

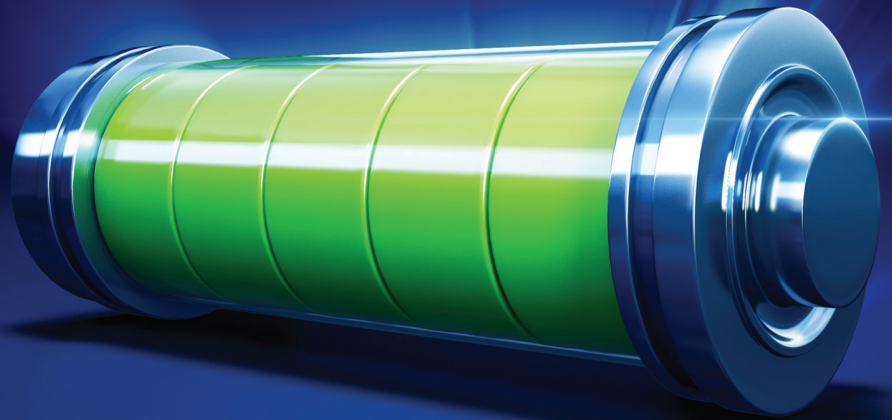


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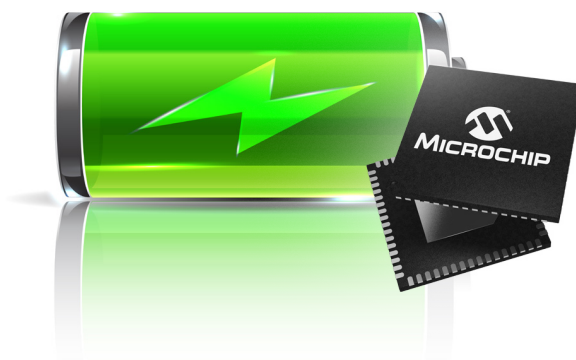


eXtreme Low Power (XLP)  
PIC® Microcontrollers



## Microchip's XLP PIC® MCUs

As more wearables, wireless sensor networks, and other Internet of Things (IoT) enabled smart devices are getting powered from battery, energy conservation becomes paramount. Today's connected applications must consume little power and, in extreme cases, last for up to 20+ years while running from a single battery. To enable applications like these, products with Microchip's eXtreme Low Power (XLP) technology offer the industry's lowest Run and Sleep currents.



## Benefits of XLP PIC MCUs



### Low Sleep Currents with Flexible Wake-Up Sources

- Sleep current down to 9 nA
- Brown-Out Reset (BOR) down to 45 nA
- Real-time clock down to 300 nA
- Watch-Dog Timer (WDT) down to 200 nA



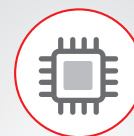
### Battery-Friendly Features

- Enable battery lifetime greater than 20 years
- Low-power supervisors for safer operation (BOR, WDT)
- Core Independent Peripherals (CIPs) take the load off the CPU and perform extremely complex tasks in self-sustaining mode at lowest possible energy requirement



### VBAT Battery Back-Up

- Automatic switch-over upon loss of VDD
- Maintains Real-Time Clock/Calendar (RTCC) and user registers
- Powered separately from 1.8–3.6V source (coin cell)



### Large Portfolio of XLP MCUs

- 8–121 pins, 4 KB–1 MB Flash
- Wide selection of packages
- Active mode currents as low as 30  $\mu$ A/MHz with efficient instruction set with over 90% single-cycle instructions

## XLP PIC MCU Application Examples

### Internet of Things

- Remote controls
- Security systems
- Portable meters
- Wireless sensors
- Electronic locks
- Asset tracking

