All Flash Microcontrollers Contribute to Improving System Competitiveness

NISHIZAWA Kazuyuki, OBA Koji

Abstract

Every "All Flash" microcontroller product is loaded with flash microcontrollers in order to improve the system competitiveness of our customers. Since the re-programming of software is possible with flash microcontrollers, large benefits result in terms of lead time and cost during system development. Furthermore, since flash microcontrollers available from NEC Electronics are provided with "peace of mind," which comes through the elimination of uncertainties, such as the "small number of available products" or "high cost," making it possible to develop through to production all on flash microcontrollers. Additionally, the benefits of flash microcontrollers can be maximized through a development environment that can improve the efficiency of system development as well as a programming environment that can improve productivity.

Keywords

Microcontroller, flash memory, flash microcontroller, embedded device, developing environment, programming environment

1. Introduction

Microcontrollers are mounted on a variety of devices for system control, with the range of devices to which microcontrollers are embedded broadening extensively over the last few years.

The market of embedded devices, on the other hand, is required to respond to diversifying needs with meticulously detailed products while responding to fluctuations of demand.

All these products have been unified by the use of microcontrollers with built-in flash memory (hereinafter referred to as "flash microcontrollers") to respond to such a market and to contribute towards improving our customers' system competitiveness by offering a "shorter lead time" and "reduced costs" through the implementation of the "All Flash" microcontrollers.

2. Concept of All Flash Microcontrollers

Significant benefits in terms of lead time and cost result from system development through to production since software can be re-programmed with flash microcontrollers, unlike conventional mask ROM microcontrollers (**Fig. 1**). During the development stage a shortening of the development time is realized with "software that is variable until immediately prior to production" and "development or evaluation of mask ROM microcontrollers is not necessary."

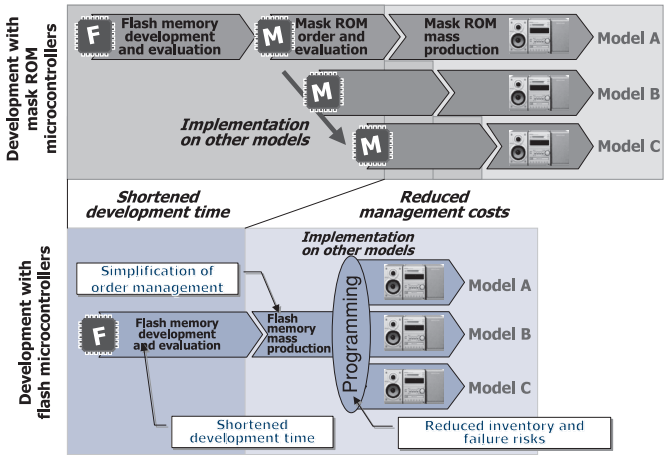

Fig. 1 Supply chain realized by flash microcontrollers.

In the production stage a reduction in management costs is realized with a "simplification of order management through the adoption of common parts" and "inventory risk reduction through the programming of software in production."

Even though flash microcontrollers offered such a high degree of convenience, there were some "fears," such as "the small number of available products," "the development environment is difficult to use" and "programming of the software is troublesome," which led to the more frequent use of mask ROM microcontrollers for mass production.

With "All Flash" microcontrollers, however, "peace of mind" is provided through "numerous product lines," "convenient

development environment" and "substantiated programming environment" that eliminates such "fears". All these make it easier for our customers to adopt flash microcontrollers and for flash microcontrollers to become their key device for improving system competitiveness.

3. Numerous Product Lines

Product lines are shown in **Fig. 2**.

The 8-bit "All Flash" microcontrollers are successors to conventional products, 78K0S and 78K0/Kx1. The product lines offer not only improved functions but also a variety of products have a number of pins ranging from ten to 80, as well as ROM capacities that support 1KB to 128KB. These all make smooth migration possible between products. Furthermore, products that incorporate various peripheral functions (such as LCD controller/driver, USB, etc.) are also being offered, making it possible for NEC Electronics to provide optimum products for a diverse range of applications.

In addition, a substantial assortment of compact packages that were not available with conventional products are being offered to provide support for the miniaturization of the system and to reduce mounting surfaces, as shown in **Photo 1**.

Features of 78K0/Kx2, which are representative products of the "All Flash" microcontrollers, are introduced below.

