INTEL-IRRIS

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

This project is part of the PRIMA Programme supported by the European Union

Intel-IrriS

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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

Intel-IrriS

Building the INTEL-IRRIS LoRa IoT platform Part 1: soil sensor device

(annex for IRD PCB v5 – RAK3172)

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham
Université de Pau, France

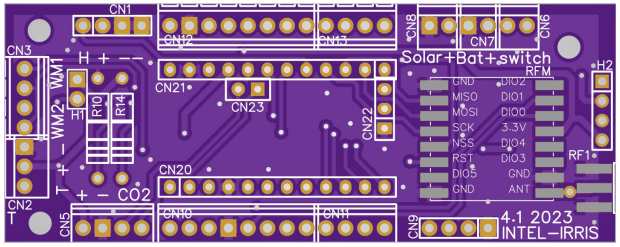
UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

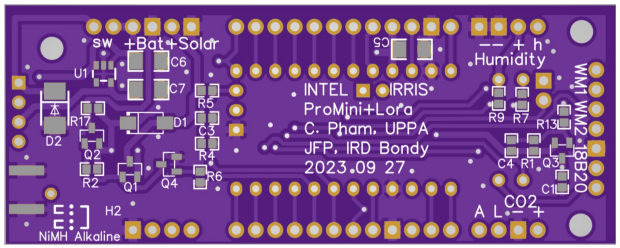
LIUPPA

WAZIUP
IoT – from idea to reality
WAZIHUB

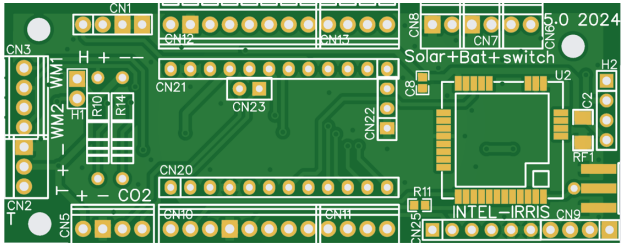
Important

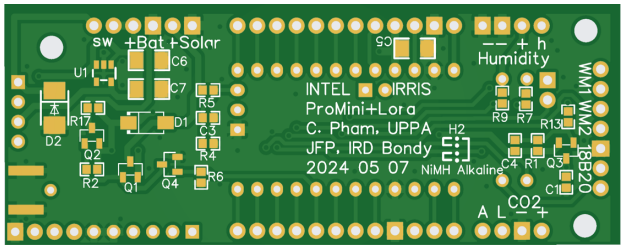
- This tutorial is an update for the IRD PCB v5 based on the RAK3172 radio module
- Reader MUST first look at the tutorial presenting the IRD PCB v4.1 to understand the common instructions
- This tutorial only presents the differences between the 2 versions





IRD PCB v4.1 for RFM95W radio



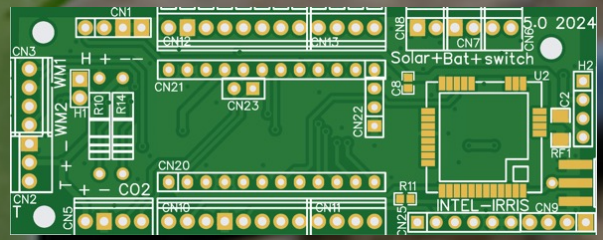


IRD PCB v5 for RAK3172 radio

INTEL-IRRIS

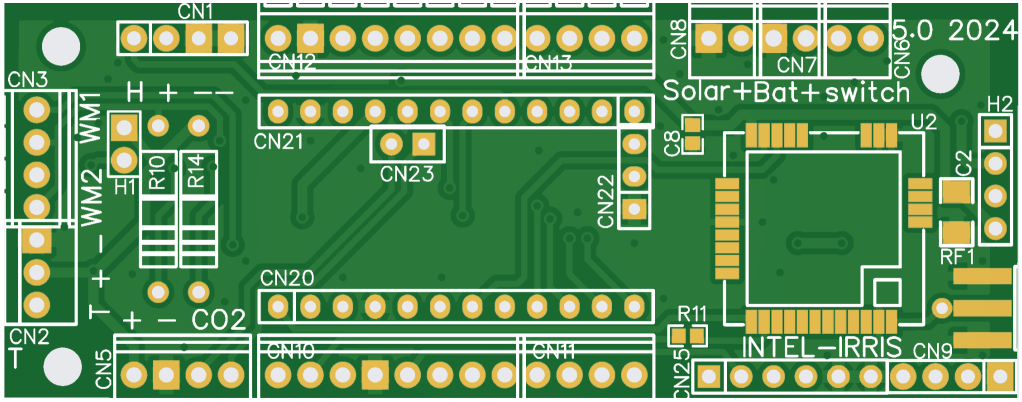
Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

