BlueNRG-LP ARtM

The 3rd series of BlueNRG family

EMEA Marketing and Application

Sep 2020

BlueNRG-LP ARtM agenda

#1 BlueNRG family update
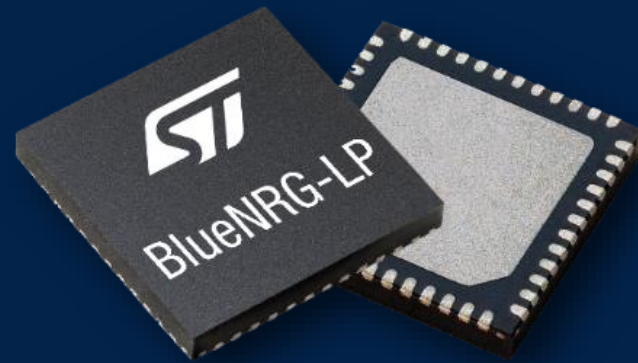
#2 BlueNRG-LP introduction

#3 Benefits and enhancements

#4 Development resources

#5 Summary and key benefits

BlueNRG family value

STMicroelectronics Low Power RF

Flexibility

Various topology capabilities from add on BLE (NP,DP) to SoC (AP)
Portfolio to fit application and associated technical requirements

Simplicity

Evaluation and demonstration kits
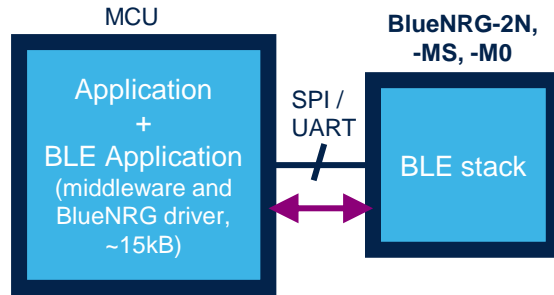Powerful SDK with SW examples and smart phone app

Customer support

Hardware and software design checks and guidance
Training, recommendations, bring up, pre-cert, on-line/site support
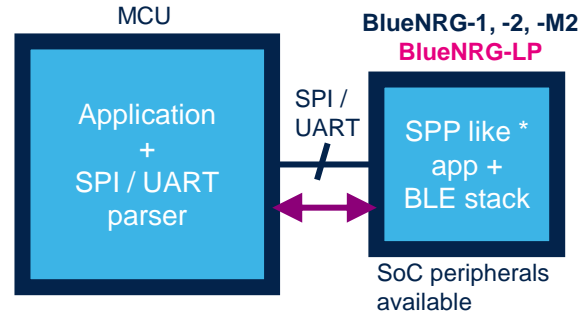
BlueNRG topologies

SPP like * = Built-in application enabling UART/SPI to BLE bridge. Available in ST DK.

BlueNRG key performance indicators

Chipset Module	Network co-processor		Wireless Programmable SoC		
	BlueNRG-MS BlueNRG-M0	**BlueNRG-2N**	**BlueNRG-1**	**BlueNRG-2 BlueNRG-M2**	**BlueNRG-LP**
RF range *	96 dB	96 dB	96 dB	96 dB	105 / 112 dB DR LE1M / LR
Data rate	200 kbs	700 kbps	250 kbps	700 kbps	1200 kbps
Power ** consumption	9.7 uA	8.5 uA	8.5 uA	8.5 uA	<6 uA
BLE cert / BLE feat	4.2 / 4.1	5.0 / 4.2	5.0 / 4.2 LE Data Len excluded	5.0 / 4.2	5.2 / 5.0+

*) Bluetooth SiG range estimator tool : https://bluetooth.com/learn-about-bluetooth/bluetooth-technology/range#estimator

**) With beacon average power cons : adv conn 31 bytes, 3secs, +5dbm

2.4GHz Wireless portfolio

ST: the most complete Bluetooth ® LE + 802.15.4 portfolio in the market!

STM32WB

Dual-Core

FEATURES

Single-Core

BlueNRG

BlueNRG-2
Bluetooth LE 5.0
Application processor
Cortex-M0 32MHz,
256KB QFN32,
QFN48, WLCSP34

BlueNRG-2N
Bluetooth LE 5.0
Network processor
QFN32, WLCSP34

BlueNRG-1
Bluetooth LE 5.0
Application processor
Cortex-M0 32MHz,
160KB QFN32,
WLCSP34

BlueNRG-MS
Bluetooth LE 4.2
Network processor
QFN32, WLCSP34

BlueNRG-LP
Bluetooth LE 5.2
Application processor
Cortex-M0+ 64MHz,
**Industry leading
radio performance,
security features**
Flash: 256KB Flash
RAM: up to 64KB
up to 32 GPIOs
QFN, WLCSP49

STM32WBx0
Bluetooth LE 5.0
Zigbee, Thread
Application processor
Dual core Cortex-M4,
64MHz / M0+, 32MHz
Advanced Security
Flash: 320K up to 1MB
RAM: 48K up to 128K
UQFN48 (30 GPIOs)

