

DIGITAL SYSTEM DESIGN USING IC's

INTRODUCTION

An electronic circuit formed on a small piece of semiconducting material, which Performs the same function as a larger circuit made from discrete components. Digital ICs use logic gates which work only with values of ones and zeros. A low signal sent to a component on a digital IC will result in a value of 0, while a high signal creates a value of 1. Digital ICs are the kind you will usually find in computers, networking equipment, and most consumer electronics. Logic gates perform basic logical functions and are the fundamental building blocks of digital integrated circuits. Most logic gates take an input of two binary values, and output a single value of a 1 or 0. Some circuits may have only a few logic gates.

In the following examples, each logic gate except the NOT gate has two inputs, A and B, which can either be 1 (True) or 0 (False). The resulting output is a single value of 1 if the result is true or 0 if the result is false.

1. **AND** - True if A and B are both True.
2. **OR** - True if either A or B is True.
3. **NOT** - Inverts value: True if input is False; False if input is True.
4. **XOR** - True if either A or B are True but False if both are True.
5. **NAND** - AND followed by NOT: False only if A and B are both True.
6. **NOR** - OR followed by NOT: True only if A and B are both False.
7. **XNOR** - XOR followed by NOT: True if A and B are both True or both False.

Apparatus Required: Bread board, IC7432, seven segment display, 4:16 mux decoder, LED, wires, power supply.

Use of breadboard: Uses of Breadboards A breadboard is used to make up temporary circuits for testing or to try out an idea. No soldering is required so it is easy to change connections and replace components. Parts will not be damaged so they will be available to re-use afterwards. The photograph shows a circuit on a typical small breadboard which is suitable for beginners building simple circuits with one or two ICs (chips) Wire the power leads of chips first, using a color scheme if possible. Traditionally, in DC applications RED = +5 Volts and BLACK = Ground.



Connections on Breadboard: Breadboards have many tiny sockets (called 'holes') arranged on a 0.1" grid. The leads of most components can be pushed straight into the holes. ICs are inserted across the central gap with their notch or dot to the left. Wire links can be made with single-core plastic-coated wire of 0.6mm diameter (the standard size). Stranded wire is not suitable because it will crumple when pushed into a hole and it may damage the board if strands break off. The diagram shows how the breadboard holes are connected.

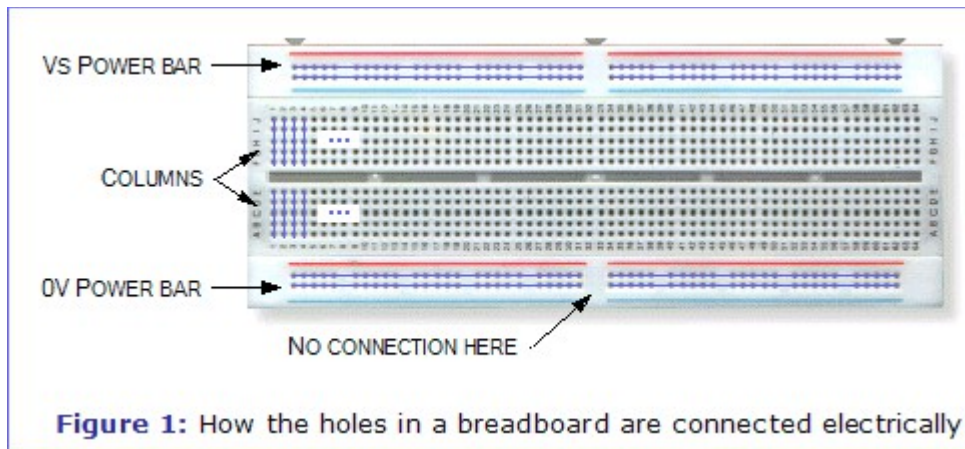


Fig1.Bread board.

A Design Using Digital IC's

7-segment Display:

The first and foremost aspect of this circuit is decoder. A decoder is a combinational circuit which is used to convert a binary or BCD (Binary Coded Decimal) number to the corresponding decimal number. It can be a simple binary to decimal decoder or a BCD to 7 segment decoder.

Another relevant section is the combinational logic circuit. A combinational logic circuit is a system of logic gates consisting of only outputs and inputs. The output of a combinational logic circuit depends only on the present state of the inputs and nothing else. Best examples of such circuits are Encoders and Decoders, Multiplexers and De-multiplexers, Adders, Sub tractors etc.

To understand the design and operation of these logic circuits, one needs to have a good knowledge about Boolean algebra and logic gates. For example few basic Boolean algebra rules to be followed are the complementary law, associative law, De-Morgan's law etc.



A 7 segment LED display consists of an arrangement of 8 LEDs such that either all the anodes are common or cathodes are common. A common cathode 7 segment display consists of 8 pins – 7 input pins labeled from 'a' to 'g' and 8th pin as common ground pin.

