# Microcontrollers

Apollo & Apollo Blue Family

Ambiq Micro is the leader in ultra-low power design with the Apollo and Apollo Blue family of microcontrollers providing the most energy efficient processing solutions in the market and offers the world's lowest power real-time clock (RTC). At the heart of each product is Ambiq Micro's patented Subthreshold Power Optimized Technology (SPOT™) platform, which dramatically reduces energy consumption without compromising processing power, quality, or functionality.

Ambiq Micro's SPOT™-based microcontrollers break new ground in bringing neural networks like voice wake word recognition, voice command recognition, complex sleep analysis, and predictive sensory processing to battery and energy harvesting powered edge devices. These highly-integrated microcontrollers offer an Arm® Cortex®-M4F core at power levels that are even lower than competing Arm® Cortex®- M0+ solutions. Applications like hearables, wearables, medical monitors, IoT devices, and remote wireless sensors benefit from Apollo and Apollo Blue microcontrollers by gaining the flexibility to dramatically increase battery life, add more complex intelligent processing, and use smaller batteries or unique power supplies.

The Apollo Blue microcontrollers further integrate an energy-efficient Bluetooth 5 low-energy radio combined with improved communication features to enable always-connected, ultra-low power designs. The Apollo Blue family also provides a dedicated second core for ultra-low power BLE5 connectivity providing superior RF throughput and leaving plenty of resources available for user applications. The radio performance and interoperability has already been proven to be reliable and robust in millions of products sold by the most trusted brands in consumer and technology products around the world.
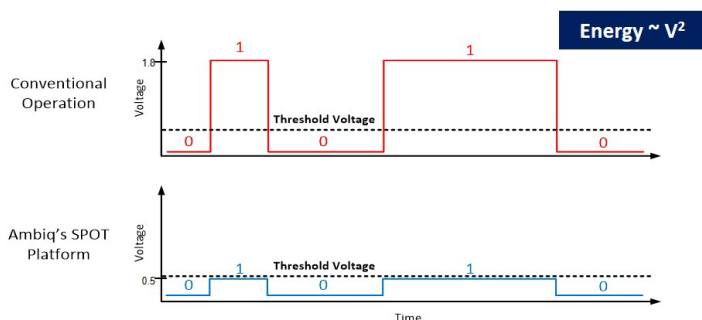
Subthreshold operation can reduce energy usage

Apollo3 Blue – Next Generation Ultra-Low Power MCU

It manages a further reduction in power consumption compared to the so far unprecedented values of the former Apollo generations. The Apollo3 Blue's TurboSPOT™ brings groundbreaking levels of energy efficiency to mobile, battery powered devices by increasing the computational capabilities of the Arm® Cortex®-M4F core to 96MHz while lowering the active power consumption to <6uA/MHz. An integrated DMA engine combined with the extra computing bandwidth gives engineers the flexibility to add more complex sensor processing algorithms to their energy-sensitive products without sacrificing quality or battery life.
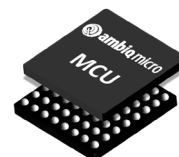
The Apollo3 Blue also provides a dedicated second core for the ultra-low power BLE5 connectivity platform providing superior RF throughput and leaving plenty of resources available for user applications. The radio performance and interoperability has already been proven to be reliable and robust in real-world consumer products which are currently shipping in massive volume.

Breakthrough Subthreshold Design

Rather than using transistors that are turned all the way "on", subthreshold circuits use the leakage of "off" transistors to compute in both the digital and analog domains. With most computations handled by using only leakage current, total system power consumption in the order of nano amps is easily achieved. Compared to a typical circuit operating at 1.8V, a "near-threshold" circuit operating at 0.5V can achieve an improvement in dynamic power.

Operation at such low voltages is problematic due to susceptibility to noise, high sensitivity to temperature, and variability due to process drift. In developing the SPOT™ platform, Ambiq Micro has addressed all of these challenges by redesigning every analog and digital circuit in the chip to adapt for the temperature, voltage, and manufacturing variations that would otherwise be problematic at these voltage levels.

Despite the comprehensive use of subthreshold voltages in the SPOT™ platform, Ambiq Micro's products can be used like any other semiconductor device and are implemented using industry-standard CMOS manufacturing flows. The one difference: dramatically reduced power consumption.

MCU Selector Guide

	Apollo / Apollo Lite	Apollo2	Apollo2 Blue	Apollo3 Blue
MCU Frequency	24MHz	48 MHz	48MHz	48 MHz 96 MHz TurboSPOT™
MCU	32-bit Arm® Cortex®-M4F	32-bit Arm® Cortex®-M4F	32-bit Arm® Cortex®-M4F	32-bit Arm® Cortex®-M4F DMA
MCU Power Efficiency	34 uA/MHz	10uA/MHz	10uA/MHz	<6uA/MHz
Flash	512KB/256KB	1MB	1MB	1MB
SRAM	64KB/32KB	256KB	256KB	384KB
Voltage	2.2 - 3.8V	1.8 - 3.6V	1.95 - 3.6V	1.8 – 3.6V
ADC	10 bit, 13-channel, up to 800 kSps ADC	14 bit, 15-channel, up to 1.2 MSps	14 bit, 15-channel, up to 1.2 MSps	14 bit, 15-channel, up to 1.2 MSps
Temperature Sensor	Yes	Yes	Yes	Yes
Voltage Comparator	Yes	Yes	Yes	Yes
UART	1	2	2	2
I/O	I^2C /SPI master I^2C /SPI slave	I^2C /SPI master (6x) I^2C /SPI slave	I^2C /SPI masters (4x) I^2C /SPI slave	I^2C /SPI master (6x) I^2C /SPI slave
I^2S	-	I^2S slave for PDM Audio Pass-through	I^2S slave for PDM Audio Pass-through	I^2S slave for PDM Audio Pass-through
PDM	-	Dual Interface for Mono and Stereo Audio Microphones	Dual Interface for Mono and Stereo Audio Microphones	Dual Interface for Mono and Stereo Audio Microphones
Wireless Connectivity	-	-	BLE 5	BLE 5
RF Sensitivity	-	-	-95dBm	-95dBm
RF TX Max	-	-	+5dBm	+4dBm
RX current	-	-	3.5mA	3mA
TX current	-	-	5.05mA @ 0dBm 8mA @ +5dBm	3mA @ 0dBm
Packages	2.49 x 2.90 mm 41-pin CSP (27 GPIO)	2.5 x 2.5 mm 49-pin CSP (34 GPIO)	4 x 4 x 0.9 mm 64-pin LGA (31 GPIO)	3.3 x 3.2 mm 65-pin CSP (37 GPIO)
	4.5 x 4.5 mm 64-pin BGA (50 GPIO)	4.5 x 4.5 mm 64-pin BGA (50 GPIO)		5 x 5 mm 81-pin BGA (50 GPIO)