STM32WBx5
Bluetooth LE 5.0
802.15.4, Zigbee 3.0 Thread
Application processor
Dual core Cortex-M4, 64MHz
/ M0+, 32MHz
**Advanced Security
Rich Analog
Rich peripherals (USB,
LCD, Q-SPI, SAI)**
Flash: 256K up to 1MB
RAM: 48K up to 256K
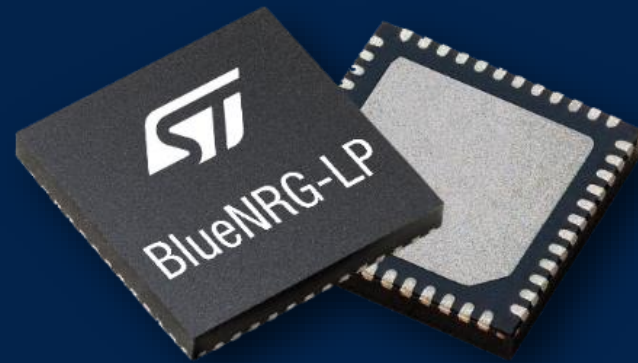Up to 72 GPIOs,
UQFN48, VQFN68,
WLCSP49, WLCSP100,
BGA129

ULTRA-LOW POWER

Bluetooth LE CONNECTIVITY

ADVANCED CONNECTIVTY - MULTI-PROTOCOL

BlueNRG-LP introduction

Low-Power
BLE programmable SoC

- **High speed 2 Mbps** for faster data transfer
- **Long Range** (125/500kbps) connectivity
- **Advertisement Extension** and Dataset
- **Improved channel selection** and mapping
- **GATT Caching for** energy-efficiency improvements
- **Up to 128 concurrent connections**

Go faster, go further!

BlueNRG-LP parts numbers scalability

QFN48	BlueNRG-345M	BlueNRG-355M
QFN32	BlueNRG-345A	BlueNRG-355A
WLCSP49	BlueNRG-345V	BlueNRG-355V

32KB RAM   64KB RAM

BlueNRG-LP
Bluetooth Low Energy 5.2 Certified SoC

Key Highlights

Bluetooth LE 5.2 certified

Radio performances
- RX Sensitivity level
  - -97dBm @ 1Mbps
  - -104 dBm @ 125bps
- Up to +8 dBm output power level.
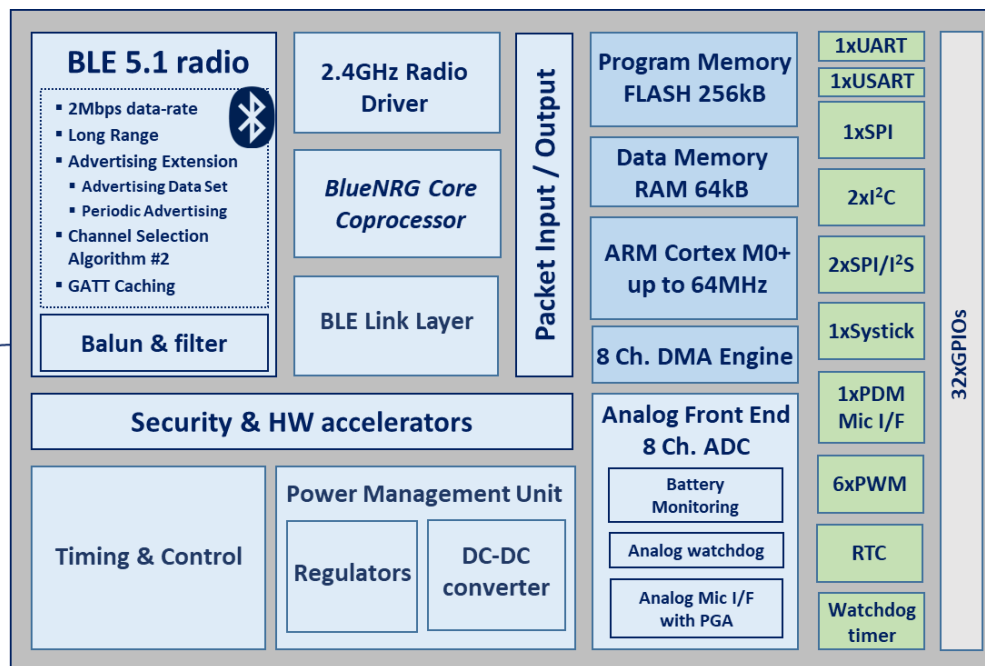- 4.3 mA TX current
- 3.4 mA RX current

Reduced BOM cost
- Integrated Balun
- Capacitor-less 32MHz crystal.

Advanced security set
- Flash read/write protection.
- Secure bootloader
- SWD access can be disabled

Block Diagram

BLE 5.1 radio
- 2Mbps data-rate
- Long Range
- Advertising Extension
  - Advertising Data Set
  - Periodic Advertising
- Channel Selection Algorithm #2
- GATT Caching

Balun & filter

2.4GHz Radio Driver

BlueNRG Core Coprocessor

BLE Link Layer

Packet Input / Output

Program Memory FLASH 256kB

Data Memory RAM 64kB

ARM Cortex M0+ up to 64MHz

8 Ch. DMA Engine

Analog Front End 8 Ch. ADC
- Battery Monitoring
- Analog watchdog
- Analog Mic I/F with PGA

Security & HW accelerators

Timing & Control

Power Management Unit
- Regulators
- DC-DC converter

- 1xUART
- 1xUSART
- 1xSPI
- 2xI²C
- 2xSPI/I²S
- 1xSystick
- 1xPDM Mic I/F
- 6xPWM
- RTC
- Watchdog timer

