PocketQube ISTsat.ONE

The PocketQube ISTsat.ONE board is built around a CMWX1ZZABZ-091 module which integrates a STM32L072CZ microcontroller (Core ARM Cortex-M0) and a SX1276 LoRa radio that should work in the 868 MHz band (European ISM). The board is represented in figure 1 where some key elements are identified.

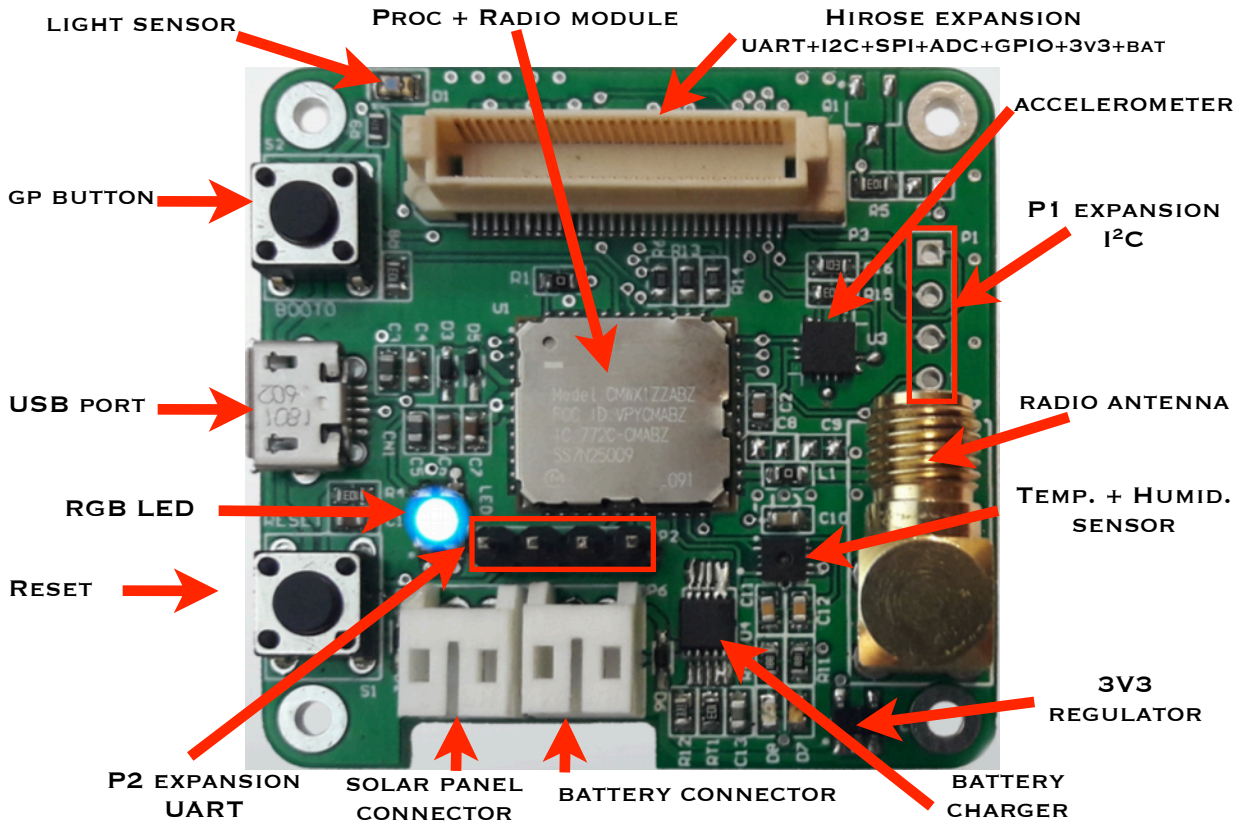

Fig. 1 - PQube ISTsat.ONE

The board communicates with an host computer through an USB port and can be powered by a COTS battery (commonly used in cellular phones) and/or by a solar panel.

The main components are listed in table 1 and identified in figure 1.

