

Intro to STM digital world

MCU, WireLess, MEMS, PLM, etc

By: Enrico Marinoni

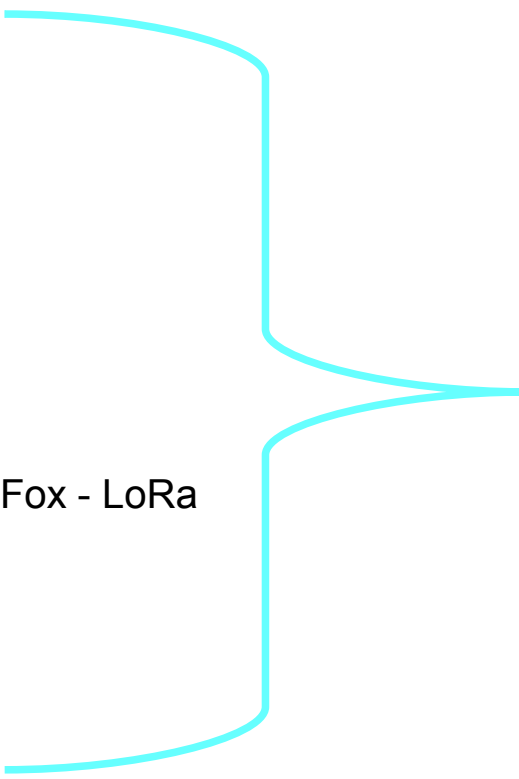
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Summary

- Introduction
- MCU
 - STM8
 - STM32
 - SPC5
- BlueTooth
- Sub1Ghz
 - LoRa
 - SigFox
 - Comparison SigFox - LoRa
 - 6LoWPAN
- PLM
- NFC & RFID
- MEMS



*Click on the labels
for go directly to
relative page.*

Introduction

Please refer to my [website](#) that is a database concerning MCU, PLM, MEMS, WireLess, etc.

- I suggest you to choose, in the **black box**, the topics of your interest.
- I also suggest to use the **Search Box** present in the right of the page.

EMCU

STMicroelectronics digital components
(by E.Marinoni)



This software, schematics, tutorial, etc are provided "as is" "no guarantee is released", the use of the released material here is only for a rough guide.
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*The main idea of EMCU.EU and EMCU.IT is:
if all people share their experience (in our case HW/SW) the world will be better*

Home MCU Motor Control & C RF & Connectivity MEMS & Sensors Wireless Charger IoT & Security MKT ST Days References
MicroPython & Python Linux Standard Connectors Truly useful electronic applications Arduino and STM32 Free time Who I'm Privacy

STM32 Standard Peripheral Libraries to STM32Cube Low-Layer (LL) APIs migration tool

Posted on 21/09/2017 by wp_2592768

[STM32 Standard Peripheral Libraries to STM32Cube Low-Layer APIs migration too](#)

ATTENTION
Use FIREFOX or CHROME for a clear view of the images present in this web site

September 2017

Intro to STM MCU



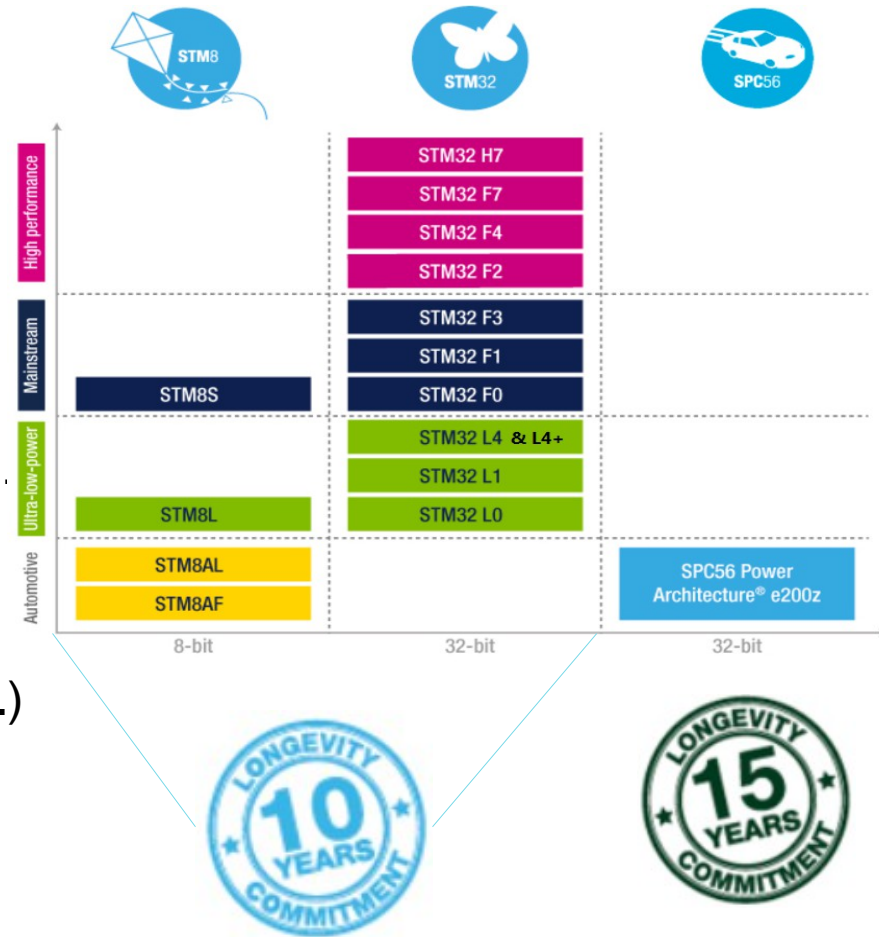
Intro to STM MCU

STM offers three MCU families that are:

STM8 8bit core, 16 timers, 10bit ADC, EEPROM, etc
Available in Ultra Low Power version (**STM8L**) with RTC and LCD driver.
Available for automotive applications (**STM8A**).

STM32 32bit core, based on CORTEX Mx family
Available in Ultra Low Power version (**STM32L**)

SPC5 32bit core for automotive applications



STM8

STM8



STM8 1/2



ST's 8-bit microcontroller platform is implemented around a high-performance 8-bit core and a state-of-the-art set of peripherals.

This platform is manufactured using an ST-proprietary embedded non-volatile memory technology.

The STM8 allows fast and safe development through enhanced stack pointer operations, advanced addressing modes and new instructions.

Performance: @24MHz – **6 DMIPS** – **5 CoreMark**

The STM8 platform supports four product series:

The STM8 platform supports four main product lines:

STM8S, general-purpose MCU

STM8L, ultra-low-power EnergyLite™ MCU

STM8A, automotive MCU

STM8AL, automotive ultra-low-power MCU



STM8 2/2

The nice thing is that the STM for STM8 family gives us the **libraries in C** to manage all the peripherals of STM8. In the package of the libraries there are also included dozens of examples concerning the use of all the STM8 peripherals.

A wide choice of solutions.

starter kits Numerous boards



STM8L101-EVAL
STM8L1526-EVAL STM8/128-EVAL STM8-SK/RAIS ST-ICE

IDE solutions



(*) C compiler free of charge

STM8 promotion kits



STM8/128_MCKIT ST-LINK-v2

Software/Hardware solution providers



- [STM32 & STM8 selector is here](#)

STM32

STM32

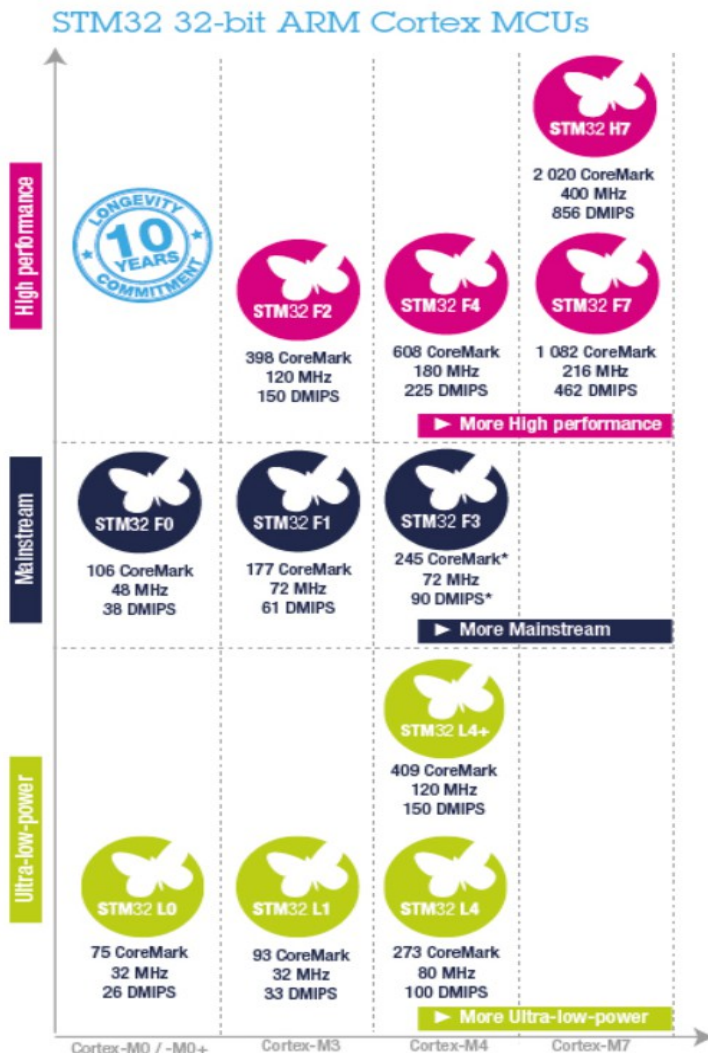


STM32 1/5

The **STM32** family is a 32-bit MCU based on the ARM® **Cortex®-Mx** processor is designed to offer new degrees of freedom to MCU users.

It offers a 32-bit product range that combines very high performance, real-time capabilities, digital signal processing, and low power, low voltage operation, while maintaining full integration and ease of development.

The unparalleled and large range of STM32 devices, based on an industry-standard core and accompanied by a vast choice of tools and software, makes this family of products the ideal choice, both for small projects or an entire platform.



STM32 2/5

- What should I use to develop on STM32 ?
- How to install the toolchain for develop on STM32
- How to program the STM32
- CUBE or CUBE-MX & Library
- Tutorial on CUBE-MX and CUBE Library
- STM32 Open Development Environment
- STM32 – Evaluation Boards
- STM32 Class B – Self Test Library
- STM32 SIL2/3
- STM32 cryptographic library
- Graphical libraries for STM32
- STMicroelectronics video on YouTube
- STM32 & STM8 selector is here

STM32 Ecosystem



Software tools

STM32CubeMX
Configuration and initialization tool

Integrated Development Environments (IDE)

STM Studio Monitoring tool

► More software tools



Embedded software

STM32Cube embedded software

STM32Cube embedded software expansion

► More embedded software



Hardware tools

STM32 Nucleo development boards,
Discovery kits and Evaluation boards

STM32 Nucleo expansion boards

ST-LINK in-circuit debugger/programmer



Join the STM32 Community!
community.st.com/stm32

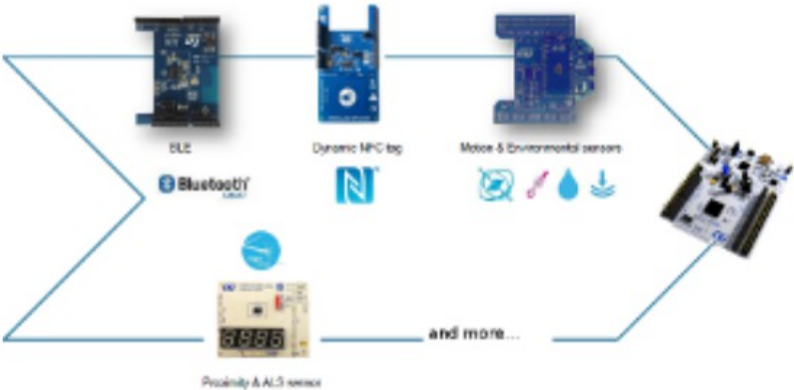
STM32 3/5

STM32 – Evaluation Boards

X-NUCLEO expansion board



	STM32 Nucleo	Discovery kits	Evaluation boards
Typical use case	Flexible prototyping, community	Prototyping, creative demos	Full feature evaluation
Extension possibilities	+++	++	+++
Connectivity	Arduino™ ST Morpho	ST	ST



