

n-PN LoRaWAN Reference Design

n-Blocks

Table of Contents

Overview	1
Murata CMWX1ZZABZ Features	2
STM32L082 MCU Features	2
SX1276 Features	2
Main Features of the Board	3
Board Pinout	4
Getting started	4
Integrated Development Environment (IDE)	7
Firmware Structure	9
Examples	11
Gallery	13
Related articles in this Wiki	13



n-PN LoRaWAN

n-PN LoRaWAN has been designed to offer a practical and cost effective solution for users seeking to add LoRa connectivity to their projects with minimal previous experience in networking. The form factor is based on n-Blocks and is customized for Pervasive Nation.





License	GPL 2.0
Status	Tested
Buy at:	
Categories	
Hardware repo	Bitbucket
Firmware repo	Bitbucket

Overview

n-PN LoRaWAN 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. It is based on Murata CMWX1ZZABZ LoRa module and also features STM32L082 microcontroller. The exclusive combination of an Arm® Cortex®-M0+ core and STM32 ultra-low-power features, makes the STM32L082 the best fit for applications operating on batteries or supplied by energy harvesting. It is the ideal solution for users looking to design IoT projects with minimal previous experience in networking having a low power device.



Communication with the module can be achieved via UART, SPI, or I2C peripheral interfaces. GPIOs provide plenty of flexibility for connecting sensors, switches and status LEDs, and the module is powered from a 1.6 to 3.6 VDC supply.

Murata CMWX1ZZABZ 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
- Typical applications: smart metering, wearables, tracking, M2M and internet of things (IoT) edge nodes

STM32L082 MCU Features

- Up to 192 KB Flash, 20KB RAM
- Low voltage 1.65 to 3.6 V
- Dynamic Voltage Scaling
- 5 clock sources
- Advanced RTC w/ calibration
- Multiple USART, SPI, I2C
- Multiple 16-bit timers
- 2 watchdogs
- Program Voltage Detector
- Reset circuitry POR/PDR
- 16-bit ADC (hardware oversampling)
- Ultra-safe, low-power BOR (brownout reset) with 5 selectable thresholds
- LCD interface, comparator, DAC
- Hardware Encryption Engine AES 128-bit

SX1276 Features



- LoRa Modem
- 168dB maximum link budget
- +20dBm 100 mW constant RF output vs. V supply
- +14dBm high efficiency PA
- Programmable bit rate up to 300kbps
- High sensitivity: down to -148dBm
- Excellent blocking immunity
- Low RX current of 9.9mA, 200nA register retention
- Fully integrated synthesizer with a resolution of 61Hz
- FSK, GFSK, MSK, GMSK, LoRa and OOK modulation
- · Built-in bit synchronizer for clock recovery
- Preamble detection
- 127dB Dynamic Range RSSI
- Automatic RF Sense and CAD with ultra-fast AFC
- Packet engine up to 256 bytes with CRC
- Built-in temperature sensor and low battery indicator

Main Features of the Board

- 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
 - I2C capability
 - UART capability
 - Power supply and JTAG connections
- Different LoRaWAN antenna choices
- Si7006 Silabs Relative Humidity and Temperature Sensor with I2C Interface
- LSM303AHTR STM 3D digital linear acceleration sensor and a 3D digital magnetic sensor with I2C Interface
- M24LR64E-R STM dynamic NFC/RFID tag IC with a dual-interface, electrically erasable programmable memory (EEPROM) with I2C 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

Board Pinout



Getting started

To configure all the necessary tools to start working with the n-PN board, two main elements need to be downloaded by the user.

• An Integrated development environment (IDE). Although the n-PN board can



support a wide variety of IDEs to work with, KEIL environment can be chosen 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 instructionshere).
- 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).
- After installing KEIL (MDK) IDE(and the license activated) and downloading the Nimbus SDK, there are several basics examples (using LoRaWAN technology) which the user can start working with. The examples can be found following the path: LoRaWAN_Examples / STM32CubeExpansion_LRWAN_V1.1.4 / Projects / Multi / Applications / LoRa /.



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

• Open N-PN folder.



Organize 🔻 🛛 🔭 Open	Include in library	e with 🔻 🛛 Burn 🔹 New folder		8	•	(
🔶 Favorites	Name	Date modified	Туре	Size		
E Desktop	🍌 N-PN	09/03/2018 15:44	File folder			
🗼 Downloads						
E Recent Places						
Uropbox						
ConeDrive - Cork						
ConeDrive - Perso						
Librarier						
Documents						
Music						
Pictures						
Videos						
_						
Computer						
Local Disk (C:)						
Storage (E:)						
C Nimburd durin 0						

• Open Button project (Double click on **Button.uvprojx**).