3.1 Low Costs Realized Through Adoption of Most Advanced Process in Industry

The "SuperFlash®" technology of Silicon Storage Technology Inc. of the United States, which makes it possible to re-programming data at high speeds and with a low power consumption, is used in our products and the new 0.15µm process, the most advanced process for flash microcontrollers in the industry, has been adopted. The new process was developed with an emphasis on such features as low cost and low leakage for the targeted 8-bit microcontrollers that have a broad market.

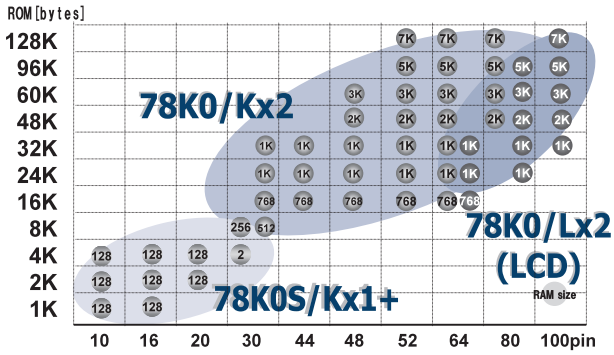

Fig. 2 Product implementations.

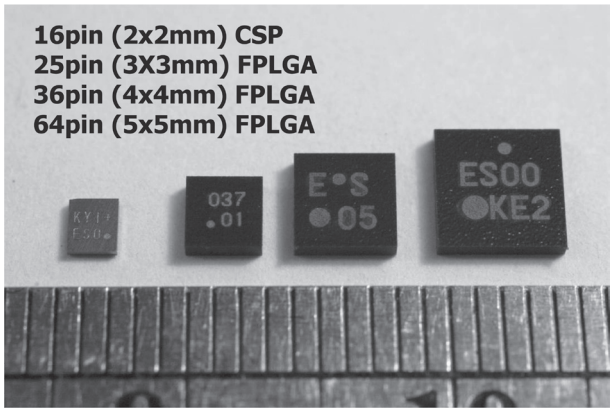

Photo 1 Compact package making contribution for system miniaturization.

Furthermore, a chip size, amounting to less than one-fifth the size of conventional products in terms of surface area for products of equivalent specifications, has been achieved through a broad review and modifications to specifications relating to assembly processes, such as the multilayering of wiring layers, adoption of the CUP (Circuit Under Pad) structure around the terminals to reduce the I/O buffer spaces, reduced bonding pad sizes, bonding pad arrangements with a narrow pitch and reduced scribe lines that determine the dicing region to one-half of conventional products. As shown in **Photo 2**, our flash

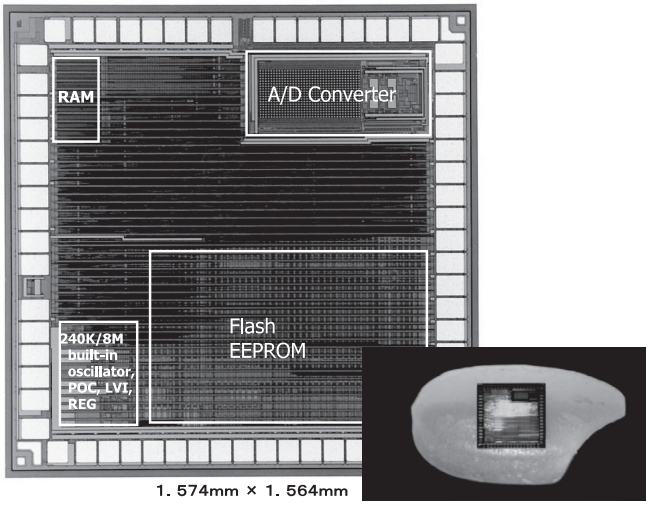

Photo 2 Numerous peripheral functions are incorporated into chip, smaller than grain of rice.

memory product is smaller than a grain of rice and can store 32KB of data.

Furthermore, the total system costs are reduced through the incorporation of an EEPROM function, internal oscillator, power on clear (POC) function and low voltage indicator (LVI) circuit.

The EEPROM function secures a portion of the built-in flash memory as a data area, which can be used as a replacement for EEPROM with the software library. The built-in oscillator is a highly accurate 8MHz clock that can be used as the system clock and a 240kHz clock that can be used as a watchdog timer. The combination of the POC and LVI with the reset function ensures initialization of the system.