### Wearables

- Fitness monitors
- Wearable sensors

### Smart Energy

- Energy meters
- Flow meters
- Smart plugs
- Energy management

### Connected Home

- Bluetooth® Low Energy devices
- Security
- Thermostats
- Smoke detectors

### Energy Harvesting

- Solar harvesting
- RF-powered devices

### Medical

- Glucometers
- Blood pressure meters
- Patient monitors
- Pulse oximeters



# Microchip's Low-Power Solutions

## Cloud Connectivity for IoT-Enabled Embedded Systems



The Internet of Things is drastically changing interaction with objects and devices in any location. When you combine XLP PIC® microcontrollers with a variety of wired/ wireless technologies from Microchip, you can design an end-to-end solution for the Internet of Things. You can successfully connect your embedded system to the cloud and take advantage of all of its benefits using Microchip's complementary products such as:

- XLP PIC MCUs which run communication stacks like RF4CE, MiWi™ Wireless Networking Protocol and cloud interface
- zigbee® and IEEE 802.15.4 low-power radio modules
- Certified Wi-Fi®, Bluetooth and Bluetooth Low Energy (BTLE) modules
- LoRa® long-range communication modules

## End-to-End Design Solutions for Wearables

Extremely small, wearable devices are popular, either as stand-alone accessories or as companions for use with a smart-phone. Wearable technology is being developed for many applications including medical diagnostics, fitness monitoring and personal entertainment. Our MCU portfolio meshes perfectly with the needs of wearable designs, offering:

- Ultra-low power
- Low-profile and small-footprint
  - QFN, uQFN and chip-scale packages
- Secure personal data
  - Integrated hardware cryptography
  - 10x performance with increased energy savings
  - Extensive cryptographic libraries
- Effortless connectivity with Microchip's complementary wireless portfolio
  - Certified Wi-Fi, Bluetooth/BTLE modules
  - Seamless cloud connectivity



## Intelligent Healthcare Device Designs

Medical devices that are intended to be portable or wearable must be designed to consume minimal power and run on a single battery while maintaining a compact form factor. Microchip's XLP technology offers the industry's lowest currents for Run and Sleep modes, allowing for maximum battery lifetime and compact product size with features like:

- XLP integrated Analog PIC MCUs
  - 16-bit Delta-Sigma Analog-to-Digital Converter (ADC) and high-speed 10 Msps 12-bit SAR ADC for precision measurements
  - Integrated analog peripherals such as op amp and high-speed comparators for system cost reduction and board space optimization
  - Integrated LCD and USB
- Modern human interfaces with integrated capacitive mTouch® sensing
- Operate from a single cell battery
- Low profile and small footprint
  - QFN, uQFN and chip-scale packages
- Effortless interface with Microchip's complementary products
  - Sensor fusion hub
  - Certified Wi-Fi, Bluetooth/BTLE modules
  - Seamless cloud connectivity



## Smart Energy and Smart Grid

As the demand and cost for energy continue to increase, there is a focus on improving energy efficiency, leading to new smart grid and smart energy solutions. The goal is to improve energy distribution management and energy utilization and prevent tampering. Microchip offers innovative XLP PIC microcontrollers for smart grid, smart metering and utility communication systems design. Key features include:

- Industry's leading XLP low-power modes for energy-efficient designs
- XLP integrated Analog PIC MCUs
  - Dual-channel 16-bit Delta-Sigma ADC for precision measurements
  - Integrated LCD and USB for external interface
- Modern human interfaces with integrated capacitive mTouch sensing
- Effortless connectivity with
  - Wired Ethernet
  - Bluetooth
  - IEEE 802.15.4 with ZigBee and MiWi protocols
  - Wi-Fi communication
  - LoRa long-range communication



## Robust Thermal Management



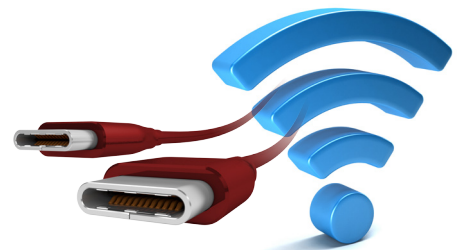
As the Internet of Things continues to evolve, it is likely that the thermostat will play a central role in managing appliances and sensors throughout the home. The XLP PIC microcontroller-based Connected Home Console can serve as a starting point for your smart thermostat or home automation control, leveraging features like:

