arm Education

Embedded Systems Essentials with Arm: Getting Started

Module 5

SV1 (5): Before you begin

Hello and welcome to this lab, which will cover analog input and output.

In this lab, we will continue to explore the capabilities of embedded microcontrollers by implementing an audio wave generator. The volume and the pitch will be tuneable via potentiometers. This will make use of the AnalogIn Mbed API as well as the PwmOut API which we will introduce but cover in more detail in the next module.

By the end of the lab you will have gained insight and practical experience with the Mbed API for analog input and output.

Before starting the exercise, let us have a short review of these topics.

To be readable by a processor, an analog real-world-signal needs to be converted into a digital signal. This means that a sensor's function is to convert the physical signal into an electrical one.

After sampling with a sample-and-hold-stage or time-discretization, the signal is converted, via an analog-to-digital converter or ADC, into time- and value-discrete digital samples.

In the inverse operation, a digital-to-analog-converter or DAC converts the samples into real-world analog type values. The values can only be analog because the sampling and quantization is a real loss of information which cannot be recovered or substituted.

Embedded systems often need to measure values of physical parameters. These parameters are usually continuous, meaning analog, and not in a digital form, which computers, which operate on discrete data values, can process.

Here we can see a number of real-world examples of when analog/digital conversion can be used. These include thermostats, digital cameras, blood pressure monitors, air bag controllers, and a lot more.

A DAC connects the digital input values to a resistor network, in which the input voltage of the according bits is binary weighted. This is usually done with a R-2R-resistor network. The output voltage is the analog equivalent to the digital input number, weighted with the reference voltage.

There are usually three steps in an analog to digital conversion. First, select the input line to be converted with the multiplexer. Because an ADC stage consumes the chip area and is complex to build, due to its need for precision, the number of ADCs must be kept to a minimum. An upstream multiplexer switches the analog line to the respective input and makes it available for a conversion. Next, the sample-and-hold is usually a switched capacitor, which is loaded with the actual voltage of the analog signal and keeps it constant during the conversion time. Finally, the ADC converts the analog signal into a digital signal.