32xGPIOs

Device information

- High Throughput: 2Mbps Data Rate
- Distance Robustness: Long-range 125kbps or 500kbps
- Advertisement Extension: 255 bytes Advertising data, Advertising Data Set and Periodic Advertising Sync Transfer
- Frequency Hopping Robustness: Channel Selection Algorithm #2
- GATT caching
- Up to 128 concurrent connections
- ARM Cortex-M0+, 64 MHz
- 256-Kbyte Flash, **64-Kbyte** (32-KByte) SRAM , MPU
- One-time-programmable (OTP) memory area of 1 kB
- Extensive peripheral set: 2 x SPI / I2S, 1x SPI, 2 x I²C, 1 x USART, 1 x UART, 6 x PWM, 1 x PDM, 1 x 12-bit ADC SAR
- Analog microphone i/f with PGA
- True Random Number Generator (RNG)
- Hardware encryption AES maximum 128-bit security co-processor
- HW public key accelerator (PKA)
- CRC calculation unit
- 48-bit unique ID
- Operating supply voltage: from 1.7 to 3.6 V
- Operating temperature: from -40 up to 85 'C or -40 up to 105 'C
- Package available: QFN32 (20 GPIOs), QFN48 (32 GPIOs), WLCSP49 (26 GPIOs)

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BlueNRG-LP applications

Asset tracking and beacons

- Ultra-low power consuption
- Market leading BLE range
- SigFox LPWAN with S2-LP
- Cost optimized (2-layer PCB, int. Balun & xtal caps, device variants)

Smart tools and appliances

- Future proof with BTH5.2 certi.
- 10 years longevity
- Flexible arch. (SoC or add on)
- Device security

Industrial connectivity

- Remote UI, remote control units
- Enhanced processing & periph
- Audio IF (PDM, Analog, I2S)
- 10 years longevity
- Device security

Lighting and building automation

- Lighting, ventilation, heating, HVAC, smart locks
- BLE MESH, +105ºC compliancy (T version)
- Adv. ext. (AE), Long Range (LR), CSA #2
- Application security

Personal electronics

- Toothbrush, shaver, e-cigarette massage tools, gaming, etc.
- Enhanced processing & peripherals
- MEMS sensor libraries
- BLE stack flexibility, RF driver
- 2Mbps PHY and secure OTA
- Device package and mem. variants

Connected toys, robots

- Toys, robot vacuum, lawn mover, pool robot. etc.
- Flexible arch. (SoC or add on)
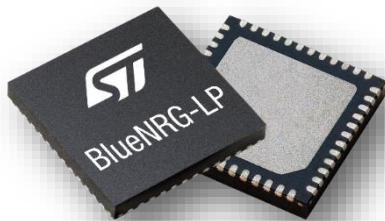- Cost optimized (2-layer PCB, int. balun, xtal caps, device variants)

Healthcare, wearable

- Auto injectors, dispencers, inhalers, sports sensors
- 10 years longevity, security

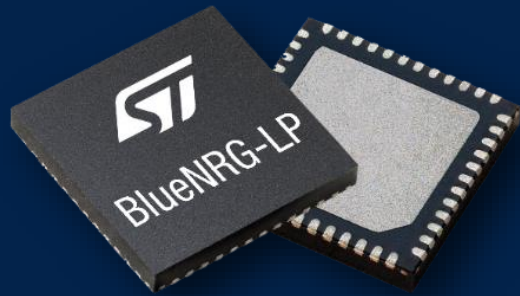## People and animal tracking

- Social distancing and tracing, worker tracking, pet & livestock tracking, prisoner tags
- Ultra-low power, application security
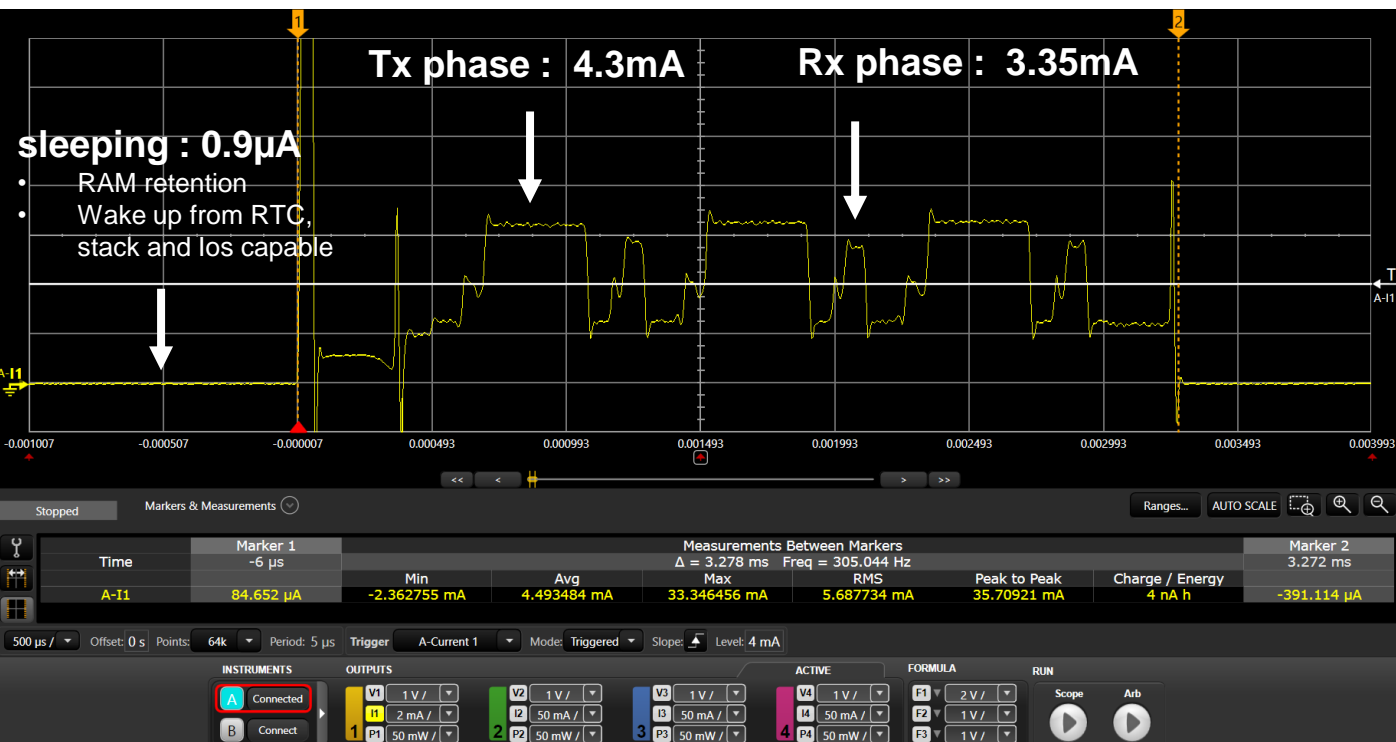- Cost effective in application

