Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

Intel-IrriS

Building the Intel-IrriS IoT platform
Part 1: soil sensor device

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Prof. Congduc Pham
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Université de Pau, France

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

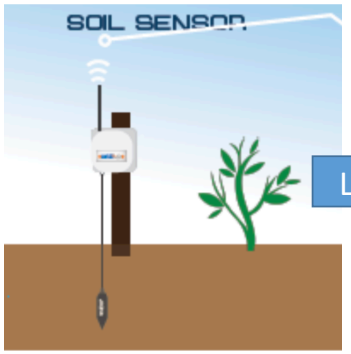
LIUPPA

WAZIUP
IoT – from idea to reality
WAZIHUB

Review: Technology components

Sensor part

Intel-IrriS



LPWAN

Control part

Embedded Database

Software updates

Embedded User Interface

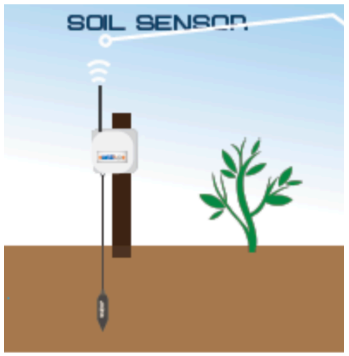
wifi

SMS

Review: Low-cost sensors

Sensor part

Intel-IrriS



- Build on low-cost, low-power IoT expertise
- Increase accuracy of low-cost sensors by automatic and remotely controlled procedures for advanced calibration
- Enable deployment of several complementary low-cost sensors
- Include agricultural models / knowledge with corrective & predictive analytics

Review: Smart embedded control

- Build on low-cost embedded & open IoT gateway expertise
- Implement the “Intelligent Irrigation in-the-box” with "plug-&-sense" approach
- Model complex water-soil-plant interaction
- Embed Decision Support System (DSS) and disruptive Artificial Intelligence (AI)
- Integration of various knowledge streams
- Fully autonomous

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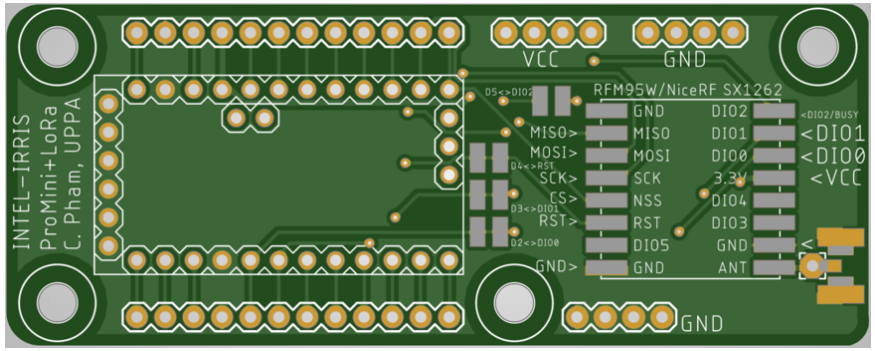
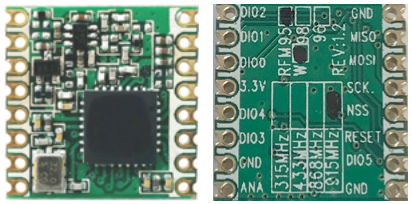
Review: Starter-kits

- "Intelligent Irrigation in-the-box", "plug-&-sense"
- At least 100 starter-kit will be distributed

Soil sensor: electronic parts

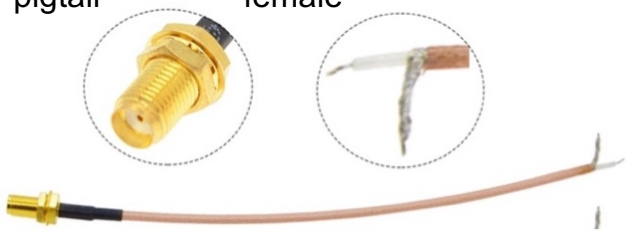


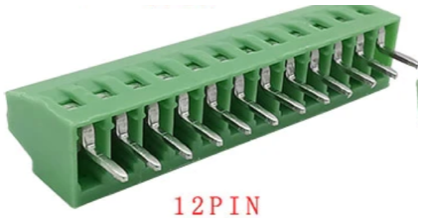


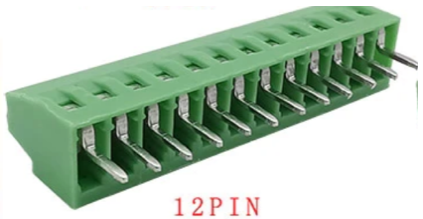
RFM95W (868MHz)
RFM96W (433MHz)
NiceRF SX1262 (868MHz)
NiceRF SX1268 (433MHz)
NiceRF SX1280 (2.4GHz)

