Application Ideas for 8-bit Low-Pin-Count Microcontrollers
Introduction

8-bit low-pin-count (LPC) microcontrollers have taken advantage of process shrinks to increase their functionality and thus serve more applications than ever before at lower cost. While even LPC devices were becoming pad-limited by the 0.35μm technology node, advances in architecture, motor control, smart energy management, Ethernet and wireless connectivity requirements for home automation and control, have led to a new range of applications for 8-bit MCUs.

Today, the 8-bit field is led by MCUs made with advanced process technology that enables integration of a few precision analog peripherals, configurable general-purpose I/O (GPIO) pins, serial interfaces and a fast-data-bus architecture. With this functionality, the devices offer good-precision analog signal capture, conversion and conditioning; modest signal-processing capability; and a reasonable amount of integrated memory — all within the minimum pad ring.

According to Gartner Dataquest, 8-bit microcontrollers account for more than half of the processor market by volume. This market research firm estimates that the 8-bit MCU market was about $5 billion in 2008.

Strengths of the latest 8-bit MCUs include:

- High performance — Clock speeds into the tens of megahertz
- Integrated features — Flash memory, internal high-speed clocks and timers, analog peripherals, smart card interface, integrated touch controller, motor control, wireless interface, wired network connectivity such as integrated Controller Area Network (CAN) and Local Interconnect Network (LIN) buses, and many other features
- High reliability
- Small package size
- Low power consumption — Flash devices consuming only nanowatt-range current
- Low cost
- Low electromagnetic interference (EMI)

This technology backgrounder gives a quick review of 8-bit MCU applications that are growing in importance today, with a particular focus on home appliances. Following this application roundup, a look at Fujitsu MCU features shows how these devices address application requirements.

Overview of 8-bit MCU Applications

Several application segments are expected to have strong market demand in the near future.

Medical

The physiological signals acquired by most medical devices are analog and require signal conditioning such as amplification and filtering before being measured, monitored, or displayed. 8-bit MCUs can implement an ultra-low-power platform that includes the complete signal chain for applications such as personal blood pressure monitors, pulsoximeters, and heart rate monitors. Remote patient monitoring is also a growing trend, using devices with integrated RF/ZigBee or Wi-Fi interfaces and transceivers. As portability becomes a growing trend in medical products, manufacturers are seeking technologies such as MCUs that reduce design complexity and development time.

Portable consumer

The characteristics that make MCUs ideal for battery-powered medical products suit these devices to a variety of portable consumer applications, including intelligent toys, IP cameras, and Internet radios. With built-in LCD controllers and touch-sensor controllers, 8-bit MCUs provide a consumer-friendly platform that enables rapid development. ZigBee transceivers make these devices easily portable yet always network-connected.

Smart sensor applications

Devices such as smoke detectors, thermostats and glass breakage detection systems take excellent advantage of 8-bit MCUs’ ultra-low power consumption and integrated high-performance analog features. Integrated wireless networking features are also quite useful for such smart sensor applications to strengthen home automation, remote monitoring and control. These types of applications are growing so strongly, some observers expect that 95 percent of all devices accessing the Internet will be MCUs in sensors and machine-to-machine applications.

Smart metering

A smart meter can measure consumption in more detail than a conventional meter and communicate that information via a network to the local utility. 8-bit microcontrollers offer the perfect combination of ultra-low-power and high performance analog integration.
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(16- to 21-bit delta-sigma ADC, comparators, etc.). 8-bit MCUs can measure single- or three-phase electric power, water and gas, with integrated wireless interfaces for communication of the data for automated meter reading (AMR).

**Commercial streaming-media applications**

Point-of-sale (POS) terminals and vending machines can use low-cost MCU-based platforms to bring sales information to consumers in an engaging, interactive way.