BlueNRG-LP

The lowest average power consumption

Tx phase : 4.3mA

Rx phase : 3.35mA

sleeping : 0.9μA
- RAM retention
- Wake up from RTC, stack and Ios capable

5.8uA average power consumption (advertising 31 bytes, every 3secs, 3V, +0dbm)

0.9μA sleep current : best on the market.

Outstanding active Rx and Tx current

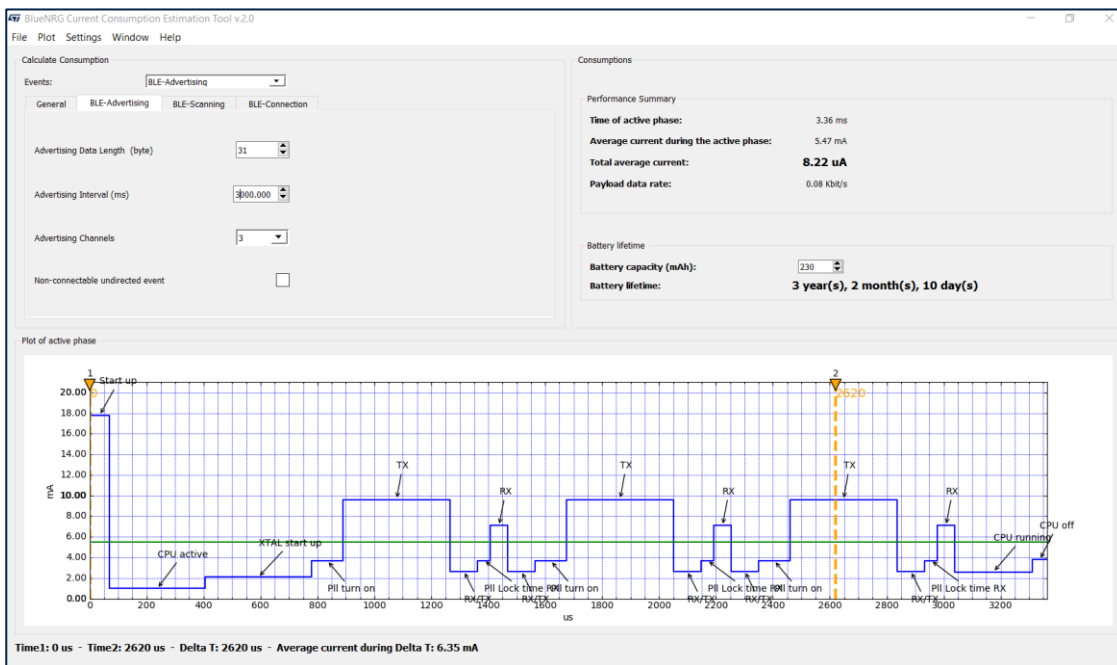BlueNRG-LP   designed for ultra low power applications

BlueNRG-LP is offering one of the best power efficient solution on the market

Easily estimate & measure power consumption

Estimate power consumption

estimate the average current consumption and the **battery lifetime** in the applicative cases using **PC tool**

STSW-BNRG001

Measure Power Consumption

Perform **real measurements** using our evaluation kit, dedicated SW and documentation

Dedicated example in STSW-BNRGLP-DK
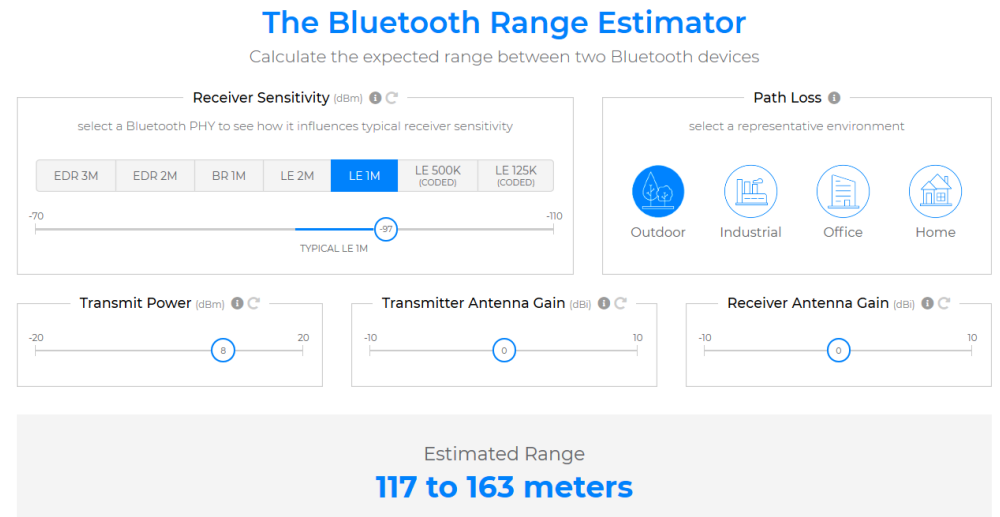App note available (rf-support-emea@st.com)