- XLP PIC MCUs with integrated LCD driver for rich information displays
- Effortless integration with low-power wireless modules for IoT connectivity
- Large-memory LCD MCUs supporting RF communication stacks
- Modern human interfaces with capacitive mTouch sensing
- Single cell battery operation
- Complementary range of temperature sensors

## Versatile Wired and Wireless Connectivity

Communication technologies have been commonplace in homes and industry for many years. Recent trends in applications supporting cloud computing, the Internet of Things and smart grid initiatives have created a renewed demand for standardized, low-power communication technology. Whether you are considering adding wired or wireless connectivity to your application, Microchip's XLP PIC microcontrollers support a wide variety of communication, offering:

- XLP PIC MCUs with integrated USB device, host and OTG
- Free software libraries for communication protocols:
  - USB
  - Bluetooth and Wi-Fi communication
  - IEEE 802.15.4-based ZigBee and MiWi protocols
- Support for LoRa long-range communication
- Pair any XLP MCU with the MCP2200 USB to UART Serial Converter
- Extend battery life for products with USB for data upload/download



# Microchip's Low-Power Solutions

## Safety and Security for IoT-Enabled Designs

Embedded applications in the Internet-connected world demand secure data and long battery life. Microchip's XLP PIC microcontrollers ensure data integrity without sacrificing power consumption through an integrated hardware crypto engine. These MCUs offer unique key creation and secure key storage for applications such as IoT sensor nodes and access control systems with features like:

- Integrated hardware cryptography
  - AES256, DES, 3DES cryptography, secure RAM, OTP for key management
  - True random number generator for key generation, auto key destruct on tamper detect
- Integrated LCD and USB for external interface
- Human interfaces with capacitive mTouch sensing
- Free communication protocol stacks
- Seamless integrated with certified Wi-Fi, Bluetooth/BTLE modules, zigbee and IEEE 802.15.4 low-power radio modules for IoT connectivity



## Low-Power Energy Harvesting

Microchip's XLP PIC microcontrollers with the industry's leading low-power modes enable energy harvesting, battery-free and power-constrained applications with features such as:

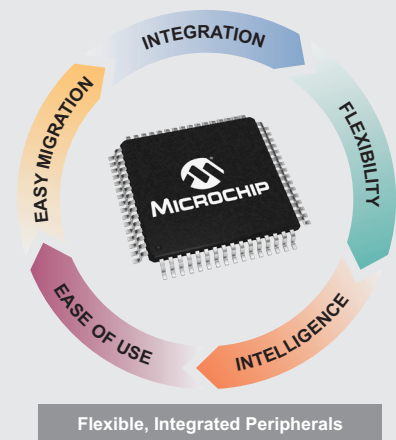
- Ultra-low power consumption
  - Sleep currents as low as 9 nA
  - Brown-out reset down to 45 nA
  - Watch-dog timer down to 200 nA
  - Real-time clock/calendar down to 300 nA
  - Run currents down to 30  $\mu$ A/MHz
- Flexible low-power modes based on application needs
  - Idle mode, Sleep mode, Deep-Sleep modes
  - Low-power retention sleep mode
- Effortless integration with wireless 802.15.4 RF connectivity
  - 2.4 GHz
  - Sub-GHz
- Ideal for applications with:
  - RF sensors
  - Temperature sensors
  - Remote controls
  - Security sensors

## Low-Power Peripheral Integration

XLP PIC microcontrollers with low-power Core Independent Peripherals (CIPs) and other highly integrated peripherals, enable low-cost solutions that require reduced energy and development time. Low-power peripherals like LCD, op amp, Real-Time Clock/Calendar (RTCC), mTouch sensing, USB, DMA, cryptography and additional CIPs take MCU performance to a new level with the least possible power consumption. With a number of on-board modules designed to increase the capability of the system, these XLP MCUs offer the best value in embedded design.










