Das Forschungsprojekt ParKli wird gefördert durch die Baden-Württemberg Stiftung im Programm "Innovationen zur Anpassung an den Klimawandel".

Baden-Württemberg Stiftung
WIR STIFTEN ZUKUNFT

Projektpartner

Herman Hollerith Zentrum
für Services Computing Böblingen

Hochschule Reutlingen
Reutlingen University

open science for open societies

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Website	www.parkli.de

This document was translated with Deepl Pro https://www.deepl.com/

Important links:
Github Project PCB Board: https://github.com/os4os-repo/ParKli_WaterQualitySensor
Repository with further images: https://datahub.openscience.eu/dataset/parkli-boje

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Term: 01.07.2021 - 30.06.2024

Parkli platform: www.parkli.de

Building instructions for the ParKli buoy

The following document serves as a step-by-step guide to building the ParKli buoy, describing the individual components and providing links to further information. Some of the components can be produced using a 3D printer, others can be purchased either online or locally, e.g. in a DIY store.

Table 1 shows the 3D print elements, including a brief description and the names of the .stl data.

Important: The document is constantly evolving and it is recommended that you always use the latest document from our site.

We have tried to document as much detail as possible. If you have any questions, please send an email to parkli@os4os.eu.

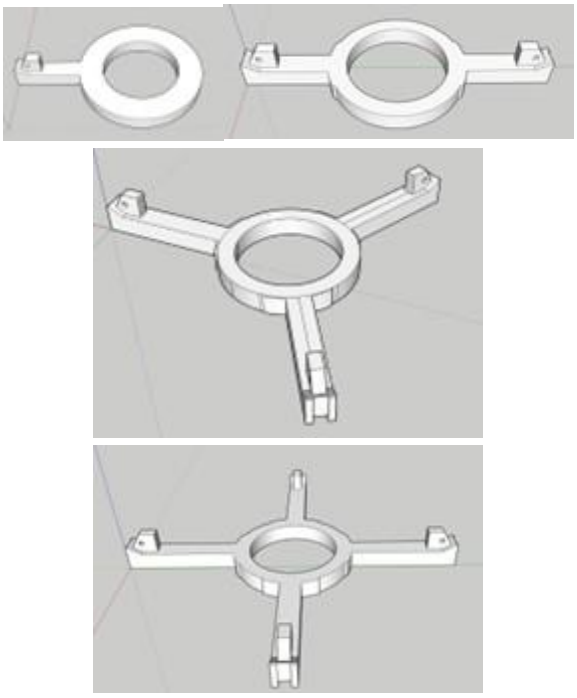
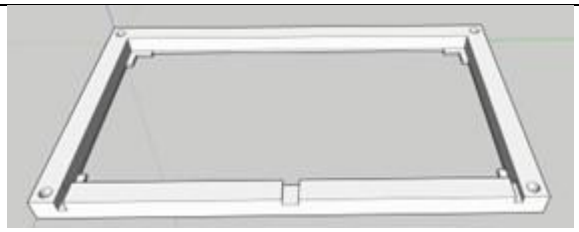
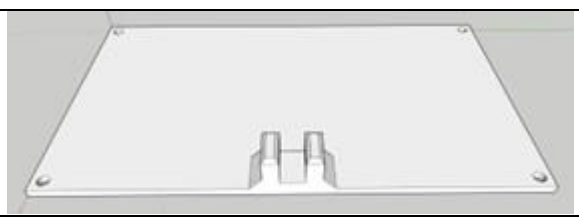
Components

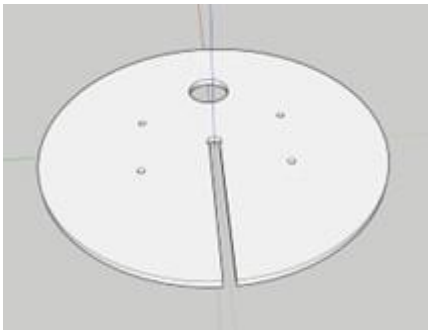
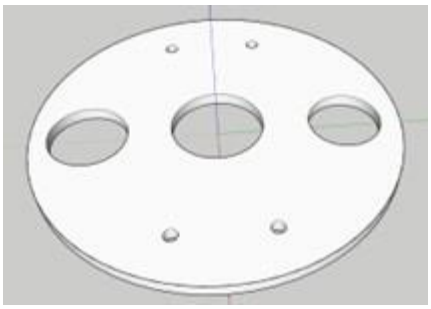
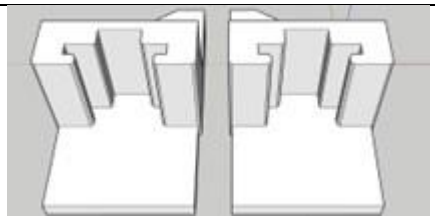
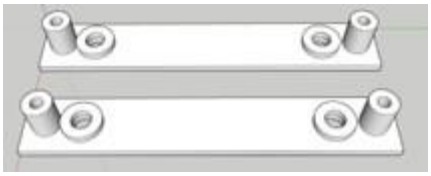
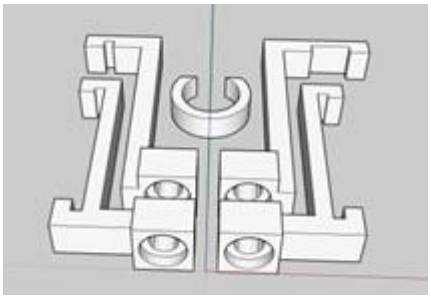
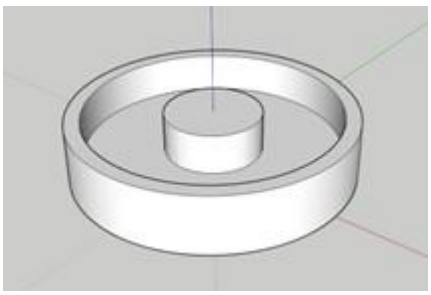
Components from the 3D printer