The best range

Sensitivity -97dbm @1Mbps
Sensitivity - 104 dBm @ LE S=8 (Long range)

Max output power up to +8dbm (PA extension possible)

The best dynamic range : 105dB (1Mbps)

Long Range provides sensitivity improvement

Range improvement depending antenna & environment

The Bluetooth Range Estimator
Calculate the expected range between two Bluetooth devices

Receiver Sensitivity (dBm)
select a Bluetooth PHY to see how it influences typical receiver sensitivity

| EDR 3M | EDR 2M | BR 1M | LE 2M | LE 1M | LE 500K (CODED) | LE 125K (CODED) |

-70 ———————————— -97 ———————————— -110
TYPICAL LE 1M

Path Loss
select a representative environment

Outdoor   Industrial   Office   Home

Transmit Power (dBm)
-20 ———— 8 ———— 20

Transmitter Antenna Gain (dBi)
-10 ———— 0 ———— 10

Receiver Antenna Gain (dBi)
-10 ———— 0 ———— 10

Estimated Range
117 to 163 meters

https://www.bluetooth.com/learn-about-bluetooth/bluetooth-technology/range/#estimator

BlueNRG-LP offers one of the best budget link on the market, extending range and user experience.
On top of it, Long Range feature allows extra range enhancement.

The best range
Mont Saint Michel Bay

BlueNRG-LP client

BlueNRG-LP server advertising @+8dbm

🟡 **1 Mbps - 960m**
LE1M PHY

🔴 **Long Range - 1.3km**
Coded PHY LE S=8

Range measurement report available
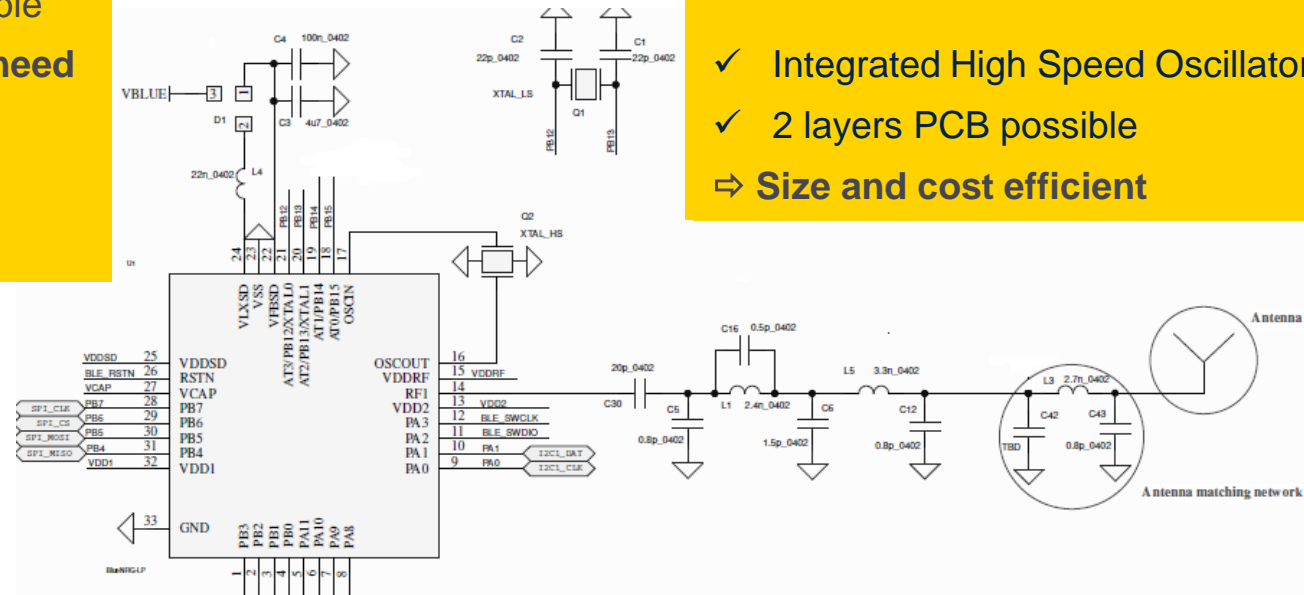
BlueNRG-LP
Flexible & integrated

Flexible

- ✓ Internal SMPS or internal LDO
- ✓ External 32kHz or internal RO
- ✓ QFN32, QFN48 and WCSP49 package available
- ⇨ **Adapt HW size and cost versus application need**

- ✓ Flexible Cortex-M0+ Core speed
- ⇨ **Processing power on demand**

Integrated

- ✓ Integrated balun - 50Ω single ended output
- ⇨ **Only few discretes matching/filtering needed**

- ✓ Integrated High Speed Oscillator capacitor
- ✓ 2 layers PCB possible
- ⇨ **Size and cost efficient**

