

## Getting started with n-PN board

### INTRODUCTION

This document describes the software, firmware environment and development recommendations required to build an application around n-PN board with some demonstration firmware.

The n-PN board is a low-cost and easy-to-use development kit to quickly evaluate and start some development with LoRaWAN protocol using an ARM® 32-bit Cortex™-M and totally compatible with n-Best ecosystem.

For more information on the n-PN board visit: [www.nblock.com](http://www.nblock.com).

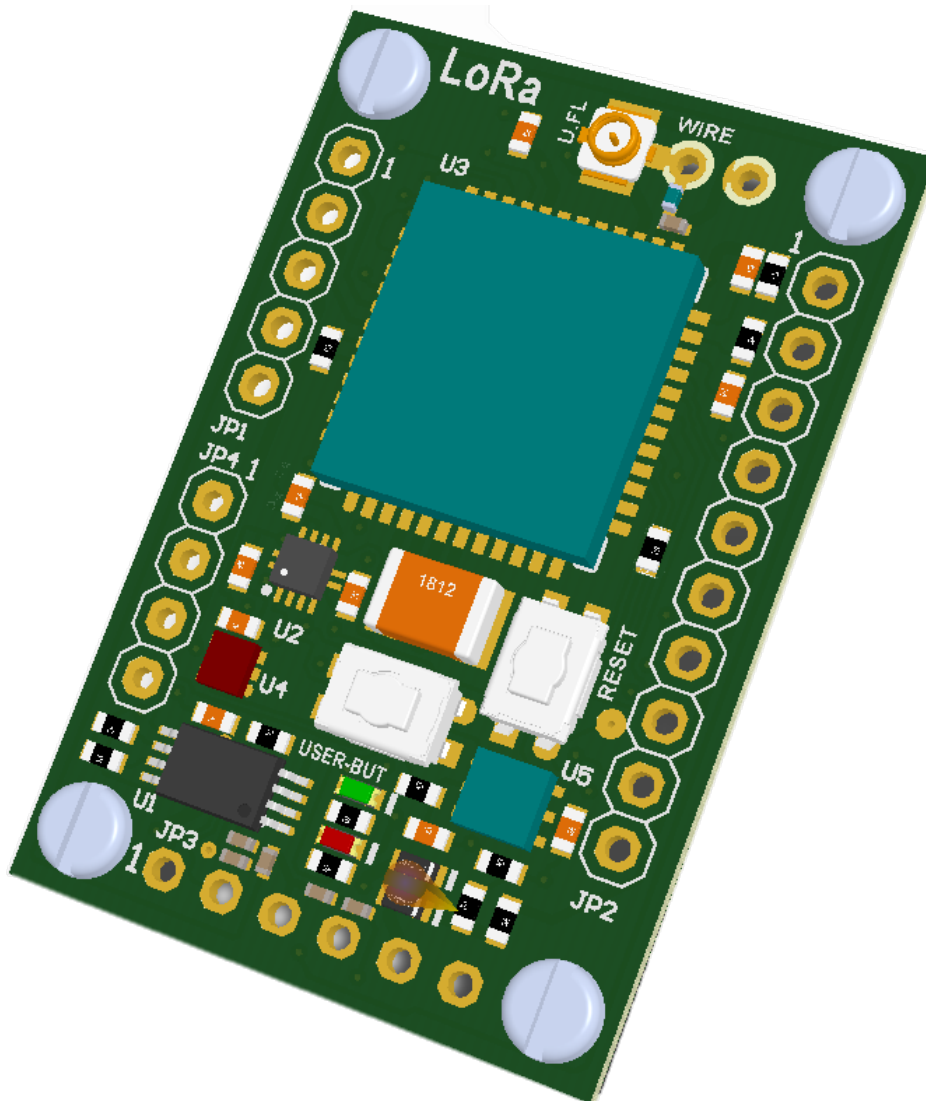


Figure 1: n-PN board<sup>1</sup>

1. Picture not contractual

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## HARDWARE

### FEATURES

- CMWX1ZZABZ Murata LoRaWAN module with Semtech (SX1276) + STM (STM32L0)
- 2 user LEDs
- 1 user and 1 reset push-buttons
- Board expansion connectors:
  - 15 GPIOs with alternative functionality
  - 4 ADC channels
  - NFC antenna capability.
  - SPI capability
  - I<sup>2</sup>C capability
  - UART capability
  - Power supply and JTAG connections
- Different LoRaWAN antenna choices
- Si7006 Silabs Relative Humidity and Temperature Sensor with I<sup>2</sup>C Interface
- LSM303AHTR STM 3D digital linear acceleration sensor and a 3D digital magnetic sensor with I<sup>2</sup>C Interface
- M24LR64E-R STM dynamic NFC/RFID tag IC with a dual-interface, electrically erasable programmable memory (EEPROM) with I<sup>2</sup>C Interface
- AN48836B Panasonic Hall sensor
- Support of a wide choice of Integrated Development Environments (IDEs) including IAR™, Keil®, GCC-based IDEs, Arm® Mbed™
- Full compatibility with n-Best Studio
- Dimensions: 25x38mm

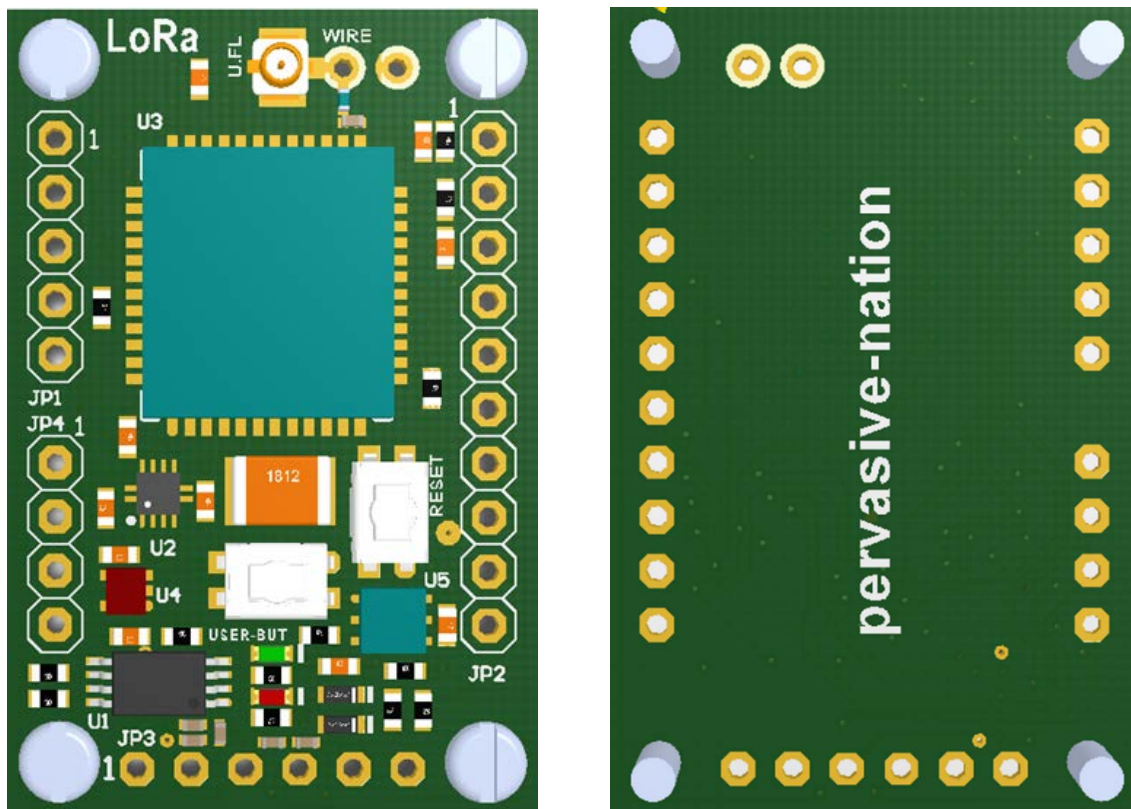


Figure 2: Front and Back n-PN board<sup>1</sup>

1. Picture not contractual

## DEVICES

## CMWX1ZZABZ MURATA LORAWAN MODULE

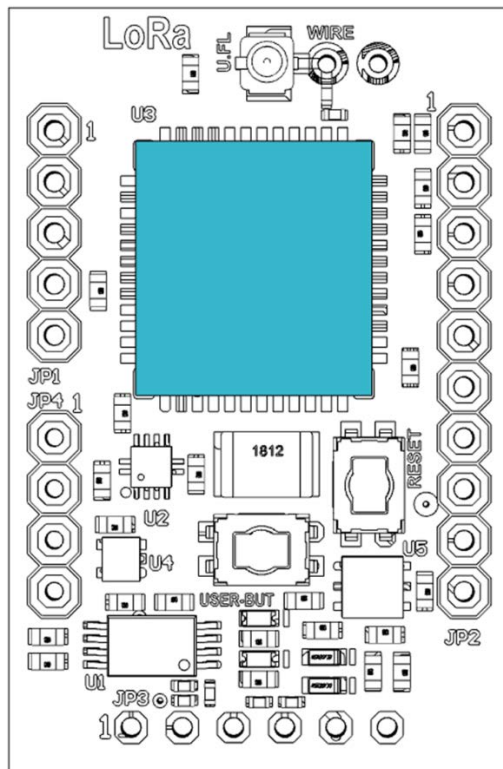


Figure 3: n-PN board: Murata LoRaWAN Module (U3)

## FEATURES

- Integrated TCXO with robust low-drift thermal characteristics provides an accurate clock source for the RF transceiver
- Pre-certified radio regulatory approvals for operating in the 868 and 915MHz industrial, scientific and medical (ISM) spectrum in most geographical regions of the world
- MCU includes 192kB Flash and 20kB RAM
- Normal output power is +14dBm but a PA boost function can be selected to increase RF output to + 20dBm for long-range applications
- Operating temperature: -40 + 85°C

## SENSORS

*E-COMPASS*

An ultra-low-power high-performance system-in-package featuring a 3D digital linear acceleration sensor and a 3D digital magnetic sensor.