Components can be manufactured in different designs. The solar module holder can hold one, two or four modules.

Table 2 shows the printing time and material consumption in metres and grams for the production of the 3D printed elements. For the version with four solar modules, this results in a printing time of 53 hours, a material consumption of 82 metres and 245 grams.

Table 1 ID and description of the 3D print elements and name of the .stl files

Buoy 3D prints		
ID	**Name and image 3D model**	**Description of the components**
3D01		Bracket for attaching the solar modules to the main pole of the buoy. There are three options for attaching one, two or four solar modules. ***Files***: - Bracket1SolarPanels.stl Printing time: 4 hours 5 minutes Material: 6.75 metres, 20 grams - Bracket2SolarPanels.stl Printing time: 3 hours 35 minutes Material: 5.70 metres, 17 grams - Bracket3SolarPanels.stl Printing time: 2 hours 34 minutes Material: 3.85 metres, 17 grams - Bracket4SolarPanels.stl Printing time: 6 hours 18 minutes Material: 9.88 metres, 29 grams
3D02		Upper bracket for the PV modules ***File***: - SolarTop.stl Printing time: 2 hours 31 minutes Material: 4 metres, 12 grams
3D03		Lower bracket for the PV modules ***File***: - SolarBottom.stl Printing time: 5 hours 1 minute

		Material: 7.41 metres, 22 grams
3D04		Top cover for the small buoy with the pH sensor ***File***: - TopCoverpH.stl Printing time: 3 hours 51 minutes Material: 5.73 metres, 17 grams
3D05		Bottom cover for the small buoy with the pH sensor ***File***: - BottomCoverpH.stl Printing time: 1 hour 16 minutes Material: 1.93 metres, 6 grams
3D06		Sensor box bracket ***File***: - HolderSensorBox.stl Printing time: 1 hour 51 minutes Material: 3 metres, 9 grams
3D07		Sensor box mounting bracket ***File***: - MountingSensorBox.stl Printing time: 2 hours 5 minutes Material: 3.02 metres, 9 grams
3D08		PCB board mounts ***File***: - PCBHolders.stl Printing time: 1 hour 47 minutes Material: 2.9 metres, 9 grams
3D09		Cover bar ***File***: - CoverBar.stl Printing time: 2 hours 18 minutes Material: 3.68 metres, 11 grams

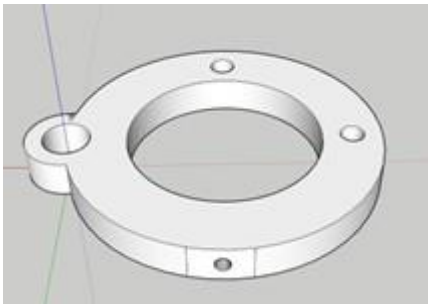
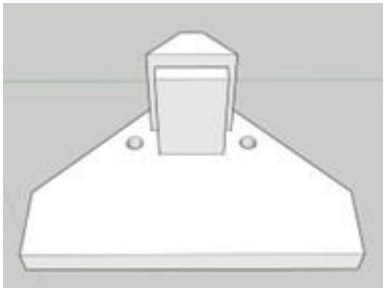
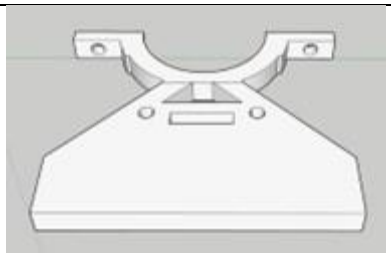
3D10		Holder sensors ***File***: - HolderSensors.stl Printing time: 4 hours 7 minutes Material: 6.52 metres, 19 grams

Table 2 Printing time and material consumption in metres and grams for the production of the 3D printed elements

ID	STL file	Printing time	Material consumption in metres	Material consumption in grams
3D01	Bracket1SolarPanels.stl	4.08	6.75	20
	Bracket2SolarPanels.stl	3.58	5.70	17
	Bracket3SolarPanels.stl	2.57	3.85	17
	Bracket4SolarPanels.stl	6.30	9.88	29
3D02	SolarTop.stl	2.52	4.00	12
3D03	SolarBottom.stl	5.02	7.41	22
3D04	TopCoverpH.stl	3.85	5.73	17
3D05	BottomCoverpH.stl	1.27	1.93	6
3D06	HolderSensorBox.stl	1.85	3.00	9
3D07	MountingSensorBox.stl	2.08	3.02	9
3D08	PCBHolders.stl	1.78	2.90	9
3D09	CoverBar.stl	2.30	3.68	11
3D10	HolderSensors.stl	4.12	6.52	19

