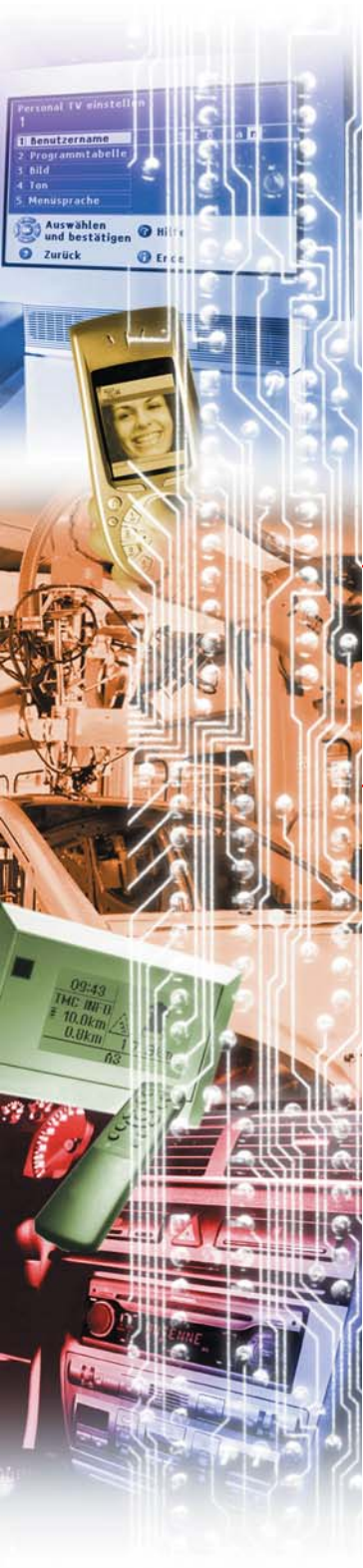EMBEDDED SOLUTIONS

MICROCONTROLLERS

PRODUCT OVERVIEW

MICROCONTROLLERS

CONTENTS

INTRODUCING FUJITSU MICROELECTRONICS EUROPE

Fujitsu Microelectronics Europe is a major supplier of semiconductor products to the European and global market. The company's main business focus is on providing system solutions to the automotive, industrial/home appliance, networking/telecommunications and multimedia markets.

The engineering support from experts in both the application areas and Fujitsu products saves customers time and effort.

Fujitsu offers a broad range of semiconductor devices, including sensors, ASICs, RF devices, MPEG encoders & decoders, microcontrollers, graphic display controllers, microprocessors, FRAM and FCRAM™. The company is also a leader in colour plasma display panels.

Fujitsu Microelectronics Europe's new headquarters in Langen.

Maidenhead
Regional Office &
Mixed Signal Division

Langen
Fujitsu Microelectronics Europe
Headquarters - ASIC, MCU, RF and
Multimedia Design Centres

Levallois
Regional Office

München
Regional Office &
ASIC Design Centre

Milan
Regional Office

EXPERTISE IN THE AUTOMOTIVE AND INDUSTRIAL MARKETS

Fujitsu's Microcontroller product portfolio of more than 500 products is based on 8/16 and 32-bit Architectures and is the result of continuous development activity. The basis for these developments is the know-how that Fujitsu engineering departments world wide have built up in close co-operation with Fujitsu's customers.

In Europe this expertise is organised in a business unit supporting the Automotive and Industrial markets.

Both markets require high quality products with state-of-the-art network interfaces such as CAN, LIN, IDB1394, FlexRay™ or Ethernet. The product portfolio ranges from smart and small 8-bit to high performance 32-bit RISC Microcontrollers.

Fujitsu embedded Flash technology has always been the basis for reliable products. The fourth generation of this technology is now available.

European Microcontroller Design Centre (EMDC)

The centre has completed about 100 development projects since its foundation in 1997. In close partnership with our European customers innovative products have been specified and give our customers a competitive edge in global competition. Fujitsu is a leader in
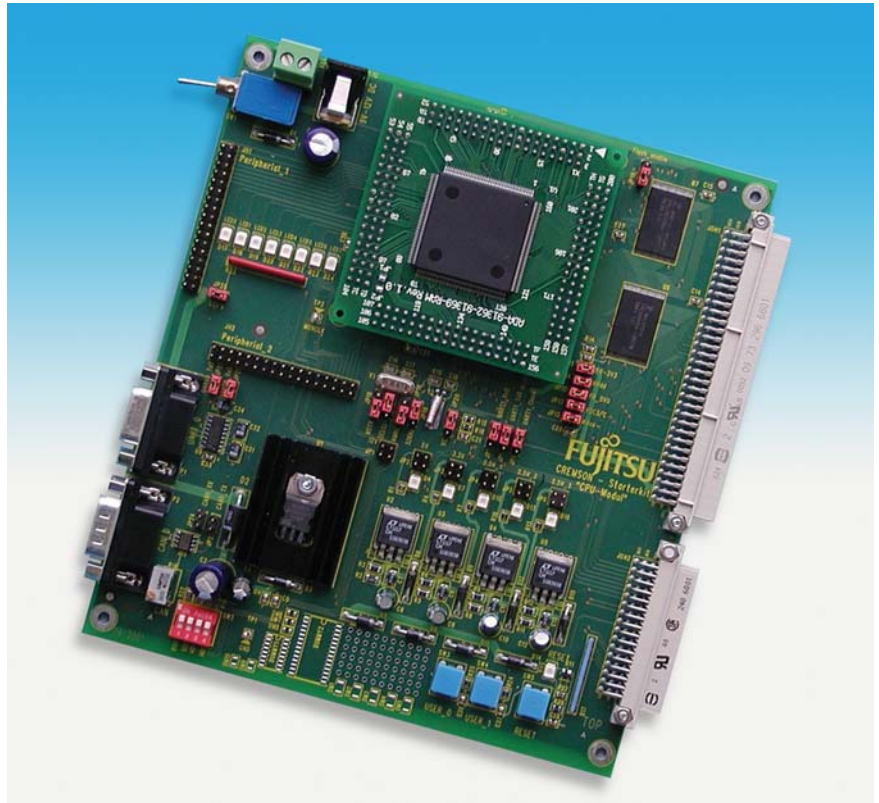
FlexRay Node, host controller (MB91F467).

fully-featured CAN and LIN MCUs and the steadily growing design centre is already preparing the next product generation which includes products with on-chip FlexRay.

Dedicated local application support team
FME's application engineering group is a one-stop shop for our customers. They find expertise in their application area, deep knowledge of Fujitsu's products and a high level of experience with the tool environment, which Fujitsu also provides.

The Fujitsu Softune Workbench is the development environment for all 500 different MCUs (8 to 32-bit) and includes a state-of-the-art C-Compiler, Assembler and Debugger. It is free of charge in Europe. Getting started is easy with the support boards and training on offer. Application notes, software examples and EMC support complete the picture.

EXPERTISE IN THE AUTOMOTIVE AND INDUSTRIAL MARKETS

Quality

Formal Quality Systems like ISO9000, have been established since 1994. Products for automotive systems are certified to ISO/TS 16949. In future, Fujitsu automotive MCUs will be fully AEC-Q100 compliant.

Environmental Support

Fujitsu's usage of materials is fully compliant with the time plan for implementation of RoHS and WEEE programmes.

More information is available at FME's MCU WebPage:

http://www.fujitsu.com/emea/services /microelectronics/micros/
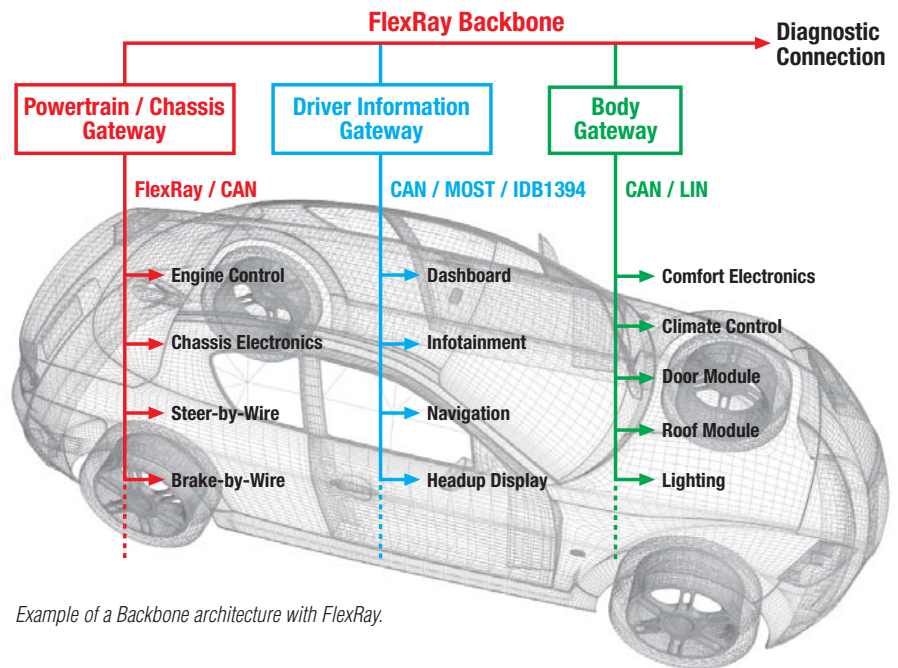
Example of a Backbone architecture with FlexRay.

The 2kBytes/256 Bytes embedded FRAM enables high-speed data writing, with up to 10^{10} write cycles.

Access to partners

These partners complement Fujitsu's offerings especially with regard to operating systems, driver software and development tools. Please see the 3rd party support page at http://www.fme.gsdc.de/gsdc.htm for more information.

AUTOMOTIVE STRENGTHS

Fujitsu's European Microcontroller Design Centre today boasts experience from more than 100 automotive development projects.

This is demonstrated by a host of smart on-chip features that meet the requirements of our automotive customers. Substantial software support for Fujitsu microcontrollers is also in place.

Programmable port levels

Many CAN microcontrollers feature programmable port levels. In addition to TTL and C-MOS levels, so-called 'automotive levels' (with VIL = 0.5 Vcc) can be selected. This is a valuable feature as ground levels in vehicles may show offsets of several Volts.