STM32 4/5

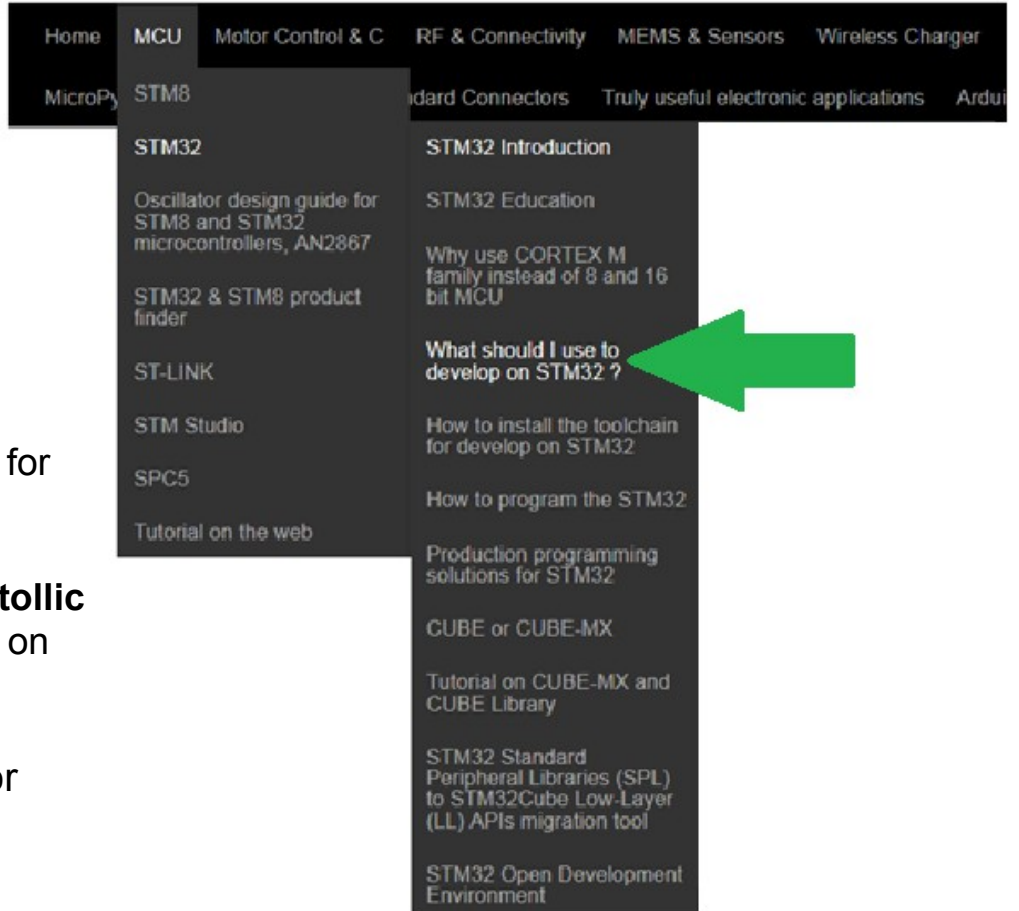
See how STM can help release your creativity for the next 10 years:

- [Participate in the STM Community](#), a powerful social community application where you can ask and answer questions, share projects, events, videos, knowledge, or learn from and engage with other community members
- [Subscribe to STM newsletters](#) to be the first informed about our innovative products and solutions as well as special events including seminars, conferences, webinars and on-line courses.
- [Watch one of STM recorded webinars](#) available for on-demand viewing.
- Tutorial, examples and more, are available on my STM32 pages

Home	MCU	Motor Control & C	RF & Connectivity	MEMS & Sensors	Wireless Charger
MicroPy	STM8	Standard Connectors	Truly useful electronic applications	Ardui	
	STM32	STM32 Introduction	STM32L0xx – ultra-low-power EnergyLite™ MCU – Cortex M0+		
	Oscillator design guide for STM8 and STM32 microcontrollers, AN2867	STM32 Education	STM32L1xx – ultra-low-power EnergyLite™ MCU – Cortex M3		
	STM32 & STM8 product finder	Why use CORTEX M family instead of 8 and 16 bit MCU	STM32L4xx – ultra-low-power EnergyLite™ MCU – Cortex M4		
	ST-LINK	What should I use to develop on STM32 ?	STM32F0xx – Cortex M0		
	STM Studio	How to install the toolchain for develop on STM32	STM32F1xx – Cortex M3		
	SPC5	How to program the STM32	STM32F2 – High Performance – Cortex M3		
	Tutorial on the web	Production programming solutions for STM32	STM32F3 – mixed-signal MCU – Cortex M4		
		CUBE or CUBE-MX	STM32F4 – High Performance – Cortex M4		
		Tutorial on CUBE-MX and CUBE Library	STM32F7xx – high performance – Cortex M7		
		STM32 Standard Peripheral Libraries (SPL) to STM32Cube Low-Layer (LL) APIs migration tool	STM32H7xx – very high performance – Cortex M7		
		Environment			

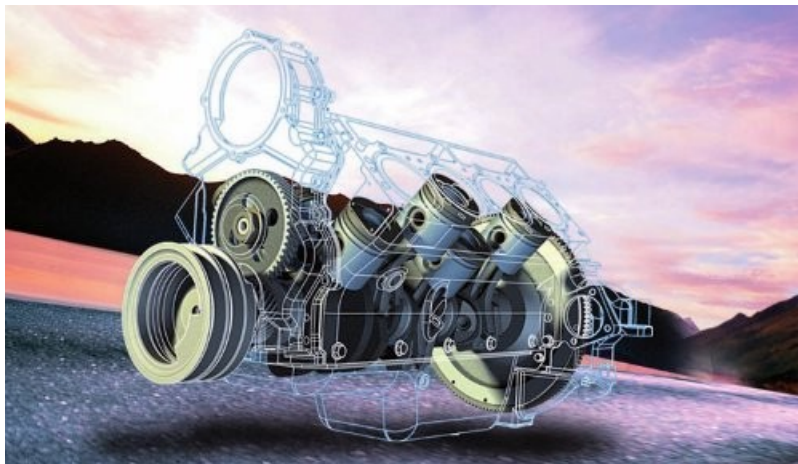
IDE - Compiler

- KEIL free for all STM32 until 32K of exe
- KEIL totally free (no limits) for STM32F0 & STM32L0
- IAR limited for small STM32 to 8K of exe and for other limited to 32K of exe
- ATOLLIC, at the end of 2017, **ST acquires Atollic** and now is totally free for all STM32 (it based on GCC)
- AC6 – System WorkBench is totally free for STM32 (based on GCC)
- mBED (from ARM)



SPC5

SPC5

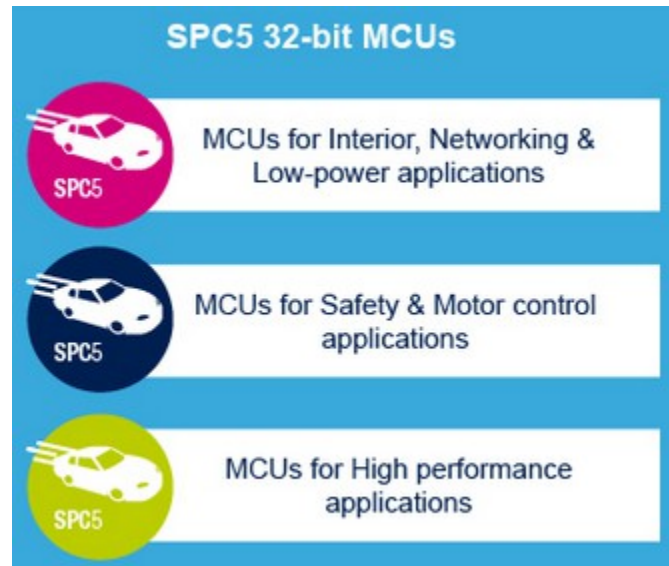


SPC5 1/4

ST's **SPC5** 32-bit microcontrollers are designed using industry's standard **Power Architecture®** and STM's proprietary embedded Flash technology.

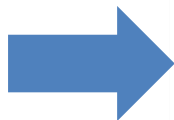
They combine a scalable range of single, dual and multi-core solutions (Power Architecture e200z0 to e200z4) with innovative peripheral sets that are optimized for **car applications**, such as **engine management, chassis, safety, body control, advanced driver assistance**, and for all applications requiring long-term reliability.

- Single- to multi-core architectures
- Technology range from 90 nm down to 40 nm
- Full performance up to **150 °C**
- **15** years product longevity
- High-end peripherals set, including **ISO CAN FD**
- Internal manufacturing (front-end and back-end) for security of supply
- Safety compliance to standards such as **ISO 26262** (up to **ASIL-D**)
- **Data security compliance** to standards including **SHE** (Secure Hardware Extension) and **EVITA** (e-safety vehicle intrusion protected applications)
- Complete development environment (from free-of-charge IDE, code compiler and low-cost debugger solution up to high-end solutions supporting **AUTOSAR** designs).

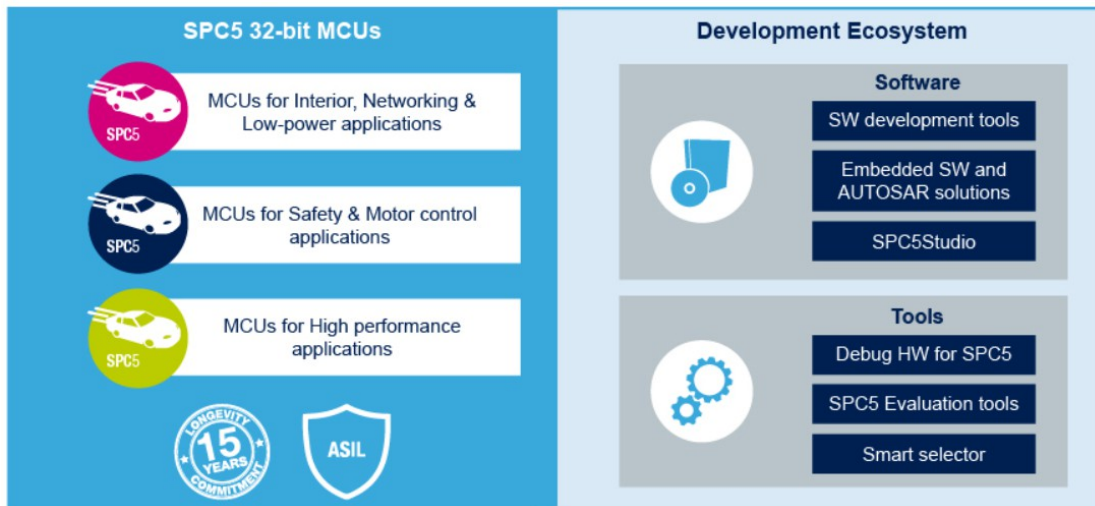


SPC5 2/4

SPC5-STUDIO is a free tools for develop on the SPC5 families



- A basic kit for test/development on SPC5 is:
SPC5-Studio (IDE and Compiler) +
SPC5-UDESTK (Emulator) +
SPC5x-Discovery (EvaBoard)
- SEL-SPC5 – 32-bit Automotive MCUs Smart Selector** is [here](#)





SPC5 MCUs toolchain



Discovery kits

Quick starter kit for early evaluation

ST Discovery boards enable the user for a quick evaluation of main device features



Premium boards

Complete HW solutions for advanced development

ST Premium boards ensure full access to device's features and functionalities



SPC5Studio

Freeware Eclipse based Development Studio

SPC5Studio integrates our Resources Configurator, Code Generator supporting major third party tools



Embedded Software & AUTOSAR Solutions

Drivers and Software Libraries

Crypto and flash SW Libraries
Core & Instruction Self test Libraries
AUTOSAR MCAL

ST network of third parties and partners

- IDE/Compilers
 - Green Hills MULTI
 - Wind River Compiler and Workbench
 - Cosmic Compiler
 - HighTec
- Debuggers/Emulators
 - Lauterbach PowerDebug and PowerTrace
 - PLS UAD/UDE
 - iSystem ic3000
 - Raisonance Rlink
- Calibration tools
 - VertiCal and proprietary calibration solution
- Operating systems and SW
 - EB
 - ETAS
 - Vector
 - STMicroelectronics and partners
- Trainings
 - MicroConsult for products and toolchain
 - Intecs for getting started with Autosar
- Design House
 - Intecs
 - Raw Power



WireLess

- WiFi modules
- Bluetooth component & modules
- Sub1Ghz component & modules
- SigFox
- LORA
- NFC & RFID



Bluetooth



Bluetooth

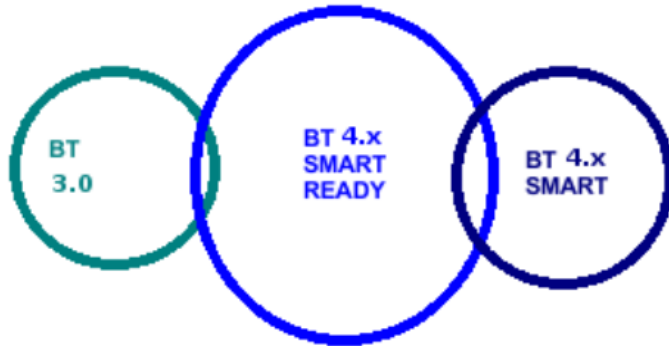


BT technology

Up to now there are different release of BT, for example there is the Classic BT **v2.1**, **v3.0** and there is the new **BTLE v.4.x**

For see the differences from the different release of BT see [here](#) and [here](#).

Here I want to highlight the differences inside the BTLE 4.x that are: **Smart Ready** and **Smart** (see below).



Very important is that with the BTLE is not necessary use the Apple Crypto Chip for release the APP for iOS.

BT Classic



- **BT Classic** (Version 3.x only modules)
 - Modules
 - **ODP2** Bluetooth v.3.0 Class2 – iAP2
 - **ODP1** Bluetooth v.3.0 Class1 – iAP2
 - **Evaboard** for **IoT** application (**bridge** WiFi, Sub1GHz and BT classic) is the: **STEVAL-IDI004V2**

BLE or BTLE



BTLE (Versioni 4.x) Components

BlueNRG-1 Bluetooth Low Energy System On Chip (BTLE v.4.0)

The BlueNRG-1 extends the features of award-winning BlueNRG network processor, enabling the usage of the **embedded Cortex M0 for running the user application code.**

The evaboard is:

STEVAL-IDB007V1 - Evaluation platform based on the BlueNRG-1

See [this](#) video and also [this](#) (GUI explanations).

BlueNRG-2 - Bluetooth Low Energy System On Chip (BTLE v.4.2)

The BlueNRG-2 extends the features of award-winning BlueNRG network processor, enabling the usage of the **embedded Cortex M0 for running the user application code.**

The evaboard is:

STEVAL-IDB008V1 - Evaluation platform based on the BlueNRG-2

BlueNRG-MS Bluetooth Low Energy Network Processor supporting (BTLE v.4.1)

The evaboard are:

STEVAL-IDB005V1 Bluetooth low energy board based on the BlueNRG-MS network processor

STEVAL-IDB005V1D - RF daughterboard platform based on BlueNRG-MS

STEVAL-IDB006V1 - BlueNRG-MS based Bluetooth® Smart USB

STEVAL-WESU1 - Wearable sensor unit reference design for fast time to market

BLE or BTLE

BTLE (Versioni 4.x) Modules

SPBTLE-RF – Very low power modules for Bluetooth v4.1 Smart (BTLE v.4.1)

This module is based on BlueNRG

The evaboard is: **X-CORE-IDB05A1** Bluetooth Low Energy expansion board based on SPBTLE-RF module.