7 Segment Display Decoder Circuit Design:

Step 1: The first step of the design involves analysis of the common cathode 7-segment display. A 7-segment display consists of an arrangement of LEDs in an 'H' form. A truth table is constructed with the combination of inputs for each decimal number. For example, decimal number 1 would command a combination of b and c (refer the diagram given below).

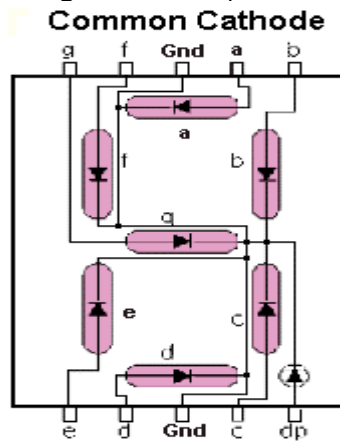


Fig.2 LED

The second step involves constructing the truth table listing the 7 display input signals, decimal number and corresponding 4 digit binary numbers.

The truth table for the decoder design depends on the type of 7-segment display. As we mentioned above that for a common cathode seven-segment display, the output of decoder or segment driver must be active high in order to glow the segment.

The figure below shows the truth table of a BCD to seven-segment decoder with common cathode display. In the truth table, there are 7 different output columns corresponding to each of the 7 segments. Suppose the column for segment 'a' shows the different combinations for which it is to be illuminated. So 'a' is active for the digits 0, 2, 3, 5, 6, 7, 8 and 9.

The Truth table for 7-segment decoder:



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

Fig.3 Truth Table.

From the above truth table, the Boolean expressions of each output functions can be written as

$$\begin{aligned}
 a &= F1(A, B, C, D) = \sum m(0, 2, 3, 5, 7, 8, 9) \\
 b &= F2(A, B, C, D) = \sum m(0, 1, 2, 3, 4, 7, 8, 9) \\
 c &= F3(A, B, C, D) = \sum m(0, 1, 3, 4, 5, 6, 7, 8, 9) \\
 d &= F4(A, B, C, D) = \sum m(0, 2, 3, 5, 6, 8) \\
 e &= F5(A, B, C, D) = \sum m(0, 2, 6, 8) \\
 f &= F6(A, B, C, D) = \sum m(0, 4, 5, 6, 8, 9) \\
 g &= F7(A, B, C, D) = \sum m(2, 3, 4, 5, 6, 8, 9)
 \end{aligned}$$

K-Map Simplification:

The below figures show the k-map simplification for the common cathode seven-segment decoder in order to design the combinational circuit.

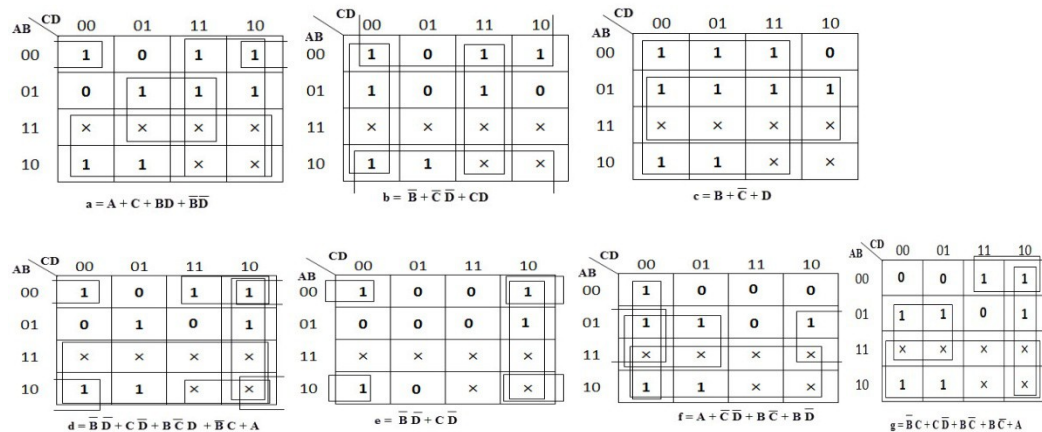


Fig .4.K-Map

From the above simplification, we get the output values as:

$$a = A + C + BD + \bar{B} \bar{D}$$

$$b = \bar{B} + \bar{C} \bar{D} + CD$$

$$c = B + \bar{C} + D$$

$$d = \bar{B} \bar{D} + C \bar{D} + B \bar{C} D + \bar{B} C + A$$

$$e = \bar{B} \bar{D} + C \bar{D}$$

$$f = A + \bar{C} \bar{D} + B \bar{C} + B \bar{D}$$

$$g = A + B \bar{C} + \bar{B} C + C \bar{D}$$

The final step involves drawing a combinational logic circuit for each output signal. Once the task was accomplished, a combinational logic circuit can be drawn using 4 inputs (A,B,C,D) and (a,b,c,d,e,f,g) output.

