STM32WL3x wireless MCU line

Wireless MCUs for efficient long-range communications

The STM32 portfolio

Five product categories

Wireless MCU

Short- and long-range connectivity

Ultra-low-power MCU

Mainstream MCU

High-performance MCU

32-bit general-purpose microcontrollers: from 75 to 5,072 CoreMark score

Embedded MPU

32- and 64-bit microprocessors





Enabling edge AI solutions

Scalable security

MPU portfolio

MCU portfolio

sub-GHz connectivity in wireless applications

Smart industries

Smart cities

Smart agriculture

Smart homes

Asset tracking

Low-power, **global coverage, roaming.** Combined with sensing applications (accelerometer, pressure sensors).

Metering

Multiprotocol and low power
10 years from non-rechargeable battery
Fluid flow sensing
LCD driver

Alarm systems

Ultra-low-power Rx profile (**Rx sniff mode**) radio with combination of proprietary protocol support.

Remote controls

NEW

Efficient transmitter

Ultra-low-power modes with wake-up and retention capability.

STM32 sub-GHz product families

sub-GHz MCU dual core			STM32WL55
sub-GHz MCU single core		STM32WL3x	STM32WLE5
sub-GHz transceiver	1st generation SPIRIT1	2nd generation S2-LP	
	General-purpose sub-GHz radio	Ultra-low-power sub-GHz radio	
Supported modulation	2 (G)FSK (G)MSK - OOK ASK -	2/4 (G)FSK (G)MSK BPSK (Sigfox) OOK ASK DSSS + IQ I/F (STM32WL3 only)	2 (G)FSK (G)MSK BPSK (Sigfox) - - LoRa
Supported protocols	M-Bus, LoWPAN	M-Bus, LoWPAN, KNX, sigfox, Wi-SUN, mioty	M-Bus, LoWPAN, KNX, sigfox, Wi-SUN, mioty, LoRaWAN

What the STM32WL3x offers

Highly integrated, low-power MCU for long-range connectivity

Arm Cortex® M0+ core up to 64 MHz
+ sub-GHz dual radio

LONGEVITY 10 YEARS COMMITMENT

Lower design complexity

One single die in packages down to 5 x 5 mm integrating:

- 256 Kbytes of flash memory
- 2 radios: sub-GHz multi-modulation radio & wide band wake-up radio
- Analog sensing peripherals
- LCD driver

Flexibility

- Simple and ultra flexible platform with multiple modulation support: 4-(G)FSK up to 600 Kbps, 2-(G)FSK, (G)MSK, DBPSK, DSSS, OOK, ASK
- IQ interface to develop your own modulation for even more flexibility
- OOK always on wake-up radio

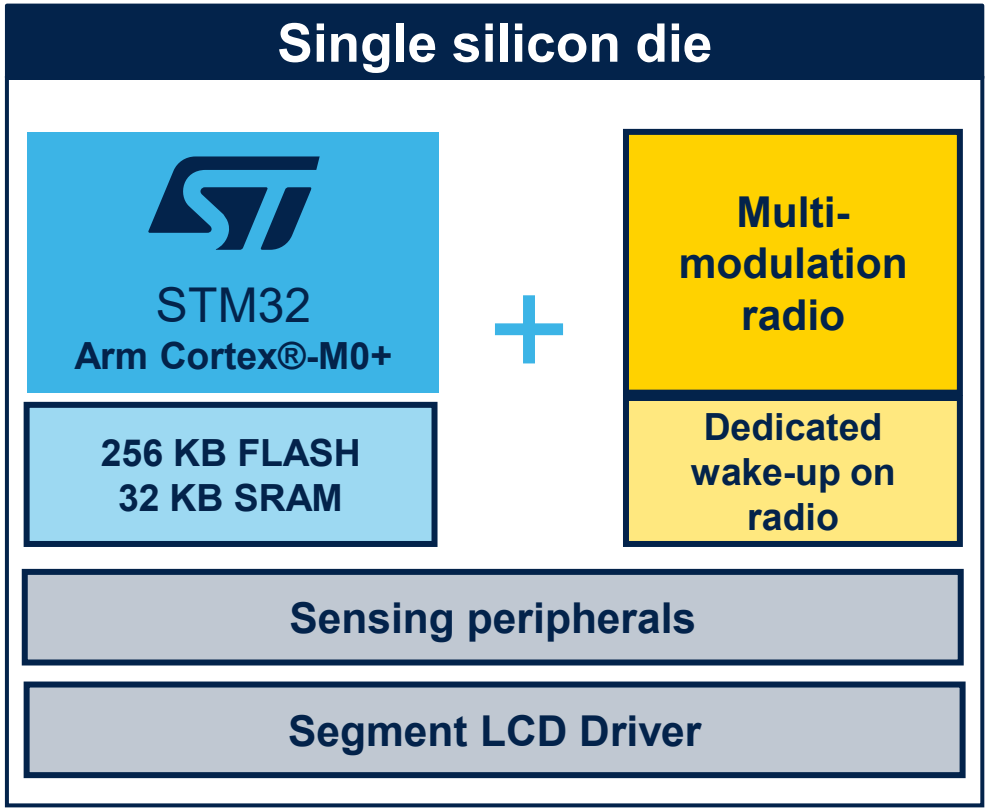
Longer battery life for IoT devices

- Low-power consumption radio down to 5.6 mA (Rx) & 10 mA (Tx at 10 dBm)*
- Additional dedicated wake-up on radio with 4.2 µA always-on receiver for system wake-up