SPBTLE-RF0 - is an easy to use Bluetooth® Low Energy network processor module, compliant with Bluetooth v4.1.

The SPBTLE-RF0 module supports multiple roles simultaneously, and can act at the same time as Bluetooth Low Energy master and slave device.

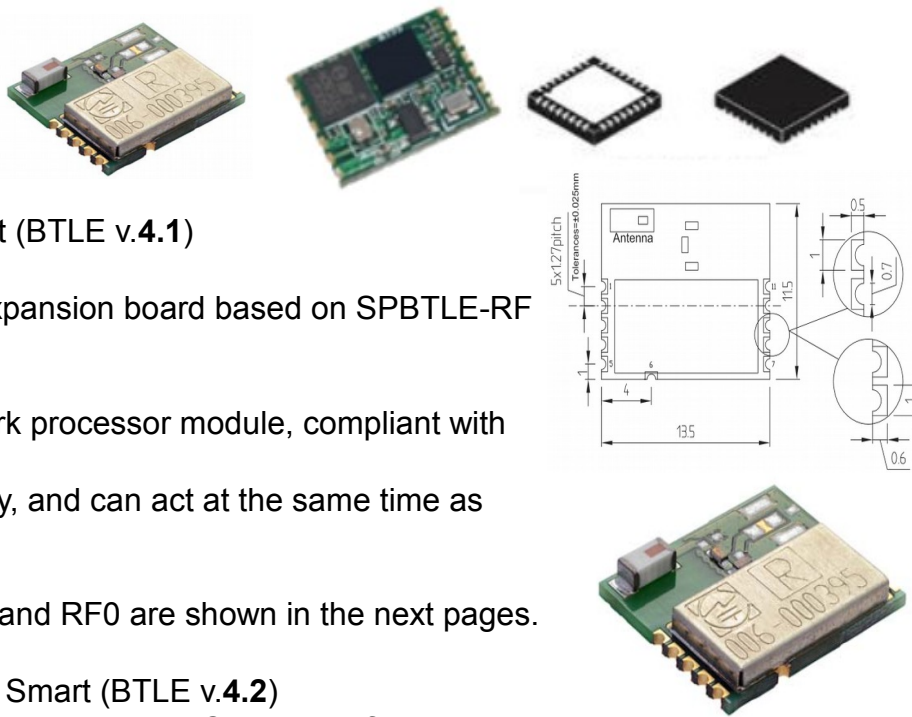
The RF is on top for low consumption respect to the RF0.

RF0 is very similar to RF but cost less. The differences from RF and RF0 are shown in the next pages.

SPBTLE-1S – SPBTLE-1 low power module for Bluetooth v.4.2 Smart (BTLE v.4.2)

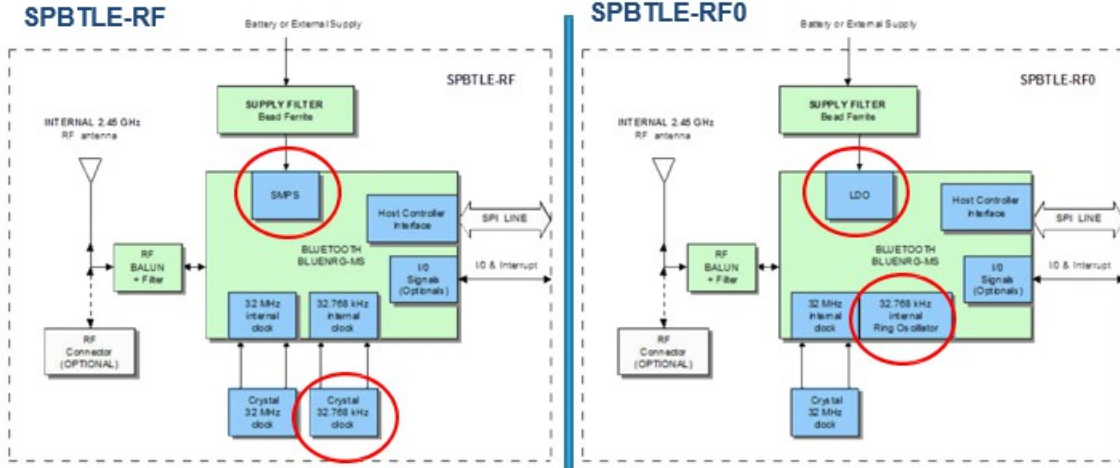
This module is based on BlueNRG-2 , **enabling the usage of the embedded Cortex M0 for running the user application code**

The evaluationboard is: **STEVAL-IDB007V1M** Bluetooth Low Energy based on BlueNRG-2, enabling the usage of the embedded Cortex M0 for running the user application code



BLE or BTLE

SPBTLE-RF vs SPBTLE-RF0



	SPBTLE-RF	SPBTLE-RF0
Voltage regulator	SMPS	LDO
Low Speed clock	Crystal oscillator	Internal Ring Oscillator
Status	Sampling and MP	Sample 2017Q1, MP by the end Q2 2017

BLE or BTLE

SPBTLE-RF vs SPBTLE-RF0 BlueNRG current Consumption Estimation Tool 1.2



General Advertising Scanning Connection

Type of Device: BlueNRG-1 **DC-DC Converter Active** ☒

High Power mode ☒ Pout 5 (+2dBm)

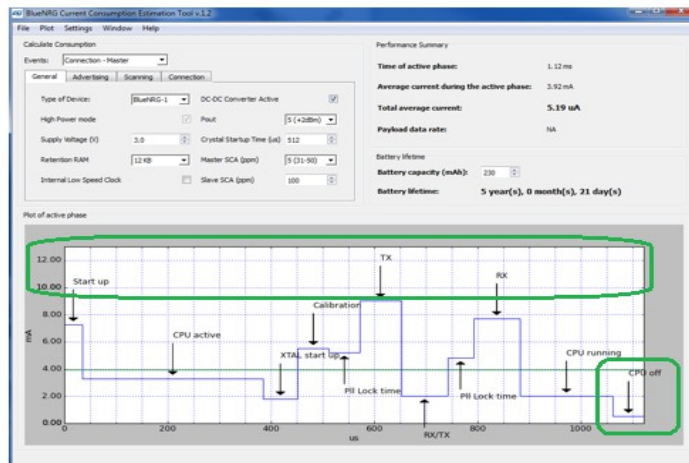
Supply Voltage (V) 3.0 Crystal Startup Time (us) 512

Retention RAM 12 KB Master SCA (ppm) 5 (31-50)

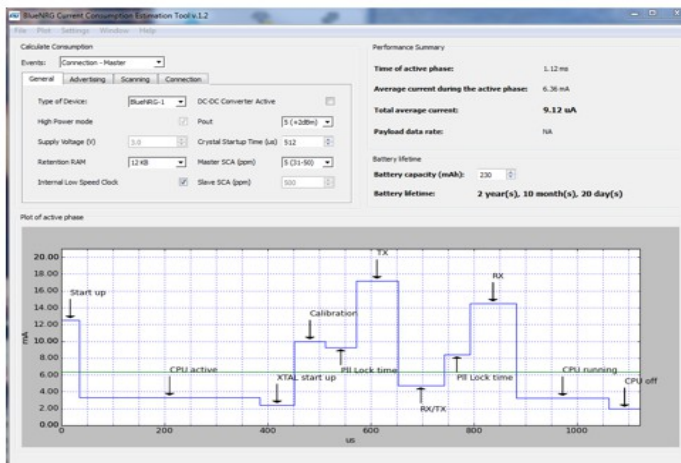
Internal Low Speed Clock ☐ Slave SCA (ppm) 100

STSW-BNRG001

SPBTLE-RF

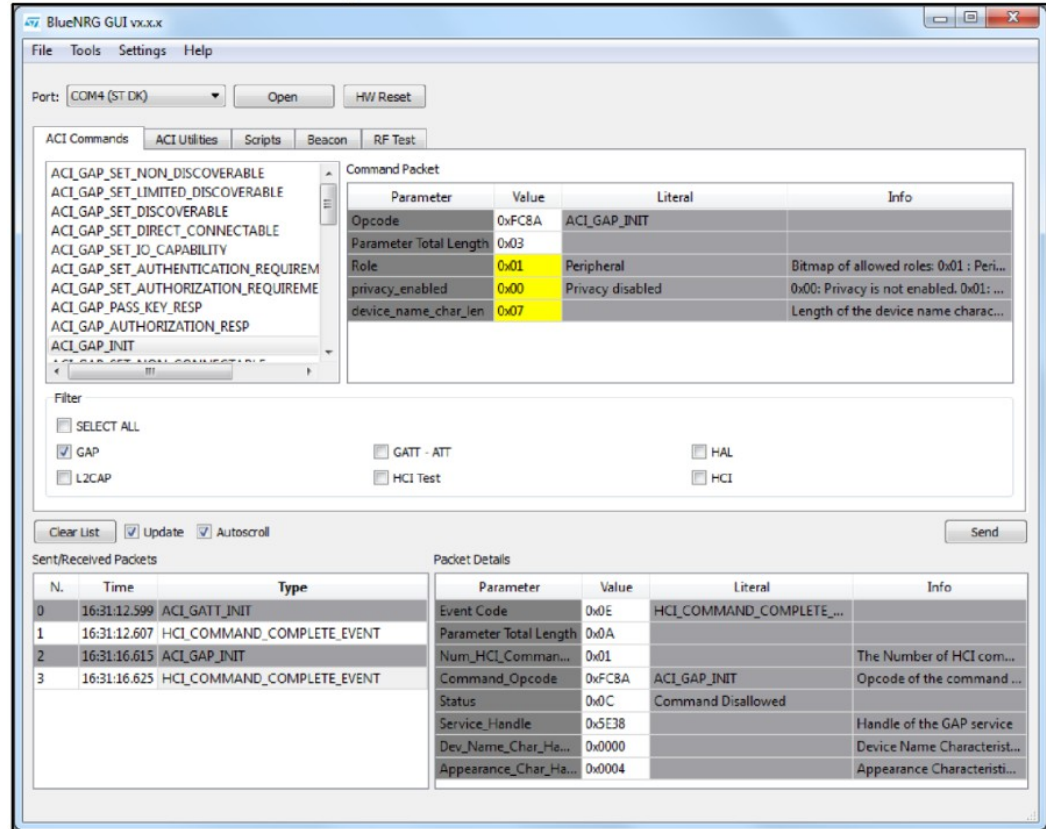


SPBTLE-RF0



BLE or BTLE -SDK

- **STSW-BLUENRG1-DK** for *BlueNRG-1* and *BlueNRG-2 DK*
- **STSW-BNRGUI**, for *BlueNRG* family GUI
- **STSW-BNRG001**, *BlueNRG* current consumption estimation tool



BLE or BTLE - tutorial & link



How to use **X-NUCLEO-IDB04A1** (BlueNRG evaboard) + **NUCLEO-L053R8** and **BlueNRG APP** for **Android** and **iOS** (Apple) is [here_](#).
The **VIDEO** is [here](#).

Creating a **BTLE** star network connected via **Wi-Fi** to **IBM Bluemix** cloud is [FP-NET-BLESTAR1](#)

[BLUEMICROSYSTEM1](#) – Bluetooth low energy and sensors software expansion for STM32Cube

OSXSmartConnPS – Bluetooth low energy profiles for the X-CUBE-BLE1 expansion for STM32Cube

[See the BlueNRG + CUBE + iPhone video](#) (sorry for the poor quality of the video)

[Quick Start Guide – Bluetooth Low Energy expansion board based on the BlueNRG for STM32 NUCLEO \(X-NUCLEO-IDB04A1\)](#) (See from pg.15)

BALF-NRG-01D3 – 50 Ω nominal input / conjugate match balun to BlueNRG transceiver, with integrated harmonic filter

BlueNRG [Guideline from Evaluation to Production](#) V3.0

[AN4630](#) – PCB design guidelines for the **BlueNRG** and **BlueNRG-MS** devices

[PM0237](#) – Programming manual

[Università degli Studi di Padova](#) (In Italian language) – Confronto tra Bluetooth Basic Rate e Bluetooth Low Energy

[SensiBLE](#) IoT Module

Sub1Ghz

Sub1Ghz



Sub1Ghz

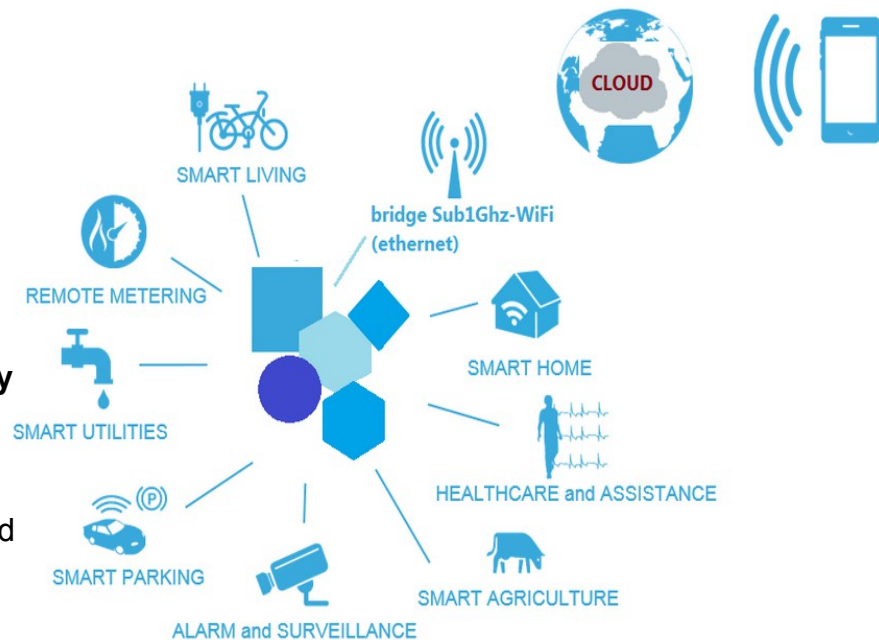
STM Sub1GHz solutions includes **transmitters**, **transceivers** and **modules** supporting a host of different applications in home and building automation (Smart Home and Smart City) as well as industrial process control (Smart Factory) and automated metering infrastructures (Smart Grid) or, more broadly, for the Internet of Things (IoT).

