

32-bit Microcontroller for High-Performance Home Appliances

MB91480 Series

FUJITSU has now added the MB91480 Series for high-performance home appliances to the lineup of our “FR family” of 32-bit microcontrollers. The MB91480 Series will contribute to energy saving and low noise via precise control in home appliances, which have been incorporating an increasing number of advanced features and enhanced performance in recent years.

Overview

This product is a microcontroller for high-performance home appliances. It has a 5V interface built on the core of our original architecture, RISC CPU. To offer advanced functions in home appliances such as air conditioners, washers and dryers, refrigerators, IH cooking heaters, and microwaves, it mounts a 32-bit CPU core with maximum operation speed of 80MHz, a high-performance A/D converter, and a special 32-bit high-speed product-sum operation macro. It also incorporates 2 units of multifunction timers capable of three-phase PWM control that allows 2 motors operation.

Lineup

Fig.1 presents the lineup for our 32-bit microcontrollers with 5V interface.

FUJITSU has introduced the MB91260 and MB91265 Series to the lineup as well as the MB90470 Series that has improved CPU processing capability and enhanced A/D converter functions. Using this MB91470 Series as the base, the MB91480 Series is now added to the lineup. It has 2 multifunction timer units capable of three-phase PWM control to address 2 motors operation. In this series, a mask

ROM product is currently in planning to follow the Flash memory-mounting MB91F487.

MB91F487 Features

■ Adopting the FR60 core

This product adopts the FR60 core, which is instruction-compatible with the FR Series. FR60 is our 32-bit RISC CPU core, which realizes high performance and low power

Photo 1 External View



consumption. It is capable of operating at 80MHz (source oscillation: 10MHz, PLL: 8-fold multiplication) at maximum.

High-speed A/D converter

This product mounts 18 channels of 8-/10-bit resolution A/D converters and it is thus suited for applications where

analog measurement values are frequently used. The minimum conversion time for the A/D converter is 1.2μs. This product mounts 3 A/D converter units (4 channels×2 units/10 channels×1 unit); it can therefore be used more effectively by dividing the units into different measurement applications.