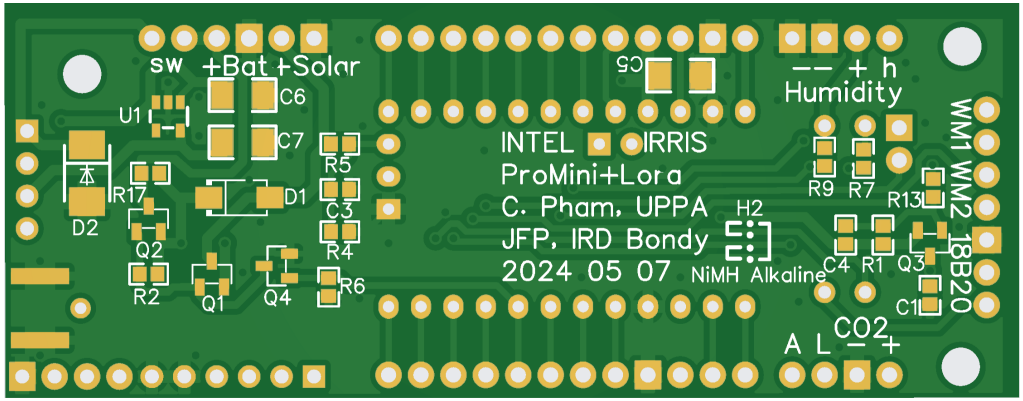
IRD PCB v5



The IRD PCB v5 – raw version

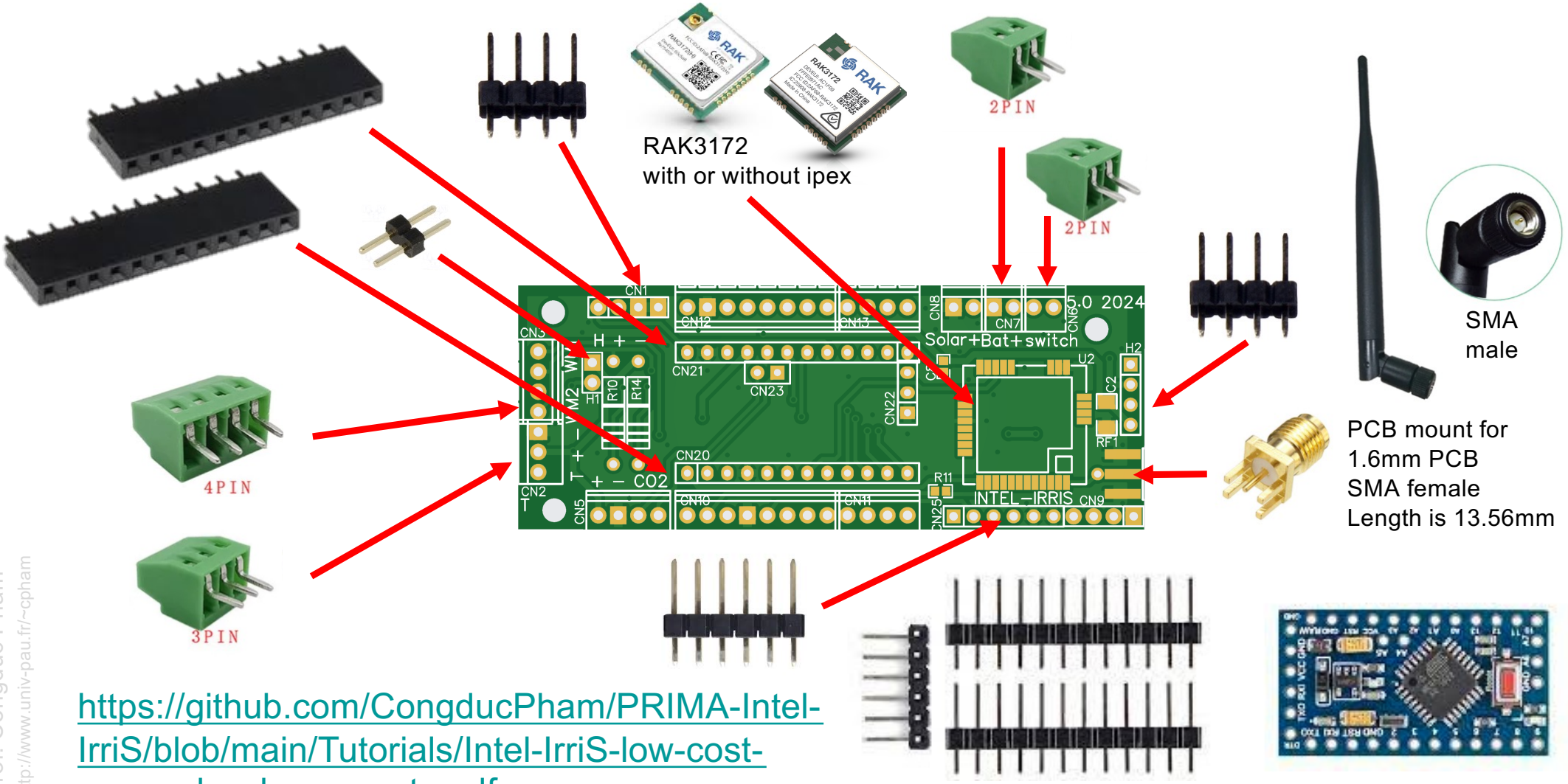
- You can order the raw version of the IRD PCB, which means only the PCB, without any electronic components soldered by the manufacturer
- It is the so-called DIY approach
- The raw version is not intended to have solar charging capabilities





Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

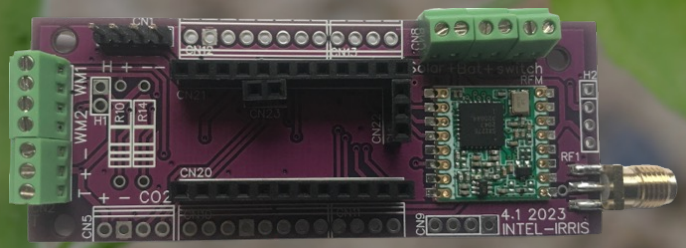
Electronic parts - starter-kit version



https://github.com/CongducPham/PRIMA-Intel-IrriS/blob/main/Tutorials/Intel-IrriS-low-cost-sensor-hardware-parts.pdf

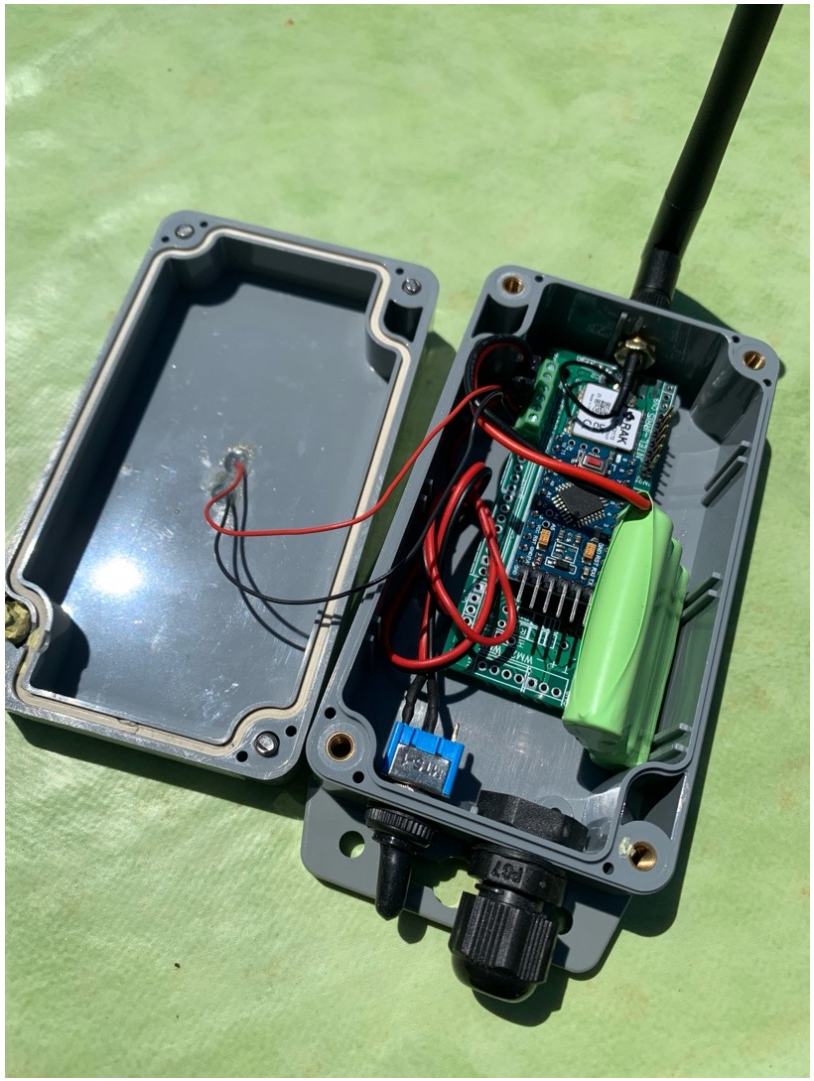
INTEL-IRRIS

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



THE IRD PCBA v5

Soil device with PCBA v5, final result




INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
PROGRAM THE
ARDUINO

Config for IRD PCB v5 (1)

- For raw version, uncomment `IRD_PCB` in BoardSettings.h

```
//uncomment for WAZISENSE v2 board
//#define WAZISENSE

//uncomment for IRD PCB board
#define IRD_PCB
```

- For PCBA version, also uncomment `IRD_PCBA`

```
////////////////////////////////////////////////////////////////////
//uncomment for IRD PCB board
#define IRD_PCB
//also uncomment for IRD PCB board fully assembled by manufacturer
//with all components, including solar circuit
#define IRD_PCBA
```

- ONLY for solar version, uncomment `SOLAR_BAT`

```
////////////////////////////////////////////////////////////////////
// uncomment only if the IRD PCB is running on solar panel
// MUST be commented if running on alkaline battery
// code for SOLAR_BAT has been written by Jean-François Printanier from IRD
#define SOLAR_BAT
// do not change if you are not knowing what you are doing
#define NIMH
```