Table 3 Further 3D print elements and names of the .stl files

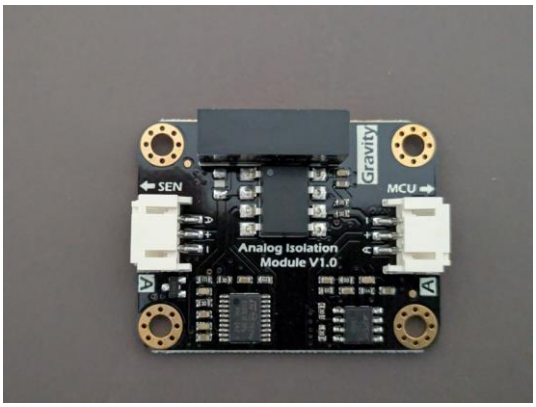
Buoy 3D prints		
ID	**Name and image 3D model**	**Description of the components**
0D01	 	Bracket for attaching the buoy (main pole) to a table. This makes it easier to assemble the buoy. ***Files***: - TableFixingSmall.stl Printing time: 1 hour 29 minutes Material: 2.45 metres, 7 grams - TableFixing.stl Printing time: 5 hours 48 minutes Material: 9.53 metres, 28 grams - TableFixingBottom.stl Printing time: 5 hours 34 minutes

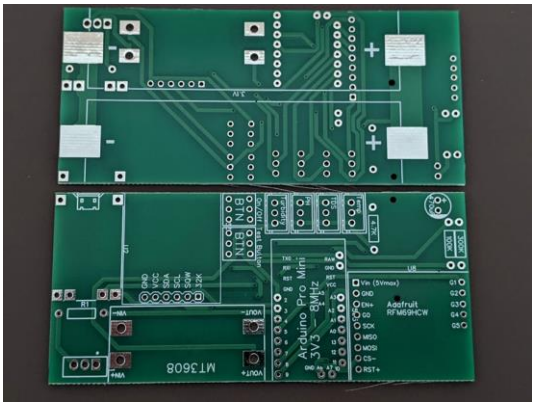
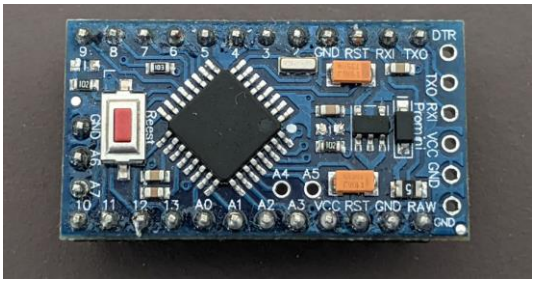
			Material: 9.38 metres, 28 grams

Other components

Table 4 Components required to build a Secchi disc - 3D components

Picture	Description of the components
 	**Buoy**: Buoy with pole and float. *Piece: 1*
	**Clamp fasteners:** *Piece: 4*
	**Solar modules**: DC 6V 1W mini solar panel Units: 1-4 depending on design variant

	**Analogue pH meter kit**: Gravity Analogue pH Meter Kit Analogue pH meter developed for Arduino controller LED as operating indicator, a BNC connection and a PH2.0 sensor interface are included Measuring range: 0-14PH Accuracy: ± 0.1pH (25°C) Piece: 1
	**TDS sensor**: Analogue TDS sensor kit compatible with Arduino microcontrollers. For measuring the TDS value and indicating the cleanliness of the water. Can be used for household water, hydroponics and other areas of water quality testing TDS range: 0 ~ 1000ppm / TDS accuracy: ± 10% F.S. (25 ℃) 3.3~5.5V operation. Piece: 1
	**Gravity: Analogue Signal Isolator**: 6N137, STM8S103F3P6 Isolator Interface Gravity Platform Evaluation Expansion Board. Piece: 1
	**Temperature sensors**: 3M Cable DS18B20 digital stainless steel waterproof temperature sensor for Arduino and Raspberry Pi Quantity: 3

	**Sensor housing**: Industrial housing made of polycarbonate (UV stabilised). Piece: 1
	**Cable gland and locknut:** Cable gland, PG 16, Ø 9 - 14 mm, silver-grey, IP68. Piece: 1
	**Pressure equalisation screw:** M6 Pressure equalisation element M6 PA66 Black. • External thread: M6 • with ring and locknut • Material: Polyamide 66 (black) Piece: 1
	**PCB Board**: PCB board manufactured specifically for the buoy. Carrier platform for all microelectronic elements. Piece: 1
	**Arduino Pro Mini** • Microcontroller: ATmega328 • Operating voltage: 3.3 V • Recommended input voltage: 3.35 - 12 V • Digital inputs and outputs (I/O pins): 14 (including 6 PWM outputs) • Analogue inputs: 6 • Current per I/O pin: 40 mA • SRAM 1 KB • EEPROM: 512 bytes