3.2 Low Power Consumption and Low Noise Realized

Support for a wide operating range from 1.8 to 5.5V, along with a low power consumption and low noise, was made possible through the adoption of the new process. To lower power consumption, low voltage operations (2.5V) were used, made possible by the built-in regulator, optimization of transistor sizes matched to the operating frequencies, optimization of logic circuits (simplification of circuits, reduction of test circuits by implementing scans, etc.) and the adoption of gated clock, have all been devised to improve the design. All this made it possible to achieve a consumption of 2.3mA (typ) for 5V supply & 10MHz operation, as shown in **Fig. 3**, which is a reduction of less than one-third of conventional products.

Furthermore, to lower the noise, a reduction in the higher harmonic components and characteristic improvement by 10dBμA over conventional products, in terms of EMI (electromagnetic interference) characteristics have been realized, as shown in **Fig. 4**, through improvements to the chip design, such as lowering the impedance of power/ground lines and separating power/ground lines. In terms of EMS (electromagnetic susceptibility) characteristics, a characteristic improvement up to a maximum of five times, in comparison with conventional products, has also been achieved.

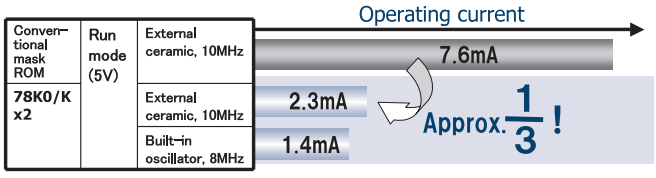

Fig. 3 Low power consumption is one-third that of mask ROM microcontroller.

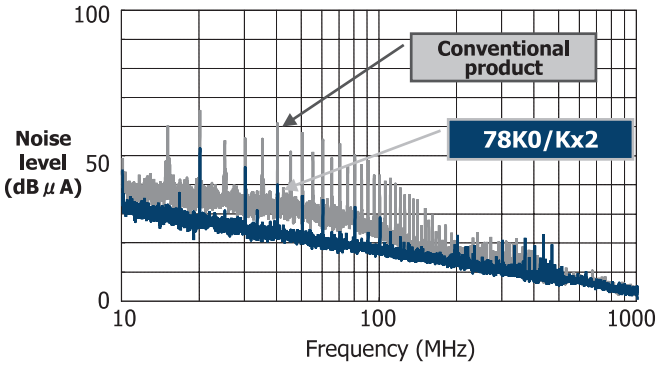

Fig. 4 Sample EMI characteristics.

3.3 Malfunction Prevention and Security Improvement

Strategies to thwart malfunctions and tampering are important for systems. This product is enabled to ensure resumption of normal operations even when malfunctions occur, through the incorporation of a watchdog timer that operates on an independent built-in oscillator, automatic system setup, which is critical with hardware when reset is released (option byte) and other features.

Furthermore, when the customer software is programmed the flash microcontrollers before they are delivered, the security levels, such as program/erase/read disabled, can be selected and set in order to protect internally stored software as well.

4. Convenient Development Environment

How efficiently development is conducted with software, from implementation to evaluation, has a significant impact on the development time and cost of systems with microcontrollers. A development environment that suits the needs of our customers and accommodates each step of the development as shown in **Fig. 5** is provided for “All Flash” microcontrollers.

Along with providing the substantiated functions of basic tools, such as an integrated development environment (PM+) using compilers and assemblers as well as an in-circuit emulator (IECUBE), tools for improving efficiency of development, such as a device driver configurator (Applilet), emulator (SM+), simplified on-chip debug emulator (MINICUBE2), are available.

4.1 Device Driver Configurator

The device driver configurator (Applilet) is a tool providing

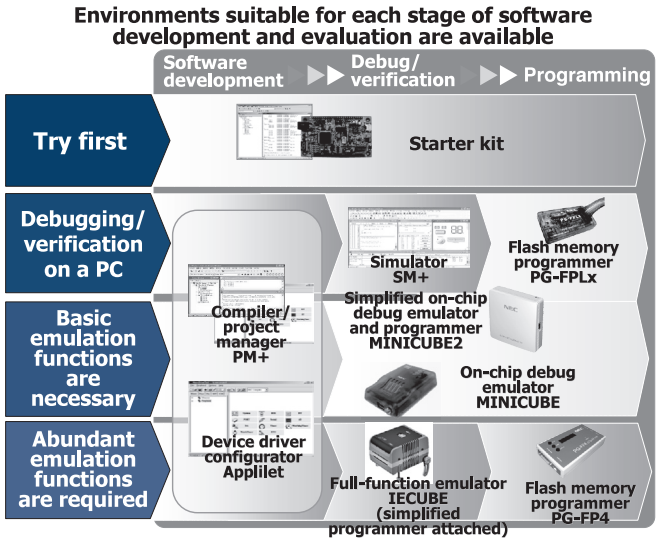

Fig. 5 Substantiated development environment.