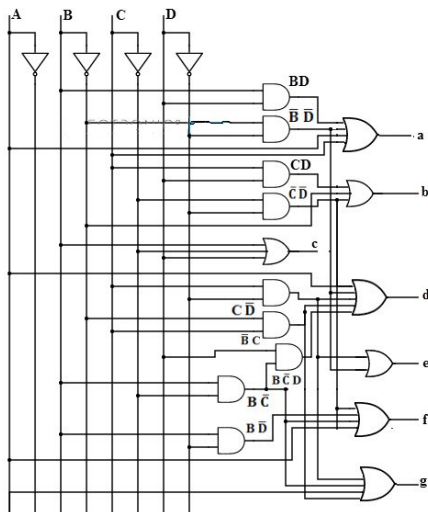


Fig.5 Circuit Implementation

Display Decoder Circuit Operation:



This above circuit implemented in IC 7432 with seven segment display, the detail as shown bellow. While doing this experiment we need following equipments.

1. Bread board
2. Black wire and red wire
3. IC 7432
4. Power Supply.

Connect the wire as per circuit as shown.

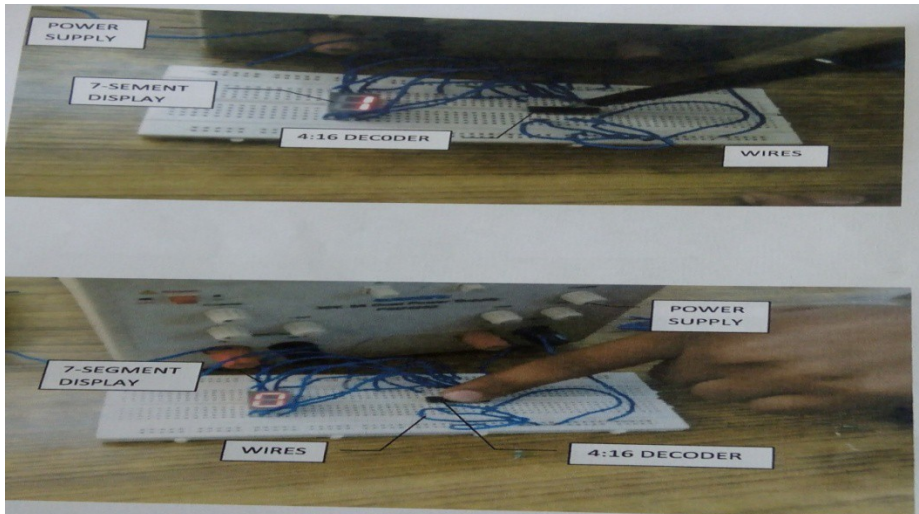


Fig.6 The implementation of 7-segment display.

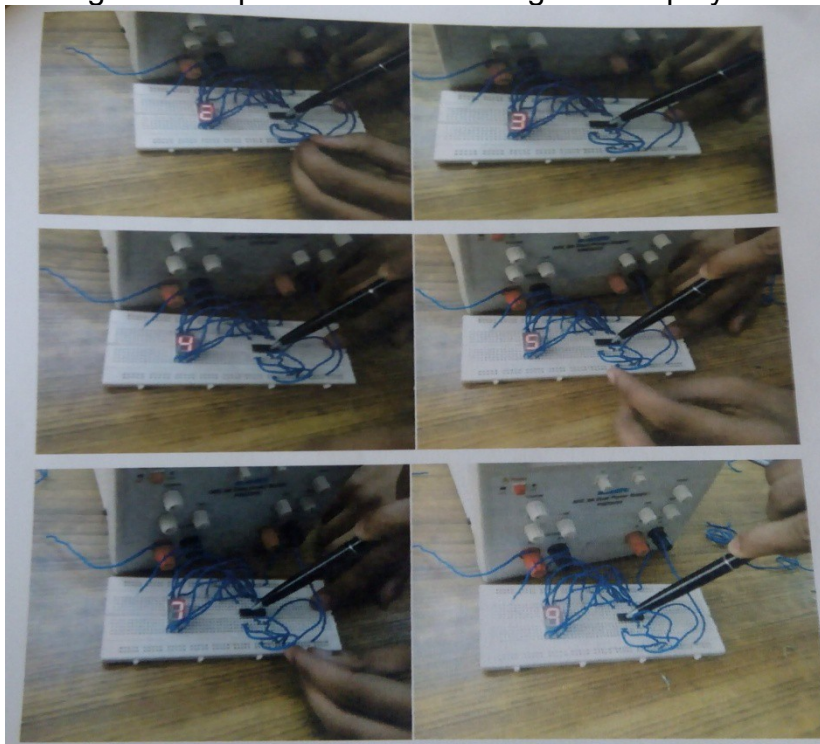


Fig 7.Implemetation of 7-segment display



Precautions:

1. There should be maintenance resistances connected to the LED.
2. LED should be tested before use.
3. Connection should be made properly.
4. Voltage supply should be made in limit, not more than 5 volt.