	• Clock rate: 8 MHz Piece: 1
	**LoRaWAN Breakout:** • Adafruit (RFM69HCW radio transceiver breakout, 868MHz, 915MHz, Adafruit) • DELOCK 88915 ISM antenna • SMA BU P SMA plug connector, socket, print, gold-plated pin Piece: 1
	**Batteries** Liitokala 18650 NCR18650B - 3.7 V 3400mAh battery (Li-Ion) Piece: 1
	**Battery charging module:** Lithium Battery Charger Module 5V 1A Lithium battery charger module with Micro USB with double protection functions for 18650 batteries. Piece: 1
	**Voltage regulator**: MT3608 DC-DC Adjustable Step-up Voltage Regulator Boost Voltage Regulator 2V-24V. Piece: 1

Other parts and consumables

- SHRINK TUBING W ADHESIVE 4:1 SW 2/8
- Solder butt connector
- 2.54 mm JST-XH connectors
- Resistors 4.7 kΩ, 100 kΩ and 300 kΩ
- Capacitor 470µF
- MOSFET 1 HEXFET 110 W, logic-level N-channel MOSFET (IRFZ 44N)
- Lötzin

Assemble step by step

The following tools are required or recommended:
Cutting mat, ruler, cutter knife, side cutter, cordless screwdriver, drills of different diameters, soldering station, pliers, screwdriver (flat and Phillips), saw for cutting open the centre float (e.g. band saw), hot glue gun.

Buoy / Housing

Prepare buoy

In the first step, the buoy is dismantled into its individual parts. The buoy consists of three floats, a rod, three intermediate elements and a fastening chain.

Picture 1 Buoy disassembled into its individual parts

The following materials and tools are required:

- Column drilling machine
- Bandsaw
- Drill bits with a diameter of 8, 10, 35 mm

A total of three holes are drilled in the pole of the buoy to feed the cables through.

1. Drill hole 15 cm from the top to the upper edge of the hole, diameter 10 mm

2. Hole 44 cm from the top to the upper edge of the hole, diameter 35 mm

3. Hole 70 cm from the top to the upper edge of the hole, diameter 35 mm

Figure 2 Bar of the buoy incl. drill holes

The sensor housing is housed in the centre float. To do this, the floating body is cut into two halves. At least four holes with a diameter of 8 mm are drilled into the lower part so that any water that enters can also escape again.

A 4 x 5 cm recess is cut into the centre section to feed the cables through.

1. Recess 4 x 5 cm

2. Prepared centre float

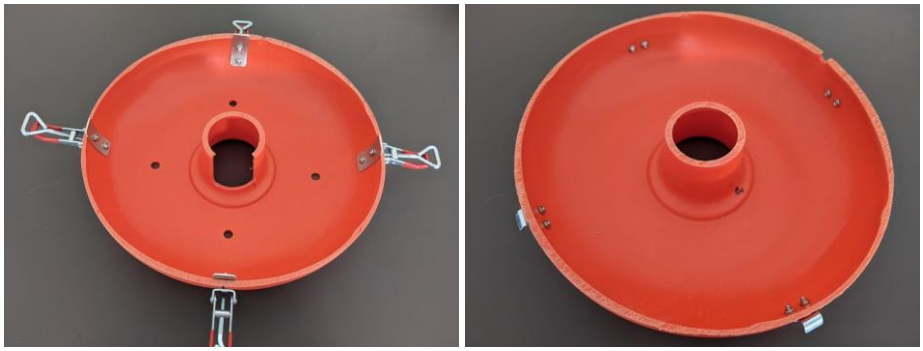


Figure 3 centre float incl. drill holes and mounted tension fasteners

Prepare sensor housing

The sensor housing is an industrial housing made of polycarbonate (UV stabilised). The housing must first be prepared so that the fully assembled PCB board can be installed.

The first step is to remove the two studs (left and right) using a chisel or suitable tool.

Remove the two knobs (left and right)

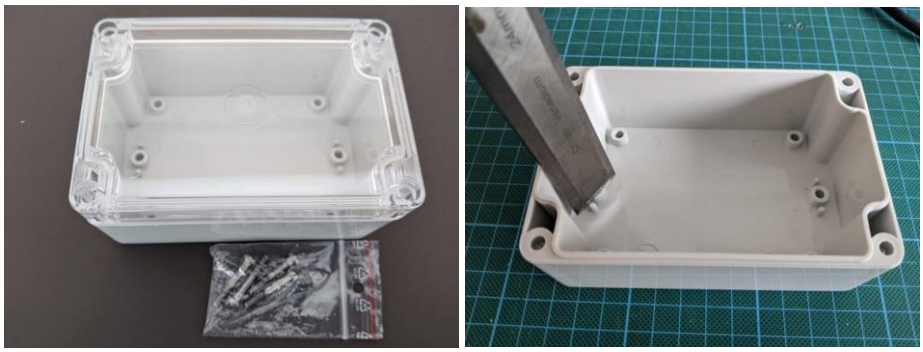


Illustration 4 Sensor housing, removing the nubs

Next, the holes for the cable gland, the pH sensor, the LoRaWAN antenna and for the pressure equalisation screw are drilled.

