



LoRa Based Solutions



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Firmware, Embedded Hardware Design Engineer,
Custom ARM SBCs | pixma.github.io

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Professional Embedded Linux Hardware Design, Firmware and Software Engineer,
having 5+ years of industrial and startup work experience.

🔗 Developer 📍 Kolkata 📅 Csit '13 [in](#) [f](#) [s](#) [pixma.github.io](#)



LoRa Based Solutions



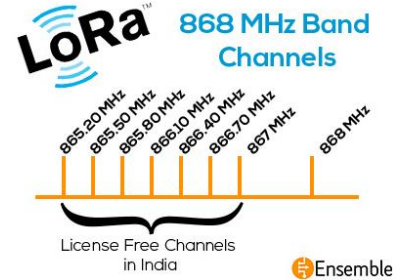


LoRa Based Solutions

HARDWARE



LoRa Based Solutions



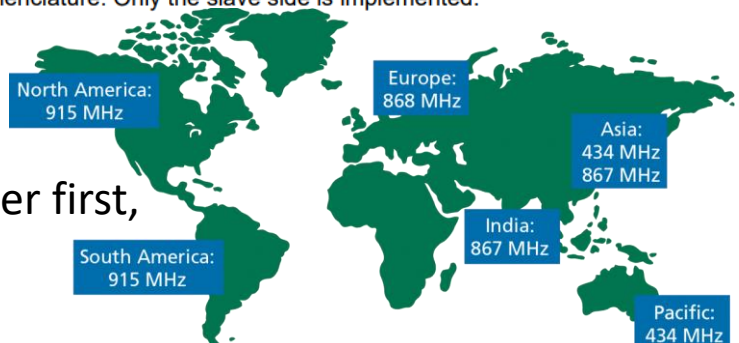
LoRa Products								
	Part Number	Frequency Range (MHz)	Link Budget (dB)	RX Current (mA)	FSK Max DR (kbps)	LoRa DR (kbps)	Max Sensitivity (dBm)	TX Power (dBm)
NEW	SX1261	150–960	163	4.6	300	0.018–62.5	-148	+15
	SX1262	150–960	170	4.6	300	0.018–62.5	-148	+22
	SX1268	410–810	170	4.6	300	0.018–62.5	-148	+22
	SX1272	862–1020	158	10	300	0.3–40	-138	+20
	SX1273	862–1020	150	10	300	1.7–40	-130	+20
	SX1276	137–1020	168	11	300	0.018–40	-148	+20
	SX1277	137–1020	158	11	300	1.7–40	-138	+20
	SX1278	137–525	168	11	300	0.018–40	-148	+20
	SX1279	137–960	168	11	300	0.018–40	-148	+20

Part Number	Frequency Range	Spreading Factor	Bandwidth	Effective Bitrate	Est. Sensitivity
SX1276	137 - 1020 MHz	6 - 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm
SX1277	137 - 1020 MHz	6 - 9	7.8 - 500 kHz	0.11 - 37.5 kbps	-111 to -139 dBm
SX1278	137 - 525 MHz	6- 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm
SX1279	137 - 960MHz	6- 12	7.8 - 500 kHz	.018 - 37.5 kbps	-111 to -148 dBm

Popular - SX1276/77/78/79 is a half-duplex, low-IF transceiver.

4.3. SPI Interface

The SPI interface gives access to the configuration register via a synchronous full-duplex protocol corresponding to CPOL = 0 and CPHA = 0 in Motorola/Freescale nomenclature. Only the slave side is implemented.

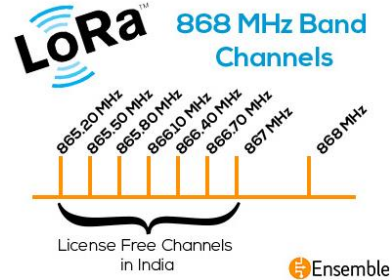


Select your Radio Part Number first, and the frequency!



LoRa Based Solutions

Frequency? 868MHz - Modules



With MCU Embedded Type ABZ

Order Number CMWX1ZZABZ

- 860-930MHz LPWA Module
- Chipset: Semtech (SX1276) + STM (STM32L)
- Modulation: FSK, OOK and LoRa™ Modulation
- Small form factor LoRaWAN™ module
- MCU Chipset: STM32L0 Series
- CPU: ARM Cortex-M0+
- Peripheral Interfaces: I2C, UART, USB, SPI
- Pre-certified radio regulatory approvals: 868 & 915 MHz spectrum

Recommended In Production ?