Clock modulation

This feature improves electromagnetic compatibility which is becoming an ever important requirement with increasing CPU speeds.

Clock modulation reduces emission peak levels by distributing the system clock frequency over a certain frequency range. This means that sharp high peaks are converted to a wider slewed signal in the frequency spectrum – with reduced emission levels. Graph 1 shows EMI measurement without clock modulation; Graph 2 shows clock modulation switched on.

EMI reduction by clock modulation (Frequency modulator)
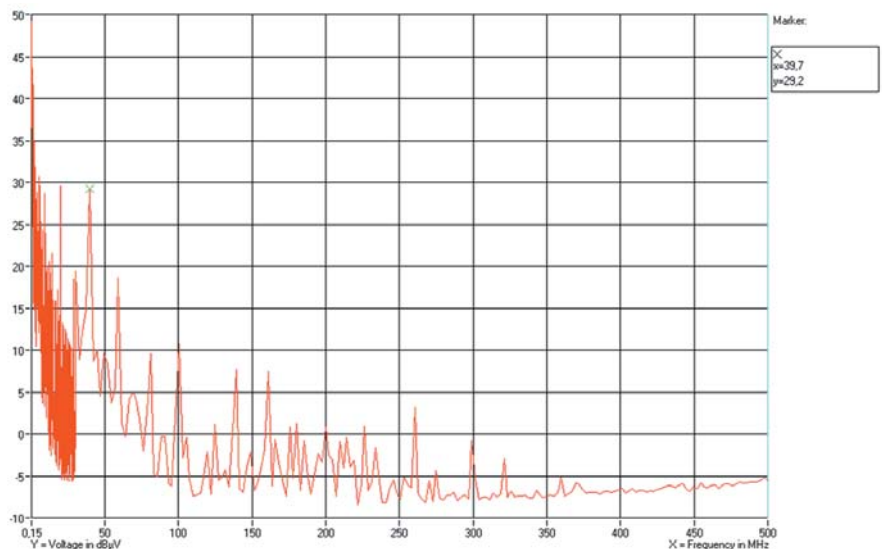
Graph 1: Emission IEC Norm 61967 part 4, MB90F394, FMOD=off.
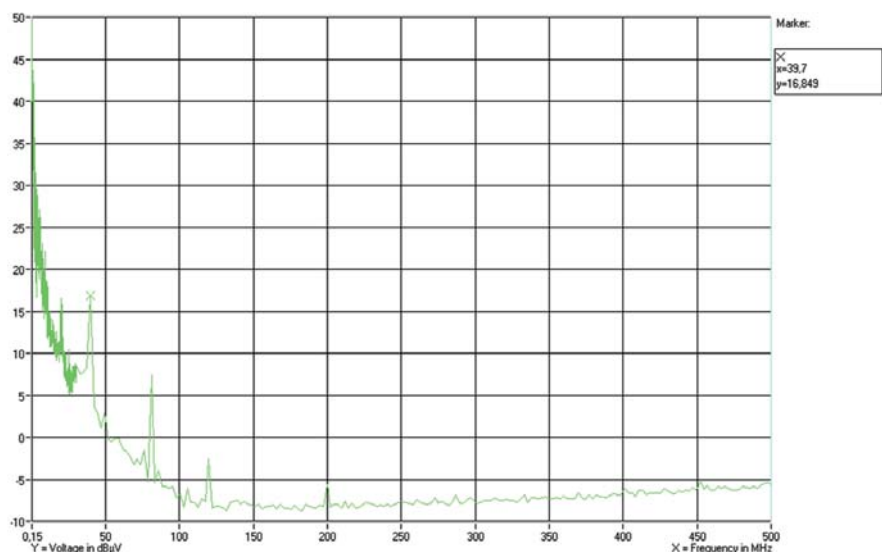
Graph 2: Emission IEC Norm 61967 part 4, MB90F394, FMOD=on.

LIN USART

A powerful serial communication interface with hardware support for LIN protocol is incorporated into every new Fujitsu CAN microcontroller. This interface supports SPI mode and baud rates up to 4MBaud in USART mode.

INTRODUCTION TO FUJITSU MICROCONTROLLERS

This brochure presents the next generation of Microcontrollers from Fujitsu, incorporating improvements in process technology and many new cost-effective on-chip features.

Fujitsu's expanding portfolio of 16-bit CAN Microcontrollers reasserts the company's number one position in this market, with more than 50 different devices ranging from 48-pin to 120-pin packages

The choice of 8-bit MCUs is even larger. The new and expanding 8FX family offers more for less.

For highest performance the 32-bit RISC portfolio was expanded by the new MB91460 series, which is already a standard demanded by customers in the automotive and industrial markets.

To find out about the latest devices, development tools and documentation, please visit:
http://emea.fujitsu.com/microelectronics

F^{2}MC-8L CPU-CORE ARCHITECTURE

16-bit CPU Register

Accumulator   Temporary Accumulator   Register Banks

PC	Program Counter
IX	Index Pointer
EP	Extra Pointer
SP	Stack Pointer

AH **A** AL   TH **T** TL   #d8

ALU

Processor Status

PS

32 Register Banks consisting of 8x8 bit registers
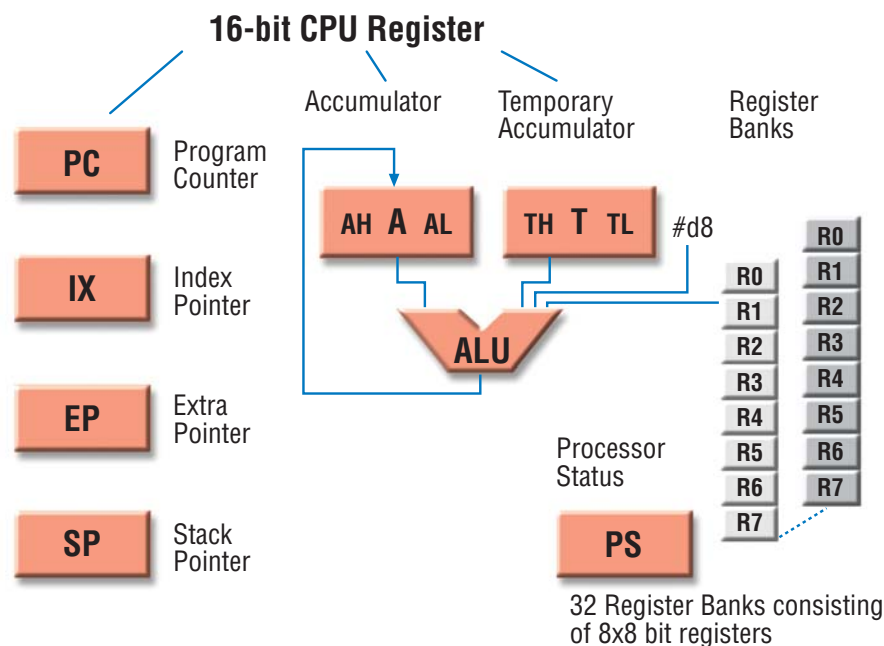
Fujitsu's advanced F^{2}MC-8L CPU core consists of seven 16-bit registers plus a maximum of 32 register banks, each consisting of eight 8-bit registers. The register banks can be used for a high-speed context switch after an interrupt.

CPU-Core Features

- 8-bit CPU Core
- Highly efficient Instruction Set
- Two 16-bit Accumulators with A-T architecture
- Data operation: 1/8/16-bit
- Enhanced bit manipulation: Clear, Set and Test bit

- 64kB Program/Data memory address space
- Multiply and Divide operations

F^{2}MC Power Saving Modes

GEAR* Dynamic selection of CPU cycle time in four ratios (e.g. 0.4, 0.8, 1.6 and 6.5µs at 10MHz clock)
SUB RUN** Switch to run from sub-clock. Turn off main oscillator
SLEEP Peripheral functions are running, CPU Core is in power down
CLOCK** Only the low-speed clock and prescaler are running
STOP Chip is in complete power down
*   Where applicable
** Where 2nd low-speed clock is available

COMPACT-ICE FOR LOW COST DEBUGGING OF F²MC-8L MICROS

A compact size, combined with the power to support microcontroller system designers with a cost-efficient solution for their daily work, makes Fujitsu's C-ICE (Compact In-Circuit Emulator) a highly valuable support tool.

It not only offers the ability to emulate microcontrollers operating at a voltage starting at 2.7V, it also supports sophisticated debugging features, such as multi-level break-points, bit-level event trigger capabilities and high level language support.

The emulation environment operates under Windows 9x, XP and Windows NT/2000.

Fujitsu's emulator for 8-bit micros makes designs easy and transparent.