1. Drill hole for the cable gland (diameter 25 mm), centred on the right-hand side of the housing.

2. Holes for the pH sensor (diameter 12.5 mm) and the LoRaWAN antenna (diameter 7 mm)

3. Hole for the pressure equalisation screw (diameter 6 mm), in the centre of the upper side of the housing.

Figure 5 with drilling points (left) and finished drilled housing

Attaching the mounting brackets to the sensor box

Required parts:

- Prepared sensor box
- 3D07 - printed mounting brackets (see Table 1)
- 4 hexagon head screws 4.8, 3 x 10
- 4 hexagon nuts M3

Figure 6 Attaching the mounting brackets to the sensor box

Prepare and install sensors

Prepare pH sensor

So that the pH sensor can be connected to the PCB board, the end of the cable that goes to the PCB must be fitted with an XH-3Y connector. Please refer to the circuit diagram (see Figure 12), the data line is connected to the centre pin.

Parts required:

- Analogue pH meter kit
- 1 x 2.54 mm XH-3Y connector, socket, straight
- 3 x 2.54 mm pins

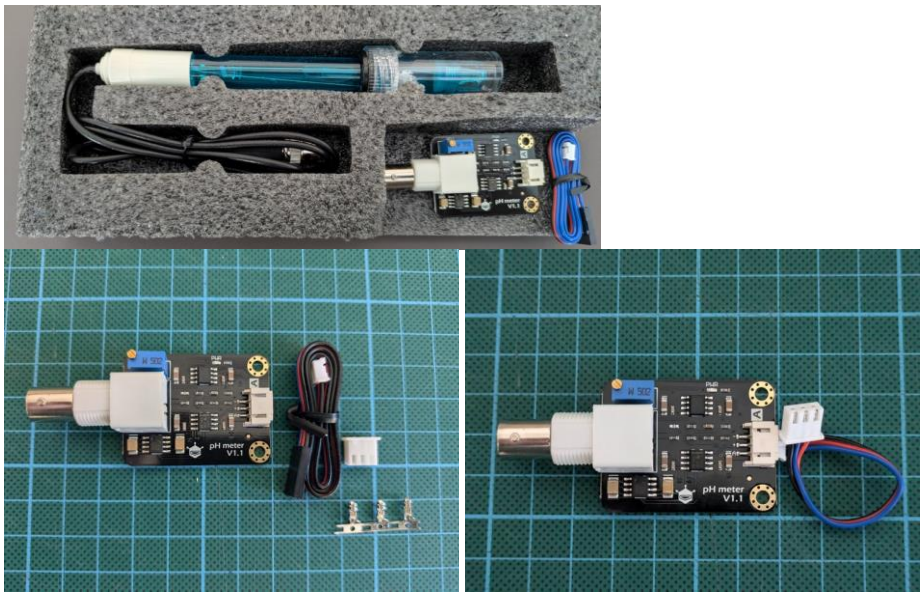


Figure 7pH7 and circuit board

TDS and analogue signal isolator

So that the TDS sensor can be connected to the PCB board, the end of the cable that goes to the PCB must be fitted with an XH-3Y connector. As both pH and TDS measure voltages, a signal isolator is also attached to the TDS sensor. The two PCBs are then connected together with the two screws.

Parts required:

- TDS sensor
- Analogue signal isolator
- 1 x 2.54 mm XH-3Y connector
- 3 x 2.54 mm pins
- 2 x M3 6 mm stainless steel screws
- 2 x M3 hexagon nuts stainless steel