BlueNRG-LP offers flexibility with cost and size integrated solution

BlueNRG-LP fast OTA capability

upgrade of a Sensor BLE typical application
~80KB (stack included)

ST BLE Sensor App

BlueNRG-1
65secs

BlueNRG-2
12 secs

BlueNRG-LP
5 secs

Enhanced set of Standard peripherals

- USART, LPUART, I2S/SPI **(x3)** , I²C **(x2)**
- PDM, 16-bit 6 channel **advanced timer**
- Independent RTC with capabilities to wake-up system.
- Independent WDG, Independent SysTick, …
- 12bits ADC – 8 channels, **analog µPhone input**, PGA,…
- Battery monitoring
- …

Comprehensive and easy to use APIs

Based on ST HAL or LL APIs

Multiple code Examples for each peripherals

Covering multiple customer use case

SPI master DMA
SPI Slave DMA
SPI Master IT
SPI Slave IT
SPI Master polling
SPI Slave polling

BlueNRG-LP Navigator v.1.0.0

Peripherals HAL drivers examples

The **BlueNRG-LP** includes 256kB of programming flash memory, 64kB of Static RAM memory with retention and SPI, USART, I2C standard communication interface peripherals.

It also features multifunction timer, watchdog, UART, a 12 bits ADC and a DMA controller.

Opening to more demanding application
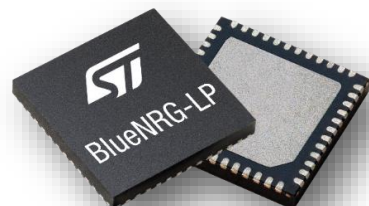
Improving MIPS X 2

M0+ Cortex up to **64Mhz**

Extended RAM

Up to 64KB RAM

Thanks to enhancement BlueNRG-LP customers taking benefits from wide in-house product portfolio

Easy integration of any ST MEMS sensors portfolio, thanks to drivers available @GitHub and fully compatible with BlueNRG-LP DK

Capability to run advanced SW algorithm

Voice over BLE
MIPS improvement allowing more performant algorithm integration *(OPUS)*

Motion Algorithms
Gesture and Activity recognition

BlueNRG-LP

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Enhanced security features

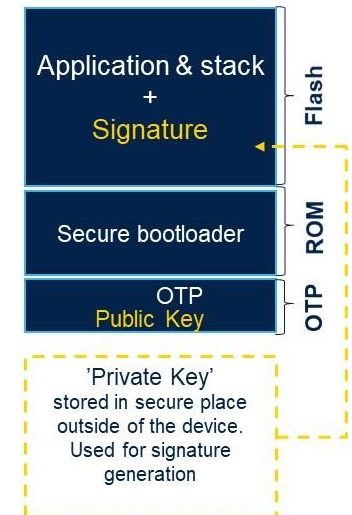## Flash protection : disabling SWD & UART access (refer RM0479)

3 level of Protection preventing application cloning & modification

- 3 level of **Protection** preventing application cloning & modification.

- Protection against external memory access (Reversible or Irreversible)

Secure boot : FW image authentication (refer AN5471)

Ensure that only a firmware image signed with a correct Private Key is executable

- Secure bootloader in ROM

- FW image authentication before execution - Only Signed image can be executed.

Application & stack + Signature — Flash

Secure bootloader — ROM

OTP Public Key — OTP

'Private Key' stored in secure place outside of the device. Used for signature generation

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BlueNRG-LP
Development resources

1 DK package & associated protocol

2 BLE key SW examples

3 DK tools : BLE out of the box

4 Development flow

BlueNRG-LP evaluation boards

BlueNRG-LP evaluation kit - Available & orderable !

QFN48   > **STEVAL-IDB011V1** (orderable)

WCSP49 > **STEVAL-IDB010V1** (available end Q2 21)

QFN32   > No dedicated kit – reference HW available (rf-support-emea@st.com)

Evaluate and prototype

- **Integrating various MEMS sensors**

  Pressure LPS22HH, Audio MP34DT05A & IMU LSM6DSOX

- **Power, Flash & debug through USB**

  CMSIS DAP debugger/programmer – drag & drop FW

- **Button and LEDs for prototyping and debug**

Full documentation

- Reference schematics and layout

- PCB design guideline : AN5526

- Bring up the BlueNRG-LP : AN5503

BlueNRG-LP – Certified solution

BlueNRG-LP is fully certified.	
BLE certification PHY and stack certified as per below table	**Regional certification** Compliant with regional regulation (RED, FCC, ARIB, etc.)

Bluetooth 5

	BlueNRG-LP (QFN & WLCSP) BT5.2
QDID (PHY)	**150274** (Component - BT5.2)
QDID (Stack)	**151645** Stack 3.0 - DK1.0 - BT5.2

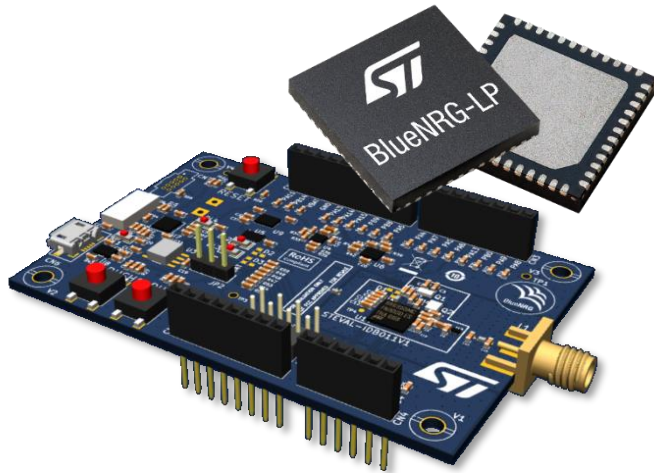| Full documentation |
|---|
| DTM FW available in STSW-BNRGLP-DK |
| Regional certification AN – On st.com End October |

HW Evaluation Kit

SW Development Kit

Tackle your market!

