Mini Spectrometer User Guide
edit : 2025-03-14

Index

The Hardware
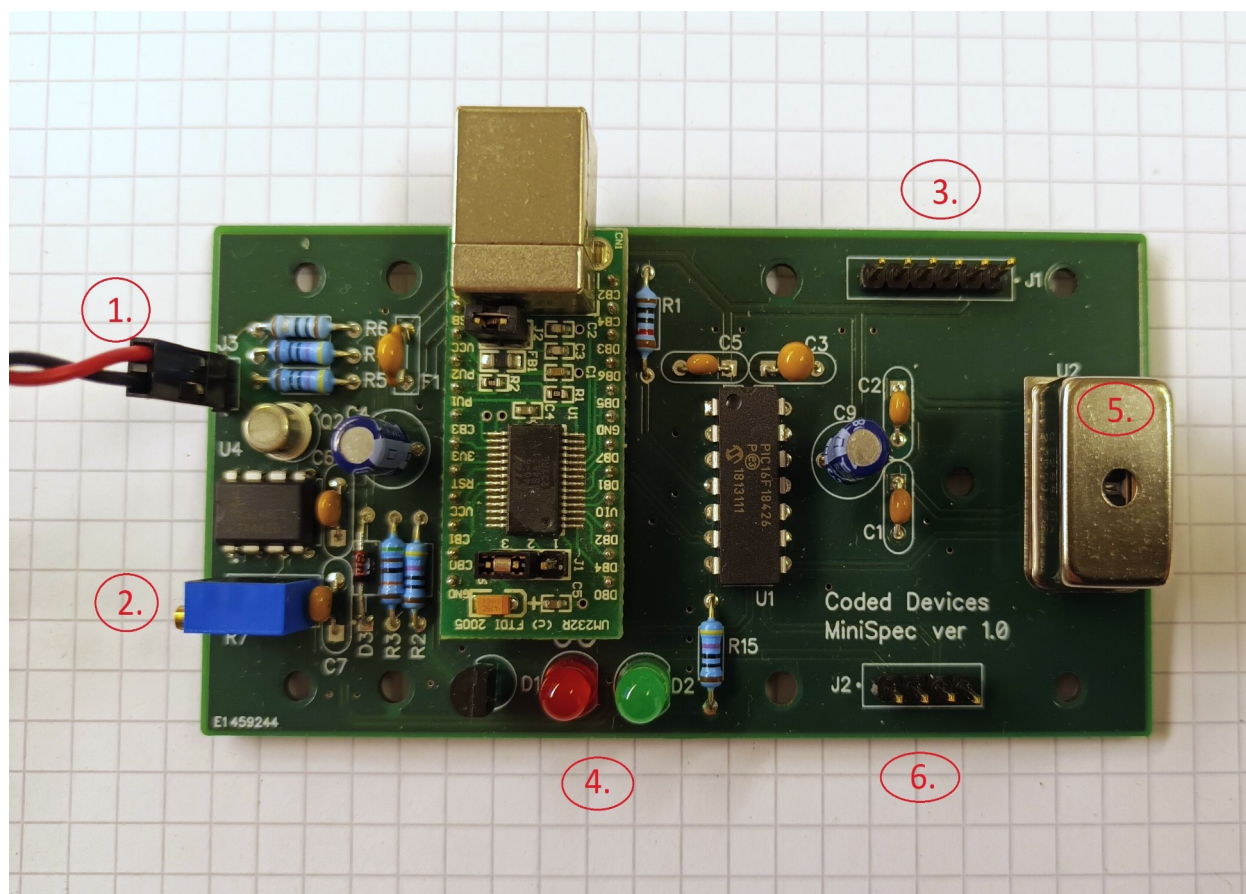
Note! The instrument is designed to be used with a plastic enclosure. The electrical connections are accessible from the bottom and a short circuit may occur if the instrument is placed on conductive material or parts. If your application requires using the device without the enclosure, ensure there is no risk of short circuits by using insulating pads underneath.