Config for IRD PCB v5 (2)

- Uncomment `SOFT_SERIAL_DEBUG` in BoardSettings.h

```
//////////////////////////////////////////
// uncomment for IRD PCB RAK version where
#define SOFT_SERIAL_DEBUG
```

- Uncomment `RAK3172` in RadioSettings.h

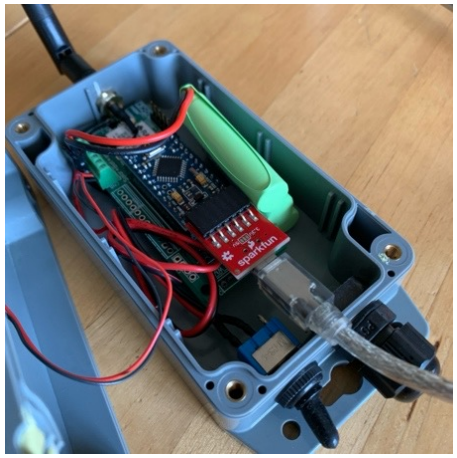
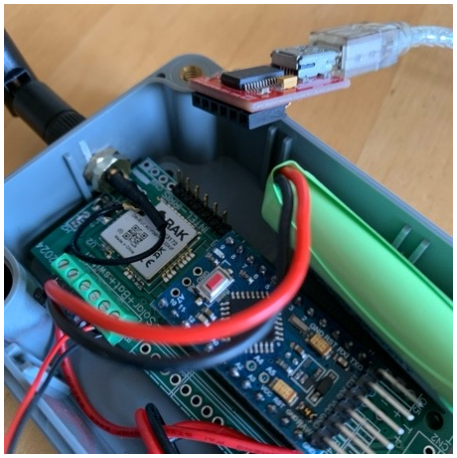
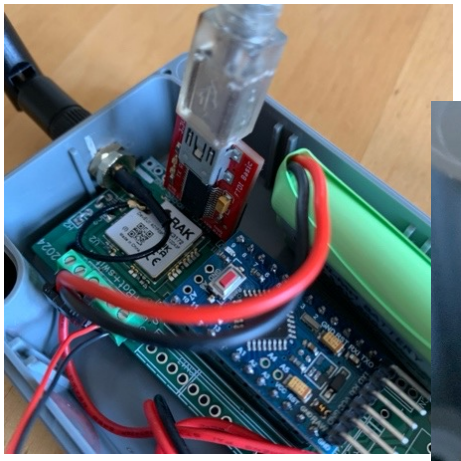
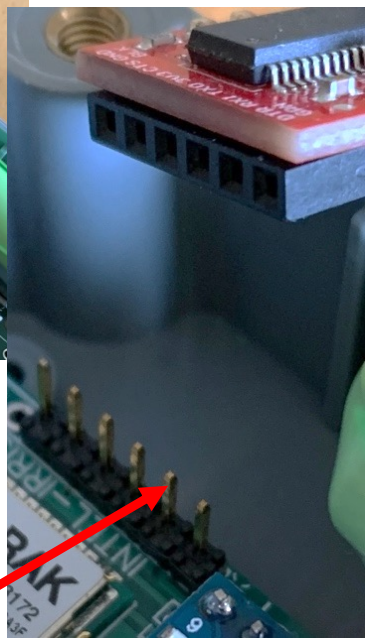
```
//////////////////////////////////////
// please uncomment only 1 choice
//#define SX126X
//#define SX127X
//#define SX128X
#define RAK3172
//////////////////////////////////////
```

Serial monitor with IRD PCB v5

- After flashing the Arduino, it is usually desirable to watch at the text output from the Arduino IDE serial monitor to check that everything went OK
- With IRD PCB v5, the RAK radio module is controlled by AT commands received on its serial port and sent by the Arduino on its serial port (baud rate is normally set to 38400)
- Therefore, Arduino's TX/RX pins are connected to the RAK3172 and the serial monitor used traditionally to look at text output can not use the default Arduino TX/RX pins
- The IRD PCB v5 uses a software defined serial port for the text output where only TX is defined on digital pin 2

Connect the FTDI USB-Serial

- After flashing the Arduino with the FTDI USB-Serial cable (left photo), unplug it in order to plug it again on the dedicated debug header on the IRD PCB v5 (middle & right photo)

