MONOCLE

KduPRO

User's guide and technical documentation

Institut de Ciències del Mar

EMBIMOS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776480

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Special thanks to Xavi Salvador for providing nice pictures of the KduPRO.

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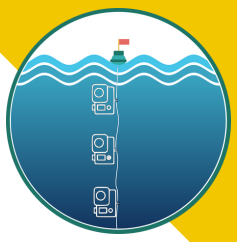
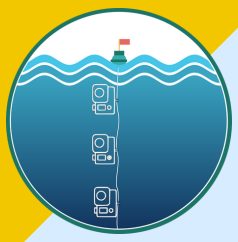


Contents



System description

The **KduPRO** is a low-cost and Do-It-Yourself moored instrument that measures the diffuse attenuation coefficient (Kd), used to assess water transparency.

This parameter is strongly affected by different water quality-related components (such as the presence of phytoplankton, organic matter and sediment concentrations).

Deployment of the KduPRO

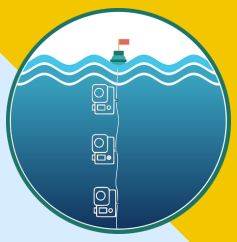
The KduPRO is the modular version of the KdUINO, redesigned to obtain accurate Kd measurements in the first meters of the water column.

Each module contains a light sensor that allows measures in the spectral zone of PAR (Photosynthetically Active Radiation), red, green and blue, and can store data independently.

The depth of each module can be modified according to the requirements of the project or the environment, offering to the user a custom array of sensors.

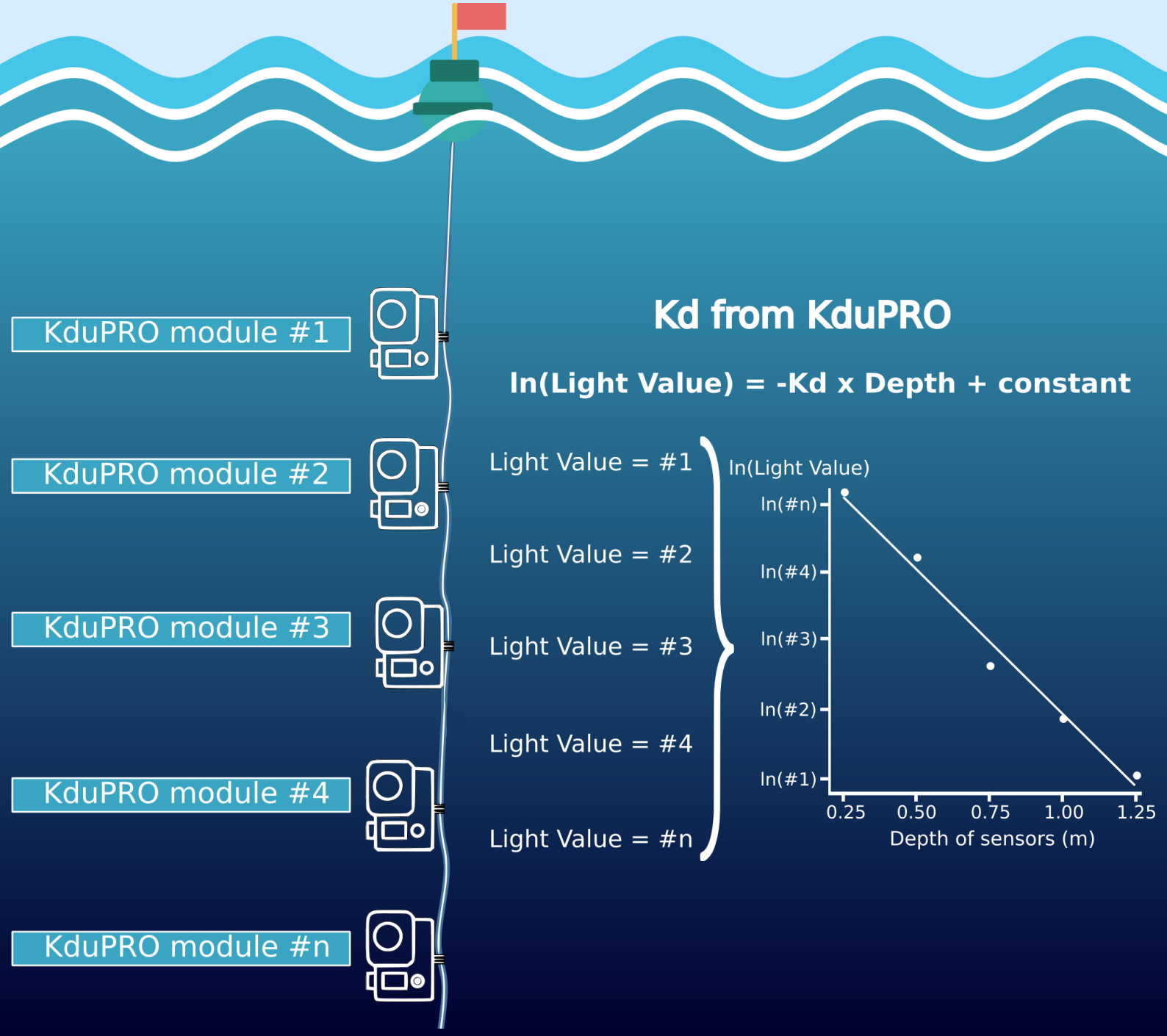
In this document, we will give general instructions for build and use a KduPRO.

Measuring Kd



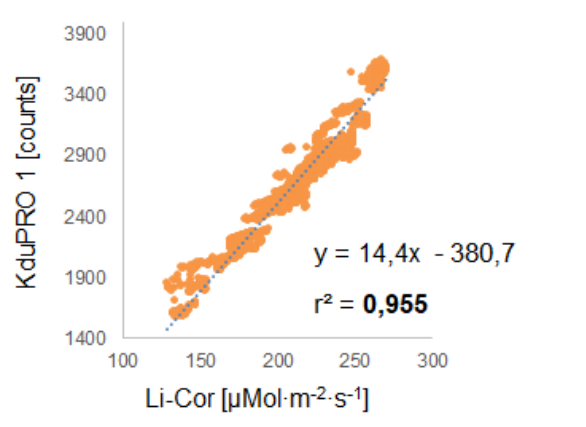
How does **KduPRO** measure the diffuse attenuation coefficient (Kd)?
Each module of KduPRO is placed at a known depth, and measure the light value by its sensor.

We convert those light values to logarithms and calculates the linear regression. With this parameter, it is obtained the slope, and by means of the negative value of this slope, Kd is obtained.



Physical meaning

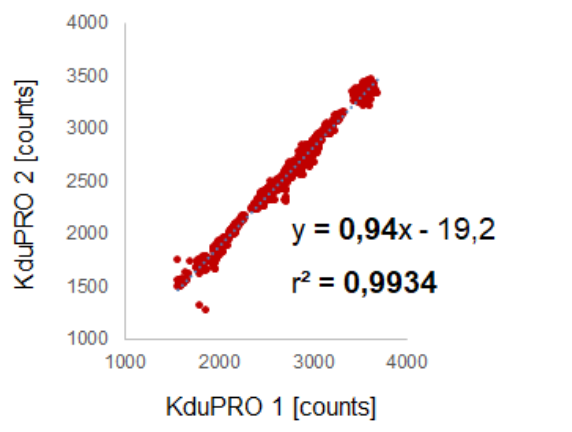
The **KduPRO** has been compared with other reference sensors, obtaining significant results. For this reason, the KduPRO can be expressed in these same units (µMol·m-2·s-1).



Relation between one module of KduPRO and Li-COR Li-192 reference sensor

Reproducibility

Different modules of the KduPRO have been compared between them, offering a good reproducibility of the measurements.