In the picture above, we have numbered the parts of the instrument that the user should be aware of.

1. <u>LED connector</u>. The red wire is connected to the anode of the LED.

2. <u>LED current adjustment</u>. You can manually adjust the LED voltage using this trimmer. Note that the voltage can also be controlled via software (LED intensity 0...31). One recommended method is to first set the intensity value in the software to its maximum (31), and then manually adjust the trimmer to achieve the highest usable level.

3. <u>Microcontroller programmin connector</u>. Connect the Microchip PICKit programmer so that the black triangle on the programmer points to the rightmost pin of this connector. For more information about programming the microcontroller, refer to the separate instruction titled "Programming the microcontroller of Mini Spectrometer".

4. <u>Signal LEDs</u>.
<u>The red LED</u> indicates that the resettable fuse has cut the current flow due to an over current situation. Ensure that there are no short circuits and that an excessive amount of current is not being drawn through the connectors J1, J2 and J3.
<u>The green LED</u> flashes twice when the connection to the PC is established and the PC app is started.

5. <u>The aperture of the spectrometer</u>. In the center of the top surface is a circular window through which light enters the spectrometer.

6. <u>Extension connector</u>. A peripheral device, such as a sensor or switch, can be connected to the microcontroller via this connector. The pins are connected as follows from left to right: +5V, GND, microcontroller pin nr 11 (RA2), microcontroller pin nr 3 (RA4). Drawing more than 20 mA of current through this connector may cause the resettable fuse F1 to cut the current flow.

About the Mini Spec App

Company Coded Devices Oy holds the copyright for the Mini Spec App used with the Mini Spectrometer instrument.

The application for the Mini Spectrometer (Mini Spec App) is licensed under GNU, granting users the freedom to modify it and distribute their own versions. Feel free to edit, improve and share your customized version without restrictions.

The application is written in Python 3. To run it, you will need the following additional Python 3 libraries:
- Matplotlib,
- tkinter and
- PySerial.

Other libraries are either included in the standard Python 3 package or delivered with the Mini Spec App files.

You can find the Mini Spec software files in the GitHub repository at the following URL: **https://github.com/codeddevs/mini-spec-app**

How to Begin

0. Prerequisites
We assume that you have already installed all required Python 3 libraries (listed above) and copied the following Mini Spec Python files to your computer:
- mini_data.py
- mini_file_operations.py
- mini_gui.py
- mini_instrument.py
- mini_main.py
- mini_temp.py
- mini_timed_multi_data.py

1. Connect the Mini Spectrometer to the PC using a USB cable.

2. The spectrometer will indicate readiness by blinking the green LED twice.

3. Navigate to the directory where you have stored the mini spec app python files.

4. Identify the COM Port Used by the Mini Spectrometer:

- **Windows** : open the Device Manager and navigate to *Ports (COM&LPT)*. Find *USB Serial Port (COM 3)* or a similar entry. Note the COM port number (e.g., COM3).
- **Linux** : open the terminal and execute the command *sudo dmesg | grep tty*. Look for a line like "*FTDI USB Serial device converter now attached to ttyUSB0*." Note the port name (e.g., ttyUSB0).

5. Set COM setting into the settings file *mini_settings.py*:
- Open the mini_settings.py file.
- **Windows** : set *comport_name = "COM3"* (replace with the actual COM port number).
- **Linux** : set *comport_name = "/dev/ttyUSB0"* (replace with the actual port name).
- Save the modified *mini_settings.py* file.

6. Set calibration coefficients into the settings file *mini_settings.py*. Locate the correct calibration coefficients in the device registration document.
- Open the mini_settings.py file.
- Locate and edit the values of the calibration coefficient variables (e.g., *calib_a0, calib_b1*) to match the values specified in the registration document.
- Save the changes made to the *mini_settings.py* file.

