CMPE 322: Micro-controllers and Interfacing

Lab #4
Due 11/15/2023

Fall 2023

Deliverables

- Code (C or assembly)

- Answer the questions and discuss your work and methods. Take pictures for the report.

- Demo to the instructor

Introduction and requirements

This lab is a continuation of the previous lab. The Basys MX 3 has four 7-segment displays that use common anode. The connection diagram is shown in figure 1 below.
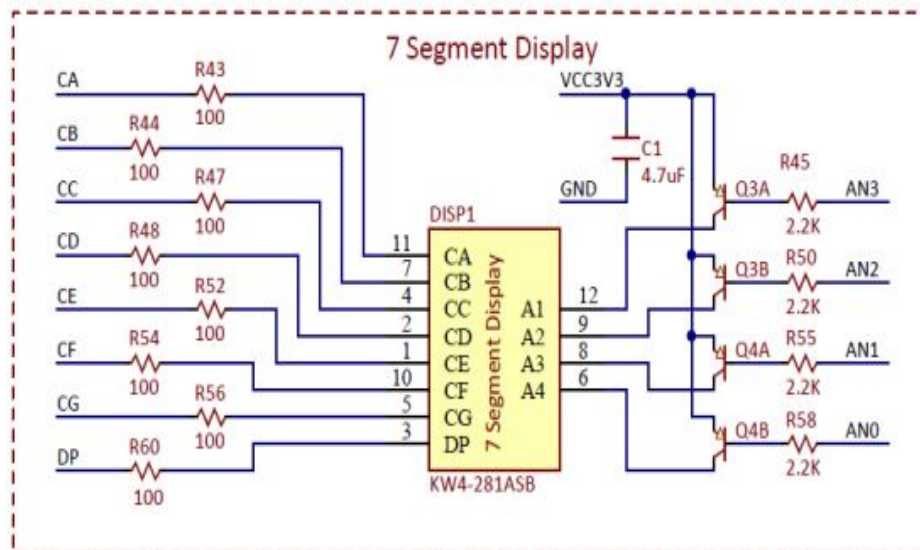

Figure 1: Seven segment connection diagram

In the previous lab we used one display only, in this lab we use all four displays. The principle is to trick the human eye using a scanning display controller. A scanning display controller circuit can be used to show a 4-digit number on this display. This circuit drives the anode signals and corresponding cathode patterns of each digit in a repeating, continuous succession at an update rate that is faster than the human eye can detect. Each digit is illuminated just one-fourth of the time, but because the eye cannot perceive the darkening of a digit before it is illuminated again, the digit appears continuously illuminated. If the update, or "refresh", rate is slowed to around 45 hertz, a flicker can be noticed on the display. In order to

make each of the four digits appear bright and continuously illuminated, all should be driven once every 1 to 16ms, with a refresh frequency of about 1 KHz to 60Hz. For example, if every digit is refreshed every 3 ms, corresponding to a frequency of 333Hz, the entire display will be refreshed every 12ms. The controller must drive low the cathodes with the correct pattern when the corresponding anode signal is driven high. To illustrate the process:

1. If AN0 is asserted while CB and CC are asserted, then a "1" will be displayed in digit position 1.

2. If AN1 is asserted while CA, CB, and CC are asserted, a "7" will be displayed in digit position 2.

3. If AN0, CB, and CC are driven for 4ms, and then AN1, CA, CB, and CC are driven for 4ms in an endless succession, the display will show "71" in the first two digits.

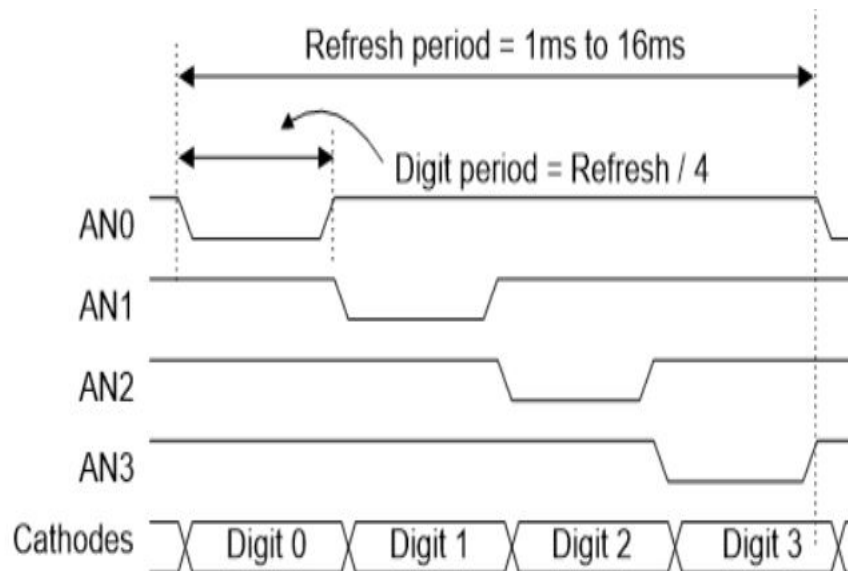An example timing diagram for a four-digit controller is shown in Figure 2.

Figure 2: Example for timing diagram for a four-digit controller

Requirements

Write code to do the following

1. Display a four-digit number of your choice

2. Count up from 0 to 20

3. Count down from 9999 to 9979

4. Display numbers 33, 999 and then their sum

5. Display numbers 33, 44 and their product