Digikey: 490-16143-1-ND
Price: 1 x 17.82 USD



Link: [Hyperlink](#) Radio Band Only



Brand Name: CDSENET

Port Number: 1

Type: Wireless Module

Size: 25mm * 40mm

RF IC: SX1276

Supply Voltage: 5.0 – 5.5V

Interface: SPI

Is_customized: Yes

Working Frequency: 868MHz

Model Number: E19-868M30S

Working Frequency : 868 MHz

Distance: 10000m

RF connector: SMD

Power: 30dBm (1W)

Place of Origin: CN

Aliexpress: E19-868M30S
Price: 1 x 7.19 USD



Link: [Hyperlink](#) Radio Band only

LF7611 LoRa transceiver for
863-928MHz band

☆☆☆☆☆ (No reviews)



- SX1276 RF transceiver
- EU868MHz/US915MHz
- UART host interface
- Tx power: +18.6dBm
- Rx: down to -139dBm

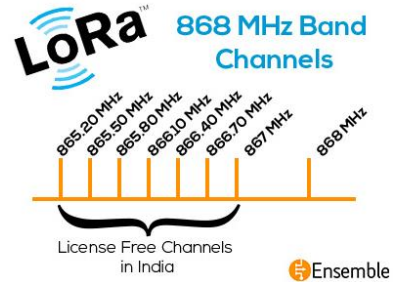
- Vendor: MAXIIOT
- Category: Featured products, Latest Products, LoRa end-device module, LoRa Module

Ipwanlab.com: LF7611
Price: 1 x 6.3 USD



LoRa Based Solutions

Frequency?
868MHz - Modules



Link: [Hyperlink](#)
Radio Band Only
Ultra Low Power sub 1GHz
Multichannels Radio Transceiver

The RC-CC1310-XXX module is based on Texas Instruments CC1310F128 component. This device combines a flexible, very low power RF transceiver with a powerful 48 MHz Cortex M3 microcontroller in a platform supporting multiple physical layers and RF standard.

N.3 Versions available :

- RC-CC1310-434 Freq. : 433MHz
- RC-CC1310-868 Freq. : 868MHz (CE RED Certified)
- RC-CC1310-915 Freq. : 915MHz (FCC Certified)

Ready for use Small Size for SMD mounting (Dimensions 15x 22mm) - Metal shield

868MHz version is CE CERTIFIED (Radio Equipment Directive 2014/53/EU)

915MHz version is FCC CERTIFIED.

radiocontrolli.com: **RC-CC1310-868**

Price: 2 pcs = 12 €

Select your module, with MCU or,
Without MCU.



LoRa Based Solutions

MCU Selection



Module MCU Requirements for SX127x

Table 1: Module MCU Requirements for SX127x

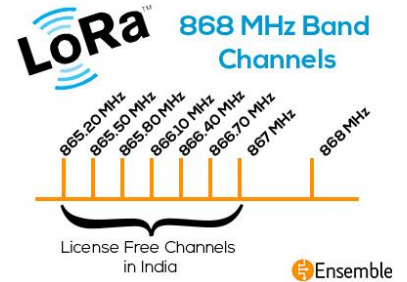
Parameter	Minimum Settings	Recommended Settings
MCU RAM	8 KB ¹	16 KB
MCU Flash	128 KB ¹	256 KB
AES 128 bits	AES decryption in software	Secure Element ²
Radio DIOs connected to MCU IRQ inputs	DIO0, DIO1, DIO2	DIO0, DIO1, DIO2, DIO3
SPI (4 wires: SCK, MOSI, MISO, NSS)	Mandatory	
RTC (32.768 kHz XTAL) ³	Recommended for accurate time keeping	Mandatory for Class B nodes and FUOTA
IEEE 64-bit Extended Unique Identifier EUI-64 (OUI: 24 or 30 bits, SN: 40 or 34 bits)	Mandatory ⁴	

1. These parameters are only recommendation for the standalone LoRaWAN™ for Classes A, B and C and basic application. Depending on the integration level, the minimum memory size could be higher or lower.
2. The LoRaWAN™ Specification V1.1 mandates the use of a secure element to perform multicast downlink actuation. For other situations, the Secure Element is a nice to have.
3. The RTC should be able to handle sub-seconds. Otherwise, the RTC should be used in conjunction with another timer to have a sufficient resolution. A resolution of approximately 1 millisecond is recommended.
4. The EUI-64 can be obtained directly from the Secure Element (if used). Nevertheless, the application is free to use whichever EUI-64 as long as its uniqueness is guaranteed.



LoRa Based Solutions

MCU Selection



Module MCU Requirements for SX127x

Radio DIO used by LoRaWAN™ for SX127x

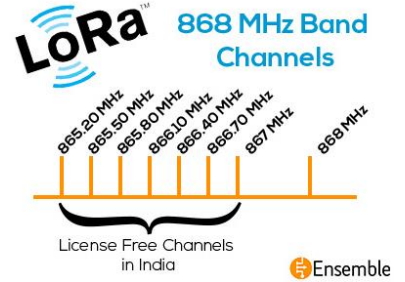
Table 2: DIO Usage for SX127x in LoRa® and FSK

DIO Pin	LoRa® Parameter	FSK Parameter
DIO0	TxDone, RxDone	TxDone, RxDone
DIO1	RxTimeout	FifoLevel
DIO2	-	SyncAddrDetect
DIO3	ValidHeader ¹	-
DIO4	-	-
DIO5	-	-

1. Reserved for future use. The radio DIO must be connected to IRQ input lines of the MCU for good operation of LoRaWAN™.



LoRa Based Solutions



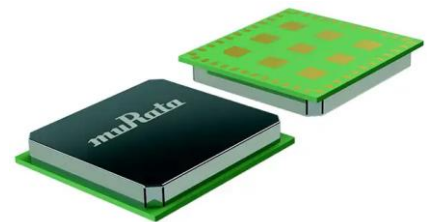
Going with In-Built MCU Modules for 868 MHz Frequency?