Figure 1 Lineup of FUJITSU Microcontrollers with 5V Interface

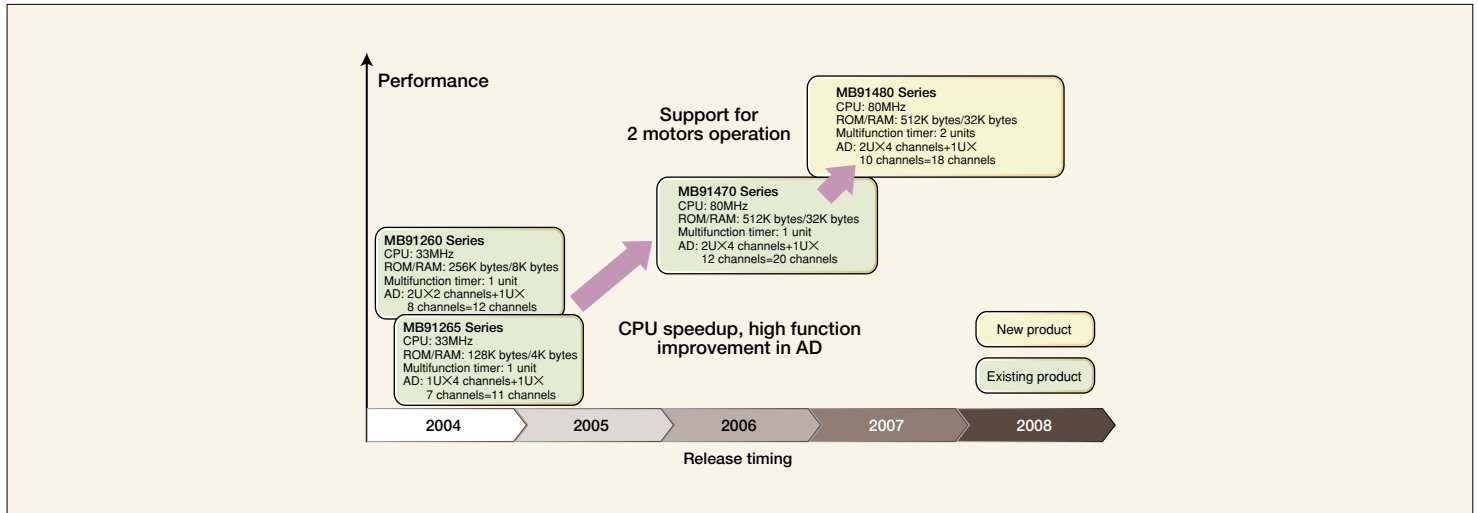
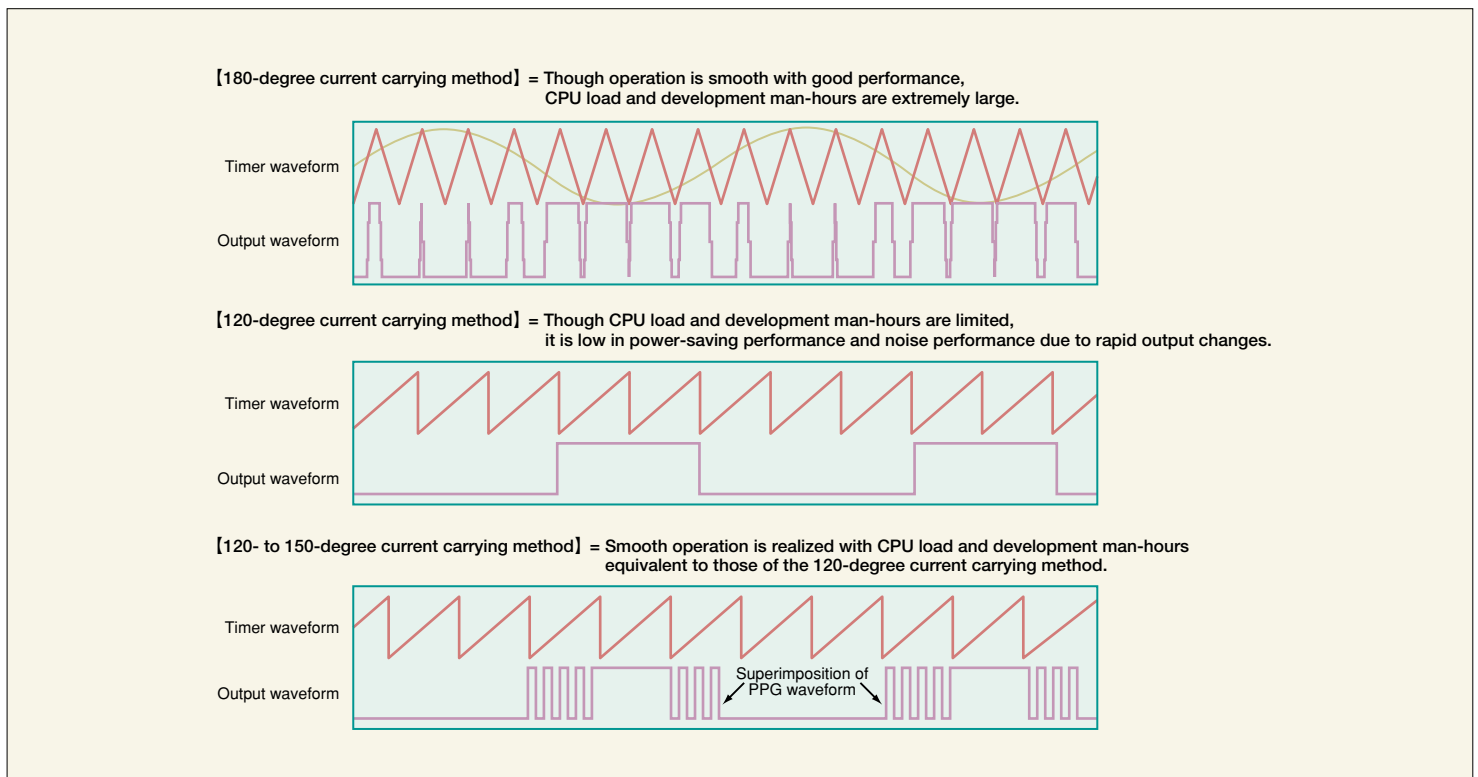


Figure 2 Difference in Inverter Control by the Current Carrying Method



A/D converter engagement function

Interlock startup is possible in all A/D converter units by using the free-run timer (output compare function) in the multifunction timer block. It is also possible to transfer the converted data by DMA with completion of the conversion process, using the A/D converter as the trigger. This enables efficient inverter control such as control on a rotation element by detecting the current running through the protective resistance of the motor-driving element at the A/D converter.

