



INTEL-IRRIS

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



INTELLIGENT IRRIGATION SYSTEM FOR LOW-COST AUTONOMOUS WATER CONTROL IN SMALL-SCALE AGRICULTURE



Building the Intel-IrriS LoRa IoT platform Part 3: the INTEL-IRRIS starter-kit



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INTEL-IRRIS starter-kit

- "Intelligent Irrigation in-the-box", "plug-&-sense"
- From idea to reality!



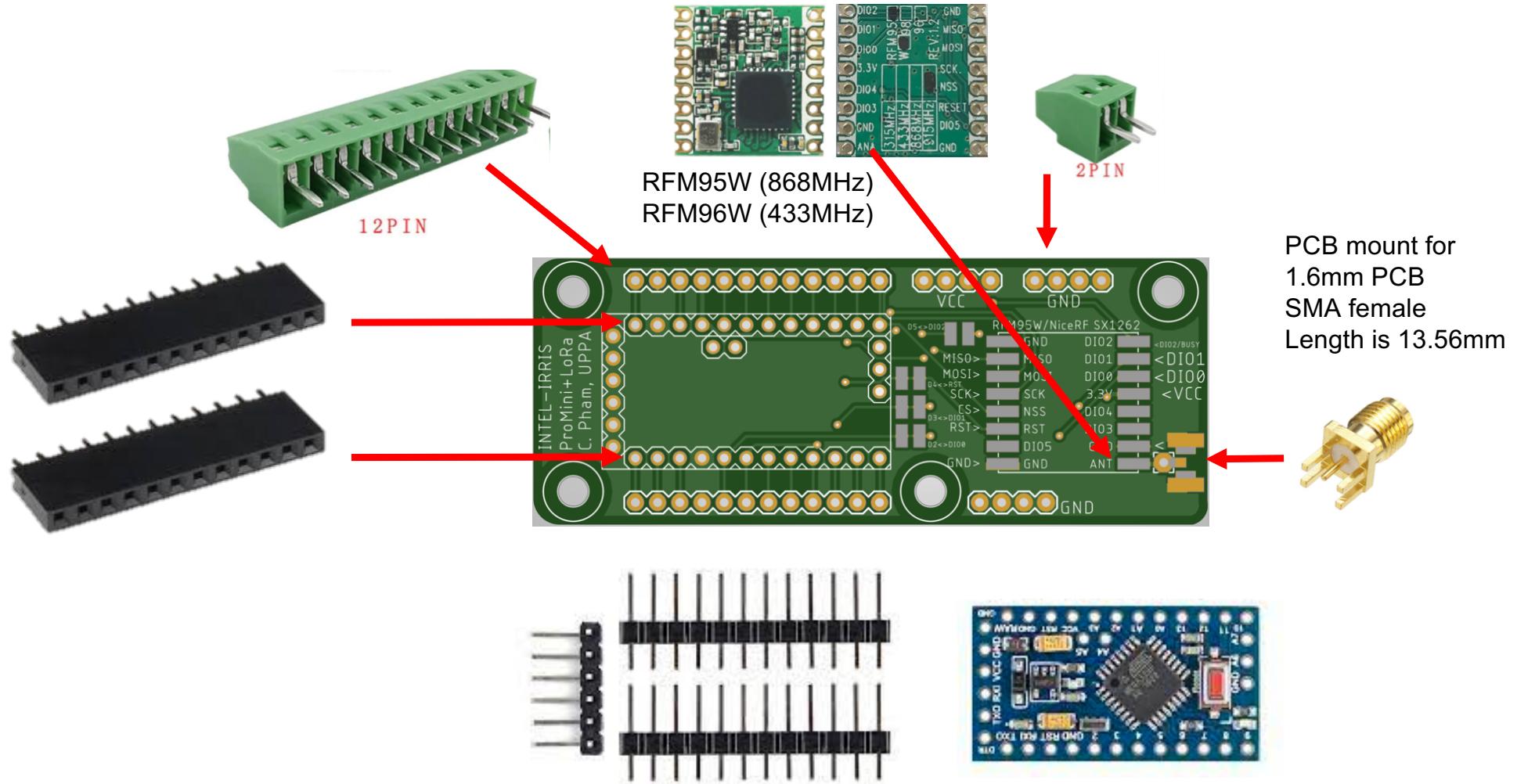
Preparing the starter-kits at UPPA



This non-technical video shows
the preparation of the kits
<https://youtu.be/5nznRcloe40>

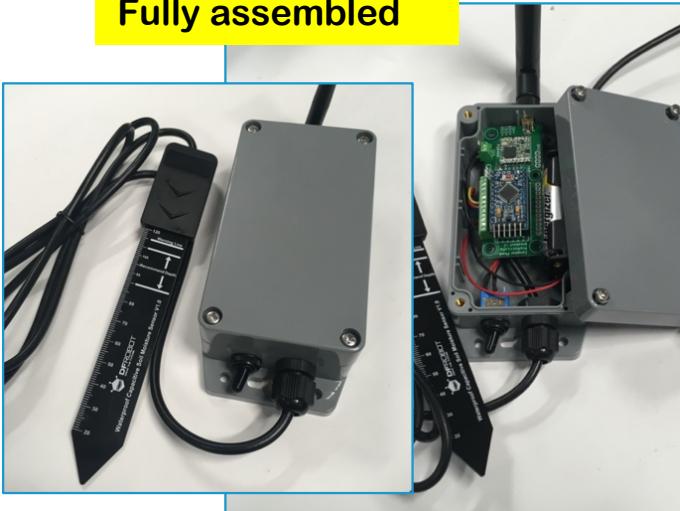


Soil sensor: electronic parts starter-kit version



Soil sensor device

Fully assembled



Packaging in enclosure



To be assembled

2 versions of the soil device

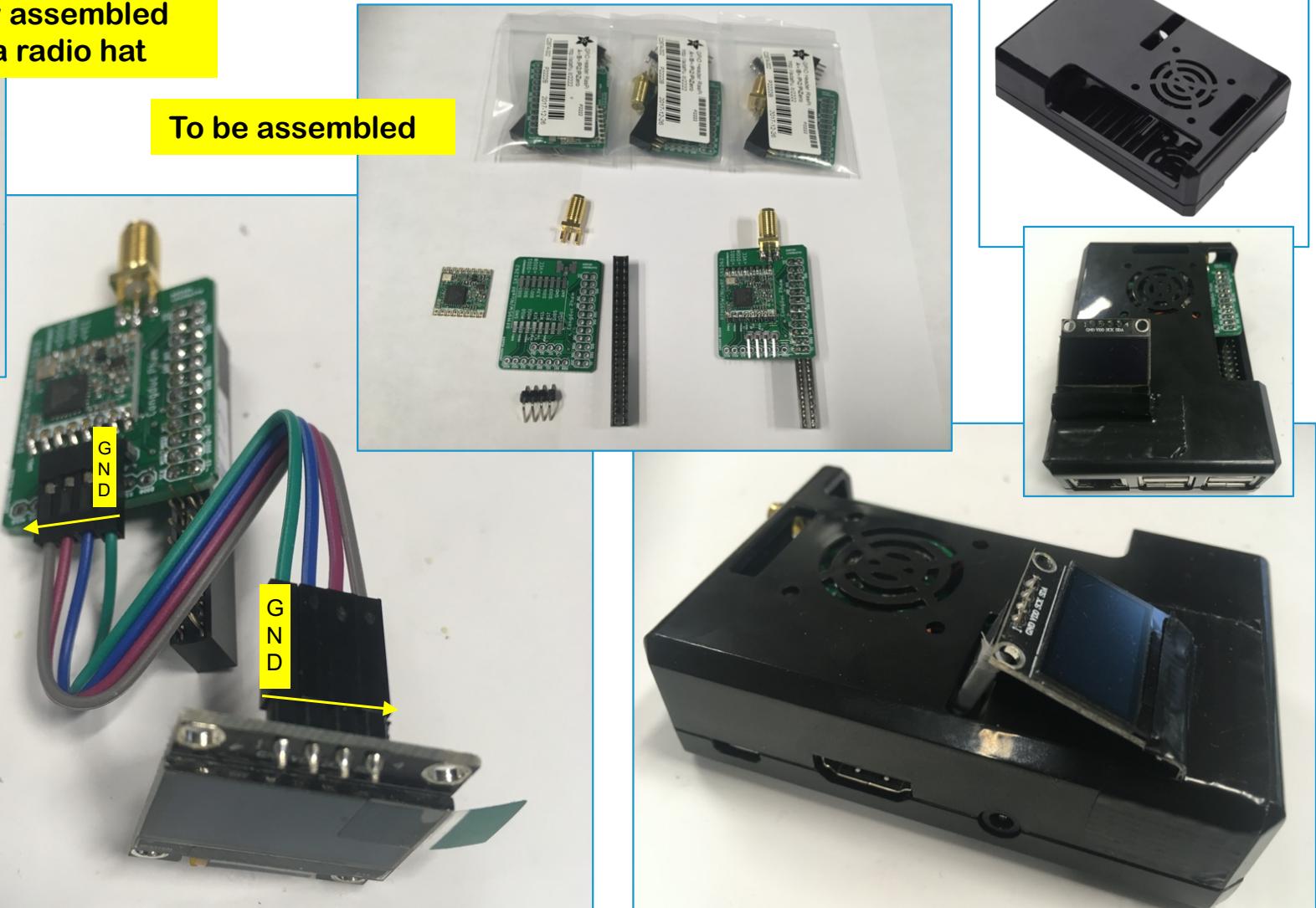


A soil temperature
sensor can be added

SEN0308
capacitive sensor

Watermark WM200
Water tension sensor

Gateway (WaziGate)