Emulator Features

- Real-Time Trace
- Multi-level hardware Break points
- Low-Voltage Microcontroller support
- C, Assembler or mixed level debugging

THE NEW 8-BIT MCU FAMILY - F²MC-8FX CPU CORE ARCHITECTURE

- 8-bit CPU Core
  - Seven 16-bit registers
  - High speed, 100ns cycle time @ 10MHz CPU clock
  - Up to 32 memory mapped register banks (each bank consists of eight 8-bit registers)
  - A-T architecture
- Optimised internal bus
  - Reduced instruction cycles
  - Pipelining of the internal bus
- 64kByte linear addressing space
- Powerful arithmetic operation and transmission
  - Division instruction: 16-bit / 16-bit = 16-bit
  - Data transmission up to 16-bit
- Clock Multiplier Circuit
  - PLL x1, x2, x2.5
- Enhanced Interrupt
  - Four interrupt levels selectable for each interrupt

Features

- Instruction compatible with F²MC-8L (except Divide/Multiply instruction)
- Enhanced CPU performance (Minimum instruction execution time: 100ns)
- F²MC-8FX new function (16-bit, 16-bit division instruction, 4 Interrupt levels)
- Low leakage process technology (1.8V operation, 1µA supply current at watch mode)
- Dual-operation flash with flash security

- Hardware LIN available on every device
- Compact and low price debug environment

Dual-operation flash: execute program code from one bank while writing to or erasing another

- No delay in Program execution
- Replacement of external E²PROM with following advantage:
  1) Faster process (programming, erasing)
  2) Improved code security (manipulation prevention
  3) Smaller PCB area

Roadmap
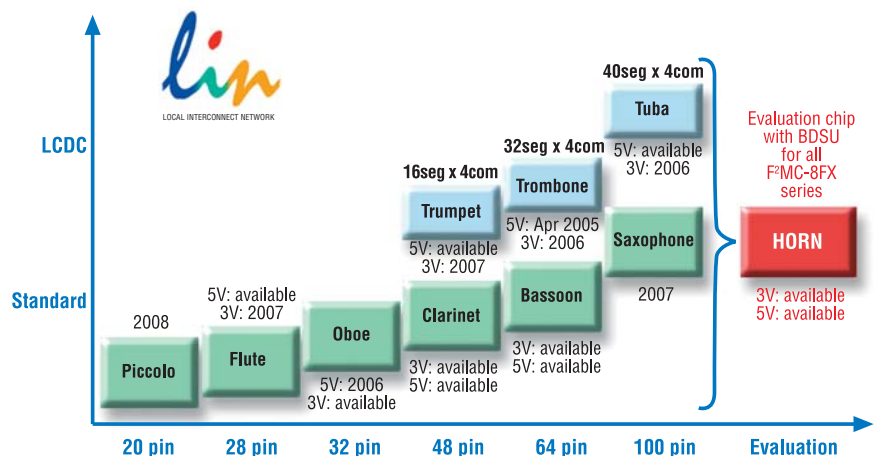
8FX product roadmap: for every series both 5V version and 3V version are planned.

Executes program code from one bank while writing to or erasing another.

THE NEW 8-BIT MCU FAMILY – F²MC-8FX

Compact and low cost 8FX development set-up

- Softune workbench for software development: version V30L28R07
- BGM Adaptor for evaluation: MB2146-09
- Evaluation Board: MB2146-401
- MCU Board (with evaluation chip on board): MB2146-301, MB2146-303

Header Boards are available for evaluating directly in user system: MB2146-220 (64-pin), MB2146-210 (48-pin).
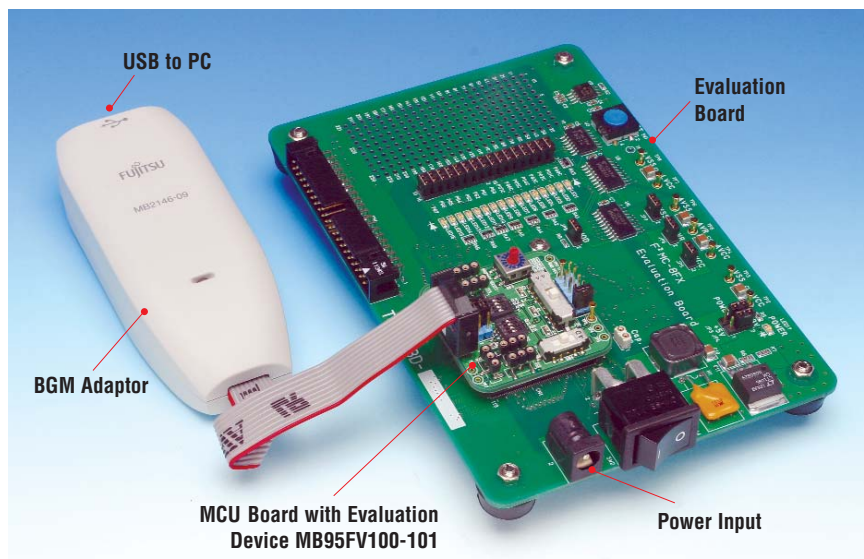
Compact and low cost 8FX development set-up.

Feature of the BGM adaptor for F²MC-8FX family

Adaptor model for debugging	MB2146-09
Host interface (download time)	USB: 12Mbps (125kbps: at an operating frequency of 4MHz)
Execution control	Continuous execution, step execution
Instruction execution break	256 points
Data break	2 points
Emulation memory	The size equivalent to Flash ROM MB95FV100 (60kBytes)
Trace capacity	16 branches
Sequential break	2 levels (only code)

Evaluation kit

CONCERTO-Kit with MB95F108H on its board, provides the opportunity to program dual-operation flash, test 8FX core and the peripherals with low cost and low effort.
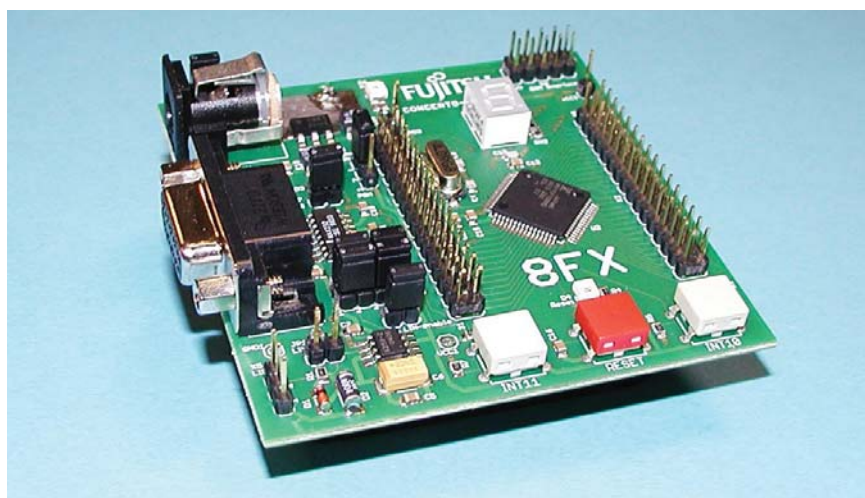
The flash device MB95F108H (5V version 'Bassoon') mounted on the low cost Bassoon evaluation board: CONCERTO board.

8-BIT PRODUCT LINE-UP

F²MC-8L Low Power/Low Voltage Microcontrollers

Features Series MB89xxx	Part	ROM/OTP/Flash (kByte)	RAM (Byte)	Max. Clock MHz (Sub-clock)	Ports	Ext. Inter.	PWM	PWC	Timer/Counter	UART	I²C	SIO	ADC	LCDC	Buzzer	Special Features	Power Saving Modes	Pin Count
130/A	MB89131 MB89P131 MB89133A MB89P133A MB89135A MB89P135A	4 4 8 8 16 16	128 128 256 256 256 256	4.2 (32kHz)	36	3 3 11 11 11 11	–	–	2 X 8-bit or 1 x 16-bit	–	–	1 x 8-bit	4 x 8-bit	–	Yes	(A-Version with on-chip Remote Control)	SLEEP STOP WATCH	48
140	MB89144 MB89145 MB89146 MB89P147	12 16 24 32	256 512 768 1024	8 (32kHz)	54	2	1 x 8-bit	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	12 x 10-bit	–	Yes	VFD Driver (24 outputs) 12-bit Programmable Pulse Generator	SLEEP STOP WATCH	64
140/A	MB89143A MB89144A	8 12	256 256	8 (32kHz)	54	2	–	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	8 x 10-bit	–	Yes	VFD Driver (24 outputs) CLOCK	SLEEP STOP	64
150/A	MB89151/A MB89152/A MB89153/A MB89154/A MB89155/A MB89P155/A	4 6 8 12 16 16	128 256 256 256 256 256	4.2 (32kHz)	43	12	–	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	–	4 x 36	Yes	Remote Control, (A-Version with on-chip LCD voltage booster)	SLEEP STOP WATCH	80
160/A	MB89161/A MB89163/A MB89165/A MB89P165/A	4 8 16 16	128 256 512 512	4.2 (32kHz)	54	12	2 x 8-bit	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	8 x 8-bit	4 x 24	–	Remote Control, (A-Version with on-chip LCD voltage booster)	SLEEP STOP WATCH	80
170/A	MB89173 MB89P173 MB89174A MB89P175A	8 8 12 16	384 384 512 512	3.58 (32kHz) 7.16 (32kHz)	37	11	–	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	–	–	Yes	DTMF Generator	SLEEP STOP WATCH	48
180	MB89181 MB89182 MB89183 MB89185 MB89185L MB89P185	4 6 8 16 16 16	128 256 256 256 256 256	4.2 (32kHz)	43	12	–	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	–	4 x 32	Yes	Remote Control 3V version	SLEEP STOP WATCH	64 64
190/A/AH	MB89191 MB89191A MB89191AH MB89193 MB89193A MB89193AH MB89195 MB89P195 MB89195A MB89P195A	4 4 4 8 8 8 16 16 16 16	128 128 128 256 256 256 256 256 256 256	4.2	22 19 19 22 19 19 22 22 19 19	11	–	–	2 x 8-bit or 1 x 16-bit	–	–	1 x 8-bit	– 8 x 8-bit 8 x 8-bit – 8 x 8-bit 8 x 8-bit – – 8 x 8-bit 8 x 8-bit	–	Yes	Remote Control, 9 x High Current Outputs (H version)	SLEEP STOP	28
201	MB89F202	16	512	12.5	27	4	1 x 8-bit	–	2 x 8-bit or 1 x 16-bit	1ch	–	1 x 8-bit	1 x 10-bit	–	–	Flash, 1 x 12-bit PPG, 21-bit timebase timer 5V	SLEEP STOP	34
210	MB89215PFV MB89215PFM MB89P215PFV MB89F217PFM	16 16 16 32	512 512 512 1024	10	22	3	1 x 8-bit	–	2 x 8-bit or 1 x 16-bit	1ch	–	1ch	8 x 10-bit	–	No	LIN HW support, 12-bit PPG	SLEEP STOP	30 48 30 48
470	MB89475 MB89P475	16 16	512 512	12.5 (32kHz)	39	9	1 x 8-bit	2 x 8-bit	2 x 8-bit or 1 x 16-bit	1ch	–	–	8 x 10-bit	–	Yes	21-bit time base timer	SLEEP STOP WATCH	48
480	MB89485 MB89P485	16 16	512 512	12.5 (32kHz)	42	12	1 x 8-bit	2 x 8-bit	2 x 8-bit or 1 x 16-bit	1ch	–	-	4 x 10-bit	4 x 31	yes	LCD with booster, 6-bit PPG	SLEEP STOP WATCH	64
490	MB89498 MB89F497 MB89F499	48 32 60	2048 1024 2024	12.5 (32kHz)	66 62 66	16	2 x 8-bit	–	4 x 8-bit or 2 x 16-bit	1(SIO)	1	1ch	8 x 10-bit	4 x 32 4 x 36 4 x 32	–	21-bit timebase timer 3V	SLEEP STOP WATCH	100
530	MB89535A MB89537/C/H/HC MB89538/C/H/HC MB89P538 MB89F538	16 32 48 48 48	512 1024 2048 2048 2048	12.5 (32kHz)	53 52	12	2 x 8-bit	1 x 8-bit	1 x 16-bit	2ch	1 (C version)	1 x 8-bit	8 x 10-bit	–	–	Mask versions 2 x 12-bit + 1 x 6-bit PPG 3V & 5V(H) Flash, 2ch 12-bit PPG	SLEEP STOP WATCH	64

Notes: ● MB89Pxxx signifies OTP device ● MB89Txxx signifies ROMless device ● MB89Fxxx signifies Flash device ● All series feature a built-in Watchdog timer.