They support network operated in the license-free **ISM** and **SRD** frequency bands at **169, 315, 433, 868, and 915 MHz** and several modulation schemes such as **2(G)FSK, 4(G)FSK, OOK** and **ASK**.

STM transceivers also support advanced technologies such as **frequency hopping, auto-acknowledgment** and **antenna diversity** to secure error-free data transmission even in harsh-environmental or challenging-logistical conditions

STM Sub1GHz modules, operating in IMS and SMD band, are based on our transceivers and are equipped with antenna, **xtal** and **balun**. **Modules** are available with or without the host microcontroller for enhanced flexibility. They provide a ready to use solution, fully RF, **ETSI, IC, RED** and **FCC** certified, that helps minimize time to volume.

STM ICs and module are supported by an **extensive set of evaluation boards, software, firmware** and **application notes**.



Sub1Ghz - components

S2-LP – transceiver (TX/RX)

Band: **433**, **868** and **915/920** MHz

Modulation: 2(G)FSK, 4(G)FSK, OOK, ASK and **-135** dBm.

Consumption: **7** mA **RX** and **10** mA **TX @ +10** dBm

Ready for: **Sigfox**, **Wireless M-Bus**, **6LoWPAN**, **ENOCLEAN** and **IEEE 802.15.4g** networking connectivity, simplifying the design of **IoT** applications and enabling remote sensors to directly connect to the cloud without the need for a local gateway.

The evaboard is: **STEVAL-FKI868V1** – Sub-1GHz transceiver development kit based on S2-LP



- **P2P** based on S2-LP (STEVAL-FKI868V1) and NUCLEO-L053R8 is [here](#).
- Info regarding **SigFox** are [here](#).
- Info regarding **ENOCLEAN** are [here](#).

Sub1Ghz - components

STS1TX – transmitter (TX only)

Band: **169, 315, 433, 868, and 915/920** MHz

Modulation: **2FSK, GFSK, MSK, GMSK, OOK, ASK**
and **-120** dBm

SPIRIT1 – transceiver (TX/RX)

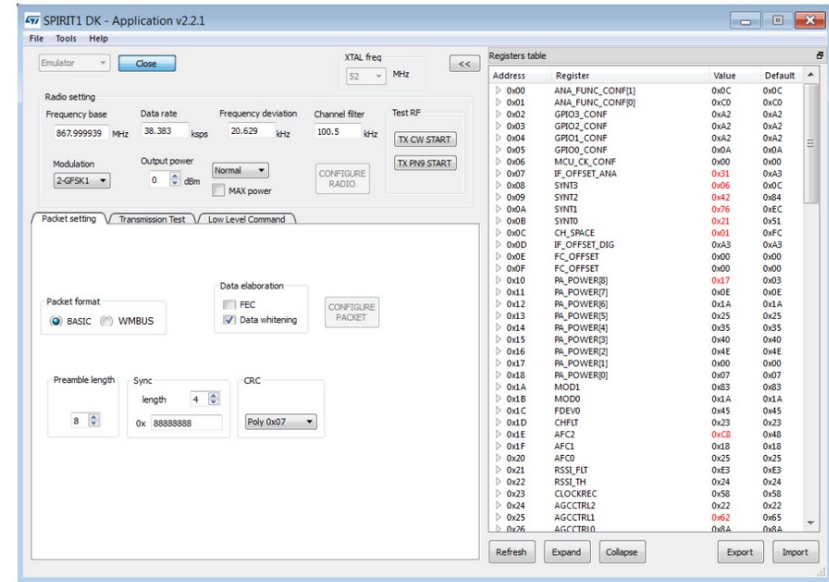
Band: **169, 315, 433, 868, and 915/920** MHz

Modulation: **2FSK, GFSK, MSK, GMSK, OOK, ASK**
and **-120** dBm.

Consumption: **9** mA RX and **21** mA TX at **+11** dBm

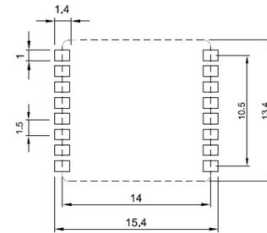
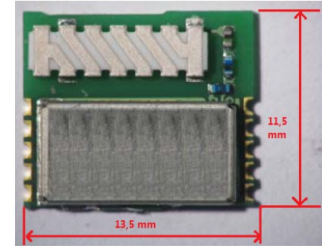
Ready for: **Wireless M-Bus** and **6LoWPAN** networking
connectivity, simplifying the design of **IoT** applications
and enabling remote sensors to directly connect to the
cloud without the need for a local gateway.

There are a lot of eval board for Spirit1, the list is [here](#)
The **SDK** for the above boards is [STSW-CONNECT009](#)



Sub1Ghz - Modules

- **SPSGRF** - available at **868** or at **915** MHz – (*Antenna + SPIRIT1*)
 - The **evaboar** for SPSGRF at **868**MHz is the: **X-NUCLEO-IDS01A4**
 - Read my tutorial: [How to use the P2P example](#)
 - The **evaboar** for SPSGRF at **915**MHz is the: **X-NUCLEO-IDS01A5**
 - The **evaboar** for SPSGRF at **868**MHz for **IoT** application (**bridge WiFi, Sub1GHz** and **BT classic**) is the: **STEVAL-IDI004V2**
 - **STEVAL-IDS001V4M** – **868** MHz RF USB dongle based on the SPIRIT1 SPSGRF-868 module
 - **STEVAL-IDS001V5M** – **915** MHz RF USB dongle based on the SPIRIT1 SPSGRF-915 module
- **SP1MLxx** – available at **868** or at **915** MHz – (*Antenna + SPIRIT1 + STM32L1 + AT commands*)
 - **STEVAL-IDI005V1** – SP1ML 868 MHz wireless sensor board powered by a coin cell battery
 - **STEVAL-SP1ML868** – USB dongle for SPIRIT1 low power RF modules SP1ML-868
 - **STEVAL-SP1ML915** – USB dongle for SPIRIT1 low power RF modules SP1ML-915



LORA

LORA



LoRa

LoRa is a **wireless communication technology** developed to create the **low-power, wide-area networks (LPWANs)** required for machine-to-machine (**M2M**) and Internet of Things (**IoT**) applications ([see this short PDF](#)).

LoRa is a **spread-spectrum** technology with a wider band (usually 125 kHz or more).
It's frequency-modulated chirp utilizes coding gain for increased receiver sensitivity. (From: [LinkLabs](#))

Key features of LoRa technology:

- Long range: > 15 km/9mi range
- Low-power: 5-10 year expected battery lifetime
- Low-cost: from end-node sensor cost to upfront infrastructure investment
- Secure: with embedded end-to-end AES-128 encryption of data
- Geolocation: enables indoor/outdoor tracking without GPS
-
- **LoRaWAN™** is a **global LPWAN specification created by the LoRa Alliance™** to drive a single standard for seamless interoperability across the industry.

LoRa technology is ideally suited for the applications:

LORA

The **STM32 Nucleo pack for LoRa™** technology and high-performance **FSK/OOK RF transceiver modem** ([**P-NUCLEO-LRWAN1**](#)) combined with the **LoRaWAN software expansion package for STM32Cube** ([**I-CUBE-LRWAN**](#)) is the quickest way to build a **LoRaWAN** end-node device.

[**P-NUCLEO-LRWAN1**](#) – The KIT for make a **LoRaWAN™** node.

This KIT contain two boards that are:

* [**NUCLEO-L073RZ**](#)

* [**I-NUCLEO-SX1272D**](#) (expansion board based on Semtech [**SX1272MB2xAS**](#))

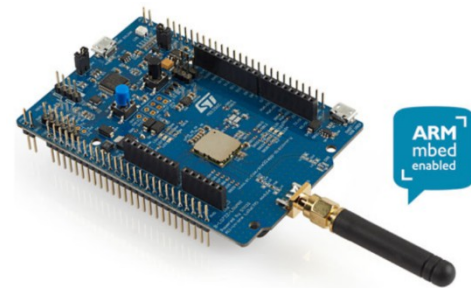
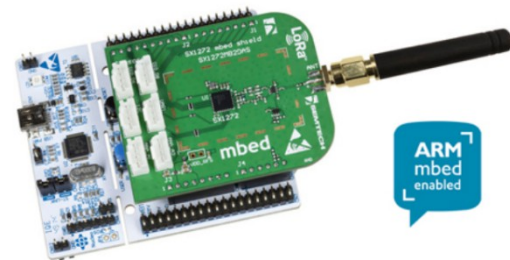
This tool, in association with the certified embedded software solution ([**I-CUBE-LRWAN**](#)), provides the means to set up a complete **LoRaWAN™** node compliant with **class A**, based on the Semtech [**SX1272MB2xAS**](#) LoRa™ extension board.

The **SW** for LoraWAN is: [**I-CUBE-LRWAN**](#)

See the: [**UM2085**](#) *Ultra-low-power STM32 and LoRa® Nucleo pack with NUCLEO-L073RZ board and I-NUCLEO-SX1272D RF expansion board*

See [this video](#) and [see this short PDF](#)

[**B-L072Z-LRWAN1**](#) – STM32L0 Discovery kit LoRa, low-power wireless (on board there is the MURATA module)



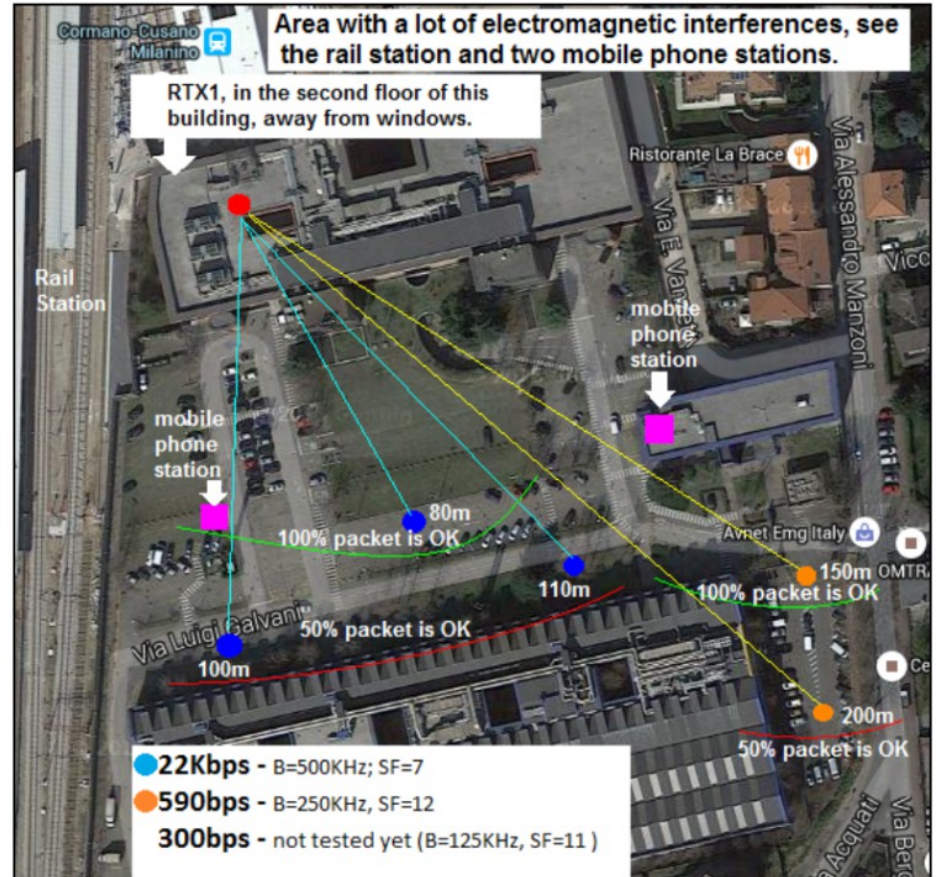
LORA

PingPong test based on:
STM32 (NUCLEO-F401RE) + LoRa (Semtech
– SX1272 – I-NUCLEO-SX1272D) under
mBED

The ready to use kit is: P-NUCLEO-LRWAN1

Important NOTE:

The TX output power used for the tests shown below was set to: **+14 dBm** (25mW)
The max power output of the SX1272 is **+20 dBm** (100mW)



SigFox



Sigfox (styled SIGFOX), is a French company that builds wireless networks to connect low-energy objects such as electricity meters, smartwatches, and washing machines, which need to be continuously on and emitting small amounts of data. Its technology is aimed at the Internet of Things (IoT). (From [WikipediA](#))

SigFox is a **narrowband** (or ultra-narrowband) technology.

It uses a standard radio transmission method called binary phase-shift keying (BPSK), and it takes very narrow chunks of spectrum and changes the phase of the carrier radio wave to encode the data. This allows the receiver to only listen in a tiny slice of spectrum which mitigates the effect of noise. (From: [LinkLabs](#))

The **coverage** of SigFox is [here](#).

Here there is a [Sigfox Overview](#).

SigFox

STM kit for SigFox

S2-LP – transceiver (TX/RX)

Band: 433, 868 and 915/920 MHz

Modulation: 2(G)FSK, 4(G)FSK, OOK, ASK and **-140 dBm**.

Consumption: **7 mA RX** and **10 mA TX @ +10 dBm**

Ready for: **Sigfox**, **Wireless M-Bus**, **6LowPAN** and **IEEE 802.15.4g** networking connectivity, simplifying the design of **IoT** applications and enabling remote sensors to directly connect to the cloud without the need for a local gateway.