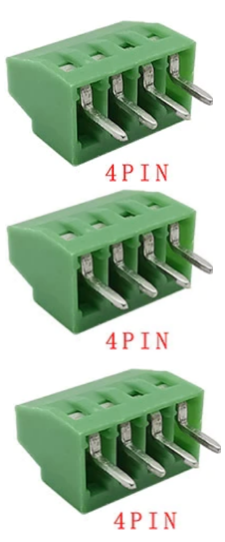
PCB mount
or pigtail

SMA
female





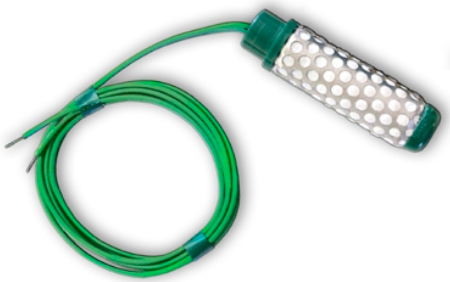




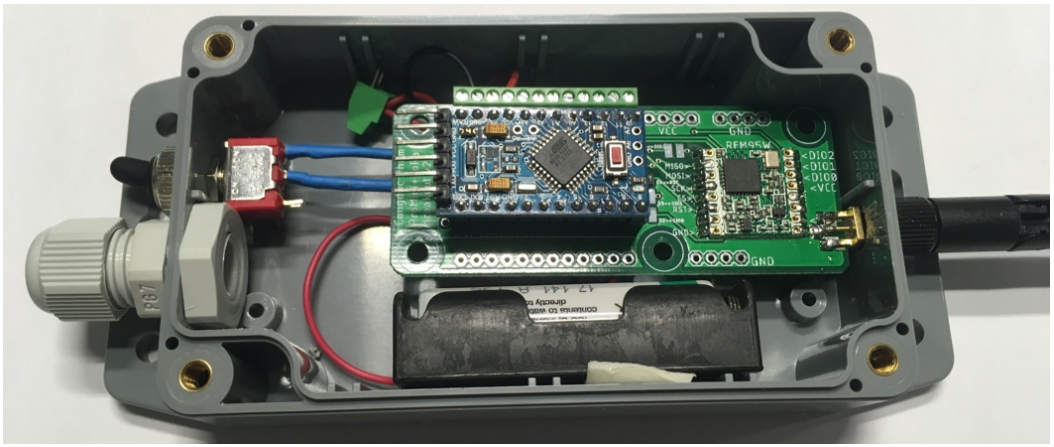
optional

SMA
male

Soil sensor: casing parts & integration



proof-of-concept



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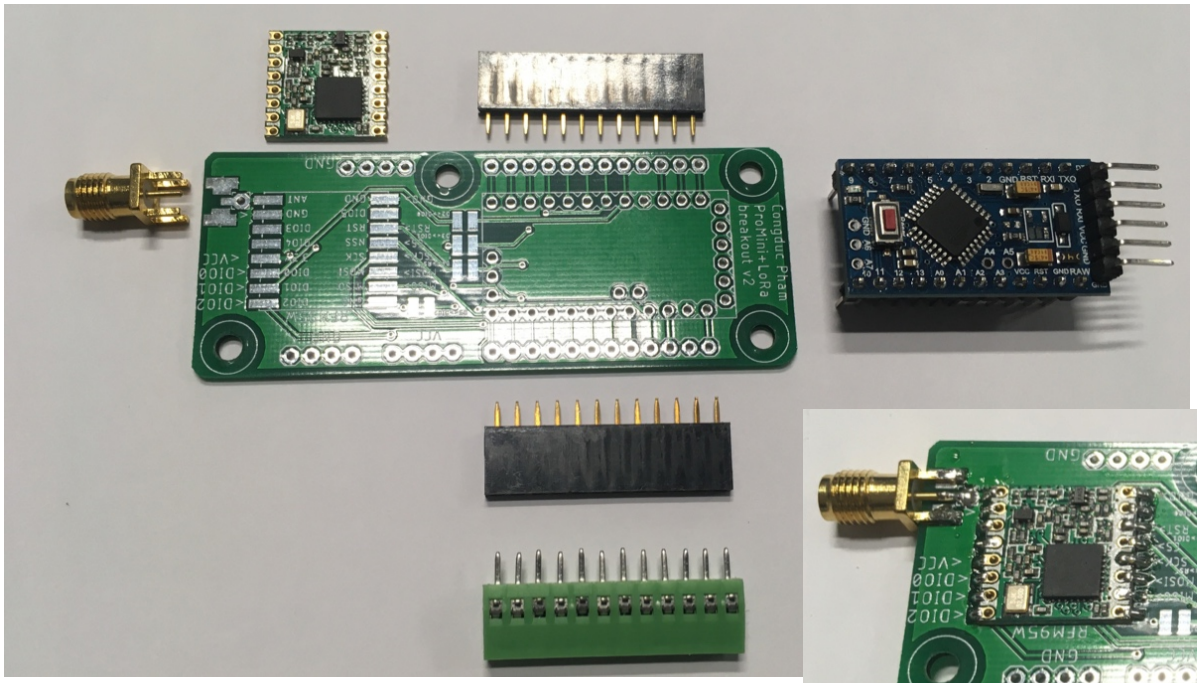
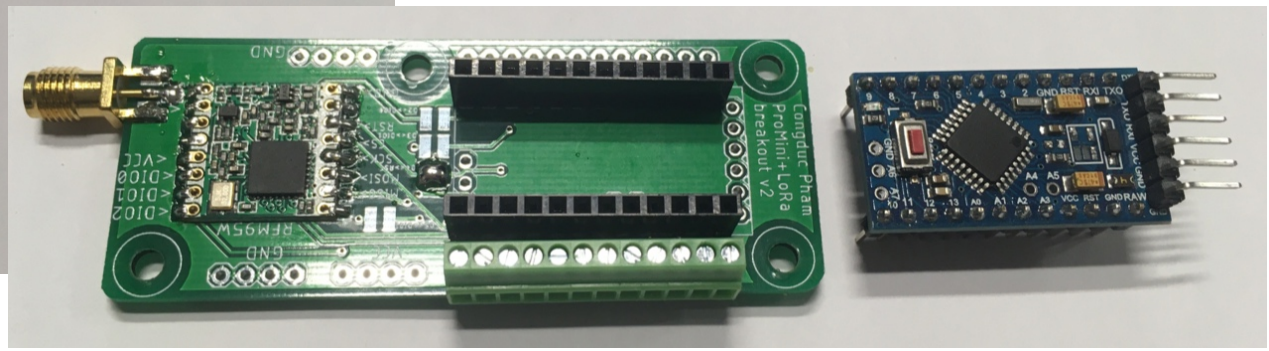
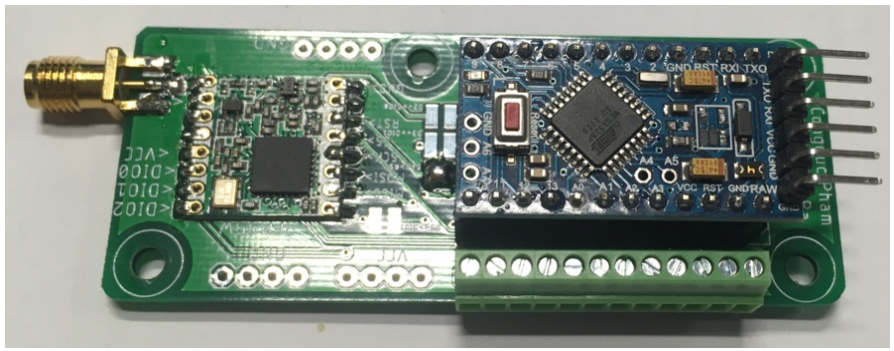
Assembling the PCB board







A dedicated video will show how to solder the components

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Get an enclosure for outdoor usage

Here, it is an IP65 box which dimension is 115 x 65 x 40mm
https://www.gotronic.fr/art-boitier-abs-etanche-g304m-17977.htm

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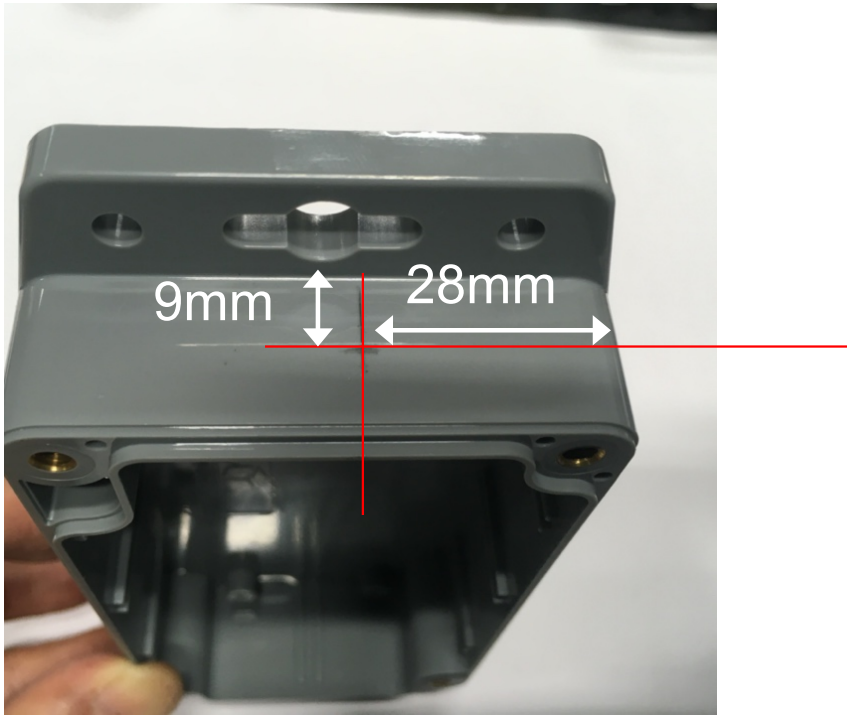
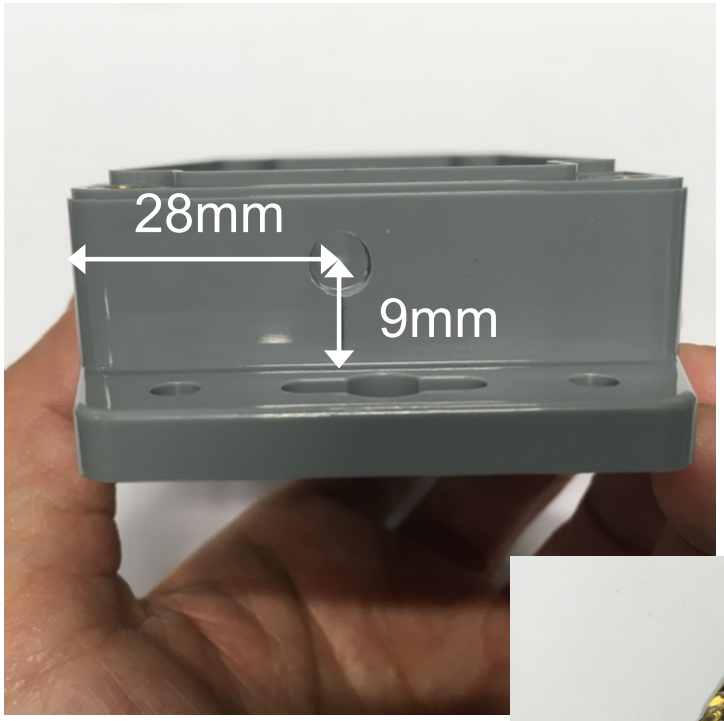
Drilling machine and drilling bits

at least a simple cordless drilling machine is necessary
if you have a (small) bench drilling machine it is of course better
then you need an assortment of drilling bits for **metal**, not for wood nor concrete! Here, you will mainly need 7mm and 13mm bits
it is also interesting to have step drill bits