**Low-Power, CPU-Free Performance** – Low-power peripherals are smartly interconnected to allow nearly zero latency in the sharing of data, logic inputs or analog signals without additional code or interruption of the CPU. Since this frees the CPU to perform other system tasks and reduces Flash memory consumption, the CPU can be put into low-power states consuming minimal energy, while the peripherals perform necessary functions. This significantly reduces energy consumption by MCU.

**Significant Savings** – By taking the load off the CPU, low-power peripherals allow the MCU to perform extremely complex tasks, such as cryptography and communication, thus allowing the CPU to perform additional tasks and eliminating the need to migrate to a complex and expensive system. Additionally, significant BOM cost savings can be realized by replacing off-board discrete components with these integrated peripherals.



## XLP MCU Portfolio

With many pin, memory and peripheral combinations available, Microchip's XLP products have the right combination of features for your low power application. The product families below include some key XLP PIC MCUs. For a complete list of XLP MCUs, datasheets and other references please visit the XLP Design Center at [www.microchip.com/xlp](http://www.microchip.com/xlp).

Device	Flash Memory (KB)	Pins	Sleep (nA)	WDT (nA)	RTCC (nA)	1 MHz Run (µA)
<b>8-bit XLP PIC® Microcontrollers</b>						
PIC18F "K42"	16–128	28–48	60	720	–	45
PIC16F153xx	3.5–28	8–48	50	500	–	32
PIC16F188xx	7–56	28–40	50	500	–	32
PIC16F191xx	7–56	28–64	50	500	400	32
PIC18F "K40"	16–128	28–64	50	500	–	32
<b>16-bit XLP PIC Microcontrollers</b>						
PIC24FJ128GB204 	64–128	28–44	380	240	300	178
PIC24FJ128GA310 	64–128	64–100	330	270	400	150
PIC24FJ128GC010  	64–128	64–100	420	270	350	178
PIC24FJ256GA705	64–256	28–48	190	220	350	191
PIC24FJ256GB412  	64–256	64–121	70	100	170	155
PIC24FJ1024GB610 	128–1024	64–100	190	220	350	190
<b>32-bit XLP PIC Microcontrollers</b>						
PIC32MM "GPL"	16–64	20–36	500	80	400	–
PIC32MM "GPM" 	64–256	28–64	650	220	350	–
PIC32MX1/2 	128–256	28–64	673	800	710	–

## Complementary Analog, Interface and Connectivity Products

Microchip offers a wide portfolio of complementary Analog, Interface and Connectivity products that can be used in developing low-power applications. The portfolio meets today's demanding design requirements addressing linear, mixed-signal, power management, thermal, interface and connectivity products. When combined with XLP microcontrollers, these devices enable low-power designs in consumer, medical and IoT applications. Microchip's complementary Analog, Interface and Connectivity products includes:

- Linear
  - Amplifiers
  - Comparators
- Wireless
  - Wi-Fi modules and antennas
  - Bluetooth modules
  - Bluetooth silicon
  - LoRa, zigbee and MiWi solutions
- Power management
  - DC/DC converters
  - Battery chargers
  - System supervisors/voltage detectors
- Safety and security
  - Smoke detector ICs
  - Piezoelectric horn drivers
- Thermal management
  - Temperature sensors
- Timing
  - Oscillators
- Mixed signal
  - Power monitoring and metering
  - 8/10/12-bit ADCs
  - Digital potentiometers
  - Power measurement ICs
  - Voltage references

## References

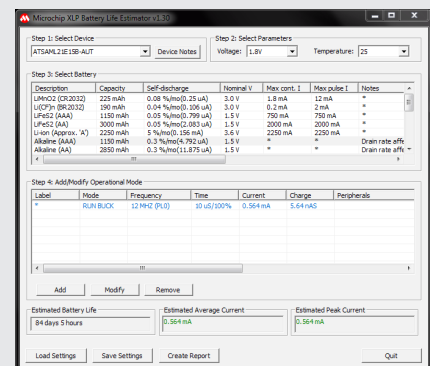
### XLP Battery Life Estimator (Free Download)

The XLP Battery Life Estimator is a free software utility that aids in developing low-power applications with Microchip's PIC MCUs with XLP technology.