7. In that directory open the terminal (Linux) or Command Prompt (Windows) or PowerShell (Windows).

8. Execute command *python mini_main.py* (If your system has both Python 2 and Python 3 installed use command *python3 mini_main.py*).

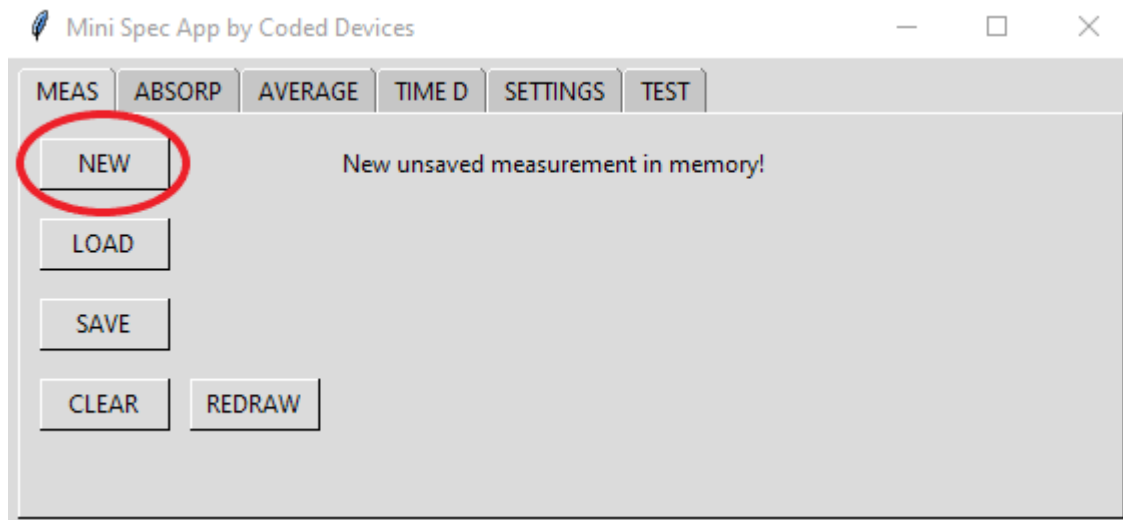**9. Following text will appear on terminal or command prompt:**

```
*** Mini Spec ***
Copyright (c) 2024 Coded Devices Oy
PC Software version 2024-3-28
Connecting to hardware...

Firmware version : 1.0.3.1
Source intensity : 5
```
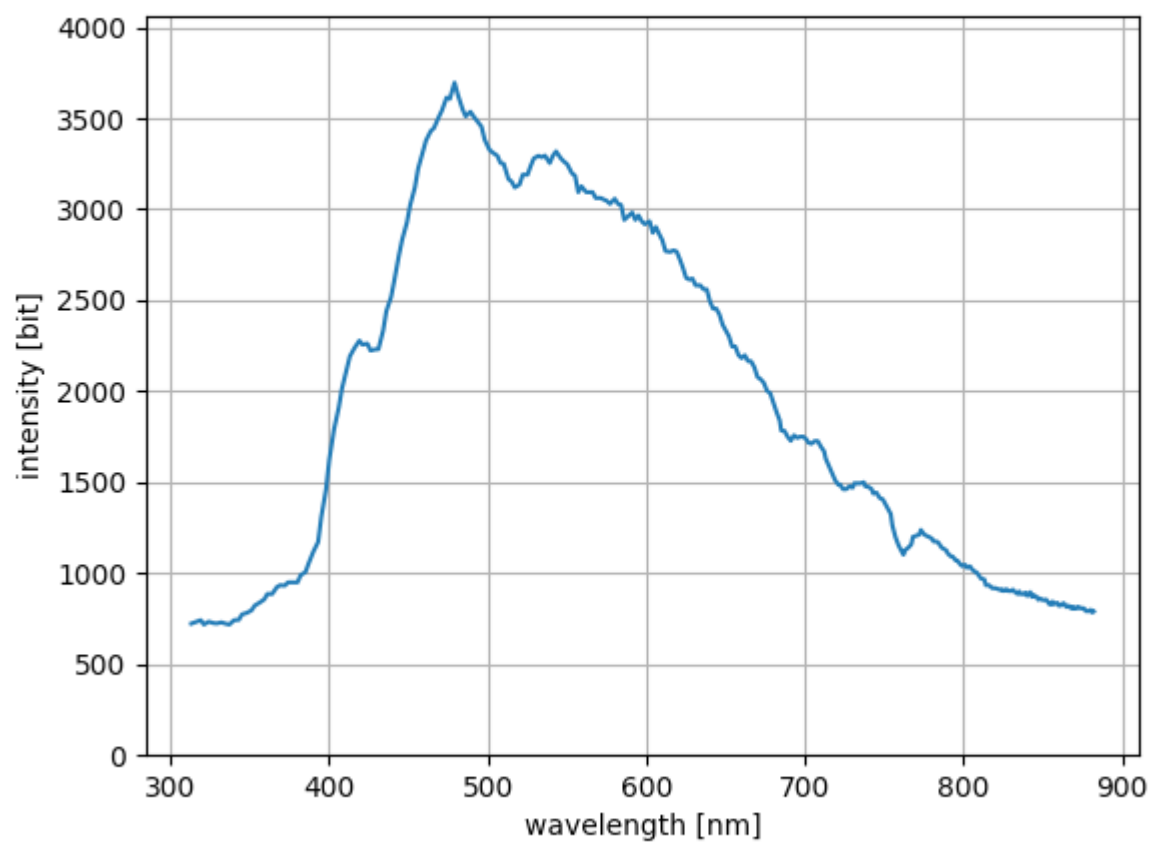
And the Mini Spec App control panel opens on the screen. **You are ready to start.**