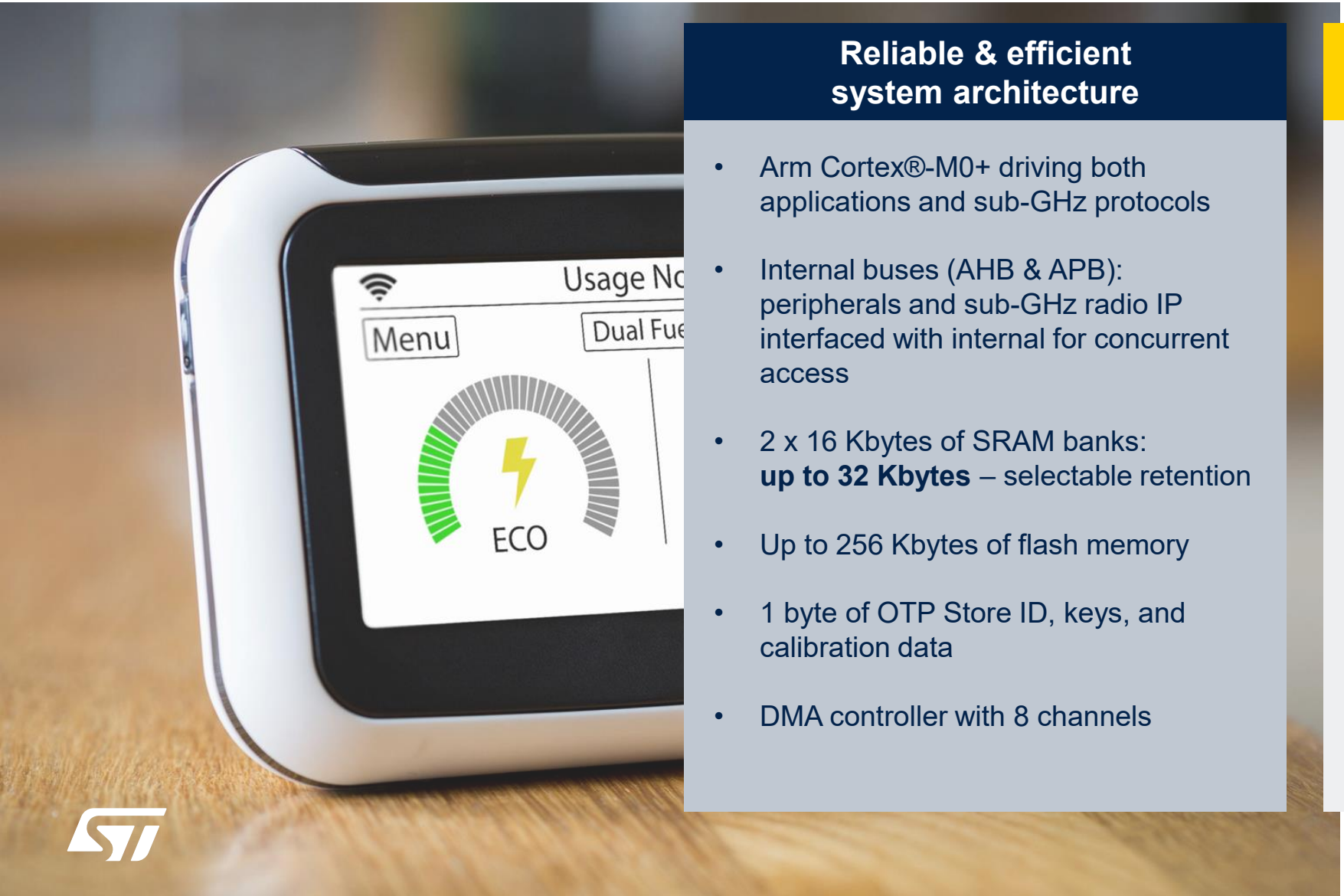
** Including MCU core consumption (in WFI mode)*

Wireless MCU combining multiprotocol sub-GHz radio & application features

PACKAGES
- QFN48 6 x 6 mm
- QFN32 5 x 5 mm



High integration for reduced design complexity



Reliable & efficient system architecture

- Arm Cortex®-M0+ driving both applications and sub-GHz protocols
- Internal buses (AHB & APB): peripherals and sub-GHz radio IP interfaced with internal for concurrent access
- 2 x 16 Kbytes of SRAM banks: **up to 32 Kbytes** – selectable retention
- Up to 256 Kbytes of flash memory
- 1 byte of OTP Store ID, keys, and calibration data
- DMA controller with 8 channels

Integrated peripherals

- Standard peripherals (2 x SPI, 2 x I²C, UART, low-power UART)
- 12-bit ADC (1 Msps frequency, 8 channels, single-ended & differential, temperature, and battery level)
- Timers: 2 general-purpose 16-bit timers, 4+1 PWMs, watchdog timer, RTC, 3 specific sub-GHz IP timers (LP timer)
- Analog comparator and 6-bit DAC (threshold)
- Analog LC sensor
- Up to 20-pin LCD driver

STM32WL3x ultra-low-power dual radios

Highly efficient sub-GHz radio

Two radios
One single chip

Dedicated ultra-low-power Wideband wake-up radio

Main radio (RX/TX)
Rx current (LPM): 5.6 mA*
Tx current (10 dBm): 10 mA*

With autonomous sequencer
sniff-mode, frequency hopping,
low duty-cycle mode,
listen before talk (LBT).