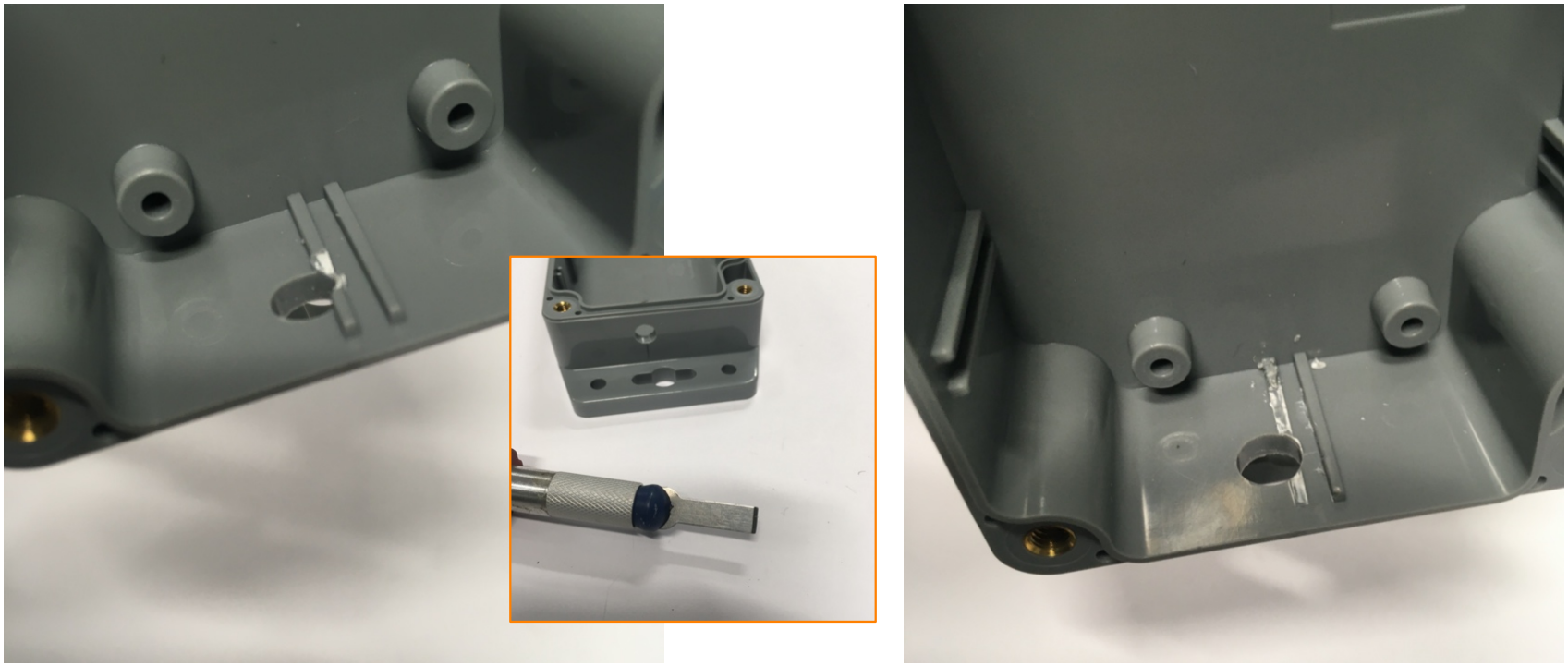
Drill a hole for the SMA connector





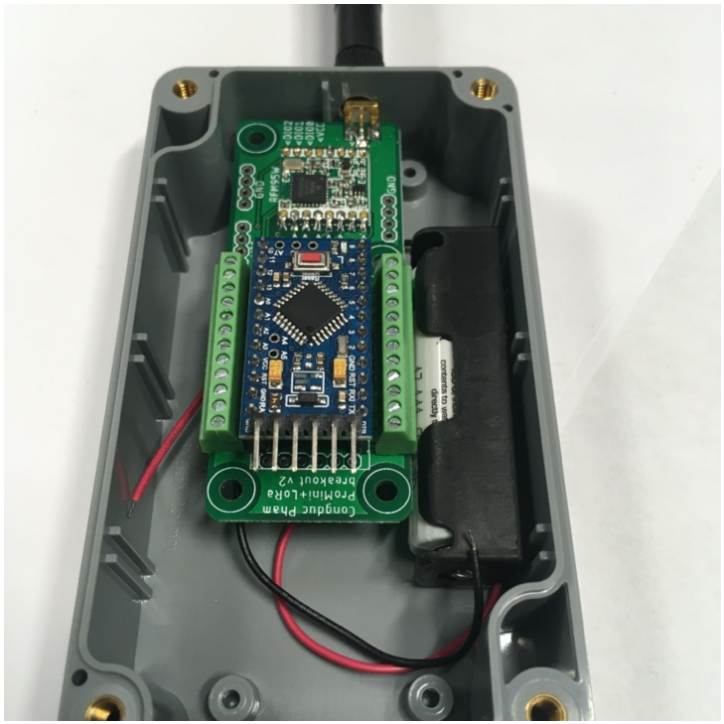
28mm for the right edge:
- measure from the flat side as the corner is round
9mm from the outside bottom
use a 7mm drill bit for metal, not for wood nor concrete!

Remove unwanted plastic part



- we need to remove the plastic reinforcement part for this particular enclosure
- use a flat cutter for instance to remove and smooth the inside part (a small plier can be used first to remove most of the part)

Placing the PCB board



the PCB board can be placed, with the SMA connector going through the hole

both 2-AA (left) and 1-AA (right) battery holder can be used

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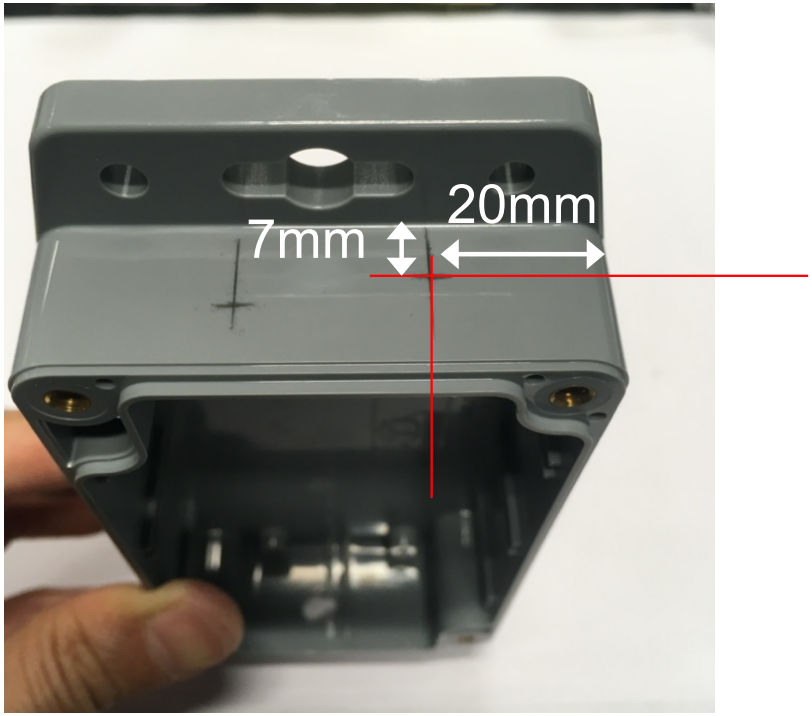
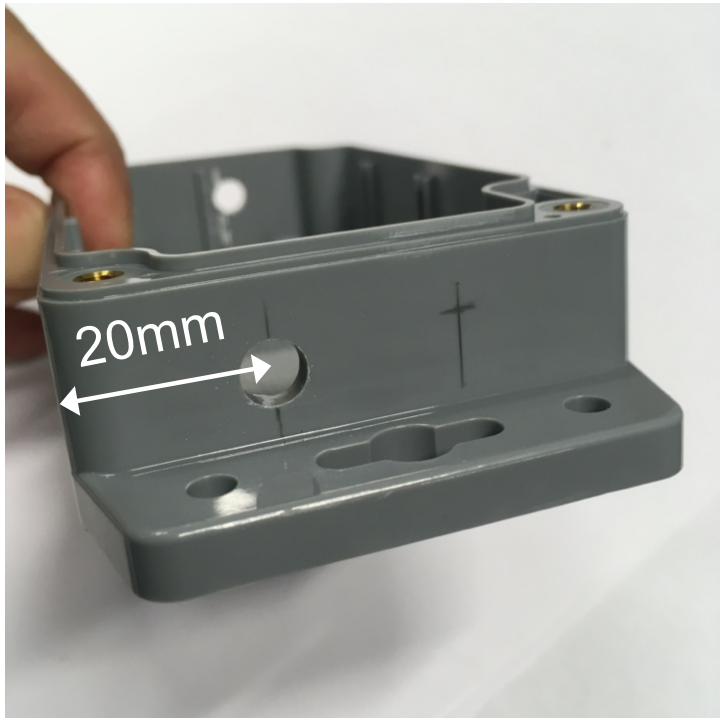
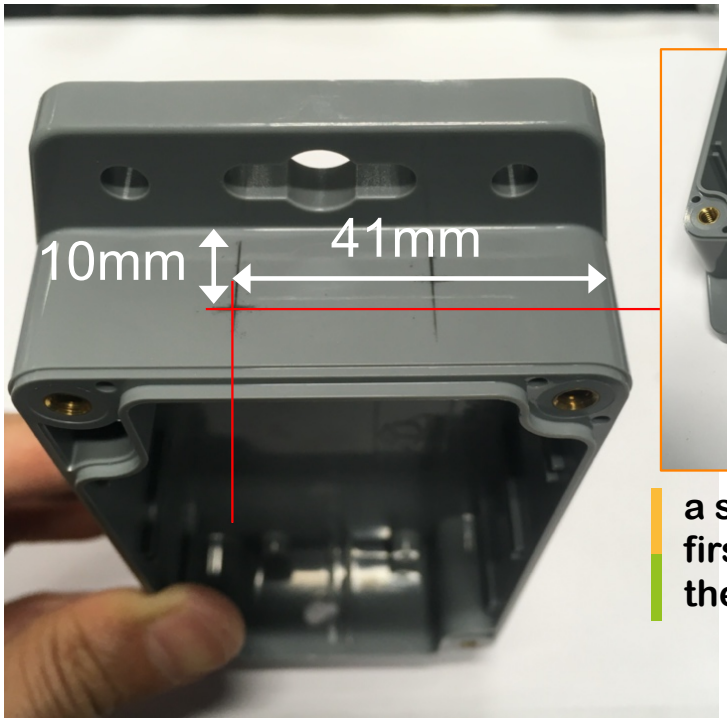
Drill a hole for the external switch



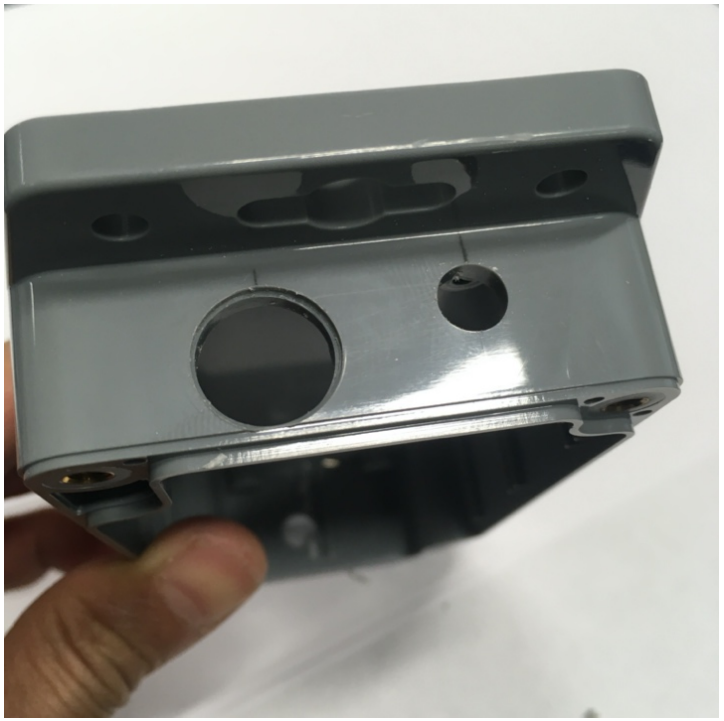


20mm for the right edge:
- measure from the flat side as the corner is round
7mm from the outside bottom
use a 7mm drill bit for metal