support for the preparation of software (device drivers) that control built-in peripheral functions, such as timers and the serial interface. Peripheral functions have become abundantly available with microcontrollers in recent years and the preparation of device drivers requires extremely large amounts of time. By using the Applilet, however, device drivers can be prepared simply by selecting them from menus, thereby significantly reducing the development time.

4.2 Simulator

The simulator (SM+) is a tool to simulate and evaluate software of a CPU and peripheral functions for the microcontroller of personal computers. Evaluations linked with peripheral functions, such as the connection of basic components, including LEDs and switches, as well as the monitoring of arbitrary pattern output signals, can be performed. Evaluations performed with conventional in-circuit emulators require that the target system to be completed. Using the SM+, however, it is possible to evaluate software before the hardware is completed, thereby making it possible to shorten the development time.

4.3 Simplified On-Chip Debug Emulator

The simplified on-chip debug emulator (MINICUBE2) is compact and low cost, yet suitable for 8 to 32-bit "All Flash" microcontrollers. Since it is able to cover the debugging of approximately 200 types of microcontrollers with varying performances and features, as well as programming flash memory all with a single unit, it is a product with a superior cost performance. Furthermore, since a USB connection can be made to a personal computer, as well as the compact size feature, it can also be used for system evaluation under various environments, ranging from laboratories to locations in the field.

5. Substantiated Programming Environment

Software is usually not programmed in flash microcontrollers and therefore, it is necessary to program software that has been evaluated by the customer. Various programming environments for flash microcontrollers are available for "All Flash" microcontrollers to suit the needs of our customers.

We ship "products with software programmed at NEC Electronics" to customers who require a stable supply. We introduce our "business partners who provide programming services" when emergency responses or programming in short periods of time are required.

The "programming in production line", however, is recommended to our customers who want to maximize the benefits of flash microcontrollers with regards to shortening the lead time and reducing costs (**Fig. 6**). Not only is it possible to continue the development of software until immediately before production, also implementation to offshoot models becomes easy by merely re-programming the software. We are providing a broad range of services for programming in production lines through cooperation with our business partners, with the customization of programs to suit the production lines of customers and provide support for implementation.

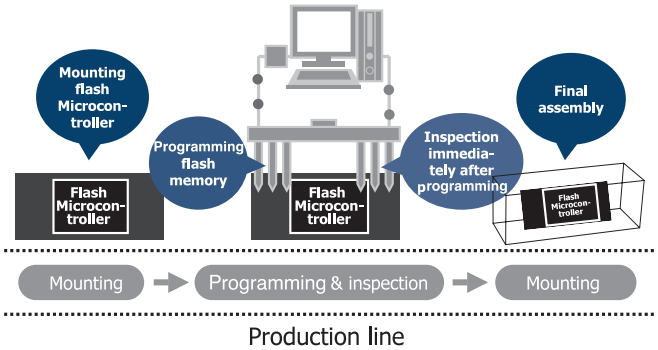

Fig. 6 Example of programming in production line.

6. Conclusion

Numerous products, convenient development environments and substantiated programming environments have been described thus far for the "All Flash" microcontrollers, thereby contributing towards "shortening the lead time" and "reducing costs" of the entire span of processes of our customers, from development through to production. We will continue with our further substantiation of "All Flash" microcontroller products ranging from 8-bit to 32-bit.

Authors' Profiles

NISHIZAWA Kazuyuki
Team Manager,
2nd Microcomputer Division,
4th Systems Operations Unit,
NEC Electronics Corporation

OBA Koji
Team Manager,
2nd Microcomputer Division,
4th Systems Operations Unit,
NEC Electronics Corporation

●The details about this paper can be seen at the following.
Related URL: http://www.necel.com/micro/en/index.html