Lecture 01 – Number Systems (*Binary, Octal, Decimal, Hexadecimal)*

ECE09 – Digital Electronics 1: Logic Circuits and Switching Theory

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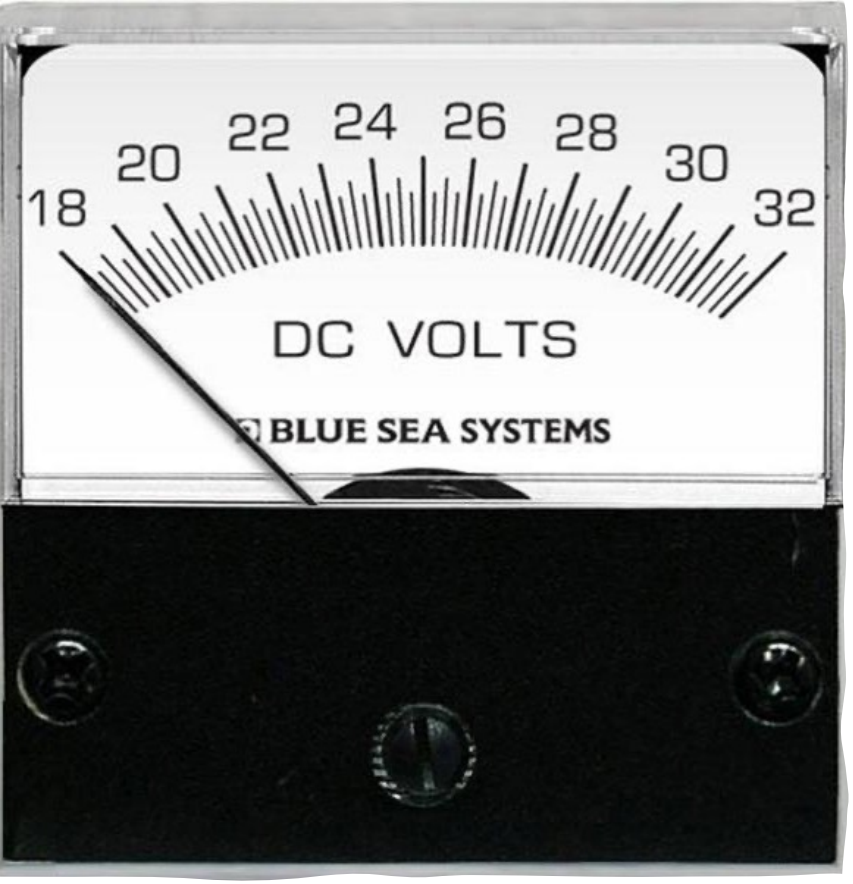


Numerical Representation of Quantities

- Analog Representation
  - A quantity represented by a voltage, current or meter movement that is proportional to the value of that quantity.
  - Continuous
- Digital Representation
  - Quantities that are represented not by proportional quantities but by symbol called digits.

Digital and Analog Systems

Digital System

- Combination of devices designed to manipulate physical quantities or information that are represented in digital forms.

Examples: digital watch, logic gates

Analog System

- Contains devices that manipulates physical quantities that are represented in analog form.

Examples: amplifiers, analog watch

Advantages of Digital Systems

1. Ease of Design
2. Higher resolution and output quality
3. More error/fault tolerance
4. Greater flexibility in design and application
5. Digital signals can be transmitted over long distances.
6. Less noise, distortion and interference

