

16-bit Microcontrollers with Built-in New CPU Specialized for Automotive Systems F²MC-16FX Family MB96320/340/350/380 Series

These products are optimal for next-generation body control systems as they have approximately 5-fold speedup from our conventional products at maximum and current consumption has been reduced by approximately one fourth. There are built-in 32-message buffers in the CAN controllers of all products in this series.

Overview

Due to the growing recognition of environmental problems, the development of “eco” cars has been advanced in recent years in the automobile industry to address driving exhaust gas reduction and improved fuel efficiency. IT progress in automobiles utilizing ITS (Intelligent Transportation Systems) is also advancing rapidly. Such next-generation automobile systems require real-time processing at higher speed.

These products are microcontrollers capable of realizing high-performance, low-power consumption systems using the newly developed 16-bit CISC CPU, F²MC-16FX as the core. While speeding up the maximum operation frequency from the conventional 24MHz to 56MHz, it has improved the processing performance by nearly 5-fold (approximately 2.5-fold by comparison with identical frequency) of our conventional products with built-in pipeline functions. The F²MC-16FX family is optimal for controlling body control modules, automobile air conditioners, dashboards, lights, various sensors, etc.

Fig.1 presents a comparison of processing performance by

16FX/16LX and **Fig.2** is a comparison of current consumption by 16FX/16LX. The current consumption is approximately one fourth that of our conventional products. We plan to expand the product lineup from 48-pin to 144-pin.

Fig.3 shows the lineup of the F²MC-16FX family.

Photo 1 External View



Figure 1 Comparison of 16FX/16LX Processing Performance by the Memory Model (Dhrystone 2.1: Internal operation frequency 24MHz)

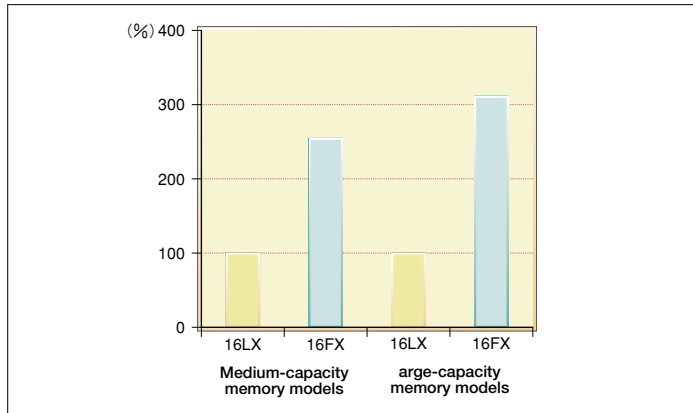


Figure 2 Comparison of Current Consumption by 16FX/16LX (Dhrystone 2.1: 4MIPS operation, Vcc=5V)

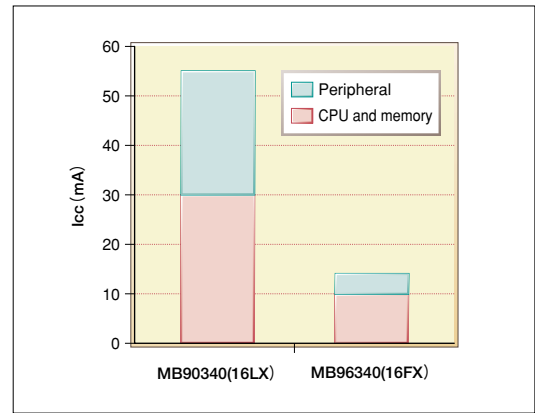
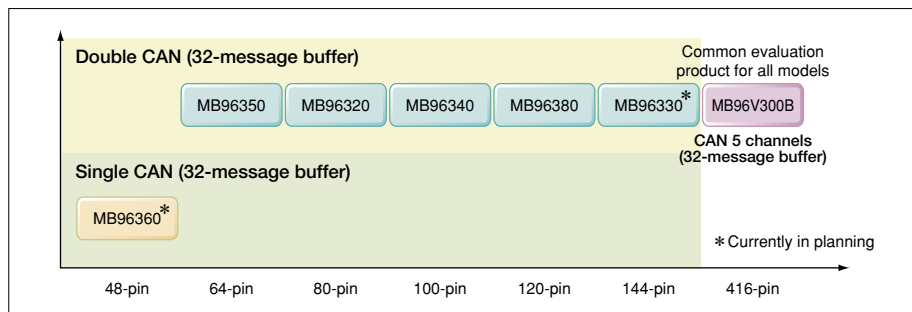


Figure 3 Lineup of the F²MC-16FX Family



Product Features

Fig.4 presents the block diagram of the F²MC-16FX family products.