First round of starter-kits

- 1 fully assembled & configured soil sensor device
- NEED TO INSTALL 2-AA BATTERIES
- 4 soil sensor devices to be assembled & configured
- 1 fully assembled radio LoRa hat
- 4 radio LoRa hats to be assembled
- INTEL-IRRIS WaziGate image to be downloaded & flashed
- **IMPORTANT**
 - 1 starter-kit= 1 soil sensor + 1 INTEL-IRRIS WaziGate gateway
 - 1 starter-kit / farm to be deployed and tested
 - The WaziGate is **only pre-configured for 1 soil sensor / farm**
 - If there are several soil sensors in a farm, see **advanced configuration**
- **All tutorials & videos: <http://intel-iris.eu/tutorials-slides>**

Assembling starter-kit

Algeria (UORAN1), Morocco (ENSA Safi)

- Soil sensor device
 - [Tutorial slides on building & assembling the outdoor LoRa IoT soil sensor device](#)
 - [Video n°1. YouTube tutorial video showing how to build the IoT microcontroller platform for the LoRa IoT soil sensor device.](#)
<https://youtu.be/3jdQ0Uo0phQ>
 - [Video n°2. YouTube tutorial video showing how to build the outdoor LoRa IoT soil sensor device.](#) <https://youtu.be/zcazzDbXvHk>
 - [Video n°3. YouTube tutorial video showing how to wire the SEN0308 capacitive sensor.](#) <https://youtu.be/zcazzDbXvHk>
- INTEL-IRRIS WaziGate
 - [Tutorial slides on preparing the INTEL-IRRIS WaziGate IoT gateway](#)
 - [Video n°4. YouTube tutorial video demonstrating the INTEL-IRRIS soil sensor device & WaziGate framework.](#) <https://youtu.be/zcazzDbXvHk>

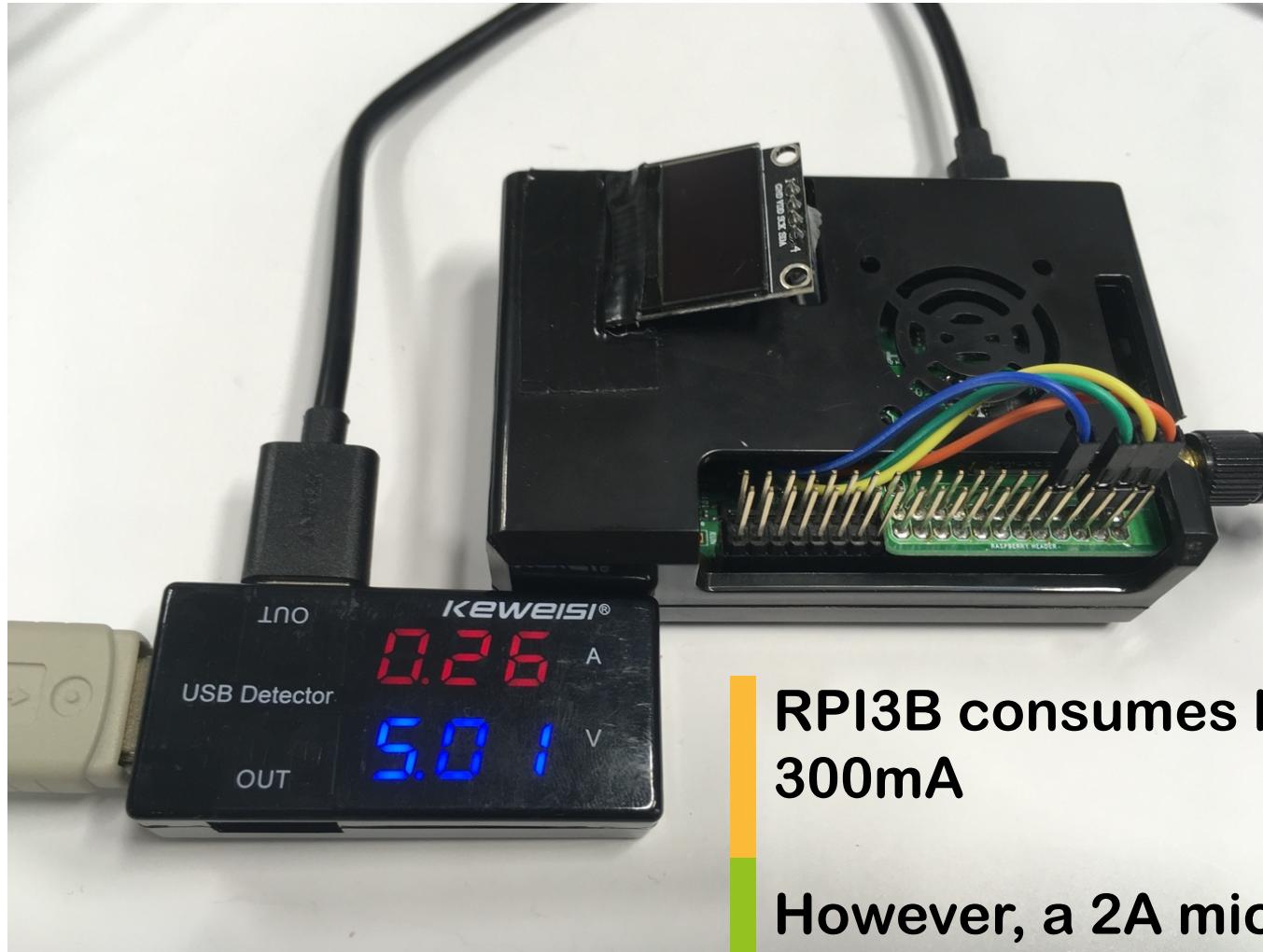
Preparing Wazigate

- Plug the LoRa radio hat on the Raspberry, screw in the antenna



- Download SD card image from <http://intel-irris.eu/results>
- select EU433 (Algeria, Morocco) or EU868 (Europe, France)
- Flash SD card (min 8GB): [Video n°4 at t=124s](https://youtu.be/j-1Nk0tv0xM?t=124s),
<https://youtu.be/j-1Nk0tv0xM?t=124>, then insert SD card

Powering the WaziGate

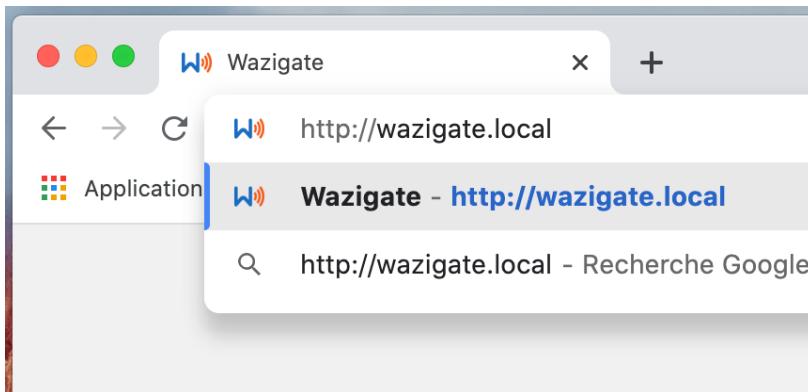
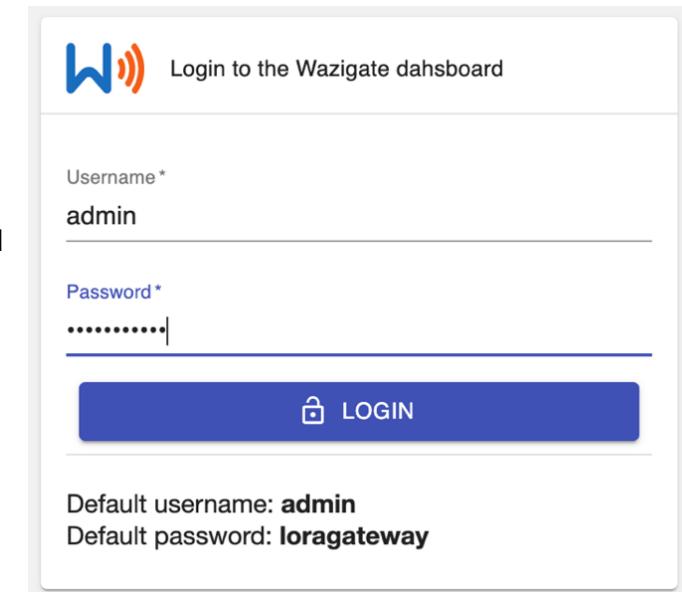


