Lab Experiment 8

Decoder Circuit: Binary-Coded-Decimal to 7-segment Decoder

COMPONENTS

- 7447 BCD to 7-segment decoder
- LSD 3221-111 7-segment
- Jumper Wires
- Protoboard
- 220 Ω DIP resistors

INTRODUCTION

A Binary Coded Decimal is a number in which each decimal digit is coded as a binary number. Each decimal digit can be one of the following: 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9. The largest decimal symbol is 9, and its binary representation needs 4 bits (1001_2.)

Therefore the input to a decoder that accepts a BCD number needs 4 input variables. In this experiment we will assign the letters A (LSB), B, C, and D (MSB) to the BCD input variables.

A very popular and user friendly display for decimal symbols is the 7 segment display. This display consists of 7 rectangular shaped LEDs arranged in a figure 8.1. Each one of these is named **a** through **g** as can be seen in the following picture. There are two types of 7 segment displays, namely the common *anode* and the common *cathode*. Here we will use a common anode display. **Pin 3 is connected to +5V**. A 220 Ω resistor is connected to the cathode of each LED. To light any particular LED segment, its resistor must be grounded. Therefore a ground (or 0) turns the LED on. Keep in mind that pins 4, 5, and 12 are not present in the display.

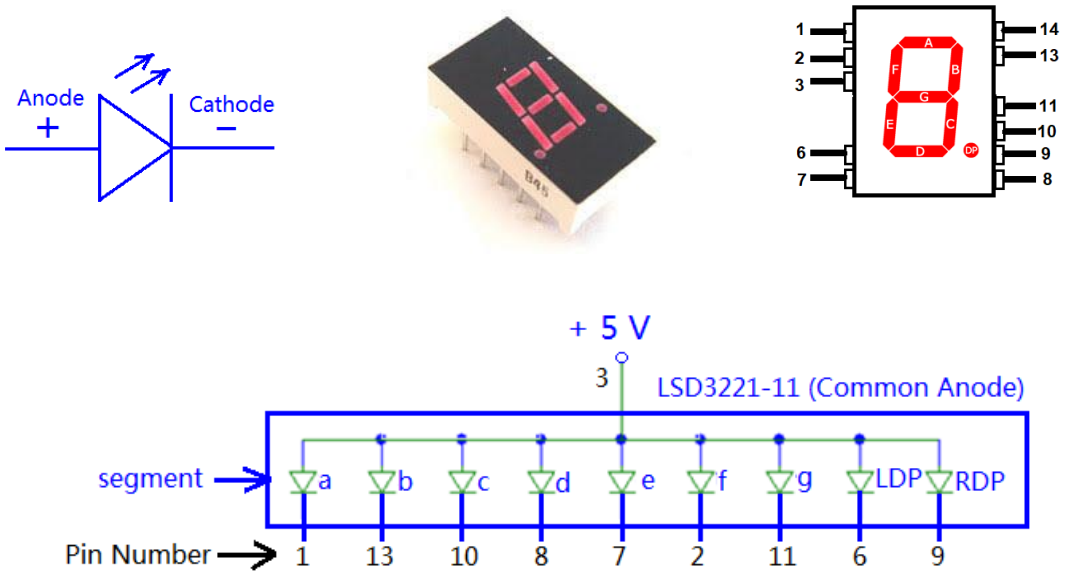
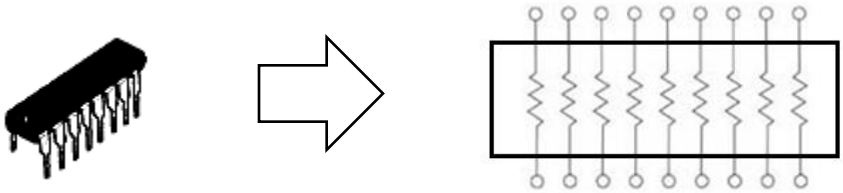


Figure 8.1 – 7 Segment Display

In order to represent a decimal symbol, a combination of segments is lit at the same time. For example, 0 would be seen if all the segments are lit except segment g. Here are the 0 through 9 representations.

Each LED needs a series resistor to take the surplus voltage and limit the current to a safe value. Here we need seven 220Ω resistors. We will use a resistor pack of 8 resistors built into a DIP (we will use 7 of the 8 resistors.) This is what the package looks like and a diagram of how the resistors are arranged inside the DIP.



