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Laboratory #2

ECE 2022

1 Introduction

This laboratory consists of two parts. In the first part of the lab, you will design and build a 2 bit BCD to 7 Segment decoder and display a number from 0 to 3 on a 7 Segment display. In the second part of the lab, you will use an IC 4 bit BCD to 7 Segment decoder instead of the 2 bit BCD to 7 Segment decoder you build in part one to display a 4 bit BCD number on a 7 segment display.

You received several parts today (see Table 1). Try to identify each part.

1	8 DIP Switch
1	9-1×1 KΩ Resistor Network
1	8×330 Ω Resistor Network
1	7 Segment Display with Common Anode
1	74LS04 (6 Inverters)
1	74LS08 (4 AND with 2 Inputs each)
1	74LS47 (4 bit BCD to 7 Segment Decoder)

Table 1: Parts for Laboratory #2

2 Design and Build a 2 bit BCD to 7 Segment Decoder

As was mentioned in the pre-lab, a full blown 4 bit BCD to 7 Segment decoder is too extensive a circuit to build during a lab session. Therefore, you will build a 2 bit BCD to 7 Segment decoder using the knowledge you acquired before coming to lab (from the pre-lab).

Upon finishing this part of the lab you must have the following items complete:

1. Completed Truth Table
2. Completed Karnaugh Maps
3. Simplified logic equations
4. Draw the decoder circuit schematic and show to the TA
5. Build the circuit and show to the TA

During part 2 of this laboratory you will implement a full 4 bit to 7 segment display decoder using a single chip implementation.

2.1 Build and Show a 2 bit BCD Value on a 7 Segment Display

Having designed a 2 bit BCD to 7 Segment decoder in the pre-lab, you will now implement it using logic gates on your protoboard. Show your circuit schematic to the TA before proceeding to build the circuit.

Additionally, you will build an input and an output circuit so that you can select a number to display on the 7 Segment display. The blocks of the final circuit you will build are outlined in the following sections.

NOTE: You will be using the display portion of the following circuit, with the 74LS47 decoder that you will utilize in the second part of this lab, during lab #3. Consequently, we recommend that you build this part of the circuit on the *right* side of the protoboard and save it for next lab.

2.1.1 Input Circuit

The input circuit consists of an 8 DIP Switch and a resistor array. Figure 1 shows the schematic of the input circuit. Although you only need two switches for the 2 bit BCD to 7 Segment decoder, implement four switches as you will need them in part two for the full 4-bit 74LS47 implementation.

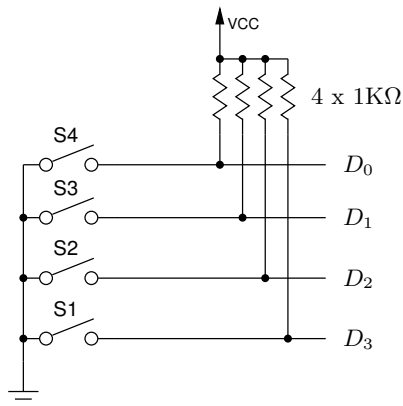


Figure 1: Schematic of the Input Circuit

The input circuit uses four resistors of the same value, all connected with one pin to Vcc. A resistor network can do this much more elegantly than using the individual resistors in your kit(s). Figure 2 shows how the resistors in the resistor network are connected. Pin 1 is the pin that is connected to all the resistors. It is marked on the plastic by either an indentation or a dot.

2.1.2 Output Circuit

The output circuit consists of a resistor network and the 7 Segment display. The 74LS47 chip has high sink current outputs and can sink up to 24 mA. This is sufficient to drive an LED. However a current limiting resistor is needed. Figure 3 shows the schematic of the output circuit.

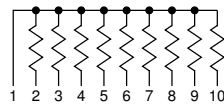


Figure 2: 9-1×1 KΩ Resistor Network

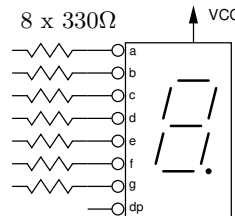


Figure 3: Schematic of the Output Circuit

The output circuit uses seven resistors of the same value all connected to the 7 Segment display. A 330 Ω resistor network is provided for this. Figure 4 shows the resistors in the resistor network.