- Select your PIC MCU with XLP technology and your battery type
- Enter application Run and Sleep times
- Select peripherals and input application currents
- View battery life, average and maximum current estimates
- Customize by adding device profiles and battery specifications
- Save profiles and compare results

### Application Notes

- **AN1861:** Bluetooth Smart Communication Using Microchip's RN4020 Module and 16-bit PIC MCU
- **AN1556:** Blood Pressure Meter Design Using Microchip's PIC24F Microcontroller and Analog Devices
- **AN1416:** Low Power Design Guide: A Single Source for Low Power Consumption from the Viewpoint of the MCU
- **AN1267:** XLP Technology: An Introduction to Microchip's Low-Power Devices



## Featured Development Tools



### 8-bit Curiosity Development Boards

8-bit Curiosity Development Board (DM164137) and 8-bit Curiosity High Pin Count (HPC) Development Board (DM164136) serve as a cost-effective, fully integrated 8-bit development platform targeted at first-time users, makers and those seeking a feature-rich, rapid prototyping board with easy IoT connectivity.

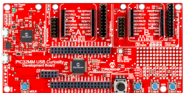
- Integrated programmer/debugger with USB interface
- MikroElektronika mikroBUS interfaces supporting click boards



### 16-bit Curiosity Development Boards

PIC24F Curiosity Board (DM240004) and PIC24FJ256GA7 Curiosity Board (DM240016) serve as a low-cost platform featuring 16-bit PIC24F XLP microcontrollers.

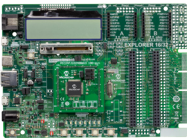
- Integrated programmer/debugger with USB interface
- MikroElektronika mikroBUS interfaces supporting click boards



### 32-bit Curiosity Development Boards

32-bit Curiosity Boards are a low-cost platform featuring 32-bit PIC32MM XLP microcontrollers. PIC32MM Curiosity Development Board (DM320101) provides wireless connectivity with Microchip's BM71 BLE module footprint and PIC32MM USB Curiosity Development Board (DM320107) has two X32 Interfaces that facilitate integration of the PIC32 Audio Codec Daughter Card.

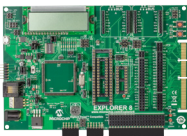
- Integrated programmer/debugger with USB interface
- MikroElektronika mikroBUS interfaces supporting click boards



### Explorer 16/32 Development Board (DM240001-2)

This board supports PIC24F XLP microcontrollers and provides the perfect platform to prototype applications using several expansion possibilities through its wide ecosystem support.

- Integrated programmer/debugger with USB interface
- Two mikroBUS interfaces supporting click boards and a PICtail™ Plus interface



### Explorer 8 Development Kit (DM160228)

This board enables development with 8-bit PIC MCUs ranging from 6-100 pins.

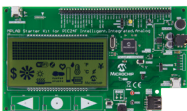
- Two Pmod™ interfaces supporting Digilent Pmods
- Two mikroBUS interfaces supporting click boards



### LCD Explorer XLP Development Board (DM240314)

This board enables development with the 16-bit family of PIC XLP MCUs in 100 pins.

- 96 segments LCD display, LEDs, buttons and mTouch cap button
- PICtail Plus connector



### MPLAB® Starter Kit for PIC24F Intelligent Integrated Analog (DM240015)

This kit features the PIC24F “GC” family with advanced integrated analog that reduces BOM cost, lowers noise and has faster throughput.

- On-board sensors such as light sensor, potentiometer, microphone and temperature
- Custom LCD features a 296 dot-matrix array for text display and 17 special icons

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