Relation between different modules of KduPRO

Results obtained during MONOCLE field campaign (Loch Leven, 2018)

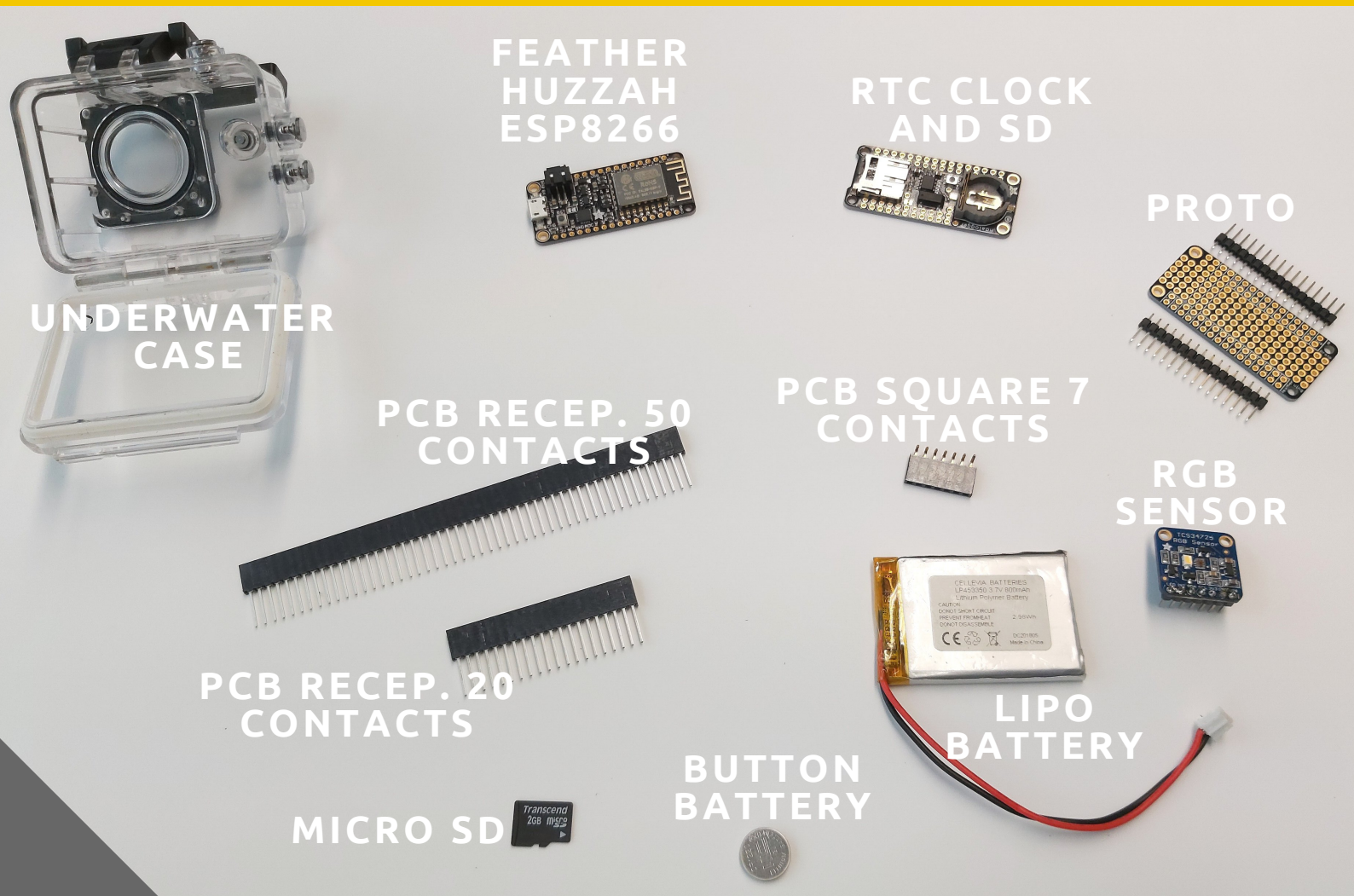
Measurements with different modules of KduPRO and Li-COR Li-192 reference sensor

System installation

Hardware components

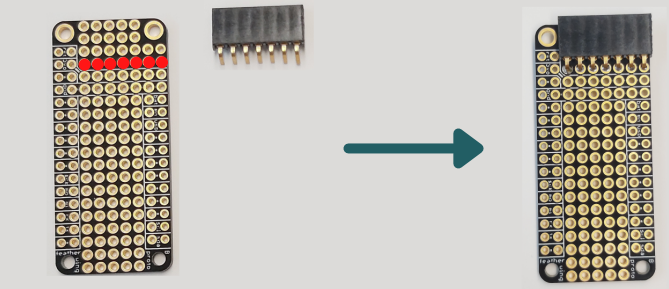
Component	*Cost (€)*
Feather HUZZAH ESP8266	19.49
Adalogger FeatherWing RTC Clock and SD	9.60
FeatherWing Proto	5.31
Underwater case (GoPro or similar)	15.69
TCS34725 color RGB sensor	11.76
Lithium-ion Polymer Battery	8.41
MicroSD	13.39
CR1220 Button Battery 3V	1.33
PCB socket 2.54 mm square 7 contacts	2.19
PCB Receptacle 2.54 mm board-to-board 20 contacts	3.47
PCB Receptacle 2.54 mm board-to-board 50 contacts	6.67
	Total
	97.31

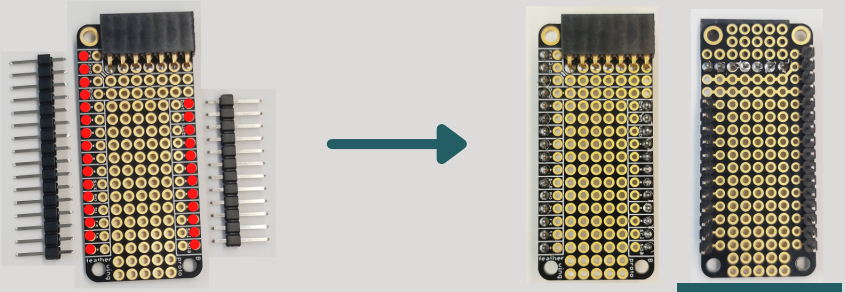
Budget for build one module of KduPRO



Installation

1 Solder the PCB socket-7contacts and the assembled headers to the FeatherWing Proto

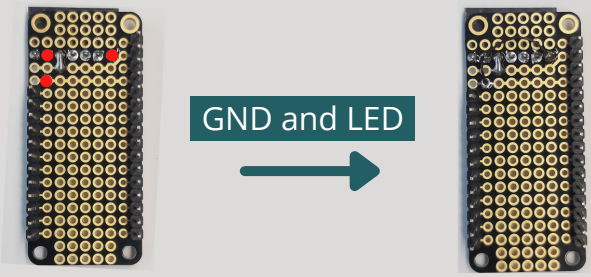


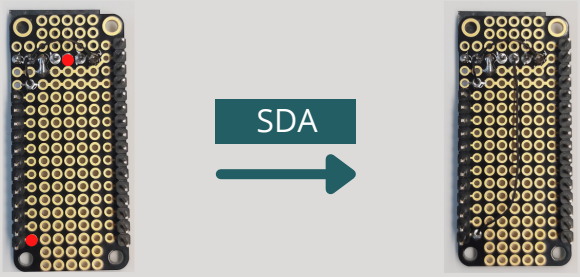


Reverse

Installation

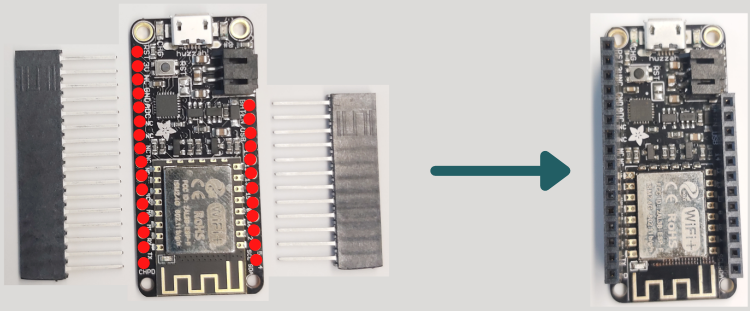
2 Solder the circuit of the FeatherWing Proto