Drill a hole for the cable gland



a step drill bit can be used
first, drill to 12mm
then use a 13mm drill bit

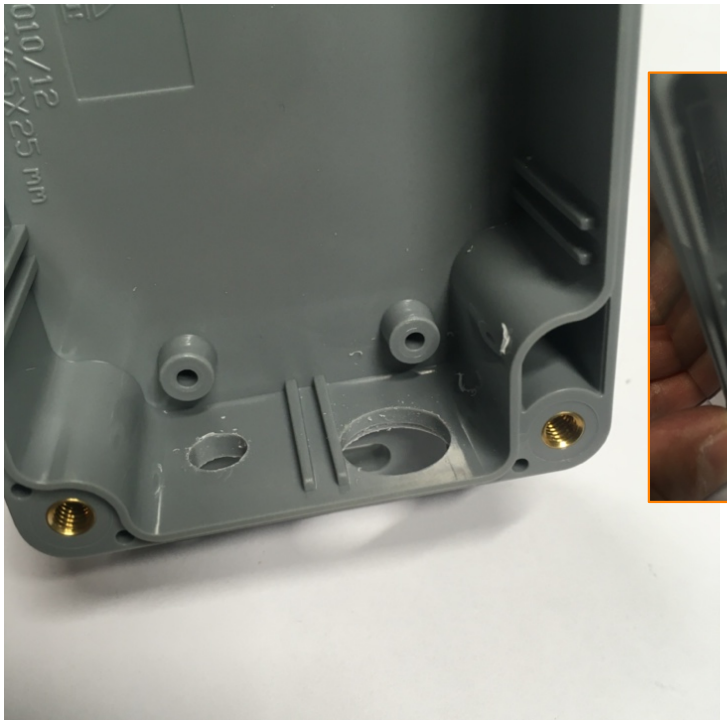


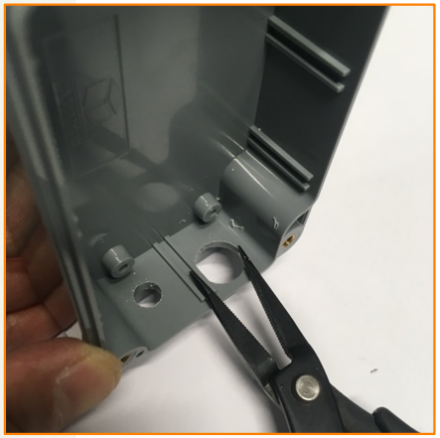
41mm for the right edge:
- measure from the flat side as the corner is round

10mm from the outside bottom

use a 13mm drill bit for metal

Remove unwanted plastic part





again, we need to remove the plastic reinforcement part for this particular enclosure

use a flat cutter for instance to remove and smooth the inside part (a small plier can be used first to remove most of the part)

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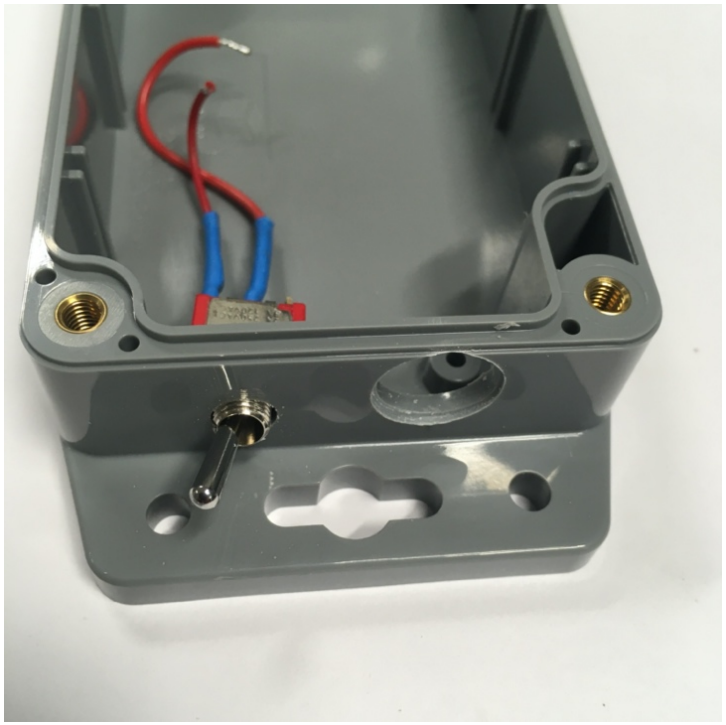
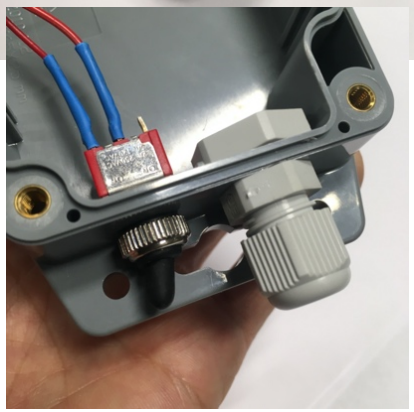
Placing switch and cable gland





- test that everything is OK
- the switch has a water-proof cap

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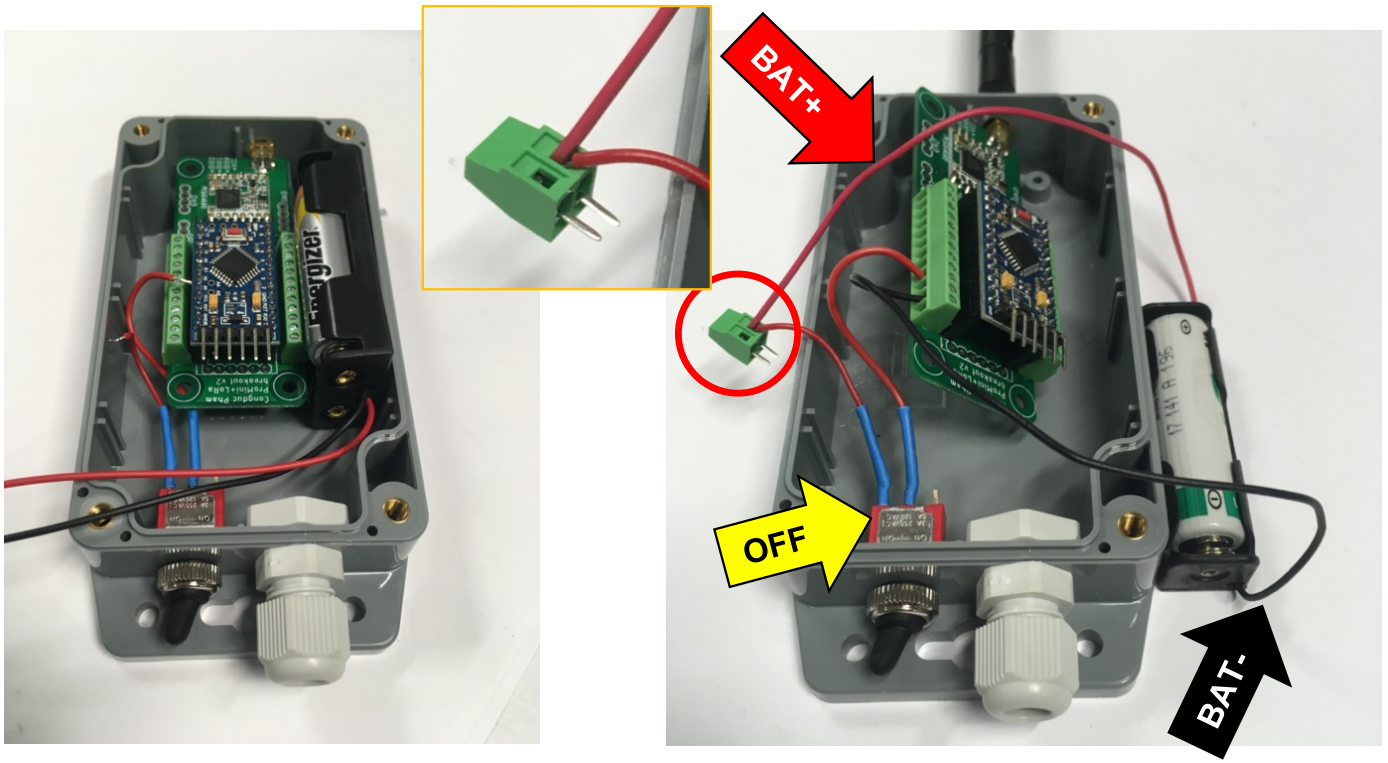
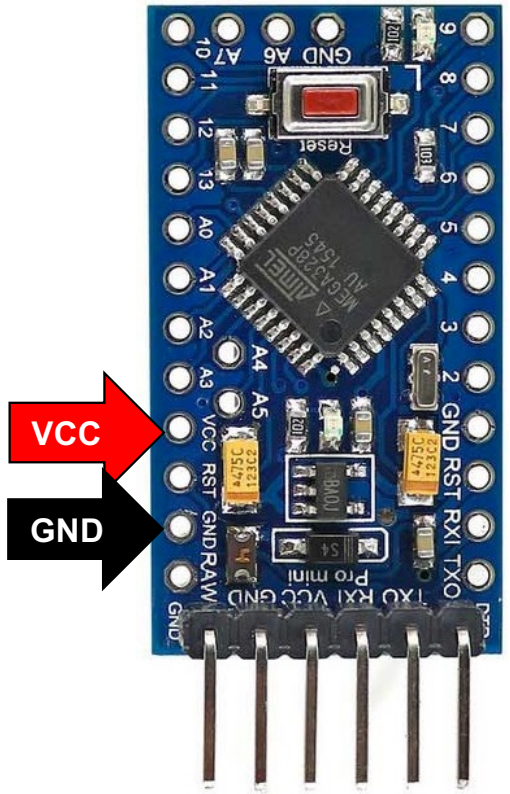
Connecting switch, battery & board





- Connect <u>together</u> switch "off" pin (left) with BAT +
- Connect directly switch "on" pin (middle) to board's VCC
- Connect directly BAT – to board(s GND
- Toggling the switch to right will then power the board