8-BIT PRODUCT LINE-UP

F²MC-8L Low Power/Low Voltage Microcontrollers

Features Series MB89xxx	Part	ROM/OTP/Flash (kByte)	RAM (Byte)	Max. Clock MHz (Sub-clock)	Ports	Ext. Inter.	PWM	PWC	Timer/Counter	UART	I²C	SIO	ADC	LCDC	Buzzer	Special Features	Power Saving Modes	Pin Count
560/C/H/HC	MB89567/C/H/HC MB89P568	32 48	1024 1024	10 (32kHz)	50	12	2 x 8-bit	1 x 8-bit	2 x 8-bit or 1 x 16-bit	2ch	1	1 x 8-bit	8 x 10-bit	4 x 24	–	1 x 6-bit PPG 1 x 12-bit PPG Remote Control 3V & 5V(H) mask versions	SLEEP STOP WATCH	80
570	MB89577 MB89P579A	32 60	3k 3k	10 (32kHz)	82	4	–	–	2 x 8-bit, 1 x 16-bit or 2 x 16-bit	1ch	1	(SIO)	12 x 10-bit	4 x 14	–	Bridge Circuit, D/A 2-ch, Comparator, 21-bit Timebase Timer	SUB-CLOCK SLEEP STOP WATCH	100
580B/BW	MB89583B/BW MB89585B/BW MB89P585B/BW	8 16 16	512 1024 1024	6	53	8	2 x 8-bit	–	–	1ch	–	–	–	–	–	USB I/F rev 1.0 low and full speed, PLL, 21-bit Time-base Timer, 'BW' :outputs at low level until USB connection takes place	SLEEP STOP	64
620	MB89623 MB89625 MB89P625 MB89626 MB89627 MB89P627 MB89628 MB89629 MB89P629 MB89T623 MB89T625 MB89T627	8 16 16 24 32 32 24 32 32 ext ext ext	256 512 512 768 1024 1024 3072 3072 4096 256 512 1024	10	53 53 53 53 53 53 53 53 53 34 34 34	4	1 x 8-bit	1 x 8-bit	1 x 16-bit	–	–	2 x 8-bit	8 x 8-bit	–	Yes	External Bus Interface	SLEEP STOP	64
630	MB89635 MB89636 MB89637 MB89P637 MB89T635 MB89T637	16 24 32 32 ext ext	512 768 1024 1024 512 1024	10 (32kHz)	53 53 53 53 34 34	4	2 x 8-bit	1 x 8-bit	1 x 16-bit	1ch	–	1 x 8-bit	8 x 10-bit	–	Yes	External Bus Interface	SLEEP STOP WATCH	64
650/A	MB89653A MB89655A MB89656A MB89657A MB89P657A	8 16 24 32 32	256 512 768 1024 1024	10 (32kHz)	64	16	2 x 8-bit	–	4 x 8-bit or 2 x 16-bit	–	–	1 x 8-bit	8 x 8-bit	4 x 32	Yes	–	SLEEP STOP WATCH	100
660	MB89663 MB89665 MB89P665	8 16 16	256 512 512	10	52	4	1 x 8-bit	–	2 x 8-bit or 1 x 16-bit	1-ch	–	1 x 8-bit	8 x 8-bit	–	–	Input Capture 2-ch, Output Compare 2-ch	SLEEP STOP HW-STB	64
800	MB89803 MB89805 MB89P808	8 16 48	256 512 2048	10	32	2	1 x 8-bit	1 x 8-bit	–	1ch	–	1 x 8-bit	–	4 x 70	–	–	SLEEP STOP	100
820	MB89821 MB89823 MB89P825	4 8 16	128 256 256	5	32	2	1 x 8-bit	1 x 8-bit	–	1ch	–	1 x 8-bit	–	4 x 50	–	–	SLEEP STOP	80
850	MB89855 MB89857 MB89P857 MB89T855	16 32 32 ext	512 1024 1024 512	10	53	4	2 x 8-bit	–	–	1ch	–	1 x 8-bit	8 x 10-bit	–	–	External Bus Interface, Motor PWM	SLEEP STOP	64
860	MB89863 MB89865 MB89867 MB89P867	8 16 32 32	256 512 1024 1024	8 10 10 10	38 68 68 68	1 4 4 4	2 x 8-bit	–	–	1ch	–	1 x 8-bit	8 x 10-bit	–	–	External Bus Interface, Motor PWM	SLEEP STOP	48 80 80 80
930	MB89935B MB89P935B	16 16	512 512	10	21	11	1 x 8-bit	–	1 x 8-bit	1ch	–	–	8 x 10-bit	–	–	Input Capture 1-ch, 12-bit Programmable Pulse Generator	SLEEP STOP	30

Notes: ● *MB89Pxxx signifies OTP device* ● *MB89Txxx signifies ROMless device* ● *MB89Fxxx signifies Flash device* ● *All series feature a built-in Watchdog timer.*

8-BIT PRODUCT LINE-UP

F²MC-8L Low Power/Low Voltage Microcontrollers

Features Series MB89xxx	Part	ROM/ OTP/ Flash (kByte)	RAM (Byte)	Max. Clock MHz (Sub-clock)	Ports	Ext. Inter.	PWM	PWC	Timer/ Counter	UART	I²C	SIO	ADC	LCDC	Buzzer	Special Features	Power Saving Modes	Pin Count
940	MB89943 MB89P945	8 16	512 512	8	37	3	2 x 8-bit	–	2 x 16-bit or 1 x 16-bit	–	–	–	2 x 8-bit	4 x 17	–	Stepper Motor Driver 1-ch, 3.5 to 5.5V Operation, Low Voltage Reset, External Voltage Monitor Interrupt	SLEEP STOP	48
950	MB89951 MB89953 MB89P955	4 8 16	128 256 512	5	33	2	1 x 8-bit	1 x 8-bit	–	1ch	–	1 x 8-bit	–	4 x 42	–	–	SLEEP STOP	64
960	MB89965 MB89P965	16 16	512 512	10 (32kHz)	37	11	–	–	2 x 8-bit or 1 x 16-bit	–	1	1 x 8-bit	4 x 10-bit	–	–	3.0 to 5.5V Operation	SLEEP STOP WATCH	48 64
990	MB89997	32	128	4.2	22	11	–	–	2 x 8-bit or 1 x 16-bit	–	–	–	–	–	–	Remote Control	SLEEP STOP	28

Notes: ● MB89Pxxx signifies OTP device ● MB89Txxx signifies ROMless device ● MB89Fxxx signifies Flash device ● All series feature a built-in Watchdog timer.

F²MC-8FX Low Power/High Performance Microcontrollers

Features Series MB95xxx	Part	ROM/ Flash (kByte)	RAM (Byte)	Max. Clock MHz (Sub-clock option)	Max Ports	Ext. Inter.	16-bit PPG (Duty)	8-bit PPG (H/L)	Compound Timer*	16-bit Reload Timer	LIN-UART	UART/ SIO	I²C	ADC	LCDC	Special Features	Power Saving Mode	Pin Count
100	MB95F108A MB95106 (_/H/T/K/)(S/W)	60 32	2k 1k	10 (32kHz)	54	12	2	2	2	1	1	1	1	12 x 10-bit	No	Low-Voltage-Detection optional for 5V version Dual-Operation-Flash, SPI**	SLEEP STOP WATCH TIMER	64
110	MB95F118H MB95116 (_/H/T/K/)(S/W)	60 32	2k 1k	10 (32kHz)	40	8	1	2	2	No	1	1	1	8 x 10-bit	No	Low-Voltage-Detection optional for 5V version Dual-Operation-Flash, SPI**	SLEEP STOP WATCH TIMER	48, 52
120	MB95F128 MB95128 (_/H/T/K)(S/W)	60	2k	10 (32kHz)	87	12	2	2	2	1	1	1	1	12 x 10-bit	4 x 40	Low-Voltage-Detection optional for 5V version Dual-Operation-Flash, SPI**	SLEEP STOP WATCH TIMER	100
130	MB95F136A MB95135 (_/H/T/K)(S/W)	32 16	1k 512	10 (32kHz)	20	8	1	1	1	No	1	1	No	8 x 10-bit	No	Low-Voltage-Detection optional for 5V version, SPI**	SLEEP STOP WATCH TIMER	28
140	MB95F146A MB95145 (_/H/T/K)(S/W)	32 16	1k 512	10 (32kHz)	24	8	1	2	2	No	1	1	No	8 x 10-bit	No	Low-Voltage-Detection optional for 5V version, SPI**	SLEEP STOP WATCH TIMER	32
150	MB95F156A MB95135 (_/H/T/K)(S/W)***	32 16	1k 512	10 (32kHz)	40	8	1	2	2	No	1	1	No	8 x 10-bit	4 x 16	Low-Voltage-Detection optional for 5V version, SPI**	SLEEP STOP WATCH TIMER	48
160	MB95F166A MB95165 (_/H/T/K)(S/W)***	32 16	1k 512	10 (32kHz)	53	8	1	2	2	No	1	1	1	8 x 10-bit	4 x 32	Low-Voltage-Detection optional for 5V version, SPI**	SLEEP STOP WATCH TIMER	64

