Getting started with the ultra-low-power STM32 and LoRa® Nucleo pack

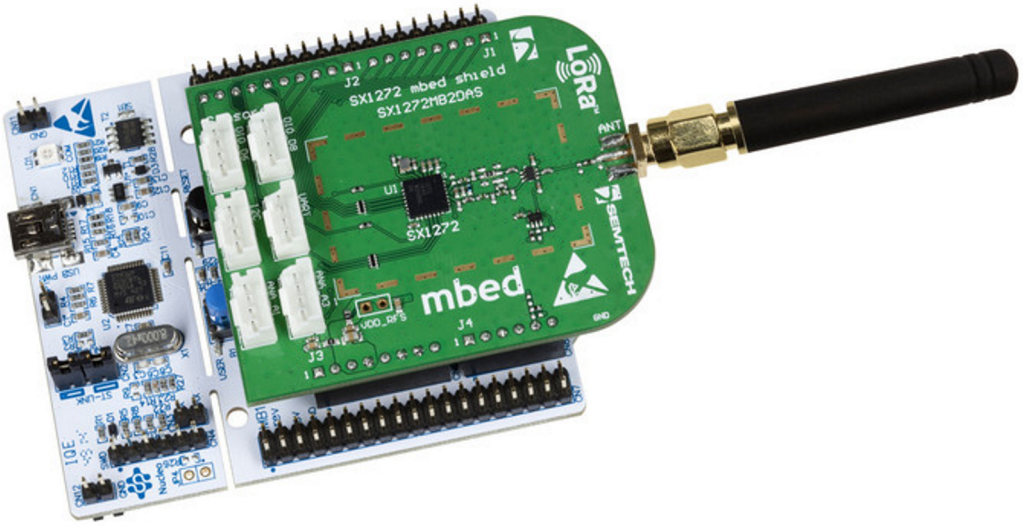
Introduction

The ultra-low-power STM32 and LoRa® Nucleo pack (P-NUCLEO-LRWAN1) is a kit based on a NUCLEO-L073RZ board and on a SX1272MB2DAS LoRa® RF expansion board from Semtech corporation. The expansion board includes the low-power transceiver SX1272 which features the long-range modem LoRa®. This modem provides high-performance LoRa® modulation as well as OOK/FSK modulation. The P-NUCLEO-LRWAN1 Nucleo pack is compatible with the I-CUBE-LRWAN1 Expansion Package, a certified middleware stack, compliant with the LoRaWAN™ specifications V1.0.2. It provides support for bidirectional end-devices in Class-A, Class-B and Class-C protocols and for end-devices activation either through over-the-air activation (OTAA) or activation by personalization (ABP).

This document describes the hardware environment required to build the system and to run applications based on the P-NUCLEO-LRWAN1 Nucleo pack.

For more details, refer to the *STM32 LoRa® software expansion for STM32Cube* databrief (DB2961).

Figure 1. P-NUCLEO-LRWAN1 Nucleo pack



Picture is not contractual.

1 Getting started

The NUCLEO-L073RZ board is Arm® Mbed™ compliant.