On the website where this small manual is listed the reader can also find the schematics of the PQube ISTsat.ONE board as well as some useful

documentation. As soon as more documentation will become available, it will be published on the same website.

Table 1 - list of main components.

Processor:	STM32L072CZ	Temp/Humidity sensor:	SHT31
Radio (LoRa):	SX1276 @ 868MHz	Accelerometer:	LIS3
Bat. Charger:	MCP73833	light sensor:	photo-diode (ADC2)
3.3V regulator:	TPS73733	RGB LED:	PB7, PB6 & PB2

It should be noted that some sensors are connected to digital ports while others (analog) are conected to ADC ports. Table 1 lists some of the ports used by sensors / peripherals that are included in the board. However, not all of them are listed. Table 2 includes a more exaustive list of such resources.

Table 2 - Ports used for connecting peripherals

Resource	Ports
Temp + Humid (SHT31)	ACD4 & ADC3
Accelerometer (LIS3)	I2C & Int1
Photo-diode (D1)	ADC2
RGB LED	PB7, PB6 & PB2
Header P1 (I2C)	P1-SDA, P2-SCL, P3-GND, P4-Vcc
Header P2 (UART)	P1-Tx, P2-Rx, P3-GND, P4-Vcc

On the software side, this system can be developed using different Integrated Development Environment (IDE)

Mbed IDE

Being one of the most suited for embedded systems development the Arm®Mbed framework can be used to develop software for the PQube ISTsat.ONE.

Figure 2 shows a typical Mbed IDE where can be noticed the integration of such IDE into a common browser. This cloud-based environment brings much flexibility to the development process as the programs can be shared among several developers easily.