The built-in resources of these products deliver the following features:

16FX Core

These products adopt a 16FX core with instruction compatibility with the 16LX series.

- 16-bit CISC, minimum instruction execution time 17.8ns (56MHz)
- 5-stage pipeline
- 8-byte instruction queue
- Basic instruction executed in 1 cycle/fast interrupt (interrupt transition time: 10 cycles)/NMI function (setting possible by a register)

Built-in Flash memory capacity

- Main Flash memory: 128Kbytes/160Kbytes/288Kbytes/416Kbytes/544Kbytes
- Satellite Flash memory: 32Kbytes (optional)
- Flash memory security supported

Built-in RAM capacity

6Kbytes/12Kbytes/16Kbytes/24Kbytes

CAN controller (with built-in 32-message buffers)

It conforms to CAN specification version 2.0 part A and part B. It has built-in prioritized 32-message buffers for data and ID. Communication speed up to 1Mbps is supported.

Various timers

Timers that address pulse output to DC motor, pulse input from sensors, and so forth.

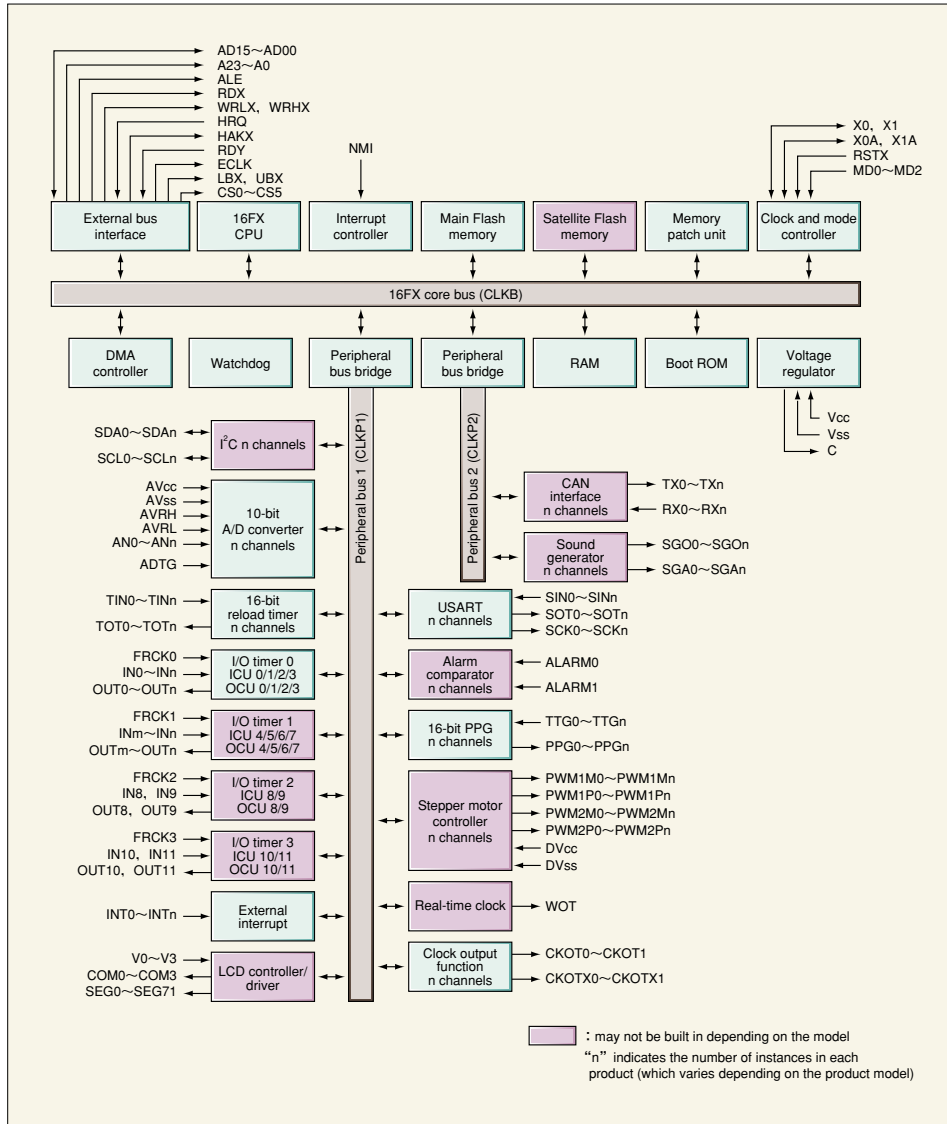
- 16-bit free-run timer
- 16-bit input capture
- 16-bit output compare
- 16-bit PPG: Selection from one-shot output/PWM output possible (simultaneous output possible up to 4 channels)
- 16-bit reload timer

Various interfaces

USART enables simple addressing of master-slave function in LIN communication.