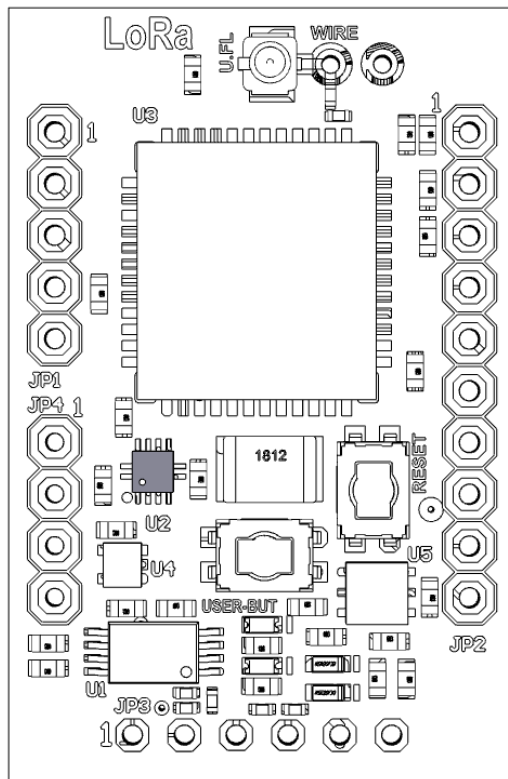


Figure 4: n-PN board: E-compass LSM303AHTR (U2)

## FEATURES

- 3 magnetic field channels and 3 acceleration channels
- $\pm 50$  gauss magnetic dynamic range
- $\pm 2/\pm 4/\pm 8/\pm 16$  g selectable acceleration full scales
- Anti-aliasing filter
- 16-bit data output
- Embedded 256-level FIFO
- Embedded temperature sensor
- Embedded digital functions: step detector, step counter, significant motion and tilt
- Programmable interrupt generators for free-fall, motion and magnetic field detection
- Operating temperature:  $-40 + 85^{\circ}\text{C}$

### RELATIVE HUMIDITY AND TEMPERATURE

Fully factory-calibrated humidity and temperature sensor elements with an analogue to digital converter, signal processing, and an I2C host interface. The innovative CMOS design of this device offers the lowest power consumption in the industry for a relative humidity and temperature sensor.

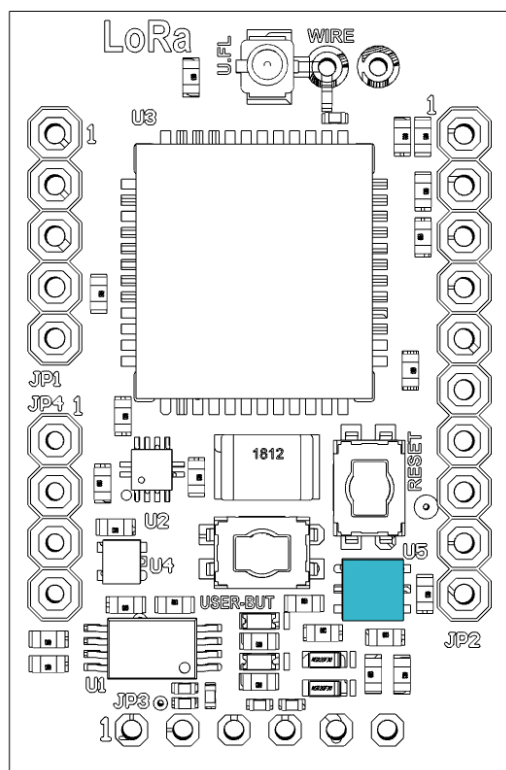


Figure 5: n-PN board: Relative Humidity and Temperature Sensor Si7006 (U5)

### FEATURES

- Precision Relative Humidity Sensor:  $\pm 5\%$  RH (maximum) @ 0–80% RH
- Temperature Sensor:  $\pm 1.0$  °C accuracy (maximum) @ -10 to +85 °C
- Integrated on-chip heater
- Excellent long term stability
- Factory calibrated
- Low Power Consumption: 2.2  $\mu$ W at 3.3 V, 1 Hz
- 0 to 100% RH operating range
- Up to -40 to +125 °C operating range

### HALL SENSOR

A magnetic sensor, a Hall element, an offset cancel circuit, an amplifier circuit, a sample and hold circuit, a Schmidt circuit, and output stage FET are integrated on a single chip housed in a small package.

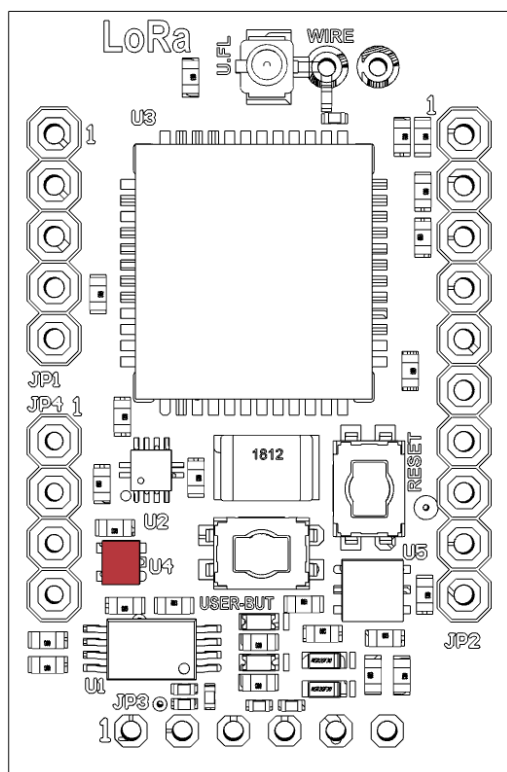


Figure 6: n-PN board: Panasonic Hall sensor AN48836B (U4)

### FEATURES

- High sensitivity (6 mT max) due to offset cancel circuit and a new sample and hold circuit
- Small current by using intermittent action
- CMOS inverter output. (no pull-up resistance)
- Both south and north poles and can be used without regard to magnetic polarity
- Operating ambient temperature : - 40 to +85 °C



**DYNAMIC NFC/RFID TAG SENSOR**

It is a Dynamic NFC/RFID tag IC with a dual-interface, electrically erasable programmable memory (EEPROM).

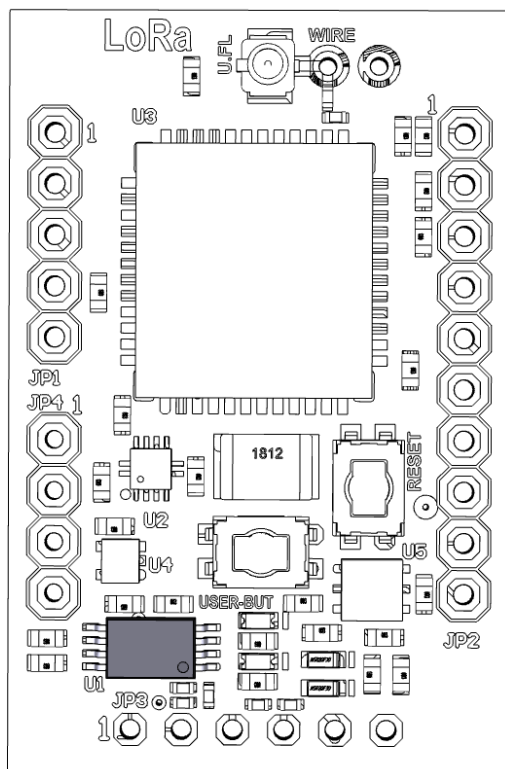


Figure 7: n-PN board: NFC/RFID Tag M24LR64E-R (U1)

**FEATURES**

- ISO 15693 and ISO 18000-3 mode 1 compatible
- 13.56 MHz  $\pm$  7 kHz carrier frequency
- To tag: 10% or 100% ASK modulation using 1/4 (26 Kbit/s) or 1/256 (1.6 Kbit/s) pulse position coding
- From tag: load modulation using Manchester coding with 423 kHz and 484 kHz subcarriers in low (6.6 kbit/s) or high (26 kbit/s) data rate mode. Supports the 53 kbit/s data rate with Fast commands
- Read Block & Write (32-bit blocks)
- Four sink current configurable ranges
- 64-Kbit EEPROM
- Operating ambient temperature : - 40 to +85 °C

## LEDS

Two user LEDs on board.

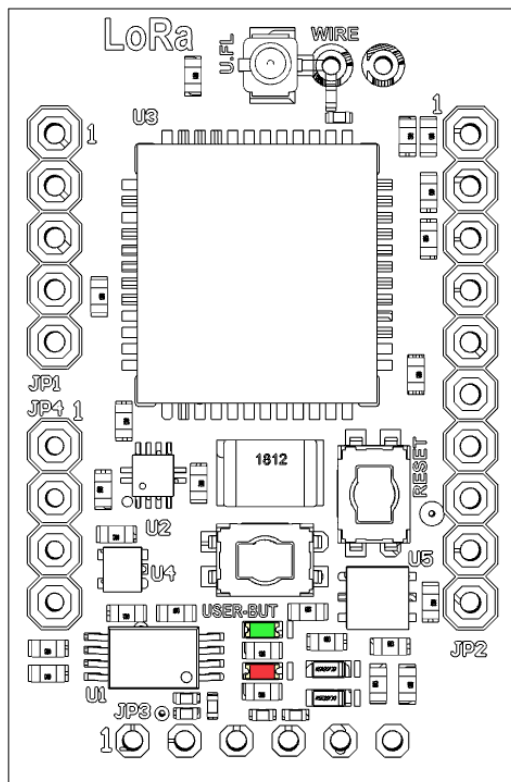


Figure 8: n-PN board: LEDs

## FEATURES

- LED1: Green LED
- LED2: Red LED

## BUTTONS

Two buttons on board.

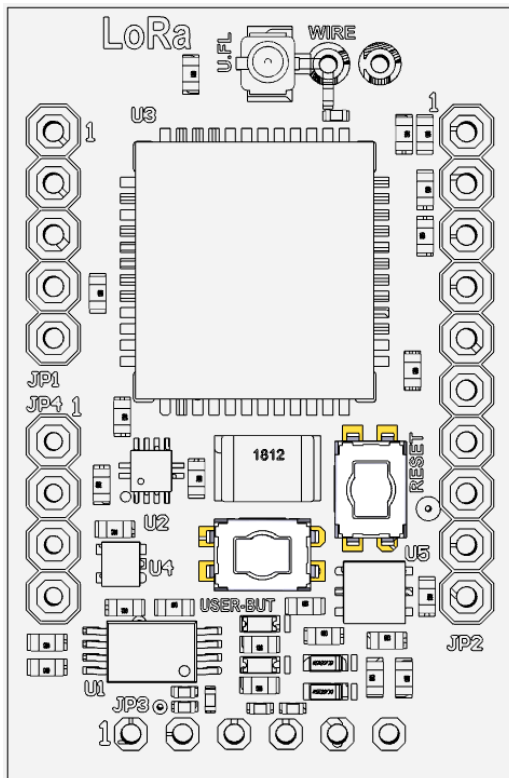


Figure 9: n-PN board: Buttons

## FEATURES

- 1 User button (USER-BUT)
- 1 Reset button (RESET)

## CONNECTORS

Four connectors on board.

### JP1: PROGRAMMER CONNECTOR

In order to download a custom firmware, a ST-Link or compatible programmer has to be connected to the programmer connector (JP1).