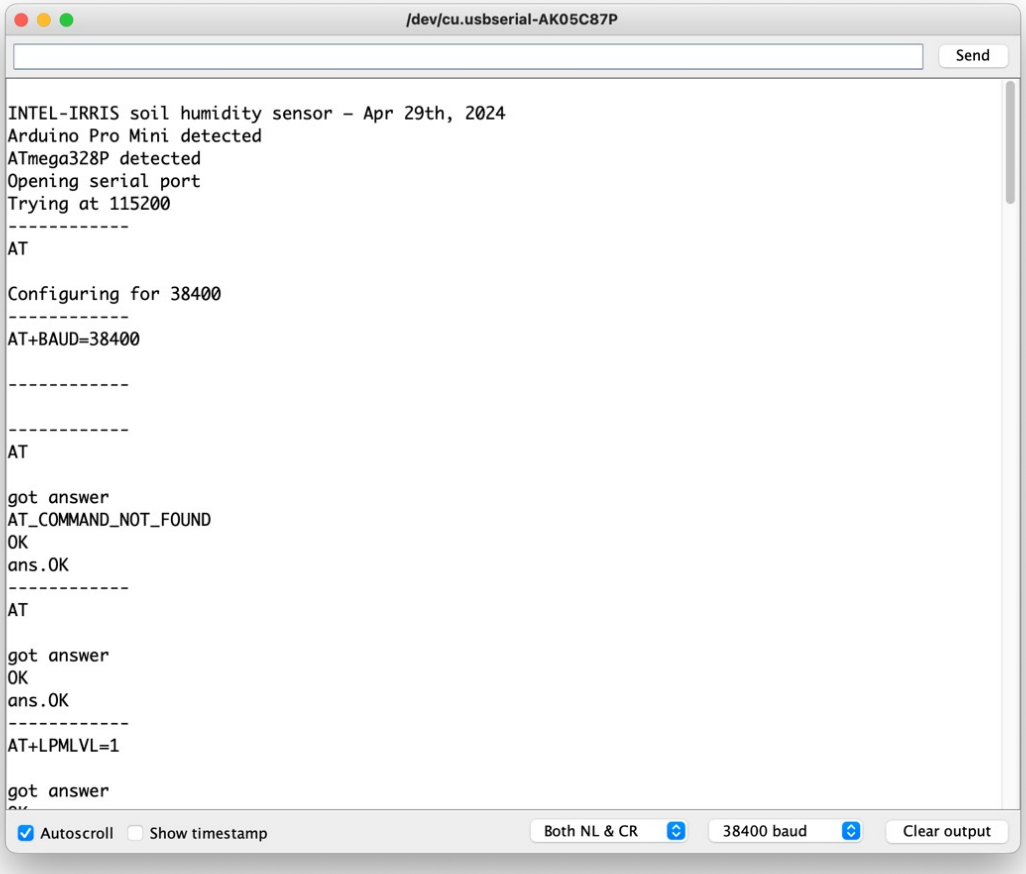





- Battery should be connected, but switch is on OFF
- Be sure to connect the RX pin of the FTDI USB-Serial to the TX pin of the debug header on the IRD PCB v5

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Getting text output from the board

- Order of steps is important!



Open serial monitor, you should see nothing

Set baud rate to 38400

Switch ON the board

See output from board

Check that transmission is OK

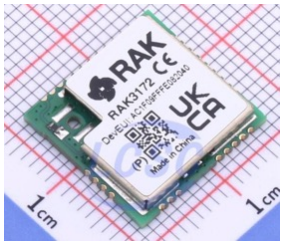
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

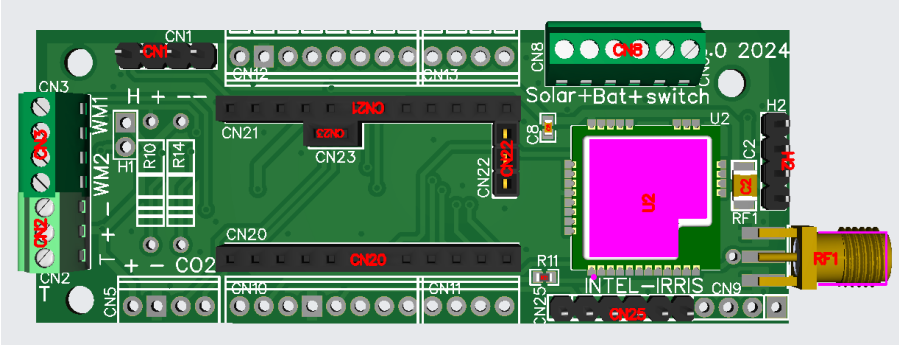
Annex: RAK3172 baud rate

- Latest version of RAK3172 is using by default (factory setting) a baud rate of 115200, which is too fast (mostly for RX) for the Arduino Pro mini based on ATMega328P microcontroller
- The INTEL-IRRIS code is actually reprogramming the RAK3172 to use a baud rate of 38400, therefore you do not need to worry about setting the correct baud rate for RAK3172, especially with the fully assembled version of the PCB where the RAK3172 is provided and assembled on the PCB by the PCB manufacturer

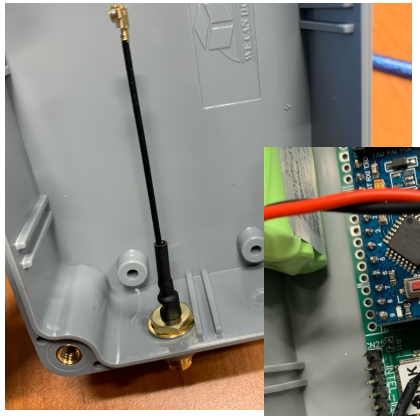
Annex: IPEX or not IPEX?