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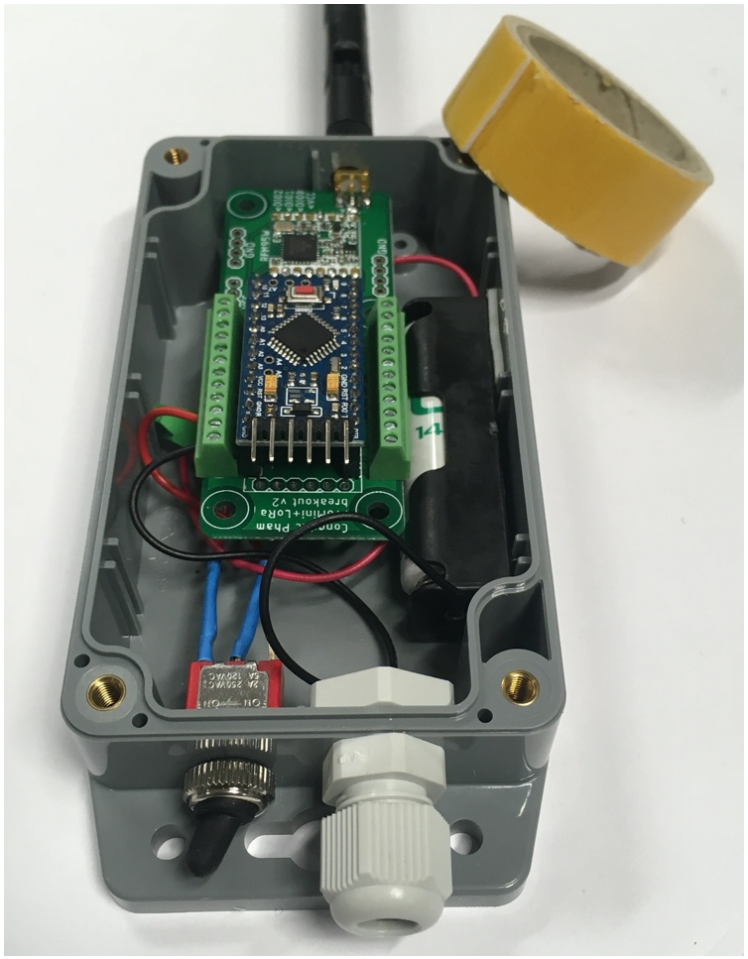
Putting it altogether



Here we use a 1-AA battery pack
Fix the battery pack with double-side tape
e.g. those used to fix mirrors on wall
Then we use a 3.6V Lithium battery

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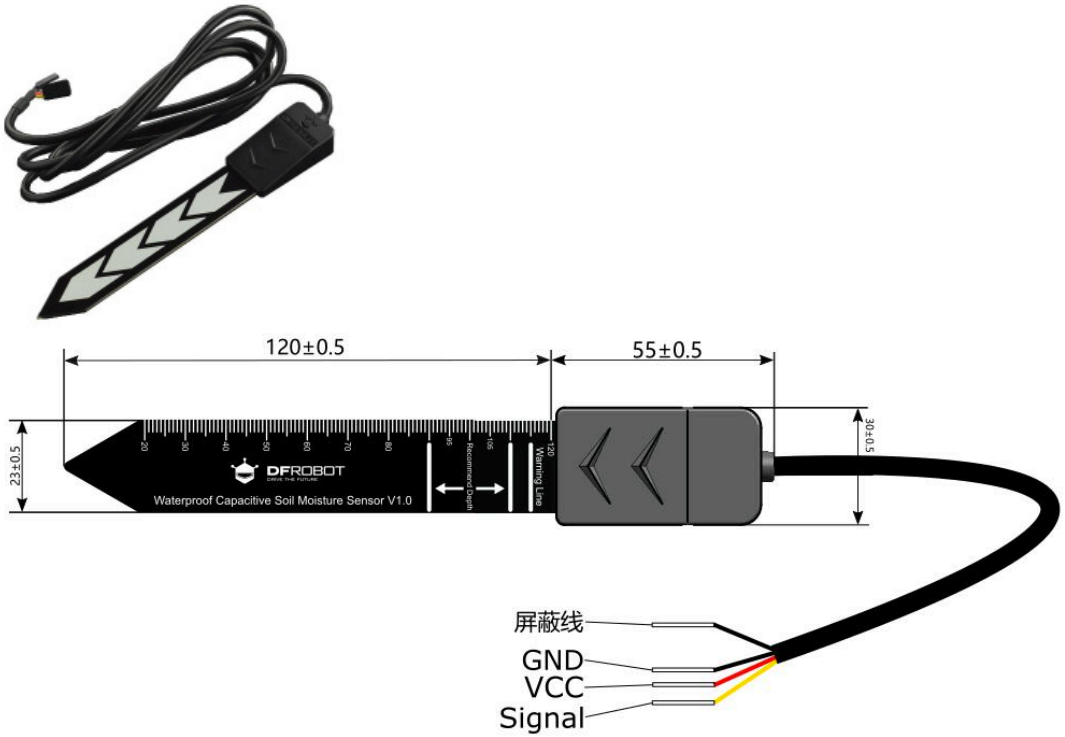
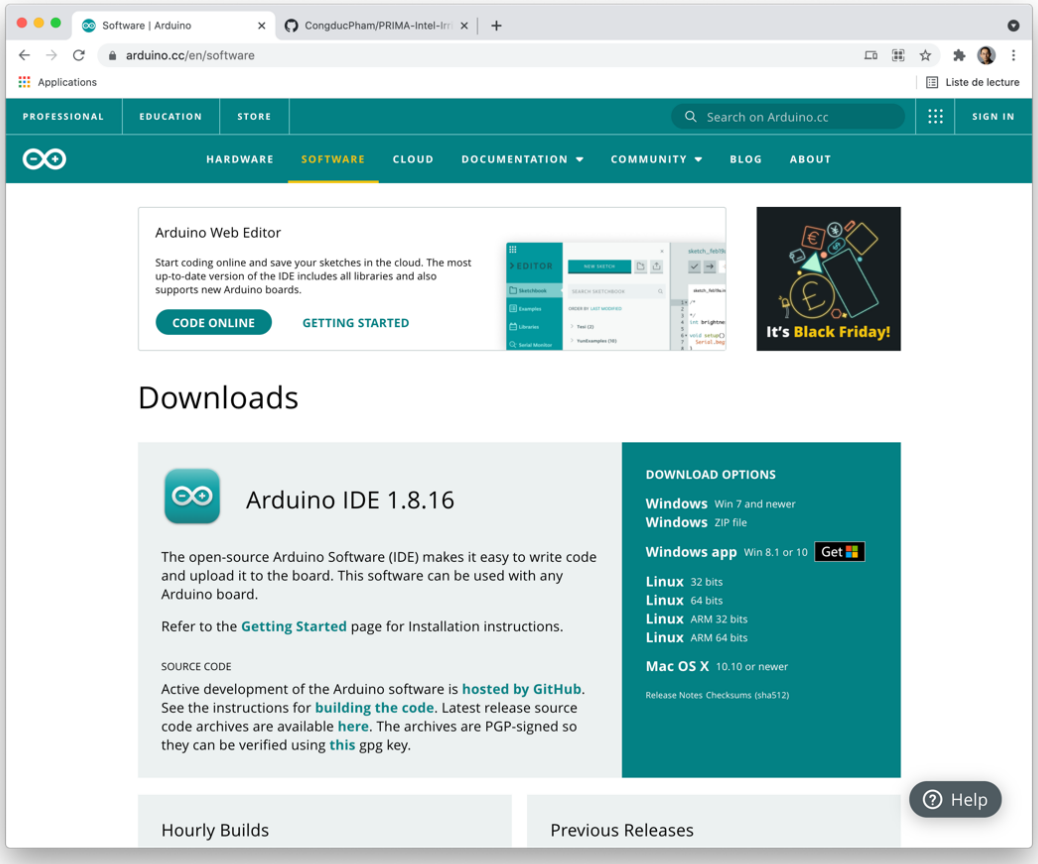
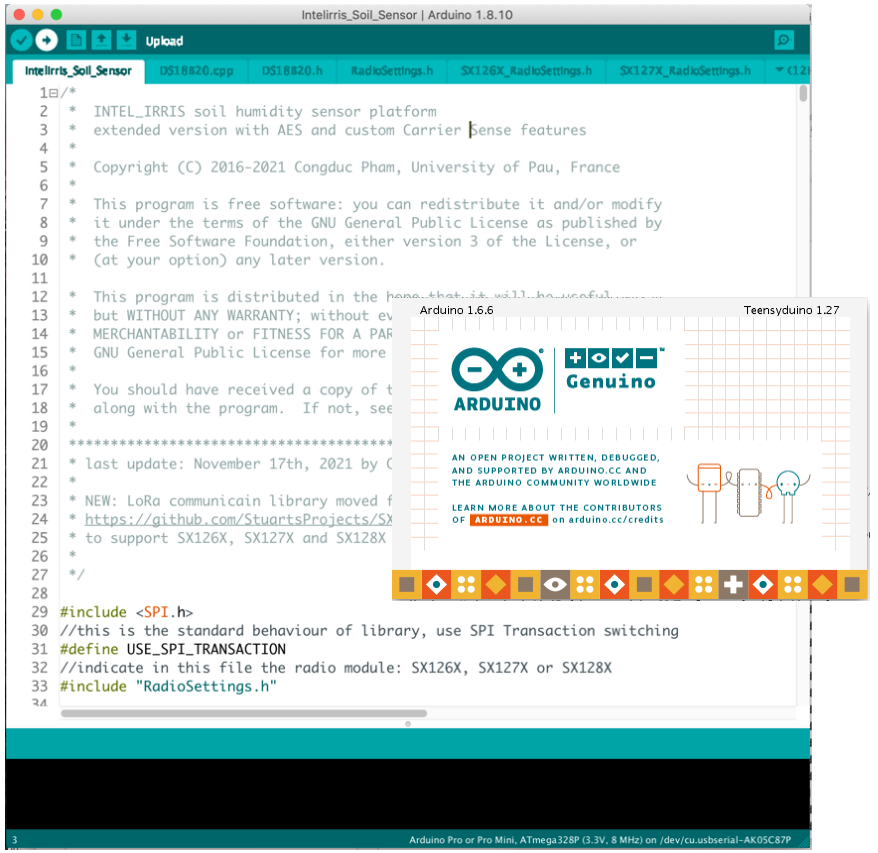
Last step: connect the SEN0308



