

DESIGN OF CODE CONVERTERS

OBJECTIVE:

1. Design and build gray code to binary converter.
2. Design and build BCD-to-7 segment converter.

APPARATUS:

- Seven segment display.
- SN 7400 quad 2-input NAND gates (1)
- SN 7410 triple 3-input NAND gates (4)
- SN 7420 dual 4-input NAND gates (4)
- SN 7404 HEX inverter (1)
- SN 7446 BCD-to-seven segment decoder.

THEORY:

The conversion from one code to another is common in digital systems. Sometimes the output of a system is used as the input to the other system. A conversion circuit is necessary between 2 systems if each system uses different codes for the same information.

In this experiment you will design and construct 3-combinational circuit converters:

See section 4-5 in your book for further information.

Procedure:

1. *Gray code to Binary converter:*

Gray code is one of the codes used in digital systems. It has the advantage over binary numbers that only one bit in the code word changes when going from one number to the next. (See Table 1).

Design a combinational circuit with 4 inputs and 4 outputs that converts a four-bit gray code number into an equivalent four-bit Binary number. Use Karnaugh map technique for simplification. Use LogicWorks for pre-lab demonstrations. Select the library “7400dev.clf” in the Parts Palette and then select the XOR chip 74-86. This would give you a set of 4 XOR’s as shown in Fig. 1, just like the hardware chip 74-86. You could use as many as needed from these XOR gates in your design. Get back to ALL LIBRARIES and select switches for the inputs and Binary Probes as indicators of the outputs. Verify your design in the pre-Lab. During the Lab construct the circuit and verify its operations.

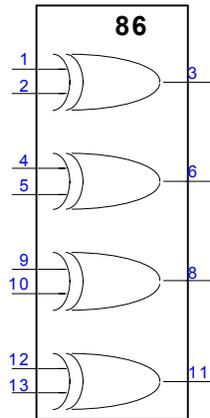


Figure. 1 XOR chip74-86

Decimal	Gray	Binary
0	0000	0000
1	0001	0001
2	0011	0010
3	0010	0011
4	0110	0100
5	0111	0101
6	0101	0110
7	0100	0111
8	1100	1000
9	1101	1001
10	1111	1010
11	1110	1011
12	1010	1100
13	1011	1101
14	1001	1110
15	1000	1111

2. **BCD-to-seven Segment converter:**

A light emitting Diode (LED) is a PN junction diode. When the diode is forward biased, a current flows through the junction and the light is emitted. See Fig.2.

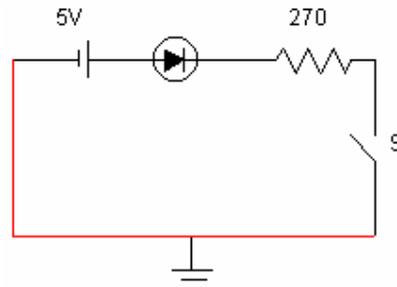


Figure.2

A seven segment LED display contains 7 LEDs. Each LED is called a segment and they are identified as (a, b, c, d, e, f, g) segments. Figure 3.

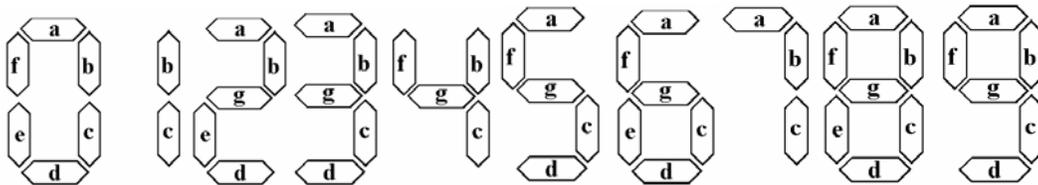


Figure 3. Digits represented by the 7 segments

The display has 7 inputs each connected to an LED segment. All anodes of LEDs are tied together and joined to 5 volts (this type is called common anode type). A limiting resistance network must be used at the inputs to protect the 7-segment from overloading.

BCD inputs are converted into 7 segment inputs (a, b, c, d, e, f, g) by using a decoder, as shown in Fig.4.