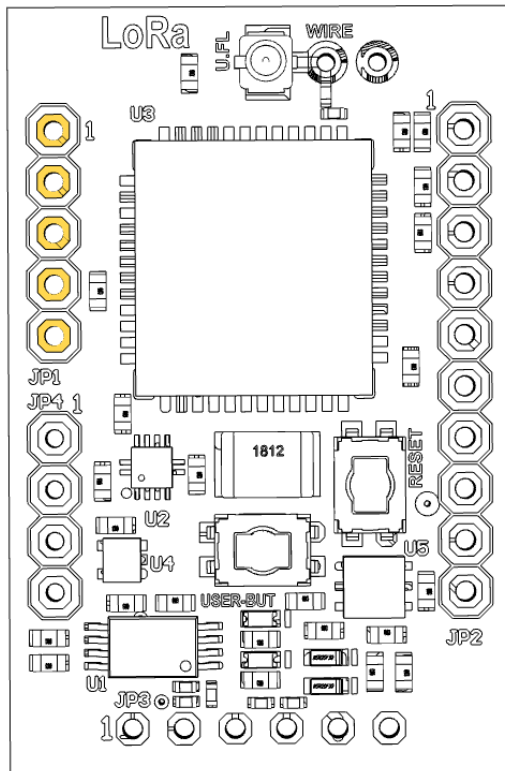
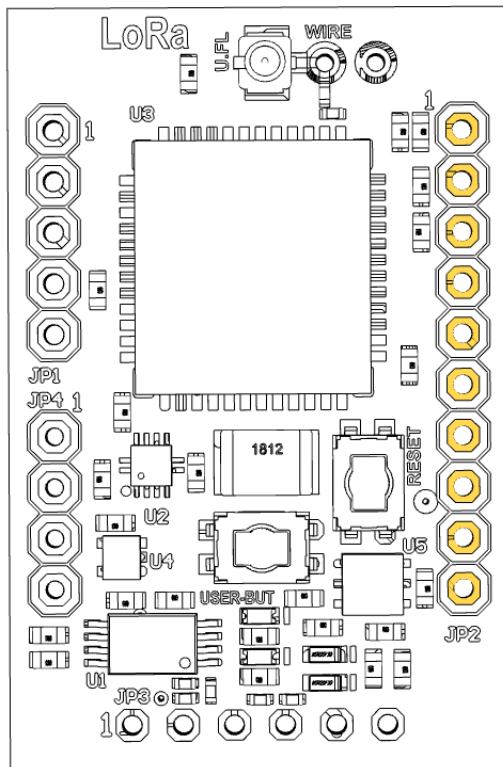


Figure 10: n-PN board: Programmer Connector (JP1)

## DESCRIPTION

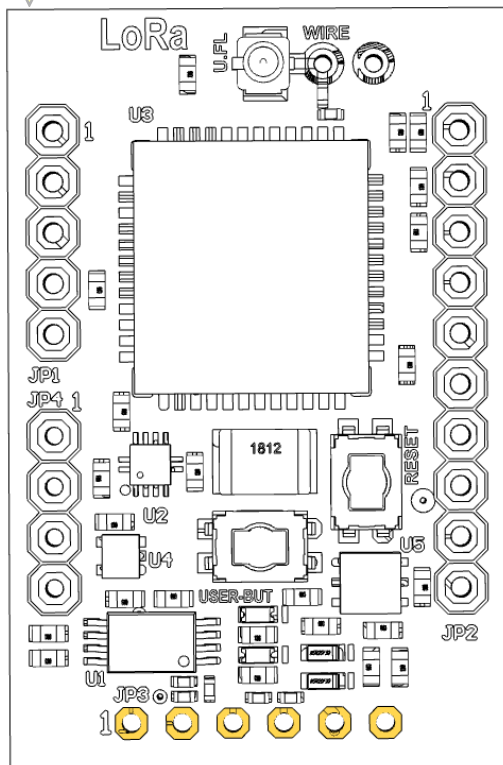
DESCRIPTION	
PIN 1	J-SWDIO
PIN 2	J-SWCLK
PIN 3	J-VCC
PIN 4	J-GND
PIN 5	J-RESET

*JP2: EXPANSION CONNECTOR***DESCRIPTION**

DESCRIPTION	
PIN 1	A1
PIN 2	A2
PIN 3	GPIO/A3
PIN 4	GPIO/A4
PIN 5	3.3V OUTPUT
PIN 6	GPIO/I <sup>2</sup> C_SCL
PIN 7	GPIO/I <sup>2</sup> C_SDA
PIN 8	GPIO/USART1_TX
PIN 9	GPIO_USART1_RX
PIN 10	GND

Figure 11: n-PN board: Expansion Connector (JP2)

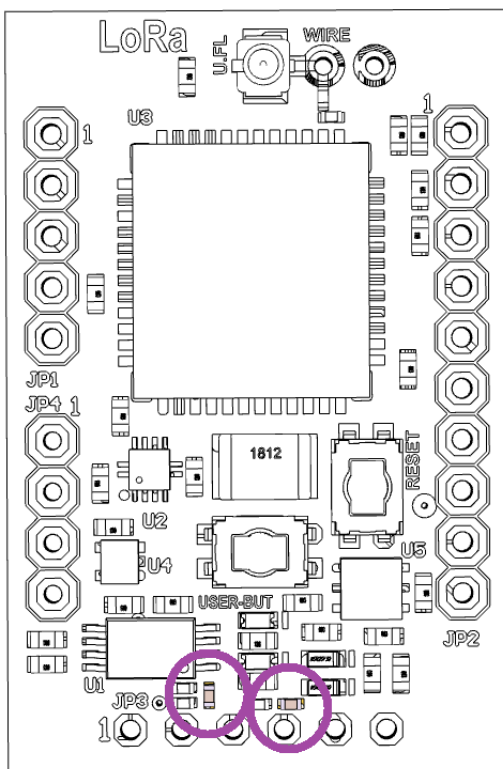
JP3: CONNECTIVITY CONNECTOR



DESCRIPTION

DESCRIPTION	
PIN 1	GPIO/I <sup>2</sup> C_SDA
PIN 2	GPIO/I <sup>2</sup> C_SCL
PIN 3	EXTERNAL NFC1 ANTENNA
PIN 4	EXTERNAL NFC2 ANTENNA
PIN 5	VBAT
PIN 6	GND

Figure 12: n-PN board: Connectivity Connector (JP3)



NOTE

In order to use an external NFC antenna, **R5** and **R15** must be removed.

Figure 13: n-PN board: R5 and R15

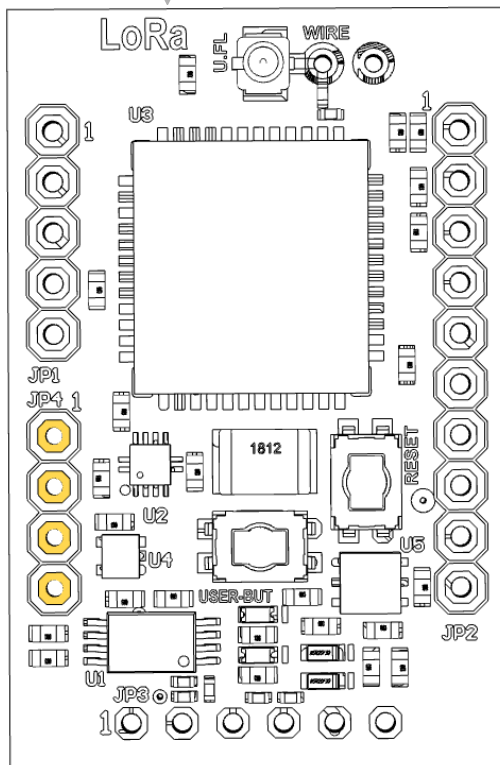
**JP4: EXPANSION CONNECTOR**

Figure 14: n-PN board: Expansion Connector (JP4)

**DESCRIPTION**

DESCRIPTION	
PIN 1	GPIO/SPI2_MOSI
PIN 2	GPIO/SPI2_MISO
PIN 3	GPIO/SPI2_SCK
PIN 4	GPIO/SPI2_NSS

**ANTENNA CONNECTORS**

Two different antenna connectors can be used. One of those must be used to guarantee the correct behaviour of the system.

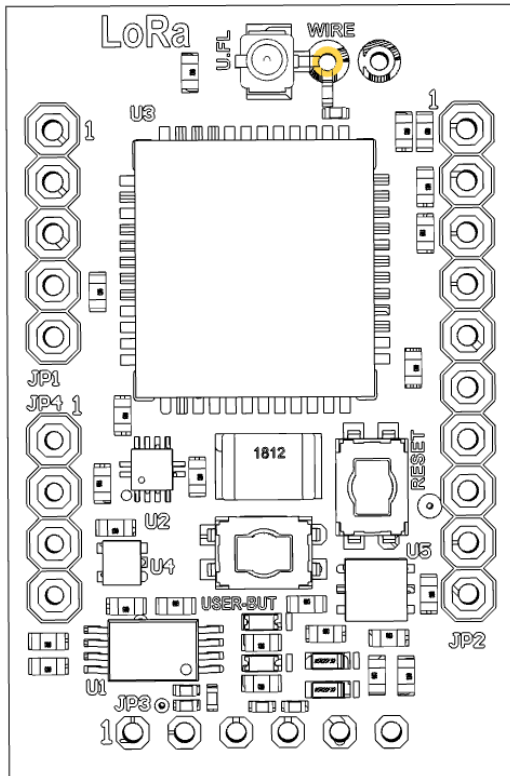
**JP5: WIRE ANTENNA CONNECTOR**

Figure 15: n-PN board: Wire antenna connector (JP5)

**DESCRIPTION**

A wire antenna must be solder.



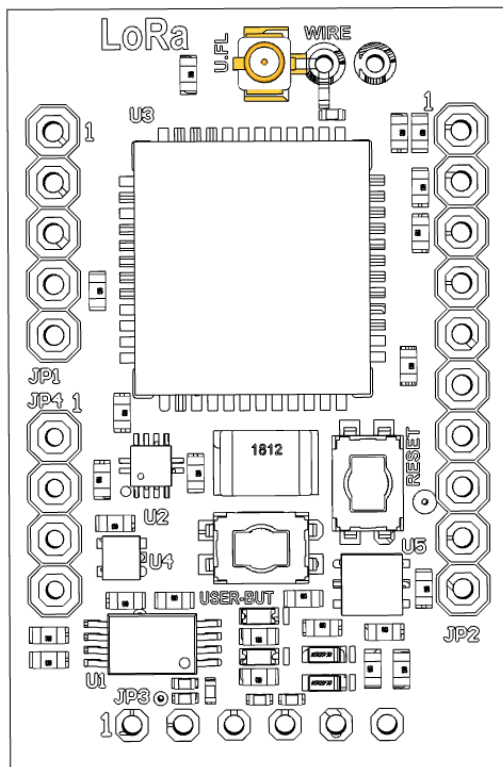
**JP6: U.FL-R ANTENNA CONNECTOR**

Figure 16: n-PN board: U.FL-R antenna connector (JP6)

**DESCRIPTION**

An U.FL-R antenna must be connected.