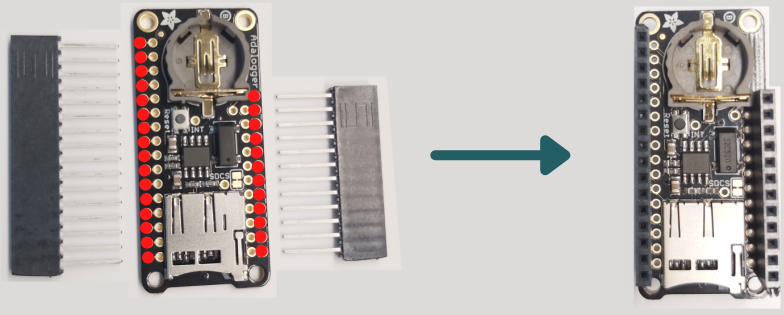


Installation

3 Solder the PCB receptacles to the Feather HUZZAH ESP8266

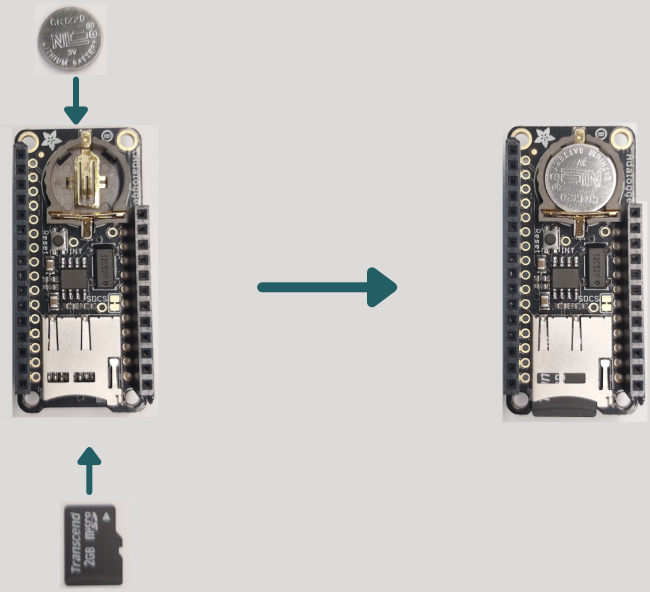


4 Solder the PCB receptacles to the Adalogger FeatherWing



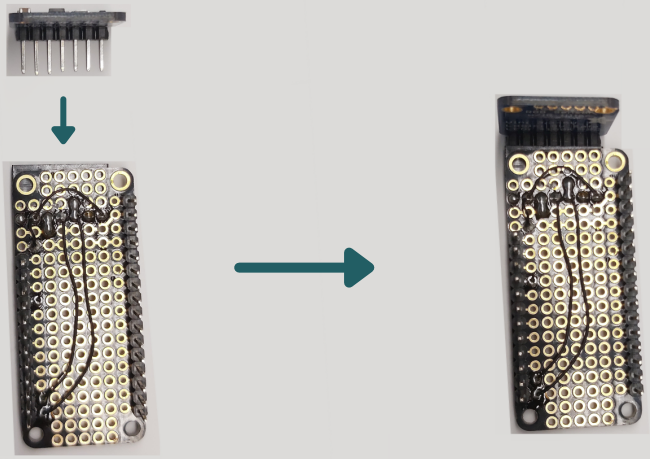
Installation

5 Insert microSD card and battery button to Adalogger FeatherWing RTC Clock and SD



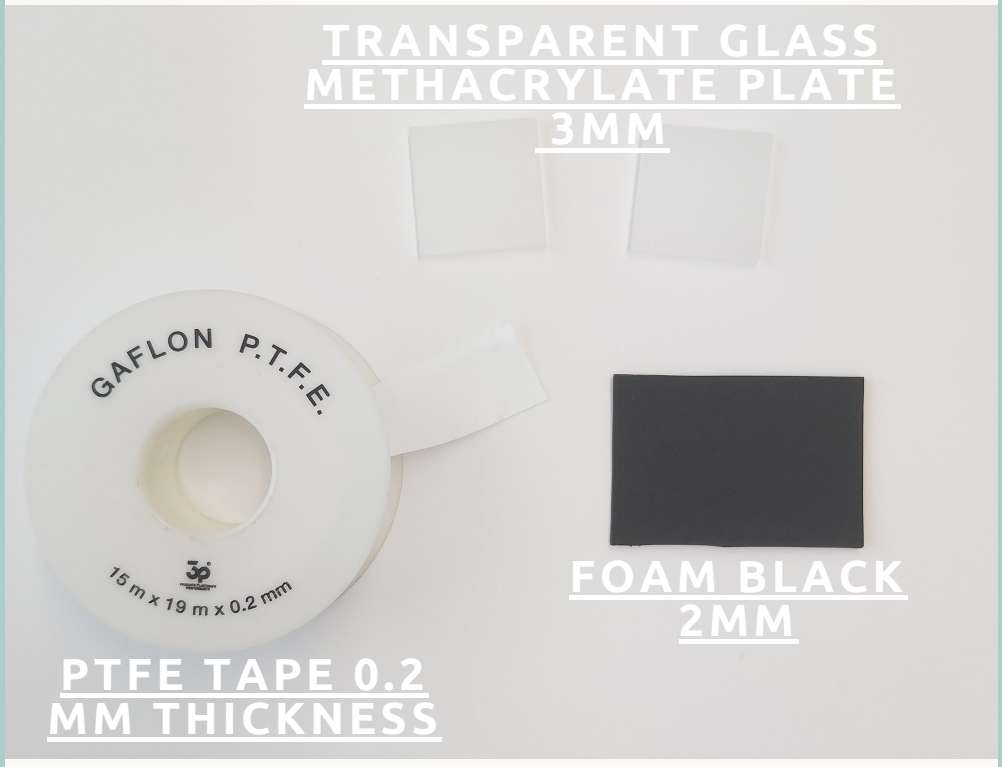
6 Insert the TCS34725 sensor into the PCB socket of FeatherWing Proto.