RPI3B consumes less than
300mA

However, a 2A micro USB charger
is needed to avoid undervoltage

Checking the WaziGate

- Power the WaziGate, no Internet is required, wait 3-4mins (boot)
- Connect to **WAZIGATE_XXXXXXXXXXXXXX** WiFi network
 - default WiFi password is loragateway
- Open web navigator. Go to <http://wazigate.local> or <http://10.42.0.1>

Login to the Wazigate dashboard

Username *
admin

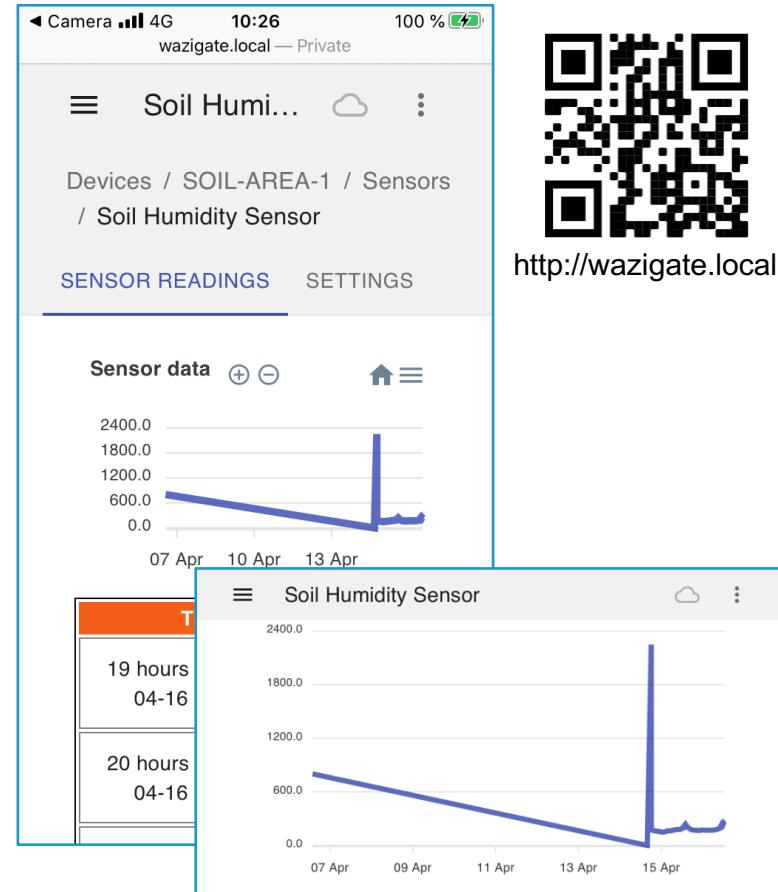
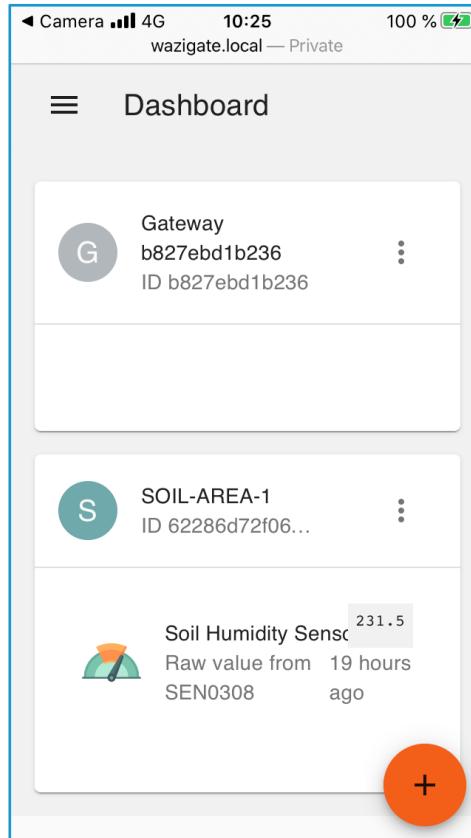
Password *
.....

LOGIN

Default username: **admin**
Default password: **loragateway**

- Use default login to connect
 - User: admin
 - Password: loragateway

WaziGate's dashboard



<http://wazigate.local>



<http://10.42.0.1>

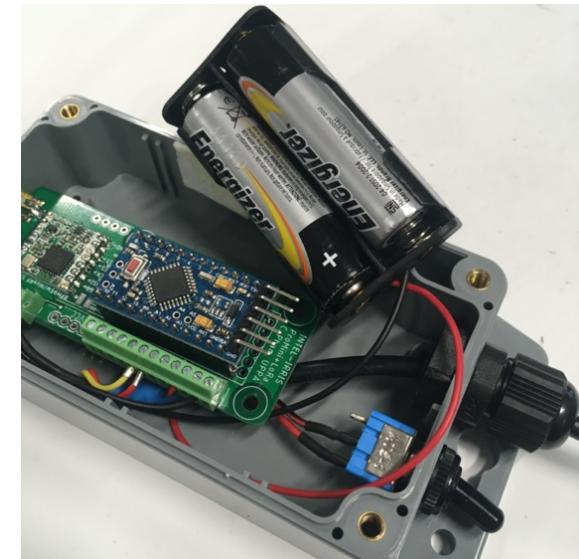
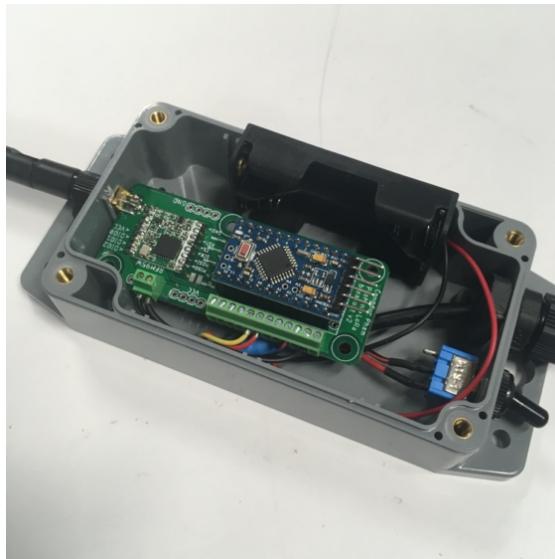
Look at [Video n°4 at t=239s](#)

<https://youtu.be/j-1Nk0tv0xM?t=239>

Preparing soil sensor device

install batteries

- Remove cover & install 2-AA batteries in battery holder
- Best way is to detach the battery holder



- Put back cover and be sure to tighten the cover
- Procedure is the same if you need to replace the batteries



Take good AA batteries

- Install new & high-grade alkaline AA batteries to allow for at least 2 years of autonomy
- Take a well-known brand



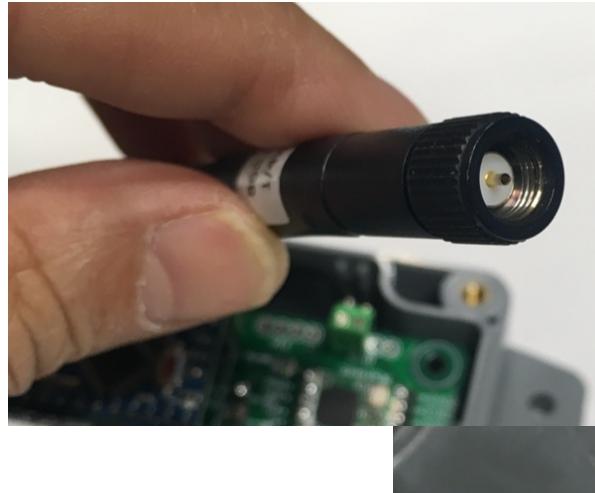


Never transmit without antenna

- NEVER, NEVER transmit without an antenna
- Doing so can damage the radio module
- If your board is already connected to the radio module and you need to flash the board, connect the antenna
- If you need to update the existing code and your device already run a code that transmit data, connect the antenna
- It is safer when programming the device to remove the Arduino board from the PCB and program it disconnected from the radio module
- If you deploy a device, make sure that the antenna is correctly connected before powering on the device and realizing any transmission test