**QUICK START**

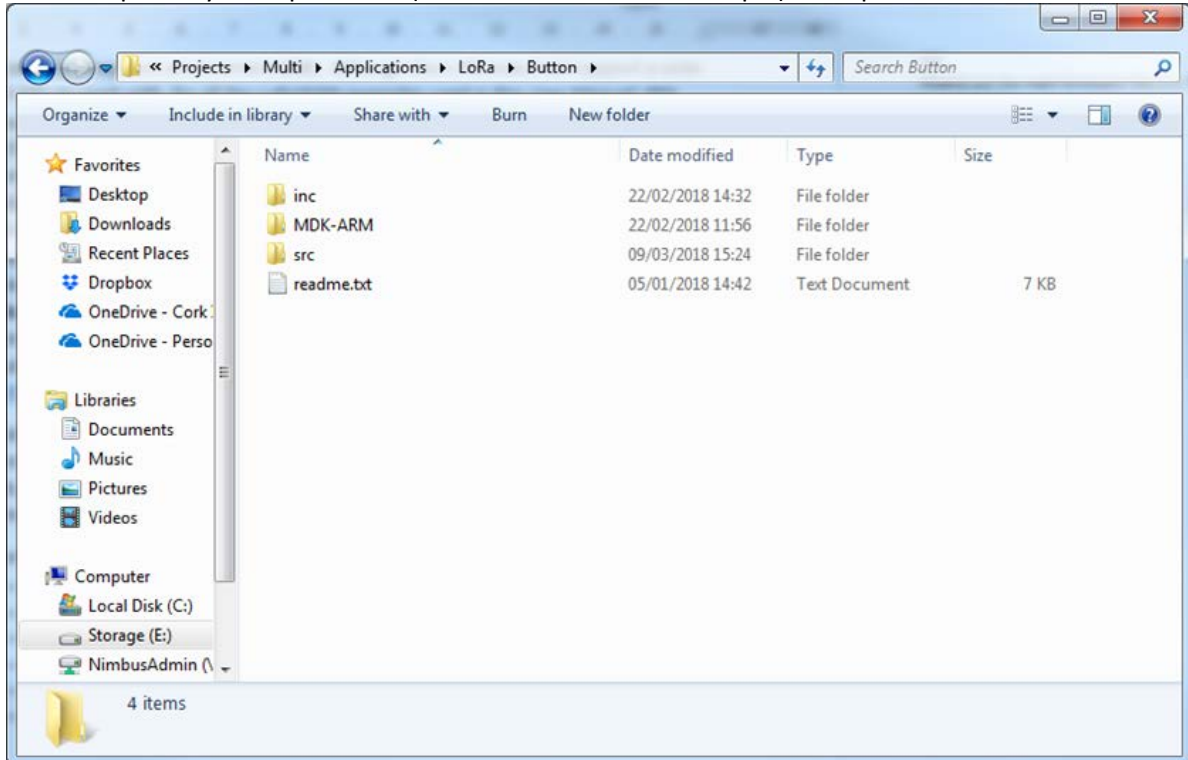
This section describes how to configure all the necessary tools to start working with the n-PN board. Briefly, two main elements need to be download by the user.

1. An integrated development environment (**IDE**). Although the n-PN board can support a wide variety of IDEs to work with, for all the LoRaWAN examples used in this *User Manual*, KEIL environment was chose for two main reasons:
  - a. STM provides all the necessary LoRaWAN protocol drivers for the microcontroller embedded in the n-PN board for this IDE.
  - b. KEIL IDE (MDK Version 5) is *free* for STM32F0 and STM32L0 microcontrollers and due to the n-PN board has an STM32L0 microcontroller, we are allowed to activate the license for this software environment (follow the instructions described in the next link: <http://www2.keil.com/stmicroelectronics-stm32/mdk>)
2. The **Nimbus SDK** which contains the minimum files to start working with the n-PN board as well as some basic examples that the user can use as templates (Nimbus SDK is based on STM32CubeExpansion\_LRWAN\_V1.1.4 and can be found in the next repository: [https://bitbucket.org/nimbus\\_it/pn\\_lora\\_node](https://bitbucket.org/nimbus_it/pn_lora_node)).

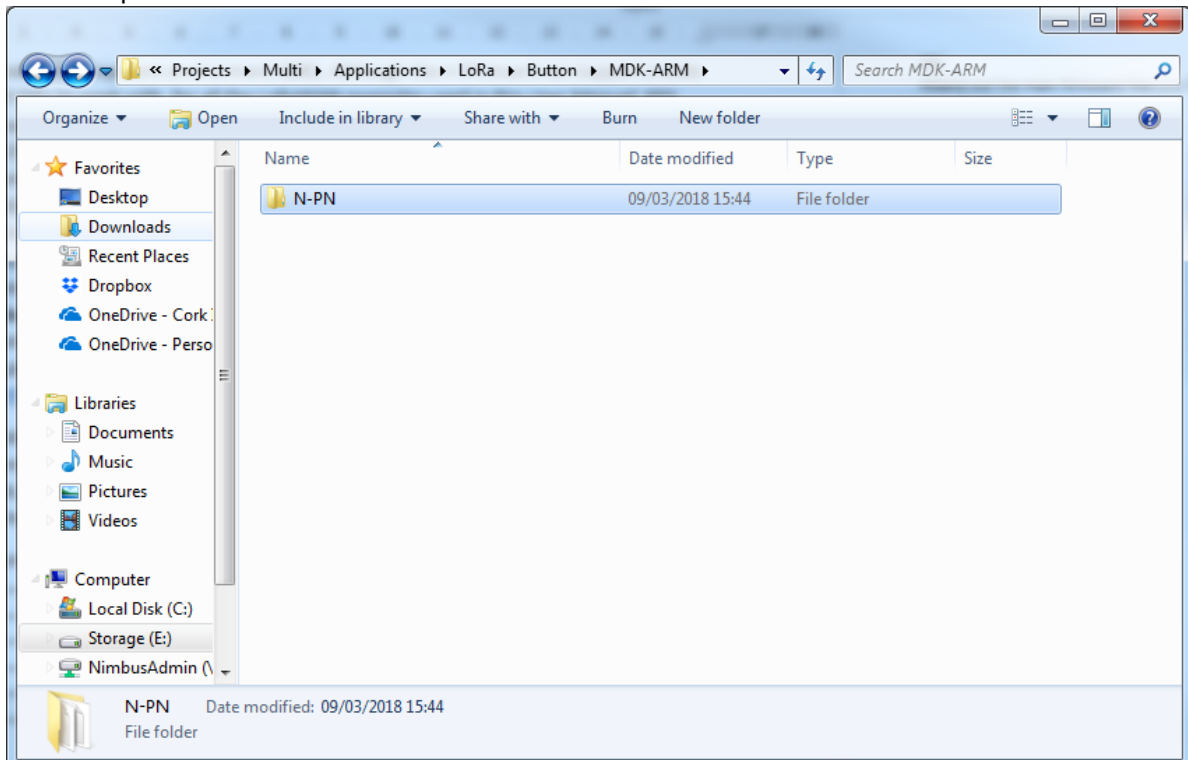
Once both KEIL (MDK) IDE is installed (and the license activated) and the Nimbus SDK was downloaded, there are several basics examples (using LoRaWAN technology) which the user can start working with. Those examples can be found following the next path: *LoRaWAN\_Examples / STM32CubeExpansion\_LRWAN\_V1.1.4 / Projects / Multi / Applications / LoRa /*

The next procedure has to be followed to run one of those examples:

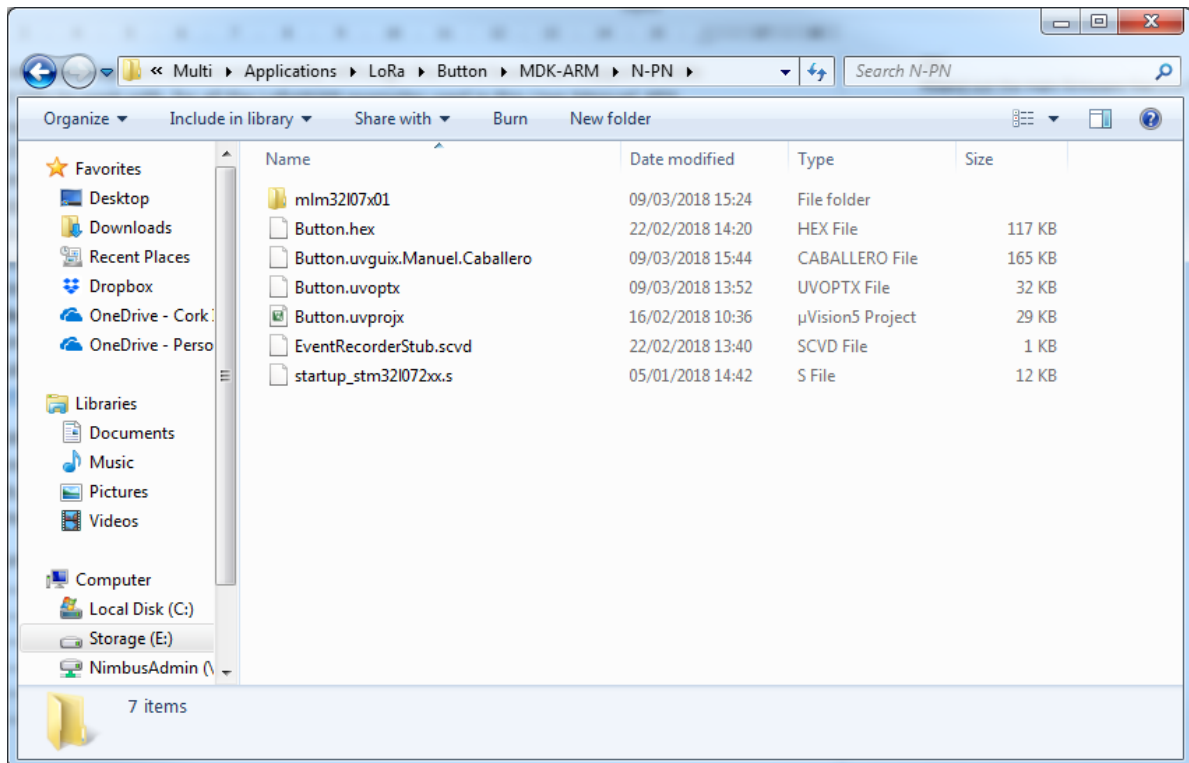
**STEP 1.** Open Any Example folder (Button folder for this example) and open *MDK-ARM* folder