The evaboard is:

STEVAL-FKI868V1 – Sub-1GHz transceiver development kit based on S2-LP

STM release a complete SW **package** that is:

STSW-S2LP-SFX-DK is an evaluation SW package for **SigFox** networking with the **S2-LP** high performance, ultra-low power RF transceiver.

The basic kit for test SigFox must be composed by:

NUCLEO_64pins + **STEVAL-FKI868V1**

We suggest to use the **NUCLEO-L152RE** or **NUCLEO-L053RE** + **STEVAL-FKI868V1**



SigFox vs. LORA



SigFox vs. LORA

- Comparison n.1
- Comparison n.2
- Comparison n.3

6LoWPAN

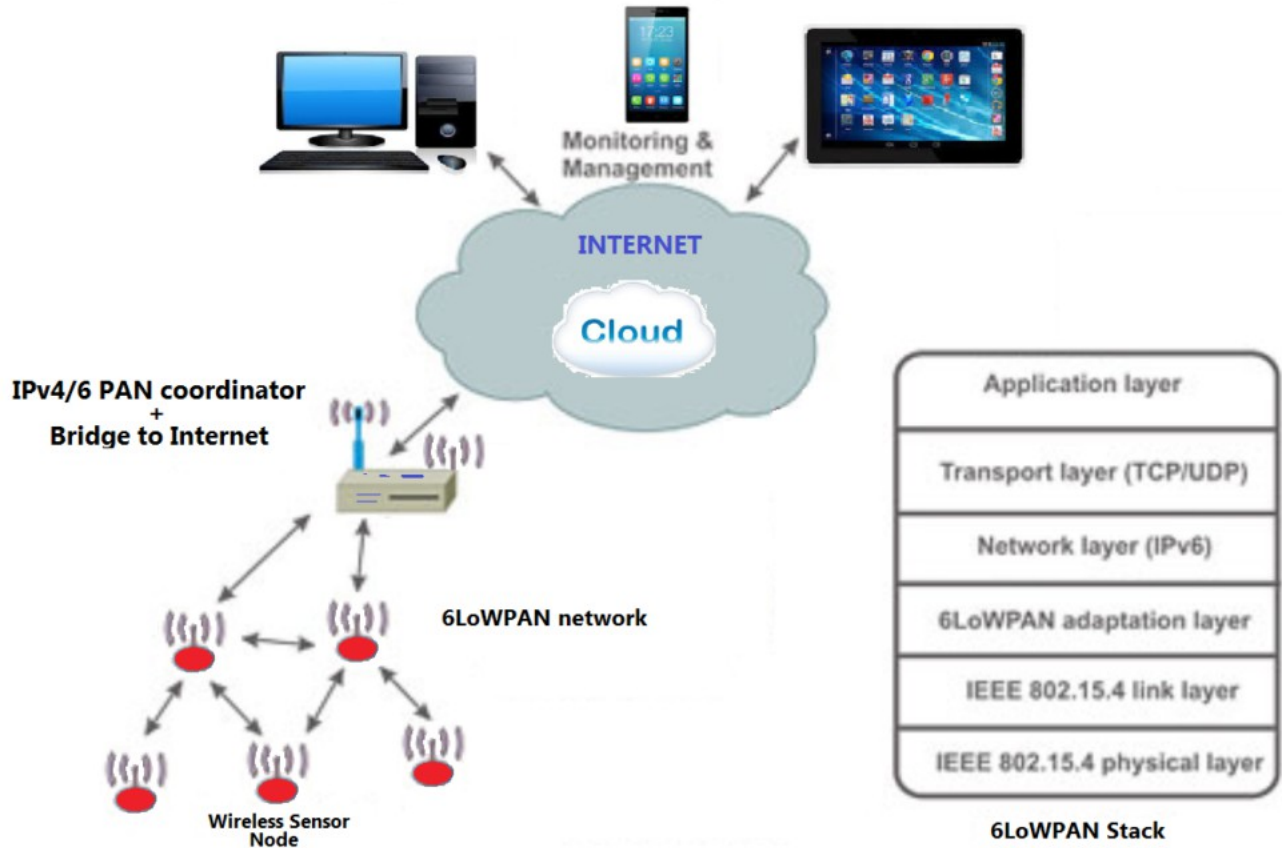


6LoWPAN

6LoWPAN – Enabling IPv6 over Low-power Wireless Sensor Devices

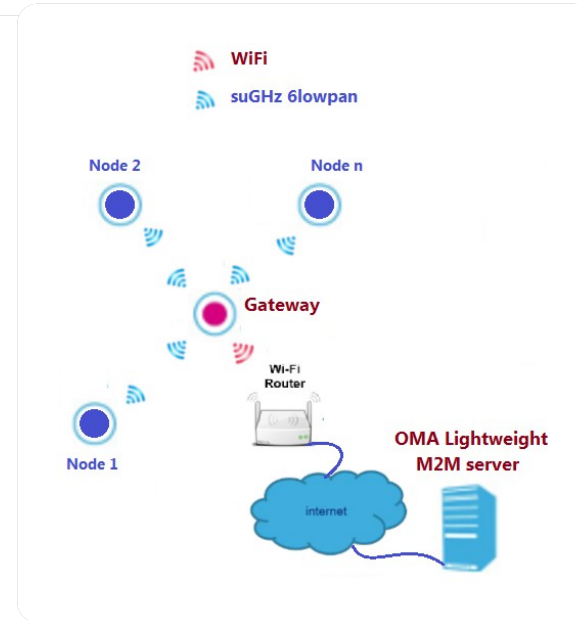
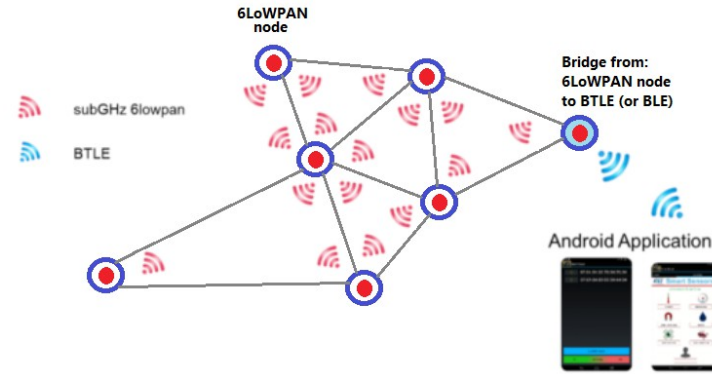
6LoWPAN is an acronym of **IPv6** over **Low power Wireless Personal Area Networks**.

6LoWPAN is the name of a concluded working group in the Internet area of the IETF.

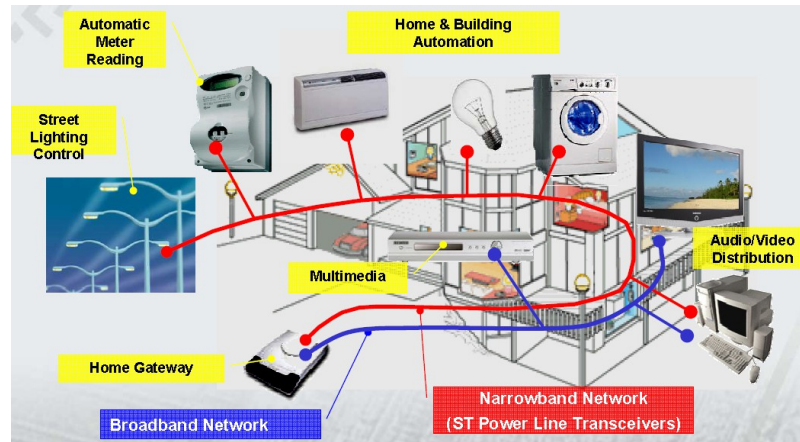


6LoWPAN

- Quickly build a Contiki, 6LoWPAN, BTLE sensor network
- 6LoWPAN wireless sensor network connected to the Internet through WiFi module
- STM Tutorial: 6LoWPAN, Step-by-Step Guide to Creating a Network and Sending Data to the Internet



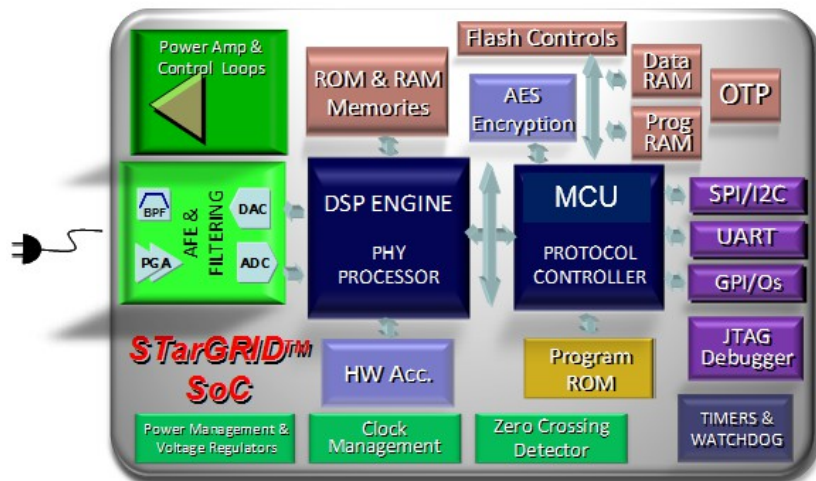
PLM



Since the early 90s, STM has been committed to supporting advances in narrow-band power-line communication (PLM/PLT/PLC) technologies that then became largely adopted by Automatic Meter Reading (AMR) and Automatic Meter Infrastructures (AMI) solutions at the heart of the smart grid concept.

STM large and expanding offer ranges from STM first generation analog FSK transceivers with an integrated power-line driver to a second generation, dual-core, multi-protocol, **STarGRID®** system-on-chip platform with an **integrated power-line driver, analog front-end** and **AES encryption** that supports **B-FSK, B-PSK, Q-PSK, 8-PSK** and **OFDM** modulations.

STM newest release is the future-proof, fully-programmable, dual-core **STCOMET** SoC platform supporting channels up to 500 kHz, with an integrated AFE, power-line driver and programmable modem. The STCOMET platform also includes a fully-integrated smart meter SoC that embeds high-performance metrology functions.



OPEN meter

Open Public Extended Network metering



- Scalable pin-to-pin compatible solutions
- Programmable DSP for multiple modulations
- 8-bit core for multiple protocols management
- Suitable for CENELEC and FCC bands
- Integrated AFE & Power Amplifier
- AES Encryption
- Lowest BOM



ST7590

PRIME
ALLIANCE

- OFDM modulation
- 128 kbps baud
- **PRIME "certified"** by KEMA
- Selected by **IBERDROLA** for STAR PROJECT

meters
AND **more**
OPEN TECHNOLOGIES



ST758x

- n-PSK modulation
- 28.8 kbps baud
- The only **Meters&More** compliant (ST7581)
- Deployed in **ENEL/ENDESA** project (13M meters)



ST7570

- S-FSK modulation
- 2.4 kbps baud
- **IEC 61334-5-1 + LINKY** compliant
- Ready for **ERDF G1**





ST7540

- Simple and cost effective networks
- Command & control (AC & DC)
- CENELEC A, B and C bands

PHY transceiver with basic MAC. Protocol and applic. implemented by the customer in the host MCU

Bit Rate

Up to
4.8kbps

Protocol Feature

- KNX compliant PHY
- Ready for point to point communication
- Suitable for CTM upper layers implementation in host controller

ST7570

- AC Street lighting
- AC Automatic Meter Reading (AMR) and sub-metering
- AC solar (micro) Inverters communication
- CENELEC A, B and C bands

Turn-key standard protocol embedded solution

Up to
2.4kbps

- IEC 61334-5-1 PHY + MAC compliant
- Additional communication features (LINKY)
- Embedded repeating function
- Suitable for DLMS/COSEM application in external host



ST7580

- ST7538/40 backward compatible
- Performing command & control (AC&DC)
- Solar DC&AC connectivity
- Home, Building & factory automation
- Smart Energy applications
- CENELEC A, B and C bands

PHY transceiver with basic MAC. Protocol and application implemented by the customer in the host MCU

Up to
28.8kbps

- Configurable multiple PHY layer
- Embedded simple Data Link
- Suitable for CTM upper layers

ST7590

- High Performance Smart Metering
- Smart Grid applications (AC & DC)
- CENELEC A band

Turn-key standard protocol embedded solution

Up to
128 kbps

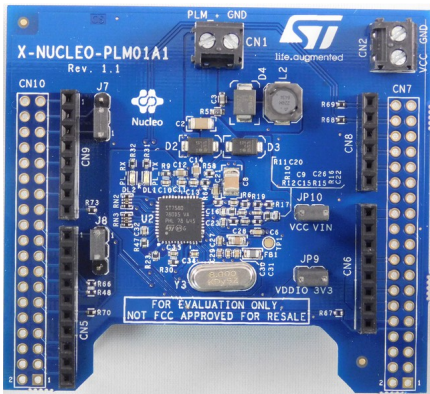
- PRIME protocol compliant
- Dynamic Routing
- Plug&Play
- Suitable for DLMS/COSEM standard applications and future TCP/IP

ST7540 vs. ST7580 (1)

	ST7540	ST7580
Carrier frequency value	To be selected among 8 values	Any value (1 Hz resolution) between 9 kHz and 250 kHz
Channel reception	Single	Dual (2400 bps max)
PSK max. bitrate	Not supported	28800 bps
FSK max. bitrate	4800 bps	9600 bps
Powerline frame format	Selectable composition	Fixed composition
Powerline frame length	Selectable (<i>bits</i>)	Selectable (<i>bytes</i>)
Host interface	SPI	UART
Host interface dataflow	Bitstream	Frame syntax
Host interface max. bitrate	4800 bps	57600 bps
Host interface delays	Fixed	Depending on processing

ST7538 vs. ST7580 (2)