Preparing soil sensor device

screw in the antenna

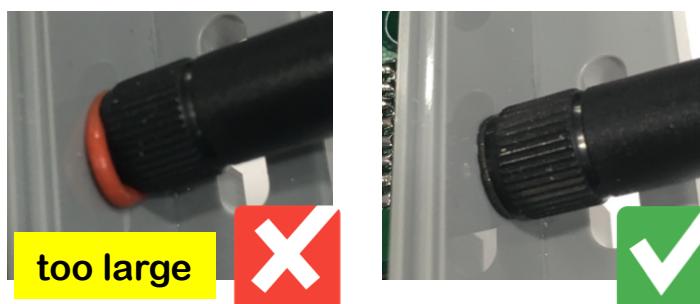
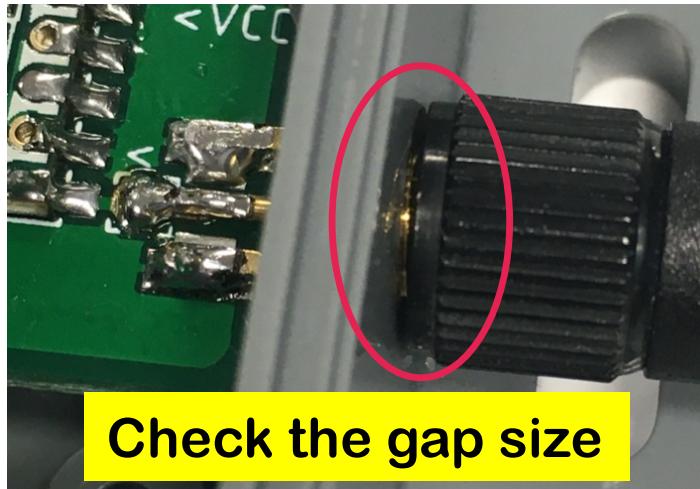


Be sure to connect the matching antenna
Here, SMA female with SMA male antenna
Need to screw the antenna in all the way

The antenna junction is critical because this
is where rain water can come in



The antenna junction



Even when the antenna is screwed in all the way, there might still be a gap

Even with no apparent gap, it is necessary to waterproof the junction

Take an o-ring for that purpose, but do not take it too thick or too large!

Too thick: the antenna will not be screwed in all the way!

There are o-ring for SMA connector but the gap size is an indication

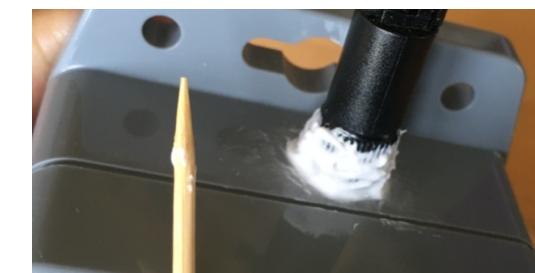
Do not have or can not use o-ring?

Maybe the gap is too big? Use silicon joint sealant

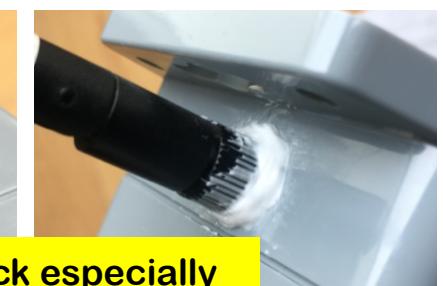


First, screw in the antenna all the way

Put small amount of silicon around the antenna junction (use a flat screw driver or other flat tool)



Use a wet toothpick to finish and clean the silicon all around the antenna junction



check especially
the back side

Even with o-ring, it is safer to add silicon!

Put the device sticker

- Put the INTEL-IRRIS device sticker on the device cover
- See how the OFF and ON position are indicated
- You may use a waterproof marker to write the device address



Testing transmission to WaziGate

- Test with the fully assembled & configured soil sensor device
 - Check that antenna is connected
 - Switch ON the soil sensor device to get data transmission
 - Wait for about 10s, then switch OFF the soil sensor device
 - Check reception of data on WaziGate's dashboard
 - You need to refresh the web page on the web navigator



Look at [Video n°4 at t=331s](#)
<https://youtu.be/j-1Nk0tv0xM?t=331>

Transmission to WaziGate



Parameters for
INTEL-IRRIS WaziGate
(default in red)

LoRaWAN™
SF12BW125
868.1MHz | 433.175MHz
Node id is 26011DAA
1 msg/60mins
1 sensor
XLPP data



This dedicated video will show all these steps, from connecting the SEN0308 to testing transmission to the WaziGate
Video n°4: <https://youtu.be/j-1Nk0tv0xM>

Intelirris_Soil_Sensor | Arduino 1.8.13

```
Intelirris_Soil_Sensor DS18B20.cpp DS18B20.h RadioSettings.h SX126X_RadioSettings.h SX127X_RadioSettings.h SX128X_RadioSettings.h

27 */
28
29 //*****
30 //  _ \      /_ \      _ \ _ 
31 // / \ \_ - - / \_ - - / \_ - 
32 // | | / \_ \_ | | / \_ \_ | | / \_ 
33 // | | \_ \_ | | \_ \_ | | \_ \_ | | \_ \ 
34 // | | \_ \_ | | \_ \_ | | \_ \_ | | \_ \_ | | \_ \ 
35 // \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ 
36 // \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ 
37 // \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ / \_ \_ 
38 ****/
39
40 ///////////////
41 // sends data to INTEL-IRRIS WaziGate edge-gateway
42 #define TO_WAZIGATE
43
44 ///////////////
45 // Frequency band - do not change in SX127X_RadioSettings.h anymore
46 //#define BAND868
47 //#define BAND900
48 #define BAND433
49
50 ///////////////
51 // Test device
52 //#define TEST_DEVICE_RANDOM
53
54 ///////////////
55 // uncomment to have a soil tensiometer watermark sensor
56 //#define WITH_WATERMARK
57
```

Be sure that

```
#define TO_WAZIGATE
```

is uncommented

Intelirris_Soil_Sensor | Arduino 1.8.13

```
Intelirris_Soil_Sensor DS18B20.cpp DS18B20.h RadioSettings.h SX126X_RadioSettings.h SX127X_RadioSettings.h SX128X_RadioSettings.h

27 */
28
29 //*****
30
31 / -- \      / -- \      [ ] [ ]
32 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
33 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
34 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
35 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
36 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
37 [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]
38 *****/
39
40 ///////////////
41 // sends data to INTEL-IRRIS WaziGate edge-gateway
42 #define TO_WAZIGATE
43
44 ///////////////
45 // Frequency band - do not change in SX127X_RadioSettings.h anymore
46 //#define BAND868
47 //#define BAND900
48 #define BAND433
49
50 ///////////////
51 // Test device
52 //#define TEST_DEVICE_RANDOM
53
54 ///////////////
55 // uncomment to have a soil tensiometer watermark sensor
56 //#define WITH_WATERMARK
57
```

