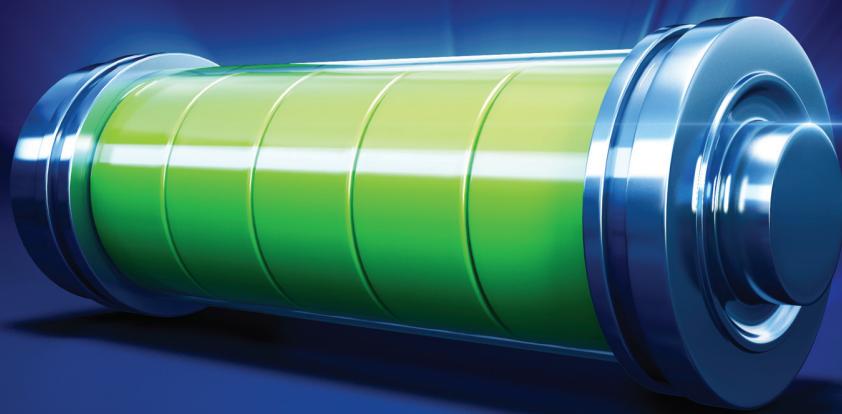




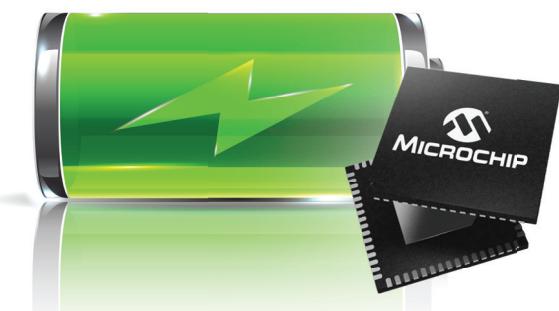
eXtreme Low Power (XLP) PIC® Microcontrollers



Looking Beyond Low-Power MCUs

Microchip's XLP PIC® MCUs

As more wearable technology, wireless sensor networks and other smart things are connected to the Internet of Things (IoT), 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 400 nA
- Watch-Dog Timer (WDT) down to 200 nA



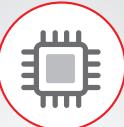
Battery-Friendly Features

- 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, 4–256 KB Flash
- Wide selection of packages
- Active mode currents as low as 35 µA/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. It is connecting the whole world. 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 quickly becoming popular, either as stand-alone accessories or as companions for use with a smartphone. New wearable technology is being developed for many applications including medical diagnostics, fitness monitoring and personal entertainment. Microchip's long-standing focus on XLP PIC microcontrollers enables you to develop highly integrated, cost-effective embedded systems. 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 Intelligent Analog PIC MCUs
 - 16-bit Delta-Sigma Analog-to-Digital Converter (ADC) and high-speed 10 Msps 12-bit SAR ADC for precision measurements
 - Intelligent analog peripherals such as op amp and high-speed comparators for system cost reduction and higher integration
 - 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



Microchip's Low-Power Solutions

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 Intelligent 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. Having a dedicated interface for all of these sensors is becoming essential. The PIC 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



ZigBee
Control your world



Ethernet

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



8- and 16-bit 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:

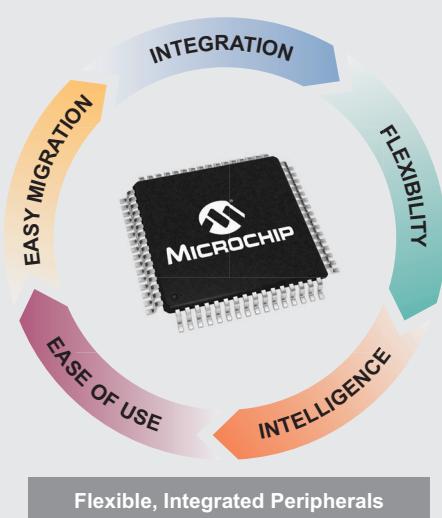
- Ultra-low power consumption
 - Sleep currents as low as 9 nA
 - Brown-out reset down to 45 nA
 - Watch-dog timer down to 200 nA
 - Real-time clock/calendar down to 400 nA
 - Run currents down to 35 A/MHz
- Flexible low-power modes based on application needs
 - Idle mode, Sleep mode
 - Low-power retention sleep mode
 - Deep-Sleep modes
- 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 technology PIC microcontrollers with low-power Core Independent Peripherals (CIPs) and other highly integrated peripherals that tightly connect with the core enable solutions with reduced energy requirements, low cost and reduced 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.