** In case of prepare a **corrective cosine filter**, please follow steps 7 to 16.
If not, continue to step 17

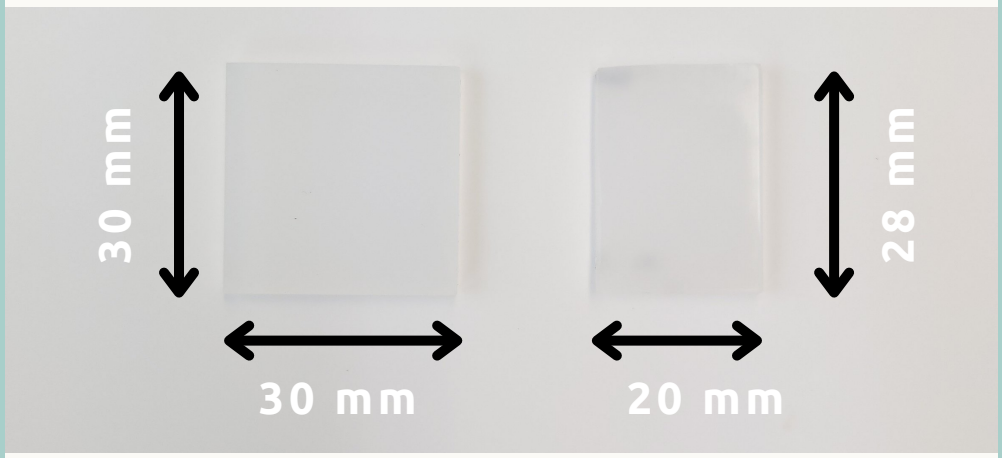


Installation

7 Material list to do a corrective cosine filter in TCS34725 sensor

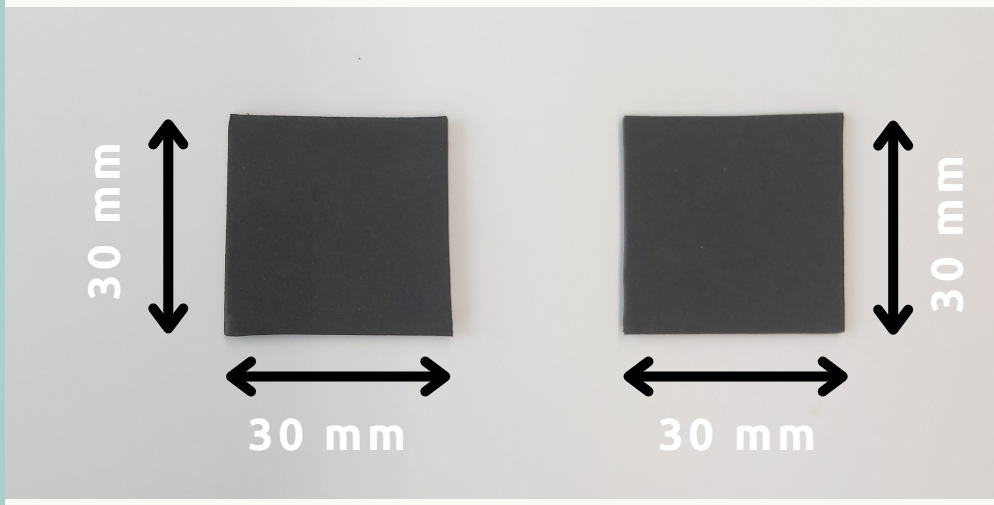


8 Cut transparent glass methacrylate plate into 2 pieces with these dimensions: 28mm x 20mm, and 30mm x 30mm

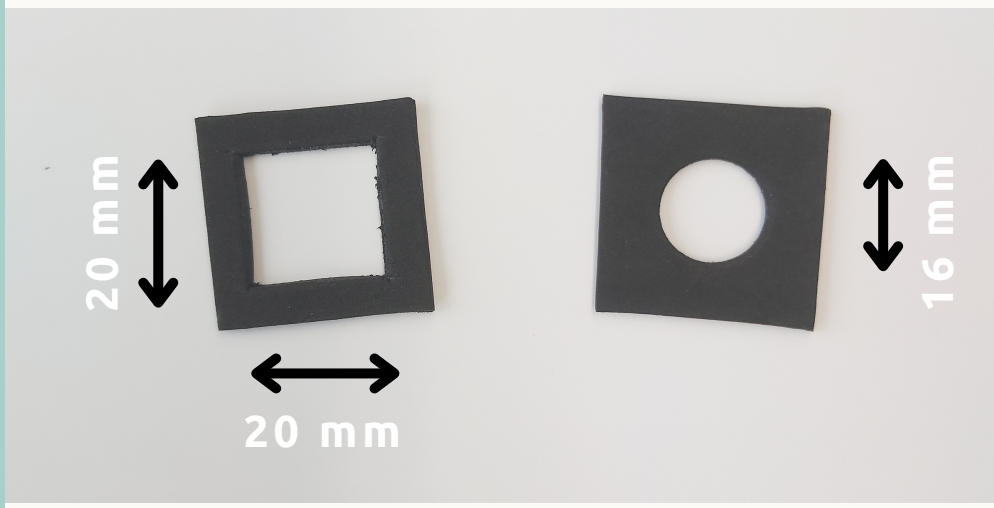


Installation

9 Cut the foam black 2mm into 2 pieces with these dimensions: 30 mm x 30 mm.

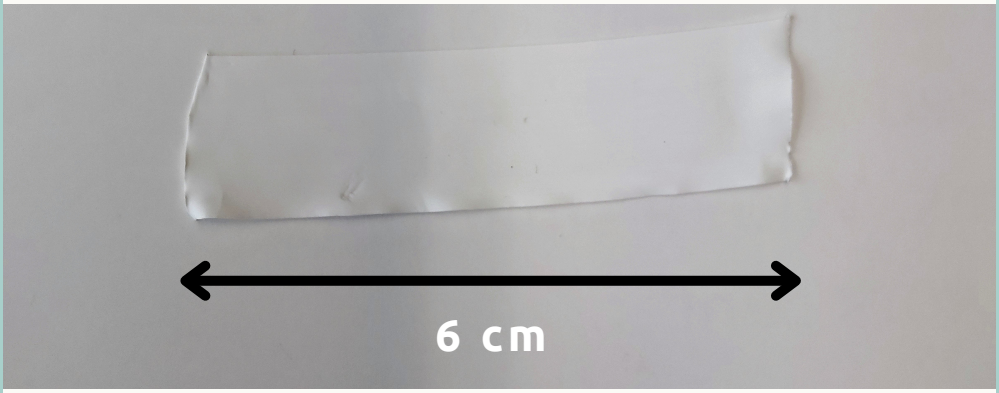


10 Cut a circular hole of 16 mm diameter from the centre, and a square hole of 20 mm x 20 mm from the centre.

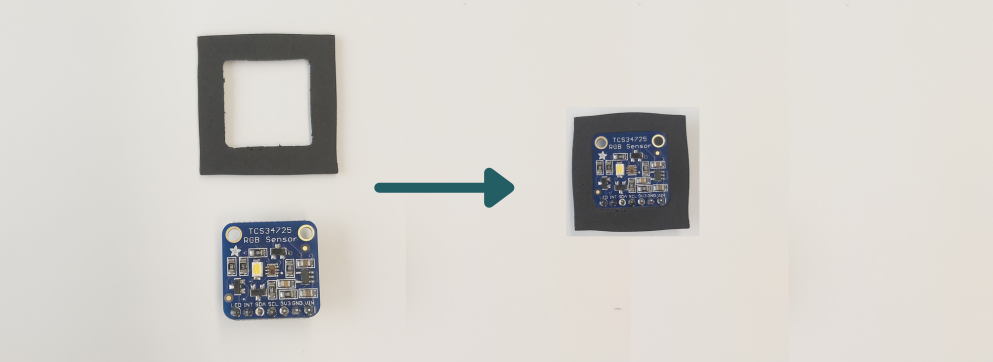


Installation

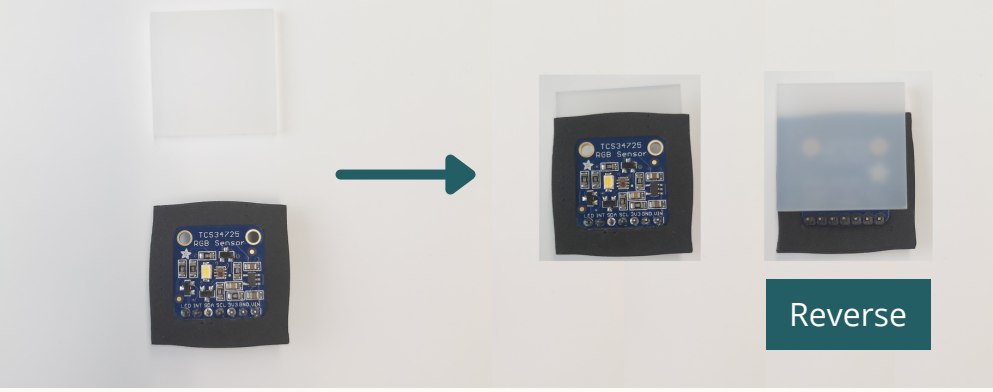
11 Cut a strip of 6 cm length of PTFE tape 2mm



