# eXtreme Low Power Solutions for Wearable Applications


## Summary

Extremely small, wearable devices are popular, either as stand-alone accessories or as companions for use with a smartphone. Wearable technology is being developed for many applications including medical diagnostics, fitness monitoring and personal entertainment.

Developers of wearable devices face many unique design challenges, including long battery life, extreme space efficiency and effortless cloud connectivity, while protecting sensitive user data. Microchip focuses on enabling you to develop highly integrated, cost-effective embedded systems with an MCU portfolio that meshes perfectly with the needs of wearable designs.



## Ultra-Tight Power Budgets

Wearable devices run on batteries that are expected to last for weeks or months. To extend the battery life in these power-sensitive applications, PIC® microcontrollers with eXtreme Low Power (XLP) technology offer the industry's lowest currents for Run and Sleep modes.

When sensing data and executing code, wearable devices need to process and transmit information as fast and efficiently as possible, and then go back to sleep in order to optimize battery life. PIC MCUs with XLP technology operate as low as 30 µA/MHz and with speeds up to 16 MIPS, enabling power-efficient applications.

Typically, wearable devices spend most of their time in sleep mode until they are needed to measure biometric data. PIC MCUs with XLP technology consume sleep currents as low as 9 nA with flexible wake-up sources and a variety of low-power modes, retaining state, RAM and time. Also, PIC MCUs offer supervisory circuits to protect stored data and to ensure safe operation when batteries are depleted or changed.

## Small Form Factor

In wearable device design, every millimeter counts. Our PIC MCU portfolio gives you the functional "building blocks" needed to architect your system with as few external components as possible. Flexible, integrated Core Independent Peripherals are designed to take the load off the CPU and reduce the amount of code needed. PIC MCUs enable you to combine several functional tasks onto a smaller, more cost-effective MCU.

Additionally, on-chip Intelligent Analog peripherals (ADCs, Op Amps, Slope Compensation and Zero Cross Detect) on PIC MCUs can be configured to autonomously provide data to the digital peripherals from sensors, touch buttons and feedback circuits for low latency and quick system response. This creates a higher-performance system, without higher clock speed and power consumption, resulting in a smaller battery. More space savings can be achieved with our small-footprint QFN packaging, making PIC MCUs the right choice to reduce size and BOM cost for wearable applications.

## Effortless Connectivity

Wireless communication, such as Bluetooth® and Wi-Fi®, are emerging as the standard communication channels for wearable devices. Microchip's wireless modules offer drop-in functionality for optimum flexibility. Modules are available for Wi-Fi, Bluetooth 2.1 and 4.2 (BLE). A space-saving module with integrated antenna and on-board software stack enables you to add wireless connectivity to any design with minimum effort. These modules have already been certified by the FCC and international agencies.

## Securing Personal Data

A growing number of wearable applications include some personal data and offer a cloud-based connection to access that data from a remote location. Encrypting personal data on the device adds another level of privacy when using Internet-based storage.

PIC MCUs with an integrated hardware crypto engine offer data encryption without sacrificing power consumption and battery life for wearable applications. These devices feature industry-standard support, up to 256-bit AES and Triple DES. The hardware crypto engine saves power, performing encryption 10× faster than software algorithms, with a quick return to low-power sleep modes. Also, these MCUs include a random number generator for creating a secure encryption key and dedicated, secure RAM, secure OTP-based key management with self destruct on tamper detect through pin. We also provide extensive security software libraries for devices that do not feature an integrated hardware crypto engine.

## Featured XLP Products for Wearable Applications

| Device Family | Flash Memory (KB) | Pins | Sleep (nA) | WDT (nA) | RTCC (nA) | 1 MHz Run (µA) | Touch Sense | Core Independent Peripherals | ADC | DAC | Highlights |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PIC18F "K42"** | 16–128 | 28–48 | 60 | 720 | – | 45 | Yes | Yes | 12-bit | 5-bit | Vectored interrupts, DMA |
| **PIC16F153xx** | 3.5–28 | 8–48 | 50 | 500 | – | 32 | Yes | Yes | 10-bit | 5-bit | Device info area, Memory access partition |
| **PIC16F188xx** | 7–56 | 28–40 | 50 | 500 | – | 32 | Yes | Yes | 10-bit | 5-bit | – |
| **PIC16F191xx** | 7–56 | 28–64 | 50 | 500 | 400 | 32 | Yes | Yes | 12-bit | 5-bit | LCD with charge pump, VBAT |
| **PIC18F "K40"** | 16–128 | 28–64 | 50 | 500 | – | 32 | Yes | Yes | 10-bit | 5-bit | – |
| **PIC24F16KL402** | 4–16 | 14–28 | 30 | 210 | 690 | 160 | Yes | Yes | 10-bit | – | – |
| **PIC24FJ128GB204** | 64–128 | 28–44 | 380 | 240 | 300 | 178 | Yes | Yes | 12-bit | – | Crypto engine, USB, VBAT |
| **PIC24FJ128GA310** | 64–128 | 64–100 | 330 | 270 | 400 | 160 | Yes | Yes | 12-bit | – | LCD, VBAT |
| **PIC24FJ128GC010** | 64–128 | 64–100 | 420 | 270 | 360 | 178 | Yes | Yes | 12- and 16-bit | 10-bit | Op Amps, USB, LCD, VBAT |
| **PIC24FJ256GB412** | 64–256 | 64–121 | 70 | 100 | 170 | 166 | Yes | Yes | 12-bit | – | Crypto engine, USB, LCD, VBAT |

## XLP Development Tools

We offer a wide range of development tools to support your low-power design effort. All are supported by a unified, MPLAB® X IDE, MPLAB Xpress Cloud-based IDE, MPLAB Code Configurator and comprehensive libraries for quick and easy device development.

### XLP Development Boards

The XLP Development Boards provide a low-cost, highly configurable development platform for our wide range of XLP MCUs.

| Part Number | Board Name | Support |
|---|---|---|
| **DM164137** | 8-bit Curiosity Development Board | 8-bit PIC® MCUs |
| **DM164136** | 8-bit Curiosity High Pin Count (HPC) Development Board | 8-bit PIC MCUs |
| **DM160228** | Explorer 8 Development Kit | 8-bit PIC MCUs |
| **DM240004** | PIC24F Curiosity Development Board | 16-bit PIC24F MCUs |
| **DM240001-2** | Explorer 16/32 Development Board | 16-bit PIC24 MCUs, dsPIC® DSCs and 32-bit PIC32 MCUs |
| **DM240314** | LCD Explorer XLP Development Board | 16-bit PIC24F MCUs |
| **DM240015** | MPLAB® Starter Kit for PIC24F Intelligent Integrated Analog | 16-bit PIC24F "GC" MCUs |

## XLP Battery Life Estimator

The XLP Battery Life Estimator is a free software utility that aids in developing low-power applications with Microchip's XLP PIC MCUs. The easy-to-use utility models the active current, sleep current and the time spent in each mode to provide an estimate of battery life. New device profiles and battery specifications can be added, allowing you to save profiles and compare results.


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