**White and brown goods**

8-bit MCUs offer easy ways to handle a variety of tasks in consumer products such as air conditioners, washing machines, refrigerators, garage door openers, smoke detectors, vacuum cleaners, heat pumps, microwaves ovens, TVs, home theater systems, radio-broadcast receivers, and sound recording products. In particular, Asia’s output of small household appliances, such as dust collectors, smart electric rice cookers, fans and remote controls, will continue to grow rapidly. The next section of this technology backgrounder provides a closer look at home appliances.

**Meeting the Demands of Home Appliances**

Large appliances such as washing machines, dishwashers and refrigerators can all benefit from the energy-saving characteristics of advanced motor-control technology. Since the refrigerator is always on, it can consume up to 50 percent of the home energy budget, with virtually all of that energy used to run the compressor motor. Most refrigerators still use constant-speed on/off compressors. However, variable-speed compressors are gaining traction in the market. These compressors enable more efficient cooling with precise temperature control, thus reducing overall energy use. In addition, manufacturers are increasingly employing more efficient brushless motors, which further reduce the amount of energy consumed.

In washing machines, performance and drive efficiency improve significantly when permanent-magnet or brushless DC (BLDC) motors replace low-end solutions such as universal triac-driven motors. Advanced control techniques based on 8-bit MCUs and the permanent-magnet or BLDC motors enable shorter washing cycles that save energy and reduce water consumption.

Even complex systems can take advantage of 8-bit MCUs to handle some simple functions. For instance, many types of applications can benefit from the use of 6- or 8-bit MCUs to control reset circuits that need a configurable time delay. Electric lighting ballast applications can use similar LPC devices because the MCUs are easy to configure and save money compared to searching for and stocking the right discrete components. With 8-bit MCUs now available for mere pennies, devices such as battery chargers, electric toothbrushes, toasters, coffee machines, and inexpensive toys now contain MCUs.

Figure 1 shows 3 block diagrams of a few example applications.

**Air Conditioner**

![Air Conditioner Diagram](image)

**Vacuum Cleaner**

![Vacuum Cleaner Diagram](image)

**Microwave Oven**

![Microwave Oven Diagram](image)

*Figure 1 — Household appliance applications*
Fujitsu low-cost, compact 8-bit MCU value proposition

The Fujitsu F²MC-8FX Family devices — the MB95100 and the new LPC MB95200/MB95300 series MCUs — offer an intelligent mix of on-chip peripherals suited to designing energy-efficient appliances and control panels. The product family is scalable and flexible enough to meet appliance requirements, with features such as motor controller, LCD controller, and touch-sensor controller (TSC) interface using SPI/I²C for human-machine interface (HMI).

F²MC-8FX family MCUs integrate memory ranging from 8 to 60 Kbytes of flash, plus 2 to 32 Kbytes of RAM. Non-volatile FRAM is also available — a fast alternative to flash memory. Package options include DIP, SOP, SSOP, QFP and LQFP, with pin counts ranging from 8 to 100 pins.

Key Features

1. Dual-operation flash memory

Products include Fujitsu's proprietary embedded dual-operation flash memory, which emulates E²PROM. The memory contains two regions, one for program storage and another for data storage. The integrated flash memory is programmable across the MCU's entire operating range, allowing users to take full advantage of the re-programmability benefits in virtually any environment.

To simplify the use of this memory, Fujitsu supplies a software E²PROM emulation library and API code for user customization free of cost and without royalty. Users who do not need flash-based E²PROM emulation can utilize the memory as conventional flash.

The embedded flash memory can be re-written 100,000 times and has guaranteed data retention for 20 years. To enhance system integrity, security and reliability, the MCUs also integrate a wide range of hardware and software system protection and flash security features. A flash security function protects customer software from being read by unauthorized external access.

2. Component integration for reduced system cost

Fujitsu 8-bit MCUs have an on-chip RC oscillator circuit and low-voltage detection circuit, thus eliminating the need for these components externally. Even the LPC devices have an on-chip RC oscillator (+/- 2 to 3%) and on-chip debug feature.