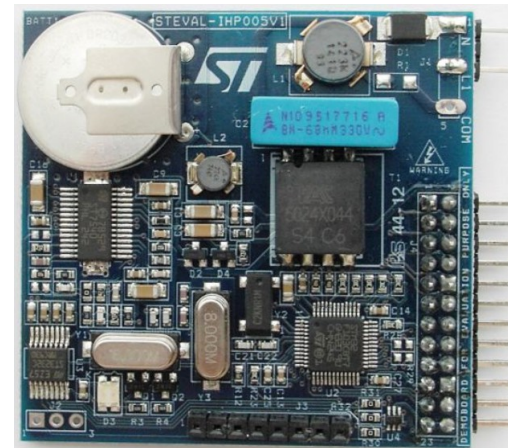
	ST7540	ST7580
Zero-Crossing synch	Optional	Optional
Embedded Power Amplifier	Up to 500 mArms – 8 Vpp single ended output	Up to 1Arms-14 Vpp single ended output with advanced thermal protection
Receiver sensitivity	54 dBμV	35 dBμV
Power supply	Single: <ul style="list-style-type: none">• from 7.5 V to 12.5 V	Dual: <ul style="list-style-type: none">• Analog part: from 8 V to 18 V• Digital part: 3.3 V (or 5 V)
Idle mode consumption	5 mA	<ul style="list-style-type: none">• Analog part: 6 mA• Digital part: 40 mA
External clock frequency	16 MHz	8 MHz
Collision detection	BU (Band-in-Use) pin signaling communication frequency occupancy	Digital output pins (TX_ON, RX_ON) signaling effective powerline communication



X-NUCLEO-PLM01A1

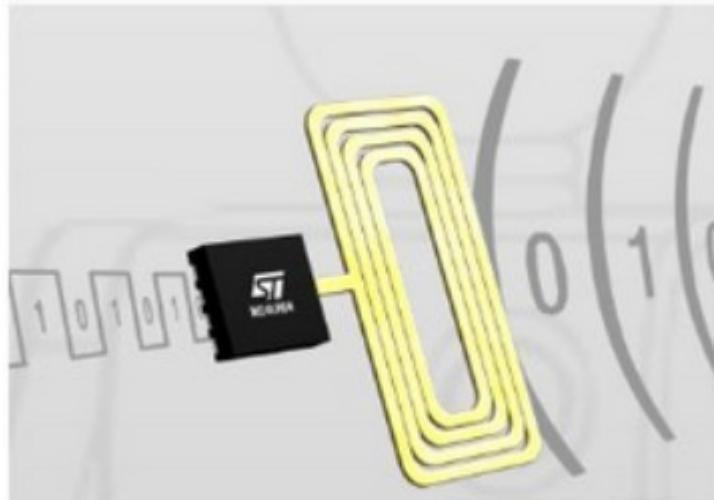




EVALKITST7580-1



STEVAL-IHP005V1

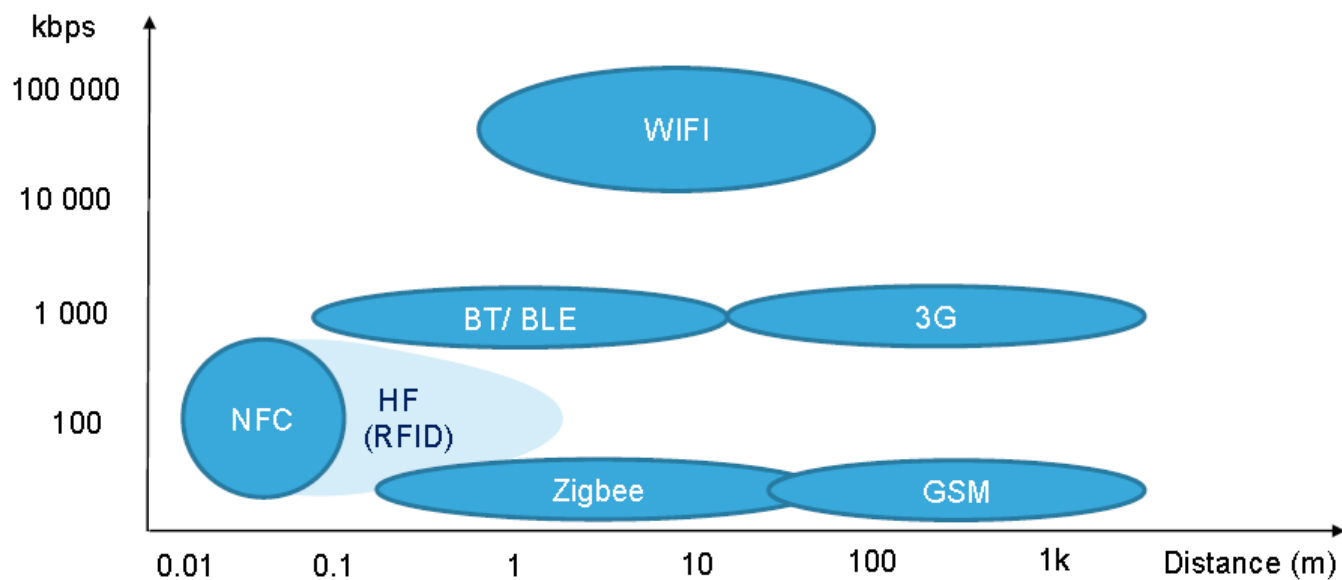
NFC - RFID



	LF	HF 	UHF 
Coupling mode	Inductive	Inductive	Electro-magnetic backscatter
Operating frequency	125kHz – 134kHz	13.56MHz	860MHz – 960MHz
Antenna	Coil	Coil	Dipole
Max operating distance	up to 1m	Vicinity: <1.5m Proximity: <10cm	~10m
Regulation	Worldwide harmonized	Worldwide harmonized	Different regulations per country
Standards	ISO14223 ISO18000-2	ISO14443 A/B ISO15693 ISO18092 ISO18000-3 NFC Forum	ISO18000-6 B/C EPC Class 1 Gen 2
Environmental influences	Small influence on operating distance Works in metal and industrial environment	Small influence on operating distance Works in metal and industrial environment	Influence on operating distance by reflection and absorption (metal and liquids)
Applications	Animal tagging	Product identification Public transport / Libraries Access control	Pallets and container ID Retail / Logistics Authentication

NFC technology position

- Complementary to Wi-Fi or Bluetooth



NFC technology

- Near Field Communication, a **short range** wireless technology operating at **13.56 MHz** based on the RFID HF standard (ISO 14443 & ISO 15693)
- Interactive and zero power, enabling convenient connection to the Internet of Things
- NFC is developed by the NFC Forum
 - To ensure interoperability between devices
 - Makes complex devices simpler to use:
 - Standard NFC data format (NDEF); e.g. URL hyperlink
 - Built-in handover in Android & Windows
- Fast growing deployment in Mobile

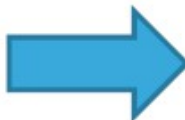


NFC devices



New market dynamics

From RFID driven before 2010...

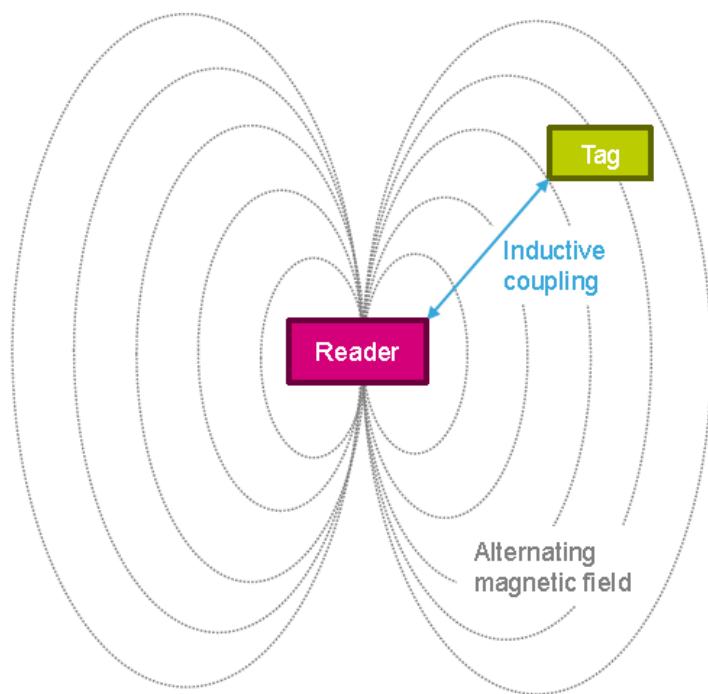


... to NFC driven after 2010



How can we communicate ?

- Communication is based on magnetic field (similar well known circuit is transformer)
- The **reader** generates an alternating magnetic field (carrier frequency) that powers the tag
- The **reader** modulates the carrier frequency to provide information to the tag
- The **tag** modulates reader's field to provide answer to the reader (backscattering concept)





- ITU standards
 - Frequency and power limits
- ISO standards
 - HF RFID standards, originally for contactless cards
 - Standardize physical interface, frames, anti-collision
 - Main standards
 - ISO 14443
 - ISO 15693
 - ISO 18092
- NFC Forum standards
 - Based on existing ISO standards. NFC forum reuse them and add new features
 - Technical specification of protocols
 - Data exchange format
 - NFC forum tag types
 - NFC record type
 - And many more...

ISO 14443 and ISO 15693

- **Common features**

- 13.56 MHz +/- 7 kHz carrier wave
- Magnetic coupling between reader and tag
- Passive RF technology: no battery, any time access even when application turned-off
- Reader talk first communication mechanism