- USART (LIN-supporting UART)
- I²C interface

Figure 4 Block Diagram of the F²MC-16FX family



- External bus interface (address: 24-bit, data: 16-bit):
Selection of little/big endian possible

High-speed 10-bit A/D converter (sequential conversion type)

Converts the analog signals from various sensors at high speed. (Minimum conversion time 1.7μs, total error ± 3LSB: Vcc=Avcc=3.0V to 5.5V)

On-chip RC oscillation circuit: RC clock/RC sleep/RC timer mode function

Reduces the stand-by current consumption dramatically by having the operation mode applying the on-chip RC oscillation clock (2MHz/100kHz: Selection possible by a register).

Low power consumption mode: Sleep/stop functions

The low power consumption modes are sleep mode (program stops) and stop mode (device stops). Utilizing them, standby current consumption can be reduced dramatically.

I/O Port

Simple connection to peripheral circuits by setting up the input level and pull-up resistance for each port.

- Input permission setting: Individual setting possible for each port
- Input level setting: Selection possible from 4 input levels: CMOS/CMOS hysteresis/ Automotive/TTL
- Pull-up resistance setting: Individual setting possible for each port (standard: 50kΩ)
- Maximum current output setting: Setting possible only for Ports 8/9/10
- Pin relocation function

Table 1 presents the input level settings and input voltage and Table 2 the current output settings.

Other Peripheral Functions

- External interrupt

Table 1 Input Level Settings and Input Voltage

	VIL (V)	VIH (V)	Input level
Input voltage	0.3Vcc	0.7Vcc	CMOS input
	0.2Vcc	0.8Vcc	CMOS hysteresis input
	0.5Vcc	0.8Vcc	Automotive input
	0.8	2.1	TTL input

Table 2 Current Output Settings

	Code	Maximum value	Current output setting
“H”/“L” level maximum output current	IOH2 / IOL2	40mA	High current output
	IOH1 / IOL1	15mA	Normal output

- DMAC
- Watchdog timer
- Real-time clock
- Stepping motor controller
- Sound generator
- LCD controller
- Alarm comparator
- Clock monitor
- Low-voltage detection circuit (optional)
- Power supply voltage: 3.0V to 5.5V

Development Environment

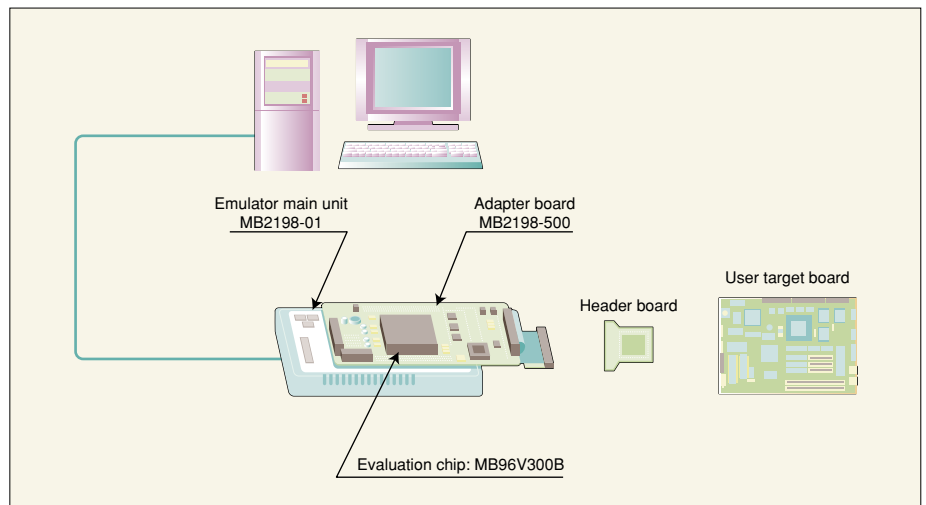
Like the conventional 16LX series, these products are supported by FUJITSU's integrated development environment SOFTUNE V3. This application software is designed to simplify programming tasks in order to meet the diversified needs of program designers.

Table 3 lists the development tools and **Fig.5** the development environment configuration.