				2	x
🔾 🗢 📕 « Multi 🕨	Applications + LoRa + Button + MDK-A	RM ► N-PN ►	▼ ← Search N-P	N	Q
Organize 👻 Include in	a library 💌 Share with 💌 Burn	New folder			0
🔆 Favorites	Name	Date modified	Туре	Size	
E Desktop	🍌 mlm32107x01	09/03/2018 15:24	File folder		
🐌 Downloads	Button.hex	22/02/2018 14:20	HEX File	117 KB	
🖳 Recent Places	Button.uvguix.Manuel.Caballero	09/03/2018 15:44	CABALLERO File	165 KB	
😻 Dropbox	Button.uvoptx	09/03/2018 13:52	UVOPTX File	32 KB	
i OneDrive - Cork	Button.uvprojx	16/02/2018 10:36	µVision5 Project	29 KB	
🝊 OneDrive - Perso	EventRecorderStub.scvd	22/02/2018 13:40	SCVD File	1 KB	
Libraries Documents Music Pictures Videos Computer Local Disk (C:) Storage (E:) NimbusAdmin (\ +	startup_stm32l072xx.s	05/01/2018 14:42	S File	12 KB	
7 items					

• The project is ready to be tested.



E\Projects\pn_lora_node\LoRaWAN_Examples\STM32C	CubeExpansion_LRWAN_V1.1.4/Projects/Multi/Applications/LoRa/Button/MDK-ARM/N-PN/Button.uvprojx - µVision	• ×			
File Edit View Project Flash Debug Peripherals	s Tools SVCS Window Help				
🗋 🗃 🖬 🖉 🕺 🖧 🗢 🗠 🚛 🚽 1	陀 勃 勃 勃 🕸 🕸 🕮 🎼 //문 🦉 GpiologHandler 🛛 🕞 🗟 🥐 🕘 🖕 🔿 🔗 🍓 🗐 🔍				
🕑 🕮 😅 🥔 📑 🙀 mim3207x01	▲ 示 ◆ ⑦ 節				
Project 🛛 🕫	D mine D locar	• ×			
Project: Button	70 * freturn N/A				
😑 🔊 mlm32107x01	71 *				
I Doc	72 * Gauthor Manuel Caballero				
Drivers/BSP/Components	73 * @date 22/February/2018 74 * Superior 9/March/2018 Some comments ware improved				
Drivers/BSP/MLM32L0301	75 * The board waits until getting a connection with	the Lon			
🛞 🛄 n-PN_Board	76 * blinks until the connection is ready).				
Orivers/CMSIS	77 * 22/February/2018 The ORIGIN				
Drivers/STM32L0xx_HAL_Driver	78 - Wpre Inis Himware was tested on the n-PN (board number 13) Using Singr 79 * Keil (v5.23.0 uVision)	LENAD			
Projects/MDK-ARM	80 * @warning Make sure that the define: LORAMAN_DUTYCYCLE_ON is declared as false	. This			
Projects/Application	81 * lora.c (Middlewares/Lora/Core).				
General Middlewares/Lora/Core	82 * gpre Inis code belongs to simplify Centre (http://www.himbus.cit.ie).				
Middlewares/Lora/Mac	84 -				
Middlewares/Lora/Mac/Regions	85 /* Includes*/				
Middlewares/Lora/Utilities	87 #include "low power manager.h"				
Middlewares/Lora/Crypto	88 #include "lora.h"				
	89 #include "bsp.h"				
90 #include "timeServer.h"					
	92 #include "version.h"				
	93				
	94 /* Private typedef*/				
	96 #define LPP APP PORT 99	-			
Project Books () Functions 0, Templates	к <u></u>				
Build Output		a 🖬			
		*			
		*			
		,			
Build Output Find In Files					
Back to previous position	ST-Link Debugger	L:63 C:24			

NOTES:

- a. 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.
- b. 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 section explains the minimum configuration to improve our work flow.