In interlock with the free-run timer (output compare function), it is possible to start up at compare clear match, zero detection point and delayed startup from the same point. A/D startup point adjustment is also possible.

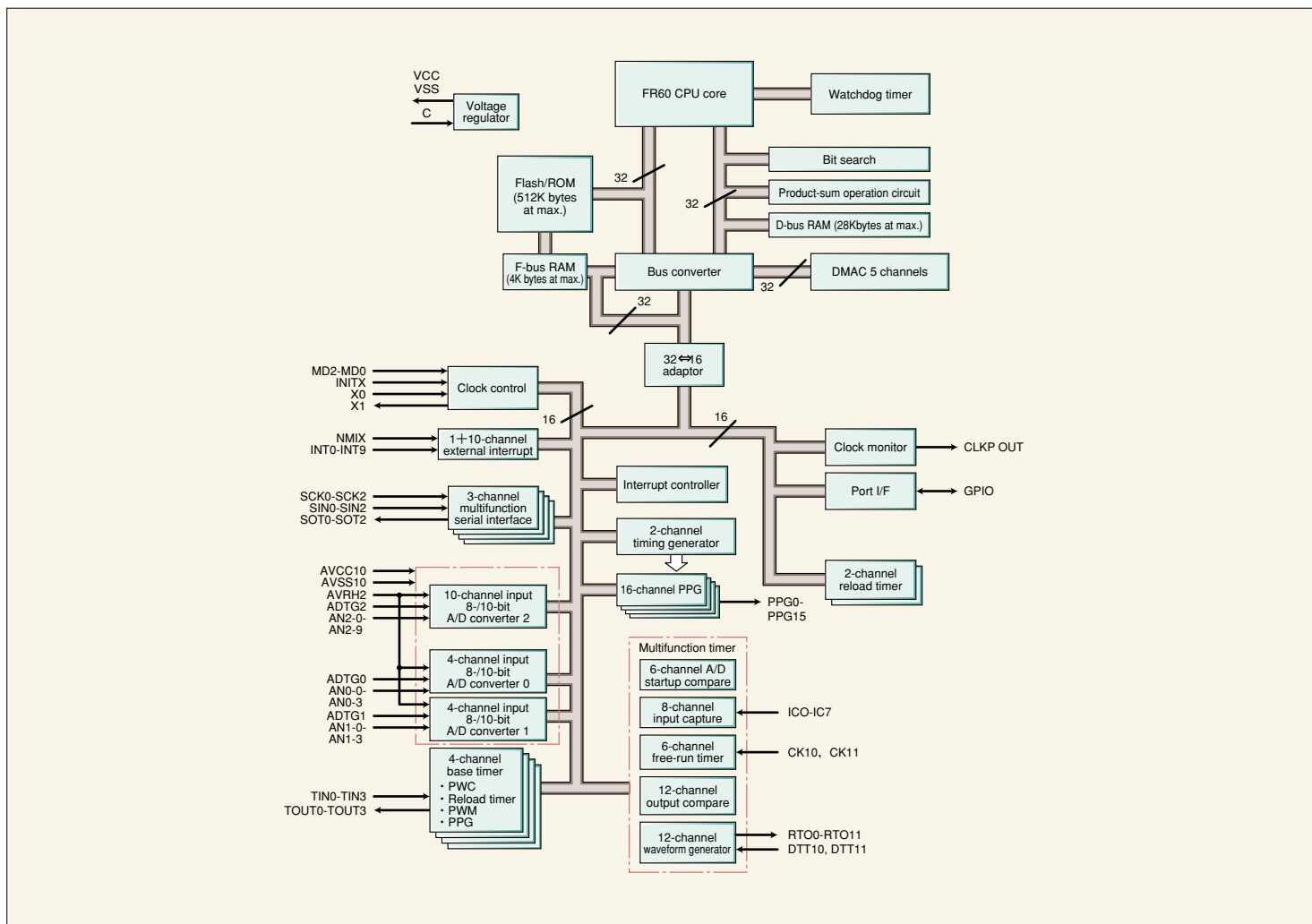
High-speed product-sum operation macro

With the assistance of the product-sum operation hardware macro, the operation performance of the microcontroller is sped up further. While the product-sum operation of 32-bit×32-bit+72-bit is executed in 7 cycles (80MHz at maximum), operation is conducted in pipeline processing. It is therefore effective for executing a large volume of operations simultaneously as in matrix calculation for 180-degree current carrying inverter control. It also allows the CPU to execute other processes during macro operation since it can operate in parallel with CPU operation.

Serial interface supporting UART/SIO/I²C

The serial interface unit for this product can be used by switching among UART, SIO, and I²C by mode setting.

Figure 3 MB91F479 Block Diagram



MB91F487 mounts 3 channels of this unit. It is possible to realize interface-type IC control by I²C, synchronized serial communication by SPI-ROM connection by SIO or with other microcontrollers and communication with other boards by UART.

■ Base timer

The base timer can be either a 16-bit PWM timer, a 16-bit PPG timer, a 16-/32-bit reload timer or a 16-/32-bit PWC timer using mode setting. In addition, the base timer can be used in 32-bit mode by combining an even number channel with an odd number channel. MB91F487 mounts 4 channels of this base timer. Since a single timer can be used in different applications by switching the mode, it can flexibly fulfill demands in customer applications.

■ 2 channels of multifunction timer

The multifunction timer offers the following functions:

- 16-bit up-down counter×3
- 16-bit output compare×6
- 16-bit input capture×4
- 8-/16-bit PPG timer×3
- Waveform generator×1
- A/D startup compare×3

It is possible to generate the carrier frequency waveform, elementary signals, non-overlap signals, and various signal controls (waveform generator block) that are necessary for inverter control. It also generates A/D converter startup signals in synchronization with the inverter control timer and takes input pulse width measurements.

