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Precision is the number of distinct or different values. We express precision in alternatives, decimal digits, bytes, or binary bits. **Alternatives** are defined as the total number of possibilities. For example, an 8-bit number format can represent 256 different numbers. An 8-bit **digital to analog converter** (DAC) can generate 256 different analog outputs. An 8-bit **analog to digital converter** (ADC) can measure 256 different analog inputs.

A **byte** contains 8 bits as shown in Figure 2.3, where each bit b_7, \dots, b_0 is binary and has the value 1 or 0. We specify b_7 as the **most significant bit** or MSB, and b_0 as the least significant bit or LSB.

Help

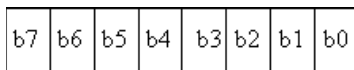


Figure 2.3

If a byte is used to represent an unsigned number, then the value of the number is

$$N = 128 \cdot b_7 + 64 \cdot b_6 + 32 \cdot b_5 + 16 \cdot b_4 + 8 \cdot b_3 + 4 \cdot b_2 + 2 \cdot b_1 + b_0$$

To practice, you can enter an 8-bit binary number in the following field and press "show" to see its value if interpreted as signed or unsigned integer. For convenience, you can also enter hexadecimal input with '0x' prefix.

$$\text{Unsigned value} = 1 \cdot 2^7 + 0 \cdot 2^6 + 1 \cdot 2^5 + 0 \cdot 2^4 + 0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 165$$

$$\text{Signed Value} = -1 \cdot 2^7 + 0 \cdot 2^6 + 1 \cdot 2^5 + 0 \cdot 2^4 + 0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = -91$$

How many binary bits does it take to represent 0x123456? When answering the question consider that fact that this number will be stored on the computer.

Hide Answer

Four binary bits are required for each hex digit. 4×6 is 24 bits.

CHECKPOINT 2.8

How many bytes of memory would it take to store a 50-bit number?

Hide Answer

There are 8 bits/byte, so 50 bits will take $50/8 = 6.25$, or 7 bytes of memory.

CHECKPOINT 2.9

Convert the binary number 01101001_2 to unsigned decimal.

Hide Answer

$0 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 64 + 32 + 8 + 1 = 105$

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CHECKPOINT 2.10

Convert the hex number 0x54 to unsigned decimal.

Hide Answer

$5 \times 16 + 4 = 80 + 4 = 84$



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