12 Put the TCS34725 sensor inside the 20 mm x 20 mm square hole of the black foam piece

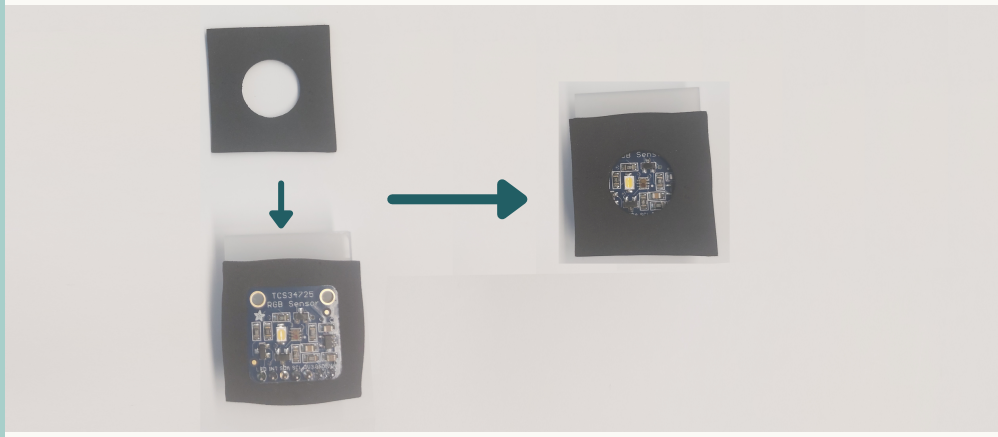


13 Stick it (with superglue) to the 30 mm x 30 mm transparent glass methacrylate plate piece (function as a support)

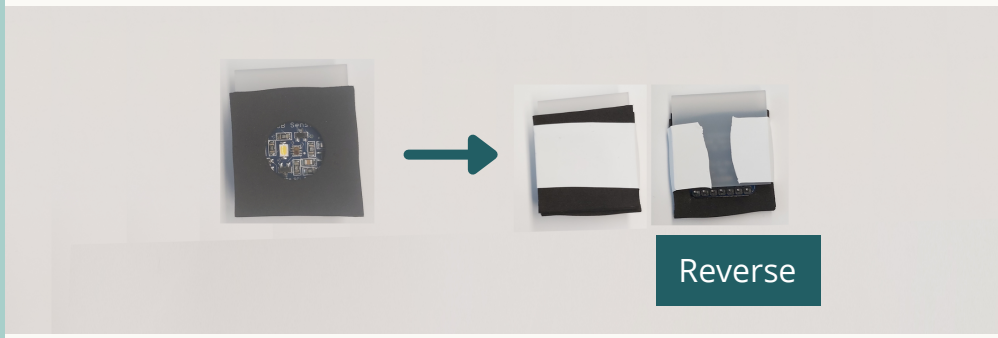


Installation

14 Stick those piece to the 20 mm x 20 mm circular hole of the black foam piece



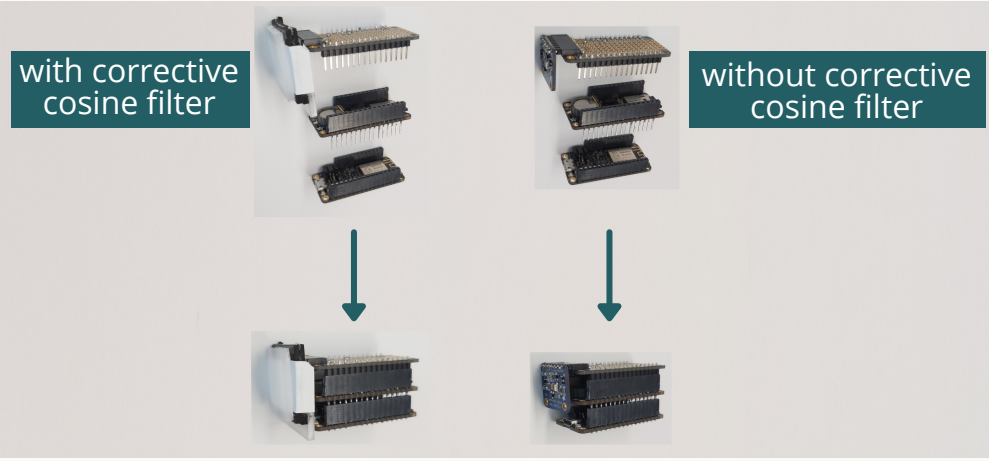
15 Put the strip of 6 cm length of PTFE tape 2mm above the piece, surrounding the hole piece



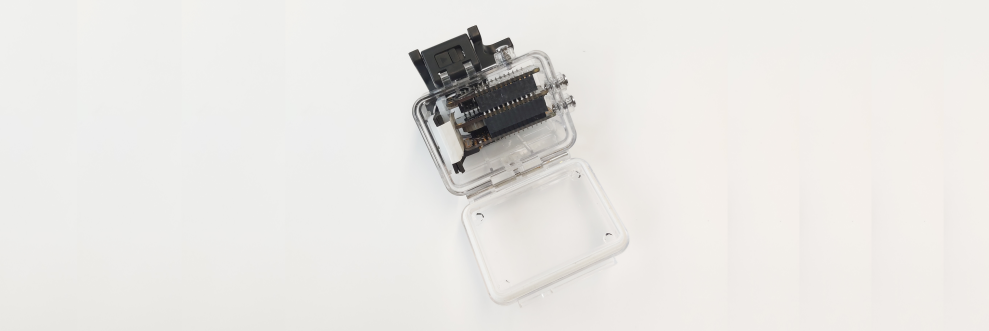
16 Stick it to the 28 mm x 20 mm transparent glass methacrylate plate piece

Installation

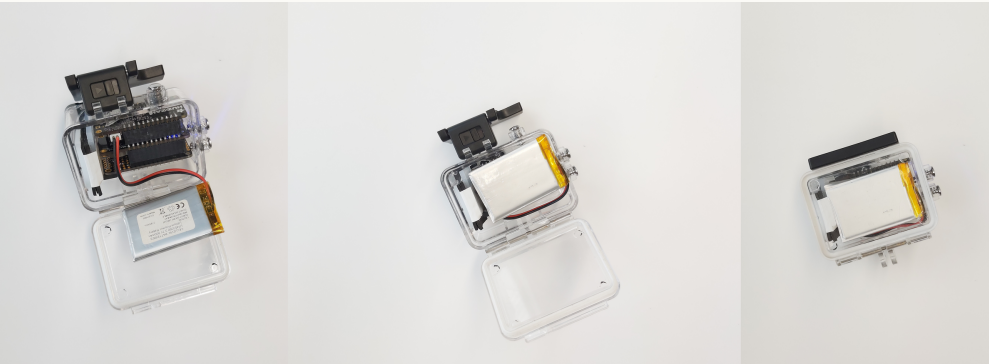
17 Join the FeatherWing Proto, the Adalogger FeatherWing and the Feather HUZZAH ESP8266



18 Put it inside the underwater case as it is shown in the picture below



19 Connect the battery and close the underwater case



Installation

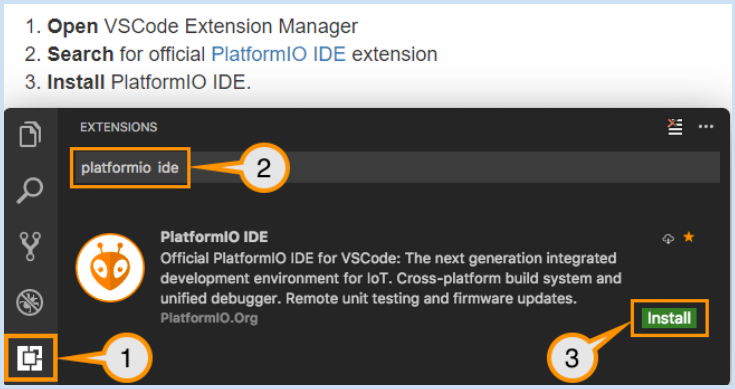
Finally, you have finished one module of the KduPRO!