Mounting three 16-bit up-down counters, the counter to be used by the output compare can be selected optionally. It is also possible to use this product to control several single-phase motors or several IH heaters by executing independent PWM control for every 2 channels in addition to the three-phase inverter motor control achieved by synchronizing 6 channels.

Furthermore, it is possible to superimpose the pulse waveforms of the PPG timer to achieve 120- to 150-degree current carrying inverter control with CPU load and development man-hours approximately equivalent to those of the 120-degree current carrying method. This enables smooth power control in inverter control without using the 180-degree current carrying method, which uses many development man-hours and large CPU load.

This product mounts 2 multifunction timer units with such functions and realizes control of 2 motors in 1 chip.

Table 1 MB91F487 Specifications

| Product name | | MB91F487 |
|------------------------------------|--------------------------------------|--------------------------------------------------|
| Minimum execution instruction time | | 12.5ns (80MHz) |
| Memory | ROM | 512K bytes (Flash memory) |
| | RAM | 32K bytes |
| Communication function | UART with I ² C functions | 3 channels |
| Analog function | 8-/10-bit A/D | 4 channels×2 units, 10 channels ×1 unit |
| Timer functions | Multifunction timer | 2 units |
| | 16-bit reload timer | 2 channels |
| | 8-/16-bit PPG timer | 8-bit×16 channels (16-bit×8 channels) |
| | 16-/32-bit base timer | 16-bit×4 channels (32-bit×2 channels) |
| | Watchdog timer | 1 channel |
| External interrupt | | 11 at max. |
| DMAC | | 5 channels |
| Product-sum operation circuit | | 1 unit (32×32+72 = 72-bit operation) |
| External bus interface | | None |
| I/O port | | 77 at max. |
| Power supply voltage | | 4.0 to 5.5V |
| Operating temperatures | | -40 to +85°C |
| Package size | | LQFP package (100-pin, 0.5mm pitch, 14mm square) |

Fig.2 shows the difference in inverter control among different current-carrying methods, **Table 1** the MB91F487 specifications, and **Fig.3** the MB91F479 block diagram.