If you use the EU433 band
make sure that

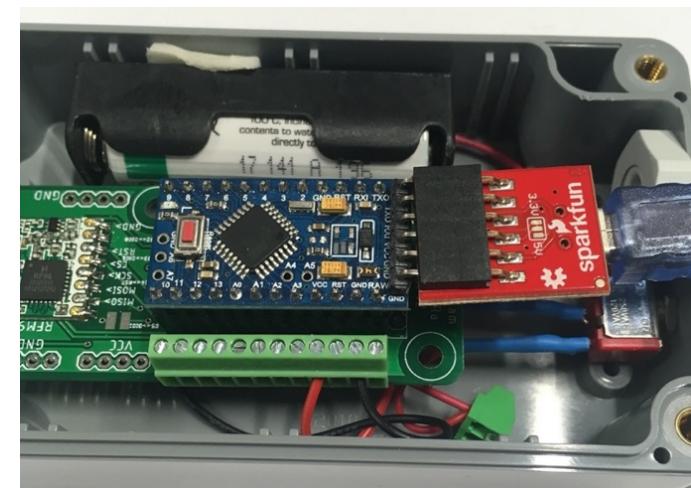
```
#define BAND433
```

**is the only uncommented
band option**

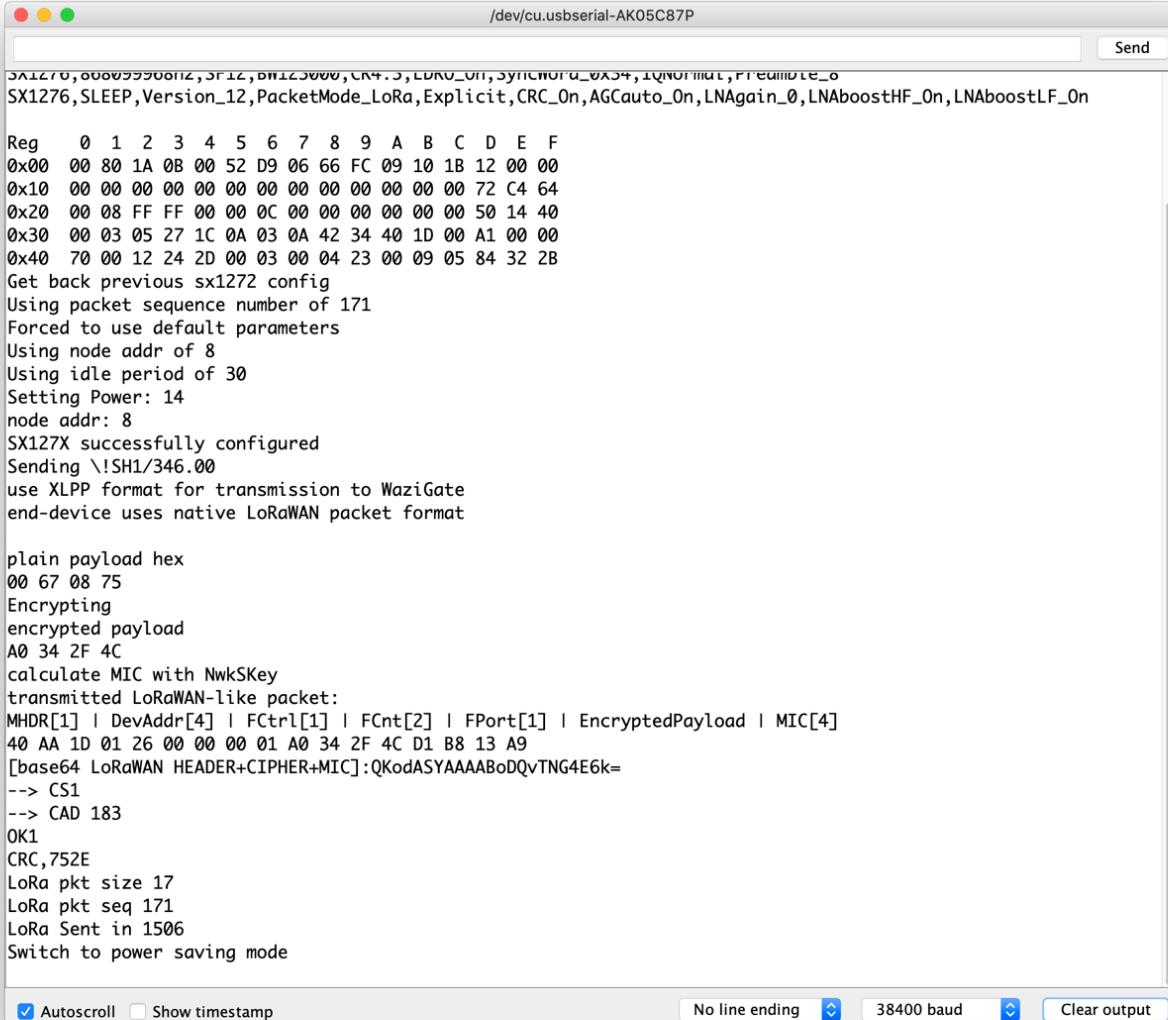
Click on the "upload" button



And wait until upload is completed



Checking that device is operational



The screenshot shows a terminal window titled '/dev/cu.usbserial-AK05C87P'. The output displays the following information:

```

SX1276,000000000000,3F12,BW125000,CR4.5,LDRX_001,SYNCHRO_0034,TQ_NORM,PREDECODE_0
SX1276,SLEEP,Version_12,PacketMode_LoRa,Explicit,CRC_On,AGCAuto_On,LNAgain_0,LNAboostHF_On,LNAboostLF_On

Reg 0 1 2 3 4 5 6 7 8 9 A B C D E F
0x00 00 80 1A 0B 00 52 D9 06 66 FC 09 10 1B 12 00 00
0x10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 72 C4 64
0x20 00 08 FF FF 00 00 0C 00 00 00 00 00 00 00 50 14 40
0x30 00 03 05 27 1C 0A 03 0A 42 34 40 1D 00 A1 00 00
0x40 70 00 12 24 2D 00 03 00 04 23 00 09 05 84 32 2B
Get back previous sx1272 config
Using packet sequence number of 171
Forced to use default parameters
Using node addr of 8
Using idle period of 30
Setting Power: 14
node addr: 8
SX127X successfully configured
Sending \!SH1/346.00
use XLPP format for transmission to WaziGate
end-device uses native LoRaWAN packet format

plain payload hex
00 67 08 75
Encrypting
encrypted payload
A0 34 2F 4C
calculate MIC with NwkSKey
transmitted LoRaWAN-like packet:
MHDR[1] | DevAddr[4] | FCtrl[1] | FCnt[2] | FPort[1] | EncryptedPayload | MIC[4]
40 AA 1D 01 26 00 00 00 01 A0 34 2F 4C D1 B8 13 A9
[base64 LoRaWAN HEADER+CIPHER+MIC]:QKodASYAAABoDQvTNG4E6k=
--> CS1
--> CAD 183
OK1
CRC,752E
LoRa pkt size 17
LoRa pkt seq 171
LoRa Sent in 1506
Switch to power saving mode

 Autoscroll  Show timestamp
  No line ending 
  Clear output

```

Open serial monitor

Set baud rate to 38400

See output from board

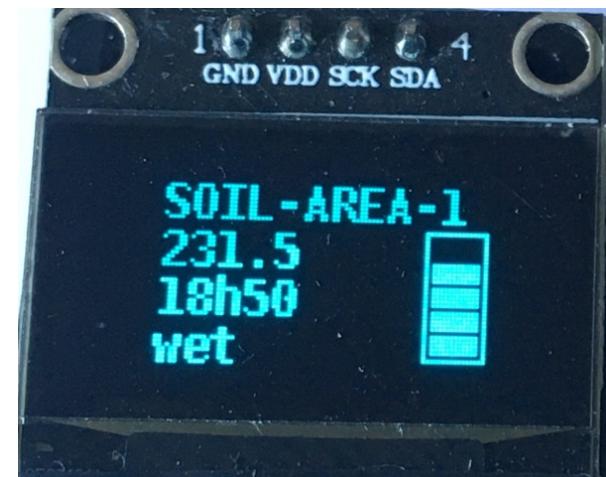
Check that transmission is OK

Deploying the starter-kit

- Calibrate the soil sensor device
 - See dedicated slides/videos [to come]
- Install the soil sensor device in the field
 - See dedicated slides/videos [to come]
- Install the WaziGate in the farmer's office/home/premise
 - Just power the WaziGate, no Internet is required
 - Test access to WaziGate's dashboard with farmer's smartphone
- **NEVER TRANSMIT WITHOUT AN ANTENNA**
- Test correct data reception on WaziGate
 - Switch ON the soil sensor device to get data transmission
 - Check reception of data on WaziGate's dashboard

With the optional OLED

- With a small .96" OLED screen, information summary is displayed for the end-user: the device name, the time of last received data, the sensor raw value and the soil condition
- The main screen is displayed for 6s every 30s. Then a screen saver display will show a shorter version of these information with a 5-bar visual
- 5 bars: very wet | 4 bars: wet
- 3 bars: wet-dry | 2 bars: dry-wet
- 1 bar: dry | 0 bar: very dry



QR code for connecting to WiFi

- The WaziGate WiFi is WAZIGATE_XXXXXXXXXXXX where XXXXXXXXXXXX is the MAC address of the Raspberry
- For instance WAZIGATE_B827EBD1B236
- With the OLED, a QR code for joining the WiFi network is generated dynamically at boot time and displayed for 10s before the main screen so that users can automatically join with a smartphone
- Then, users can scan the static QR code on the WaziGate sticker to connect to the WaziGate's dashboard or the INTEL-IRRIS WaziApp