Notes: ● MB95Fxxx signifies Flash device. *Compound timer can be used as 8-bit timer x 2ch or 16-bit timer x 1ch or built-in timer function, PWC function, PWM function, capture function and square waveform output. ** SPI can be implemented with SIO or LIN-UART. ***Under development.
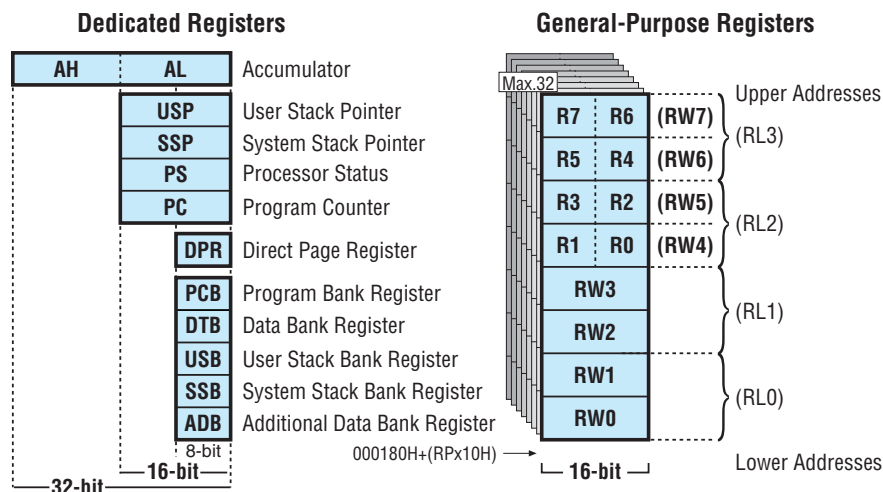
F²MC-16LX CPU-CORE ARCHITECTURE

One obvious strength of this 16-bit architecture is its excellent code efficiency. As Fujitsu has a long record in Compiler business, dating back to the early days of mainframe computers, it was a logical move not only to equip the 16LX architecture with an instruction set that is C-code optimised but also to supply the actual C-compiler which draws on this architectural strength - for example flexible addressing options. Bank registers for program code and data allow the use of 16-bit addresses - thus reducing code size while at the same time increasing processing performance.

Alternatively several memory models exist, allowing linear addressing over the complete memory range.

As the die size of MCUs mainly depends on memory resources, it is obvious that fitting more lines of C-code into the same physical memory, saves cost.

This is particularly easy with 16-bit instruction sets. 32-bit instruction sets in general produce less efficient code resulting in larger chips and more cost.

Dedicated Registers

| AH | AL | Accumulator |

USP	User Stack Pointer
SSP	System Stack Pointer
PS	Processor Status
PC	Program Counter

| DPR | Direct Page Register |

PCB	Program Bank Register
DTB	Data Bank Register
USB	User Stack Bank Register
SSB	System Stack Bank Register
ADB	Additional Data Bank Register

8-bit
16-bit
32-bit

General-Purpose Registers

Max.32

R7	R6	(RW7)	Upper Addresses
R5	R4	(RW6)	(RL3)
R3	R2	(RW5)	(RL2)
R1	R0	(RW4)	
RW3	(RL1)
RW2	
RW1	(RL0)
RW0	Lower Addresses

000180H+(RPx10H) →

16-bit

16-bit CPU-core programming model.
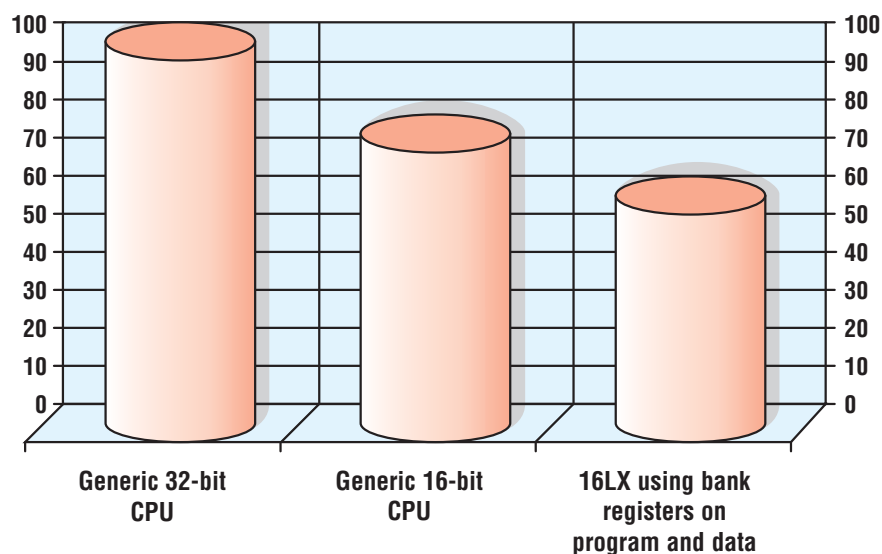
Graph shows memory use (kB) for example program written in C.

Generic 32-bit CPU — Generic 16-bit CPU — 16LX using bank registers on program and data

INTRODUCTION TO 16-BIT FAMILIES

F²MC-16LX Device Features

- Latest CMOS technology
- Mask ROM and Flash
- Up to 24MHz (42ns) maximum internal clock speed from external 4MHz
- On-chip PLL multiplies the external clock speed. PLL factor can be selected by software
- 3V MCU core offering low EMI and low power consumption features. Internal voltage regulator supports 5V operation
- Clock modulation Unit for low EMI
- Optimised instruction set for controller applications

- bit, Byte, word, long word data types
- 23 addressing modes
- variety of pointers
- 4 Byte instruction queue
- Signed multiply instruction 16-bit x 16-bit
- Signed divide instruction 32-bit / 16-bit
- EI²OS – automatic transfer function independent of CPU with 16-ch. of Intelligent I/O services
- 18-bit Time-base timer
- 15-bit Watch timer, (devices with 32kHz sub-clock only)
- Watch-dog timer
- Fast interrupt processing

- Powerful interrupt functions – 8 programmable priority levels, more than 30 possible hardware vectors and more than 200 software vectors
- Program Patch function
  - facility to 'patch over' mask programmed code with update from external memory
  - hardware breakpoints to support remote system debugging with a monitor debugger
- Power saving modes
  - 7 for single clock or 10 for dual clock
  - sleep, stop, CPU intermittent, hardware standby …

EMBEDDED FLASH TECHNOLOGY

All of the F²MC-16LX series are supported by at least one device that has Flash ROM as the user programmable memory.

Features

- New dual-operation flash
- Available block sizes 24kB, 32kB, 64kB,128kB, 256kB, 384kB and 512kB
- Blocks divided into separately erasable sectors
- Erase protection by sector capability
- 5 and 3V device types
- Supports programming by Embedded Algorithm™
- No second programming voltage required

- 10,000 erase cycles
- 20-year data retention
- Programming by 3 methods:
  - On ordinary programmer with adaptor as with traditional OTP devices
  - Using Fujitsu embedded serial programming mode via on-chip UART/SIO directly to the Flash ROM
  - Copying or downloading to Flash using customer's own bootstrap software
- Programming via CAN possible

MICROCONTROLLERS WITH CAN BUS CONTROLLER

Fujitsu has several F²MC-16LX-based devices available that have a full featured CAN Bus protocol controller as an on-chip peripheral for automotive and industrial applications. The details of these parts are listed in the table F²MC-16LX Device Features.

Features

- CAN 2.0A and 2.0B protocol controller
- Ability to group buffers into flexible multi-level configuration
- Readable error counter

- 16 message buffers (8 for MB90495G, MB90385 and MB90890 series), each individually programmable for:
  - Transmit or receive
  - 11 or 29 identifier-bits
  - Full identifier bit compare / full mask / compare against 1 of 2 mask registers