Device	Flash Memory (KB)	Pins	Sleep (nA)	WDT (nA)	RTCC (nA)	1 MHz Run (µA)
PIC16F14XX	14	14/16/20	25	290	—	25
PIC16F15XX	14	28	20	300	600	35
PIC16F17XX	3.5–9	28/40/44	50	500	—	35
PIC16F18XX	3.5–7	8–20	20	300	600	39
PIC16F19XX	7–28	28/44	60	500	600	150
PIC18LFX50	8–16	20	24	450	790	170
PIC18LF14K22	8–16	20	34	460	650	150
PIC18F46J11	16–64	28/44	13	813	813	272
PIC18F46J50	16–64	28/44	13	813	813	272
PIC18F87K90	32–128	64/80	25	350	720	181
PIC18F97J94	32–128	64/80/100	80	290	400	100
PIC16F1619	3.5–14	8/14/20	50	500	—	32
PIC16F1719	3.5–28	14/20/28/40	50	500	—	32
PICF18345	3.5–14	8/14/20	40	250	—	37
PIC16F18877	7–56	28/40	50	500	—	32
PIC18F45K22	8–64	28/40	10	300	—	20
PIC24F16KL402	4–16	14/20/28	—	210	690	150
PIC24F16KA102	8–16	20/28	20	350	490	181
PIC24F16KM204	8–16	20/28/44/48	25	500	700	204
PIC24F32KA304	16–32	20/28/44	20	400	500	204
PIC24FJ64GA104	32–64	28/44	20	220	520	250
PIC24FJ64GB004	32–64	28/44	20	220	520	250
PIC24FJ128GB204	64–128	28/44	18	240	300	178
PIC24FJ128GA310	64–128	64/100	10	270	400	150
PIC24FJ128GC010	64–128	64/100	75	270	350	178
PIC24FJ256GB412	64–256	64/100/121	80	100	170	155

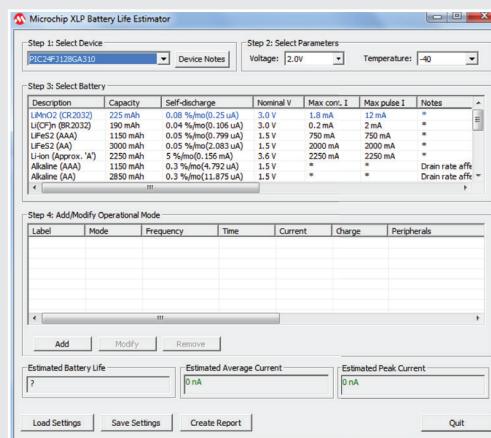
*Base sleep current included in WDT and/or RTC numbers. Typical I/O pin leakage current ± 5 nA
All numbers are typical values at minimum V_{DD}, taken from the datasheet.

References

XLP Battery Life Estimator (Free Download)

The XLP Battery Life Estimator is a free PC software tool to aid in developing low-power applications with Microchip's PIC MCUs featuring XLP technology. The utility allows you to select the target MCU and battery type, as well as input the current generated by the rest of the application. It models the active current, sleep current and the time spent in each mode to provide an estimate of battery life.

- Easy to use
 - Select your PIC MCU with XLP technology
 - Select your battery type
 - Enter application Run and Sleep times
 - Select peripherals and input application currents
 - View battery life, average and maximum current estimates
- Flexible
 - Customizable to allow new device profiles and battery specifications to be added
 - Save profiles and compare results



References

Featured Development Tools

XLP 8-bit Development Board (DM240313)



This board enables development with the 8-bit family of XLP PIC MCUs.

- Supports PIC16 and PIC18 MCUs
- LCD display, LEDs, resistive potentiometer, temperature sensor and EEPROM

8-bit Curiosity Development Board (DM164137)



This board is a cost-effective, fully integrated 8-bit development platform targeted at first-time users, makers and those seeking a feature-rich, rapid prototyping board.

Features include:

- Integrated programmer and debugger
- Easy IoT connectivity
- One mikroBUS™ socket supporting over 140 Click™ Boards

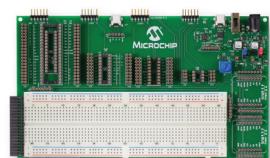
Explorer 8 Development Kit (DM160228)



Supporting the largest number of 8-bit PIC MCUs ranging from 6 to 100 pins, the Explorer 8 Development Kit is a rapid proof-of-concept tool. Features include:

- Extensive integration for optimized “out-of-box” experience
- Two Pmod™ sockets supporting Digilent Pmods
- Two mikroBUS sockets supporting over 140 Click Boards

PICDEM™ Lab II Development Platform (DM163046)



This board is a development and teaching platform for use with 8-bit PIC MCUs. Features include:

- Analog and mixed-signal focus
- Two mikroBUS sockets supporting over 140 Click Boards

XLP 16-bit Development Board (DM240311)



Designed with eXtreme Low Power in mind, this board enables development with the PIC24F family of 16-bit XLP PIC MCUs.

- Supports 20-/28-pin devices
- PICtail™ connector supports RF Modules, SD/MMC storage, speech playback modules and more
- LEDs, capacitive and mechanical buttons, resistive potentiometer, temperature sensor and EEPROM

LCD Explorer Development Board (DM240314)



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

- Flexible power options
- 96 segments LCD display, LEDs, buttons and mTouch cap button
- PICtail connector

MPLAB® REAL ICE™ In-Circuit Emulator Power Monitor (AC244008)



This development platform enables designers to identify and eliminate code that consumes high current, in real time. When combined with the MPLAB REAL ICE In-Circuit Emulator and MPLAB X IDE, it allows you to measure, graphically profile and optimize code power consumption for all of Microchip's PIC MCUs.

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. Features include:

- Analog header for clean analog signal access and integrity
- 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
- On-board debugger/programmer

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

Design Center

Visit the XLP Design Center at www.microchip.com/XLP for a complete list of XLP MCUs and datasheets, as well as other references including:

- XLP development tools
- Low power application notes
- Tips and tricks
- Webinars and videos

Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

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