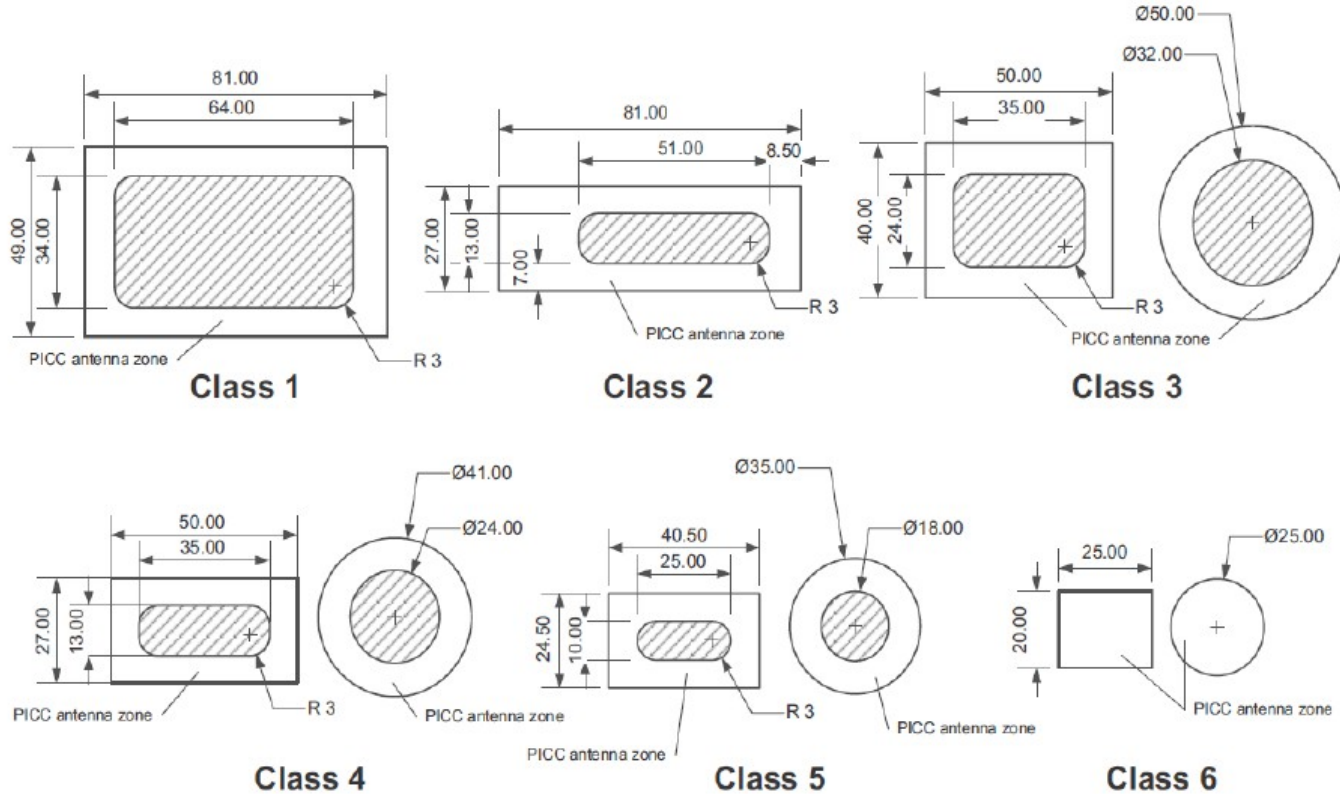
- **ISO 14443**

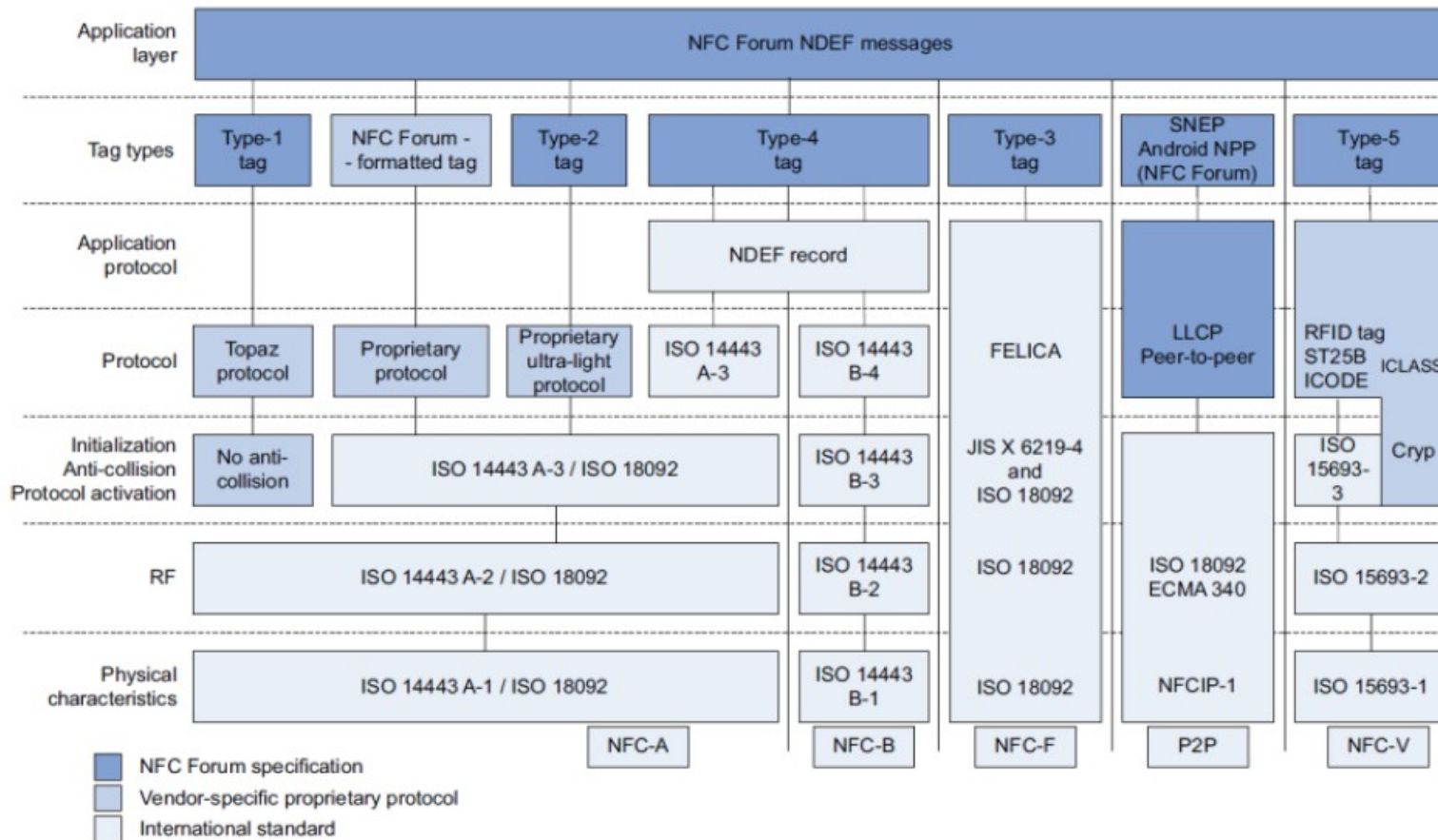
- Proximity cards
- Short range (SR) operating distance
- Communication speed up to 106 kbit/s

- **ISO 15693**

- Vicinity cards
- Long range (LR) operating distance
- Communication speed up to 26 kbit/s

Antenna classes





ST25 ecosystem

Easy to use and customer oriented





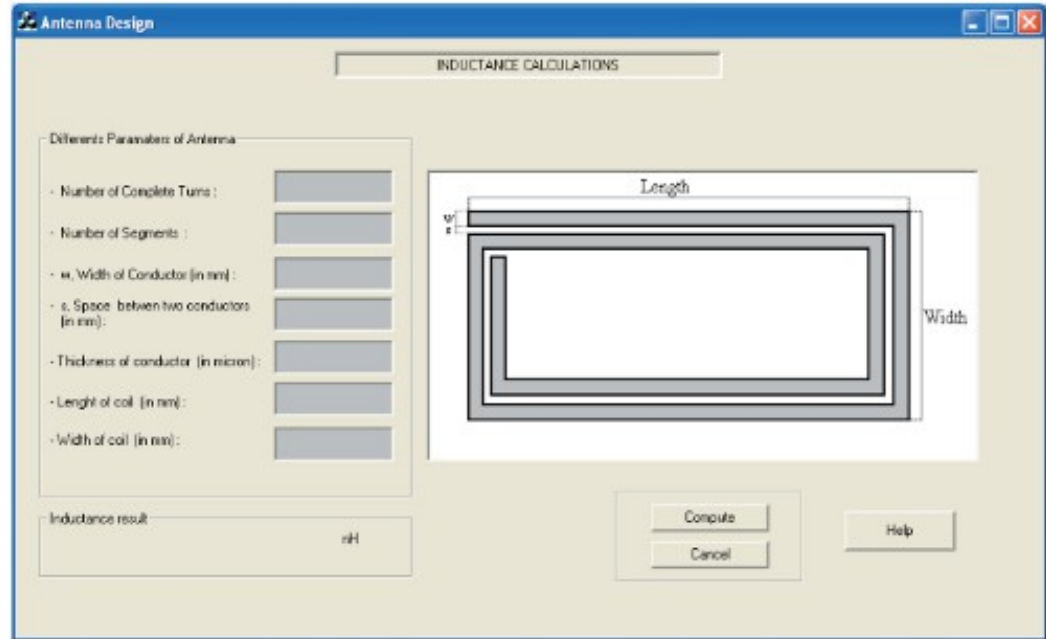
ST25 portfolio

One-stop-shop for tags and readers

Tags			Dynamic tags			HF Readers			UHF Readers	
ST25TA	ST25TB	ST25TV	M24SR	M24LR	ST25DV	CR95HF ST95HF	ST25R3909 * ST25R3910	ST25R3911B - ST25R3915	ST25RU3991 * ST25RU3992 *	ST25RU3993 ST25RU3980
ISO14443-A 106kb/s NFC type 4	ISO14443-B 106kb/s	ISO15693 up to 53kb/s NFC type 5	ISO14443-A 106kb/s NFC type 4	ISO 15693 up to 53kb/s	ISO15693 up to 53kb/s NFC type 5	ISO 14443-A/B ISO15693	ISO14443-A/B ISO 15693 FeliCa	ISO 14443-A/B FeliCa ISO15693 ISO18092	ISO18000 6c & b Gen2 Protocol	ISO 18000 6c & b Gen2 Protocol
EEPROM 512b-64Kbit 40-year 1Mcycles	EEPROM 512b-Kbit 40-year 1Mcycles	EEPROM 2K & 64Kbit 40-year 1Mcycles	EEPROM 2Kbit to 64Kbit 200-year 1Mcycles	EEPROM 4Kbit to 64Kbit 40-year 1Mcycles	256Bytes buffer EEPROM 4Kbit to 64Kbit 40-year 1Mcycles	Reader / Writer Card Emulation	Reader / Writer Limited P2P	Reader / Writer P2P EMVco & PBOC AECQ100	Reader / Writer -66/86dBm sensitivity Internal VCO	Reader / Writer -90dBm sensitivity Internal VCO
128bit password 20bit counter UID Field Detect	32bit counters Lock OTP bits UID	32bit password UID	128bit password RF disable Field Detect	32bit password E-harvesting Field Detect	Fast transfer mode 64bit password E-harvesting Field Detect	-	AAT	VHBR AAT Multi Antenna Dynamic output power	Low noise VCO DRM compliant	Dense Reader Mode Linear RSSI Automatic PSRR Auto ACK
			I2C 2.7V - 5.5V 1MHz	I2C 1.8V - 5.5V 400kHz	I2C 1.8V - 5.5V 1MHz	2Mbit/s SPI & UART 2.7V - 5.5V 230mW	6Mbit/s SPI 2.4V - 3.6V 700mW max	6Mbit/s SPI 2.4V - 5.5V 1 - 1.4W max	2Mbit/s SPI 4.1V - 5.5V 0/20dBm Output	5Mbit/s SPI 2.7V - 3.6V 0/20dBm Output

(*) NRND: Not Recommended for New Design

eDesignSuite Simple antenna design, compatible across M24LR, M24SR, SRTAG-D, ST25 series is [here](#)

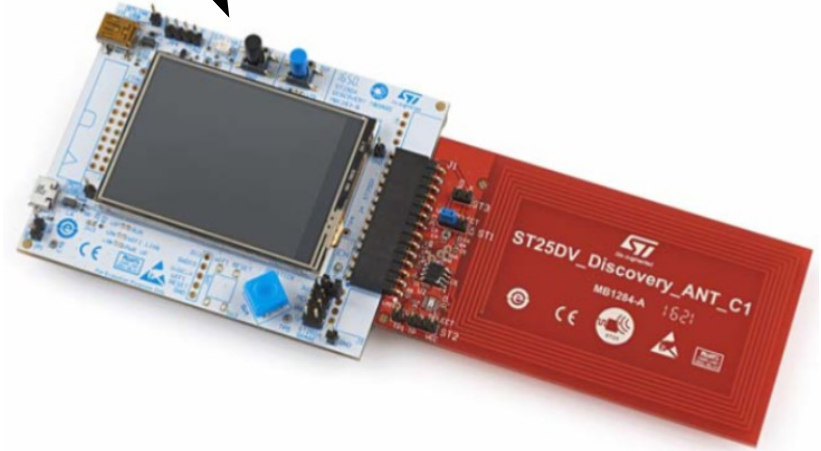


NFC – RFID - Evaluation Boards



The list of Evaluation Boards available up to now is [here](#).

- [X-NUCLEO-NFC04A1 - Dynamic NFC/RFID tag IC expansion board based on ST25DV04K for STM32 Nucleo](#)
- [ST25DV-DISCOVERY](#), discovery kit for **ST25DV04**
- [ST25R3911B-DISCO](#), discovery kit for reader **ST25R3911B**



NFC – RFID - Evaluation Boards



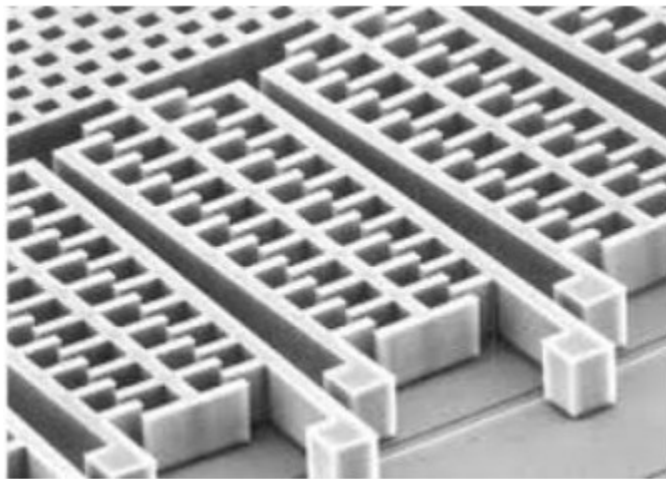
The list of Evaluation Boards available up to now is [here](#).

- **M24SR-DISCOVERY** is a demonstration kit to evaluate the features and capabilities of the **M24SR** and **BLE**
- **X-NUCLEO-NFC02A1** is a dynamic NFC/RFID tag board based on **M24LR04E-R**
- **M24LR-DISCOVERY** is a ready-to-use kit which features the **M24LR04E-R**
- **X-NUCLEO-NFC01A1** (mount **M24SR64-Y**)



MEMS

MEMS

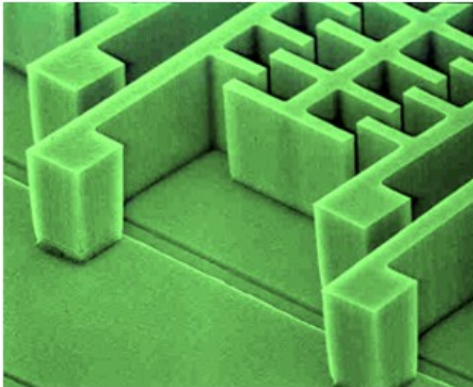


MEMS



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sensor
portfolio

ST offers the widest range of MEMS and sensors covering a full spectrum of applications from low-power devices for IoT and battery-operated applications to high-end devices for accurate navigation and positioning, Industry 4.0, augmented virtual reality components and smartphones.





Accelerometers



Advanced power-saving features that make them the ideal choice for ultra-low-power applications.

[View products](#)

Automotive sensors



Include digital accelerometers with low and high g full scale, and digital 3-axis gyroscopes.

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Gyroscopes



Analog and digital gyroscopes offer superior stability over time and temperature.

[View products](#)

e-Compasses



Include embedded self-test and smart power functionalities to minimize current consumption.

[View products](#)



Humidity sensors



A planar capacitance technology that integrates humidity & temp. sensors in the sensing element.

[View products](#)

iNEMO inertial modules



Offer more compact, robust, and easy-to-assemble solutions compared to discrete MEMS products.

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MEMS microphones



For all audio applications where small size, high sound quality, reliability & affordability are required.

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Pressure sensors



Innovative MEMS techno to provide extremely high pressure resolution, in ultra-compact & thin packages.

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Temperature sensors



Use in a wide range of applications: industrial, consumer, medical and computer market segments.

[View products](#)

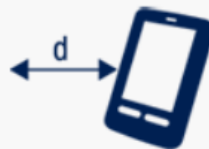
Touch sensors



Provide true multi-touch capability, supporting unlimited simultaneous touches.

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Proximity sensors



FlightSense technology can be used in a host of application areas where accurate ranging is required.