13

MICROCONTROLLERS

F^{2}MC-16LX PRODUCT LINE-UP

Overview of 16LX Families

Series	Device Part Number	Group Features	RAM	Flash/Mask (ROM)	Flash Code Security	Max. Frequency (MHz)	Sub-clock	Operating Voltage	Operating Temp	Package	Max. I/Os	Watchdog	CAN interface	CAN Message Buffers/channel	UART Standard	USART LIN	SIO
MB90330	MB90F334	USB with Min-Host function	24k	384k	No	24	Yes	3.0V to 3.6V	-40 to +85°C	QFP-120	94	Yes	No	No	4	No	1
MB90335	MB90F337	USB with Min-Host function	4k	64k	No	24	Yes	3.0V to 3.6V	-40 to +85°C	QFP-64	45	Yes	No	No	2	No	1
MB90340	MB90(F)347CE(S) MB90(F)349CE(S) MB90(F)342CE(S) MB90(F)345CE(S)	'S': version for single clock (with two additional I/O ports) 'C' version with I^{2}C bus and 24ch ADC	6k 15.75k 15.75k 20k	128k 256k 256k 512k	Yes	24	not for S versions	3.5 to 5.5V*	-40 to 105°C	QFP-100	80 (82 for S version)	Yes	1 1 2 2	16	No	4	No
MB90350	MB90(F)351/E/TE(S) MB90(F)352/E/TE(S)	Subset of MB90340 'T': low voltage detection	4k	64k 128k	No Yes	24	not for S versions	3.5 to 5.5V*	-40 to 105°C	QFP-64	49 (51 for S version)	Yes	1	16	No	2	No
MB90360	MB90F362/E/TE/(S)***	Subset of MB90350 'T': low voltage detection	3k	64k	Yes	24	not for S	3.5 to 5.5	-40 to 105°C	QFP-48	34 (36 for S version)	Yes	1	16	No	2	No
MB90385/S	MB90F387/S MB90387/S	Pin compatible to Dual Operation Flash MB90895	2k 2k	64k 64k	No	16	not for S versions	3.5 to 5.5V*	-40 to 105°C	LQFP-48	34 (36 for S version)	Yes	1	8	1	No	No
MB90390	MB90F394HA MB90F395HA MB90394HA	6 x stepper motor PWM, sound generator, RTC clock timer	10k 30k 10k	384k 512k 384k	No	20 24	No	3.5 to 5.5V*	-40 to 85°C	LQFP-120	96	Yes	2	16	2	1	1
MB90420G/425G	MB90F428GA/GB/GC MB90428GA/GB/GC MB90427GA/GB/GC MB90F423GA/GB/GC MB90423GA/GB/GC	'A': single clock, CPU operating detect unit. 'B': dual clock, CPU operation detect unit. 'C': dual clock	6k 6k 4k 6k 6k	128k 128k 64k 128k 128k	No	16	not for A versions	3.7V to 5.5V* 3.0 to 5.5V for C version	-40 to 105°C	QFP-100	58	Yes	1 1 1 2 2	16	2	No	No
MB90435	MB90F437 L/LS MB90438 L/LS MB90439 L/LS MB90F438 L/LS MB90F439 L/LS	Pin compatible to MB90540/545 series	2k 4k 6k 4k 6k	64k 128k 256k 128k 256k	Yes	16	not on S-version	4.5V to 5.5V	-40 to +105°C	QFP-100	81	Yes	No	No	2	No	1
MB90440G	MB90F443G	Triple CAN, pin Compatible to MB90540/545 series	6k	128k	Yes	16	Yes	5V +/- 10%	-40 to 105°C	QFP-100	81	Yes	3	16	2	No	1
MB90455	MB90F455 /S MB90F456 /S MB90F457 /S MB90455 /S MB90456 /S MB90457 /S	Pin compatible to MB90385 series	2k 2k 2k 2k 2k 2k	24k 32k 64k 24k 32k 64k	No	16	not on S-version	4.5V to 5.5V	-40 to +105°C	QFP-48	34 / 36 for S-version	Yes	No	No	1	No	1
MB90460	MB90F462A MB90462A	Inverter PWM for 2 Motors (AC/DC)	2k 2k	64k 64k	Yes	16	No	4.5V to 5.5V	-40 to +85°C	QFP-64	50	Yes	No	No	2	No	No
MB90470	MB90F474H MB90F474L MB90473 MB90474 MB90477 MB90478	3V supply, 2 x 8-bit Up/Down counter	16k 16k 10k 16k 8k 8k	256k 256k 128k 256k 256k 256k	No	20 12 20 16 20 20	Yes	'L': 2.4V to 3.0V 'H': 3.0V to 3.6V	-40 to +85°C	QFP-100	84	Yes	No	No	1	No	2

Note: * supply voltage 4.5V - 5.5V if AD converter is used • ** watch mode only for devices with subclock • Part numbers with prefix F are flash versions • Part numbers without prefix F are mask versions • ***under development.

ADC	PPG	OCU	ICU	16-bit I/O Timer	Pulse Width Counter	16-bit Reload Timer	Timebase Timer	Watch Timer	External Bus	Stepper Motor Interface	External Interrupts Drivers	I²C Channel	Sound Generator	LCD Interface	Power Saving Modes	Evaluation Board
10-bit 16ch	3 x 16-bit / 6 x 8-bit	4	4	1	1 x 16-bit	3	Yes	1	Yes (1MB)	No	8	3	No	No	Sleep, Stop, Timer, Watch	MB2031-01 +MB2031-20
No	2 x 16-bit / 4 x 8-bit	4	4	1	1 x 16-bit	3	Yes	1	No	No	8	1	No	No	Sleep, Stop, Timer, Watch	TBD
10-bit 16/24ch	8 x 16-bit/ 16 x 8-bit	8	8	2	No	4	Yes	Not on S version	Yes	No	16	2	No	No	Sleep, stop, timer, watch	FLASH-CAN-100P-340
10-bit 15ch	6 x 16-bit/ 12 x 8-bit	4	6	2	No	4	Yes	Not on S version	Yes	No	8	1	No	No	Sleep, stop, timer, watch	FLASH-CAN-64P-350
10-bit 16ch	2 x 16-bit/ 4 x 8-bit	No	4	1	No	2	Yes	Not on S version	No	No	8	No	No	No	Sleep, stop, timer, watch**	FLASH-CAN-48P-M26
10-bit 8ch	2 x 16-bit/ 4 x 8-bit	No	4	1	No	2	Yes	Not on S version	No	No	4	No	No	No	Sleep, stop, timer, watch	FLASH-CAN-48P-M26
10-bit 8ch	6 x 16-bit/ 12 x 8-bit only 6 connected to I/Os	8	6	2	No	2	Yes	No	No	6ch	8	1 (MB90F395)	Yes	No	Sleep, stop, timer	FLASH-CAN-120-390
10-bit 8ch	3 x 16-bit/ 6 x 8-bit only 3 connected to I/Os	No	4	1	No	2	Yes	Not on A version	No	4ch	8	No	Yes	4 x 24	Sleep, stop, timer, watch	FLASH-CAN-100P-M06
10-bit 8ch	4 x 16-bit / 8 x 8-bit 4 connected to pins	4/2	6/8	1	No	2	Yes	not on S-version	Yes	No	8	No	No	No	Sleep, Stop, Timer, Watch**	FLASH-CAN-100P-M06
10-bit 8ch	4 x 16-bit/ 8 x 8-bit only 4	4/2	6/8	1	No	2	Yes	Yes	Yes	No	8	No	No	No	Sleep, stop, timer, watch	FLASH-CAN-100P-M06
10-bit 8ch	2 x 16-bit / 4 x 8-bit	0	4	1	No	2	Yes	not on S-version	No	No	4	No	No	No	Sleep, Stop, Timer, Watch**	FLASH-CAN-48P-M26
10-bit 8ch	3 x 16-bit / 6 x 8-bit	6	4	1	2 x 16-bit	2	Yes	No	No	No	8	No	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-64P-M09
10-bit 8ch 6 x 8-bit 3 connected to pins	3 x 16-bit /	6	2	1	3 x 16-bit	1	Yes	Yes	Yes	No	8	1	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-M06

F^{2}MC-16LX PRODUCT LINE-UP

Overview of 16LX Families Continued

Series	Device Part Number	Group Features	RAM	Flash/ Mask (ROM)	Flash Code Security	Max. Frequency (MHz)	Sub-clock	Operating Voltage	Operating Temp	Package	Max. I/Os	Watchdog	CAN interface	CAN Message Buffers/ channel	UART Standard	USART LIN	SIO
MB90480	MB90F481 MB90F482	3V supply, 2 x 8-bit Up/Down counter	4k 6k	192k 256k	No	25	Yes	2.7V to 3.6V	-40 to +85°C	QFP-100	84	Yes	No	No	1	No	2
MB90495G	MB90F497G MB90497G MB90F498G	—	2k 2k 2k	64k 64k 128k	No	16MHz	Yes	5V +/- 10%	-40 to 105°C	LQFP-64	49	Yes	1	8	2	No	No
MB90520	MB90F523B MB90522B MB90523B	LCD, 2ch DA converter, Up/Down counter	4k 3k 4k	128k 64k 128k	No	16	Yes	4.5V to 5.5V	-40 to +85°C	QFP-120	85	Yes	No	No	1	No	2
MB90540G/GS MB90545G/GS	MB90F543G/GS MB90543G/GS MB90F548G/GS MB90548G/GS MB90F546G/GS MB90549G/GS	'G': dual clock. 'GS': single clock.	6k 6k 4k 4k 8k 6k	128k 128k 128k 128k 256k 256k	Yes	16MHz	not for S versions	5V +/- 10%	-40 to 105°C	QFP-100	83 81	Yes	2 2 1 1 1 1	16	2	No	1
MB90560	MB90F562B MB90561 MB90562	3ch PPG for AC or DC motor control	2k 1k 2k	64k 32k 64k	Yes	16	No	4.5V to 5.5V	-40 to +85°C	QFP-64	51	Yes	No	No	1	No	No
MB90565	MB90F568 MB90567 MB90568	3V, pin compatible with MB90560 series	4k 3k 4k	128k 96k 128k	Yes	16	No	2.7V to 3.6V	-40 to +85°C	QFP-64	51	Yes	No	No	1	No	No
MB90570	MB90F574A MB90573/C MB90574A/B/C	I^{2}C bus, 2 x 8-bit Up/Down counter, 2ch DA converter	10k 5k 10k	256k 120k 256k	No	16	No	4.5V to 5.5V	-40 to +85°C	QFP-120	97	Yes	No	No	2	No	3
MB90580	MB90F583C/CA MB90583C/CA MB90587C/CA	IE-bus (not on MB90587), 2ch DA converter	6k 6k 4k	128k 128k 64k	No	16	C-version	4.5V to 5.5V	-40 to +85°C	QFP-100	77	Yes	No	No	5	No	No
MB90590G	MB90F591G MB90591G MB90F594G MB90594G	4 x stepper motor PMW, sound generator, RTC clock timer	8k 8k 6k 6k	384k 384k 256k 256k	No	16MHz	No	5V +/- 5%	-40 to 85°C	QFP-100	78	Yes	2	16	3	No	1
MB90595G	MB90F598G MB90598G	4 x stepper motor PMW	4k 4k	128k 128k	Yes	16MHz	No	5V +/- 10%	-40 to 85°C	QFP-100	78	Yes	1	16	2	No	1
MB90800	MB90F804-101 MB90F804-201 MB90803 / S	3V, 4 x 48 LCD	16k 16k 4k	256k 256k 128k	No	25	No	2.7V to 3.6V	-40 to +85°C	QFP-100	70 72 70 / 72 for S-Version	Yes	No	No	2	No	2
MB90820	MB90F823B MB90F822B MB90822B	3ch PPG for AC or DC motor control	4k	128k 64k 64k	Yes Yes	24	Yes Not on S-Version	5V +/- 10%	-40 to +85°C	QFP-80	66	Yes	No	No	2	No	No
MB90865/S	MB90F867E(S) MB90867E(S)	pin compatible to MB90340 series	6k	128k	Yes	24	not on S-Version	3.5V to 5.5V	-40 to +105°C	QFP-100	80	Yes	No	No	No	4	No
MB90890	MB90F897/S	Dual Operation Flash, pin compatible to MB90385 series	2k	64k	No	16	not on S-Version	4.5V to 5.5V	-40 to +105°C	QFP-48	34 / 36 for S-Version	Yes	1	8	2	0	No
MB90945	MB90F947A MB90F949A MB90F946A	Cost optimised	6k 12k 16k	128k 256k 384k	No	24	No	3.5V to 5.5V	-40 to +105°C	QFP-100	82	Yes	1	16	1	1	1

Note: Part numbers with prefix F are flash versions • Part numbers without prefix F are mask versions.