LAB EXPERIMENT PROCEDURE

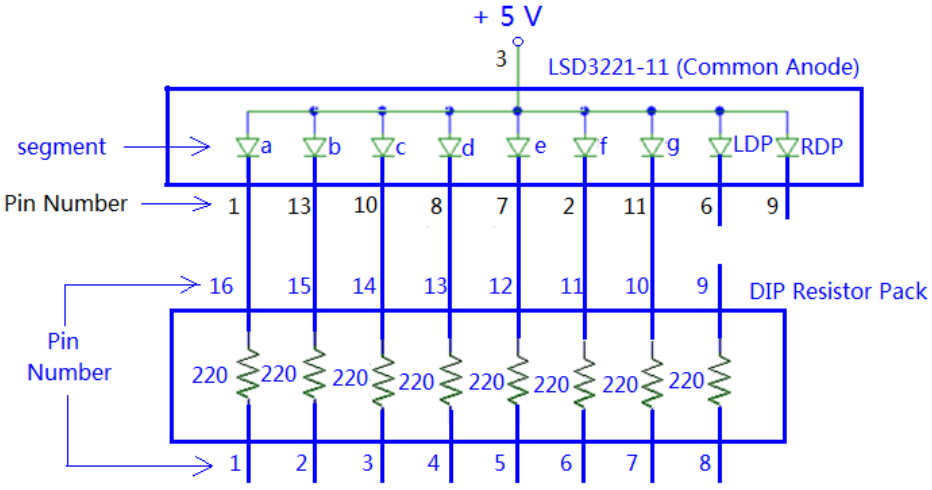
TESTING THE 7-SEGMENT

- Obtain a 7 segment display and a DIP of 8 resistors from your components kit
- Insert the 7 segment display onto the protoboard PROPERLY. Try to insert the 7 segment far to the digital board (green board). Remember that you need to save space in your protoboard for two more chips (DIP resistor and 74LS47)
- Insert the DIP resistor pack next to the 7 segment display
- To provide power to the 7 segment display, connect a jumper from **pin 3 to the Power line (+5V)** on the protoboard.
- You will now connect the resistors from the DIP resistor pack to the cathodes of each LED in the display. To connect one end of each resistor to the cathode of each LED, insert jumper wires (the red wires from your kit are a good size) according to the following table.

Segment Name	Pin # on 7 Segment Display	Pin # on DIP resistor pack
a	1	16
b	13	15
c	10	14
d	8	13
e	7	12
f	2	11
g	11	10

Table 8.1 – 7 Segment Display and DIP Connections

You have just wired the following circuit:



— You will now test each segment. Connect one end of a jumper wire to ground, in sequence, connect the other end of the jumper to pin 1 through 7 on the DIP resistor pack. Observe that segments from ***a*** through ***g*** light up in sequence. As you make each connection to ground, complete Table 8.2.

Pin # of DIP resistor pack connected to ground	Which segment will turn ON?
1	
2	
3	
4	
5	
6	
7	

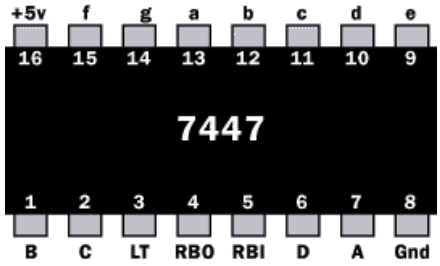
Table 8.2 – 7 Segment Display

— Once Table 8.2 is completed, turn OFF the power switch.

Connecting the 7447 BCD to 7 segment decoder to the DIP resistor pack and the 7 segment display

If we have a BCD input and we want to show the equivalent decimal digit on a 7 segment display, we need a circuit that decodes the BCD into the proper arrangement of lit LEDs on the 7 segment display. This circuit is called a BCD to 7 segment decoder. The decoder provides ground to the proper LEDs segments in order to make them light.

Here is the pinout diagram for the 7447 BCD to 7-segment decoder.



Note that pins 7 (LSB), 1, 2, and 6 (MSB) accept the BCD decimal while pins 9 through 15 give the proper output for the 7 segment display. **Pin 16 gets +5V while pin 8 goes to ground**. Pin 3 is a test pin: with no inputs, grounding pin 3 lights up all 7 segments. Pins 4 and 5 shut off the display in case of leading or trailing zeros. This is used when there are several digits displayed and there are leading or trailing zeros. For example, 00304.02000 would be displayed as 304.02; blanking out the two leading and the three trailing zeros.