STSW-BNRGLP-DK

BLE

Bluetooth™

2.4Ghz proprietary protocol

1 Byte	4 Bytes	1 Byte	1 Byte	0 to 31 Bytes	3 Byte
Preamble	NetworkID	Header	Length	Data	CRC
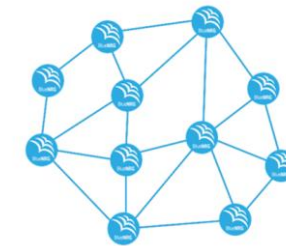
STSW-BNRG-MESH

BLE Mesh

STEVAL-IDB010V1 (WLCSP)
STEVAL-IDB011V1 (QFN48)

Free of charge **Certified Stack:** BLE and Mesh

BLE Software Development Kit

STSW-BNRGLP-DK : rich set of code examples

How to benefit and use BLE 5.0 features

Turnkey Full examples

2 X Speed

BLE_Thoughput

How to increase application data rate

BLE_SensorDemo_BlueMSapp

BLE Sensor device, OTA capable
Full OTA source (App & FW) reuse

8 X Increase broadcast

BLE_Beacon

Advertsing Extension

LPS22HH
LSM6DS0X

ST BLE
Sensor App

1.5 X Range

BLE_RC_LongRange

Enhance application range

BLE_SerialPort - SPP

Cable replacement Application

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Simple Architecture

- Free RTOS not required (code example available)

- **BLE stack schedule thanks to a dedicated hw state machine**

- Application do not require any resource manager (stack and application running on same core)

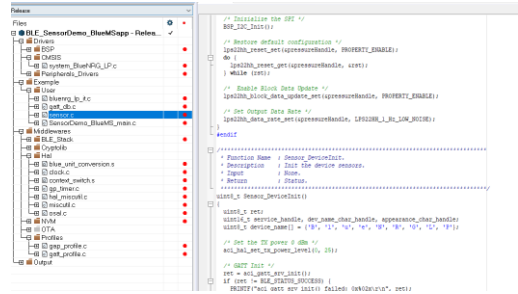- Automatic efficient power (sleep mode) management

Application simplicity

- RF HW block is not preempting any system resources to process RF activities (advertising, connected events)

- BLE events (connect, disconnect) handle over basic SW interrupts
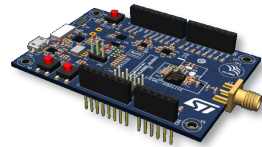
BLE Software Development Kit
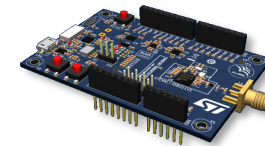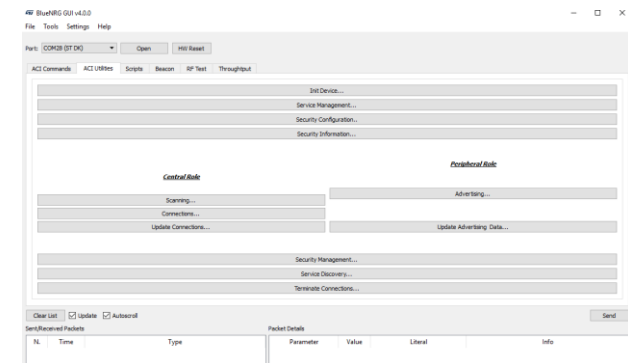
BlueNRG-LP ecosystem

IDEs

Navigator Tool

BlueNRG GUI

GCC Eclipse tool schedule in Q4 2020

BlueNRG-LP out of the box

Click & understand BLE APIs

BlueNRG-LP from evaluation to mass production

Hardware related

Eval boards
STEVAL-IDB011V1 (QFN48)
STEVAL-IDB010V1 (WLCSP)

Peripherals and pinout
RM0479

Schematic & layout
AN5526 : PCB design guidelines for the BlueNRG-LP device Application Note

Production test
Specific internal AN ready to be discussed

BTH & regional certification
BlueNRG certification process & tests AN

Orders for production prior lead time window

Enjoy product sales!

Evaluation → **HW design** → **SW implementation** → **Certif** → **MP**

Software related

Power cons. estimation
STSW-BNRG001

BLE coms and profile setup
PM0269
Bluetooth LE stack v3.x programming guidelines

OTA FW upgrade
Reference : AN5463
Bluetooth LE Over The Air Firmware Upgrade

SDK : STSW-BNRGLP-DK
GUI : STSW-BNRGUI
Flasher : STSW-BNRGFLASHER

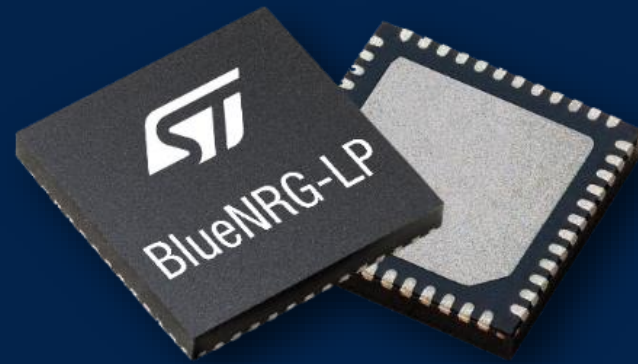**UM2735** : BlueNRG-LP Development Kit User Manual