ADC	PPG	OCU	ICU	16-bit I/O Timer	Pulse Width Counter	16-bit Reload Timer	Timebase Timer	Watch Timer	External Bus	Stepper Motor Interface	External Interrupts Drivers	I²C Channel	Sound Generator	LCD Interface	Power Saving Modes	Evaluation Board
10-bit 8ch	3 x 16-bit / 6 x 8-bit	6	2	1	No	1	Yes	Yes	Yes	No	8	1	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-M06
10-bit 8ch	2 x 16-bit/ 4 x 16-bit	No	4	1	No	2	Yes	Yes	Yes	No	8	No	No	No	Sleep, stop, timer, watch	FLASH-CAN-64P-M09
10-bit 8ch	1 x 16-bit / 2 x 8-bit	8	2	1	No	2	Yes	Yes	No	No	8	No	No	4 x 32	Sleep, Stop, Timer, Watch	FLASH-EVA2-120P-M13
10-bit 8ch	4 x 16-bit/ 8 x 8-bit only 4 connected to I/Os	4/2	6/8	1	No	2	Yes	Not on S version	Yes	No	8	No	No	No	Sleep, stop, timer, watch	FLASH-CAN-100P-M06
10-bit 8ch	3 x 16-bit / 6 x 8-bit	6	4	1	No	2	Yes	No	No	No	8	No	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-64P-M09
10-bit 8ch	3 x 16-bit / 6 x 8-bit	6	4	1	No	2	Yes	No	No	No	8	No	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-64P-M09
10-bit 8ch	1 x 16-bit / 2 x 8-bit	4	2	1	No	2	Yes	No	yes	No	8	1	No	No	Sleep, Stop, Timer, Watch	FLASH-EVA2-120P-M13
10-bit 8ch	1 x 16-bit / 2 x 8-bit	2	4	1	1	3	Yes	C-version	yes	No	8	No	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-M06
10-bit 8ch	6 x 16-bit/ 12 x 8-bit only 6 connected to I/Os	6	6	1	No	2	Yes	No	No	4ch	8	No	Yes	No	Sleep, stop, timer, watch	FLASH-CAN-100P-M06
10-bit 8ch	6 x 16-bit/ 12 x 8-bit only 6 connected to I/Os	4	4	1	No	2	Yes	No	No	4ch	8	No	No	No	Sleep, stop, timer, watch	FLASH-CAN-100P-M06
10-bit 12ch	2 x 16-bit / 4 x 8-bit, 2 connected to pins	2	2	1	No	3	Yes	No Yes	No	No	4	1	No	4 x 48	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-340
10-bit 16ch	4 x 16-bit	6	4	1	2	2	Yes	No	No	No	8	No	No	No	Sleep, Stop, Timer, Watch	5k-90820-80P FM-562-A
10-bit 24ch	8 x 16-bit / 16 x 8-bit	8	8	2	No	4	Yes	not on S-version	Yes	No	16	2	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-340
10-bit 8ch	2 x 16-bit / 4 x 8-bit	0	4	1	No	2	Yes	not on S-Version	No	No	8	No	No	No	Sleep, Stop, Timer, Watch	FLASH-CAN-48P-M26
10-bit 15ch	6 x 16-bit / 12 x 8-bit	4	6	2	No	1	1	No	No	No	8	1	–	–	Sleep, Stop, Timer, Watch	FLASH-CAN-100P-340

16-BIT SINGLE CAN BUS MICROCONTROLLERS

The **MB90340** series offers a scalable family concept approach to CAN applications such as body control, comfort applications and infotainment. The new series features different RAM/ROM sizes and different mixtures of peripherals allowing for easy migration to other MCUs in this series, which saves development time and costs.

LIN support, I²C bus interface, 24 analogue input channels, external bus interface, selectable port levels for CMOS, TTL and automotive levels are some of the enhanced features of this series. Options for CAN range are from CANless devices to 2ch CAN.

A security feature is incorporated, preventing unauthorised reading of the contents of the Flash memory.
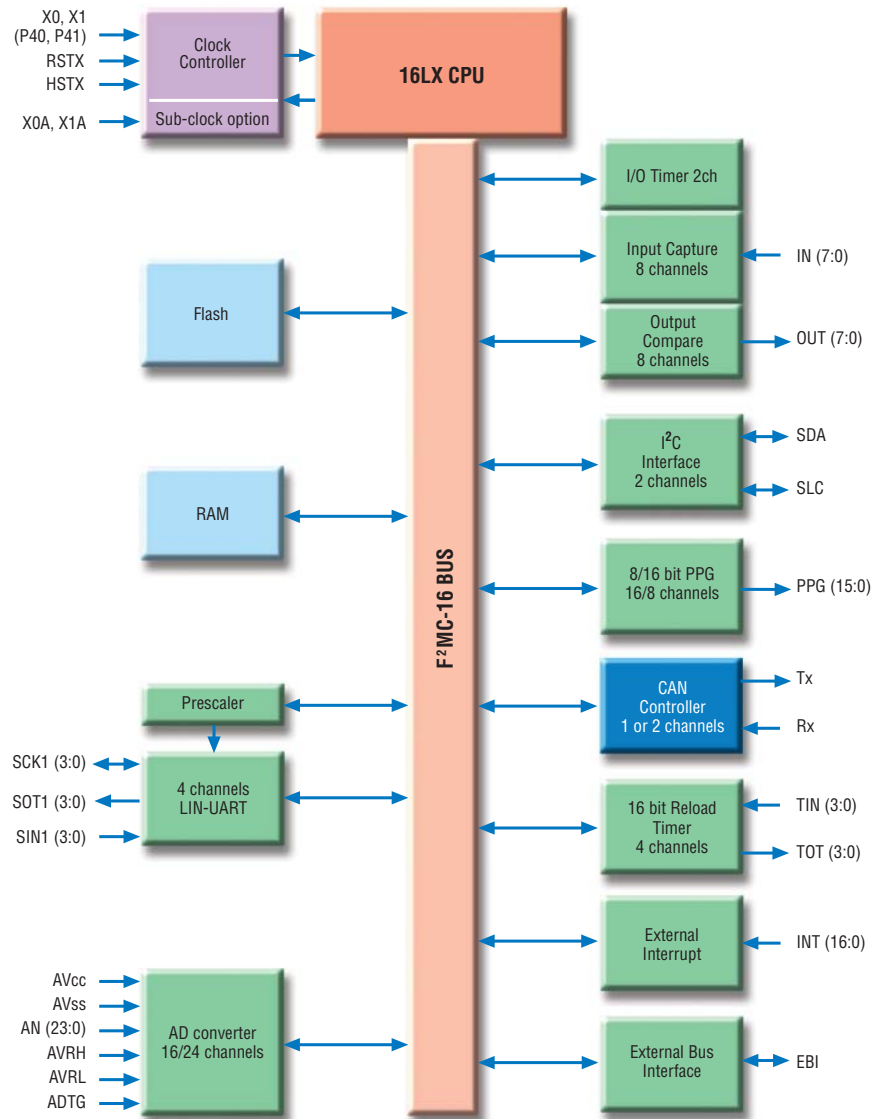
Shows the MB90340 series with LIN-USART I²C-bus, 24AD-channels, external bus and full CAN performance.

16-BIT SINGLE CAN BUS MICROCONTROLLERS

Part number	Memory type	Size (kB)	RAM (kB)	Sub-clock	CAN ch
MB90F347CE	Flash*	128	6	Yes	1
MB90F347CES	Flash*	128	6	No	1
MB90F867E	Flash*	128	6	Yes	0
MB90F867ES	Flash*	128	6	No	0
MB90F349CE	Flash*	256	15.75	Yes	1
MB90F349CES	Flash*	256	15.75	No	1
MB90F342CE	Flash*	256	15.75	Yes	2
MB90F342CES	Flash*	256	15.75	No	2
MB90F345CE	Flash	512	20	Yes	2
MB90F345CES	Flash	512	20	No	2

Note: *Mask ROM version is also available.

Features

- Fujitsu F²MC-16LX microcontroller architecture
- Max. 24MHz CPU clock
- Flash security function
- Full CAN 2.0A/2.0B interface with flexible buffering
- External bus interface
- LIN-USART 4-ch (offering SPI mode)
- I²C 2 channels
- External interrupts 8-ch
- A/D converter 10-bit x 24-ch
- Input capture 16-bit x 8-ch
- Output compare 16-bit x 8-ch
- Reload timers 16-bit x 4-ch
- Programmable pulse generator 16-bit x 8-ch or 8-bit x 16-ch
- QFP 100 package
- -40 to +105°C standard temperature range