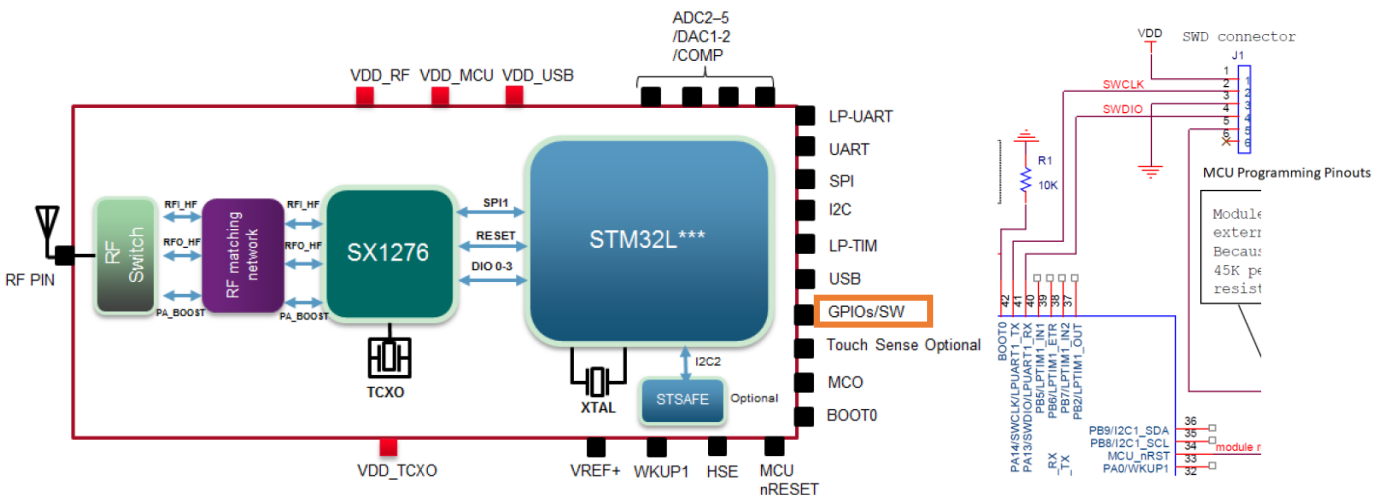
Used ?	Importance	Category	Parametric	STM32L082CZYx	STM32L072CZYx
<input type="checkbox"/>	<input type="checkbox"/>	Security	AES	yes	no

2. Part Number

Ordering Part Number	MCU	Secure element	Description
CMWX1ZZABZ-TEMP	STM32L082	NA	Engineering sample
CMWX1ZZABZ-EVK	STM32L082	NA	Evaluation board
CMWX1ZZABZ-078	STM32L082	NA	MP P/N
CMWX1ZZABZ-TEMP-1	STM32L072	NA	Engineering sample
CMWX1ZZABZ-EVK-1	STM32L072	NA	Evaluation board
CMWX1ZZABZ-091	STM32L072	NA	MP P/N

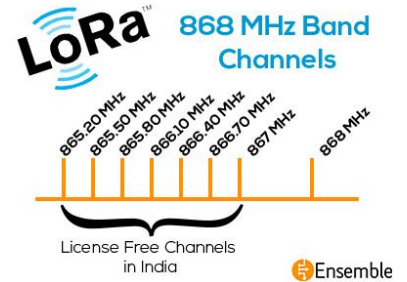


Digikey: 490-16143-1-ND
Price: 1 x 17.82 USD





LoRa Based Solutions

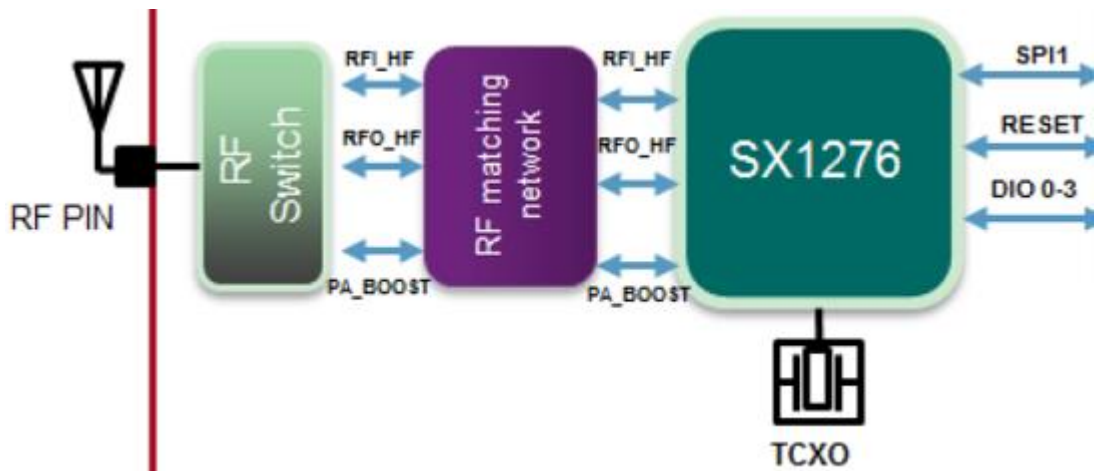


Going with Radio Band Modules for 868 MHz Frequency
Or
Going with your own Custom Module with CE?