How to Record a Spectrum

On the *MEAS* page, press the *NEW* button.

After about three seconds a newly recorded spectrum will appear in the *ABSOLUTE GRAPH* window. Below is an example of daylight spectrum measured indoors.

ABSOLUTE GRAPH

Now, you can decide whether to save the spectrum into a file, add it to an average spectrum, or use it in an absorption calculation.

How to Calculate a Relative Absorption

First, you need a reference spectrum that lacks absorption in the region of interest. Then, you measure a spectrum that shows absorption in that region. The relative absorption is calculated pointwise as *(measured[i] – reference[i]) / 100*.

Go to the *ABSORP* page. The file for the reference spectrum is displayed with the label *'Reference'*, while the actual measurement containing the absorption data is displayed with the label *'Measurement'*. The measurement is always the most recent one recorded or loaded on the *MEAS* page.

Press *CALC ABS* to make the absorption calculation, and the relative absorption spectrum will then appear on the screen.
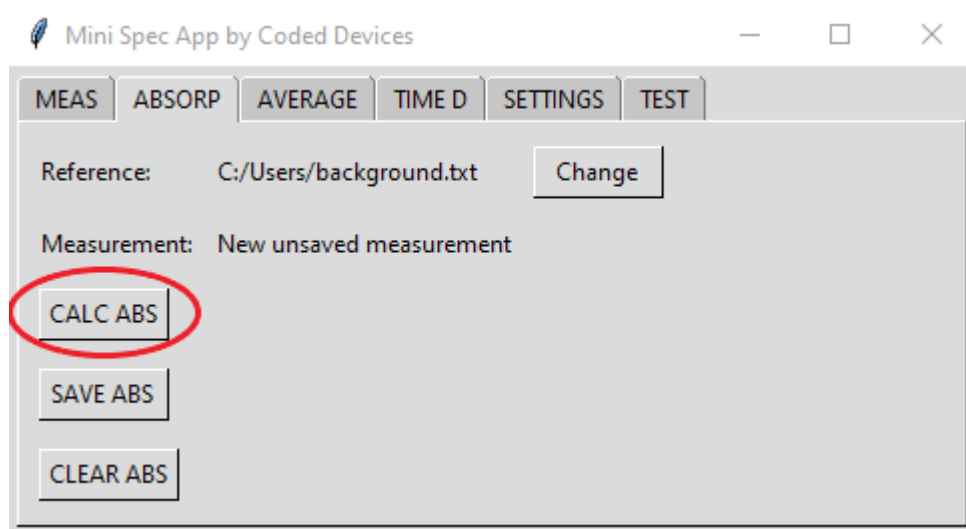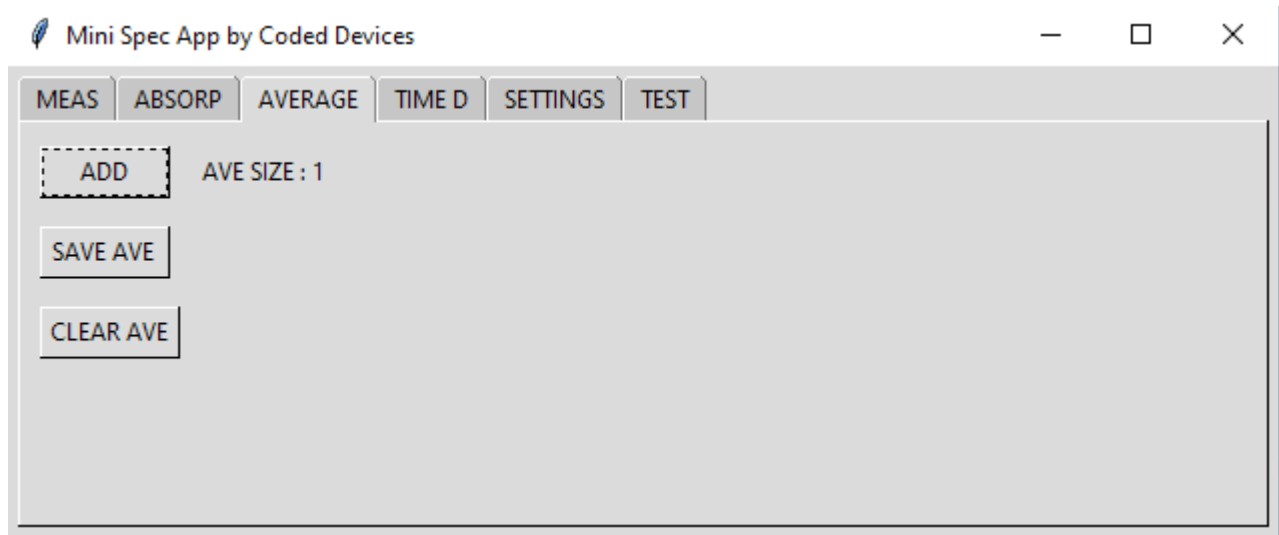