Table 3 List of Development Tools

Hardware	Emulator main unit	MB2198-01
	Adapter board	MB2198-500
	Evaluation chip	MB96V300B
	Header board	MB2198-501 (QFP-100 : 0.64mm, 14×20mm) MB2198-502 (LQFP-100 : 0.5mm, 14×14mm) MB2198-503 (LQFP-64 : 0.5mm, 10×10mm) MB2198-504 (LQFP-64 : 0.65mm, 12×12mm) MB2198-16FX-120P-M21 (LQFP-120 : 0.64mm, 16×16mm)
Software	SOFTUNE V3 Workbench (16FX version)	
	SOFTUNE V3 C Compiler	
	SOFTUNE V3 Assembler	
	SOFTUNE V3 C/C++ Analyzer	
	SOFTUNE V3 C Checker	

Figure 5 Development Environment Configuration



Application Examples

Fig.6 presents an application example in an HVAC system and **Fig.7** an example in a BCM system.

F²MC-16FX can be used in body control systems such as BCMs, air conditioners, keyless entries, tire pressure systems, dashboards, lights, and various sensors.

Table 4 lists the product configuration of the F²MC-16FX family. *

NOTES

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

Figure 6 Block Diagram of an HVAC System

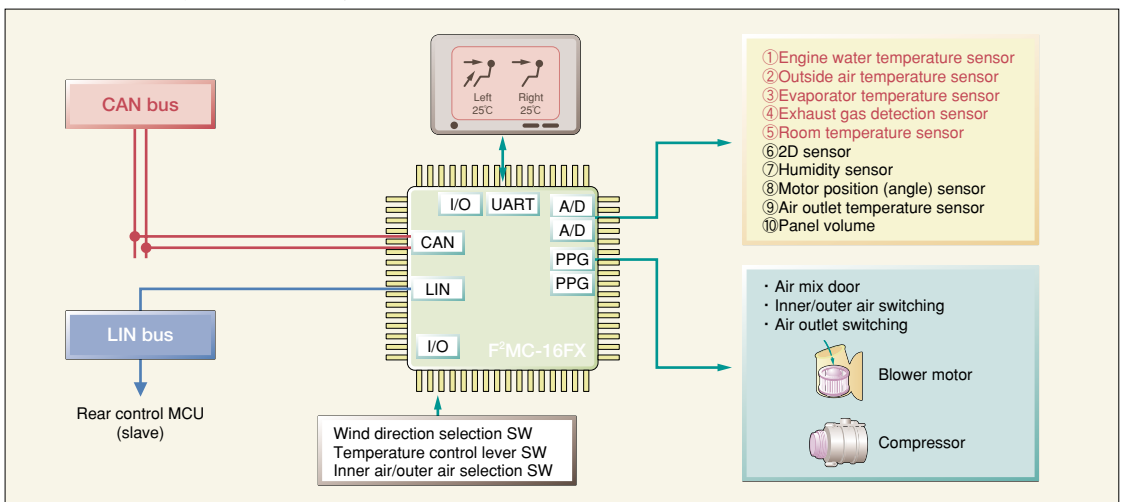


Figure 7 Block Diagram of a BCM System

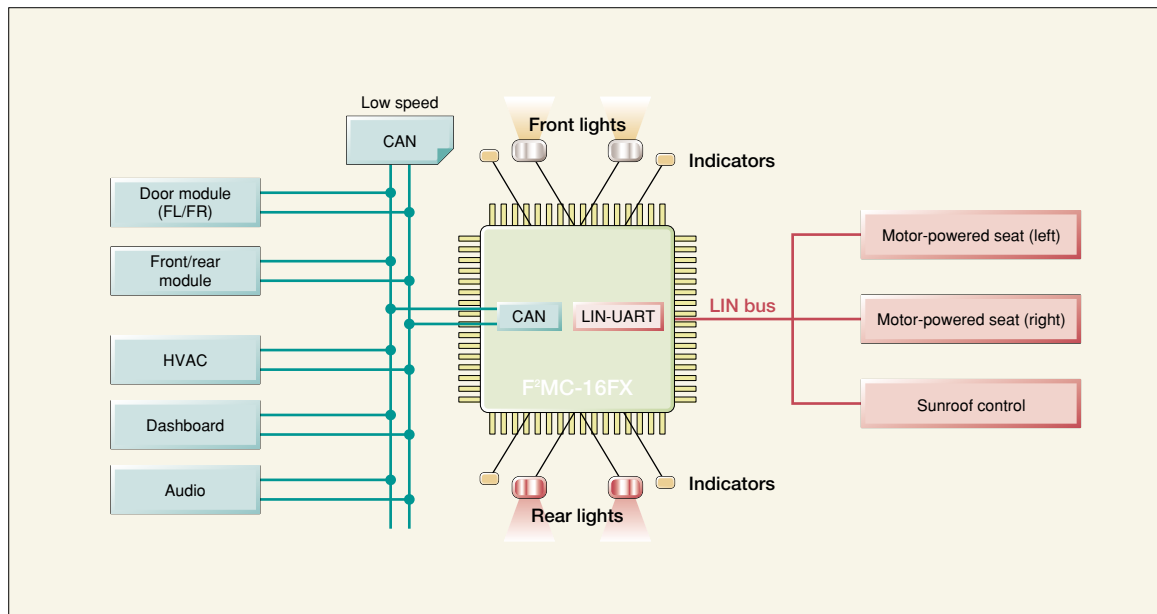


Table 4 Product Configuration

Item	model	MB96V300B	MB96F32x	MB96F34x	MB96F35x	MB96F38x
Classification		Evaluation product	Flash memory product			
System clock		On-chip PLL clock multiplication method (×1 to 16, 1/2 when PLL stops) Minimum instruction execution time: 17.8ns (56MHz) Clock source can be selected from main clock oscillator, subclock oscillator, or on-chip RC oscillator for CPU and peripheral functions.				
Flash memory: 288Kbytes RAM: 12Kbytes			MB96F326	—	MB96F356	—
Flash memory: 288Kbytes RAM: 16Kbytes			—	MB96F346	—	MB96F386
Flash memory: 416Kbytes RAM: 16Kbytes			—	MB96F347	—	MB96F387
Flash memory: 544Kbytes RAM: 24Kbytes			—	MB96F348	—	—
Flash memory: 544Kbytes Satellite Flash memory: 32Kbytes RAM: 24Kbytes			—	MB96F348H/T	—	—
Package		BGA416	LQFP-80	QFP-100 LQFP-100	LQFP-64	LQFP-120
DMA		16 channels	4 channels	6 channels	4 channels	7 channels
USART		10 channels	4 channels	MB96F348H/T: 4 channels Others: 7 channels	4 channels	5 channels
