

Digital Electronics Fundamentals 202.1

- Binary Numeral System
- Hexadecimal Numeral System
- BCD code
- Inverters
- 7 Segment Displays
- BCD to 7 Segment Drivers

1 Binary Numeral System

- The binary numeral system, or base-2 number system, represents numeric values using two symbols: 0 and 1. More specifically, the usual base-2 system is a positional notation with a radix of 2. Because of its straightforward implementation in digital electronic circuitry using logic gates, the binary system is used internally by almost all modern computers and computer-based devices such as mobile phones.
- Any number can be represented by any sequence of bits (binary digits)
- Since binary is a base-2 system, each digit represents an increasing power of 2, with the rightmost digit representing 2^0 , the next representing 2^1 , then 2^2 , and so on. To determine the decimal representation of a binary number simply take the sum of the products of the binary digits and the powers of 2 which they represent. For example, the binary number:

100101

is converted to decimal form by:

$$[(1) \times 2^5] + [(0) \times 2^4] + [(0) \times 2^3] + [(1) \times 2^2] + [(0) \times 2^1] + [(1) \times 2^0] =$$
$$[1 \times 32] + [0 \times 16] + [0 \times 8] + [1 \times 4] + [0 \times 2] + [1 \times 1] = 37$$

**Excerpt taken from: Wikipedia Article on [Binary Numeral System](#)

1.1 Binary Numbering System

Decimal pattern (Hex Value)	Binary numbers
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10 - (A)	1010
11 - (B)	1011
12 - (C)	1100
13 - (D)	1101
14 - (E)	1110
15 - (F)	1111

**Table taken from: Wikipedia Article on [Binary Numeral System](#)

2 Hexadecimal Numeral System

- In mathematics and computer science, hexadecimal (also base 16, or hex) is a positional numeral system with a radix, or base, of 16. It uses sixteen distinct symbols, most often the symbols **0–9** to represent values zero to nine, and **A, B, C, D, E, F** (or alternatively **a–f**) to represent values ten to fifteen. For example, the hexadecimal number 2AF3 is equal, in decimal, to $(2 \times 16^3) + (10 \times 16^2) + (15 \times 16^1) + (3 \times 16^0)$, or 10995
- Each hexadecimal digit represents four binary digits (bits), and the primary use of hexadecimal notation is a human-friendly representation of binary-coded values in computing and digital electronics. One hexadecimal digit represents a nibble, which is half of an octet (8 bits). Each hexadecimal digit represents four binary digits (bits), and the primary use of hexadecimal notation is a human-friendly representation of binary-coded values in computing and digital electronics. One hexadecimal digit represents a **nibble**, which is half of an octet (8 bits).
- Byte values can range from 0 to 255 (decimal), but may be more conveniently represented as two hexadecimal digits in the range 00 to FF. Hexadecimal is also commonly used to represent computer memory addresses.

**Excerpt taken from: Wikipedia Article on [Hexadecimal Numeral System](#)

3 Binary Coded Decimals (BCD)

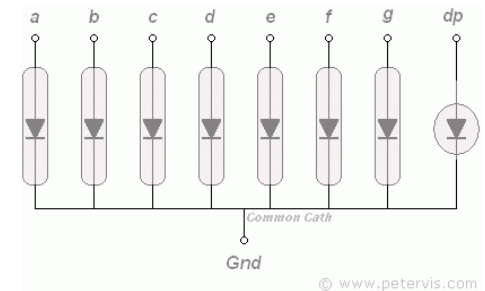
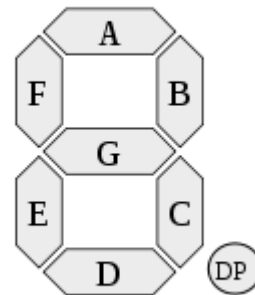
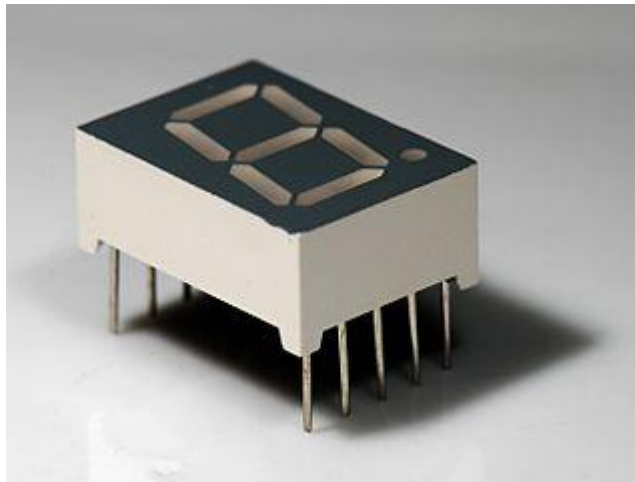
- In computing and electronic systems, binary-coded decimal (BCD) is a class of binary encodings of decimal numbers where each decimal digit is represented by a fixed number of bits, usually four.
- BCD's main virtue is a more accurate representation and rounding of decimal quantities as well as an ease of conversion into human-readable representations.