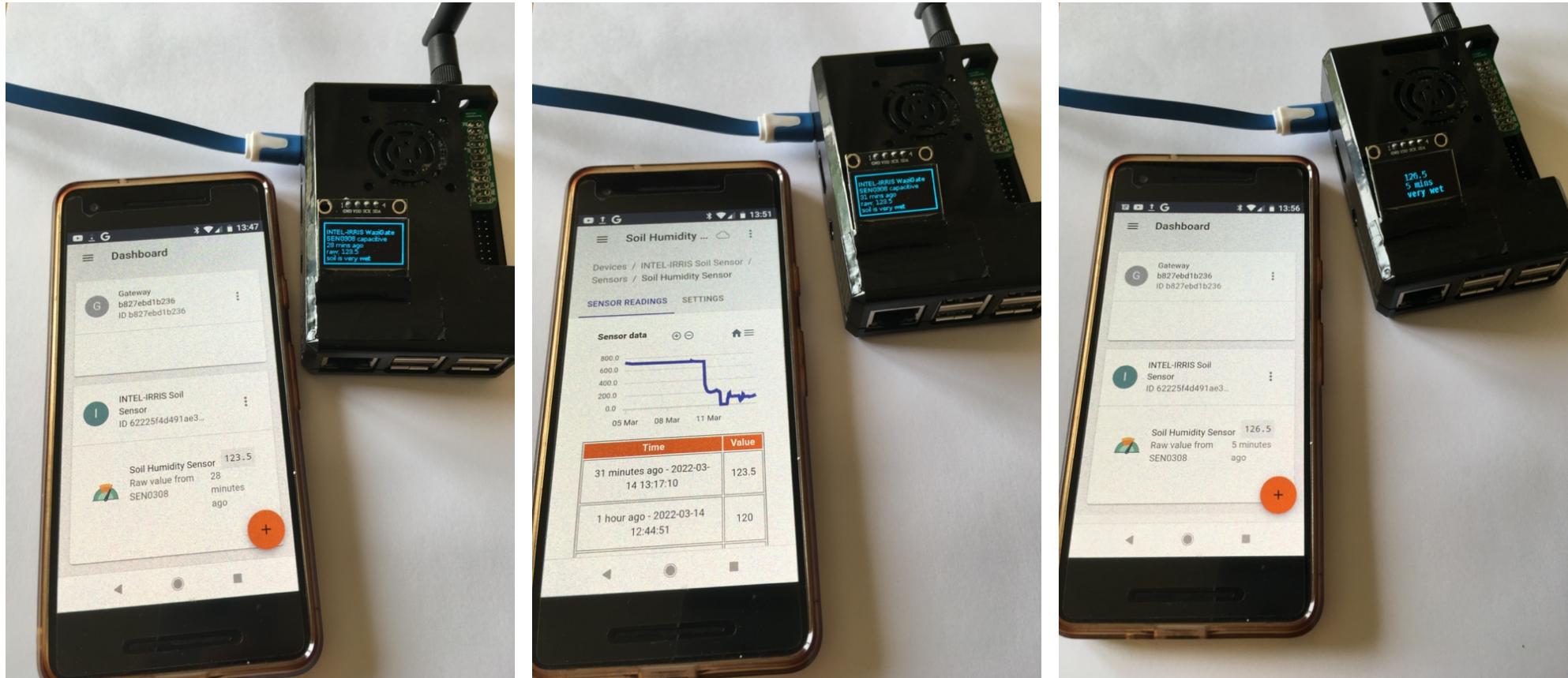
WAZIGATE_B827EBD1B236



WAZIGATE_DCA6325C2A7A



WaziGate User Interface



The WaziGate provides the simple OLED interface but also more advanced features through the WaziGate dashboard and embedded application interface (WaziApp)

A dedicated INTEL-IRRIS Irrigation WaziApp is currently being developed

1/ To have several soil sensor devices in a single farm

- Only if you need to have several soil devices in a single farm – change the device address in the soil device Arduino code

```
Intelirris_Soil_Sensor | Arduino 1.8.13
166
167
168
169
170 ****
171
172 //////////////////////////////////////////////////////////////////
173 // LORAWAN OR EXTENDED DEVICE ADDRESS FOR LORAWAN CLOUD
174 #if defined LORAWAN || defined EXTDEVADDR
175
176 //ENTER HERE your Device Address from the TTN device info (same order, i.e. msb). Example
177 //unsigned char DevAddr[4] = { 0x12, 0x34, 0x56, 0x78 };
178
179
180 //Pau
181 //unsigned char DevAddr[4] = { 0x26, 0x01, 0x17, 0x21 };
182
183 //WaziGate default
184 //26011DA
185 unsigned char DevAddr[4] = { 0x26, 0x01, 0x1D, 0xAA };
186 #else
187
188 // DO NOT CHANGE HERE
189 unsigned char DevAddr[4] = { 0x00, 0x00, 0x00, node_addr };
190
191 #endif
192
193
194
195 ****
196
197
198
```

Default address is

```
{ 0x26, 0x01, 0x1D, 0xAA };
```

Just increase the last byte

```
{ 0x26, 0x01, 0x1D, 0xAB };
```

Compile and upload the code to the soil sensor device

Advanced configuration

1/ To have several soil devices in a single farm, con't

- Left figure shows configuration of the default soil sensor device
- Create a new device, e.g. SOIL-AREA-2
- Limit device name to 12 characters for correct display on OLED

SOIL-AREA-1

Devices / SOIL-AREA-1

 Soil Humidity Sensor
Raw value from SEN0308

LoRaWAN Settings

LoRaWAN Profile: WaziDev

DevAddr (Device Address): 26011DAA

NwkKey (Network Session Key): 23158D3BBC31E6AF670D195B5AED5525

AppKey (App Key): 23158D3BBC31E6AF670D195B5AED5525

Device Codec

XLPP (Waziup Extended Low Power Payload)

Dashboard

 **Gateway** b827ebd1b236
ID b827ebd1b236

 **SOIL-AREA-1**
ID 62286d72f06c4c0001...

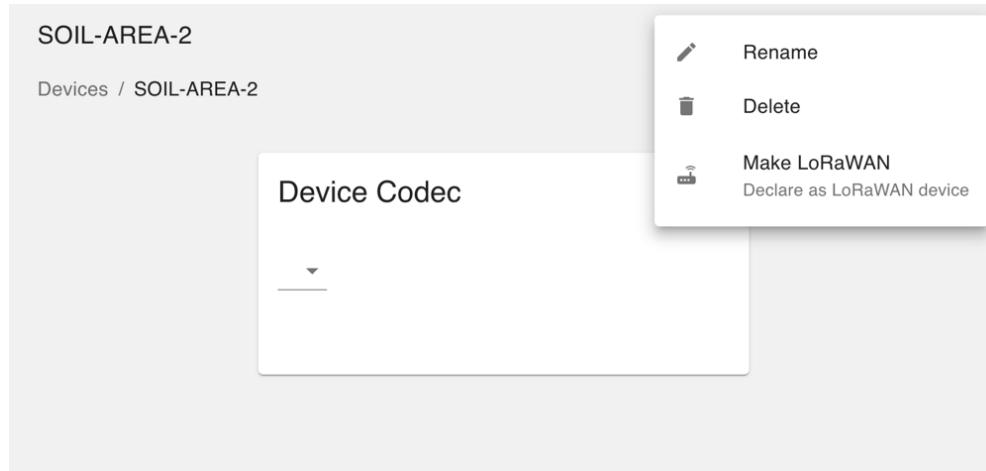
 Soil Humidity Sensor
Raw value from SEN0308
231.5
19 hours ago