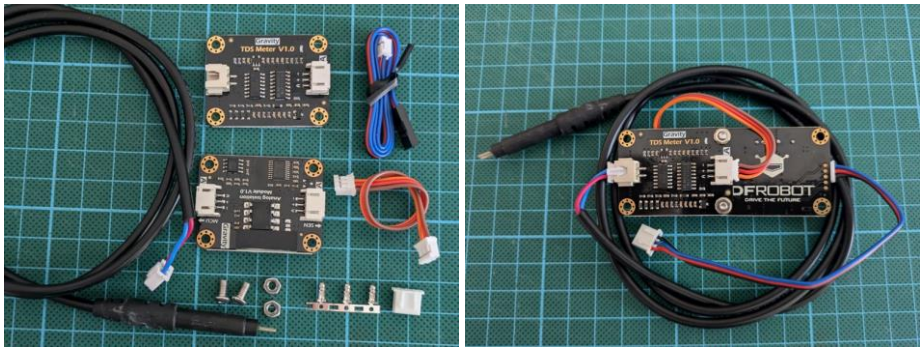


Figure 8 TDS sensor, circuit board and signal isolator

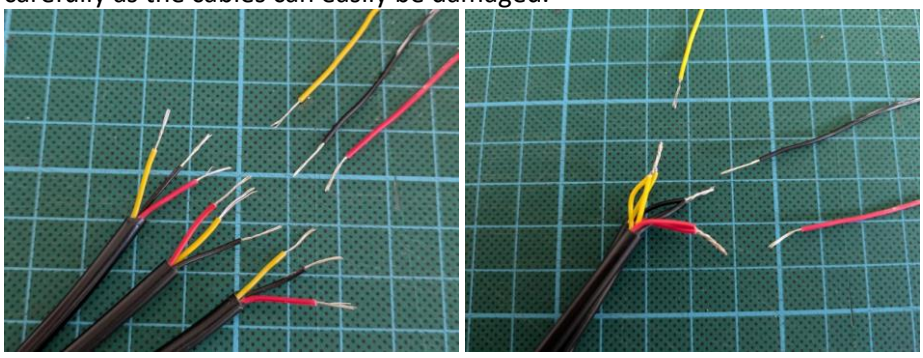
Temperature sensors

Depending on the programme code, up to 10 temperature sensors can be fitted to one connection. The images shown here show the version with three sensors. Depending on the location and purpose of the measurements, the sensors must be shortened to the required length. In the case shown here, three lengths were selected, 1, 2 and 3 metres.

Parts required:

- Temperature sensors
- 3 x soldering butt connectors heat-shrinkable 2:1 waterproof. Diameter 2.7 mm / length 40 mm
- 1 x shrink tubing, 6 cm long SHRINK TUBING M ADHESIVE 4:1 SW 2/8

1. Cut the sensors to the required length and strip the cable insulation. Please work carefully as the cables can easily be damaged.



2. Connect the individual temperature sensors with the solder joint connectors and then seal with the heat-shrink tubing.

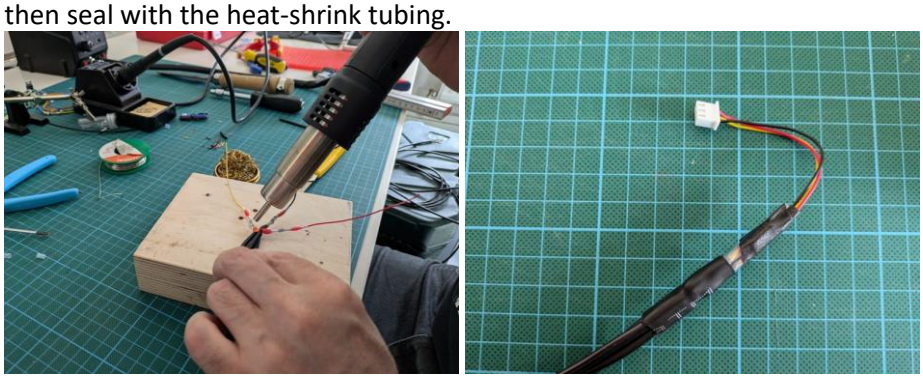


Figure 9 Manufacturing the temperature sensors

PCB board assembly

Once all the sensors have been prepared, the PCB board is fitted with the individual elements. The circuit diagram of the PCB board is shown in Figure 12 more details can be found in the GitHub project
https://github.com/os4os-repo/ParKli_WaterQualitySensor
The board is published under the CERN Open Hardware Licence Version 2 - Weakly Reciprocal Licence.

Parts required:

- Arduino Pro Mini
- LoRaWAN Breakout
- 1 or 2 batteries
- Battery charging module
- Voltage regulator
- Resistors 4.7 kΩ, 100 kΩ and 300 kΩ
- 4 x 2.54 mm XH-3Y Connector: male connector, straight

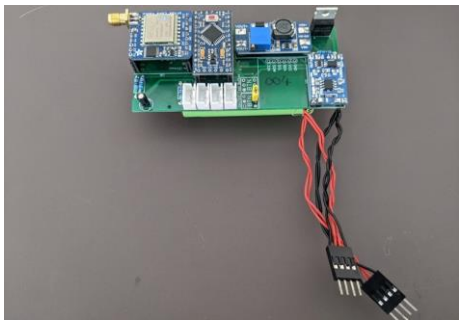


Figure 10 Assembled PCB board

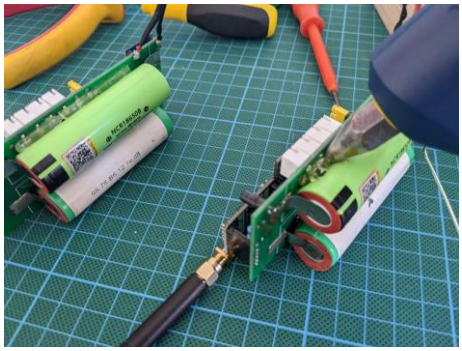


Figure 11 Attaching the batteries and fixing with a hot glue gun. Optionally, 1 or 2 batteries can be used. If 2 batteries are used, they are connected in parallel.