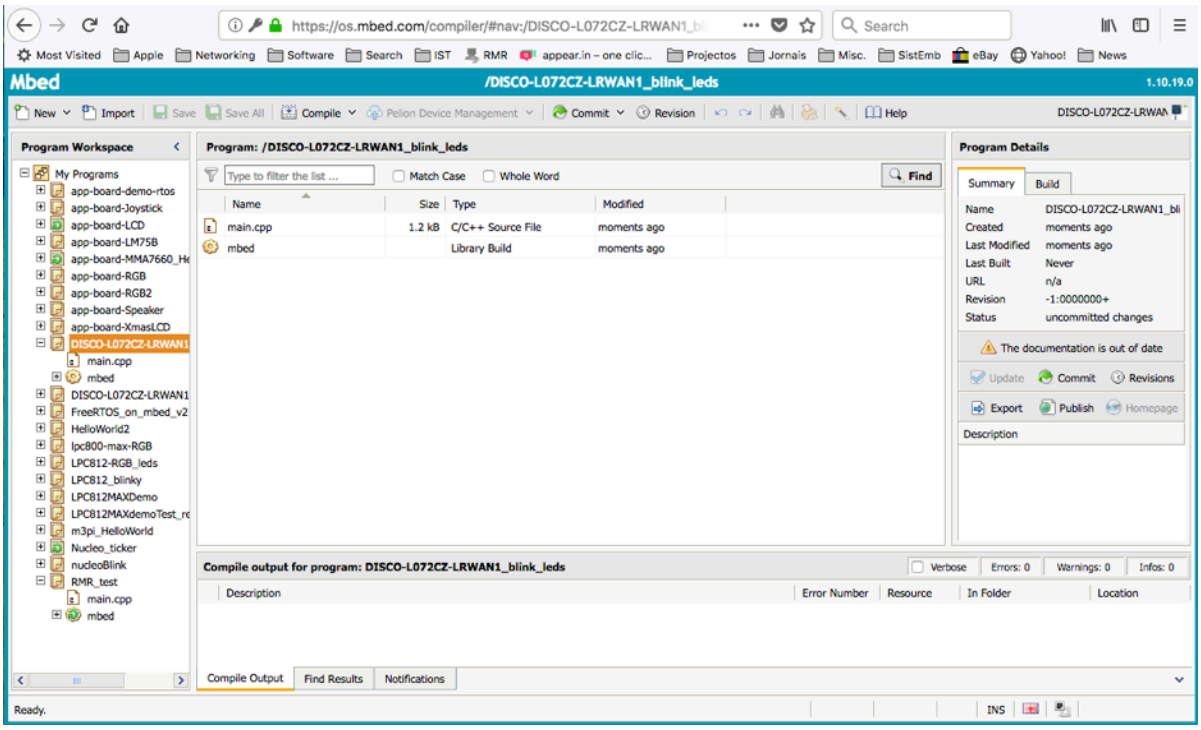

Fig. 2 - PQube ISTsat.ONE in Mbed

Furthermore, the IDE already incorporates lots of examples and useful code produced by several contributors which is useful to jump start any project one intends to carry out. There is, however, a restriction in the access to such a large repository of code. It relates to the existence of the platform to which the code is supposed to be written.

In our case, there is no PQubeISTsat.ONE available in the platform database but, fortunately, there is an equivalent board from STMicroelectronics that suits our interests: the DISCO-L072CZ-LRWAN1.

As a bonus for this board, there are a number of examples that can be compiled and ran so that a user can have an idea on the board's capacities. These examples (binary files) are included in the same website of this manual (PQube.ONE_code directory) and correspond to the following examples:

- DISCO-L072CZ-LRWAN1_blink_leds
- STM32_USBDevice_Serial

The first example blinks the LED on the board (in the original board there are four LEDs while the PQubeISTsat.ONE features just one RGB LED) while the

latter exercises the serial communications through the USB interface by providing a Virtual USB serial port taking advantage of the STM32L072 resources.

To upload these examples to the PQubeISTsat.ONE board one has to activate the bootloader firmware in the microcontroller. For that, the user should press both push buttons simultaneously and then release the reset button first, followed by the other button. Once the board is running the bootloader firmware, the user should execute the load script provided in the support website that executes the dfu-util utility; this utility isn't normally present in the host operating systems meaning that it must be downloaded and installed with the usual tools available for the purpose: <apt-get install> in debian-based linux systems and <port install> when using MacPorts in Mac OS X systems.

Arduino IDE

Another popular IDE for resource-scarce small systems is the Arduino. As shown in Figure 3, the IDE is quite straightforward to use and may comprise a lot of supported boards.