 **SOIL-AREA-2**
ID 625bd2c81779f80001...

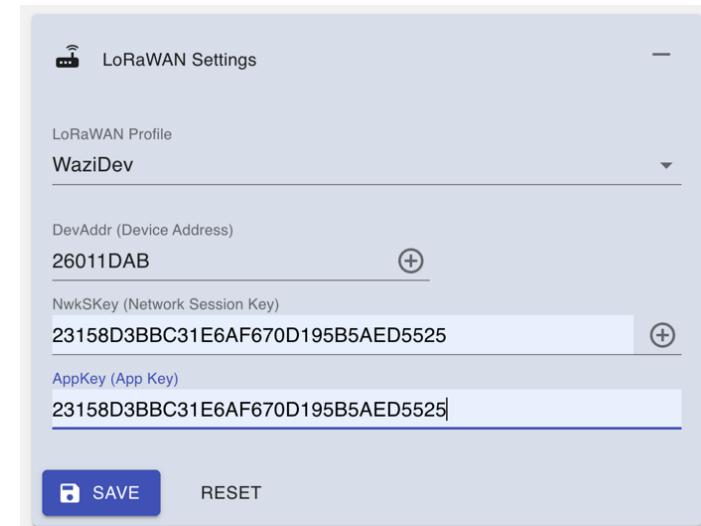
Advanced configuration

1/ To have several soil devices in a single farm, con't

- Select the new device and make it as LoRaWAN device



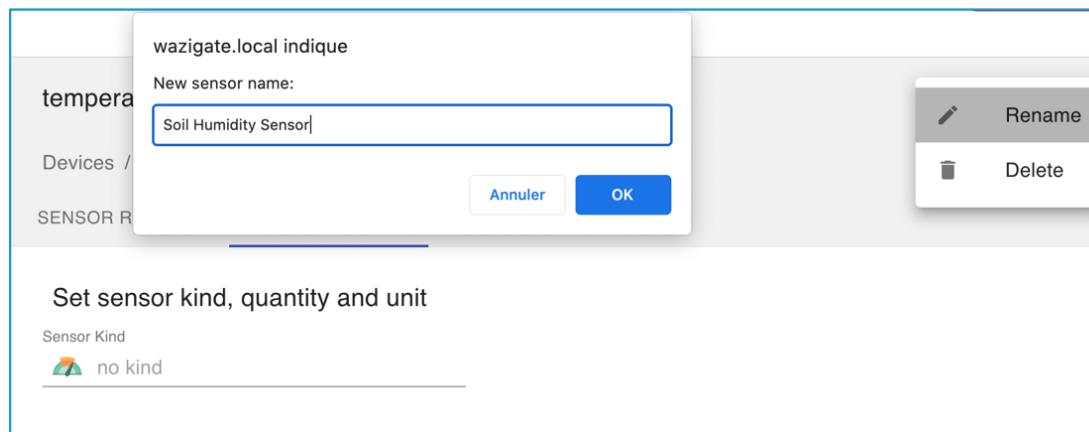
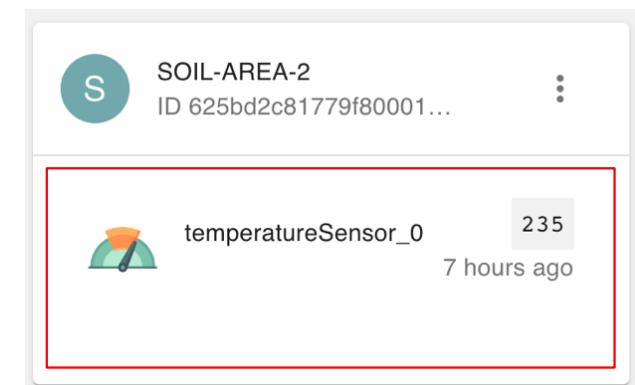
- Set the new address, matching the one of the Arduino code: 26011DAB
- keep same encryption keys
- Select XLPP as codec



Advanced configuration

1/ To have several soil devices in a single farm, con't

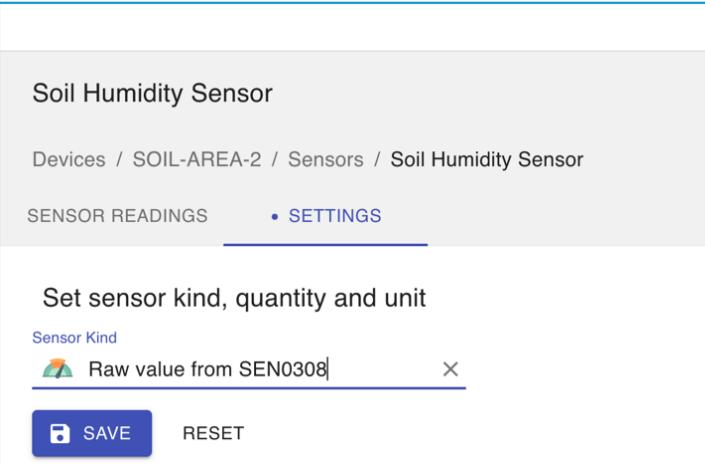
- DO NOT manually create a sensor. Instead,...
- Power on the new soil sensor device to trigger data transmission
- Refresh the WaziGate dashboard, the new data should appear
- New sensor name is "temperatureSensor_0"
- Click on the "temperatureSensor_0" and then rename it, e.g. "Soil Humidity Sensor"



Advanced configuration

1/ To have several soil devices in a single farm, con't

- Change de Sensor kind to "Raw value from SEN0308", assuming that 2nd devide is also a SEN0308 capacitive sensor



Soil Humidity Sensor

Devices / SOIL-AREA-2 / Sensors / Soil Humidity Sensor

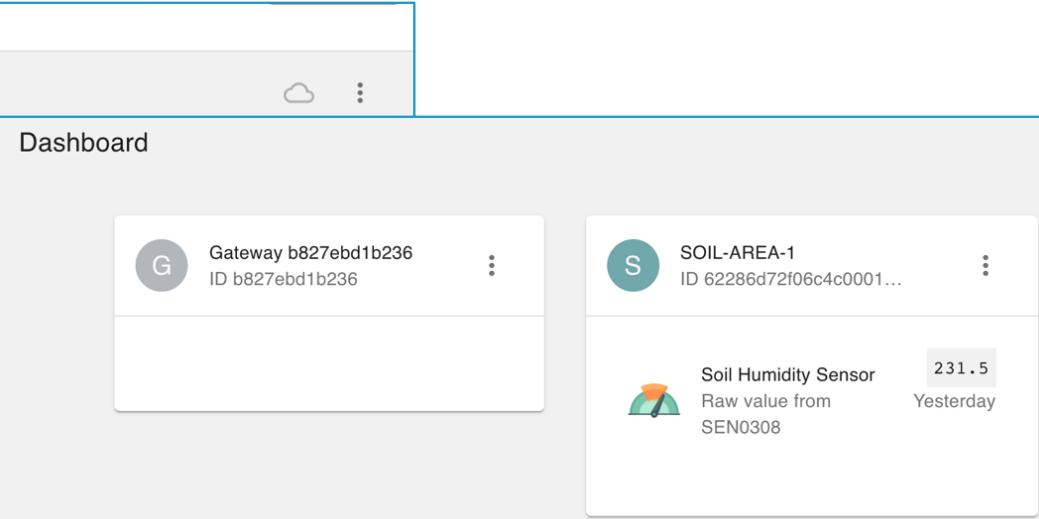
SENSOR READINGS • SETTINGS

Set sensor kind, quantity and unit

Sensor Kind

Raw value from SEN0308

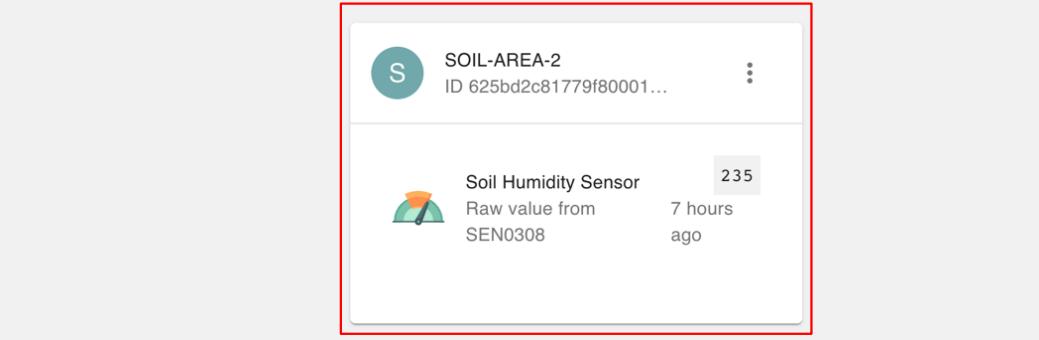
SAVE RESET



Dashboard

 G Gateway b827ebd1b236 ID b827ebd1b236	...
 S SOIL-AREA-1 ID 62286d72f06c4c0001...	...
 Soil Humidity Sensor Raw value from SEN0308	
231.5 Yesterday	

- The dashboard now displays correctly the new device with its sensor



SOIL-AREA-2
ID 625bd2c81779f80001...