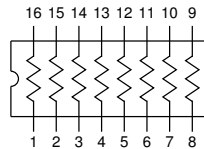


Figure 4: 8×330 Ω Resistor Network

Figure 5 shows the pin-out of the 7 Segment display. You need to connect only one of the two pins labeled *anode* to Vcc.

2.1.3 Complete Circuit

Build the 2 bit BCD to 7 Segment decoder you designed earlier in the lab (build the circuit in the center of the protoboard) and connect it to the I/O circuits as illustrated in Figure 6. Connect the two input lines to the input circuit and the seven output lines to the output circuit. Show the working circuit to the TA.

3 Show a 4 bit BCD Value on a 7 Segment Display

A 4 bit BCD to 7 Segment decoder requires many logic gates and it would take a long time to wire it. Therefore this part of the lab uses the 74LS47 chip which contains a 4 bit BCD to 7 Segment decoder. Its functionality is basically the same as the circuit you designed for the pre-lab but extended for the full 0-10 input code range. It has an input called \overline{LT} which causes all segments to light up. The inputs $\overline{BI}/\overline{RBO}$ and \overline{RBI} can be used when multiple 7 Segment decoders and displays are used to show a multiple digit number. It would prevent leading '0s' to be displayed. This lab does not use these functions.

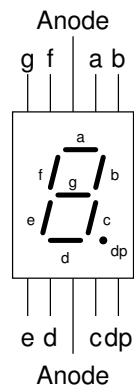


Figure 5: 7 Segment Display

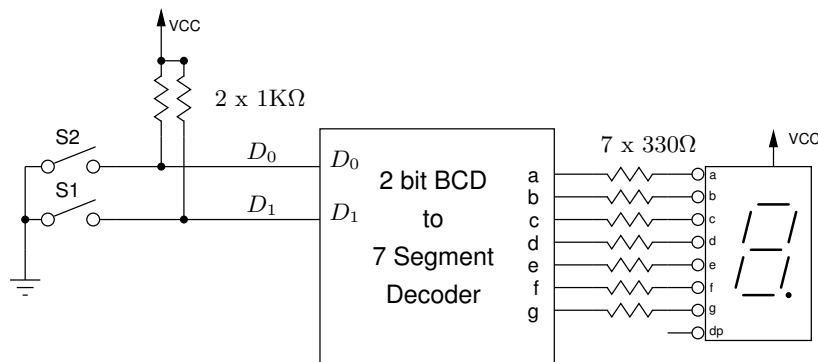


Figure 6: Complete Circuit with 2 bit BCD to 7 Segment Decoder

Upon completion of this experiment you must have performed the following tasks:

1. Build the circuit
2. Demonstrate the working circuit to the TA
3. Return the parts to the TA

3.1 Input/Output Circuit

The input and output circuit for this part of the lab is the same as for part one. Disassemble the 2 bit BCD to 7 Segment decoder. Note that you will be using all four switches of the input circuit in this part of the lab as you will be displaying a 4 bit BCD value.

3.2 Circuit using 74LS47 IC

Now add the 74LS47 decoder IC to your circuit instead of the 2 bit BCD to 7 Segment decoder you were previously utilizing. The complete schematic is shown in Figure 7. If all switches are *off*

(i.e. a logic high on all inputs) then the display should be off. If all switches are *on* (i.e. a logic low on all inputs) then the display should show “0.” Show the working circuit to the TA.

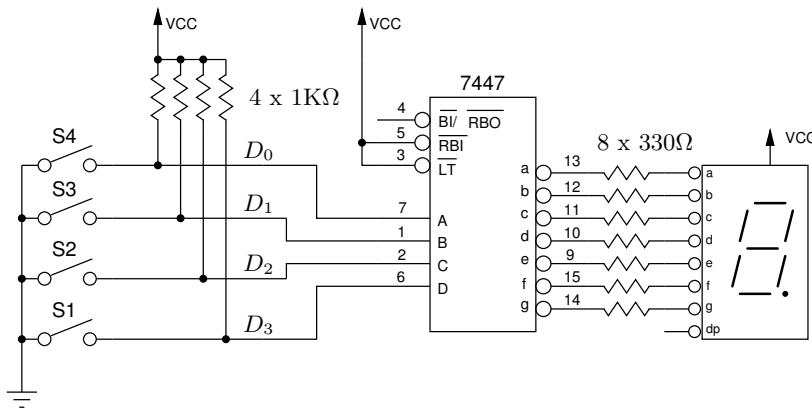


Figure 7: Schematic of the Circuit