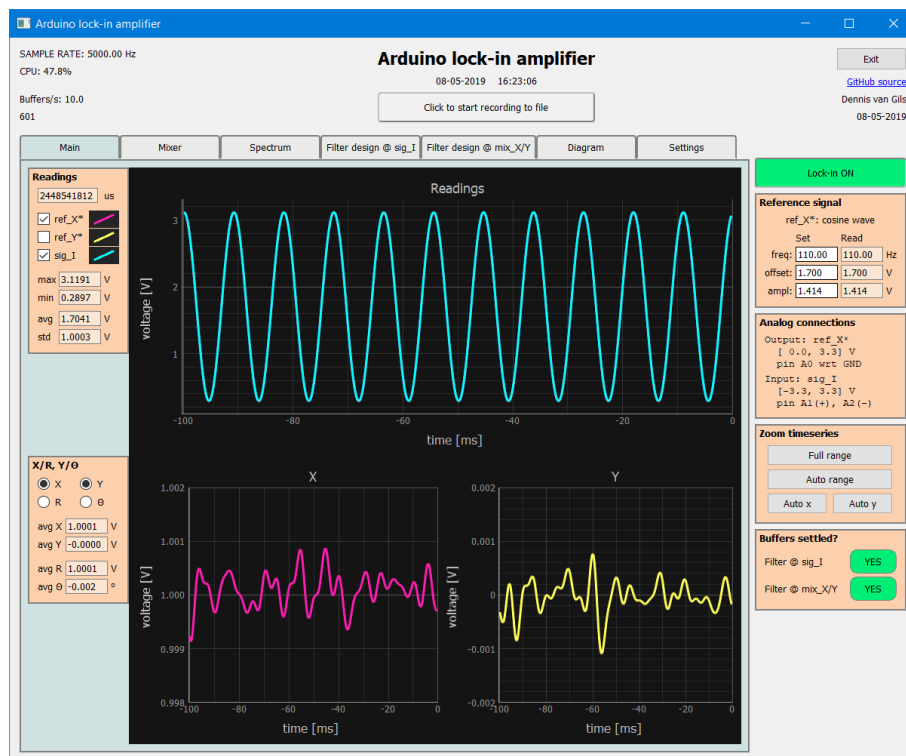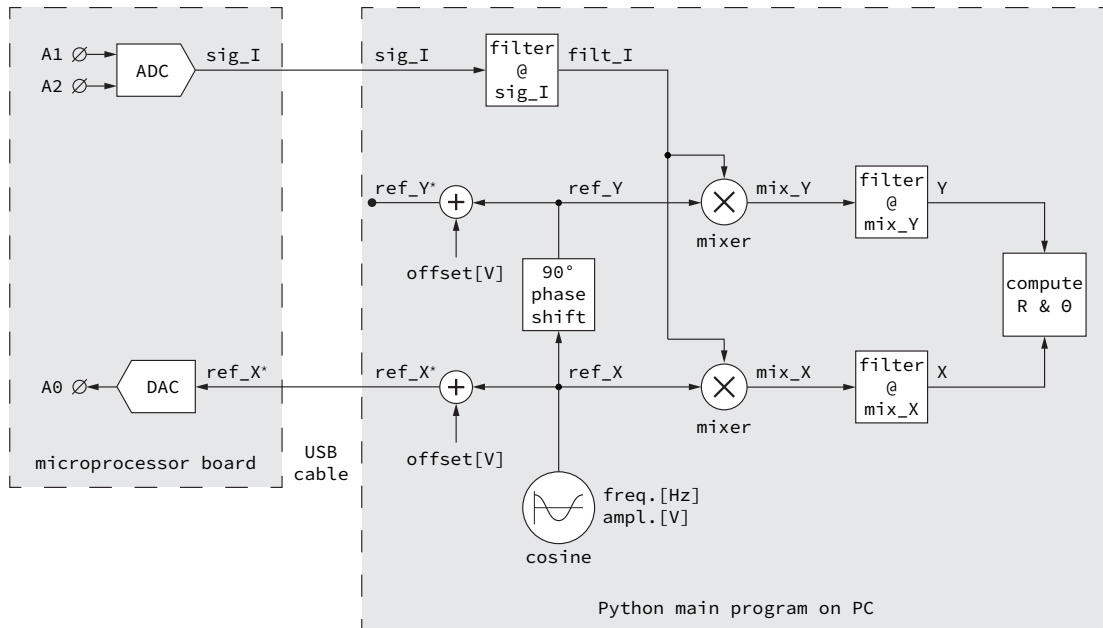# STUDENT USER MANUAL
DvG_Arduino_lock-in_amp

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1 Introduction

This document describes a lock-in amplifier running on a Atmel SAMD21 (e.g. Arduino M0) or SAMD51 (e.g. Adafruit M4) microcontroller board in combination with a PC running Python.

The microcontroller (MCU) board generates the reference signal `ref_X`* and subsequently acquires the input signal `sig_I`. This data is sent over USB to a PC running the main graphical user interface in Python. The Python program shows the waveform graphs of the signals in real-time, performs the heterodyne mixing and filtering of the signals similar to a lock-in amplifier, and provides logging to disk.

Current specifications MCU:

- Support for Atmel SAMD21 or SAMD51 chipsets

- True analog-out waveform generator (`ref_X`* between 0 to 3.3 V)

- Differential analog-in data acquisition (`sig_I` between -3.3 to 3.3 V)

- The analog-to-digital converter (ADC) and digital-to-analog converter (DAC) operate at 5 kHz sampling rate

- Double-buffered binary-data transmission over USB to a PC running Python

Current specifications Python:

- Separate computing threads for real-time communication with the MCU, signal processing and graphing

- Zero-phase distortion FIR filters

- Automatic detection of the MCU board by scanning over all COM ports

- Optional OpenGL hardware-accelerated graphing

2 Software installation

The preferred Python distribution is Anaconda Python 3.7, which can be found at:
https://www.anaconda.com/distribution/

Install Anaconda Python on your laptop. When the installation is finished, start up Anaconda Navigator and install the packages `pyserial`, `pyqtgraph` and `pyopengl` in the environment. Alternatively, the packages can also be installed using the Anaconda Prompt window and entering the following commands:

```
conda install pyserial
conda install pyqtgraph
conda install pyopengl
```

Download the source files as a `zip`-file from the GitHub site of Dennis van Gils at:
https://github.com/Dennis-van-Gils/DvG_Arduino_lock-in_amp/
Extract the `zip`-file.

When using Windows install the Adafruit device drivers at:
https://github.com/adafruit/Adafruit_Windows_Drivers/releases/

Now connect the M4 Feather Express via USB to your laptop. Start the Anaconda Prompt window and change the folder to:

```
<Download folder>\DvG_Arduino_lockin_amp-master
```

Now run the following command in the prompt:

```
ipython DvG_Arduino_lockin_amp.py
```

This will start a user interface in which you can configure and control your measurements.