Insert sensor's wire through cable gland
Connect SEN0308's wires to board:
- **VCC to board's A1**
- **GND to board's GND**
- **Signal to board's A0**

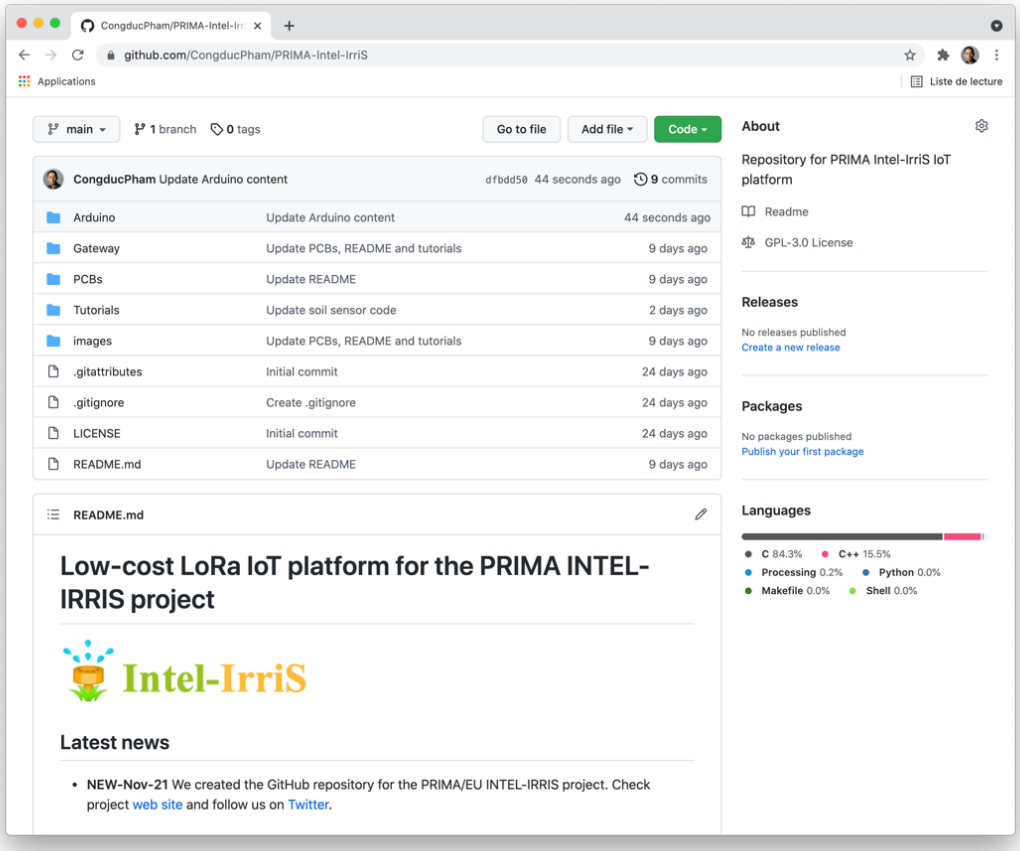
Getting the software: Arduino IDE





Install latest version of Arduino IDE from
https://www.arduino.cc/en/software

Getting the software: Intel-IrriS code



On your computer, create a `sketch` folder

Then download the whole repository as ZIP file

Unzip the file and copy the whole `Arduino` folder into your `sketch` folder

The entire Intel-IrriS GitHub repository is hosted here
https://github.com/CongducPham/PRIMA-Intel-IrriS

GitHub

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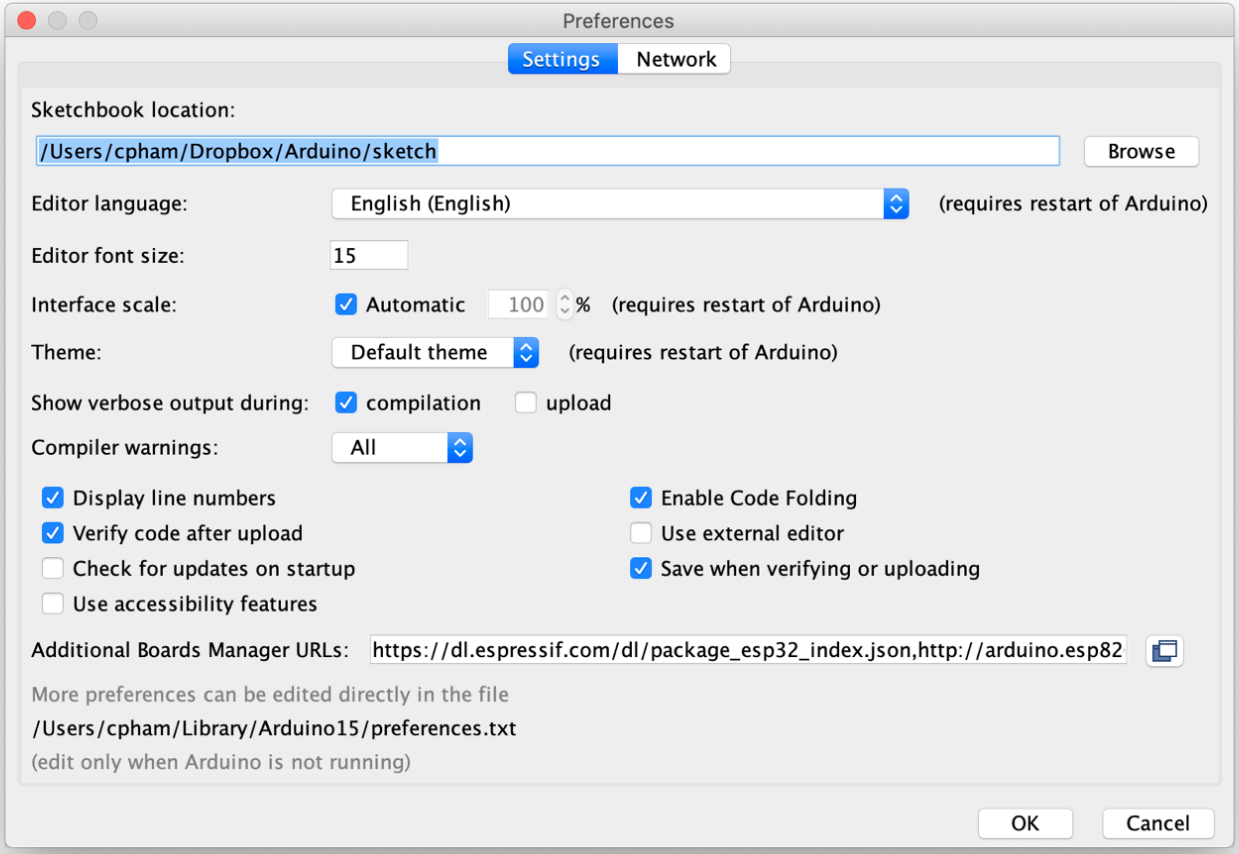
Setting your Arduino IDE



Run Arduino IDE, open Preferences
Indicate your `sketch` folder in Sketchbook location

Compiling the soil sensor code

Open the Intelirris_Soil_Sensor sketch

Select the ProMini board, 3.3V and 8MHz version

Then click on the "verify" button

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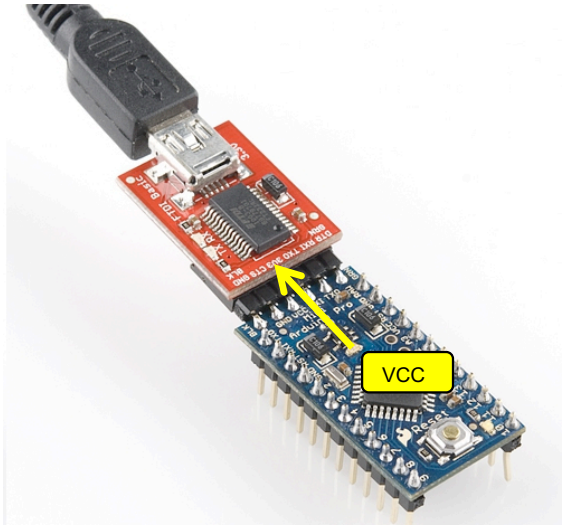
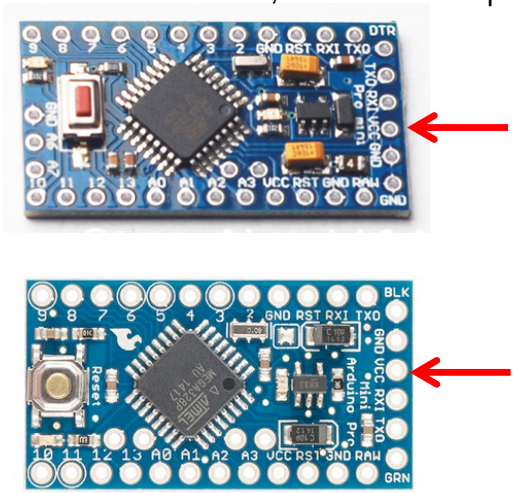
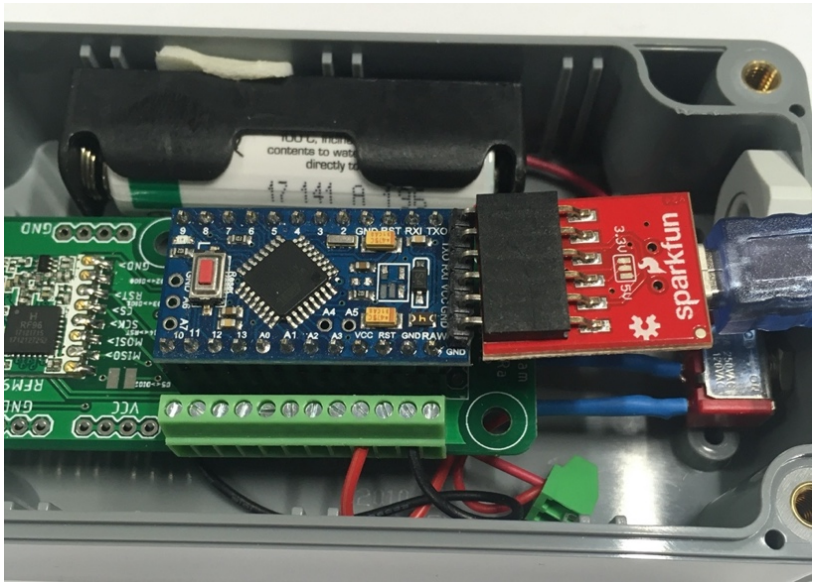
Connecting with an FTDI cable



