Every family of digital logic is a little different, but on a Stellaris® microcontroller powered with 3.3 V supply, a voltage between 2 and 5 V is considered high, and a voltage between 0 and 1.3 V is considered low, as drawn in Figure 4.2. Separating the two regions by 0.7 V allows digital logic to operate reliably at very high speeds. The design of transistor-level digital circuits is beyond the scope of this class. However, it is important to know that digital data exists as binary bits and is encoded as high and low voltages.

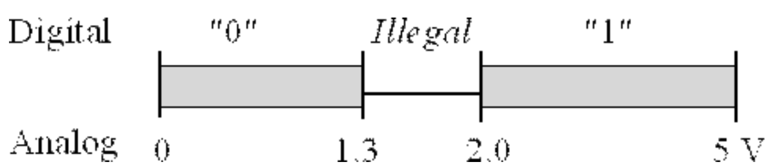

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Figure 4.2. Mapping between analog voltage and the corresponding digital meaning on the TM4C123.

If the information we wish to store exists in more than two states, we use multiple bits. A collection of 2 bits has 4 possible states (00, 01, 10, and 11). A collection of 3 bits has 8 possible states (000, 001, 010, 011, 100, 101, 110, and 111). In general, a collection of n bits has 2^n states. For example, a **byte** contains eight bits, and is built by grouping eight binary bits into one object, as shown in Figure 4.3. Another name for a collection of eight bits is **octet** (*octo* is Latin and Greek meaning 8). Information can take many forms, e.g., numbers, logical states, text, instructions, sounds, or images. What the bits mean depends on how the information is organized and more importantly how it is used. This figure shows one byte in the state representing the binary number 01100111. Again, the output voltage 3.3V means true or 1, and the output voltage of 0V means false or 0.

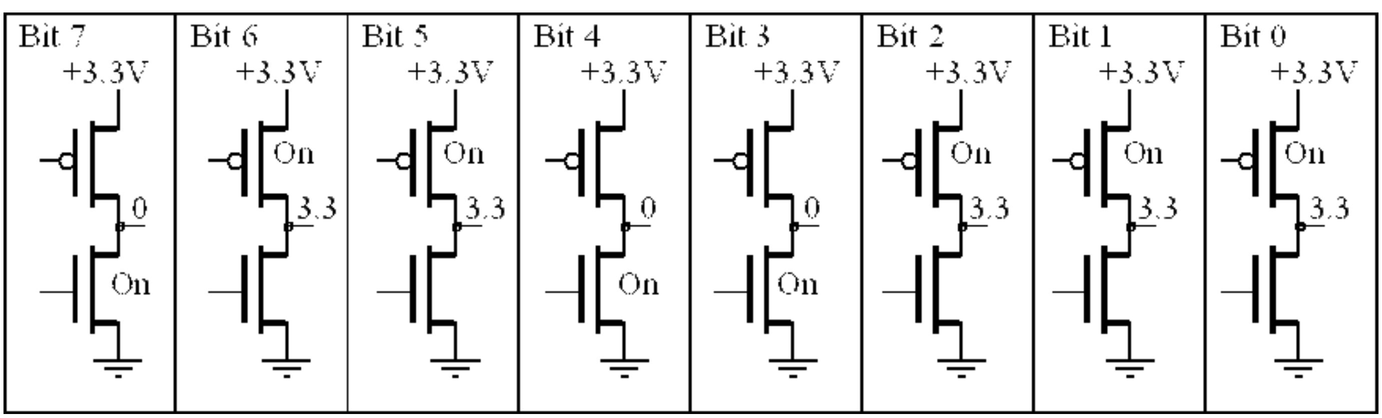

Figure 4.3. A byte is comprised of 8 bits, in this case representing the binary number 01100111.

What these 8 bits mean depends on how the computer software chooses to interpret them. Possibilities include but are not limited to an unsigned integer, a signed integer, a part of a machine code, and a character.

CHECKPOINT 4.2

Assume the circuit in Figure 4.3 contains an 8-bit unsigned integer. What is the smallest unsigned integer that can be represented? What is the largest unsigned integer that can be represented?

Hide Answer

The smallest 8-bit unsigned integer is 0 (all low). The largest 8-bit unsigned integer is 255 (all high).

CHECKPOINT 4.3

Assume the circuit in Figure 4.3 contains an 8-bit signed 2's complement integer. What is the smallest signed integer that can be represented? What is the largest signed integer that can be represented?

Hide Answer

The smallest 8-bit signed integer is -128 (0x80) and the largest 8-bit signed integer is 127 (0x7F).

CHECKPOINT 4.4

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If the data stored in Figure 4.3 represent a single character, how many possible characters might it represent?

Hide Answer

There are 256 possibilities represented by 8-bit data. Standard ASCII will fit into an 8-bit byte (UTF-8), but basic unicode requires a 16-bit halfword (UTF-16), and supplementary unicode requires 32 bits (UTF-32).

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