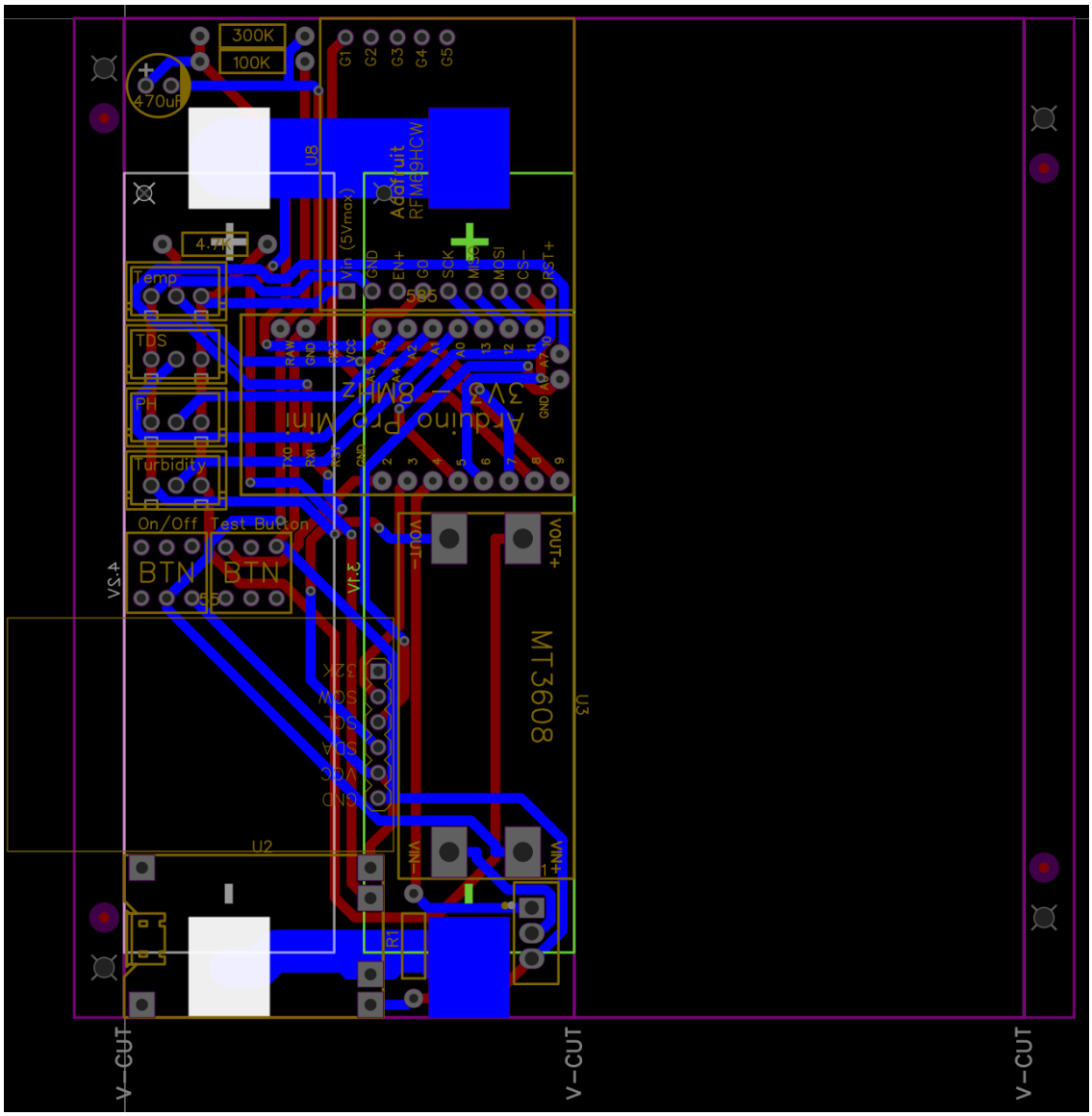


Figure 12 Circuit diagram PCB board

Project website:
www.parkli.de

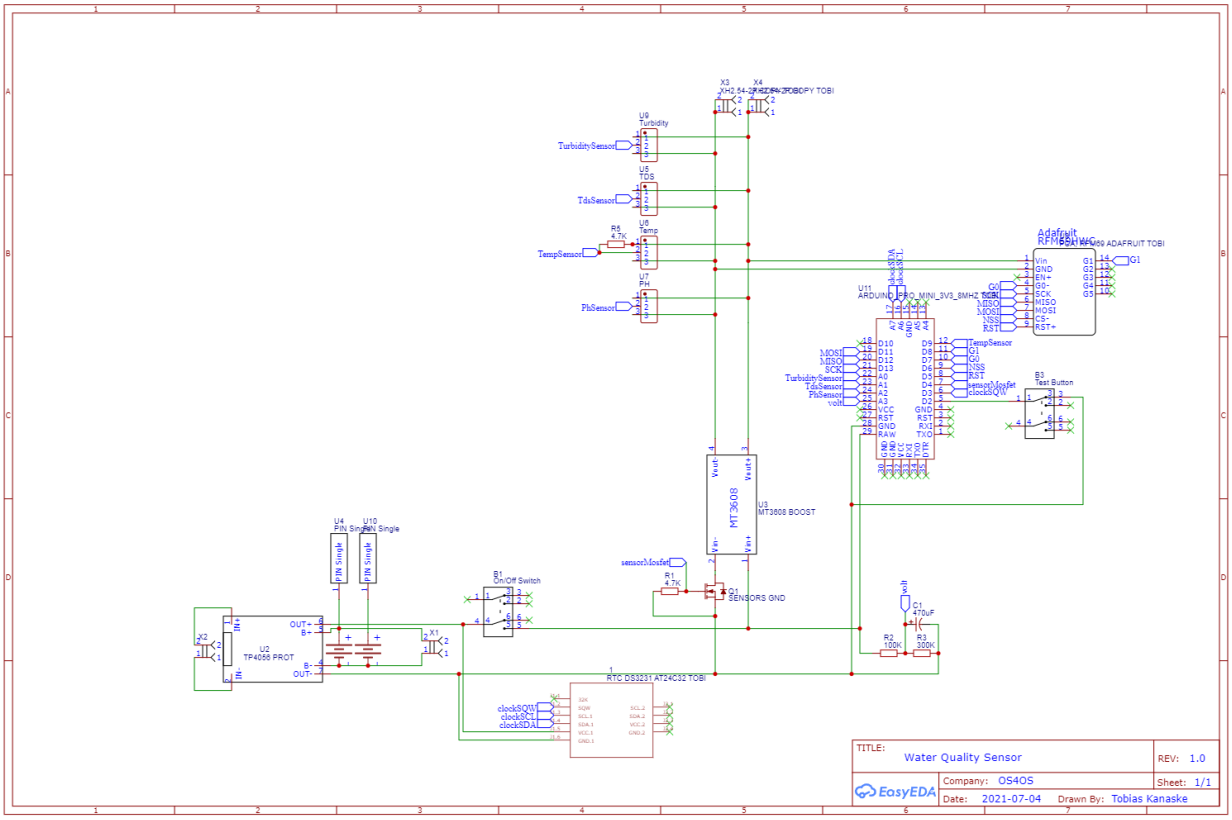


Figure 13Sensor13

Install the PCB board in the sensor box

Parts required:

- Fully assembled PCB board
- 3D08 - printed board mounts (see Table 1)
- 2 threaded screws 4.5 x 8

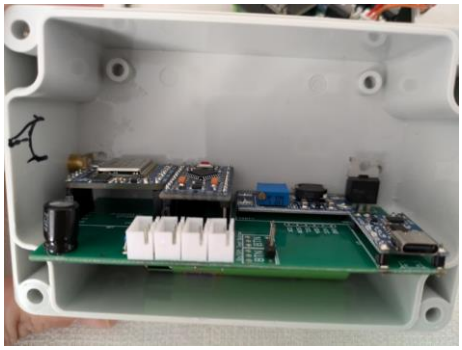


Figure 14 Installing the 15 board in the sensor box

Install the sensor box in the buoy

In the final step, the sensor box is installed in the buoy. The cables coming from the outside are fed through the hole provided in the pole and into the sensor box.