CDSNET®

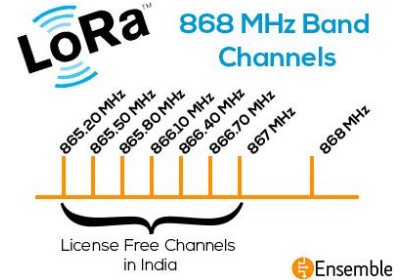


Your Custom Module with RF Can Shield

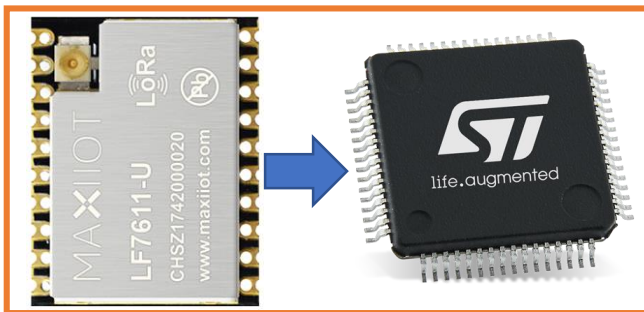




LoRa Based Solutions



Going with Radio Band Modules for 868 MHz Frequency
Or
Going with your own Custom Module with CE?



- UART
- USB 2.0
- Ethernet (Optional)
- GPIOs

Radio DIO used by LoRaWAN™ for SX127x

Table 2: DIO Usage for SX127x in LoRa® and FSK

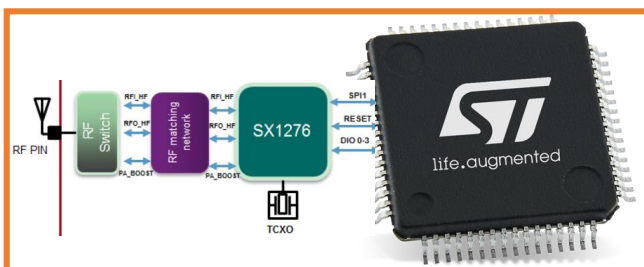
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- UART
- USB 2.0
- Ethernet (Optional)
- GPIOs



LoRa Based Solutions

SOFTWARE/FIRMWARE, IDE AND TOOLCHAIN



LoRa Based Solutions

Going with In-Built MCU Modules for 868 MHz Frequency?

Development Tools – IDE with ToolChain!

The System Workbench toolchain, called SW4STM32, is a free multi-OS software development environment based on Eclipse, which supports the full range of STM32 microcontrollers and associated boards.

The SW4STM32 toolchain may be obtained from the website www.openstm32.org, which includes forums, blogs, and trainings for technical support. Once registered to this site, users will get installation instructions at the Documentation > System Workbench page to proceed with the download of the free toolchain.

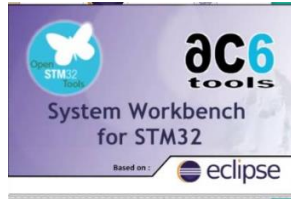
The System Workbench toolchain and its collaborative website have been built by AC6, a service company providing training and consultancy on embedded systems.

This product is supplied by a third party not affiliated to ST. For the latest information on the specification, refer to the third party's website: www.ac6.fr.

FREE IDE's

KEY FEATURES

- Comprehensive support for STM32 microcontrollers, STM32 Nucleo boards, Discovery kits and Evaluation boards, as well as STM32 firmware (Standard Peripheral library or STM32Cube HAL)
- GCC C/C++ compiler
- GDB-based debugger
- Eclipse IDE with team-work management
- Compatible with Eclipse plug-ins
- ST-LINK support
- No code size limit
- Multiple OS support: Windows®, Linux and OS X®



STM32CubeIDE is an all-in-one multi-OS development tool, which is part of the STM32Cube software ecosystem.

STM32CubeIDE 1.0 All-in-one STM32 development tool



STM32CubeIDE is an advanced C/C++ development platform with IP configuration, code generation, code compilation, and debug features for STM32 microcontrollers. It is based on the Eclipse™/CDT framework and GCC toolchain for the development, and GDB for the debugging. It allows the integration of the hundreds of existing plugins that complete the features of the Eclipse™ IDE.

STM32CubeIDE integrates all STM32CubeMX functionalities to offer all-in-one tool experience and save installation and development time. After the selection of an empty STM32 MCU or preconfigured microcontroller from the selection of a board, the project is created and initialization code generated. At any time during the development, the user can return to the initialization and configuration of the IPs or middleware and regenerate the initialization code with no impact on the user code.

STM32CubeIDE includes build and stack analyzers that provide the user with useful information about project status and memory requirements.

STM32CubeIDE also includes standard and advanced debugging features including views of CPU core registers, memories, and peripheral registers, as well as live variable watch, Serial Wire Viewer interface, or fault analyzer.

