arm Education

Embedded Systems Essentials with Arm: Getting Started

Module 3

KV1 (3): Voltages and Logic Values

Digital logic provides for two values: ‘0’ and ‘1’. When we consider voltage, 0 and 1 represent the logical state of a voltage being low or high.

However, the states of 'low’ and 'high’ are not necessarily connected to a specific voltage. Different devices may use different voltages to represent a certain logic value. "low” and “high” might represent a unipolar range from 0 to +3.3 volts in some devices, but represent different ranges or values in other devices.

The advantage of logic circuits over analog circuits is that they can cope with a certain amount of noise and signal degradation.

Rather than defining precise voltages for “0” and “1”, we can define allowable “ranges” of voltages, which will result in recognizable input signals. In addition to this, many logic chips can operate from a broad range of supply voltages, typically from just over 1.5 volts up to 6 volts.

This graph shows the range of input signal voltages that will be reliably recognized as legal logic levels. Most of the time, we will run our Cortex M processors at 3.3 volts. Taking this as an operating condition or supply voltage, we can use the graph to determine what ranges of voltages will be reliably recognized as valid logic signals. For Logic 0, it’s 0.0 to –1.1 volts (4). For Logic 1, it’s 2.4 to –3.3 volts (5).

This means that a signal of 2.0 volts will not be reliably recognized as a valid logic level because it is the “undefined” region.

Notice also that input signals that stray outside the power supply voltages may damage the processor.

In reality, output signal voltages will be very close to Vdd or Gnd, meaning ground, generally within 0.5 V, as indicated in this graph.

If we start to draw current from an output, for example to drive an LED or other device, the output voltage will tend to degrade by an amount that will increase with current drawn. In other words, as logic 1 or high voltages go down, logic 0 or low voltages tend to go up, heading towards the “undefined” region on the left graph.

Currents greater than a few milli-amps may compromise signal integrity, so be sure to check the manufacturer’s data sheet.