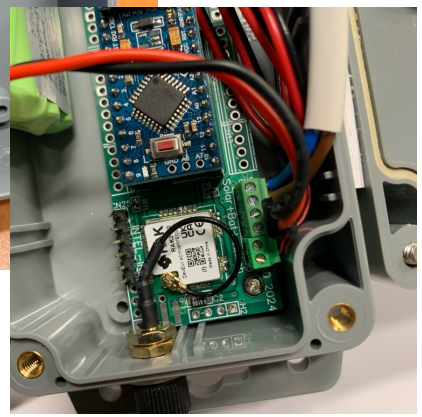
- The BOM file for the PCBA fully assembled is using the RAK3172 without the IPEX connector because we prefer to have a robust soldered RF connector

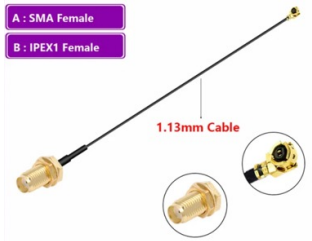




- For the raw version of the PCB, you can solder the version with IPEX and connect the antenna with an IPEX-female to SMA female short pigtail

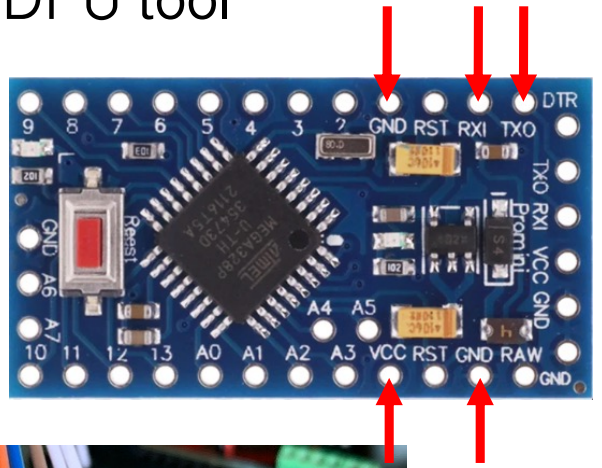


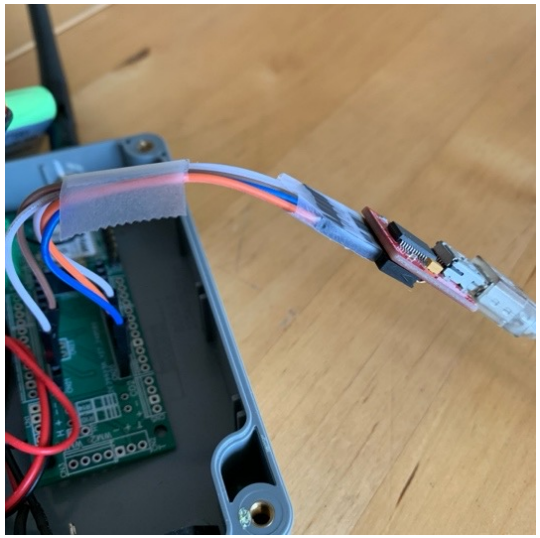


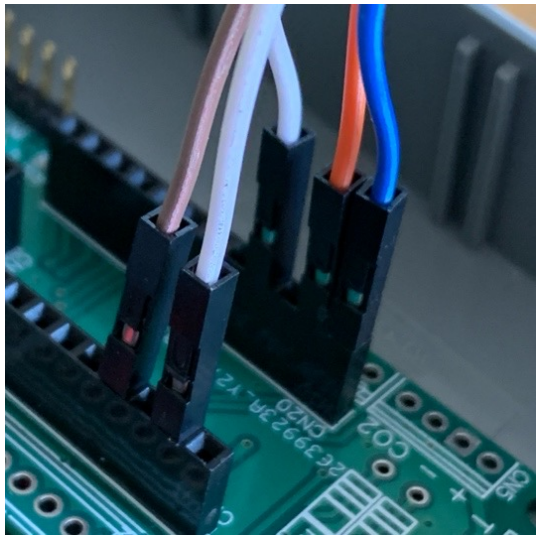


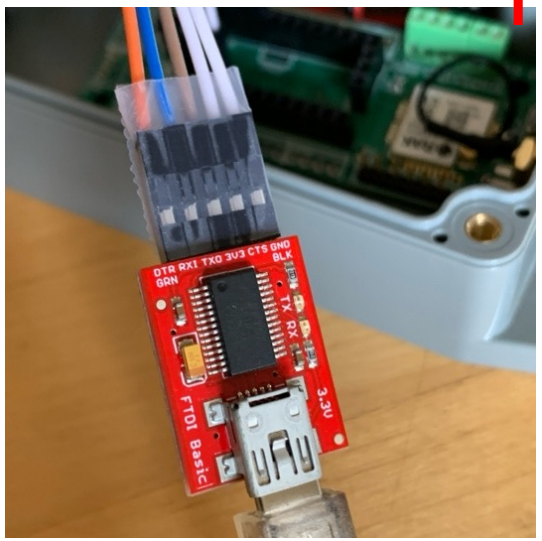
Annex: update firmware of RAK3172

- The RAK3172 can be upgraded with the RAK DFU tool
- You can use Dupont wires to directly connect VCC, GND, RX and TX of the FTDI USB-serial cable to corresponding pins on the female headers after removing the Arduino Pro Mini from its socket. DTR is not connected