Some clone version, check the VCC pin



Original Sparkfun version



For the ProMini, you need to have an FTDI breakout cable working at 3.3v

Check the VCC pin position and make it to correspond to the VCC pin of the FTDI breakout.

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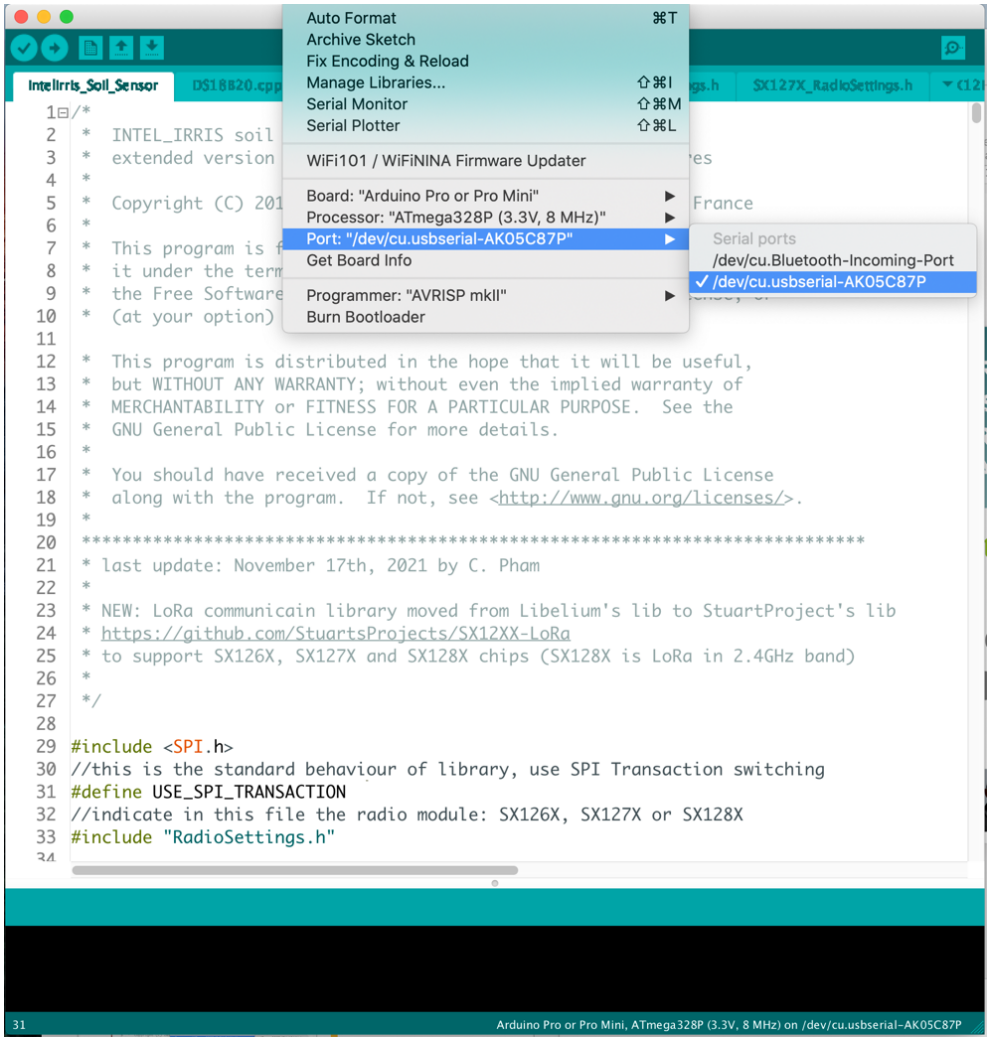
Select serial port for uploading



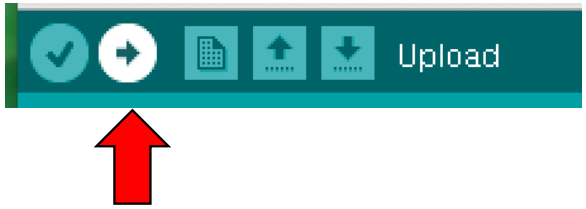
After connecting the cable to your computer/laptop USB port, try to find the serial port

If you don't find it, you may need to install specific drivers

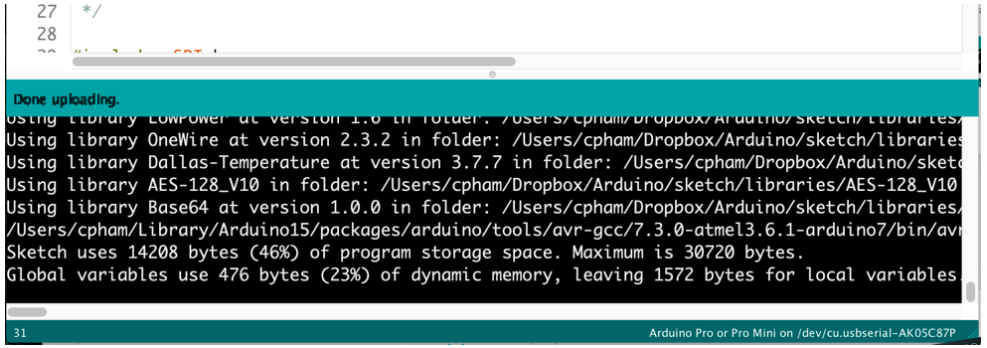
https://learn.sparkfun.com/tutorials/how-to-install-ch340-drivers/all