		Special reload timer enables wide-range baud rate setup. Supports various serial protocols. LIN function to operate as the master or slave LIN device also supported.				
I ² C		2 channels	1 channels	2 channels	1 channels	1 channels
		Master or slave function and 8-bit or 10-bit address specification, 400kbps supported.				
A/D converter		40 channels	18 channels	24 channels	15 channels	16 channels
		10-bit resolution				

Item	model	MB96V300B	MB96F32x	MB96F34x	MB96F35x	MB96F38x
16-bit reload timer		6 channels	4 channels	4 channels	4 channels	4 channels
16-bit free-run timer		4 channels	4 channels	2 channels	2 channels	2 channels
16-bit output compare		12 channels	6 channels	8 channels	4 channels	4 channels
16-bit input capture		12 channels	12 channels	8 channels	6 channels	8 channels
16-bit programmable pulse generator		20 channels	20 channels	16 channels	20 channels	8 channels
CAN interface		5 channels	2 channels	2 channels	2 channels	2 channels
Stepping motor controller		6 channels	—			5 channels
External interrupt		16 channels	15 channels	16 channels	13 channels	8 channels
NMI		1 channels				
Sound generator		1 channels	—			2 channels
LCD controller		4COM×72SEG	—			4COM×65SEG
Real time clock		MB96F348H/T: Not built-in, others: Built-in				Built-in
I/O port		136	64 (2-clock system product) 66 (1-clock system product)	80 (2-clock system product) 82 (1-clock system product)	49 (2-clock system product) 51 (1-clock system product)	94 (2-clock system product) 96 (1-clock system product)
Alarm comparator		2 channels	—	2 channels	—	2 channels
		Monitors the external voltage and generates an interrupt when it is lower or higher than the set threshold values.				
External bus interface		Built-in				
		Multiplex bus mode Non-multiplex bus mode (MB96V300 and MB96F38x only) 16-bit data bus 24-bit address bus (MB96F35x: 22-bit address bus)				
Chip selection		6	6	6	6	6
Clock output function		2 channels	2 channels	2 channels	2 channels	2 channels
Low voltage detection reset (optional)		Generates reset when the power voltage drops.				
On-chip RC oscillator		Application possible as oscillation stop detection or watchdog operation clock. Selection from 2 frequencies (100kHz, 2MHz)				