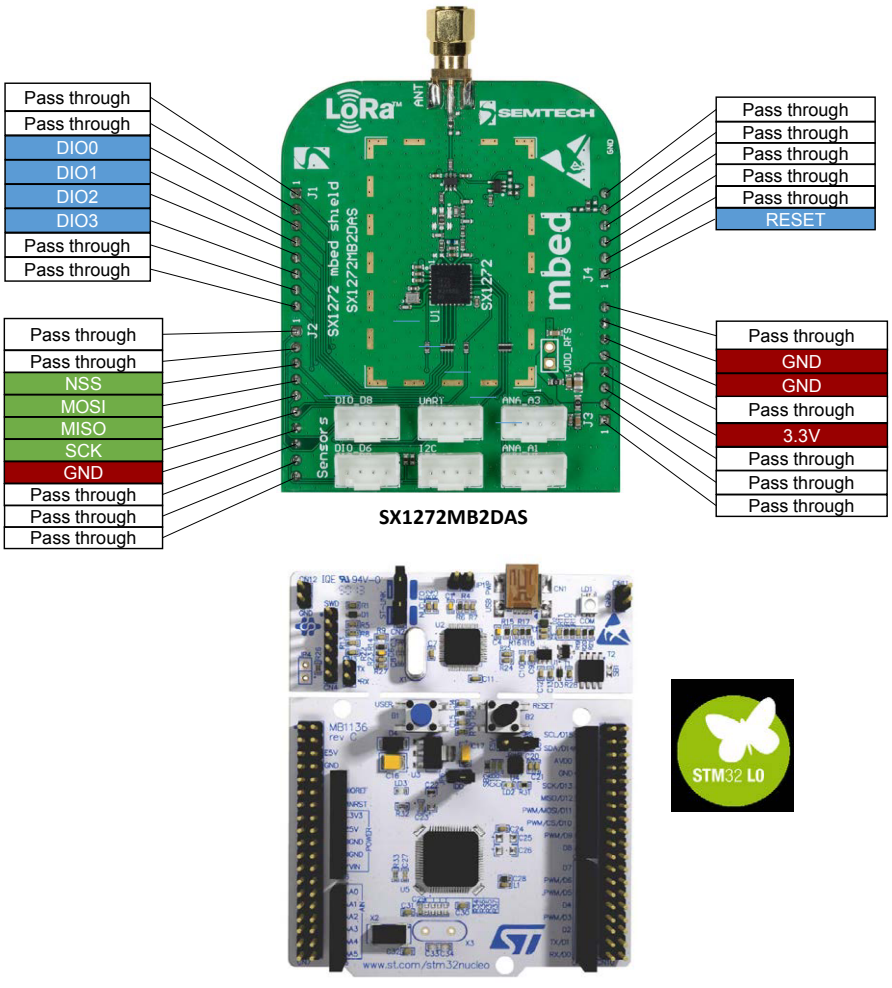
Note: Arm and Mbed are registered trademarks or trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

1.1 System architecture

The P-NUCLEO-LRWAN1 Nucleo pack is composed of two boards as shown in Figure 2. P-NUCLEO-LRWAN1 Nucleo pack system architecture):

- the NUCLEO-L073RZ board where the stack runs
- the SX1272MB2DAS LoRa expansion board from Semtech corporation, where a low-power RF transceiver including a LoRa modem is mounted

Figure 2. P-NUCLEO-LRWAN1 Nucleo pack system architecture



1.2 P-NUCLEO-LRWAN1 demonstrations

The P-NUCLEO-LRWAN1 Nucleo pack is a complete hardware development platform to prototype solutions based on the LoRa technology with a STM32.

The middleware stack (I-CUBE-LRWAN) offers a set of dedicated APIs and configuration templates to build end-devices, called LoRa objects.

LoRa objects are able to join a LoRa network and to communicate through LoRa technology, allowing users to develop easily LoRa applications. For more details, refer to the user manual *Ultra-low-power STM32 and LoRa® Nucleo pack with NUCLEO-L073RZ and I-NUCLEO-SX1272D RF expansion boards* (UM2085).

The two firmware examples listed below are provided for the STM32L073RZT6 of the NUCLEO-L073RZ board :

- **End-node** demonstration of a LoRa object ready to connect to a LoRa gateway and join a LoRa network (see Section 1.3.1 End-node demonstration).
- **PingPong** demonstration: communication example between two end-devices when a LoRa gateway is not present (see Section 1.3.2 PingPong demonstration).