FREE IDE's



STM32 IDEs





LoRa Based Solutions

Going with In-Built MCU Modules for 868 MHz Frequency?

STM32CubeMX **ACTIVE**

STM32Cube initialization code generator

STM32CubeMX is a graphical tool that allows a very easy configuration of STM32 microcontrollers and microprocessors, as well as the generation of the corresponding initialization C code for the Arm® Cortex®-M core or a partial Linux® Device Tree for Arm® Cortex®-A core, through a step-by-step process.



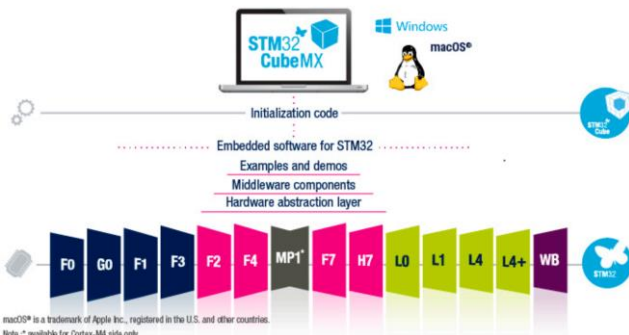
The first step consists in selecting the STM32 microcontroller or microprocessor that matches the required set of peripherals. For microprocessors, the second step allows to configure the GPIOs and the clock setup for the whole system, and to interactively assign peripherals either to the Arm® Cortex®-M or to the Cortex®-A world. Specific utilities, such as DDR configuration and tuning, make it easy to get started with STM32 microprocessors. For Cortex®-M core, the configuration includes additional steps that are exactly similar to those described for microcontrollers.

For microcontrollers and microprocessor Arm® Cortex®-M, the second step consists in configuring each required embedded software thanks to a pinout-conflict solver, a clock-tree setting helper, a power-consumption calculator, and an utility that configures the peripherals (such as GPIO or USART) and the middleware stacks (such as USB or TCP/IP). Eventually the user launches the generation that matches the selected configuration choices. This step provides the initialization C code for the Arm® Cortex®-M, ready to be used within several development environments, or a partial Linux® device tree for the Arm® Cortex®-A. STM32CubeMX is delivered within STM32Cube.

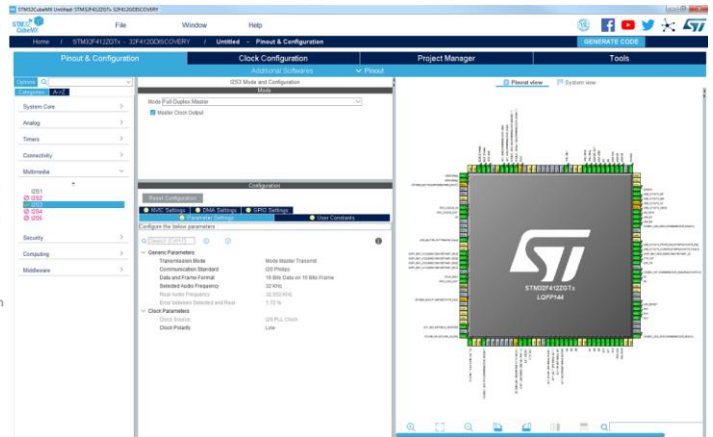
Features

- Intuitive STM32 microcontroller and microprocessor selection
- Rich easy-to-use graphical user interface allowing the configuration of:
 - Pinout with automatic conflict resolution
 - Peripherals and middleware functional modes with dynamic validation of parameter constraints for Arm® Cortex®-M core
 - Clock tree with dynamic validation of the configuration
 - Power sequence with estimated consumption results
- Generation of initialization C code project, compliant with IAR™, Keil® and GCC compilers, for Arm® Cortex®-M core
- Generation of a partial Linux® Device Tree for Arm® Cortex®-A core (STM32 microprocessors)
- Availability as standalone software running on Windows®, Linux® and macOS® (macOS® is a trademark of Apple Inc. registered in the U.S. and other countries.) operating systems, or through Eclipse plug-in

Figure 1. STM32CubeMX within STM32Cube™



macOS® is a trademark of Apple Inc., registered in the U.S. and other countries.
Note * available for Cortex-M4 side only



What is STM32Cube™?

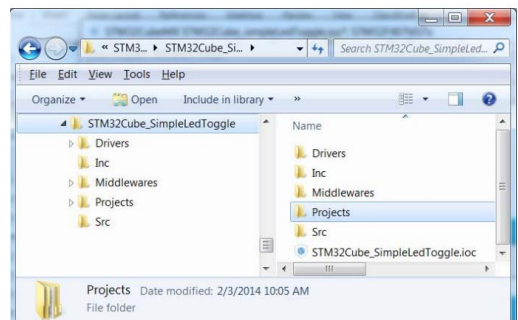
STM32CubeMX is part of STM32Cube™.

STM32Cube™ is an STMicroelectronics original initiative to significantly improve developer's productivity by reducing development effort, time and cost. STM32Cube™ covers the whole STM32 portfolio.