Uploading to your board

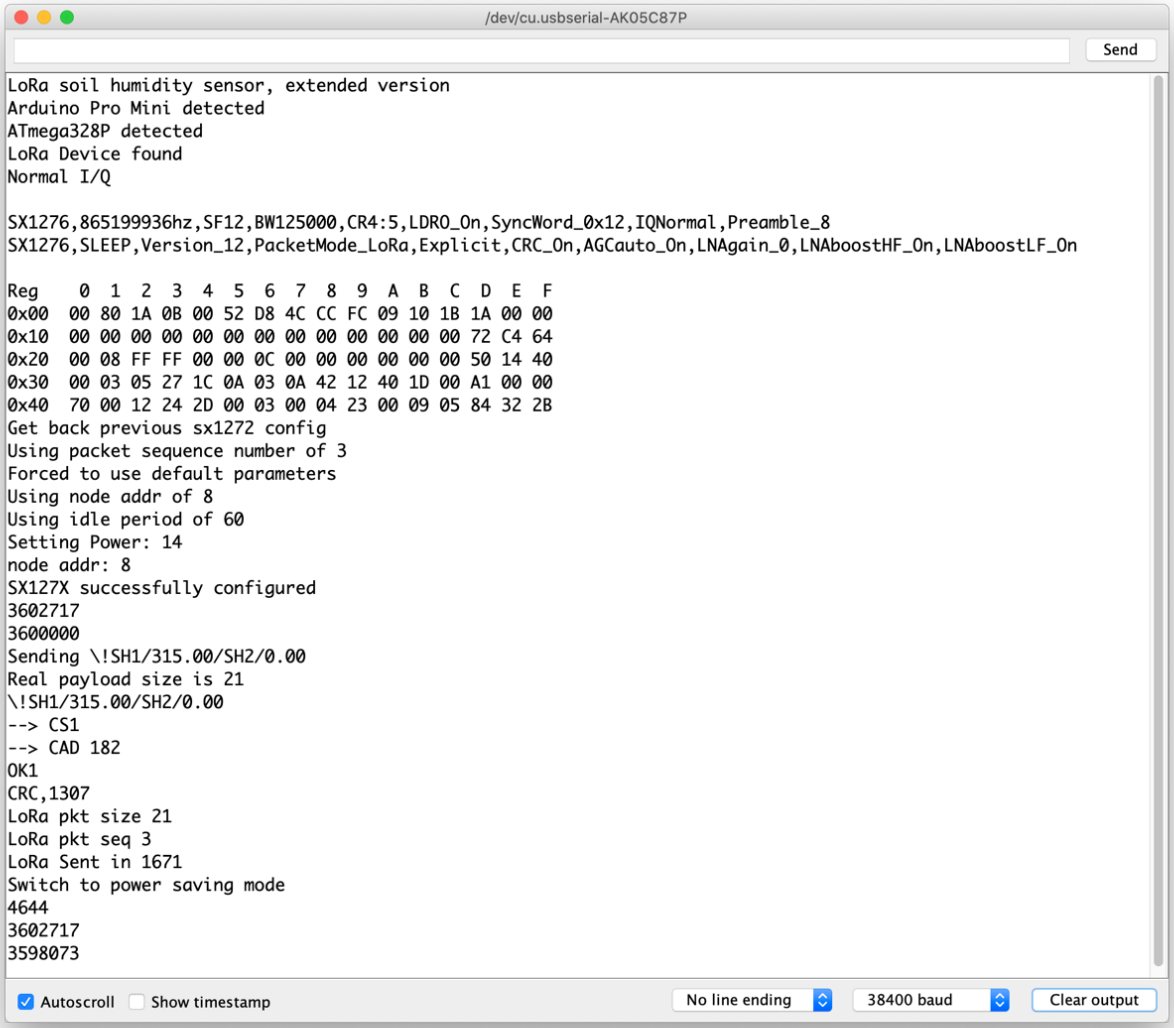
Click on the "upload" button



And wait until upload is completed



Checking that device is operational

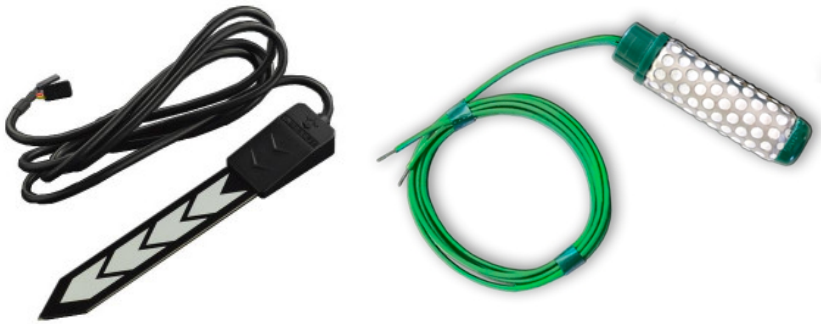


- Open serial monitor
- Set baud rate to 38400
- See output from board
- Check that transmission is OK

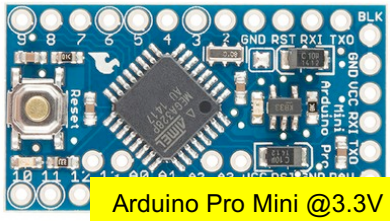
Generic & cyclic behavior

2 soil sensors can be attached

A0 (signal), A1 (pwr)
&
A2 (signal), A3 (pwr)



Physical sensor management



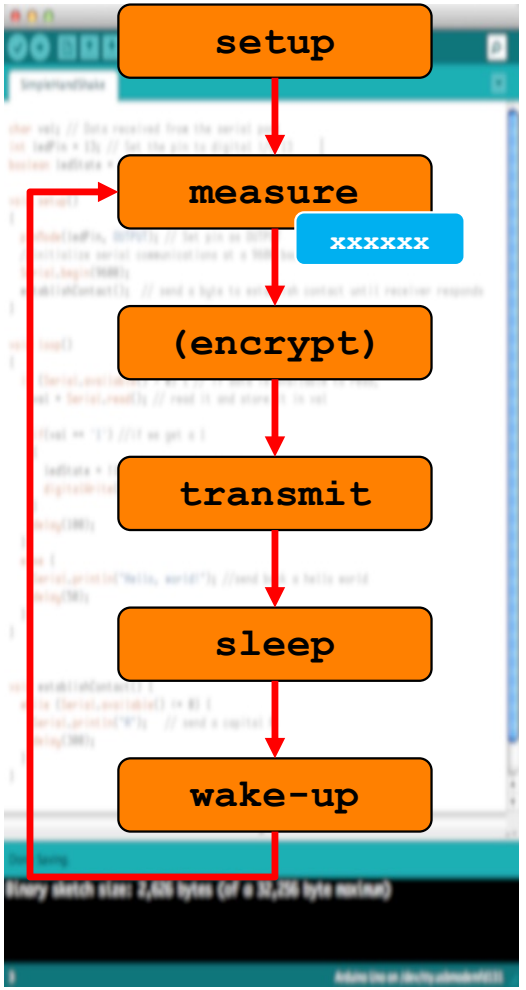
Arduino Pro Mini @3.3V

Activity duty-cycle, low power

AES encryption

Long-range transmission

Logical sensor management



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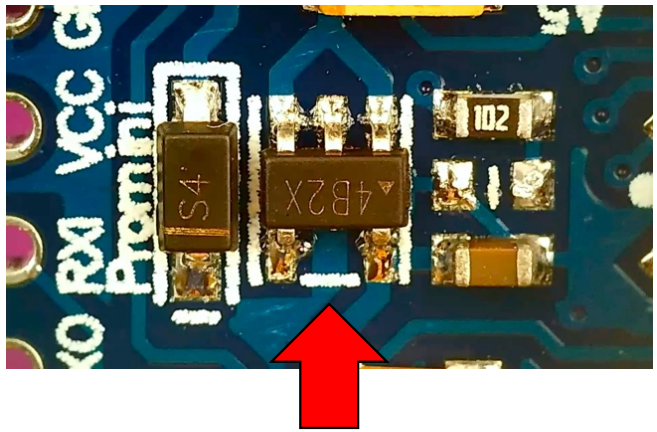
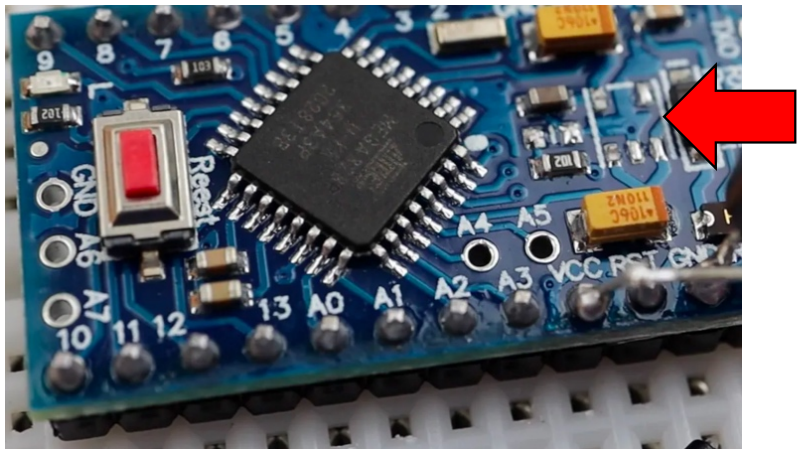
With a Watermark sensor

with a Watermark sensor, the "pseudo-AC Short Pulse" method will be used – see https://www.irrometer.com/200ss.html
D6 and D7 will be used to alternating power the sensor
A0 and A1 will be used to read signal from sensor

Reducing power consumption

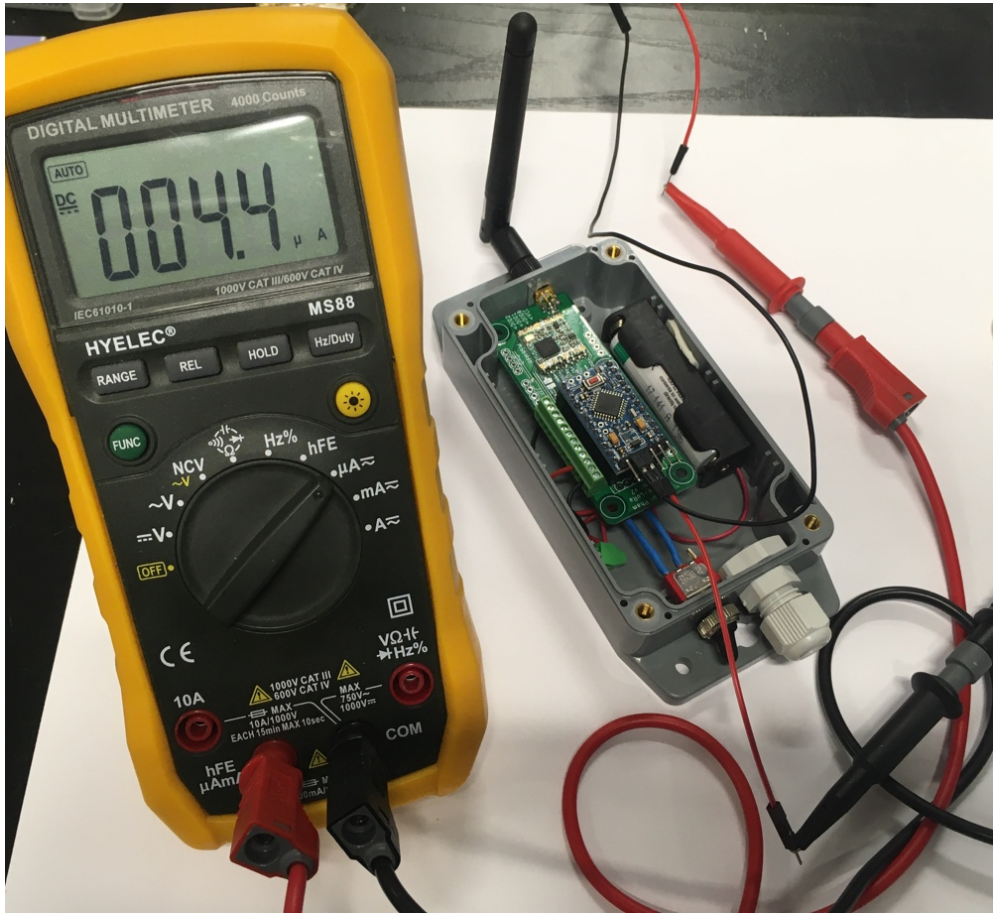


- Remove the power LED by just clipping it off with some wire cutters
- Remove the voltage regulator with a small plier
- Only inject up to 3.6V through the VCC pin
- 5uA in deep sleep mode



https://www.the-diy-life.com/making-an-ultra-low-power-arduino-pro/

Power consumption deep sleep



Measured below 5uA in deep sleep, between 2 active periods with transmissions

Expected autonomy with 1 transmission / hour:

over 2 years with either 2 AA batteries or 1 AA 3.6V Lithium battery