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



ile Edit View Project Flash Debug Periphera	is Tools SVCS Window Help		
□ □ □ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞	R R III III III IIII M R IIIII IIIIIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	• ≩ ≉ ℚ • • ⊘ ♠ ■• ۹ s for target	• ×
Doc	Options for Target 'mim32107x01'	×	
Drivers/BSP/Components Drivers/BSP/MLM32L0X01 Drivers/BSP/MLM32L0X01 Drivers/CM5IS	Device Target Output Listing User C/C++ Aam Link C Use Smulator with restrictions Settings C Link Speed to Real-Time	ver Debug Ublites Use: ST-Link Debugger Settings	nection with the Lo
Drivers/STM32L0xc_HAL_Driver Drivers/STM32L0xc_HAL_Driver Terjects/Application Data Middlewares/Lora/Core Data Middlewares/Lora/Mac Data Middlewares/Lora/Mac/Regions	Load Application at Statup Run to main() Hatalization File: Restore Debug Session Settings Pelaypoints Tobox File: Debug Session Settings Points	Load Application at Statup P Run to main() talization File: Restore Debug Session Settings P Breakpoints P Toobox	<pre>lared as false. This .cit.ie).</pre>
B Addlewares/Lora/Utilities Addlewares/Lora/Crypto	Present moders of otomatical margins Presenter CPU DLL: Parameter De SARMCM3 DLL REMAP SA	Ver DLL: Parameter:	
Project 🔞 Books () Functions 0., Tempiates	DARMCM1 DLL pCM0+ 77	ARMCM1 DLL pCM0+	*/
alid Output	OK Carcel	DefaultsHelp	
			,
Build Output			

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

📓 El/Projects/pn_Jora_node\LoRaWAN_Examples/STM32CubeExpansion_LRWAN_V11.4IProjects/Multi\Applications\LoRa\Button\MDK-ARMIN-PN\Button.uvprojx - y/Vision	0 %
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help	
🗋 😅 🖬 🖇 ム 38、ク 🗠 🔶 🍖 意 急 後 涼 家 川 川 🖉 Gpiologhtander 💿 🗟 🖉 🌒 鱼 🔗 🚓 🗐 🌂	
Project P G maine Daras	• ×
Project Button 70 A Recurr N/A	
🗟 😓 mim32107x01 🔣 Options for Target 'mim32107x01'	
B Doc Decircal Transf D doc4 Listers Lines LCC-s1 Arm. Listers Debten Listers L	
Device range copy components Device range copy co	
DoversiteSP/MLM32L0301 Code Simulator with restances Settings '* Use: [ST-Link Debugger Settings Settings Settings Settings Settings Settings Settings Settings	: Lo
Drivers/CMSS	_
Divers/STM32L0xx,HAL_Drive Divers/STM32L0xx,HAL_Drive	2 LEMAN
B Projects/MDK-ARM Presization rise.	e. This
Projects/Application Projects/Application Cortex-M Target Driver Setue Cortex-M Target Driver Setue	×
Modewares/Lora/Core Peerde Decko Jacobia	
Andoneware/Long/Mac With Windows R Performance A With Windows R Performance A	
B Mddlewarer/Lora/Ubilities V Memory Daplay V System V Debug Adapter SW Device	
B Middlewares/Lora/Crypto	
CPU DLL: Parameter: Sena number: Price No. 114,178, detected U	4
Data Di Parandar HW Vesion:	m
Dearge OLL Parameter. PW Version: P Automatic Detection ID CODE	
Pot: SW C Manual Configuration Device Name	-
Merci Merci Statute at Add Delete Update IR lerc	
Project @ Books O Functions Do Functions Download Options	
Build Output Connect: under Reset 💌 Reset Autodetect 💌 🖾 Cache Code 🗌 Verly Code Downloa	d 🔛
F Rest after Connect FC Cache Memory Download to Plash	~
	_
4	
Build Output Grind In Files OK Cancel As	ely 1
	- 4

Nimbus Embedded Systems Research • In Flash Download tab, make sure that Program, Verify and Reset and Run are selected.



Firmware Structure

• In Keil a project is structured as shown below:





- 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.

NOTE: A wire or U.FL-R antenna must be connected.



Examples

- Open Temperature_Humidity example folder and open MDK-ARM folder inside it
- Open N-PN folder
- Open Temperature_Humidity project (Double click on Temperature_Humidity.uvprojx)

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.





Nimbus Embedded Systems Research

Gallery

Related articles in this Wiki

- n-pn
- RF, CPU, nblock, BLE, nsensorRF

IMPORTANT NOTICE - PLEASE READ CAREFULLY

Nimbus Centre reserve the right to make changes, corrections, enhancements, modifications, and improvements to Nimbus Centre products and/or to this document at any time without notice.

All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.



Address: Cork Institute of Technology Campus, Bishopstown, Cork

Phone: (021) 433 5560

© 2019 Nimbus Centre - All rights reserved