Zzzz

CPU

autonomous radio management

4.2 µA **always-on** receiver
(from 100 MHz to 2.4 GHz)
Rx OOK at -50 dBm

Fully autonomous radio
for proximity detection tracking
Pass through factory application
Drive by metering application

* Including MCU core consumption (in WFI mode)

STM32WL3x main radio for long-range communication

Transmission: dual-output architecture

Up to +16 dBm output power (low-power optimized)

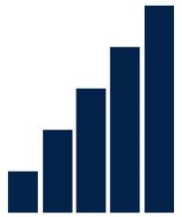
Up to +20 dBm output power (long-range capable)

Frequency range
159-185 MHz* / 276-319 MHz **
/ 413 – 479 MHz / 826 - 958 MHz

Optimized for your country regulation

Reception: Single-ended architecture

32-bit I/Q sampling: better sensitivity, interference robustness (adjacent channel blocking)



Rx sensitivity 2(G)FSK
-128 dBm at 0.3 kbps
-113 dBm at 38.4 kbps

Top-class RF performance

* Available on dedicated P/N: STM32WL33xxxxxA
** Available on STM32WL3R Line

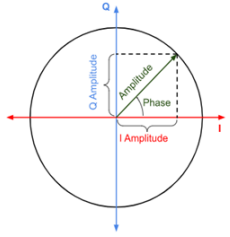
STM32WL3x main radio offers great versatility

STM32WL3 RF system-on-chip

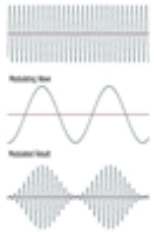
Arm
Cortex®
M0+
64 MHz

Direct radio access

IQ sample interface



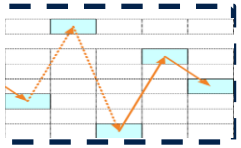
4-(G)FSK up to 600 Kbps
2-(G)FSK
(G)MSK
DBPSK
DSSS
OOK, ASK



Ultra flexible packet handler

Up to +20 dBm Tx output power

Frequency hopping



One single platform

Multiprotocol capability

PLC-RF hybrid

sub-GHz proprietary

sigfox

mioty
RX/TX

M-Bus wireless

6LoWPAN

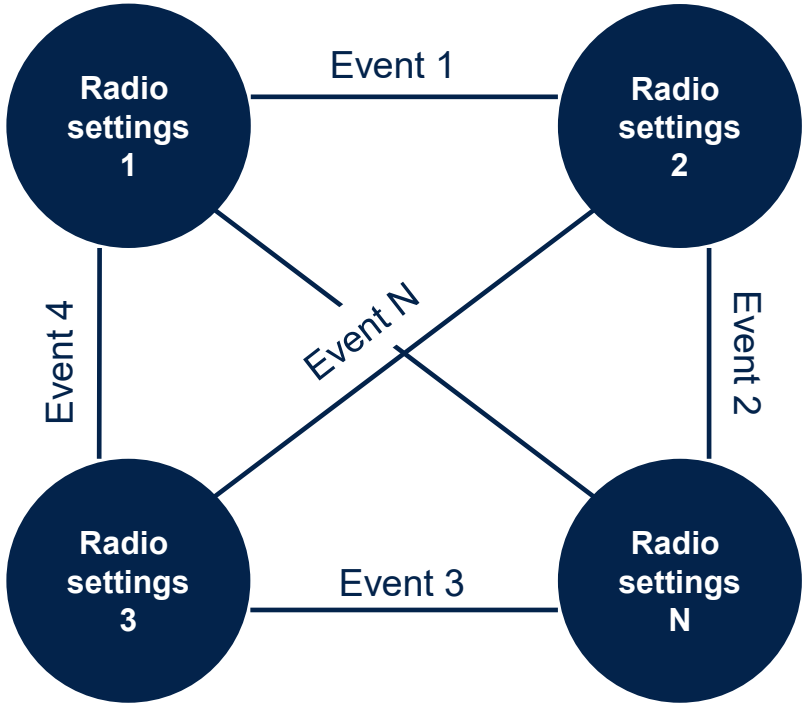
Wi SUN
HAN

KNX RF

802.15.4g

STM32WL3x main radio provides a sequencer for extended battery life

Radio sequencer simplifies proprietary protocol support



Radio settings: full radio registers settings
Events: radio interrupts or low-power timer interrupts

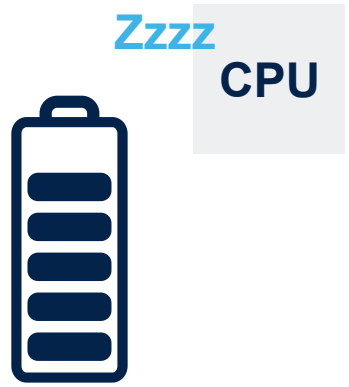
Radio sequencer principle

- **Arm Cortex®-M0+ application NOT scheduled**
- Preloaded RAM-based chained list of RF actions
- Flexible actions (dynamic register setting changes)
- Scheduled with timers

Radio features - examples

- Rx sniff mode
- Dual-band Rx sniff mode
- FHSS (frequency hopping)
- High configurable CSMA
- Auto-ACK