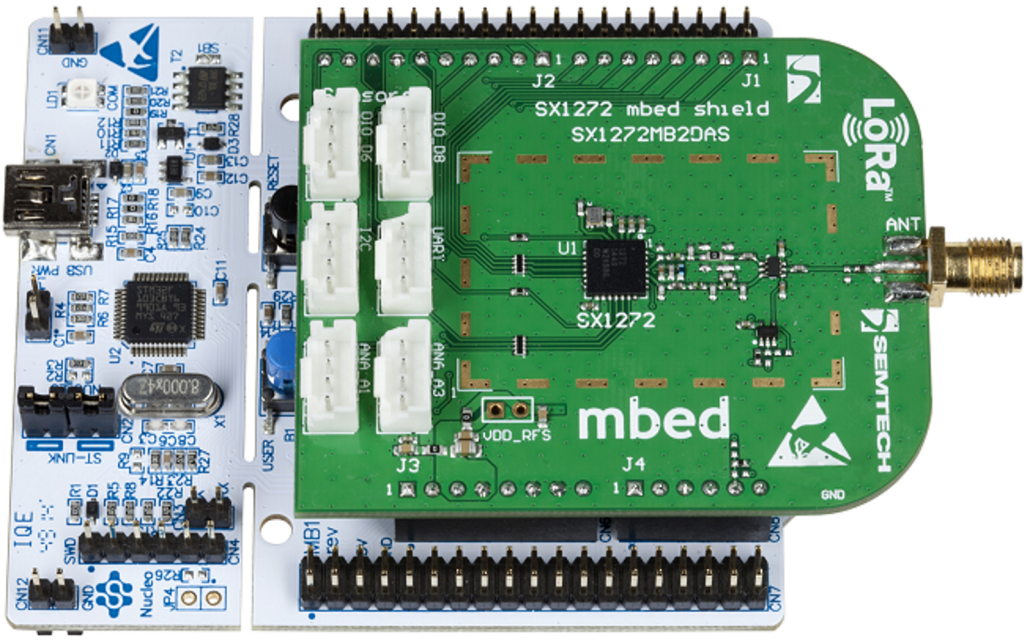
The user can develop other demonstrations with additional hardware as explained in Section 1.3.3 Another demonstration with additional hardware.

1.3 Configuration setup

To run the embedded demonstrations, follow the hardware configuration steps shown below:

1. The SX1272MB2DAS board must be stacked on a NUCLEO-L073RZ board through the Arduino™ Uno V3 connectors. Only one position is possible for this connection, since the number of pins of the Arduino connectors on each side is different (see Figure 3. SX1272MB2DAS LoRa expansion board and NUCLEO-L073RZ assembled).

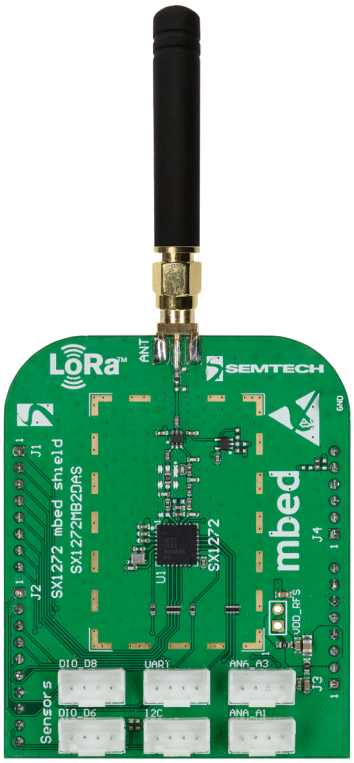
Figure 3. SX1272MB2DAS LoRa expansion board and NUCLEO-L073RZ assembled



2. On the NUCLEO-L073RZ board, verify the jumper settings: JP1 must be opened, JP5 (PWR) must be closed on U5V and JP6 must be closed (IDD).
3. On the SX1272MB2DAS expansion board, it is recommended for better performances to screw an antenna on the ANT connector (see Figure 4. SX1272MB2DAS board with antenna).

4. Connect the NUCLEO-L073RZ board to a PC with a USB Type-A to Mini-B cable (not provided in the package) to power the system.

Figure 4. SX1272MB2DAS board with antenna



1.3.1 End-node demonstration

To run this example, load the end-node firmware from the I-CUBE-LRWAN STM32Cube Expansion Package inside the STM32L073RZT6. Check that the “connect under reset” option is set in the debugger settings. As soon as the board is powered up through its USB connector, the LoRa Nucleo pack starts emitting LoRa packets and tries to join a network either through over-the-air activation (OTAA) or activation by personalization (ABP). The activation mode depends on the configuration selected in the *commissioning.h* header file.

