INTRODUCTION

The 8-bit microcontroller has been around for close to 40 years. In this age of rapidly advancing technology, when electronic devices seem to become obsolete not long after they get to market, that boggles the mind. To what can we attribute such longevity? There are a variety of reasons.

For starters, today’s 8-bit microcontrollers are not the same as the ones that first appeared in the early 1970s. They are smaller, faster, cheaper, require less power, are easier to program, and offer more features and peripherals. In the early days of 8-bit microcontrollers, 500,000 instructions per second was considered state-of-the-art. Of course, back then, typical clock rates were in the 1-2 MHz range; today’s 8-bit units offer a wide range of performance options up to 64 MHz with 16 million instructions per second.

8-bit microcontrollers are optimized for low power and simple code. They will always be the easiest and most cost-effective solution for basic embedded control. The low-cost tools and fast time to market for developing with 8-bit MCUs make them an ideal choice when engineers need to quickly solve problems. The cost-optimized 8-bit MCUs have smaller code, lower power and offer more robustness to environmental noise.

The amount of integrated memory, too, has increased dramatically over the years. Microchip’s 8-bit portfolio now ranges from 384 bytes of program memory for extremely low cost, simple applications to 128KB Flash and up to 4KB RAM for more sophisticated drivers, stacks and libraries. So, even with a low-cost 8-bit MCU, there is plenty of bandwidth to implement an internet radio or a wireless energy monitor device.

FEATURES AND PERIPHERALS

The fact of the matter is, today’s 8-bit microcontrollers pack a lot of features into a small, cost-effective package. Take Microchip’s PIC10F2XX family, for example, which comes in small 6-pin, 2x3 DFN, or SOT-23 packages. Despite being the smallest microcontrollers in the world, these MCUs are helpful for adding smarts to discrete or analog centric legacy designs where previously no electronics were needed.

Microchip’s PIC® microcontrollers integrate a broad array of peripherals, which greatly increases the number of potential applications in which they can be used. Most embedded applications require some level of connectivity with other ICs or the outside world. Microchip offers 8-bit MCUs with standard integrated communications peripherals such as SPI, USART (RS-232/RS-485), I^2C™, CAN and LIN.
Many applications are also adding Ethernet connectivity to take advantage of the internet for remote monitoring or control of embedded applications. Designers can choose between Microchip’s standalone Ethernet controllers (ENC28J60 or ENC624J600) with on-board MAC and PHY, or their single-chip PIC18F97J60 solution that integrates the 10-BASE-T Ethernet MAC and PHY into the PIC MCU in a single package. Whether you choose the integrated solution or pair the Ethernet controller with a separate PIC MCU, it is easy to add Ethernet connectivity to your 8-bit design using Microchip’s free TCP-IP stack and low-cost tools.

Other integrated peripherals are included to help designers implement stylish and low-cost user interfaces with buttons and displays. For buttons, keys and sliders, Microchip’s mTouch™ sensing solutions provide a stylish alternative to mechanical buttons for lower cost or robustness to weather, with solutions that work with metal and plastic.

![FIGURE 3: INTEGRATED PERIPHERALS FOR HUMAN INTERFACE (DISPLAYS AND TOUCH)](image)

Got an embedded control application that needs to drive a segmented display? No problem. Microchip makes many 8-bit devices with built-in LCD driver controls to directly drive up to 192 pixels. The LCD driver even includes contrast control and boost capability to compensate for various lighting conditions.

In addition to all of the connectivity and user interface peripherals, the 8-bit PIC MCUs include standard control and timing peripherals for capture/compare, pulse-width modulators (PWMs), counters/timers, and watchdog timers. The list of available analog peripherals includes: analog-to-digital converters (ADC) (up to 12-bit), digital-to-analog converters (DAC), comparators and op amps, brown-out and low-voltage detectors, temperature sensors, voltage references and regulators, and, of course, oscillators.

As more electronic applications require low power or battery power, energy conservation becomes critical. Today’s applications must consume little power, and in extreme cases, last for 20 years, while running from a battery. Products featuring Microchip’s XLP technology extend battery life and reduce standby currents to support green initiatives worldwide.

![FIGURE 4: PIC MCUs WITH EXTREME LOW-POWER EXTEND BATTERY LIFE](image)

Many low-power devices include peripherals like USB, LCD and mTouch capacitive sensing, eliminating the need for additional parts in the application, which saves cost, current and complexity. Products with XLP have system supervisory circuits specially designed for battery-powered products to protect against system failure, provide precise timekeeping, and protect as batteries are depleted or changed.

All of the 8-bit XLP, USB, Ethernet, LCD, mTouch sensing and general purpose PIC MCU families are supported by Microchip’s low-cost tools, free software, and hundreds of application notes.

8-BIT VERSUS 16- AND 32-BIT

The expanded capabilities and versatility of 8-bit microcontrollers has created an interesting dichotomy in today’s marketplace. Some manufacturers that abandoned 8-bit microcontrollers in favor of 16- and 32-bit technology now find themselves competing head-to-head with 8-bit devices in many applications. Sixteen and 32-bit devices, they argue, can do anything an 8-bit microcontroller can do. That may be true, but can they do it as efficiently and cost effectively as 8-bit microcontrollers can? The answer, in most cases, is probably not.