Optimze power
AN5466
BlueNRG-LP power save modes & Internal AN for setup measurments

Full reuse of ST Service Manager code and ST BLE Sensor App code

BlueNRG-LP Summary
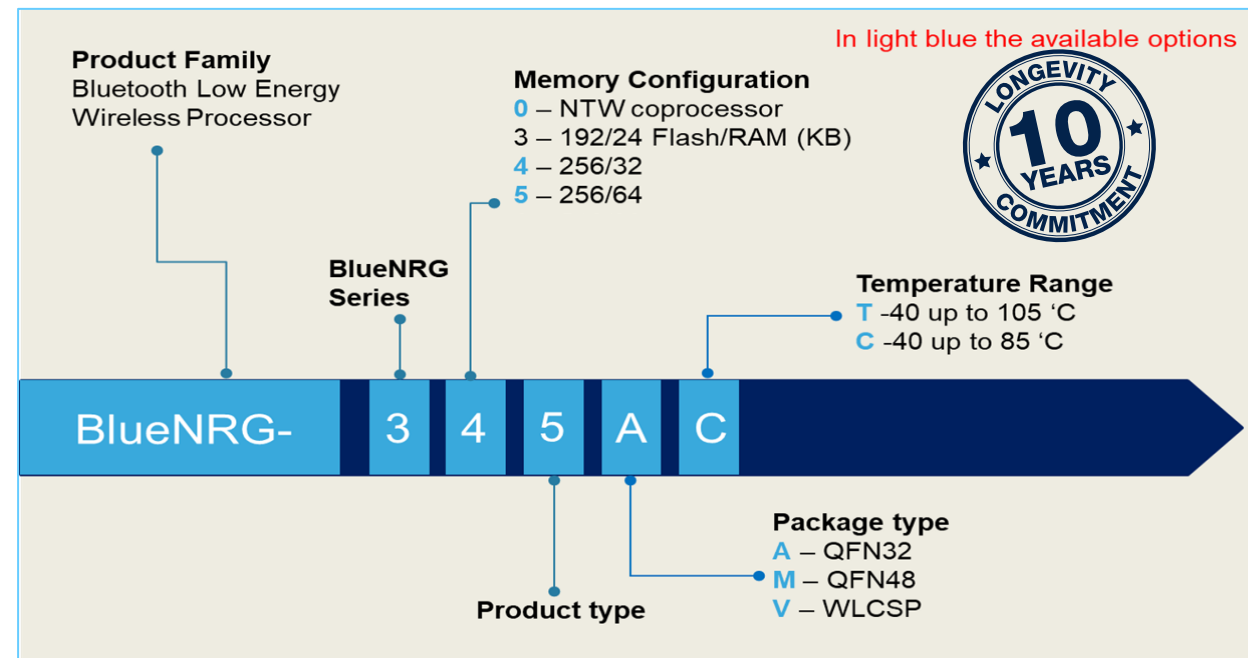
BlueNRG

ORDERING CODES

SoC 256/64KB:
- BlueNRG-355AC (QFN32)
- BlueNRG-355MC (QFN48)
- BlueNRG-355VC (WLCSP)
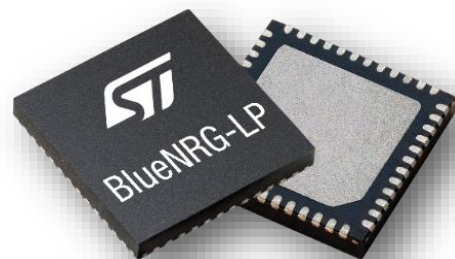
SoC 256/32KB:
- BlueNRG-345AC (QFN32)
- BlueNRG-345MC (QFN48)
- BlueNRG-345VC (WLCSP)

EVALUATION BOARDS

- **QFN48, BlueNRG-355MC** (STEVAL-IDB011V1)
  - online Sep '20

- **WLCSP, BlueNRG-355VC** (STEVAL-IDB010V1)
  - online Q2'21

The same package and RAM options exist for the T version (up to 105° C)

In light blue the available options

Product Family
Bluetooth Low Energy Wireless Processor

Memory Configuration
0 – NTW coprocessor
3 – 192/24 Flash/RAM (KB)
4 – 256/32
5 – 256/64

LONGEVITY 10 YEARS COMMITMENT

Temperature Range
T -40 up to 105 'C
C -40 up to 85 'C

BlueNRG Series

BlueNRG- 3 4 5 A C

Product type

Package type
A – QFN32
M – QFN48
V – WLCSP

CP	ES availability	MP
BlueNRG-355A (QFN32)	NOW!	November '20
BlueNRG-345A (QFN32)	October '20	December '20
BlueNRG-355MC/T (QFN48)		NOW!
BlueNRG-345M (QFN48)	October '20	November '20
BlueNRG-355V (WLCSP49)	October '20	February '21
BlueNRG-345V (WLCSP49)	Tba	Tba

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BlueNRG-LP key benefits

BlueNRG family step up

1 Market best dynamic range and current consumption

2 BLE 5.0+ full feature set : 2Mpbs, AE, Long Range

3 Extended application capability with enhanced peripherals , computational power and security

BlueNRG-LP available @st.com

Thank you

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