

BCD (Binary-Coded Decimal) Encoding

Binary-Coded Decimal (BCD) is a class of binary encodings in which each decimal digit is represented by its own binary sequence. In BCD, the binary form of a decimal number is encoded such that a 4-bit binary number represents each digit.

Each decimal digit (0-9) is represented using 4 bits, as follows:

```
0000 represents 0
0001 represents 1
0010 represents 2
0011 represents 3
0100 represents 4
0101 represents 5
0110 represents 6
0111 represents 7
1000 represents 8
1001 represents 9
```

Each decimal digit is encoded separately. For example, the decimal number 59 in BCD would be:

```
0101 1001
```

Key Features of BCD

- **Easy Conversion:** BCD is easy to convert between binary and decimal since each digit is encoded individually.
- **Limited Range:** BCD only supports decimal digits from 0 to 9 (0000 to 1001 in binary), leaving six unused binary combinations in a 4-bit group (1010 to 1111 are invalid).
- **Space Inefficiency:** BCD encoding is less space-efficient than regular binary representation because it uses more bits to represent numbers. For example, to represent 255 in regular binary, 8 bits are sufficient (11111111), but in BCD, it requires 12 bits (0010 0101 0101).

Applications of BCD

BCD encoding is often used in applications where human-readable decimal output is crucial and precision matters. Common use cases include:

- **Digital clocks** (old ones): These devices often display numbers directly in decimal form, so BCD simplifies the process.
- **Financial applications:** BCD can be used in systems requiring precise decimal representation, such as in currency and banking systems, to prevent rounding errors.

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