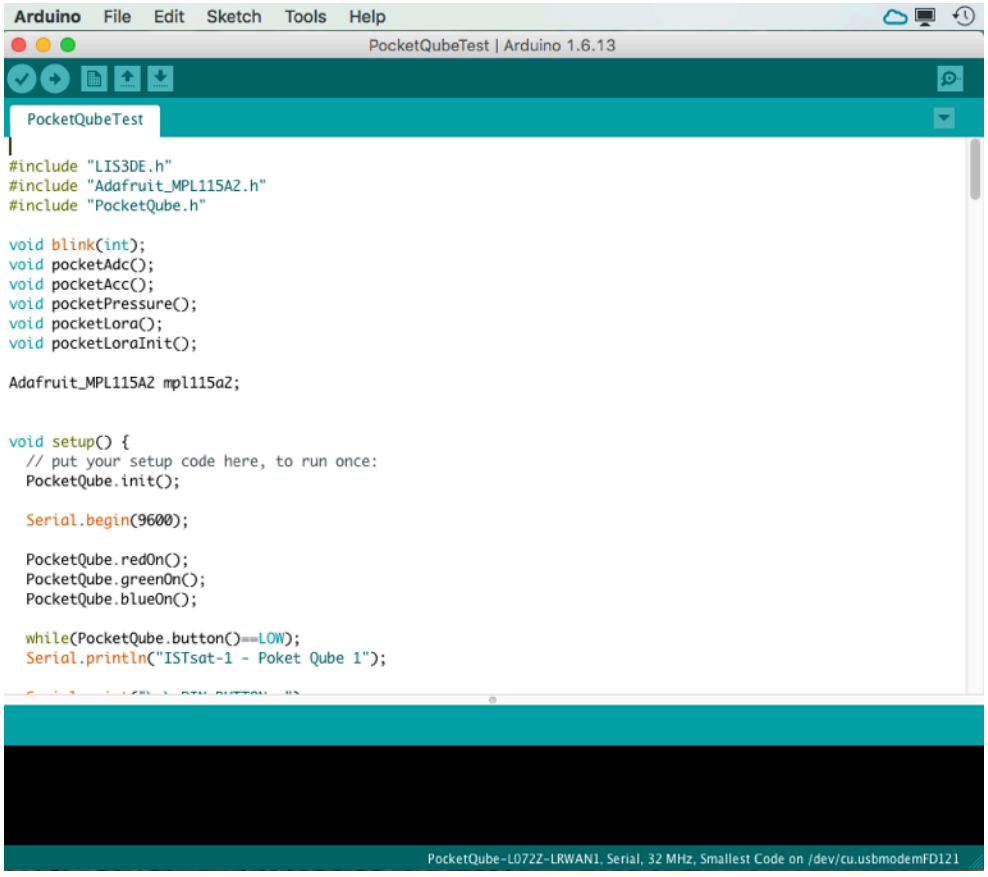

Fig. 3 - PQube ISTsat.ONE in Arduino

In order to develop software for the PQube board there are some configurations that must be made for using this IDE.

After installing the Arduino IDE (at least version `v1.6.8`) and starting the program, one should:

1. Go into Preferences
2. [1]Add
   https://grumpyoldpizza.github.io/ArduinoCore-stm32l0/package_stm32l0_boards_index.json
   as an "Additional Board Manager URL"
3. Open the Boards Manager from the Tools -> Board menu and install "Tlera Corp STM32L0 Boards"
4. Select your STM32L0 board from the Tools -> Board menu

Having done so one needs now to install the proper hardware configuration for the PQube case. To accomplish this, get the "Arduino_PocketQube.zip" file from the same directory where this manual is located and extract it to your machine.

Now, you need to locate the <hardware directory> in the Arduino installation of your machine. Then, you need to merge the "hardware" folder contained in the zip file with the one of your original Arduino installation.

This step is OS dependent:

MacOS X -> the <hardware directory> location is:
`/Applications/Arduino.app/Contents/Java/hardware/`

Windows -> the <hardware directory> location is:
`C:\Program Files (x86)\Arduino\hardware`

Linux -> the <hardware directory> location is:
`~/Arduino/hardware/`

If you are running MacOS X you can start working as your IDE is ready for developing software for the PQube.

If, on the other hand, you are working under Windows there is still a need to perform some additional installations:

[1] This was extracted from https://github.com/GrumpyOldPizza/ArduinoCore-stm32l0

Bootloader driver

1. Download Zadig
2. Plugin PQube board and toggle the RESET button while holding down the BOOT button
3. Let Windows finish searching for drivers
4. Start Zadig
5. Select Options -> List All Devices
6. Select STM32 BOOTLOADER from the device dropdown
7. Select WinUSB (v6.1.7600.16385) as new driver
8. Install Driver

Serial driver

1. Reboot board
2. Open Zadig
3. Options -> List all devices
4. Select Serial from the drop down menu and USB Serial as the driver.
5. Install Driver

No matter which OS is used, if the previous installation went well you can start developing software for the PQubeISTsat.ONE board. The best way to do this it is by using one of the examples that can be found in File-> Examples->PocketQube, provided the selected board is Tools->Board: PocketQube-L072Z-LRWAN1.

The best example is perhaps the PocketQubeTest (see Figure 3), the last example in the list, as it contains some code exercising most of the peripherals of the PocketQubeISTsat.ONE board being therefore a good starting point for your projects.

As in the case of the Mbed environment, to upload a program to the PQubeISTsat.ONE board the bootloader firmware has to be activated. For that, the user should press both PQube push buttons simultaneously and then release the reset button first, followed by the other button. However, as opposed to the Mbed case, the PQube support for Arduino already has built-in the dfu-util utility and the upload button on the IDE window should activate it. Furthermore, if the software uploaded into the board opens a serial port (shown in Tools->Board: …) there is no need to press any button as the bootloader mode is automatically activated through a command sent over the serial port.