⇒ **NO LIMIT**



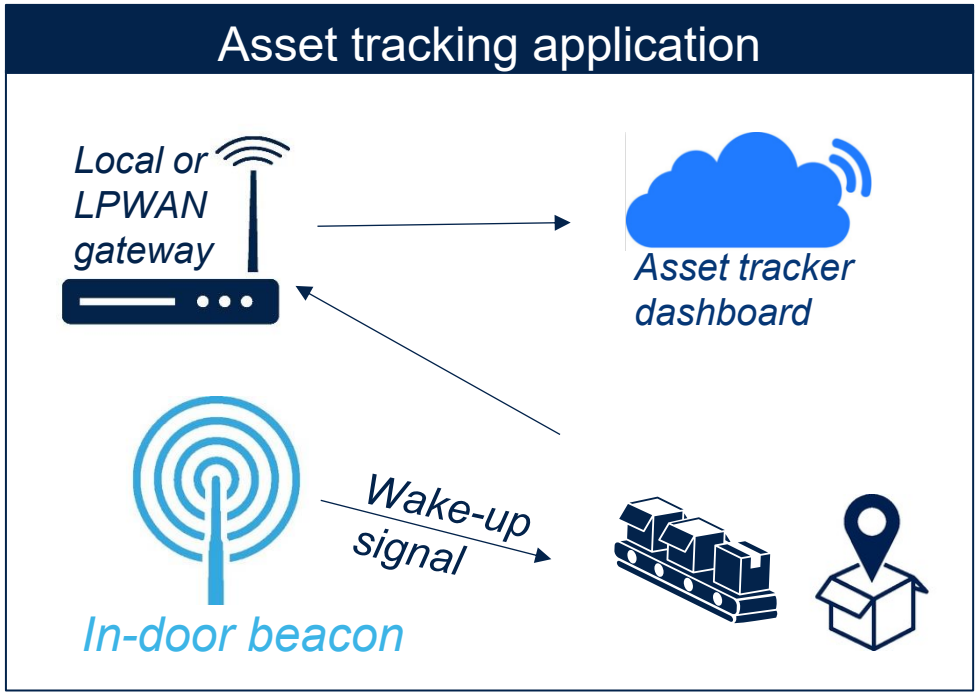
STM32WL33 wake-up radio extends battery life

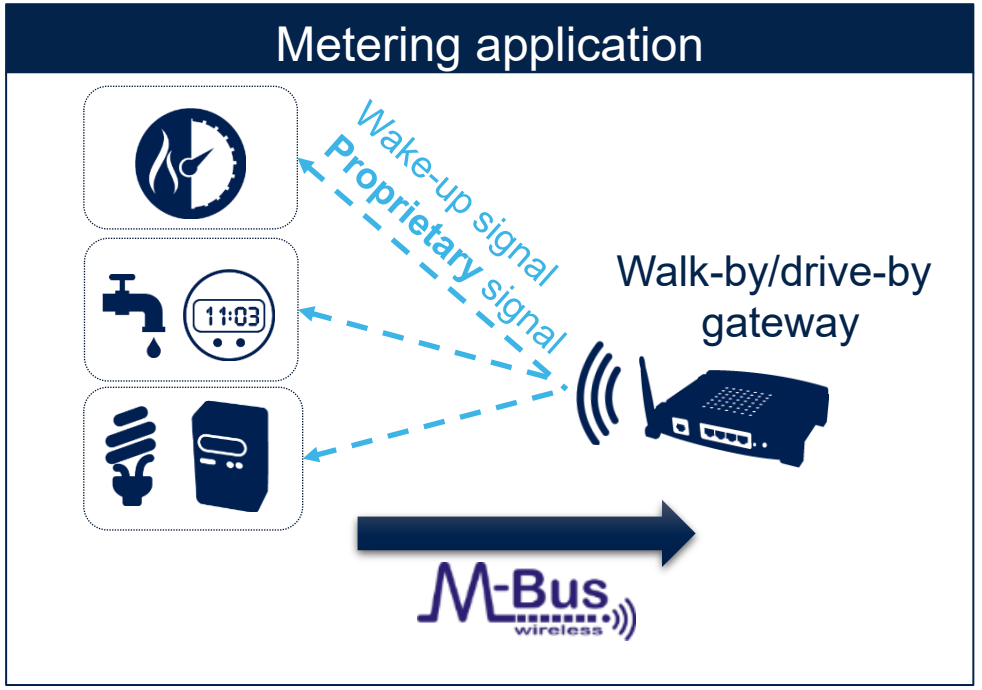
Ultra-low-power wireless proximity detection and system wake-up

Wide band: 1 single BOM for worldwide ISM (from 100 MHz to 2.4 GHz)

4.2 µA
Continuous Rx
OOK modulated packet detection

Dedicated to proximity detection
(tens of meters) -50 dBm sensitivity



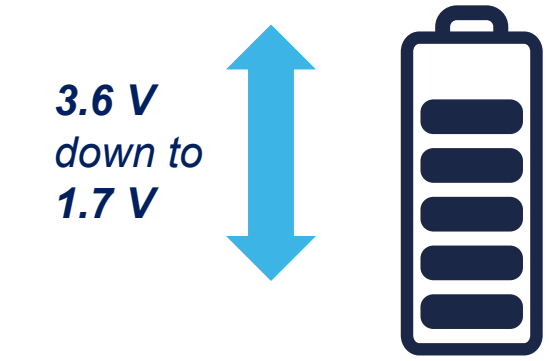


STM32WL3 internal DC-DC converter
State-of-the-art efficiency

RF SoC architecture for battery-operated applications:

Application modes	Power modes	STM32WL3 current (*)
Standby	Deep-sleep current	<1.5 µA (LSI on)
Transmission	+10 dBm	10 mA
	+14 dBm	22 mA
Reception with standard radio	Continuous Rx	5.6 mA
	Rx sniff mode	down to a few µA average
Reception with wideband radio	Rx wake-up mode (OOK modulation)	4.2 µA

Supply voltage range:



(*) **Radio + CPU** power consumption characterization obtained at 3.3 V – 868 MHz radio band

The DC-DC converter can be bypassed thanks to internal LDOs.