Decimal Digit	BCD 8 4 2 1
0	0 0 0 0
1	0 0 0 1
2	0 0 1 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

**Excerpt taken from: Wikipedia Article on [Binary Coded Decimals](#)

4 7 Segment Displays

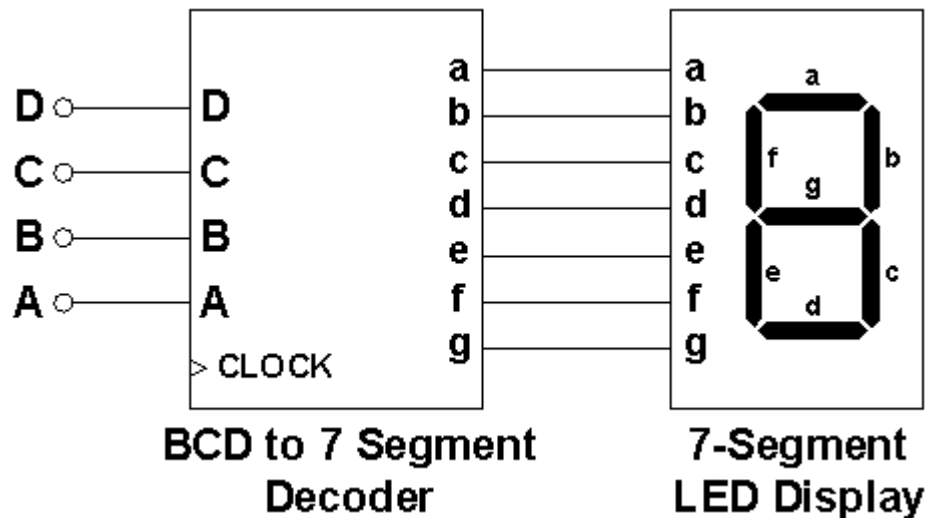
- A seven-segment display is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot-matrix displays. Seven-segment displays are widely used in digital clocks, electronic meters, and other electronic devices for displaying numerical information.
- In a simple LED package, typically all of the cathodes (negative terminals) or all of the anodes (positive terminals) of the segment LEDs are connected and brought out to a common pin; this is referred to as a "common cathode" or "common anode" device. Hence a 7 segment plus decimal point package will only require nine pins



**Excerpt taken from: Wikipedia Article on [7 Segment Displays](#)

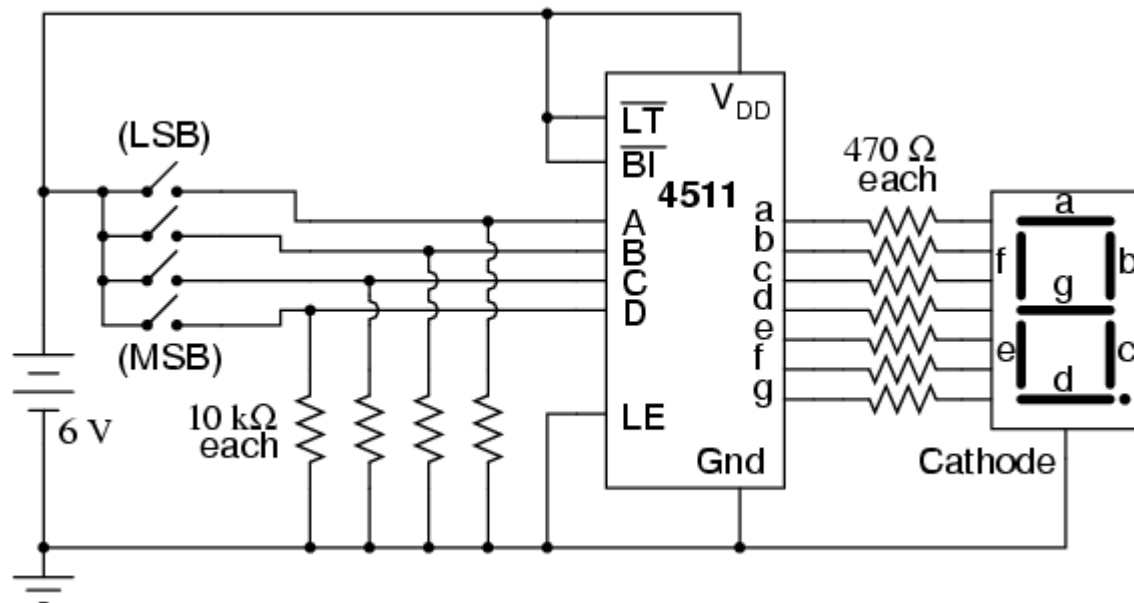
5 BCD to 7 segment Display Decoder

- A BCD to 7-segment decoder driver's function is to convert the logic states at the outputs of a BCD, or binary coded decimal into signals which will drive a 7-segment display. The display shows the decimal numbers 0-9 and is easily understood.
- Most Popular BCD to 7 Seg Decoders are the 74xx47 and 45xx11 lcs.