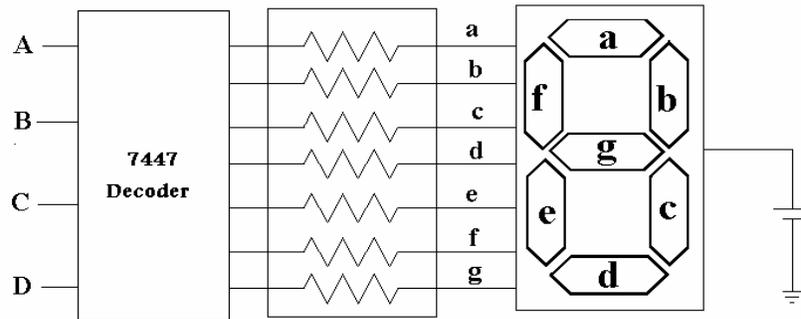


Figure. 4

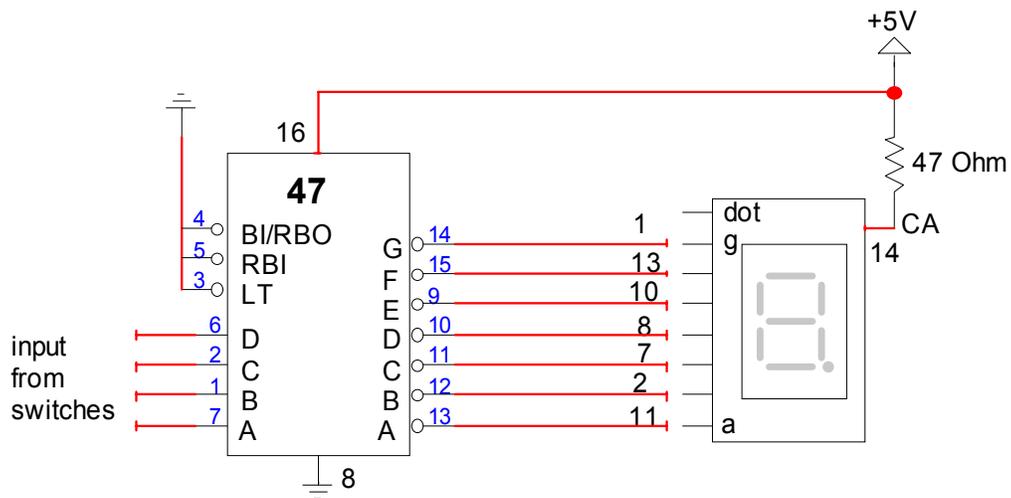
A decoder is a combinational circuit that converts binary information from n input lines to a maximum of 2^n output lines. The input to the decoder is a BCD code and the outputs of the systems are the seven segments a, b, c, d, e, f, and g. For further information and pin connections, consult the specification sheet for decoder and 7-segment units.

First design a combinational circuit which would simulate the decoder function for only the segment “a”, of the display. This can be done in the following steps:

- a) Write down the truth table with 4 inputs and 7 outputs (Table 2)
- b) For only the output “a”, obtain a minimum logic function. Realize this function using NAND gates and inverters only. For example if decimal 9 is to be displayed a, b, c, d, f, g must be 0 and the others must be 1 (For common anode type display units), if decimal 5 is to be displayed then a, f, g, c, d must be 0 and the others must be 1.
- c) Connect the output “a” of your circuit to appropriate input of 7-segment display unit. By applying BCD codes verify the displayed decimal digits for that segment for “a” of the display.
- d) Replace your circuit by a decoder IC 7447 for all of the seven segments. Observe the display and record the segments that will light up for invalid inputs sequence.
- e) Comment on the design if you don’t want to see any digit for invalid input sequence.

Table 2

Dec.	BCD				Outputs						
	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0							
1	0	0	0	1							
2	0	0	0	0							
3	0	0	1	1							
4	0	1	0	0							
5	0	1	0	1							
6	0	1	1	0							
7	0	1	1	1							
8	1	0	0	0							
9	1	0	0	1							



BCD-to-Seven Segment Decoder and 7-segment display

Note: In an actual 7-segment display the dot is on the left