Below is an example of an absorption spectrum of a pink colored plastic film.
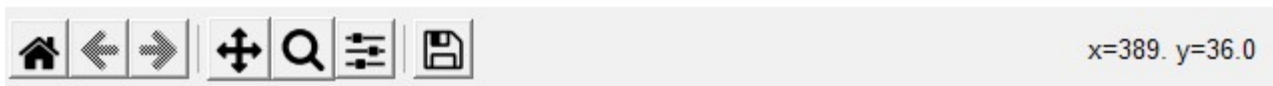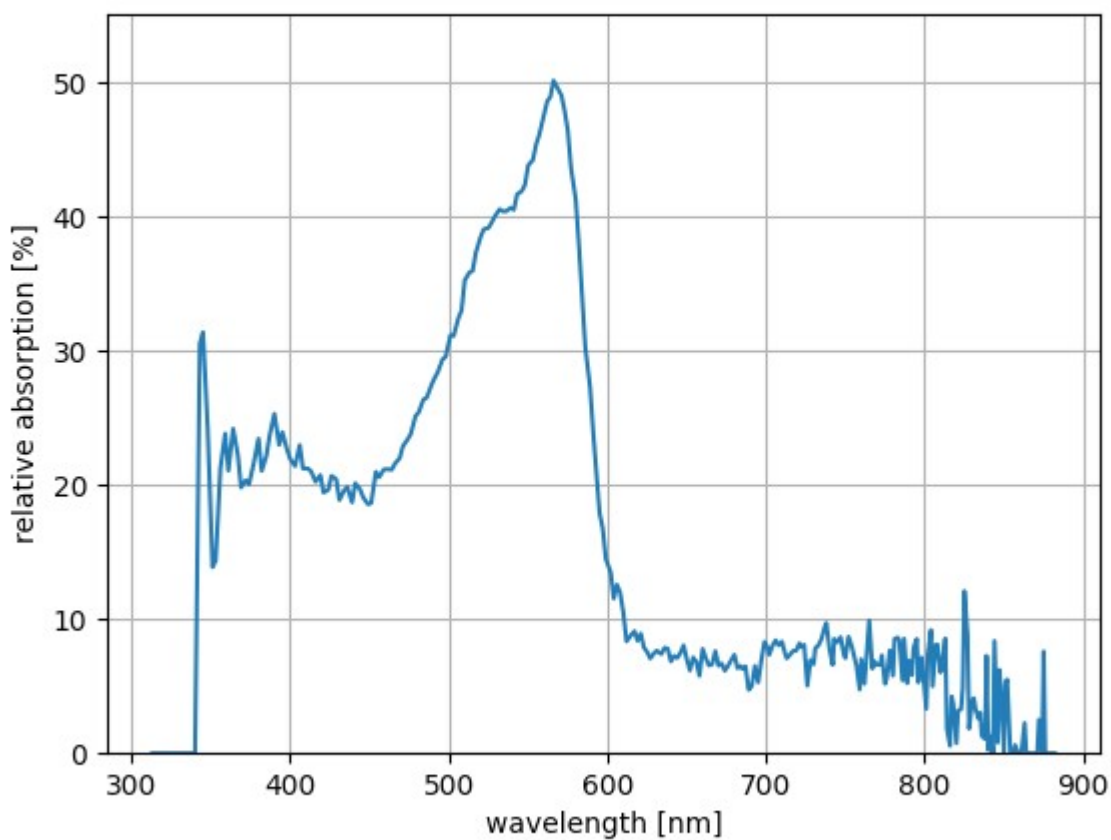
You can save the absorption spectrum by pressing the *SAVE ABS* button. To load a saved absorption spectrum, navigate to the *MEAS* page and press the *LOAD* button.

Create an Average Spectrum

Use several measured spectrums to create an average spectrum. This is a simple method to attenuate noise and other irregularities found in measured signals. It is effective as long as the measuring conditions stay unchanged.

After measuring or loading a new spectrum, open the *AVERAGE* page. There you'll find ADD button, which adds the spectrum currently in the memory into the average. Number of spectrums contributing to the average is shown next to the button.

Once you have created the average you can save it as spectrums normally. Use the button *SAVE AVE*. And if you want to clear the current average and start a new, press *CLEAR AVE*.

To open a saved average spectrum do as with other saved spectrums; go to *MEAS* page and press *LOAD* button.