Many application possibilities

WATER & GAS METERS

- **Ultra-low-power MCU**
  960 nA stop mode
  LC sensors an LCD controller
- **Worldwide deployment**
  Dual power output: +14 dBm & +20 dBm
  WW RF bands: 169 MHz*, 433 MHz, 868 MHz, 915/320 MHz

ASSET TRACKING

- Ultra-low-power **wake-up radio**
  ➔ 4.2 µA **always on** receiver
  ➔ (100 MHz to 2.4 GHz) Rx OOK at -50 dBm

HEAT COST ALLOCATORS

- **Internal LCD driver**
  Up to 12x8 or 16x4 matrix elements
- **Outstanding sensitivity**
  -132 dBm (OOK) / -128 dBm (FSK)

STM32**WL3x**

ALARM SYSTEMS

- **Low-power main radio**
  Rx current (LPM): 5.6 mA
  Tx current (10 dBm): 10 mA

SMART HOMES

- **Multiple modulations, protocols**
  4-(G)FSK up to 600 Kbps, 2-(G)FSK, (G)MSK, DBPSK, DSSS, OOK, ASK
- **+ IQ interface**

REMOTE CONTROLS NEW

- **Battery life extension**
  14 nA shutdown mode with 6 wake-up pins
- 450 nA ultra-deep-stop with RAM retention
- **Worldwide deployment**
  315 MHz, 433 MHz, 868 MHz, 915/920 MHz

* 169MHz available on dedicated P/N (STM32WL3xxxxxA)

STM32WL3x product lines tailored for your application needs

	Applications	Flash	Package	Radio	SPI/ UART	I2C	ADC	LCD/LCSC/ COMP/DAC
STM32WL33x Metering line	Water/ gas meters Heat cost allocators	Up to 256 KB	QFN32 and QFN48	Main radio + wake-up on radio	✓	✓	✓	✓
STM32WL31x IoT line	IoT sensors IoT asset tracking	Up to 128 KB	QFN32 and QFN48	Main radio	✓	✓	✓	
NEW **STM32WL3Rx** Remote control line	Remote controls Garage door openers	Up to 128 KB	QFN32 up to **6 wake-up pins**	Main radio	✓	✓	2ch*	
STM32WL30x Modem line	Open coprocessor	Up to 128 KB	QFN32	Main radio	✓			

*ADC channels

STM32WL3x global radio compliance

	169 MHz	315 MHz	433 MHz	868/920 MHz
	159-185 MHz	276-319 MHz	413-479 MHz	826-958 MHz
STM32WL33x Metering line	✓ on dedicated P/N (STM32WL3xxxxxA)		✓	✓
STM32WL31x IoT line			✓	✓
NEW **STM32WL3Rx** Remote control line		✓	✓	✓
STM32WL30x Modem line			✓	✓

STM32WL3x low-power modes

Low-power mode	DEEP STOP + WAKE-UP RADIO	DEEP STOP	ULTRA DEEP STOP	SHUTDOWN
Current	4.2 µA	960 nA	450 nA	14 nA
Wake-up sources	Wake-up radio + All GPIO	All GPIO	Wake-up pin + RST	Wake-up pin + RST
RAM retention	Up to 32KB SRAM	Up to 32KB SRAM	Up to 16KB SRAM	N/A
STM32WL33x Metering line	✓	✓		✓ Up to 1 wake-up pin
STM32WL31x IoT line		✓		✓ Up to 1 wake-up pin
NEW **STM32WL3Rx** Remote control line		✓	✓ Up to 6 wake-up pins	✓ Up to 6 wake-up pin
STM32WL30x Modem line		✓		✓ Up to 1 wake-up pin

STM32WL33: metering line (1/2)

Extending battery lifetime in smart metering applications

Multi-band support

169 MHz*, 433 MHz, 868 MHz, 915/920 MHz

Dual radio

Main radio + Wake-up on radio

Ready for analog metering

ADC + DAC + COMP

LC-based measurement of fluid flow metering (AFE + Digital)

LCD driver supporting up to 96 segments

Applications

Water & gas metering

Heat cost allocators

Packages
QFN48 6 x 6 mm
QFN32 5 x 5 mm

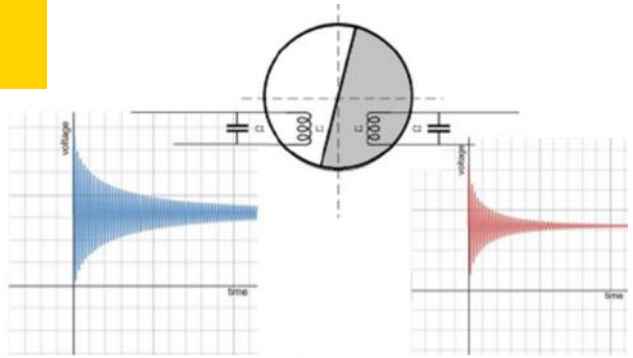
Arm Cortex®-M0+ Up to 64MHz Nested vector interrupt controller (NVIC) Memory protected unit (MPU) SWD interface	Memory	Connectivity	Main radio
	Flash up to 256KB 10k cycles, 2KB page	Up to 2x SPI (with 1x I2S) 2x I2C 1x USART 1x LPUART	8mA @ + 10dBm Tx 4mA Rx
	RAM up to 32KB (full retention)		2-(G)FSK, 4-(G)FSK, (G)MSK, OOK, ASK, DSSS, DBPSK
	1KB OTP	Up to 32 GPIOs	Up to + 20dBm Tx power -132dBm Rx sensitivity
Accelerators	Security	Timers	413-479MHz 826-958MHz 159-185MHz*
CRC calculation unit	AES 128 16-bit TRNG 64-bit unique ID	2x 16-bit GP timers 1x LP timer RTC	
	Secure boot with SWD disabling		16-bit IQ access
DMA 8 channels	Bootloader with write and readout protection	Watchdog: IWDG Systick	Direct radio registers access
System	Analog	Display	Wake-up on radio
48MHz (Radio + HSE) 64MHz HIS 32.768kHz (LSE) Internal 32kHz RCO (LSI)	12-bit ADC SAR 1 Msps	LCD driver 12x8 / 16x4	RX OOK @-50dBm
RTC 20bytes backup registers	Temperature sensor	Fluid sensor controller	100MHz- 2.4GHz
LDO, POR/PDR/PVD/BOR VDD 1.7-3.6V	Analog comparator + DAC	2x LC channel (wheel rotation) 1x LC channel (tamper)	Down to 4ua always on