**STEP 2.** Open *N-PN* folder



**STEP 3.** Open Button project (Double click on *Button.uvprojx*)



**FINISH.** The project is ready to be tested

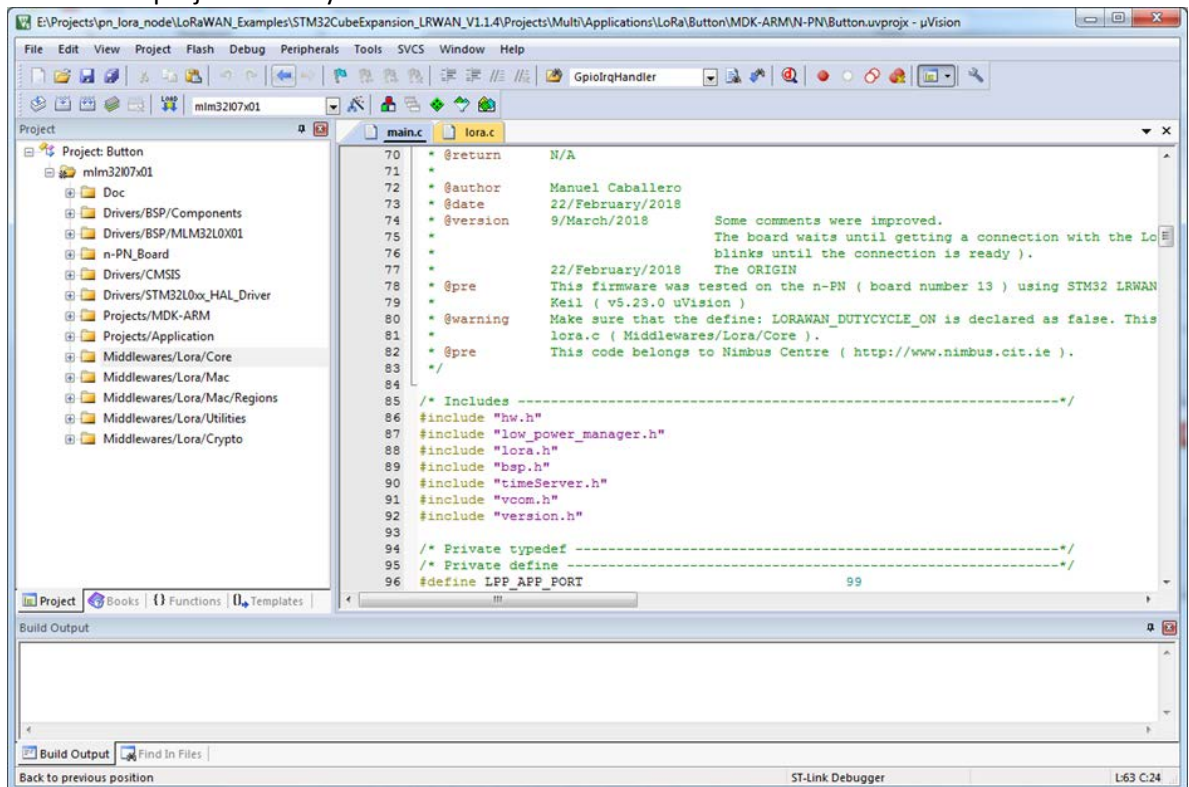


Figure 17: Open an Existing example

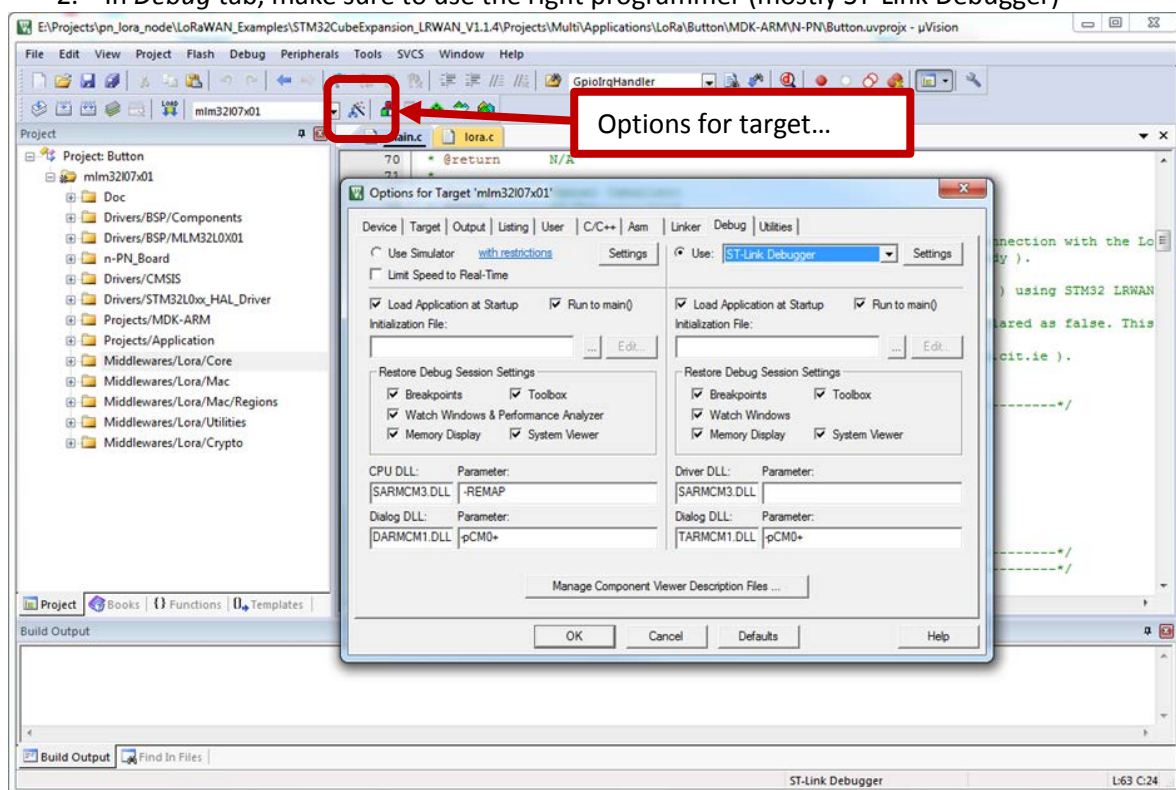
## NOTES:

- KEIL IDE (MDK) may not have the libraries installed for the microcontroller embedded in the n-PN board, so a pop-up window will appear asking us to install those libraries. Just follow the instructions to install them up. You may reset your computer after the installation.
- If we double click on *Button.uvprojx* (a project file) and Windows does not recognise the extension file, just choose KEIL (MDK).

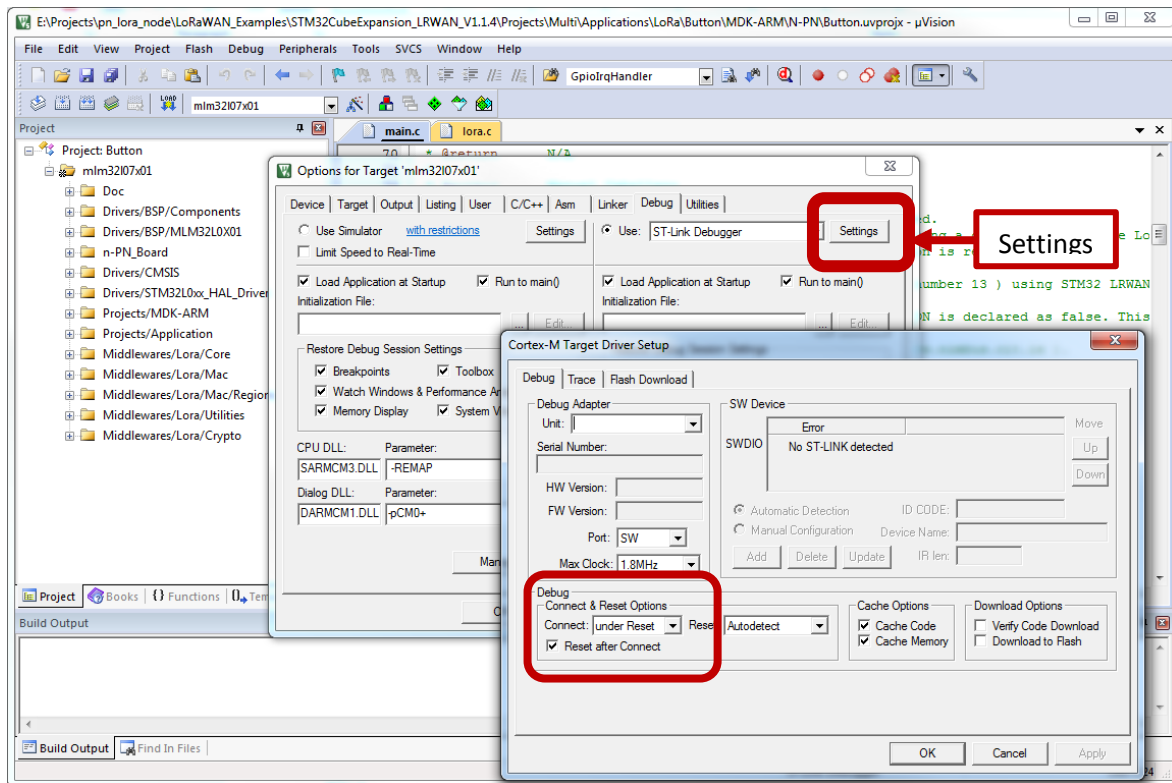
## INTEGRATED DEVELOPMENT ENVIRONMENT (IDE)

As stated, KEIL IDE (MDK) was chosen, this chapter explains the minimum configuration to improve our work flow.