Time D – what is it?
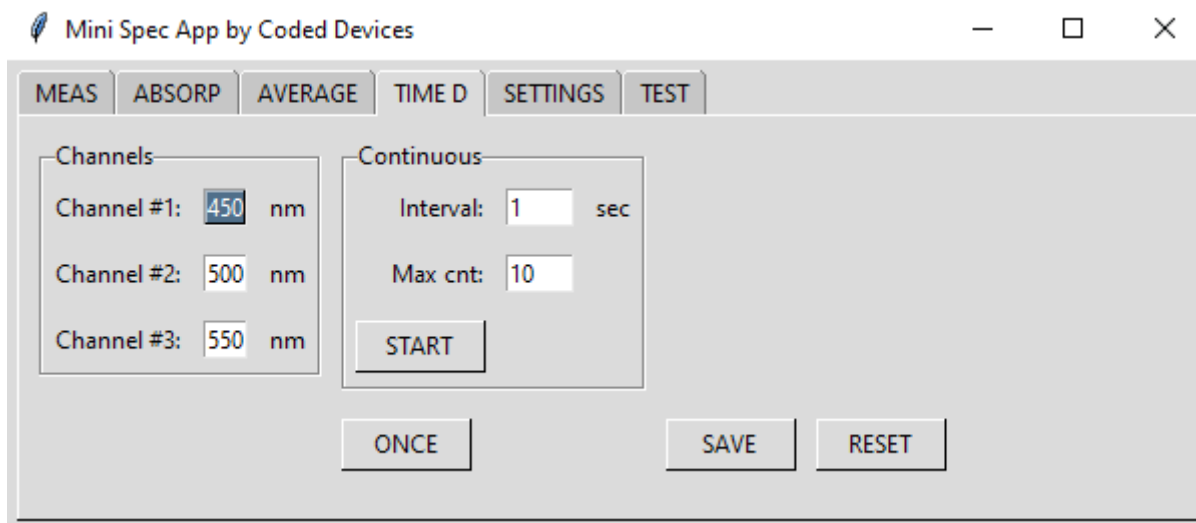
Time D is the page for making measurements in the time domain, specifically generating time series data for selected wavelengths.

Specify the wavelengths you wish to measure to select the three channels. The software will then automatically determine the appropriate channel corresponding to each specified wavelength.

Press *ONCE* button to get one set of readings from the selected channels.