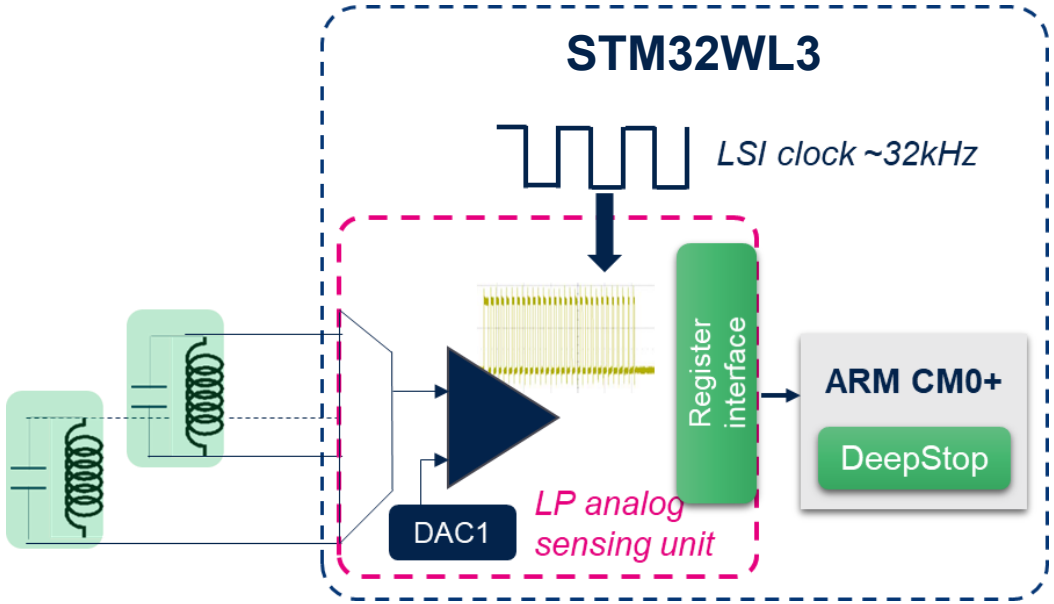
Radio features MCU features *159-185MHz on dedicated P/N (STM32WL3xxxxxA)

STM32WL33 for metering applications (2/2)

Ultra-low-power analog sensing unit based on L-C sensor controller for monitoring fluid flow

- Designed for **cost-effective** mechanic-wheel fluid metering
  - Measuring of L-C network oscillations enable detection of fluid flow metering
- The feature is based on L-C network oscillation measurement
  - Supporting up to 3x L-C networks
  - Autonomous metering circuitry (no CPU intervention, Arm Cortex® M0+ in deep stop)
  - Very little µA average current for continuous L-C metering





STM32WL31: IoT line

Empowering IoT with precision sensing, seamless connectivity, and energy efficiency

Ready for ISM bands

433 MHz, 868 MHz, 915 MHz/920 MHz

Connecting actuators & digital sensors

Up to 32 GPIO
PWM, I2C, LPUART, USART, 2xSPI

Connecting analog sensors

Internal ADC with single ended and differentials
For analog sensors monitoring

Applications

Environment sensors

Asset tracking

Smoke & fire alarms

Packages
QFN48 6 x 6 mm
QFN32 5 x 5 mm

Arm Cortex®-M0+ Up to 64MHz	Memory	Connectivity	Main radio
Nested vector interrupt controller (NVIC) Memory protected unit (MPU) SWD interface	Flash up to 256KB 10k cycles, 2KB page	Up to 2x SPI (with 1x I2S) 2x I2C 1x USART 1x LPUART	8mA @ + 10dBm Tx 4mA Rx
	RAM up to 16KB (full retention)		2-(G)FSK, 4-(G)FSK, (G)MSK, OOK, ASK, DSSS, DBPSK
	1KB OTP	Up to 32 GPIOs	Up to + 20dBm Tx power -132dBm Rx sensitivity
			413-479MHz 826-958MHz
			16-bit IQ access
			Direct radio registers access

Accelerators	Security	Timers
CRC calculation unit	AES 128 16-bit TRNG 64-bit unique ID	2x 16-bit GP timers 1x LP timer RTC
DMA 8 channels	Secure boot with SWD disabling	Watchdog: IWDG Systick
	Bootloader with write and readout protection	

System	Analog
48MHz (Radio + HSE) 64MHz HIS 32.768kHz (LSE) Internal 32kHz RCO (LSI)	12-bit ADC SAR 1 Msps
RTC 20bytes backup registers	Temperature sensor
LDO, POR/PDR/PVD/BOR VDD 1.7-3.6V	

Radio features MCU features

NEW STM32WL3R: remote control line

Small footprint, maximum battery life, and simplified remote control design

Universal remote control

4 bands supported on the same P/N:
315 MHz, 433 MHz, 868 MHz, 915MHz/920 MHz

Tailored for remote controls

Small footprint: 5x5mm, Up to 18 GPIOs, Cortex®-M0+-based
Available in TX only: P/N STM32WL3R-X