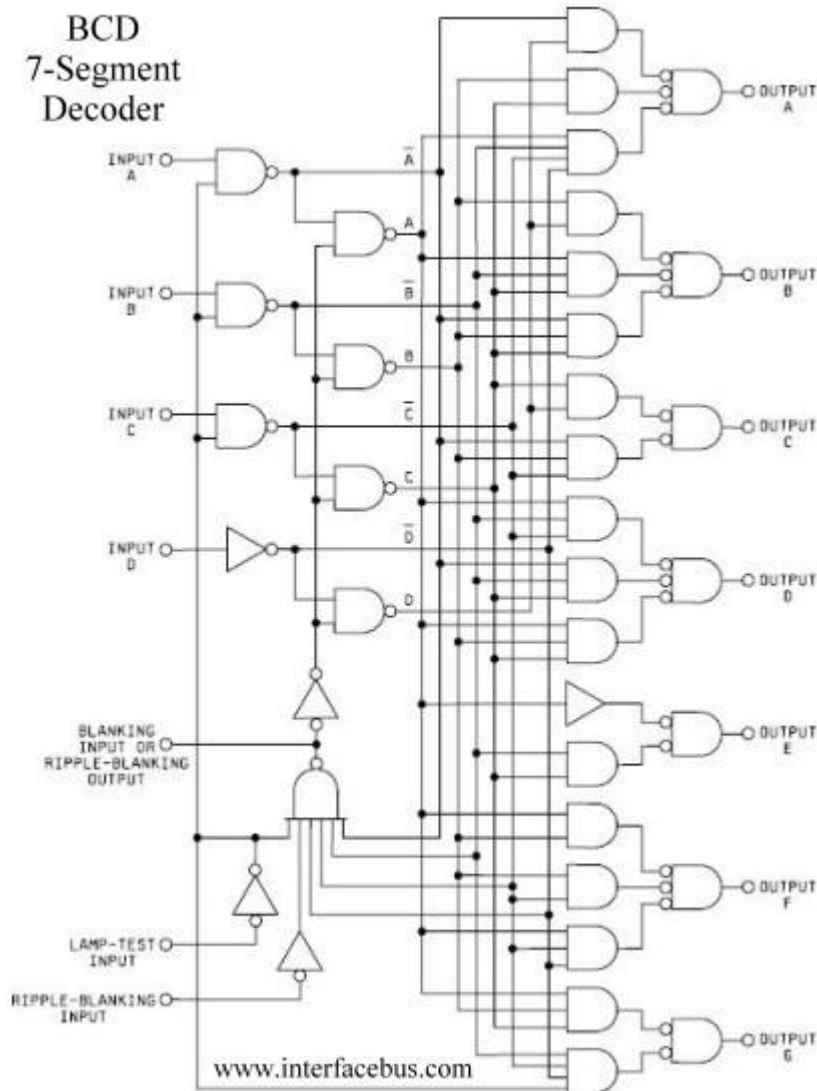
Binary Inputs				Decoder Outputs							7-Segment Display Outputs
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9

6 Typical use for a 7 Seg Display



7 Inside a BCD to 7 Seg Decoder

BCD
7-Segment
Decoder



DECIMAL OR FUNCTION	INPUTS							OUTPUTS							NOTE
	LT	RBI	D	C	B	A	BI/RBO	A	B	C	D	E	F	G	
0	H	H	L	L	L	L	H	L	L	L	L	L	L	H	1
1	H	X	L	L	L	H	H	H	L	L	H	H	H	H	1
2	H	X	L	L	H	L	H	L	L	H	L	L	H	L	
3	H	X	L	L	H	H	H	L	L	L	L	H	H	L	
4	H	X	L	H	L	L	H	H	L	L	H	H	L	L	
5	H	X	L	H	L	H	H	L	H	L	L	H	L	L	
6	H	X	L	H	H	L	H	H	H	L	L	L	L	L	
7	H	X	L	H	H	H	H	L	L	L	H	H	H	H	
8	H	X	H	L	L	L	H	L	L	L	L	L	L	L	
9	H	X	H	L	L	H	H	L	L	L	H	H	L	L	
10	H	X	H	L	H	L	H	H	H	H	L	L	L	L	
11	H	X	H	L	H	H	H	H	H	L	L	H	H	L	
12	H	X	H	H	L	L	H	H	L	H	H	H	L	L	
13	H	X	H	H	L	H	H	L	H	H	L	H	L	L	
14	H	X	H	H	H	L	H	H	H	H	L	L	L	L	
15	H	X	H	H	H	H	H	H	H	H	H	H	H	H	
BI	X	X	X	X	X	X	L	H	H	H	H	H	H	H	2
RBI	H	L	L	L	L	L	L	H	H	H	H	H	H	H	3
LT	L	X	X	X	X	X	H	L	L	L	L	L	L	L	4