— Obtain the TTL 74LS47 BCD to 7-segment decoder from your components kit
— Insert the 74LS47 decoder next to the DIP resistors
— Provide power to the 74LS47 by connecting pin 16 to +5V and pin 8 to ground.
— To simulate the BCD input, insert jumper wires from the switches to the 74LS47 as shown in Table 8.3

7447 Designation and Variable Name	74LS47 pin #	Switch #
A (LSB)	7	8
B	1	7
C	2	6
D (MSB)	6	5

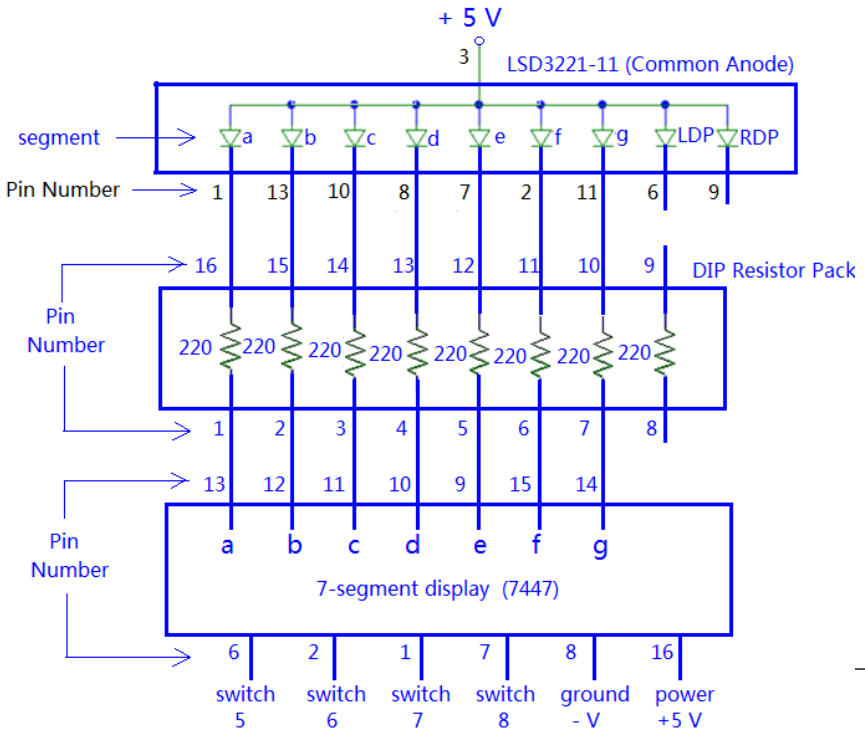
Table 8.3 – 74LS47 pin connection

— You will now connect the 74LS47 outputs to the DIP resistor pack. Insert jumper wires as assigned in the following table, Table 8.4

74LS47 pin #	DIP resistor pack pin #
13	1
12	2
11	3
10	4
9	5
15	6
14	7

Table 8.4 – 74LS47 and DIP resistor connection

You have wired the following circuit:



TESTING OPERATION

- Turn ON the digital board.
- Operate the four switches in binary sequence according to the truth table, Table 8.5.
- For each switch setting, put a **0** in the truth table if the segment is **ON** and a **1** if the segment is **OFF**. This is because we are using a ***common anode*** 7-segment
- In the last column record the 7 segment display number.

Input (Switch)				Segments							Display number
D	**C**	**B**	**A**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	
0	0	0	0								
0	0	0	1								
0	0	1	0								
0	0	1	1								
0	1	0	0								
0	1	0	1								
0	1	1	0								
0	1	1	1								
1	0	0	0								
1	0	0	1								

Table 8.5 – 7-Segment Display

QUESTIONS

1. How many pins can be used to connect power to a 7-segment display?
2. In a common anode 7-segment display, how come there is no provision for a ground connection?
3. The two types of 7 segment displays are common _____ and common _____.
4. Usually a 14 pin DIP TTL chip that has pins missing is broken. Is this true of a 7-segment display?
5. For a common cathode of a 7 segment display, a _____ will light up each segment.
6. Why is a resistor needed between the output of the decoder and each segment of the 7-segment display?

Student's Name: _____ Lab Instructor's Signature_____

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