Long battery life

Internal SMPS, Tx current (10dBm): 10 mA
450nA ultra-deep-stop with RAM retention
14 nA shutdown mode with 6 wake-up pins

Applications


Garage openers


Call/bell systems


Wireless key pads

Packages
QFN32 5 x 5 mm

Arm Cortex®-M0+ Up to 64MHz	Memory	Connectivity	Main radio
Nested vector interrupt controller (NVIC) Memory protected unit (MPU) SWD interface	Flash up to 128KB 10k cycles, 2KB page	Up to 1x SPI 1x I2C 1x USART 1x LPUART	8mA @ + 10dBm Tx 4mA Rx
	RAM up to 16KB (full retention)	Up to 18 GPIOs **6 wakeup pins* from shutdown**	2-(G)FSK, 4-(G)FSK, (G)MSK, OOK, ASK, DSSS, DBPSK
	1KB OTP		Up to + 20dBm Tx power -132dBm Rx sensitivity
			413-479MHz 826-958MHz **276-319MHz***
			16-bit IQ access
			Direct radio registers access

Accelerators	Security	Timers
CRC calculation unit	AES 128 16-bit TRNG 64-bit unique ID	2x 16-bit GP timers 1x LP timer RTC
DMA 8 channels	Secure boot with SWD disabling	Watchdog: IWDG Systick
	Bootloader with write and readout protection	

System	Analog
48MHz (Radio + HSE) 64MHz HIS 32.768kHz (LSE) Internal 32kHz RCO (LSI)	12-bit ADC SAR 1 Msps
RTC 20bytes backup registers	Temperature sensor
LDO, POR/PDR/PVD/BOR VDD 1.7-3.6V	

Radio features MCU features *Available only for STM32WL3R product line

STM32WL30: modem line

The best fit for hosted applications

Ready for ISM bands

433 MHz, 868 MHz, 915 MHz

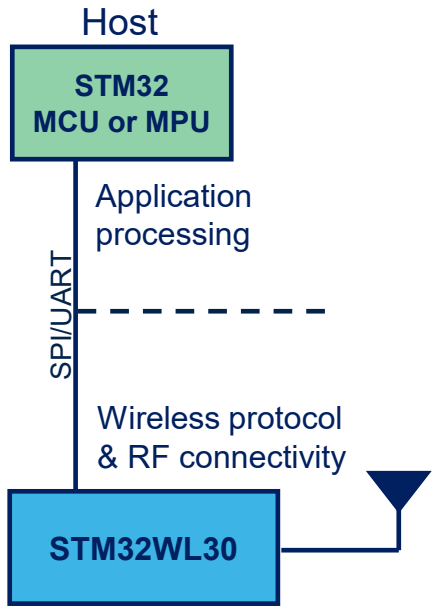
Open SoC architecture

Develop your own wireless co-processor based on STM32WL3 SoC

With minimalist peripheral set

For host connectivity
GPIO, UART & SPI

Packages
QFN32 5 x 5 mm



Arm Cortex®-M0+
Up to 64MHz

Nested vector interrupt controller (NVIC)
Memory protected unit (MPU)
SWD interface

Memory	Connectivity	Main radio
Flash up to 128KB 10k cycles, 2KB page	Up to 1x SPI 1x USART 1x LPUART	8mA @ + 10dBm Tx 4mA Rx
RAM up to 16KB (full retention)		2-(G)FSK, 4-(G)FSK, (G)MSK, OOK, ASK, DSSS, DBPSK
1KB OTP	Up to 17 GPIOs	Up to + 20dBm Tx power -132dBm Rx sensitivity
		413-479MHz 826-958MHz
		16-bit IQ access
		Direct radio registers access

Accelerators	Security	Timers
CRC calculation unit	AES 128 16-bit TRNG 64-bit unique ID	2x 16-bit GP timers 1x LP timer RTC
DMA 8 channels	Secure boot with SWD disabling	Watchdog: IWDG Systick
	Bootloader with write and readout protection	

System
48MHz (Radio + HSE) 64MHz HIS 32.768kHz (LSE) Internal 32kHz RCO (LSI)
RTC 20bytes backup registers
LDO, POR/PDR/PVD/BOR VDD 1.7-3.6V

Radio features MCU features

STM32WL3x and SPIRIT portfolio

STM32CubeWL3 framework

Tools and software supporting you throughout all your design steps

Evaluation, prototyping and selection | **Hardware and software configuration** | **Application development and debug** | **Code and hardware options programming** | **Runtime application monitoring**

STM32 Finder

STM32 boards

STM32 CubeMX

STM32 CubeWL3

STM32 CubeExpansion & Verticals and partner solutions

STM32 CubeIDE & Partner IDEs

STM32 CubeProgrammer & Programmers from partners

STM32 CubeMonitor

Worldwide support channels

STM32 CubeWL3

STM32WL3x & wireless protocols firmware

Comprehensive stack offer

mioty

OMS OPEN METERING SYSTEM GROUP

M-Bus wireless

sigfox

Proprietary & 802.15.4

Mioty stack	OMS stack	wM-Bus applications	Sigfox applications	sub-GHz radio examples
Modes Z (UL) and A (UL & DL) Uplink (UL) encoding interleaving, FEC, symbol mapping Downlink (DL) via IQ I/F demodulation & decoding Fraunhofer	OMSv4.5.1 ready for end device & for gateway devices Application layers (APL) transportation layers (TPL) authentication & fragmentation extended data link layers STACKFORCE embedded.connectivity.solutions	Meter and concentrator mode T2, C2, S2, and concurrent (T+C) examples.	CLI interface for Sigfox commands. Push-button transmission demo.	802.15.4g & basic mode based on flexible packet handler Rx sniff mode, CSMA, LBT based on RF sequencer Wakeup radio and low-power applications
		wM-Bus middleware	**Sigfox middleware**	
		Supports physical and data link layers. Enables unidirectional & bidirectional and communications.	Compliant with Sigfox network standards. Includes RF test protocol for validation.	