STM32Cube™ includes:

- A set of user-friendly software development tools to cover all the phases of a project development from conception to realization, among which:
 - STM32CubeMX, a graphical software configuration tool that allows the automatic generation of C initialization code using graphical wizards.
 - STM32CubeProgrammer (STM32CubeProg), a programming tool available in graphical and command-line versions.
 - STM32CubeMonitor-Power (STM32CubeMonPwr), a monitoring tool to measure and help in the optimization of the power consumption of the MCU.
- STM32Cube™ MCU Packages, comprehensive embedded-software platforms specific to each microcontroller series (such as STM32CubeF4 for the STM32F4 Series), which include:
 - STM32Cube™ hardware abstraction layer (HAL), ensuring maximized portability across the STM32 portfolio.
 - STM32Cube™ low-layer APIs, ensuring the best performance and footprints with a high degree of user control over the hardware
 - A consistent set of middleware components such as RTOS, USB, TCP/IP, and graphics.
 - All embedded software utilities with full sets of peripheral and applicative examples.

C code generation output folder





LoRa Based Solutions

ADDING RF SOFTWARE MIDDLEWARE TO YOUR PROJECT TEMPLATE



LoRa Based Solutions

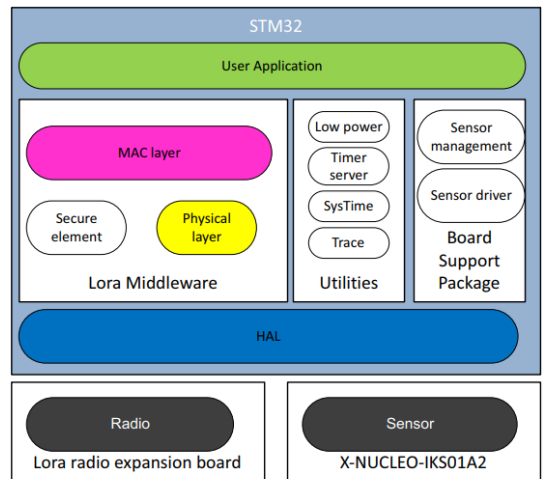
Going with In-Built MCU Modules for 868 MHz Frequency
As a Slave Node Device? Firmware : Non-RTOS.



Digikey: 490-16143-1-ND



The I-CUBE-LRWAN Expansion Package consists of a set of libraries and application examples for STM32L0, STM32L1 and STM32L4 Series microcontrollers acting as end-devices.



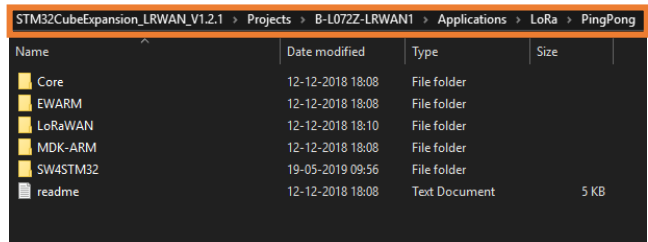
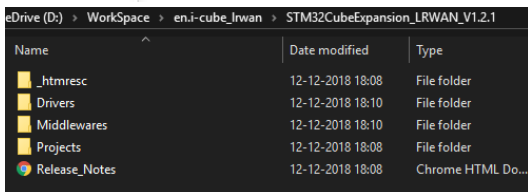
MSv41536V3



I-CUBE-LRWAN

STM32 LoRa[®] software expansion for STM32Cube

Part Number	General Description	Supplier	Supported Devices	STM32CubeMX Compatible	Deliverable	License type	Function	MCU peripherals	Middleware
I-CUBE-LRWAN ACTIVE	LoRaWAN software expansion for STM32Cube (UM2073)	ST	STM32	-	Source	Free	Connect	Connectivity	LORAWAN



PingPong/readme.txt
MCD Application Team
This application is a simple demo application software between two LoRa Objects containing a STM32Lxxx-Nucleo board and LoRa Radio expansion board.

Table 2. Software component license agreements

Software component	Owner	License
Cortex [®] -M CMSIS	Arm [®]	Open source BSD
HAL STM32 L0/L1/L4	ST	Open source BSD
LoRaWAN [™] stack	SEMTECH	Open source BSD
Project examples	ST	Ultimate Liberty (source release)



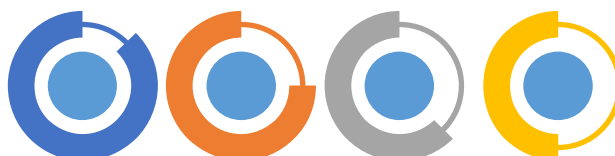
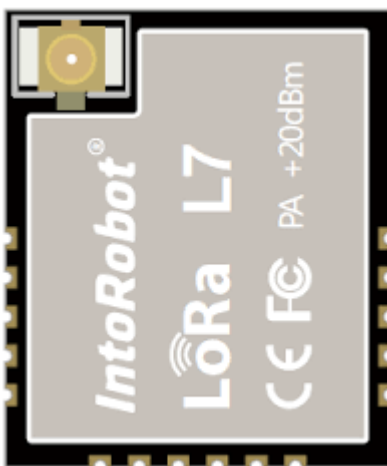
LoRa Based Solutions

Going with Modules for Other than 868 MHz Frequency
With and without MCU.