The most important thing here is to fix the sensor box securely and to install the cables without tension.

Parts required:

- Fully assembled PCB board
- Circuit board of the Gravity Analogue pH Meter Kit
- TDS sensor circuit board
- 3D08 - printed board mounts (see Table 1)
- 4 threaded screws 4.5 x 8
- 2 pan-head screws with hexagon socket M3x06 mm
- 2 hexagon nuts M3

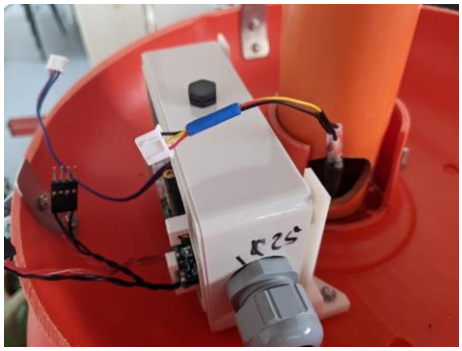


Figure 16 board, pH meter kit and TDS incl. analogue signal isolator installed in the sensor box

Settings Creality Ender 5 Plus Slicer Software

Figure 17 Creality Slicer settings, Basic tab

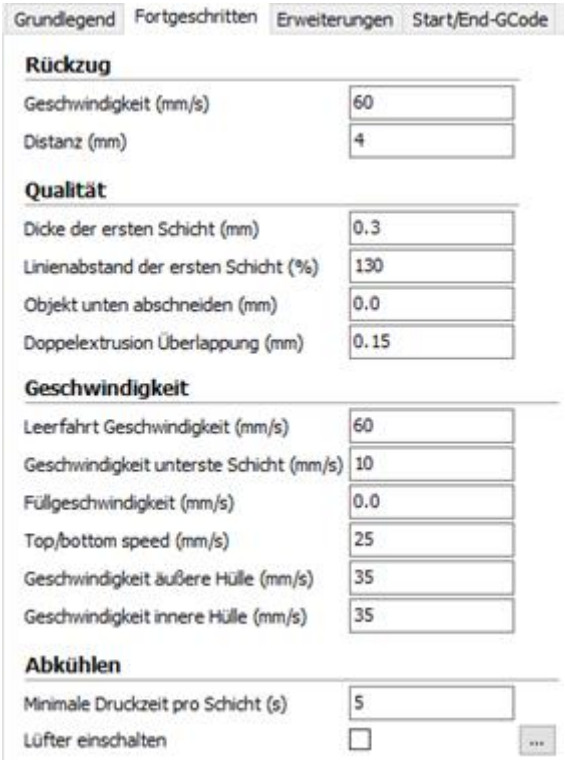


Figure 18 Creality Slicer settings, Advanced tab