STM32WL Series MCU
Long-Range Wireless System-on-Chip
System-on-Chip Made for Versatility

A Long-Range Wireless Microcontroller: one die, many IoT possibilities

Single Silicon Die

STM32L4 + LoRa (G)FSK (G)MSK BPSK = STM32 WL

World First
Make the Choice of STM32WL Series

The 7 key points that will make the difference

- Multi-modulation
- Massive integration
- Open platform
- Ultra-low-power
- Cost saving
- STM32 Security
- A large offer is coming

No matter what!
Deep Integration
Wide Purposes
4 Modulations - Many Protocols

- **LoRa**
  - (G)FSK
  - (G)MSK
  - BPSK

- **LoRaWAN**
  - Based proprietary

- **sigfox**
  - * + proprietary

- Proprietary

* Coming soon
STM32WL - a Rich Feature Set

Key features

- Arm® Cortex®-M4 DSP up to 48 MHz
- Up to 256 KB Flash and 64 KB SRAM
- Sub-GHz Radio – Multi-modulations
  - LoRa, (G)FSK, (G)MSK, BPSK
  - 2 embedded power amplifiers:
    - 1 output up to +15 dBm
    - 1 output up to +22 dBm
  - LoRa RX sensitivity: -148 dBm (SF12, BW=10.4kHz)
  - RX: 5.4mA and TX: 15mA (at 10dBm) / 87mA (at 20dBm) [3.3V]
- Peripherals
  - 3xI²C, 2xUSART, 1xLP-UART, 2xSPI
  - 7x timers + 2x ULP Comparators
- 1.8 to 3.6V voltage range (DC/DC, LDO)
- -40 to up to +105°C temperature range
- Power consumption
  - < 71µA/MHz Active mode (3V - RF OFF)
  - 1 µA Stop2 mode with RAM retention
  - 445 nA Standby mode with RTC
  - 31 nA Shutdown mode

Control

- Power supply: 1.8 to 3.6 V w/DDC+ LDO
- POR/PDR/PVD/BOR
- Crystal oscillators: 32 MHz (Radio + HSE) 32.768 KHz (LSE)
- Internal RC oscillators: 32.768 KHz + 16 MHz + 48 MHz ± 1% acc. over V and T(°C)
- 43 GPIOs
- Cyclic redundancy check
- Voltage scaling (2 modes)

Arm® Cortex®-M4 DSP 48 MHz
- Nested vector interrupt controller (NVIC)
- Memory protected unit (MPU)
- JTAG/SW debug

LoRa®, (G)FSK, (G)MSK, BPSK
- +15dBm & +22dBm Power Outputs
- -148 dBm sensitivity (LoRa)
- 150 MHz to 960 MHz

Security
- 256-bit AES/PKA
- TRNG + PCROP

Memory
- Up to 256-Kbyte Flash
- Up to 64-Kbyte SRAM
- Boot ROM
- Boot loader

Timers
- 1 x 32-bit timer
- 3x 16-bit timers
- 3x ULP 16-bit timers

Analog
- 1x 12-bit ADC SAR 2.5 Msps
- 12-bit DAC
- 2x ULP comparators
- Temperature sensor

Connectivity
- 2x SPI, 3x I2C
- 2x USART LIN, smartcard, IrDA, Modem control
- 1x ULP UART
STM32WL Sub-GHz - Portfolio

Flash memory / RAM size (bytes)

- 256K / 64K: STM32WLE5JC
- 128K / 48K: STM32WLE5JB
- 64K / 20K: STM32WLE5J8

73-pin UFBGA (0.5 mm pitch)

Legend: □ In production

Up to 43 GPIOs for full flexibility
+ Tiny package footprint
Best Suited for Many LPWAN Market

- Worldwide compatibility 150 MHz to 960 MHz Linear Range
- Multi-protocol capable
- ST Longevity commitment: 10 years life time

- Up to +22 dBm output power for wide coverage
- -148 dBm sensitivity with LoRa: Robust RF Link
- Reduced BOM cost

- Unique-IDs for enhanced traceability
- Down to 445 nA mode with RTC and 32KB of RAM for extended Battery lifetime
- Small form factor with UFBGA 5x5 package

- Up to 105 °C MCU capable
- Only 5 µs wakeup time for best latencies
- Only 5.4 mA as LoRa RX consumption for battery optimization

- Link Budget > 160 dB = Very long ranges
- Excellent battery lifetime: Only 15 mA for LoRa TX consumption @ 10 dBm
- PCROP, ECC, TRNG, PKA, for best design robustness