Press *START* to initiate the collection of the defined number of sets of readings (*Max cnt*). You can predominantly stop the series measurement by pressing *STOP*.
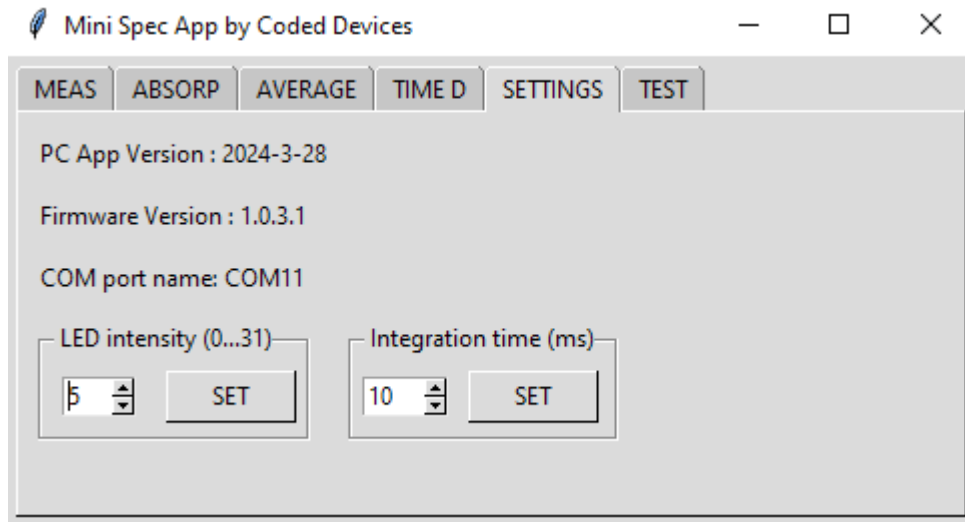
Below is an example measurement of daylight values of three selected channels measured indoors.
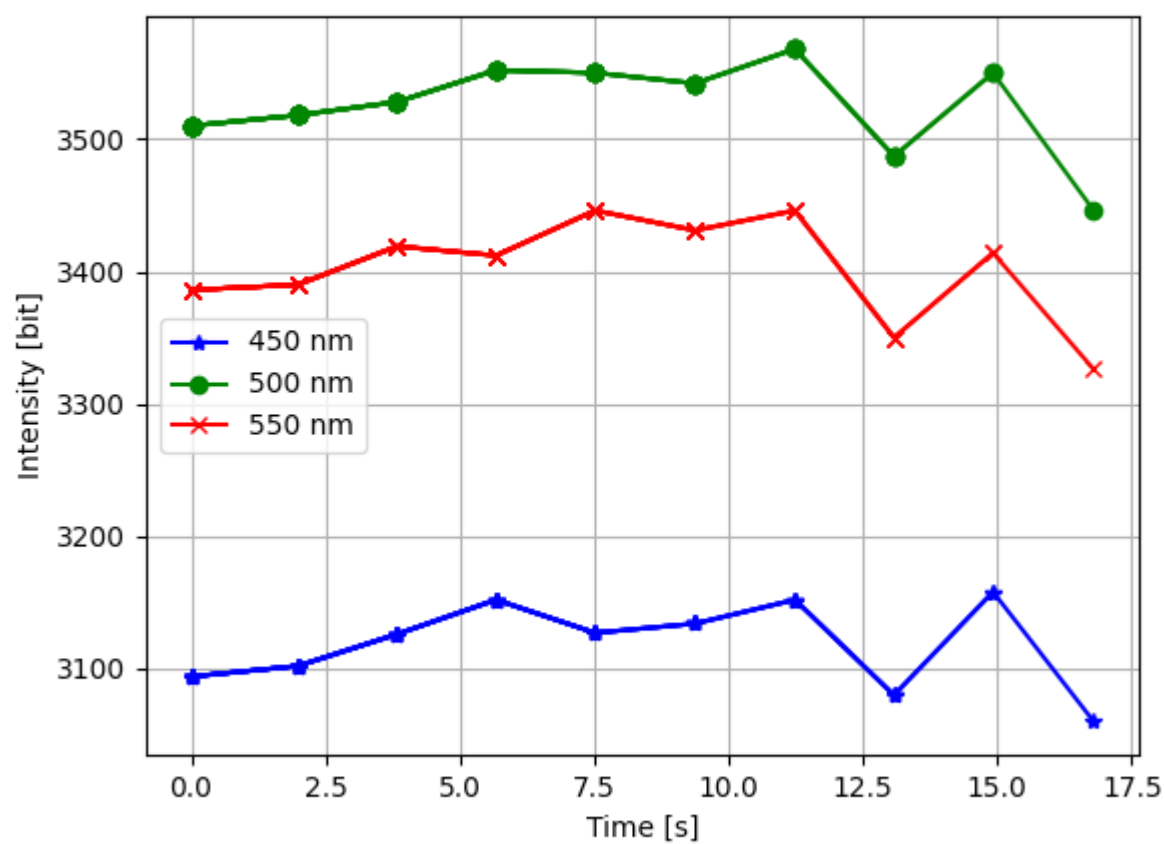
System Settings

System info and settings can be accessed via *SETTINGS* page.

PC App Version is the value of a version variable in the mini_main.py file that serves as the general software version, although other files within the project may have their own distinct versions.

Firmware Version is the version of the firmware currently programmed into the micro controller.

COM port name is the name of the serial port currently used with the Mini Spectrometer. This can be selected in the settings file mini_settings.py.

LED Intensity (0...31) adjusts the output of the LED controller of the Mini Spec board. Max value 31 sets the output to maximum and min value 0 turns the source off.

The Integration time (ms) setting adjusts the integration time of the sensor head, which defines how long the sensor collects photons during a measurement. Dim targets may require a longer integration time for a clear spectrum, while with bright targets, a longer integration time may lead to a saturated measurement.

Testing

The TEST-page is used for different tests and may change often. These tests include examples and quickly created solutions for specific applications. Therefore the documentation of the TEST page may not be up-to-date or correct.