Development Environment

This product permits program development using ICE. It mounts NQPACK (manufactured by Tokyo Eletech Corporation) on the user system board prepared with a MB91F487 foot pattern overlaying the header board and the adaptor board. On the adaptor board it mounts MB91FV470, which is the common evaluation chip for the MB91470/480 Series. The adaptor board and ICE are connected with a DSU cable. ICE can be connected to a PC using LAN, USB, or RS-232C.

The user system board can be prepared with the product chip MB91F487 foot pattern. As such, it can also be used in the operation check with the product chip when development is completed. As software, SOFTUNE V6 Workbench is available. It is an integrated development environment prepared to execute all processes of program development in one software by integrating an editor, C/C++ compiler, linker, simulator, and emulator.

Fig.4 shows the debugging environment configuration by ICE and **Table 2** the list of development tools.

Application Examples

Fig.5 presents some application examples of MB91F487. MB91F487 can be used as a main microcontroller for controlling the air conditioner outdoor unit that controls the compressor and fan motor. *

NOTES

* Other company names and brand names are the trademarks or registered trademarks of their respective owners.

Table 2 List of Development Tools

| | Product name | Model |
|----------|------------------------------------|----------------------------------------------------------------------------------------------------|
| Hardware | ICE | MB2198-01 |
| | DSU cable | MB2198-10 |
| | Adaptor board | MB2198-160 |
| | Evaluation chip | MB91FV470 |
| | Header board | MB2198-162 |
| | NQPACK | NQPACK100SD-ND (Manufactured by Tokyo Eletech Corporation) *1 unit attached to the header board |
| Software | Integrated development environment | SOFTUNE V6 Workbench |

Figure 4 Debugging Environment Configuration by ICE

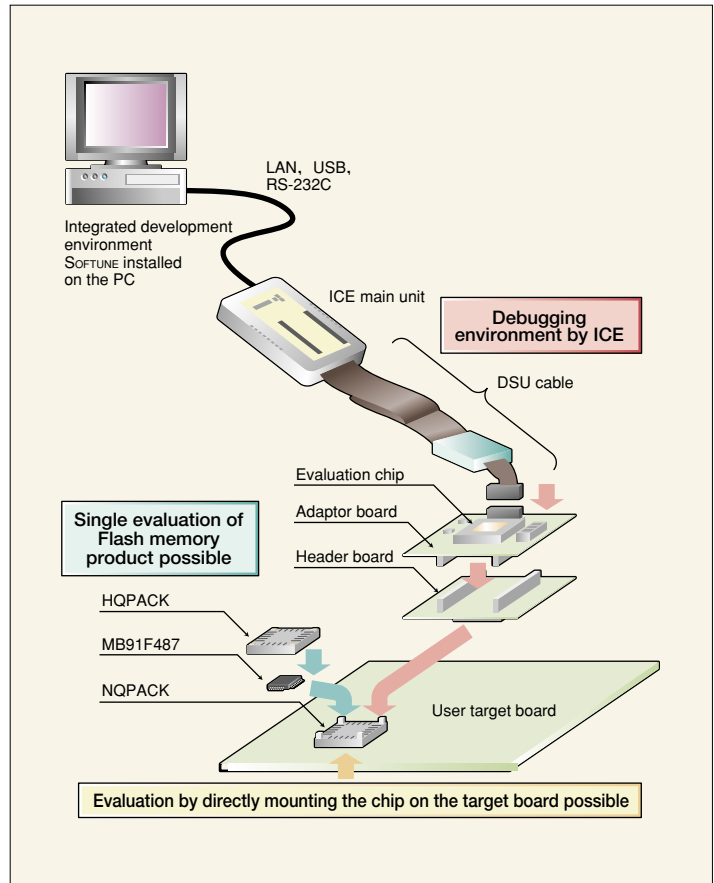


Figure 5 MB91F487 Application Examples