The LoRa Nucleo pack also outputs information on a serial COM port (RX pin of the CN3 connector and GND pin of the CN4 connector) configured as follows:

- Baud rate: 115200 bauds
- Data: 8 bits
- Parity: none
- Stop: 1 bit
- Flow control: none

When the LoRa Nucleo pack starts to boot, it displays its activation-mode identifier (OTAA or ABP) and the firmware version, as shown in the example below for an OTAA output:

```
OTAA
DevEui= 01-01-01-01-01-01-01-01
AppEui= 01-01-01-01-01-01-01-01
AppKey= 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
VERSION: 44211200
```

The example below shows the information displayed for an ABP output:

```
ABP
DevEui= 01-01-01-01-01-01-01-01
DevAdd= 0100000A
NwkSKey= 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
AppSKey= 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C
VERSION: 44211200
```

Activate trace and/or debug mode inside the hw_conf.h header file, to display more information.

1.3.2 PingPong demonstration

This example requires two P-NUCLEO-LRWAN1 Nucleo packs, with the PingPong firmware from the I-CUBE-LRWAN Expansion Package loaded in each STM32L073RZT6. Check that “connect under reset” option is set in the debugger settings. This demonstration consists in establishing a simple Rx/Tx RF link between the two LoRa objects. By default, each LoRa object starts as a master and will transmit a "Ping" message, and then it waits for an answer. The first LoRa object receiving a "Ping" message becomes a slave and sends the master a "Pong" message. The ping-pong game between them starts. Both LoRa Nucleo packs send information about their activity on a serial COM port (RX pin of the CN3 connector and GND pin of the CN4 connector) configured as follows:

- Baud rate: 115200 bauds
- Data: 8 bits
- Parity: none
- Stop: 1 bit
- Flow control: none

The example below shows the output of the two LoRa Nucleo packs:

- on Ping side (master)

```
it's 0:0:3:542 WU@ 0:50:3:542
dz
OnTxDone
txDone
it's 0:0:3:666 WU@ 0:0:4:666
dz
OnRxDone
RssiValue=-111 dBm, SnrValue=15
rxDone
...PING
it's 0:0:3:806 WU@ 0:50:3:806
dz
OnTxDone
txDone
it's 0:0:3:930 WU@ 0:0:4:930
dz
OnRxDone
RssiValue=-111 dBm, SnrValue=16
rxDone
...PING
```

- on Pong side (slave)

```
dz
OnTxDone
txDone
it's 0:0:3:134 WU@ 0:0:4:134
dz
OnRxDone
RssiValue=-112 dBm, SnrValue=14
rxDone
it's 0:0:3:273 WU@ 0:50:3:273
```

```
...PONG
dz
OnTxDone
txDone
it's 0:0:3:397 WU@ 0:0:4:397
dz
OnRxDone
RssiValue=-111 dBm, SnrValue=14
rxDone
it's 0:0:3:537 WU@ 0:50:3:537
...PONG
```

`RssiValue` and `SnrValue` indicate the quality of the radio link.

1.3.3 Another demonstration with additional hardware

The end-node demonstration can be enhanced with an X-NUCLEO-IKS01A2 board (not provided with the product package).

This board features various sensors, an Arduino Uno V3 compatible connectors and can be stacked between the NUCLEO-L073RZ board and the SX1272MB2DAS LoRa expansion board from Semtech.

The end-node firmware from the I-CUBE-LRWAN Expansion Package provides support for three sensors (temperature, humidity and pressure) that are activated with the corresponding compile switch (SENSOR_ENABLED).

Once loaded with the end node firmware, the P-NUCLEO-LRWAN1 Nucleo pack, equipped with the X-NUCLEO-IKS01A2 board, transmits the values from the three sensors inside the LoRa packets.

Revision history

Table 1. **Document revision history**

Date	Revision	Changes
06-Sep-2016	1	Initial version.
18-Nov-2016	2	Updated baud rate in section 1.3.1: Class A demonstration.
13-Jul-2018	3	Updated: • specifications versions in Introduction • Section 1 Getting started introduction • Class A by end-node in Section 1.2 P-NUCLEO-LRWAN1 demonstrations and in Section 1.3.3 Another demonstration with additional hardware • X-NUCLEO-IKS01A1 replaced by X-NUCLEO-IKS01A2 in Section 1.3.3 Another demonstration with additional hardware

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