Number Systems

Decimal Number System

- 0 – 9
- Base of 10
- Example: 7392.15_{10}

Binary Number System

- Only two symbols or possible digit values (0 & 1)
- Example: 11010.11_{2}

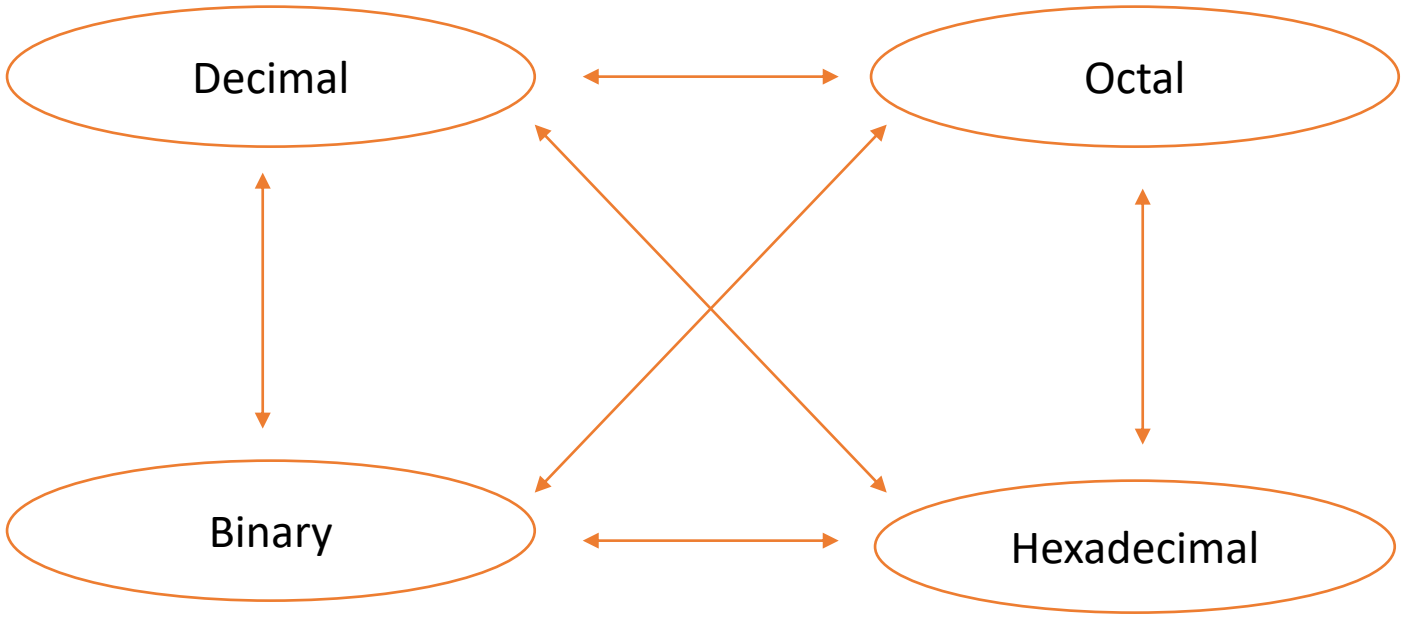
Octal Number System

- Base of 8
- 0 – 7
- Example: 127.4_{8}

Hexadecimal Number System

- Base of 16
- 0 – 9, A – F
- Example: $B65F_{16}$

Conversion Among Bases



Binary to Decimal

- Technique
  - Multiply each bit by 2^n, where *n* is the “weight” of the bit
  - The weight is the position of the bit, starting from 0 on the right
  - Add the results

Examples:

1. 11011
2. 10110101.11
3. 10110101

Decimal to Binary

- Technique
  - Divide by two, keep track of the remainder
  - First remainder is bit 0 (LSB, least-significant bit)
  - Second remainder is bit 1
  - Etc.

Examples:

1. 27
2. 181
3. 20.75

Octal to Decimal

- Technique
  - Multiply each bit by 8^n, where *n* is the “weight” of the bit
  - The weight is the position of the bit, starting from 0 on the right
  - Add the results

Examples:

1. 372
2. 24.6

Decimal to Octal

- Technique
  - Divide by 8
  - Keep track of the remainder
- Examples:

1. 250
2. 20.75

Hexadecimal to Decimal

- Technique
  - Multiply each bit by 16^n, where *n* is the “weight” of the bit
  - The weight is the position of the bit, starting from 0 on the right
  - Add the results
- Examples

1. 356
2. 431.2D

Decimal to Hexadecimal

- Technique
  - Divide by 16
  - Keep track of the remainder
- Examples:

1. 854
2. 1073.175781

Octal to Binary

- Technique
  - Convert each octal digit to a 3-bit equivalent binary representation
- Examples:

1. 472
2. 5431
3. 115.654

Binary to Octal

- Technique
  - Group bits in threes, starting on right
  - Convert to octal digits
- Examples:

1. 100111010
2. 101100011001
3. 1001101.110101100

Binary to Hexadecimal

- Technique
  - Group bits in fours, starting on right
  - Convert to hexadecimal digits
- Examples:

1. 100111110010.110001
2. 101110100110

Hexadecimal to Binary

- Technique
  - Convert each hexadecimal digit to a 4-bit equivalent binary representation
- Examples:

1. ABCDEF
2. 9F2
3. BA6

Octal to Hexadecimal

- Technique
  - Use binary as an intermediary
- Examples:

1. 1076
2. 1076.545

Hexadecimal to Octal

- Technique
  - Use binary as an intermediary
- Examples:

1. 9F2
2. BA6