- Down to 71 µA/MHz in Run mode for efficient action
- < 1 µA Stop mode with full RAM for battery life optimization
- 12-bit ADC & DAC for mixed applicative use cases
Flexible Power Scheme
**Flexible Power Scheme**

**FlexPowerControl**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Power Consumption (Typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN (Range1) at 48 MHz</td>
<td>71* / 115 µA / MHz</td>
</tr>
<tr>
<td>RUN (Range2) at 16 MHz</td>
<td>100* / 115 µA / MHz</td>
</tr>
<tr>
<td>SLEEP at 48 MHz</td>
<td>28* / 35 µA / MHz</td>
</tr>
<tr>
<td>STOP 1 (full retention)</td>
<td>4.55 µA**</td>
</tr>
<tr>
<td>STOP 2 (full retention)</td>
<td>1 µA**</td>
</tr>
<tr>
<td>STANDBY + 32 KB RAM</td>
<td>445 nA**</td>
</tr>
<tr>
<td>STANDBY</td>
<td>71 nA*</td>
</tr>
<tr>
<td>SHUTDOWN 31**** / 175 nA**</td>
<td></td>
</tr>
<tr>
<td>V_BAT 5**** / 200 nA**</td>
<td></td>
</tr>
</tbody>
</table>

- **Typ** with LDO @ V_DD = 3 V @ 25 °C

- **Wake-up time to RUN**
  - 6 cycles
  - 5 µs
  - 5.5 µs
  - 29 µs
  - 29 µs
  - 267 µs

- **RF Capable**

**Benchmark Scores**

- **High Efficiency**
  - CoreMark score = 162

- **Ultra Low-Power Platform**
  - ULPBbench score ≈ 204

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* Typical values with SMPS, **RF OFF**
** with RTC on LSE Bypass
*** Able to maintain RF context
**** All OFF

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1 Pending certification
# Flexible Power Scheme

Matching Your Application Needs

## LPWANs made easy through Ultra-Low-Power tradeoffs

<table>
<thead>
<tr>
<th>Power mode</th>
<th>Arm® Cortex®-M4</th>
<th>Peripherals</th>
<th>RAM Retention</th>
<th>RF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td>✓</td>
<td>✓</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Sleep</td>
<td>X</td>
<td>✓</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Stop 0</td>
<td>X</td>
<td>✓</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Stop 1</td>
<td>X</td>
<td>✓</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Stop 2</td>
<td>X</td>
<td>Subset</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Standby</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
<td>✓</td>
</tr>
<tr>
<td>Shutdown</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

- **Seamless toolbox** (I²C, SPI, USART, ADC/DAC, Timers, Comparators etc.)
- **RF available** in all power modes
- **Back-up registers are always available**
# Efficient Power Management

## STOP Modes Comparison

### Flexible peripherals power mapping

<table>
<thead>
<tr>
<th></th>
<th>STOP0</th>
<th>STOP1</th>
<th>STOP2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumption</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(without Real Time Clock)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typ, 25 °C, 3 V, LDO</td>
<td>400 µA</td>
<td>4.55 µA</td>
<td>1 µA</td>
</tr>
<tr>
<td><strong>Wakeup time to 48 MHz</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash</td>
<td>2.2 µs</td>
<td>5 µs</td>
<td>5.5 µs</td>
</tr>
<tr>
<td>RAM</td>
<td>2.2 µs</td>
<td>5.1 µs</td>
<td>5.5 µs</td>
</tr>
<tr>
<td><strong>Wakeup clock</strong></td>
<td></td>
<td></td>
<td>≤ 48 MHz</td>
</tr>
<tr>
<td><strong>Regulator</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main or Low-Power regulator</td>
<td></td>
<td></td>
<td>Low-power regulator</td>
</tr>
<tr>
<td><strong>Peripherals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>All</td>
<td>All</td>
<td>CSS, RTC, 3 Tamper Pins, 1x LPUART, 1x I²C, VREFBUF, 2x COMP, 1x LPTIM, Dual-WDG, CRC, EXTI</td>
</tr>
</tbody>
</table>

No impact on wakeup time from embedded DCDC
Ultra-Low Power & IoT Ready for Worldwide Applications

Best LoRa-enabled IP on the market

### Transmission

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Settings</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>+10 dBm 868/915 MHz</td>
<td>15 mA DCDC</td>
</tr>
<tr>
<td>TX</td>
<td>+20 dBm 868/915 MHz</td>
<td>87 mA DCDC</td>
</tr>
</tbody>
</table>

