as shown in figure 1. Note that the voltage level used to turn on the LEDs is not the same for the common anode and common cathode.

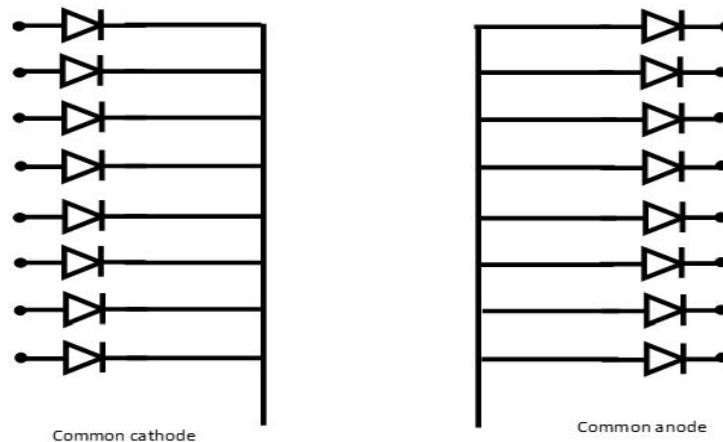


Figure 1: Common anode and common cathode

Basys MX3 uses common anode as shown in figure 2. The common anode signals are available as four “digit enable” input signals to the 4-digit display. The cathodes of similar segments on all four displays are connected into seven circuit nodes labeled CA through CG (so, for example, the four “D” cathodes from the four digits are grouped together into a single circuit node called “CD”). These seven cathode signals are available as inputs to the 4-digit display. This signal connection scheme creates a multiplexed display, where the cathode signals are common to all digits but they can only illuminate the segments of the digit whose corresponding anode signal is asserted.

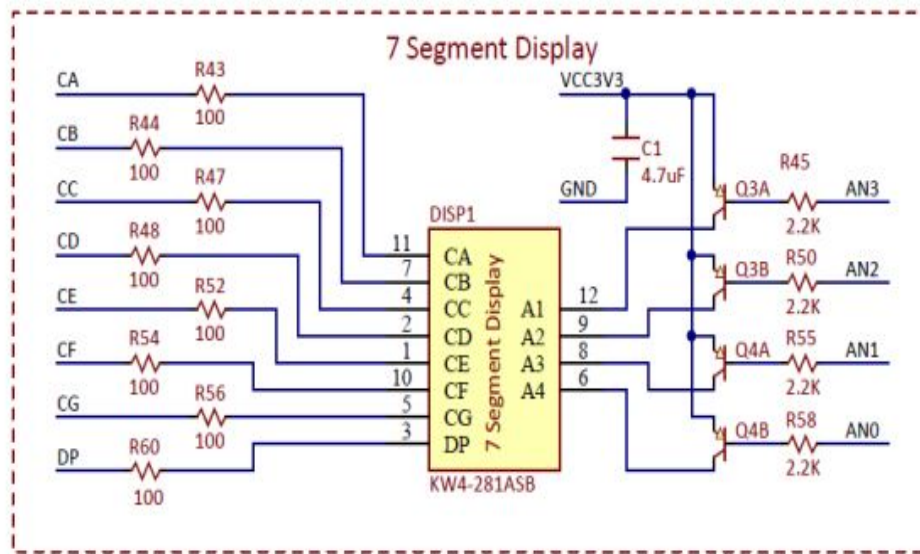


Figure 2: Seven segment connection diagram

To illuminate a segment, the anode should be driven high while the cathode is driven low; however, since the Basys MX3 uses transistors to drive enough current into the common anode point, the anode enables are inverted. Therefore, both the AN0 ... AN3 and the CA ... CG/DP signals are driven low when active.

The 7 segment connectivity is given by

| Name | PIC32 Pin | Description |
|------|------------------------|--------------------------------|
| AN0 | AN12/PMA11/RB12 | Anode 0 pin |
| AN1 | AN13/PMA10/RB13 | Anode 1 pin |
| AN2 | VREF-/CVREF-/PMA7/RA9 | Anode 2 pin |
| AN3 | VREF+/CVREF+/PMA6/RA10 | Anode 3 pin |
| CA | TRD1/RG12 | Cathode A pin |
| CB | RPA14/RA14 | Cathode B pin |
| CC | PMD14/RD6 | Cathode C pin |
| CD | TRD0/RG13 | Cathode D pin |
| CE | RG15 | Cathode E pin |
| CF | PMD15/RD7 | Cathode F pin |
| CG | PMD13/RD13 | Cathode G pin |
| DP | TRD2/RG14 | Cathode DP (decimal point) pin |

There exist different ways to perform BCD to 7 segments displays. One possibility is to use the table below that shows the digits and corresponding segments. This table assumes that the least significant bit is zero and common cathode.

| Digit | Segment on | | | | | | | Hex code |
|-------|------------|---|---|---|---|---|---|----------|
| 0 | A | B | C | D | E | F | – | FC |
| 1 | – | B | C | – | – | – | | 60 |
| 2 | A | B | – | D | E | – | G | DA |
| 3 | A | B | C | D | – | – | G | F2 |
| 4 | – | B | C | – | – | F | G | 66 |
| 5 | A | – | C | D | – | F | G | B6 |
| 6 | A | | C | D | E | F | G | BE |
| 7 | A | B | C | – | – | – | – | E0 |
| 8 | A | B | C | D | E | F | G | FE |
| 9 | A | B | C | D | – | F | G | F6 |

Table 1: Digits and corresponding segments

Requirements

1. Write code in C or assembly to display the numbers in the 7-segment display. Feel free to use the results in table 1 or a different method.
2. Display the numbers in sequence of increasing order (0, 1, 2, ... 9, 0, 1...). Each number should be displayed for at least 1 second.
3. Display the numbers in sequence of decreasing order (9, 8, 7, ... 0, 9, 8...). Each number should be displayed for at least 1 second.
4. Add two switches as digital inputs. We call them SW1 and SW2.
 - (a) If SW1 is closed and SW2 open, display the number 1.
 - (b) If SW2 is closed and SW1 open, display the number 0.
5. Perform the addition below and display the result on the 7-segment display

$$2 + 6$$