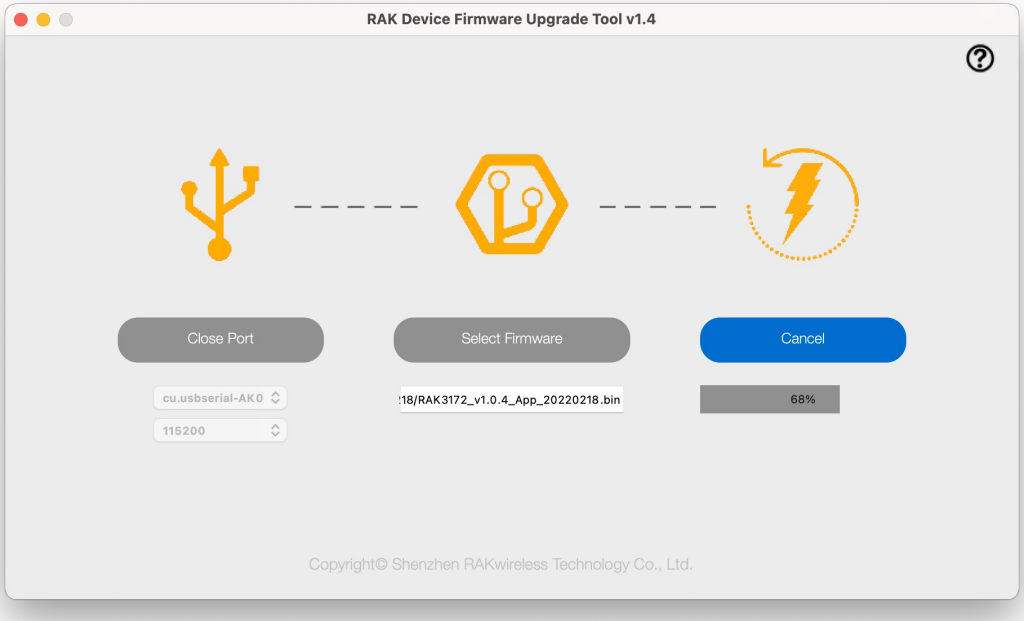






Annex: RAK DFU tool

- Get latest RAK3172 firmware from https://downloads.rakwireless.com/#RUI/RUI3/Image/ usually, it is the RAK3172-E_latest.bin file
- Use RAK DFU tool to flash the new firmware

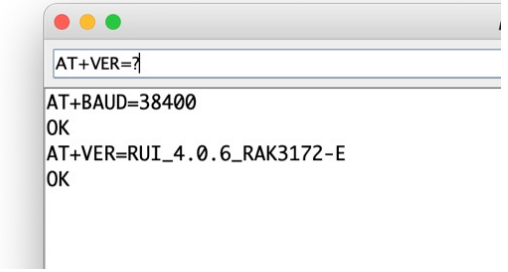


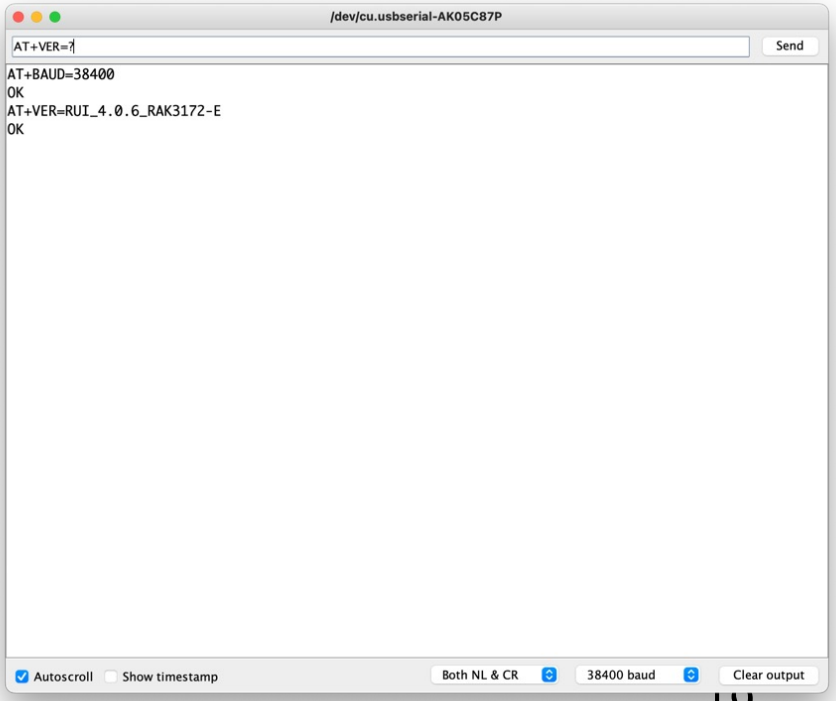
You may need to issue AT+BOOT from a serial tool in order to be able to upgrade with DFU tool