Software setup

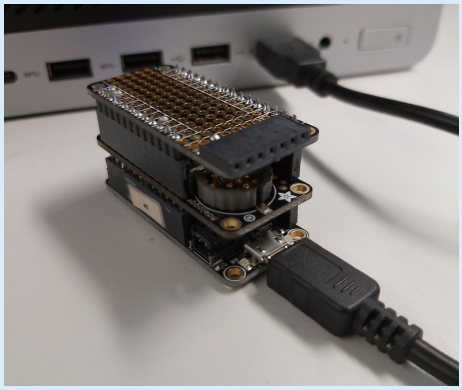
1 Download the current firmware from this repository:

https://git.csic.es/kduino/kdupro

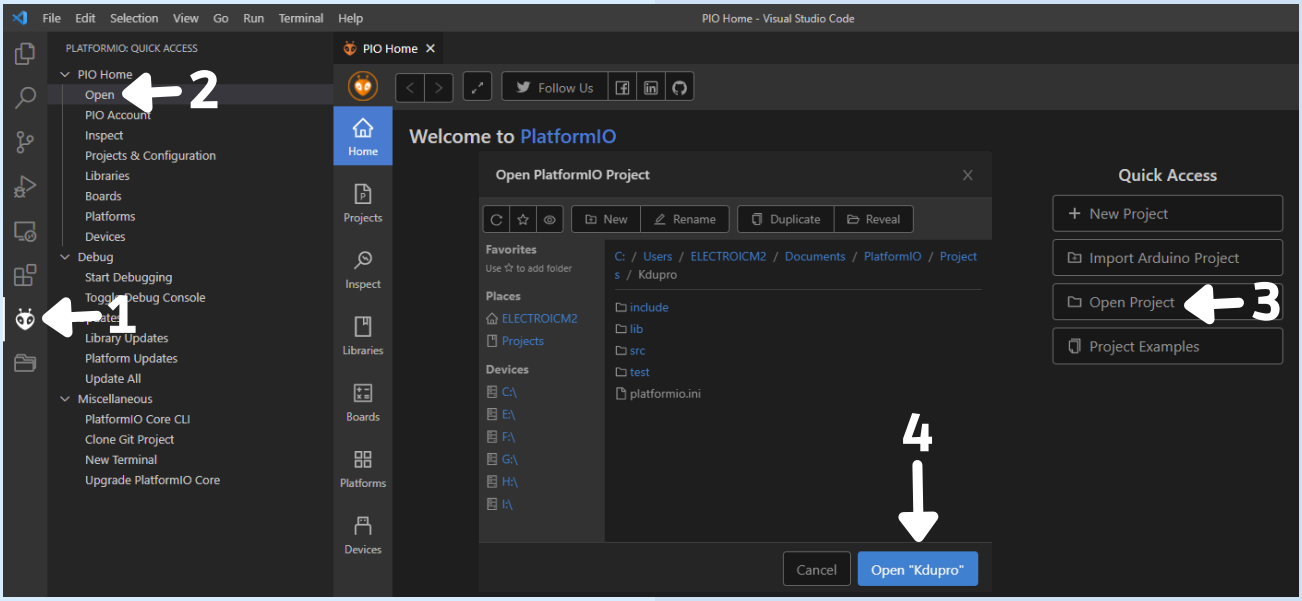
2 We suggest using the Visual Studio Code (works on Windows, Linux and Mac) and installing the PlatformIO extension to upload this firmware.



3 Connect your Feather HUZZAH ESP8266 through a USB

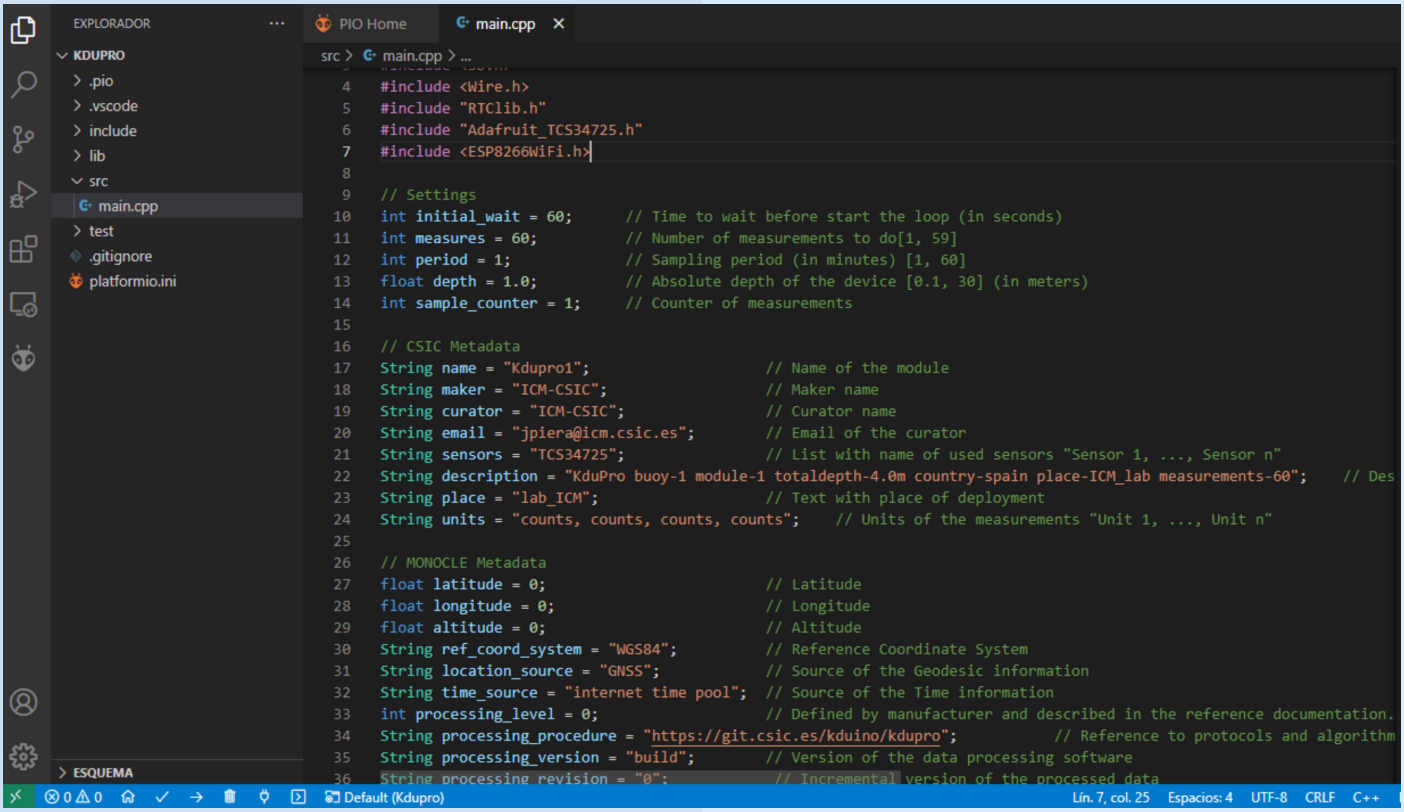


4 Open Visual Studio Code, click on the PlatformIO extension (**1**), open (**2**) and open project (**3**). Find the downloaded firmware and open the project (**4**).