Eight-bit microcontrollers are designed to interface with things that have simple inputs like switches, sensors, keyboards, and small displays. These things do not need to manipulate 32-bit data. Let’s say, for example, you want to add intelligence to a simple product like a new toaster so that it can display how long the bread has been toasting. What you need is something simple, something purpose-built, easy-to-use, and relatively inexpensive. That’s the proverbial “sweet spot” for low-end 8-bit microcontrollers.
Code density will be much smaller for an 8-bit device than it will be for a 16- or 32-bit processor. Many 8-bit microcontrollers also have a wide operating voltage range of 1.8V to 5.5V, which makes them well-suited to use in electrically noisy environments like industrial controls and automation applications. With these styles of applications in mind, Microchip has designed MCUs that are extremely robust to radiated and induced noise (EMC/EMI). Robustness is especially important for appliance and automotive applications.

Most 32-bit microcontrollers are optimized for higher frequencies, which typically means more power consumption and smaller manufacturing technology which is less robust to noise. Granted, you can solve that problem by running them slower, but there is a power consumption threshold you can’t go below, not to mention the fact that if you take that approach, you are paying for technology you can’t use. Why buy a Ferrari if you are only going to drive 35 miles per hour?

Looking at the microcontroller market in terms of the data bus width (8-, 16- or 32-bit) is really too simple. Instead, there are a range of solutions that try to balance integration, power consumption, computational efficiency, robustness and cost. In general, the 32-bit microcontrollers are a better fit for applications that have a machine interface with calculation performance and software centric designs with an RTOS or multi-tasking. For hardware centric applications that need deterministic behavior, low sleep power consumption, robust electrical characteristics, and a real world interface, the 8-bit microcontroller is still the best technical solution.

**FIGURE 5: CONTINUUM OF 8-BIT, 16-BIT AND 32-BIT MCUs**

This is true for applications such as coffee machines, toasters, key fobs, security tokens, security system sensors, toothbrushes, PC fan controllers, thermostats and thousands of other applications. Microchip provides 8-bit, 16-bit and 32-bit MCUs that meet the need for the full range of embedded applications.

**PIC MCU ARCHITECTURE**

One of the things that makes Microchip’s 8-bit microcontrollers unique is their proprietary PIC MCU core, based on a modified Harvard architecture with RISC instruction set. There are a number of advantages to using this architecture. Utilizing a modified Harvard dual-bus architecture means data and instructions get transferred on separate buses, avoiding processing bottlenecks. Over 80% of the instructions execute in a single cycle, making the core extremely efficient. Two-stage pipelining makes it possible to execute one instruction while the next one is being accessed. The combination of architectural efficiency and ease of use help designers get more done, faster with PIC MCUs. Once the initial design is complete, it is easy to migrate to another PIC MCU when requirements change. Using common peripherals and pinouts make it easy to migrate from 6 to 100 pins and from 384 bytes to 128 Kbytes of program memory when design requirements change.

**SOFTWARE AND SUPPORT**

These days your hardware is only as good as the software that tells it what to do and how to do it. If you are a hardware engineer, that fact can sometimes be a little intimidating. Microchip understands and has taken steps to alleviate that anxiety and help designers achieve faster time-to-market.

For starters, their 8-bit microcontrollers do not have to be programmed in assembly language. They can be programmed in C using a C compiler that Microchip provides free of charge. That simplifies design, speeds time-to-market, and cuts costs, all at the same time. If you are looking for higher levels of optimization, Microchip offers more sophisticated C compilers for purchase.

Continuing that theme, they also offer a large library of software written in C that can be ported not just to their 8-bit microcontrollers, but to their 16- and 32-bit devices as well, so that if your needs change in the future and you require more processing power, you do not have to go back to square one. All of the 8-bit software libraries are provided free of charge, and in most cases they will provide you with the source code so you can customize it for your particular application.

Think about that for a moment. Let’s say, for the sake of argument, you have to buy your software from a third-party vendor, and for some reason the microcontroller does not do what you want it to do. Who do you call? The software vendor will probably refer you to the microcontroller manufacturer, and the microcontroller manufacturer will probably refer you to the software vendor. So there are definitely advantages to obtaining the hardware and software from the same vendor.
Microchip also supplies its customers with a free IDE so they can take advantage of the company’s development and debugging environments at no additional cost. Plus, with so many 8-bit devices being used in so many applications throughout the world, there is a very active user community that supports one another through Microchip’s web site forums, as well as a host of other internet forums.

Designers continue to select 8-bit MCUs because they are easy to use, robust to noise, low power and cost effective. The 8-bit microcontroller may be approaching its 40th birthday, but its current technology is far from 40 years old. In fact, the things you can do with them today nobody could have envisioned years ago. Faster, more powerful devices may have entered the market since then, but in the end, it all comes down to one of the fundamentals of good engineering—using the right tool for the job.
Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
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Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company’s quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KezLoc® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.
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