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Annex: send direct AT commands

- With the FTDI USB-serial cable connected to the PCB v5 without the Arduino Pro Mini, as show on the previous slide, you can directly communicate with the RAK3172 to send AT commands for test purposes
- Any serial communication tool can be used, including the Arduino IDE serial monitor
- RAK also proposes the WisToolBox software to communicate with RAK components





Annex: AT commands for INTEL-IRRIS

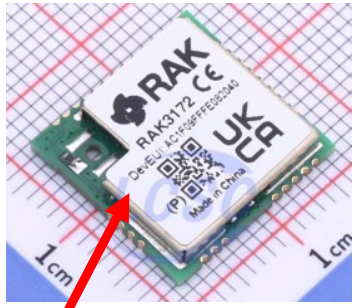
- Here is the list of AT commands used by INTEL-IRRIS code
- During setup(), for ABP mode in EU868 band, for capacitive
  - AT+BAUD=38400
  - AT+LPMLVL=1
  - AT+LPM=0
  - AT+LPM=? ; AT+VER=? ; AT+BAND=? ; AT+ADR=? ; AT+NJM=? ; AT+DEVADDR=?; AT+NWKSKEY=? ; AT+APPSKEY=?
  - AT+NJM=0 ; AT+CLASS=A ; AT+BAND=4 ; AT+ADR=0
  - AT+DEVADDR=26011DAA
  - AT+NWKSKEY=23158D3BBC31E6AF670D195B5AED5525
  - AT+APPSKEY=23158D3BBC31E6AF670D195B5AED5525
  - AT+LPMLVL=2
  - AT+LPM=1
- On wake up, to transmit (sending 898.0 and 3.45 for instance)
  - AT+SEND=1:0067231406020159
  - AT+SLEEP

Annex: OTAA with RAK3172 (1)

- The INTEL-IRRIS device with the RAK3172 can be integrated into a LoRaWAN ecosystem and configured by OTAA (Over The Air Activation) to dynamically get its address & session keys
- Uncomment `ENABLE_OTAA` in native_at_lorawan.h

```
#include "BoardSettings.h"

#define ENABLE_OTAA
```



- When using OTAA, you need to know
  - DevEUI: unique identifier of the device, it is usually pre-provisioned by the radio module manufacturer and indicated on the radio module
  - AppEUI: or JoinEUI, it is usually pre-provisioned by the radio module manufacturer. For RAK, it is usually AC1F09FFF8683172
  - AppKey: it is usually pre-provisioned by the radio module manufacturer. For RAK it is usually DevEUI+AppEUI

Annex: OTAA with RAK3172 (2)

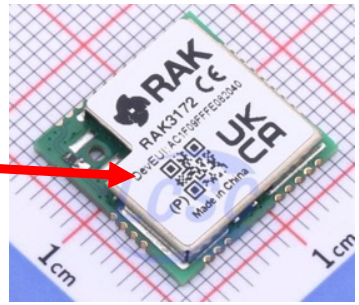
- It is possible to use the default values pre-provisioned by the manufacturer for DevEUI, AppEUI and AppKey IF YOU DIDN'T UPGRADE THE FIRMWARE
  - Leave `OVERWRITE_OTAA_EUI` commented
- If RAK3172 firmware has been updated, they may not be set anymore! In this case, uncomment `OVERWRITE_OTAA_EUI` in native_at_lorawan.cpp and set in DevEUI, AppEUI and AppKey
- Flash device and run once to set DevEUI, AppEUI and AppKey in the RAK module
- Then, comment `OVERWRITE_OTAA_EUI` to flash again and run

```
////////////////////////////////////////////////////////////////////
//ENTER HERE your device info (same order, i.e. msb)
////////////////////////////////////////////////////////////////////
//#define OVERWRITE_OTAA_EUI

#ifdef OVERWRITE_OTAA_EUI
//DevEui is normally indicated on the radio module
char* DevEuiStr="AC1F09FFFE12AAAA";
//here is the default used by RAK
char* AppEuiStr="AC1F09FFF8683172";
//here is the default used by RAK: DEVEUI+APPEUI
char* AppKeyStr="AC1F09FFFE12AAAAAC1F09FFF8683172";
#endif
```

Annex: register an OTAA device

- To register your RAK3172 OTAA device on a LoraWAN Network Server such as TheThingNetwork (TTN) you can then just enter
  - DevEUI: get it from the sticker
    For instance AC1F09FFFE12AAAA
  - AppEUI or JoinEUI: it is AC1F09FFF8683172
  - AppKey: should be AC1F09FFFE12AAAAAC1F09FFF8683172



- That's all. Once powered your device will join and you should receive data if a LoRaWAN gateway is near your device
- IMPORTANT, INTEL-IRRIS gateway is not full LoRaWAN in its single-channel version
- We will discuss how to get data from an OTAA device, locally on INTEL-IRRIS WaziGate in a dedicated tutorial