[View products](#)

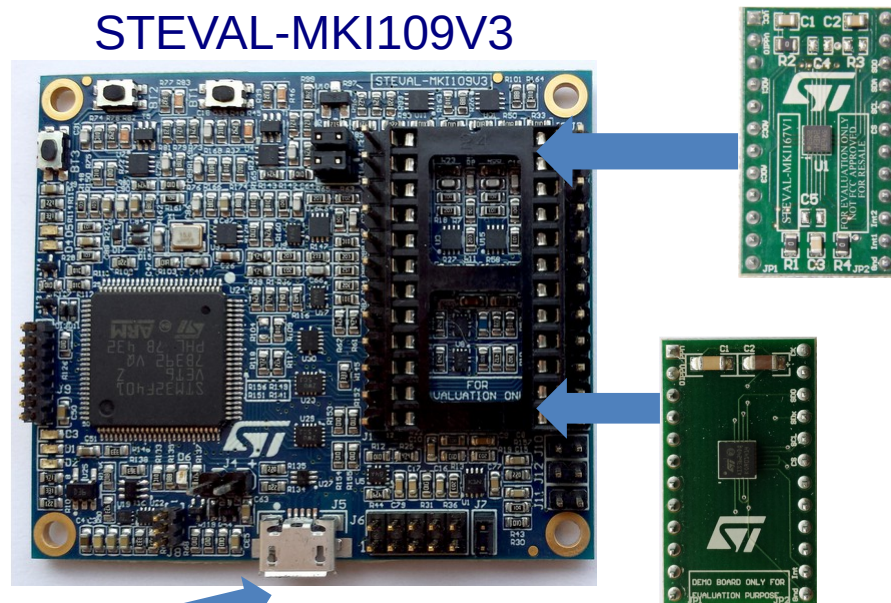
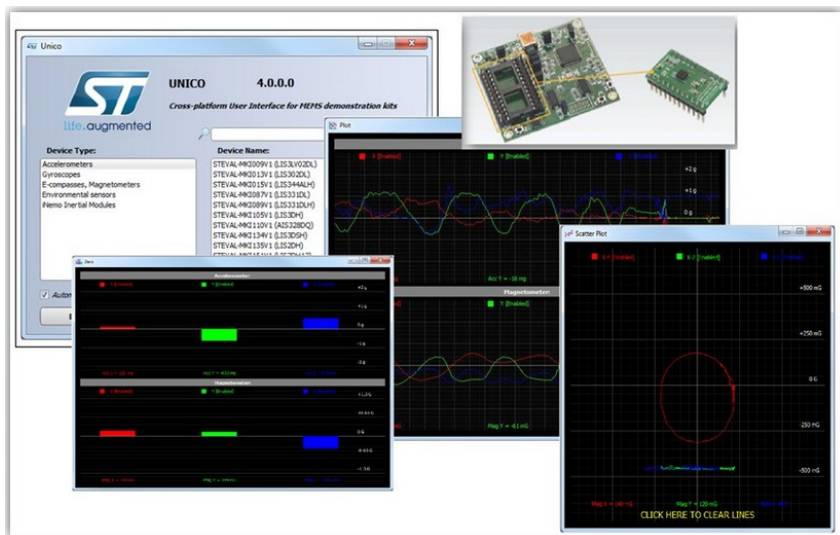
MEMS - Evaluation Board

The **STEVAL-MKI109V3** motherboard provides users with a complete, ready-to-use platform for the evaluation of STMicroelectronics MEMS products. It includes a high-performance 32-bit microcontroller (STM32) which functions as a bridge between the sensors and a PC, on which you can download and run the graphical user interface (GUI) or dedicated software routines for customized applications



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STEVAL-MKI109V3



MEMS - Evaluation Board

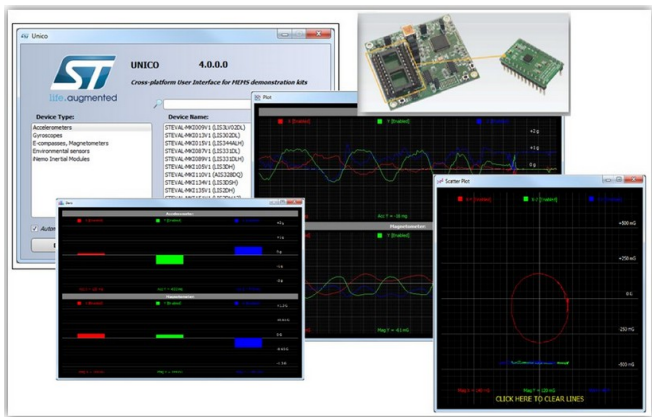
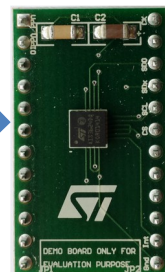
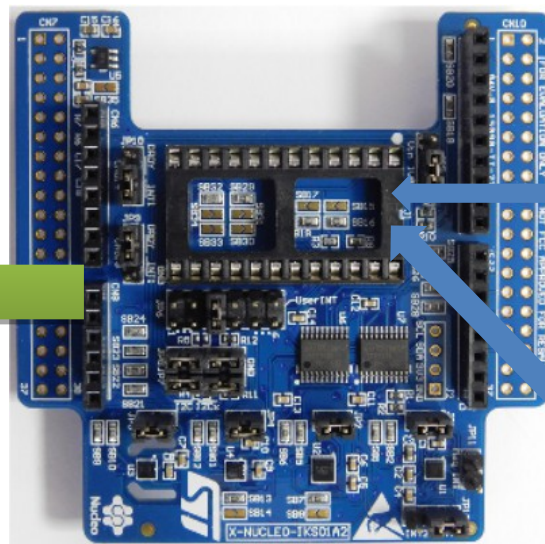
The **X-NUCLEO-IKS01A2** is a motion MEMS and environmental sensor expansion board for the STM32 Nucleo. It is equipped with Arduino UNO R3 connector layout, and is designed around the **LSM6DSL** 3D accelerometer and 3D gyroscope, the **LSM303AGR** 3D accelerometer and 3D magnetometer, the **HTS221** humidity and temperature sensor and the **LPS22HB** pressure sensor.



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sensor
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NUCLEO-BOARD
suggested:
[NUCLEO-F401RE](#)

X-NUCLEO-IKS01A2



MEMS - Evaluation Board – BLUE COIN



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sensor
portfolio

The **STEVAL-BCNKT01V1** integrated development and prototyping platform for augmented **acoustic** and **motion sensing** for IoT applications builds on the listening and balancing capabilities of the human ear.

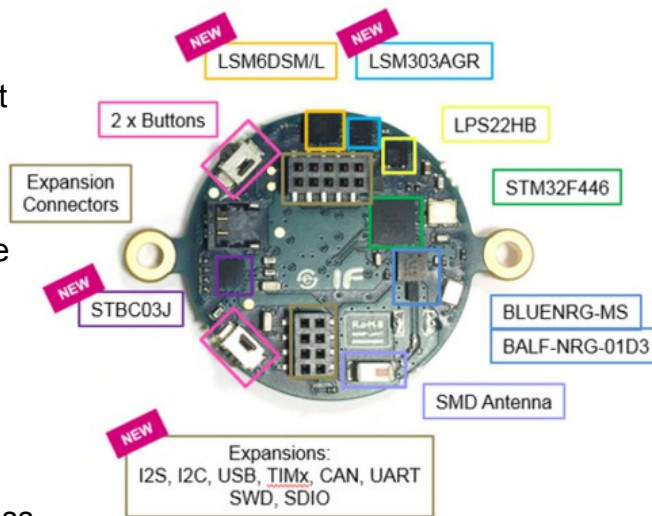
With the expanded capabilities of its starter kit, BlueCoin lets you explore advanced **sensor fusion** and signal processing functions for robotics and automation applications with a 4 digital MEMS microphone array, a high-performance **9-axis inertial and environmental sensor** unit and time-of-flight ranging sensors.

A high-performance **STM32F446** 180 MHz MCU enables real-time implementation of the very advanced sensor fusion algorithms like adaptive beamforming and sound source localization, with ready-to-use, royalty-free building blocks.

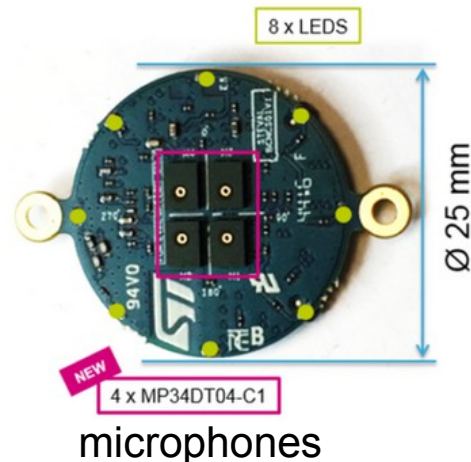
The BlueCoin can connect via the on-board **BLE** link to any IoT and smart industry wireless sensor network.

STEVAL-BCNKT01V1

BOTTOM VIEW



TOP VIEW



MEMS - Evaluation Board - WESU1

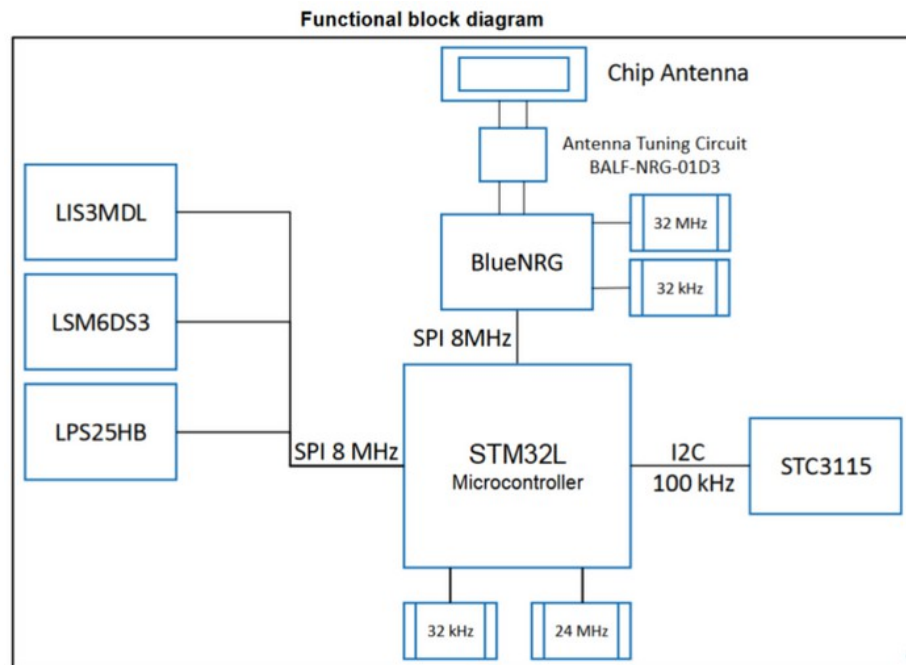
WESU1 – Wearable sensor unit reference design



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sensor
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STEVAL-WESU1 is a reference design developed and optimized to help designers implement the latest technologies in **wearable** and **portable** applications.

The small form factor of the hardware allows it to be enclosed in a watch strap, so the user can experience a real activity monitoring system and immediately begin appreciating the sensor data acquisition, as well as all of the embedded hardware and firmware features, also thanks to the **ST WeSU app** available free of charge from **Apple Store™** and **Google Play™** stores. The Apps are based on **BlueST SDK**, available on GitHub.



MEMS - Evaluation Board - SensorTile

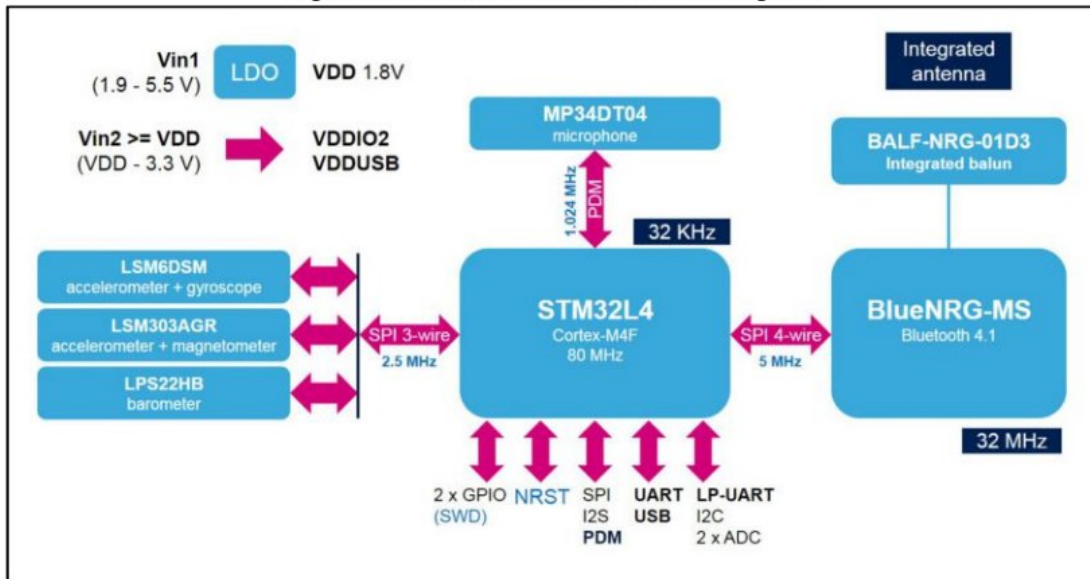
The **SensorTile** development kit, **STEVAL-STLKT01V1**, is a comprehensive development kit designed to support and expand the capabilities of the Sensor Tile and comes with a set of cradle boards enabling hardware scalability.

The development kit simplifies prototyping, evaluation and development of innovative solutions. It is complemented with software, firmware libraries and tools, including a dedicated App.





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Figure 1: SensorTile functional block diagram




EMCU

STMicroelectronics digital components
(by E.Marinoni)



This software, schematics, tutorial, etc are provided "as is" **"no guarantee is released"**, the use of the released material here is only for a rough guide.
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*The main idea of EMCU.EU and EMCU.IT is:
if all people share their experience (in our case HW/SW) the world will be better*



Home MCU Motor Control & C RF & Connectivity MEMS & Sensors Wireless Charger IoT & Security MKT ST Days References

MicroPython & Python Linux Standard Connectors Truly useful electronic applications Arduino and STM32 Free time Who I'm Privacy

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Use FIREFOX or CHROME for a clear view of the images present in this web site



Thank you!