### Reception

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Settings</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoRa Sensitivity</td>
<td>BW_L = 10.4 kHz SF = 12</td>
<td>-148 dBm</td>
</tr>
<tr>
<td>2-FSK Sensitivity</td>
<td>BR_F = 0.6 kb/s FDA = 0.8 kHz BW_F = 4 kHz</td>
<td>-125 dBm</td>
</tr>
<tr>
<td>RX</td>
<td>FSK 4.8kb/s buck 100mA max</td>
<td>5 mA DCDC 8.7 mA LDO</td>
</tr>
<tr>
<td>RX</td>
<td>LoRa® 125 kHz</td>
<td>5.4 mA DCDC 9.45 mA LDO</td>
</tr>
</tbody>
</table>

Worldwide Compatibility
Flexible Power Implementation

Tailor STM32WL to your IoT needs

STM32WL

- LDO
- DC-DC
- CORE + RF IP
- REG
- PA
- LP PA
- HP PA

Up to +15 dBm
Up to +22 dBm

Power Management Config.

2 Power Outputs
Advanced Features And Ecosystem
STM32WL - Safety and Security

Secure your application with embedded safety & security

**Safety**
- Back-up clock circuitry
- Supply monitoring
- Dual watchdog
- Flash memory with ECC (address status register)
- SRAM Parity check
- Cyclic Redundancy Check
- Brown-out reset in all modes
- Clock Security System
- Backup byte registers

**Security**
- Anti-Tamper detection
- Boot Lock
- Read & Write protection
- Memory Protection Unit (MPU)
- Software IP Protection
- True Random Number Generator
- Public Key Accelerator
- Unique IDs (64- and 96-bit)
Chips & Stacks Delivery Model

Open chips, takeaway stacks

STM32WL

- Arm Cortex-M4
- Application Firmware
  + Peripherals
  + Radio stack

Certified LoRaWAN stack

Open Platform
Open stack

Please contact your nearest ST Sales Office for more information.
A Higher Level of Integration

MCU + Radio 2-in-1 solution

STM32WL
- Arm Cortex-M4
- Application Firmware
  + Peripherals
  + Radio stack

VS

Standalone MCU

Standalone transceiver

- SoC solution (1 single die)
- All-in-1 solution - cost saving
- Simplified development helps speeding up time to market

- 2 standalone chips, or dice (SiP)
- Bigger final PCB (increased cost)
- Wired communication more exposed
STM32WL – Introductory Ecosystem

Fully integrated into the rich and market-proven STM32 ecosystem

STM32 Nucleo-64
- Flexible prototyping

Dev tools
- STM32CubeMX for pinout and clock configuration
- STM32CubeProg
- Partners IDE

Stacks
- LoRaWAN
- Sigfox

Please contact your nearest ST Sales Office for more information
Save on Your Application Cost

Optimization of the ecosystem cost

- LoRaWAN stack: free of charge
- STM32CubeMX: free of charge
- STM32CubeProg: free of charge
- System-on-chip avoids to use a second radio

Optimization of the silicon cost

- Deep integration factor
- Less external components
- Single 32 MHz crystal for CPU & embedded radio
- 32 kHz master clock output available

Integrated functionalities helps you drop the BOM down
STM32 Rolling Longevity Commitment

Longevity commitment is renewed every year

• STM32F1 (launched in 2007)  22 years of commitment
• STM32L1 (launched in 2009)  20 years of commitment
• STM32F2 (launched in 2010)  19 years of commitment
• STM32F4 (launched in 2011)  18 years of commitment
• STM32F0 (launched in 2012)  17 years of commitment
• STM32F3 (launched in 2012)  17 years of commitment
• STM32L0 (launched in 2013)  16 years of commitment
• STM32F7 (launched in 2014)  15 years of commitment
• STM32L4 (launched in 2015)  14 years of commitment
• STM32L4+ (launched in 2016)  13 years of commitment
• STM32H7 (launched in 2016)  13 years of commitment
• STM32WB (launched in 2018)  11 years of commitment
• STM32G0 (launched in 2018)  11 years of commitment
• STM32G4 (launched in 2019)  10 years of commitment
• STM32WL (launched in 2020)  10 years of commitment

Starting in 2020
A New STM32 Family Member

17 MCU product series / More than 64 MCU product lines

High-performance MCUs

Mainstream MCUs

Ultra-low-power MCUs

Wireless MCUs

arm

Cortex®-M0
Cortex®-M0+
Cortex®-M3
Cortex®-M4
Cortex®-M33
Cortex®-M7
Dual Cortex®-M7 & Cortex®-M4

More than 40,000 customers

Note: Cortex-M0+ Radio Co-processor
Releasing Your Creativity with the New STM32