

# STM32 Microcontrollers

**STM32 microcontrollers**, created by **STMicroelectronics**, are some of the most popular and versatile microcontrollers in the embedded systems world. They power everything from simple gadgets to advanced robots, thanks to their blend of performance, low power consumption, and a vast range of features.

## Understanding the Architecture

At the heart of STM32 microcontrollers is the **ARM Cortex-M core**, which comes in various versions:

- **Cortex-M0/M0+:** Ultra-low power, great for basic tasks.
- **Cortex-M3/M4:** Balanced performance with DSP capabilities for signal processing.
- **Cortex-M7:** High-performance core for demanding applications like robotics and real-time control.

Alongside the core, STM32 chips are packed with:

- **Flash memory & SRAM** for code and data storage.
- **GPIO (General-Purpose Input/Output) pins** to interact with sensors, motors, and other components.
- **Peripherals** like ADC, DAC, timers, PWM, UART, SPI, I2C, CAN, and USB for handling a wide range of tasks.
- **Power management features** with multiple low-power modes to extend battery life in portable devices.

## Popular STM32 Series

STM32 microcontrollers are divided into several families, each designed for specific applications:

- **STM32F Series (Foundation Series):** General-purpose controllers ideal for learning and prototyping. Boards like the **STM32F103 "Blue Pill"** are widely used by hobbyists.
- **STM32L Series (Low Power):** Optimized for battery-powered devices, perfect for wearables and remote sensors.
- **STM32H Series (High Performance):** Built for speed, capable of handling complex computations and real-time tasks, making them ideal for robotics and industrial automation.
- **STM32WB Series (Wireless & Bluetooth):** Designed for IoT applications, with built-in wireless communication like BLE and Zigbee.

## Why STM32 is Ideal for Robotics

STM32 microcontrollers stand out in robotics because they offer:

- **Real-Time Performance:** STM32 chips support real-time operating systems (RTOS) like **FreeRTOS**, making it easier to manage multitasking for sensor polling, control loops, and decision-making.
- **Rich Peripheral Set:** The availability of multiple timers, PWM outputs, and communication protocols makes integrating motors, encoders, IMUs, cameras, and LiDAR sensors straightforward.
- **Low Power Options:** For battery-powered robots, STM32's power-saving modes help extend runtime without sacrificing performance.

- **Scalability:** You can start with a basic STM32F103 for small projects and scale up to an STM32H7 as your robot grows more complex — all while staying within the STM32 ecosystem.

## Practical Robotics Applications

STM32 microcontrollers are used in various robotic systems:

- **Mobile Robots:** Controlling motors, processing sensor inputs (like ultrasonic or infrared), and handling wireless communication for remote control or autonomous navigation.
- **Robotic Arms:** Managing servo motors with precise PWM signals and handling inverse kinematics calculations.
- **Drones & Quadcopters:** Handling real-time stabilization and control with gyroscope and accelerometer data.
- **Humanoid Robots:** Coordinating multiple motors, integrating vision sensors, and managing balance and movement in real time.

STM32 MCUs		32-bit Arm® Cortex®-M			LONGEVITY 10 YEARS COMMITMENT	
★ High Performance	STM32F2	STM32F4	STM32H5	STM32F7	STM32H7	STM32N6
	398 CoreMark 120 MHz Cortex-M3	608 CoreMark 180 MHz Cortex-M4	Up to 1023 CoreMark 250 MHz Cortex-M33	1082 CoreMark 216 MHz Cortex-M7	Up to 3224 CoreMark Up to 600 MHz Cortex-M7 240 MHz Cortex-M4	3360 CoreMark 800 MHz Cortex-M55
» Mainstream	STM32C0	STM32G0			STM32G4	
	114 CoreMark 48 MHz Cortex-M0+	142 CoreMark 64 MHz Cortex-M0+			569 CoreMark 170 MHz Cortex-M4	
		STM32F0	STM32F1	STM32F3		
		106 CoreMark 48 MHz Cortex-M0	177 CoreMark 72 MHz Cortex-M3	245 CoreMark 72 MHz Cortex-M4		Optimized for mixed-signal applications
🔋 Ultra-low-power			STM32L4+	STM32U5	STM32U3	
			409 CoreMark 120 MHz Cortex-M4	651 CoreMark 160 MHz Cortex-M33	393 CoreMark 96 MHz Cortex-M33	
	STM32L0	STM32U0	STM32L4	STM32L5		
	75 CoreMark 32 MHz Cortex-M0+	140 CoreMark 56 MHz Cortex-M0+	273 CoreMark 80 MHz Cortex-M4	443 CoreMark 110 MHz Cortex-M33		
📶 Wireless			STM32WL	STM32WB0	STM32WB	STM32WBA
			162 CoreMark 48 MHz Cortex-M4 48 MHz Cortex-M0+	156 CoreMark 64 MHz Cortex-M0+	219 CoreMark 64 MHz Cortex-M4 32 MHz Cortex-M0+	407 CoreMark 100 MHz Cortex-M33

● Cortex-M0+  
● Radio co-processor