1. Click on *Options for Target...*
2. In *Debug* tab, make sure to use the right programmer (mostly ST-Link Debugger)



3. In *Debug* tab, Click on *Settings*
4. Make sure *under Reset* is chosen in *Connect (Debug tab)*.



##### 5. In Flash Download tab, make sure that Program, Verify and Reset and Run are selected.

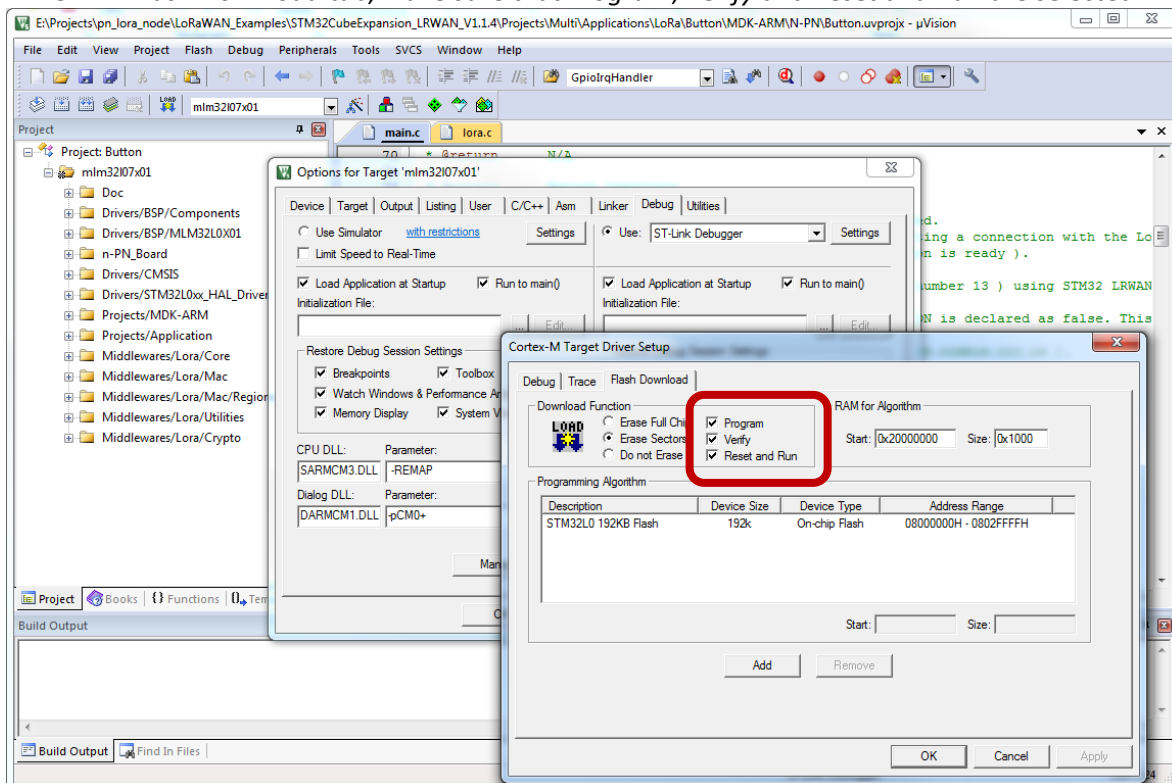


Figure 18: Minimum configuration for KEIL IDE

## FIRMWARE STRUCTURE

In Keil a project is structured as shown below:

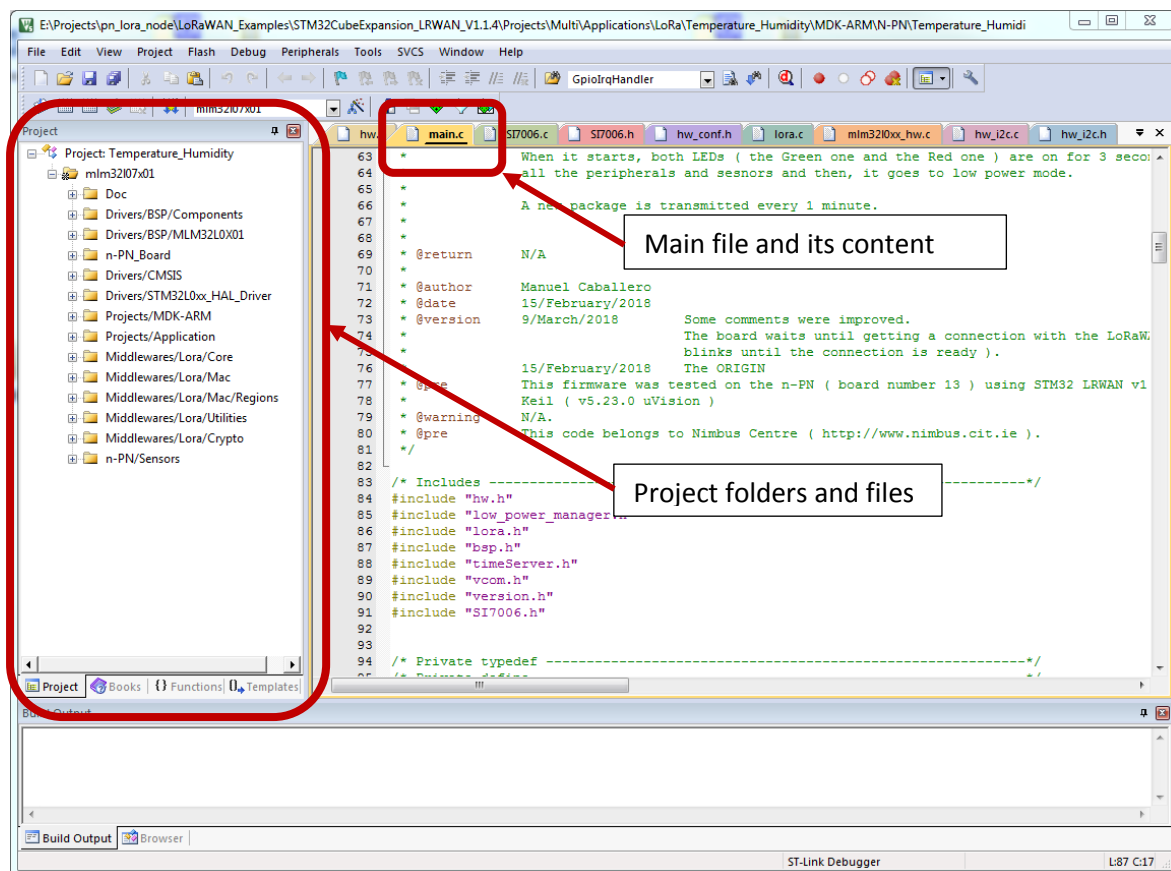


Figure 19: A project in KEIL IDE

Where the main folders are explained below:

- **n-PN\_Board:** The *b-I072z-Irwan1.c* file defines all the pinout of the n-PN board.
- **Projects/Application:** The *main.c* file for the application is placed into this folder.
- **N-PN/Sensors:** The drivers for the external sensors embedded on n-PN board are placed in this folder.

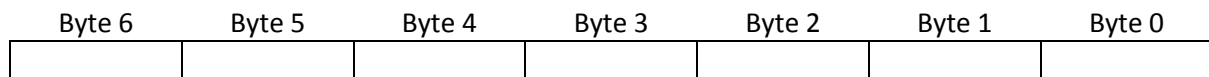
Keil IDE does not show the header files until the project is compiled, once the project is compiled, the header files can be found under the function files (clicking on the cross sign next to the function file)

Another important file is the header file called: **Commissioning.h** which can be found under the *main.c* file.

This header file contains the necessary parameters to configure your own LoRaWAN network: *LORAWAN\_DEVICE\_EUI*, *LORAWAN\_APPLICATION\_EUI* and *LORAWAN\_APPLICATION\_KEY*.

## FIRMWARE

Some examples are described below standing out how to work with n-PN on board sensors. All the examples transmit a package (**7-Bytes long**) to **LoRaWAN Pervasive Nation server**, which structure is shown below:



**Byte 0** A fixed value, it is always 0x23 (35 decimal)

**Byte 1** Battery level

**Byte 2** ---

**Byte 3** ---

**Byte 4** ---

**Byte 5** ---

**Byte 6** Counter (from 0 to 255)

### NOTE:

--- This value depends on the example, 0x00 otherwise.

*Figure 20: Package to be transmitted*

### EXAMPLE 1: COUNTER

This simple example shows how to transmit a package using LoRaWAN protocol. A counter will be incremented every one minute and its value will be stored in a package which it will be sent to the Pervasive Nation LoRaWAN server.

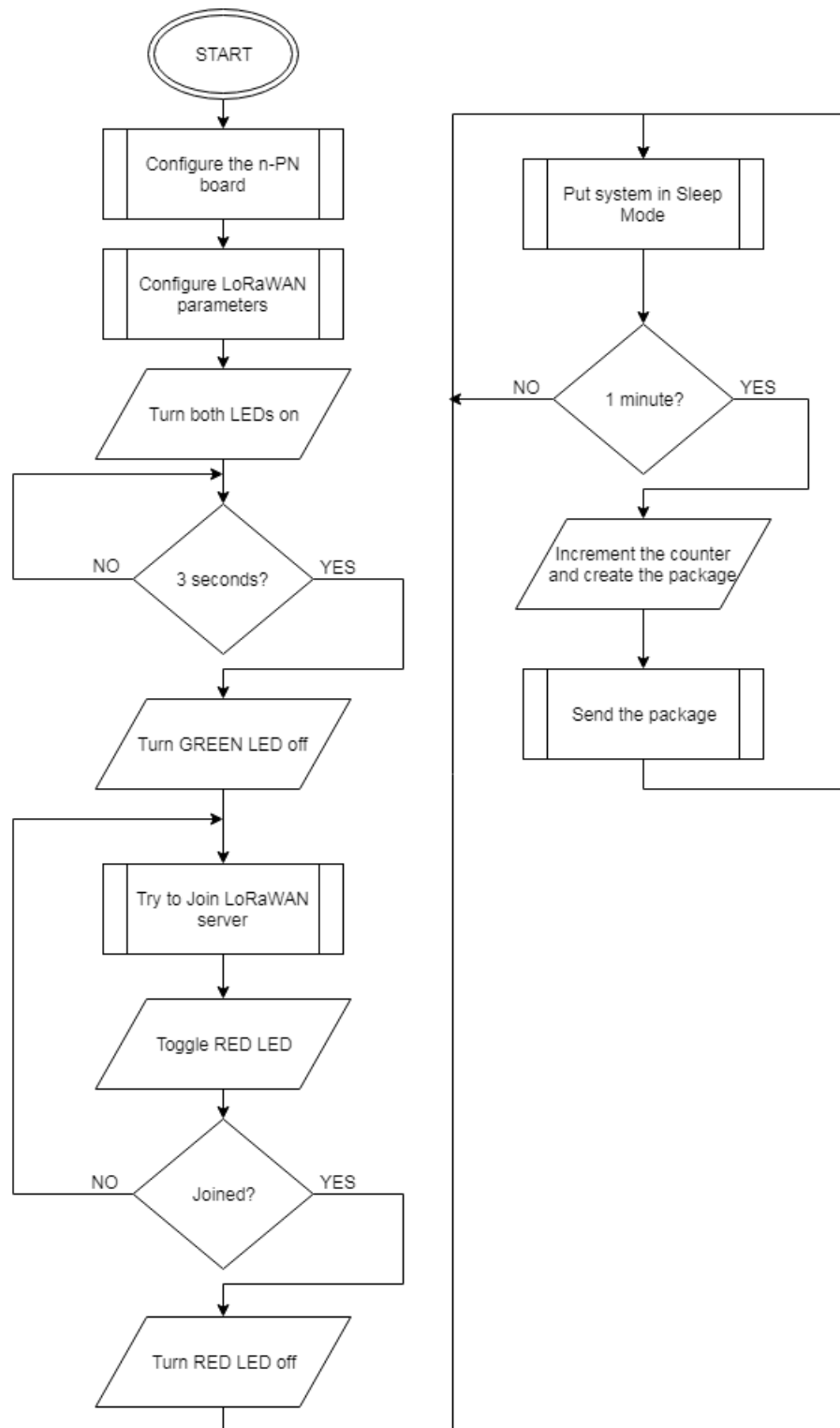


Figure 21: Example1 Flow Diagram



**NOTES:**

- The RED LED will be switched off when the n-PN board manages to connect the LoRaWAN server<sup>2</sup>
- Every time a package is transmitted, the GREEN LED will be on for about 200ms.