Soil Humidity Sensor
Raw value from
SEN0308

235
7 hours ago

Advanced configuration

1/ To have several soil devices in a single farm, end

- When there are more than 2 devices declared on the WaziGate, the OLED screen will cycle sequentially through all of them
 - Main screen device 1 (5s) -> screen saver device 1 (12s) ->
 - Main screen device 2 (5s) -> screen saver device 2 (12s) -> ...
- For the OLED **to detect correctly the devices**, the sensor name (here "Soil Humidity Sensor") or the sensor kind (here "Raw value from SEN0308") MUST contain "SEN0308" or "WM200" for respectively a capacitive or a tensiometer sensor

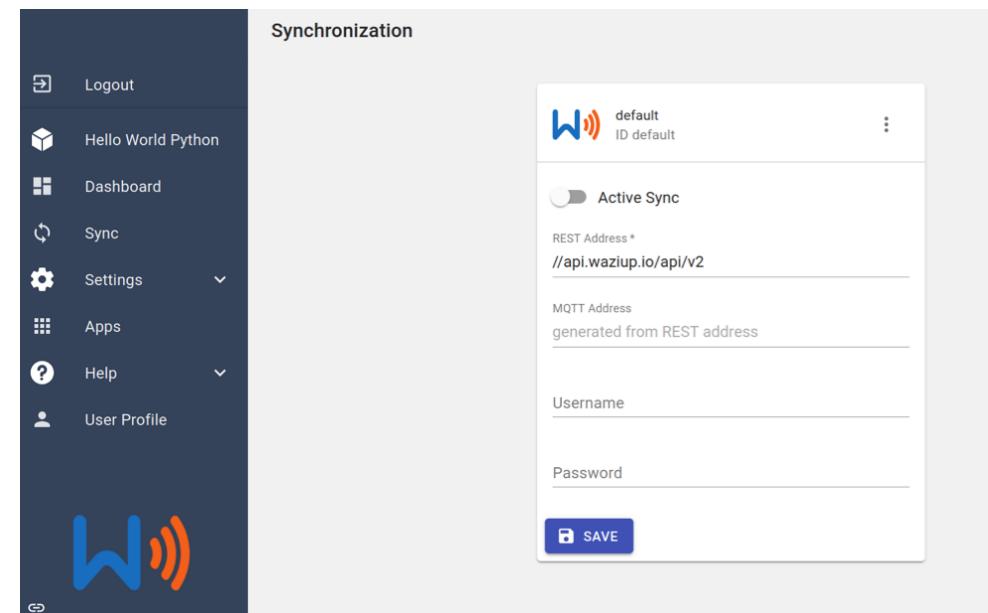


Advanced configuration

2/ To sync WaziGate and its devices to the cloud

- If you want to sync your WaziGate to the WAZIUP Cloud, look at this tutorial page to see what it means
 - <https://www.waziup.io/documentation/wazigate/v2/install/#registration-with-the-cloud>

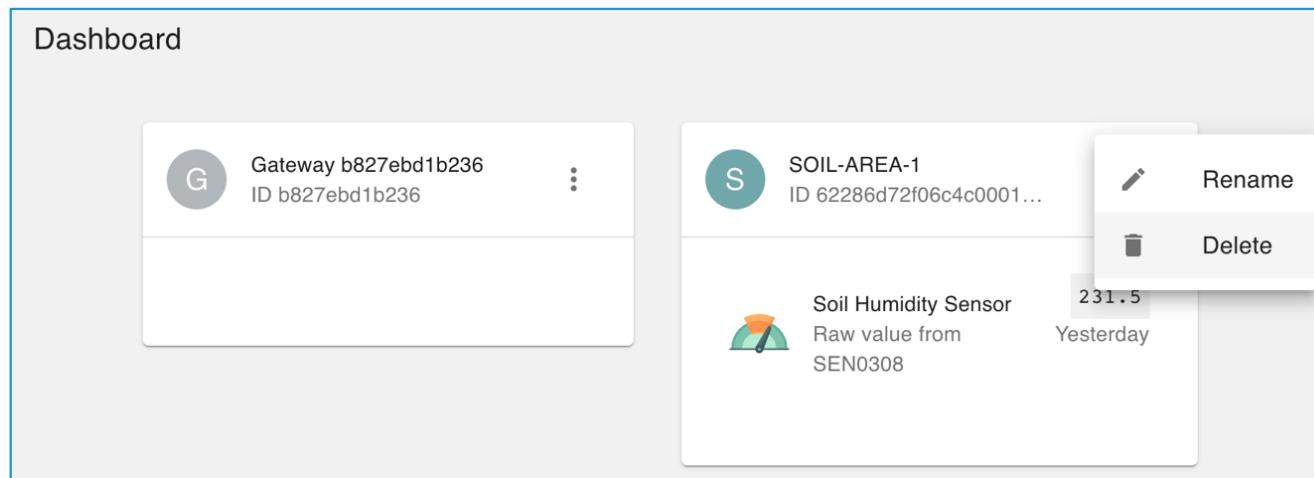
- You will need an account on WAZIUP Cloud dashboard
- If you don't have one, you need to create one first
- <https://dashboard.waziup.io/>



Advanced configuration

2/ To sync WaziGate and its devices to the cloud, con't

- We need to replace the default sensor, but first...
- ... copy the encryption keys of the default sensor
- Then, delete the default device

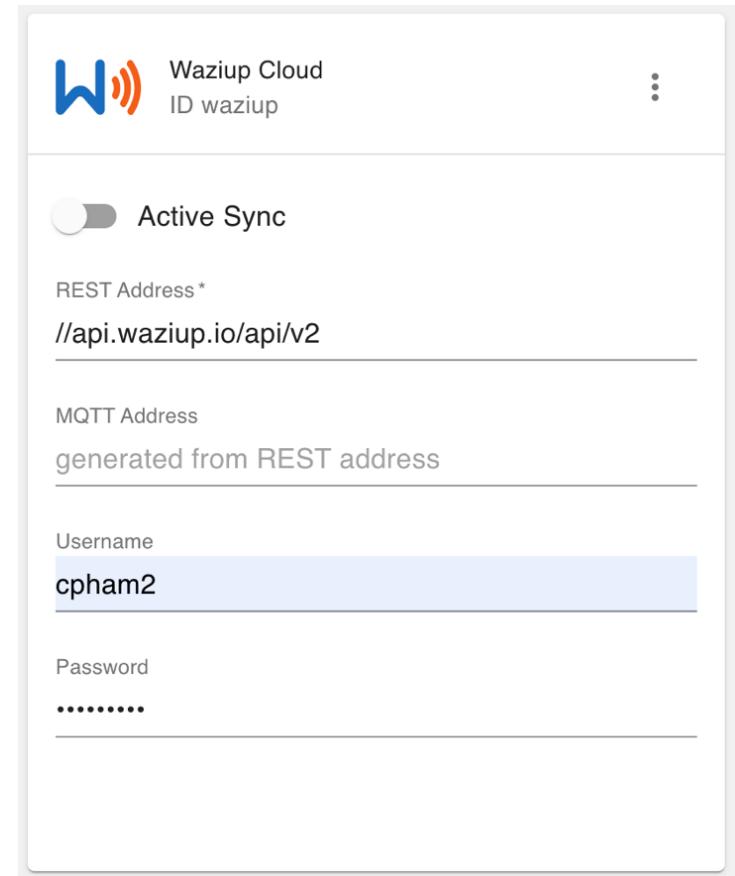



The dashboard shows a gateway card labeled 'Gateway b827ebd1b236 ID b827ebd1b236' and a soil sensor card labeled 'SOIL-AREA-1 ID 62286d72f06c4c0001...'. The soil sensor card includes a 'Raw value from SEN0308' section with a value of '231.5' and a timestamp of 'Yesterday'. A context menu is open over the soil sensor card, showing options for 'Rename' and 'Delete'.

Advanced configuration

2/ To sync WaziGate and its devices to the cloud, end

- Now, proceed as for creating a new sensor, e.g. SOIL-AREA-1
- See slides 32-35
- BUT, keep the configuration of the default sensor
 - Device address: 26011DAA
 - Copy/paste the encryption key
- Finally, enter your WAZIUP account credential in the sync menu
- And enable "Active Sync"
- Log in the WAZIUP Cloud dashboard and check that you see your gateway and your device



NOTICE ON THE STARTER-KIT



- NEVER TRANSMIT WITHOUT AN ANTENNA
- 1 FULLY ASSEMBLED & CONFIGURED SOIL SENSOR
 - NEED TO INSTALL 2-AA BATTERIES
 - TAKE HIGH-GRADE BATTERIES
 - DO NOT SWITCH ON WITHOUT ANTENNA ATTACHED
 - ALREADY CONFIGURED FOR WAZIGATE
- STARTER-KIT= 1 SOIL SENSOR + 1 WAZIGATE
- INTEL-IRRIS WAZIGATE IMAGE TO BE DOWNLOADED FROM <http://intel-iris.eu/results>
- FLASH IMAGE ON 8GB SD CARD (OR 16GB OR 32GB)
- THE WAZIGATE IS ONLY PRE-CONFIGURED FOR 1 SOIL SENSOR PER FARM
- STARTER-KIT TUTORIAL : <http://intel-iris.eu/tutorials-slides>