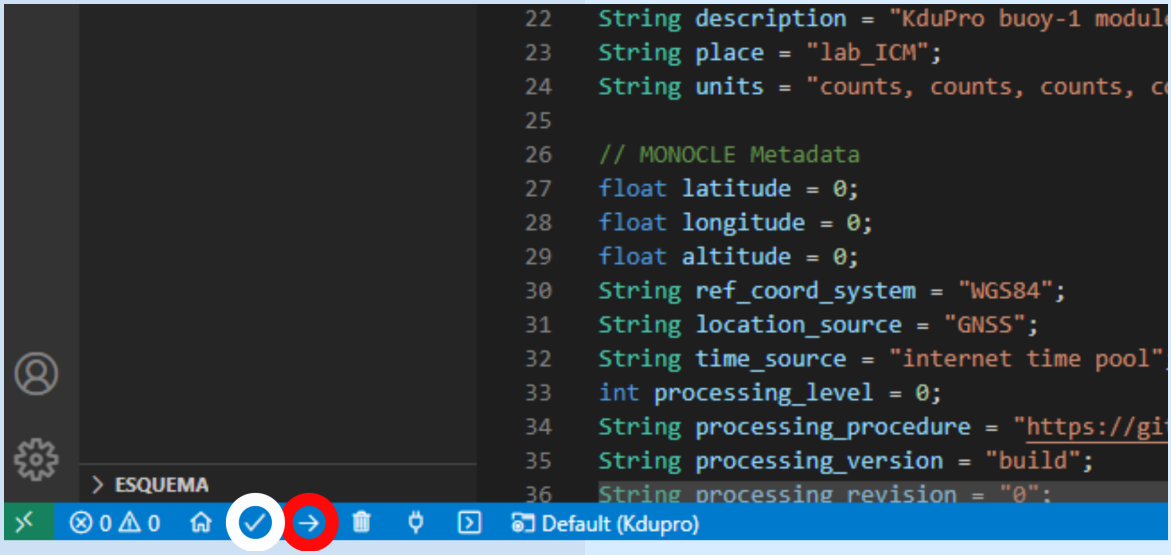


Software setup

5 Edit metadata fields in the */src/main.cpp* file for each module of the KduPRO (depth, latitude, longitude, owner contact...)



6 Click on the bottom PlatformIO toolbox **build** (marked in white in the screenshot below) and then **upload** (marked in red in the screenshot below)



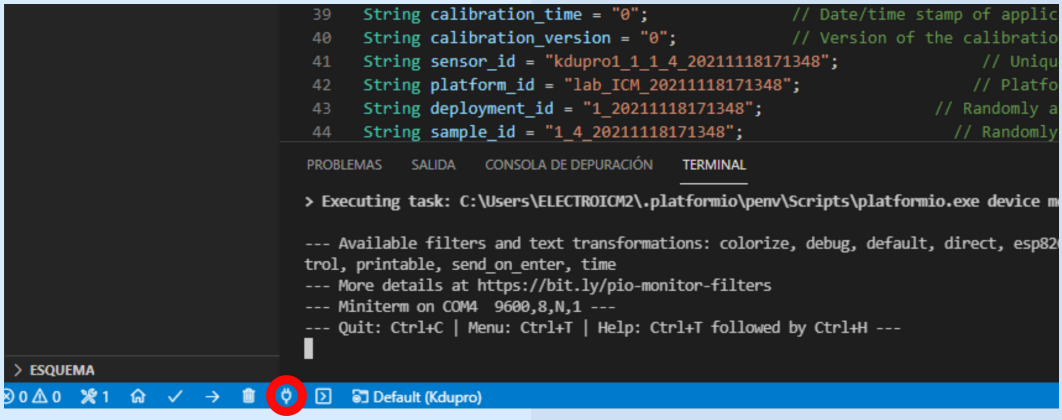
Software setup

7 When the upload is complete, the message **SUCCESS** appears

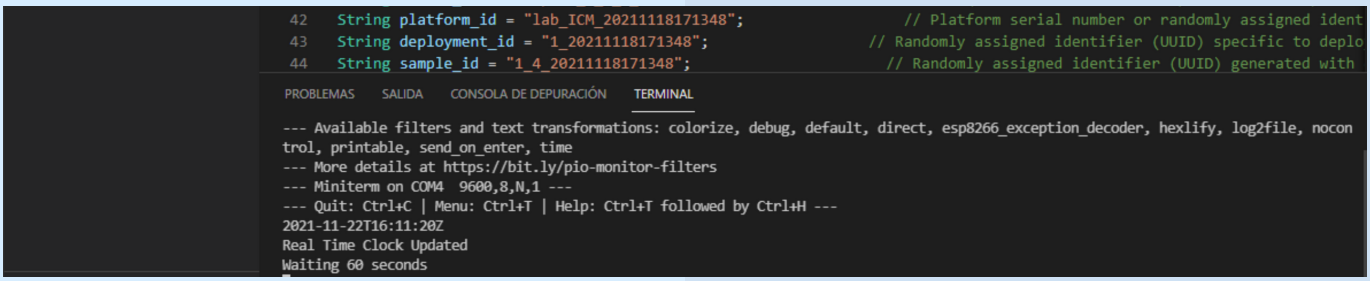
```
Writing at 0x00034000... (93 %)
Writing at 0x00038000... (100 %)
Wrote 316960 bytes (230306 compressed) at 0x00000000 in 20.3 seconds (effective 125.0 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
========================================== [SUCCESS] Took 26.78 seconds ==========================================
```

8 Finally, we need to synchronize the real-time clock (it is a function included in the KduPRO code). Open the **serial monitor** (marked in red in the screenshot below).



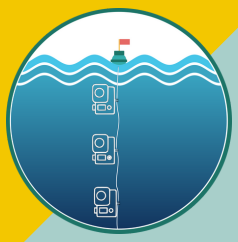
9 And enter the date and time in the following format (it is not visible when the user typing in the serial monitor): YYYYMMDDhhmmss