2. In case the RED LED is never switched off, check the FAQ.

Date	beta2_fixe d	beta2_batter y	beta2_accell D	beta2_rfi d	beta2_rfid_ma n	beta2_ssnb3l D	beta2_counte r
Fri Mar 09 2018 15:07:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	33.000
Fri Mar 09 2018 15:06:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	32.000
Fri Mar 09 2018 15:05:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	31.000
Fri Mar 09 2018 15:04:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	30.000
Fri Mar 09 2018 15:03:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	29.000
Fri Mar 09 2018 15:02:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	28.000
Fri Mar 09 2018 15:01:56 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	27.000

Date A new package every one minute.  
Beta2\_counter Incrementing counter.

Figure 22: Example1 Pervasive Nation LoRaWAN server

**EXAMPLE 2: BUTTON**

This simple example shows how to transmit a package using LoRaWAN protocol. A counter will be incremented every one minute or when the user button is pressed, its value will be stored in a package which it will be sent to the Pervasive Nation LoRaWAN server.

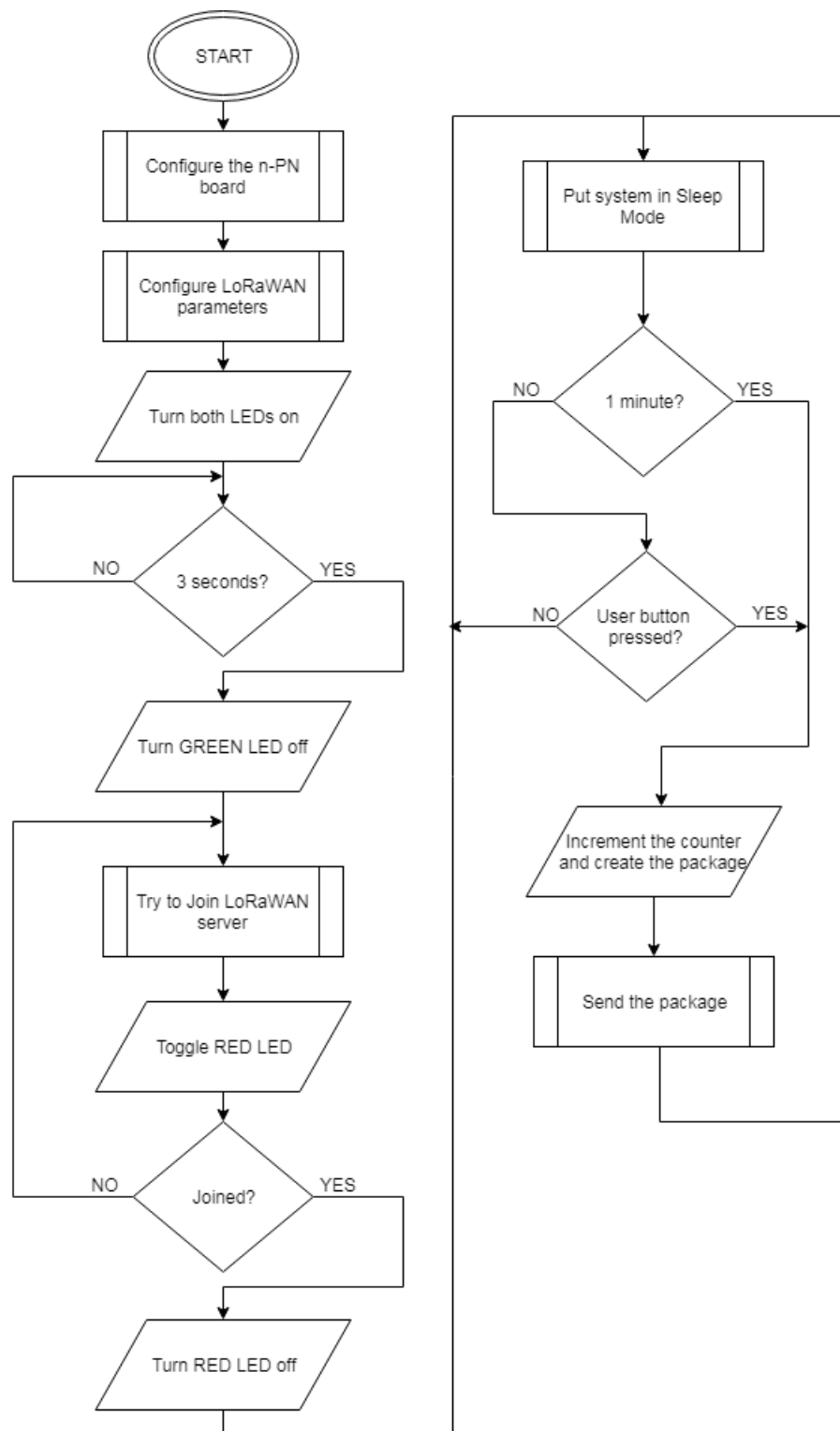


Figure 23: Example2 Flow Diagram

**NOTES:**

- The RED LED will be switched off when the n-PN board manages to connect the LoRaWAN server<sup>2</sup>
- Every time a package is transmitted, the GREEN LED will be on for about 200ms.

3. In case the RED LED is never switched off, check the FAQ.

Date	beta2_fixe d	beta2_batter y	beta2_accell D	beta2_rfi d	beta2_rfid_ma n	beta2_ssnb3l D	beta2_counte r
Fri Mar 09 2018 15:28:08 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	2.000
Fri Mar 09 2018 15:28:00 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	1.000
Fri Mar 09 2018 15:27:42 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	0.000

Date A new package every one minute or when the user button was pressed.

Beta2\_counter Incrementing counter.

Figure 24: Example2 Pervasive Nation LoRaWAN server

**EXAMPLE 3: RELATIVE HUMIDITY AND TEMPERATURE**

This simple example shows how to transmit a package using LoRaWAN protocol. A new relative humidity and temperature value will be read every one minute and its value will be stored in a package which it will be sent to the Pervasive Nation LoRaWAN server. The counter will be incremented as well.