进口SX1278芯片
MCU STM32L151CUB6A
LoRaWAN

20KM+





Long Range SigFox Based Solutions

Sigfox is the world's leading provider of connectivity for the **Internet of Things (IoT)**. Sigfox has built a global network to listen to billions of devices broadcasting data. **Sigfox** can pick-up very small signals sent by IoT devices from around the world – using the lowest amount of energy to the point where natural energy harvesting technology will be enough to power data transmissions.

A powerful solution based on **3 pillars**:

- **Low energy consumption:** our unique connectivity solution provides the lowest energy-consumption device-to-cloud. By simplifying communications, we enable unbeatable low energy consumption. Soon, there'll be no need for replacing or re-charging batteries since the devices will generate energy themselves.
- **Low cost:** with its simple approach to connectivity, Sigfox provides extremely price-competitive connectivity subscriptions and even more importantly, enables extremely simple and cost-efficient silicon modules.
- **Complementary technology:** Sigfox is compatible with Bluetooth, GPS 2G/3G/4G and Wifi. By combining other connectivity solutions with Sigfox, business cases and user experience can be drastically improved.

Sigfox, it's about connecting the unconnected! An inexpensive, long distance and lower power solution that's primed for multiple industrial and consumer applications. Through its global LPWA network and rich ecosystem of expert partners, Sigfox delivers out-of-the box, two-way, secured communication services to unlock the true potential of the Internet of Things (IoT). Sigfox provides a standard way of collecting data from sensors and devices with a single, standard-based set of APIs. Besides, the Sigfox disruptive technology complements traditional cellular M2M by enabling global, ubiquitous, ultra-long battery life solutions at the lowest cost.

Sigfox Zones

The Sigfox global network operates in different radio-frequency bands throughout the world. Multiple radio configurations exist:

- Zone 1:** Europe, Oman, South Africa
- Zone 2:** USA, Mexico, Brazil
- Zone 3:** Japan
- Zone 4:** Australia, New Zealand, Singapore, Taiwan, Hong Kong, Colombia, Argentina

Sigfox Protocol Library Architecture

The Sigfox Protocol Library is an abstraction layer. It connects your application software to the radio chipset through the manufacturer's APIs.

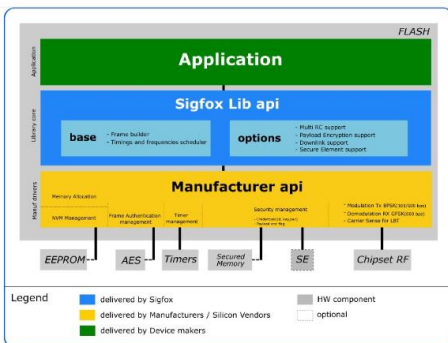
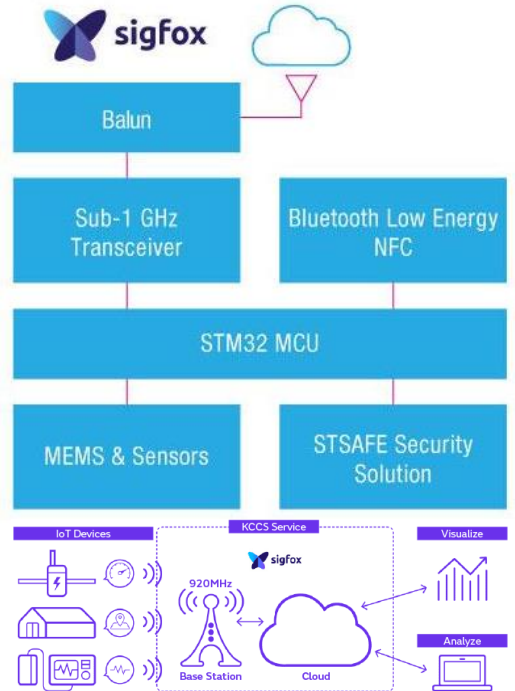


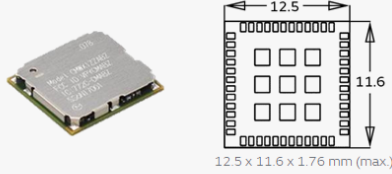
Figure 1: Sigfox Protocol Library architecture



All prices are exclusive of taxes.

Prepared By: Annim Banerjee



Part Number	CMWX1ZZABZ-07B
Appearance & Dimensions	
Supporting Zone	RCZ1, 2, 4 (*RCZ3 in plan)
(Z1: Europe, Oman, South Africa Z2: USA, Mexico, Brazil Z3: Japan Z4: Australia, New Zealand, Singapore, Taiwan, Hong Kong, Columbia, Argentina)	
Packaging	Metal Shield Can
Chipset	Semtech SX1276 ultra-long range spread spectrum wireless transceiver
MCU	STMicro STM32L0 series ARM Cortex M0+ 32 bit MCU
FLASH	192kbytes
Antenna Configuration	External
Host Interfaces	UART/SPI/I ² C
Other Interfaces	GPIO/ ADC
LGA	57 pads
RF Tx Power	+14dBm (+20dBm with PA boost)
Vdd	2.2V to 3.6V
Operating Temperature Range	-40°C to +85°C
Certifications	Sigfox Certified