4. Composite timer for flexibility in meeting system requirements

MCU timers can be configured for pulse width modulation (PWM), pulse width counter (PWC), interval timer or input capture (for measuring interval times). This timer versatility makes it easier to handle a wide variety of system requirements. A separate watchdog timer provides a safety mechanism to monitor the software flow, CPU clock, and interrupt handling and execution.

5. Non-volatile FRAM memory integration

The Fujitsu MB95R203 8-bit MCU is the first to offer integrated ferro-electric RAM (FRAM). FRAM features high-speed access, non-volatility, high endurance in write mode, low power consumption, excellent tamper resistance and no performance degradation due to radiation. FRAM is therefore ideal for use in smart cards, secure data storage, and battery-powered applications where high security, small memory size, and low power consumption are key requirements.

6. Communication interfaces

The Fujitsu 8FX MCU family supports a broad range of communication protocols typically used in large appliance system designs, offering on-chip UART, I²C, LIN-UART/SPI. The LIN-UART/SPI module simplifies development of LIN systems by enabling LIN break detection and synchronization without the use of an external timer channel.

7. Integration of application-specific features

Applications that involve analog I/O and/or motor control get extensive support in the Fujitsu 8FX MCU family. For example, LPC MCUs have key peripherals such as a 10-bit analog-to-digital converter (ADC). (A 12/16-bit ADC is under development.) The MCUs also offer advanced timer modules that span the
performance requirements needed in appliances from basic to advanced motor control.

The latest 8-bit MB95300 family devices provide functionality specifically for motor control: three independent 16-bit timer/pulse-width modulator modules. These modules enable the generation of any pulse width modulation (PWM) pattern for single- and three-phase BLDC motor control.

Additionally, the MCUs provide a number of system features for configuring many types of applications. For example, the devices can be enabled with system integrity software, including periodic test routines for the CPU register and program counter that help ensure safe, reliable operation of electronic controls in household appliances. Additional features, such as active power-on reset, low-voltage detection and low-voltage warning help protect against system failure caused by brownouts. These on-chip features place the members of this MCU family among the most robust MCU offerings in their class.

In addition, the LPC MCUs' four low-power modes help developers implement responsive power-management schemes in applications such as battery-operated devices, power tools, HVAC equipment, motor controllers and circuit breakers. The supply voltage range from 3 to 5.5V also simplifies development and eases upgrading of legacy designs.

8. Application development simplified

Fujitsu offers several ways to make application development easier, beginning with on-chip debug. The MCUs provide an in-circuit emulation (ICE) feature with a single-wire debugging, emulation and onboard flash programming interface — eliminating the need for expensive emulation tools. This capability enables developers to perform non-intrusive debugging and emulation on the fly. To help developers get applications up and running quickly and easily, Fujitsu offers flexible and cost-effective evaluation boards and starter kits for the 8-bit MCU family. Fujitsu Microelectronics also offers technical training and comprehensive support for development tools, reference designs, and software examples, along with C source code/project files, and application notes.

Fujitsu 8-bit MCU Technology Roadmap

Fujitsu has continuously improved 8-bit MCU process technology, performance, power consumption and peripheral integration as shown in Figure 4. Additionally, low-cost, easy-to-use development tools are now standard elements of the MCU offerings, along with extensive applications support.

![Figure 2 — Fujitsu value proposition and roadmap](image-url)
Conclusion
8-bit MCUs offer extensive on-chip integration that helps keep both costs and power consumption low — an ideal fit for today's market trends and applications. By providing low-cost solutions in small packages with integrated functions that meet a range of application-specific requirements, Fujitsu's 8-bit MCUs provide superior choices for systems that require high integration.

For More Information
For more information on Fujitsu 8-bit Low-Pin-Count Microcontrollers visit http://us.fujitsu.com/micro/lpc or address e-mail to inquiry@fma.fujitsu.com.