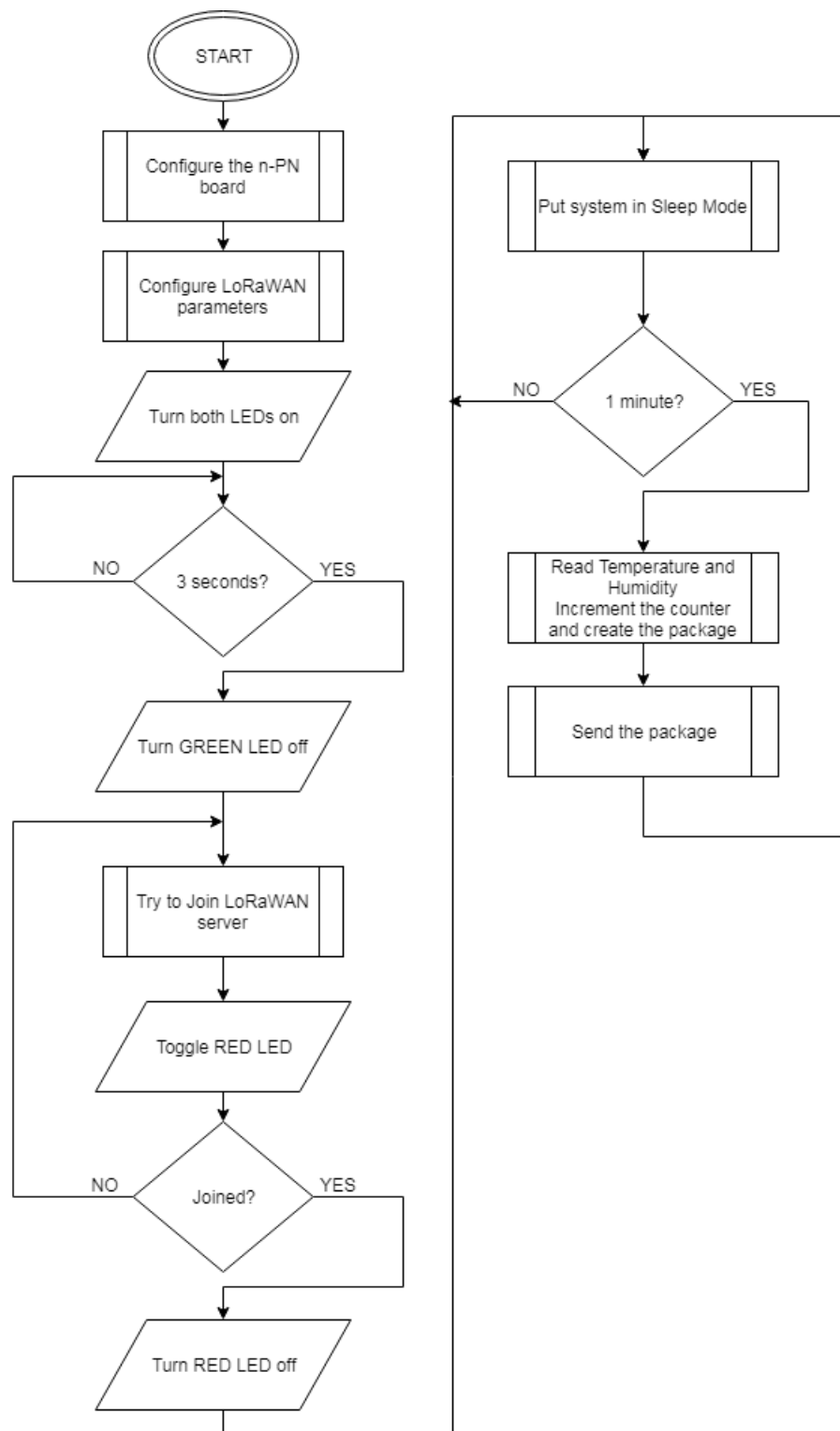


Figure 25: Example3 Flow Diagram



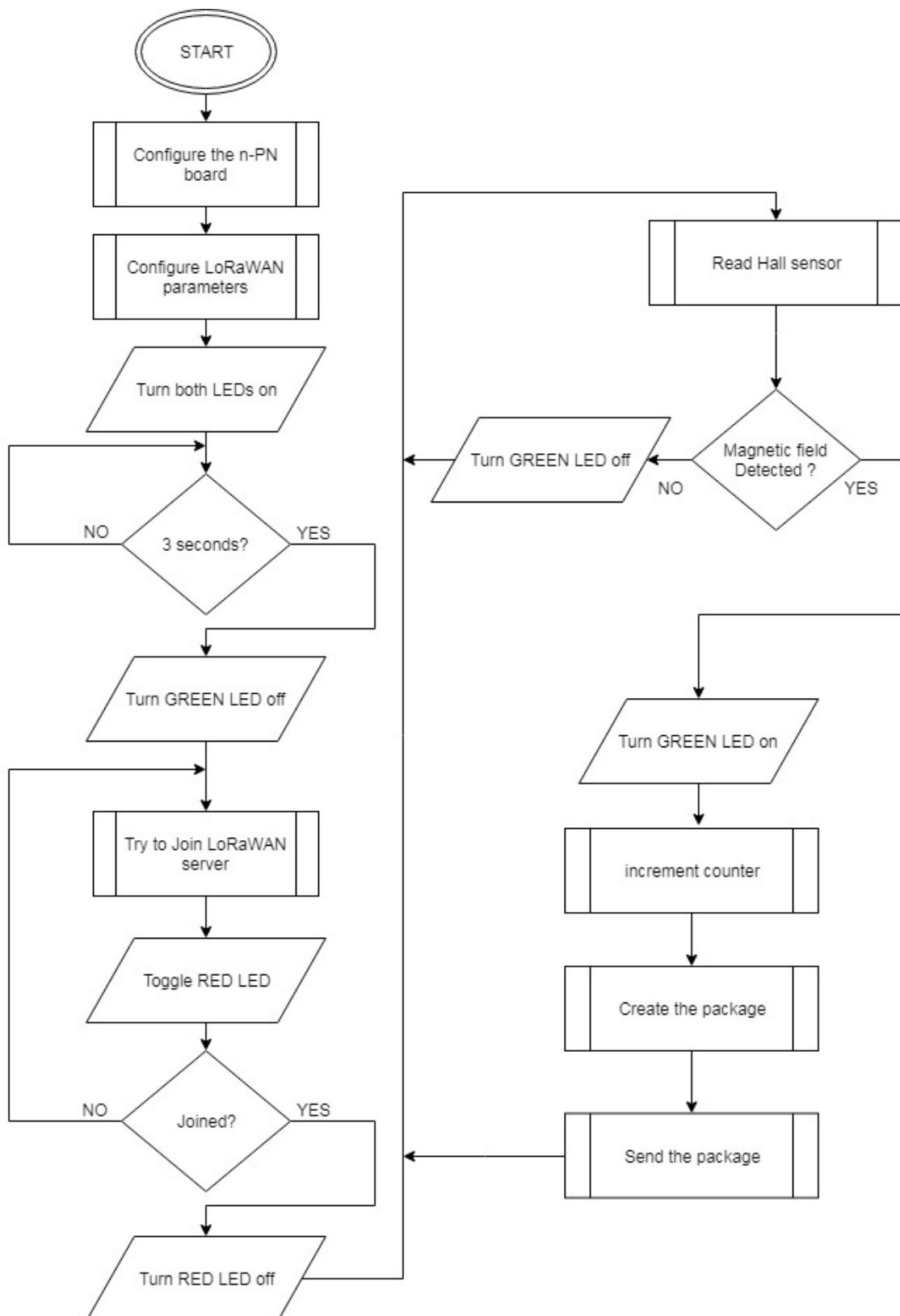


Figure 27: Example4 Flow Diagram

**NOTES:**

- The RED LED will be switched off when the n-PN board manages to connect the LoRaWAN server<sup>2</sup>
- GREEN LED does not flash during transmission in Hall sensor example.

5. In case the RED LED is never switched off, check the FAQ.

Date	beta2_fixed	beta2_battery	beta2_accellID	beta2_rfid	beta2_rfid_man	beta2_ssnb3ID	beta2_counter
Thu Mar 15 2018 14:44:59 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	3.000
Thu Mar 15 2018 14:44:40 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	2.000
Thu Mar 15 2018 14:44:23 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	1.000
Thu Mar 15 2018 14:44:06 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	0.000

Date

Package when magnetic field is detected.

Beta2\_counter

Incrementing counter when magnetic field is detected.

*Figure 28: Example4 Pervasive Nation LoRaWAN server*

### EXAMPLE 5: HALL SENSOR EXTERNAL INTERRUPT

This simple example shows how to transmit a package using LoRaWAN protocol. When a magnetic field is detected by the hall sensor an external interrupt is generated which wakes the processor from sleep mode, switches on the GREEN LED and increments the counter. A package is then sent to the Pervasive Nation LoRaWAN server. When the magnetic field is removed an External interrupt is again triggered which turns the GREEN LED off.

**Please note** in this example sleep mode functionality is enabled and a package is also sent every 60 seconds.

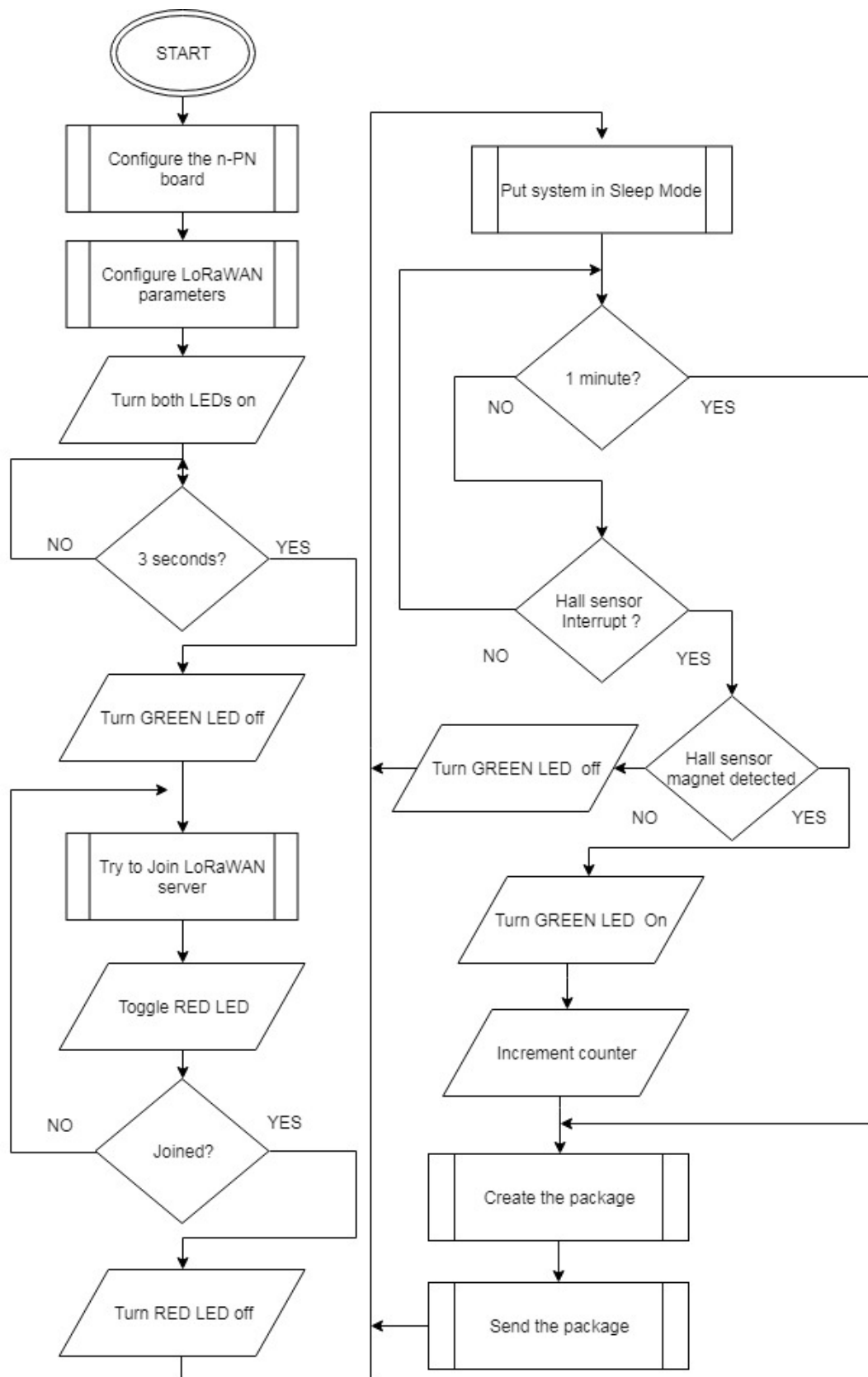


Figure 29: Example5 Flow Diagram



**NOTES:**

- The RED LED will be switched off when the n-PN board manages to connect the LoRaWAN server<sup>2</sup>
- GREEN LED does not flash during transmission in Hall sensor example.

6. In case the RED LED is never switched off, check the FAQ.

Date	beta2_fixed	beta2_battery	beta2_accellID	beta2_rfid	beta2_rfid_man	beta2_ssnb3ID	beta2_counter
Thu Mar 15 2018 16:40:09 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	3.000
Thu Mar 15 2018 16:39:51 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	2.000
Thu Mar 15 2018 16:39:46 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	2.000
Thu Mar 15 2018 16:39:36 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	1.000
Thu Mar 15 2018 16:39:22 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	0.000
Thu Mar 15 2018 16:38:51 GMT+0000	35.000	100.000	0.000	0.000	0.000	0.000	0.000

Date

Package when magnetic field is detected or every 60 seconds.

Beta2\_counter

Incrementing counter when magnetic field is detected.

Figure 30: Example5 Pervasive Nation LoRaWAN server.

**FAQS**

The RED LED is always blinking.

This behaviour could be due to several causes:

- Make sure to have one antenna connected whether on JP5 or JP6. If U.FL-R is used (JP6), make sure to use an appropriate antenna.
- Make sure to have all the LoRaWAN parameters well configured (according to your LoRaWAN server)
- Make sure you have access to your LoRaWAN server.

## REVISION HISTORY

DATE	REVISION	CHANGES
9/March/2018	1	Manuel Caballero <ul style="list-style-type: none"> <li>• Added Headings</li> <li>• Added Footer and Header</li> </ul>
13/March/2018	2	Manuel Caballero <ul style="list-style-type: none"> <li>• Added content for all headings</li> </ul>
20/March/2018	3	Ian Aherne <ul style="list-style-type: none"> <li>• Added Example4 and Example5</li> </ul>
22/March/2018	4	Manuel Caballero <ul style="list-style-type: none"> <li>• Updated the format of the document</li> </ul>

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