Long Range SigFox Based Solutions



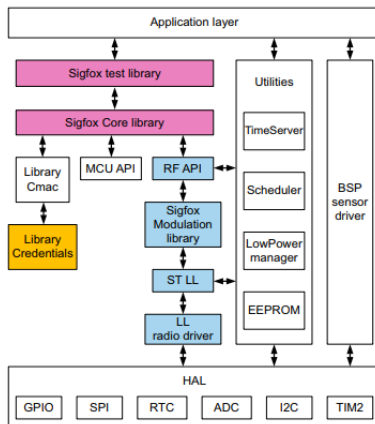
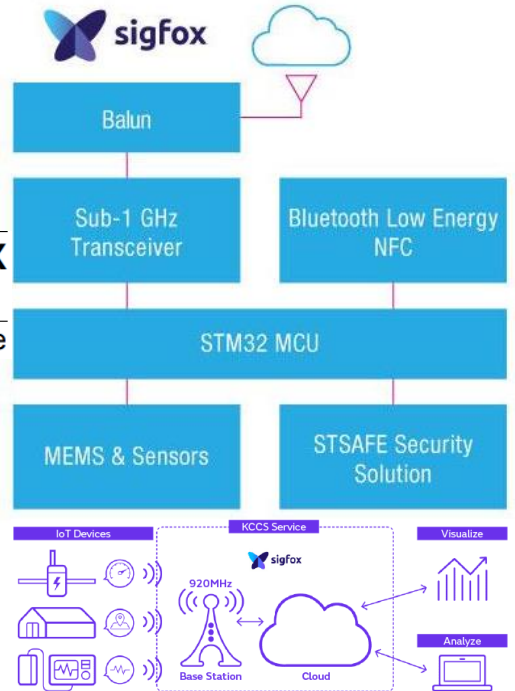
X-CUBE-SFOX

Sigfox™ software expansion for STM32Cube

Description

Sigfox™ is a long range wireless area network allowing low-power sensors to benefit from a planetary network, enabling end devices with low BOM cost.

The X-CUBE-SFOX Expansion Package consists of a set of libraries, open routines and application examples for the Murata CMWX1ZZABZ-xxx module acting as an end device.



License

X-CUBE-SFOX is delivered under the *Mix Ultimate Liberty+OSS+3rd-party V1* license.

The software components provided in this package come with different license schemes as shown in [Table 1](#).

For more details, refer to the license agreement of each component.

Table 1. Software component license agreements

Software component	Owner	License
Cortex®-M CMSIS	Arm®	Open source BSD
HAL STM32L0	STMicroelectronics	Open source BSD
Project examples	STMicroelectronics	Ultimate Liberty (source release)

The X-CUBE-SFOX Expansion Package runs on STM32 32-bit microcontrollers, based on the Arm®(a) Cortex®-M processor.

Part Number	CMWX1ZZABZ-078
Appearance & Dimensions	 12.5 x 11.6 x 1.76 mm (max.)
Supporting Zone	RCZ1, 2, 4 (*RCZ3 in plan)
	(Z1: Europe, Oman, South Africa Z2: USA, Mexico, Brazil Z3: Japan Z4: Australia, New Zealand, Singapore, Taiwan, Hong Kong, Columbia, Argentina)
Packaging	Metal Shield Can
Chipset	Semtech SX1276 ultra-long range spread spectrum wireless transceiver
MCU	STMicro STM32L0 series ARM Cortex M0+ 32 bit MCU
FLASH	192kbytes
Antenna Configuration	External
Host Interfaces	UART/SPI/I ² C
Other Interfaces	GPIO/ ADC
LGA	57 pads
RF Tx Power	+14dBm (+20dBm with PA boost)
Vdd	2.2V to 3.6V
Operating Temperature Range	-40°C to +85°C
Certifications	Sigfox Certified



Long Range SigFox Based Solutions



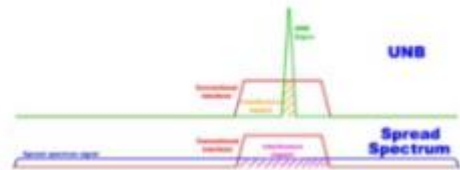
sigfox vs.



1. Ultra Narrow Band (UNB) →



2. Spread Spectrum (SS) →



	SIGFOX <small>the network & ecosystem</small>	LoRa
BUSINESS MODEL	International network and structure to enable global ecosystem.	Technology sell
TECHNOLOGY MATURITY	Mature	Private network deployments, no national network deployments
ECOSYSTEM	World #1. Devices available now.	Infancy
RANGE	Best in class	Average to good
DEPLOYMENT COST & COMPLEXITY	Low	Medium

	SIGFOX	LORA
Frequency band	868/902 MHz (ISM)	433/868/780/915 MHz (ISM)
Urban range	3-10km	2-5km
Rural range	30-50km	15-20km
Packet size	12 bytes	Defined by user
Devices per access point	1M	100k
Status	In deployment	Spec released June 2015
Topology	Star	Star



LoRa Based Solutions



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