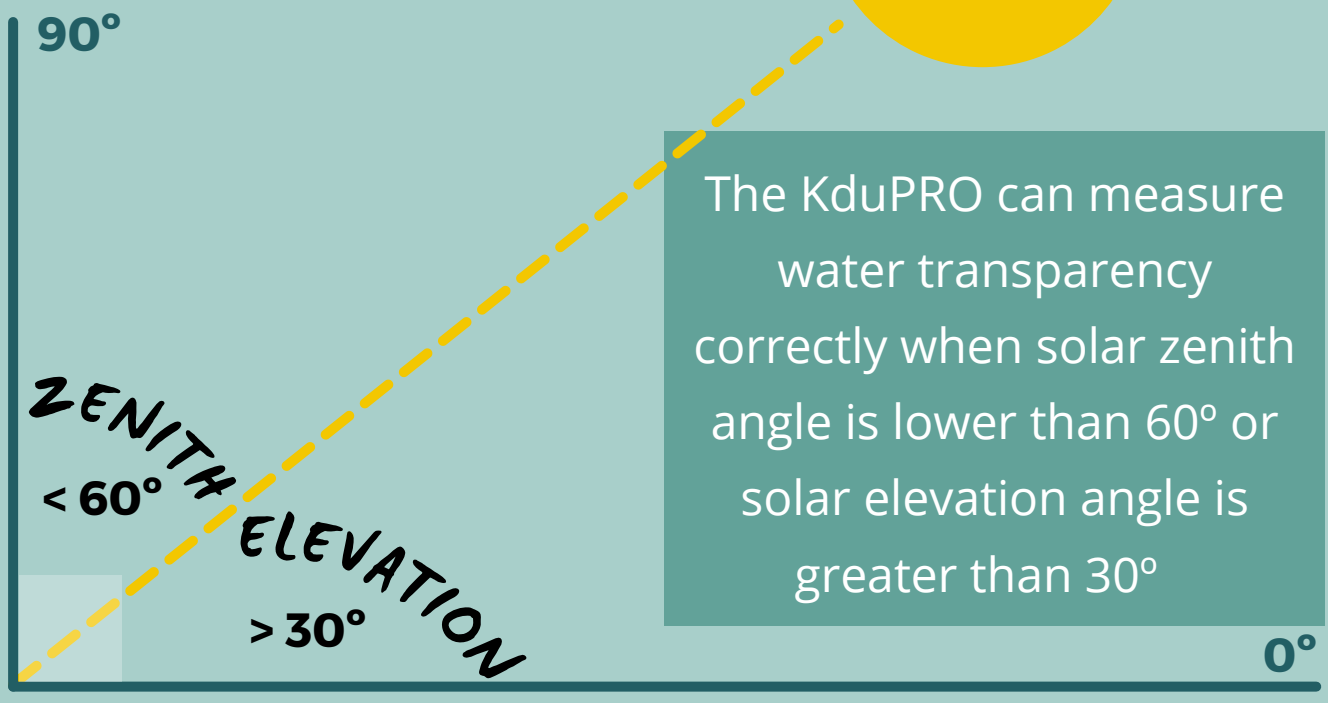
System check

- Check the locking system

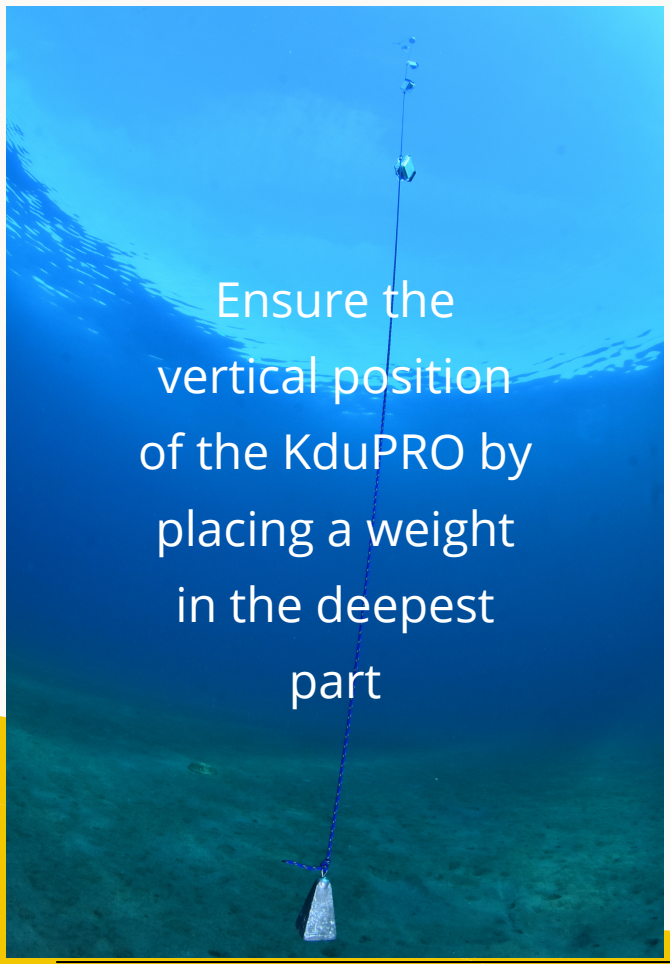
- Battery charged
- Battery button charged
- SD card empty or enough space available
- Battery cable secure
- LED blue when the battery is connected. LED off after initial wait in seconds



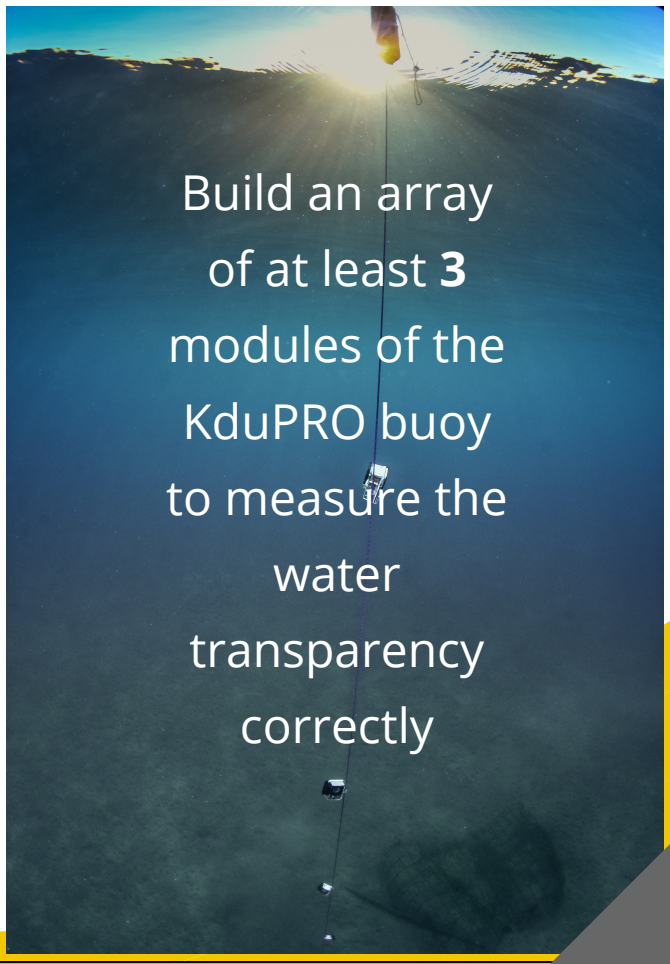
Data gathering



The KduPRO can measure water transparency correctly when solar zenith angle is lower than 60° or solar elevation angle is greater than 30°



Ensure the vertical position of the KduPRO by placing a weight in the deepest part



Build an array of at least **3** modules of the KduPRO buoy to measure the water transparency correctly

Data process

1 Download the KdUINO Data Analysis to process the KduPRO data from this repository:

https://git.csic.es/kduino/kdupro

2 Follow the instructions of the README file

README.md

Kduino Data Analysis

Kduino data analysis is a python module designed for open and analyze data files from Kduino instrumentation. Also, provide methods to generate plots and convert data files in netCDF and CSV format.

This module works with different versions of Kduino:

- Kdupro
- Kdustick
- Kdumod (in development)

Installation

Clone this repository in your local system (`git clone git@git.csic.es:kduino/kduino-data-analysis.git`) and then launch the `main.py` file to run the Kduino Data Analysis.

Usage

You need to add your data file inside `data` folder and create a new configuration file inside the properties folder. There is a template and so many examples to create your own configuration.

License

MIT

MONOCLE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776480 (MONOCLE).

System maintenance

- Clean the sealing
- Clean the underwater case (biofouling) to avoid contamination between samples

- Check the solder joints
- Update Real Time Clock in future deployments

Contact information

Contact information for KduPRO can be obtained from:

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rodero@icm.csic.es

Raul Bardaji
bardaji@utm.csic.es

Jaume Piera
jpiera@icm.csic.es

For additional material and resources, please visit the url:
https://monocle-h2020.eu/Sensors_and_services/KdUINO

If you encounter a problem testing the KduPRO, please e-mail us the following:
• A description of the problem, error messages, or other pertinent information.
• The error.log file, which is found in the error directory
This information will greatly increase the speed at which we can troubleshoot the problem

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