Low layers & HAL radio drivers

Available via partners

Available in STM32CubeWL3

Radio development tools

WiSE Studio

WiSE-RadioExplorer

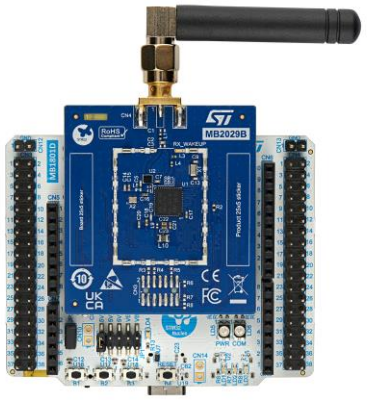
The **STM32CubeWISEre** is a graphical user interface to interact with the STM32WL3x line devices and evaluate their radio capabilities.

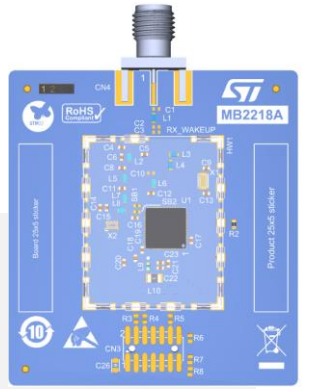
WiSE-RadioCodeGen

The **STM32CubeWISEcg** is a PC application that can be used to build a flow graph which defines the radio actions to execute under specific conditions, using the sequencer driver.

Development tools for the STM32WL3x

Speed-up evaluation, prototyping, and design



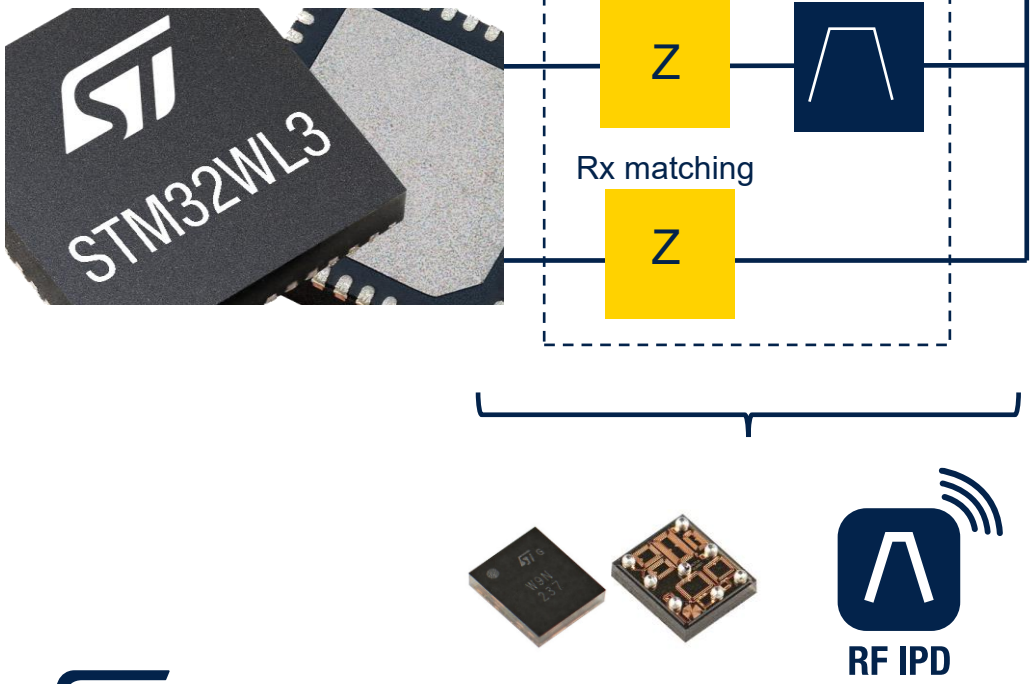


Resources to get you started: schematics, layout, BoM, and firmware examples

NUCLEO-WL33CC1 & NUCLEO-WL33CC2	NUCLEO-WL3RKB1 & NUCLEO-WL3RKB2	Free reference designs STDES-WL3xxxxx $0
High band 826-958 MHz and **low band** 413-479 MHz		**RF bands:** 169, 315, 433, 868, 915/920 MHz **Power output**: 10 dBm, 16 dBm, 20 dBm
QFN48 6 x 6 mm STM32WL**30/31/33**	QFN32 5 x 5 mm STM32WL**3R**	Both QFN32 and QFN48 on 2L and 4L PCB STM32WL**3x**

IPD list

RF IPD products as companion chips to the STM32WL3



How to pick the right one?

868/920MHz bands	826-958 MHz	Low-power mode 16dBm	4-layer PCB	MLPF-WL-01D3
			2-layer PCB	MLPF-WL-05D3
		High-power mode 20dBm	4-layer PCB	MLPF-WL-02D3
			2-layer PCB	MLPF-WL-06D3
433MHZ bands	413-479 MHz	Low-power mode 10dBm	4-layer PCB	MLPF-WL-03D3
			2-layer PCB	
		High-power mode 16dBm	4-layer PCB	MLPF-WL-04D3
			2-layer PCB	MLPF-WL-08D3
315MHZ bands	276-319 MHz	Low-power 10dBm and high-power 16dBm	2-layer PCB	MLPF-WL-09D3

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