16-BIT SINGLE CAN BUS MICROCONTROLLERS

The **MB90350** series is a derivative of the new MB90340 series for applications that require small packages. This series offers 16-bit performance at low cost and a rich feature mix in a small package. It provides an entry level to the new MB90340 series with full soft- and hardware compatibility of the embedded peripherals. CAN, I²C bus, flexible UART interface providing LIN support and 15 analogue input channels are some of the main features. A security feature is incorporated, preventing unauthorised reading of the contents of the 128kB Flash memory.
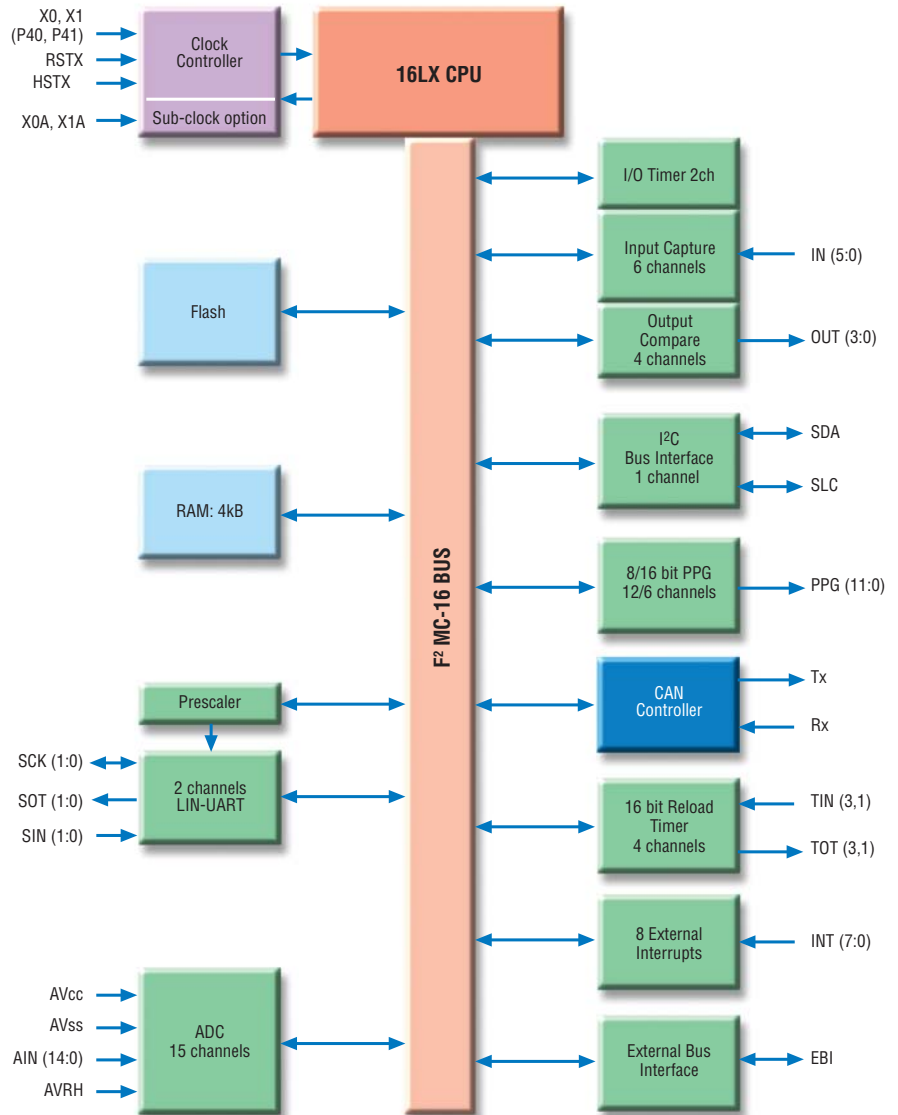
Shows the small sized MB90350 series with LIN-USART, I²C-bus, 15AD-channels, external bus and full CAN performance.

16-BIT SINGLE CAN BUS MICROCONTROLLERS

Part number	Memory type	Size (kB)	Sub-clock	Low Voltage detection Reset
MB90F352E(S)	Flash*	128	Not on S-version	No
MB90F351E(S)	Flash*	64	Not on S-version	No
MB90F352TE(S)	Flash*	128	Not on S-version	Yes
MB90F351TE(S)	Flash*	64	Not on S-version	Yes

**Note:** *Dual Operation Flash; Mask ROM version is also available.

Features

- Fujitsu F²MC-16LX microcontroller architecture
- Max. 24MHz CPU clock
- Flash security function
- Full CAN 2.0A/2.0B interface with flexible buffering
- 32kHz sub-clock
- LIN-USART 2-ch (offering SPI mode)
- External interrupts 8-ch
- A/D converter 10-bit x 15-ch
- Input capture 16-bit x 6-ch
- Output Compare Unit 16-bit x 4-ch
- Reload timers 16-bit x 4-ch
- Programmable pulse generator 16-bit x 6-ch or 8-bit x 12-ch
- Option for E²PROM emulation by dual-operation Flash
- QFP 64 package
- -40 to +105°C standard temperature range

16-BIT SINGLE/DOUBLE CAN BUS MICROCONTROLLERS

The **MB90360** series is a subset of the powerful MB90340 series condensed in to a compact 48-pin package (7 x 7mm). It has a pin compatible footprint to other Fujitsu 48-pin CAN serieses (MB90385, MB90895).

Features

- Fujitsu F^{2}MC-16LX microcontroller architecture
- Max. 24MHz CPU clock
- 64kB Flash ROM (with single voltage and 10k erase cycles), or Mask ROM
- Full CAN 2.0A/2.0B interface with flexible buffering (16 message buffers)
- 3kB RAM
- 32kHz sub-clock option
- LIN USARTs 2ch (offering SPI mode)
- External interrupts 8-ch
- A/D converter 10-bit x 16-ch
- Input capture 16-bit x 4-ch
- Reload timers 16-bit x 2-ch
- Programmable pulse generator 8-bit or 16-bit x 2-ch
- Option for Low voltage/CPU operation detection reset
- QFP 48 package
- -40 to +105°C temperature range
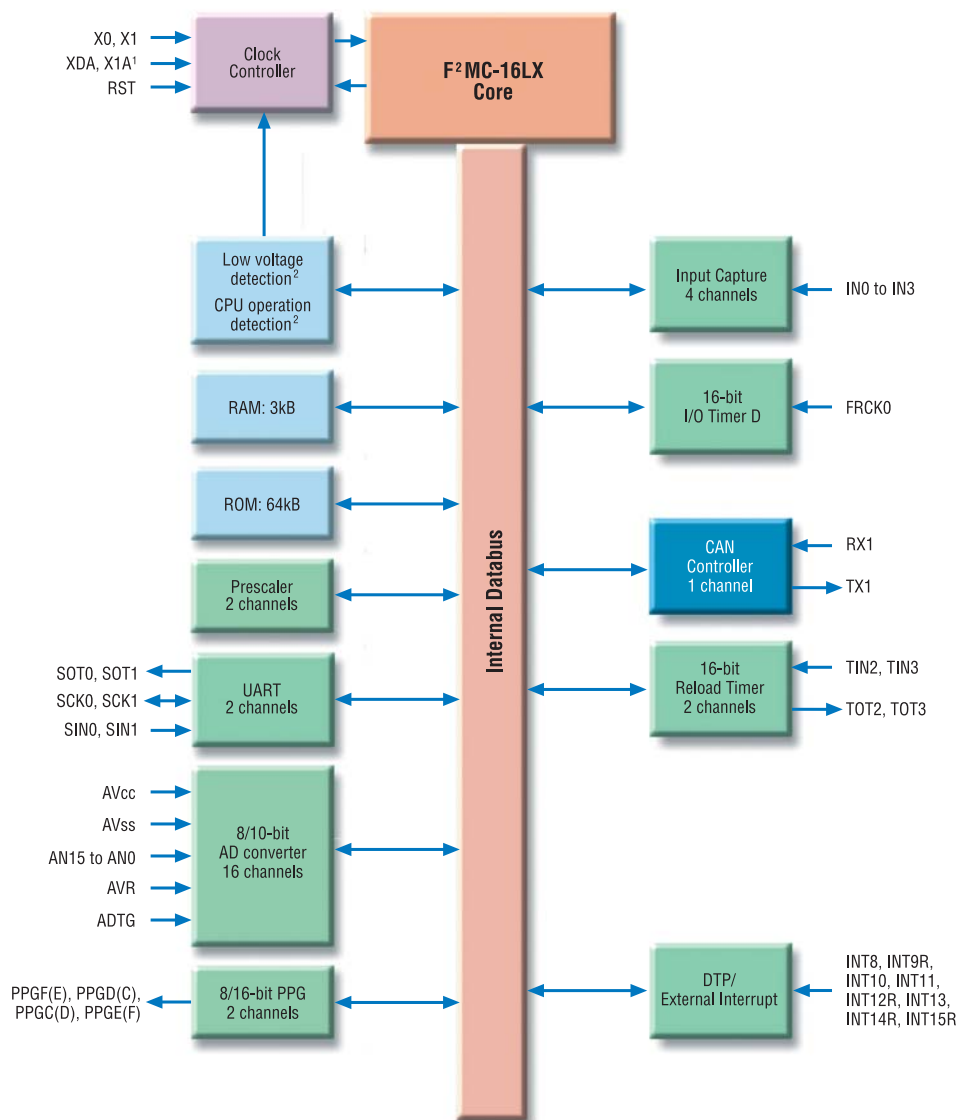
1: Only for devices without S-suffix
2: Only for devices with T-suffix

Shows the MB90360 series available in compact 48-pin package.

Part number	Memory type	Size (kB)	Sub-clock	Low Voltage detection Reset
MB90F362E(S)	Flash*	64	Not on S-version	No
MB90F362TE(S)	Flash*	64	Not on S-version	Yes

**Note:** *Mask ROM version is also available.

16-BIT DOUBLE CAN BUS MICROCONTROLLERS

The **MB90390** series is an enhanced upgrade of the MB90590 series. It is designed for high-end 16-bit automotive applications, especially Instrument clusters. So operation frequency has been increased to 24MHz combined with new features such as 6 on-chip stepper motor controllers larger embedded Flash memory and SRAM.

Features

- Fujitsu F²MC-16LX microcontroller architecture
- Max. 24MHz CPU clock
- 384kB, 512kB Flash ROM (with single voltage and 10k erase cycles), or Mask ROM
- 2 Full CAN 2.0A/2.0B interfaces with flexible buffering
- 10kB, 30kB RAM
- Stepper motor controller-driver 6 channel
- Sound generator
- UART 2-ch
- LIN-USART (offering SPI mode) 1-ch
- Synchronous serial I/O
- External interrupts 8-ch
- A/D converter 10-bit x 15-ch
- Input capture 16-bit x 6-ch
- Output compare 16-bit x 6-ch
- Reload timers 16-bit x 2-ch
- I²C (MB90F395HA only)
- Programmable pulse generator 16-bit x 6-ch or 8-bit x 12-ch
- QFP 120 package
- -40 to +85°C temperature range

Flash version = MB90F395HA (512kB Flash, 30kB RAM)
= MB90F394HA (384kB Flash, 10k RAM)
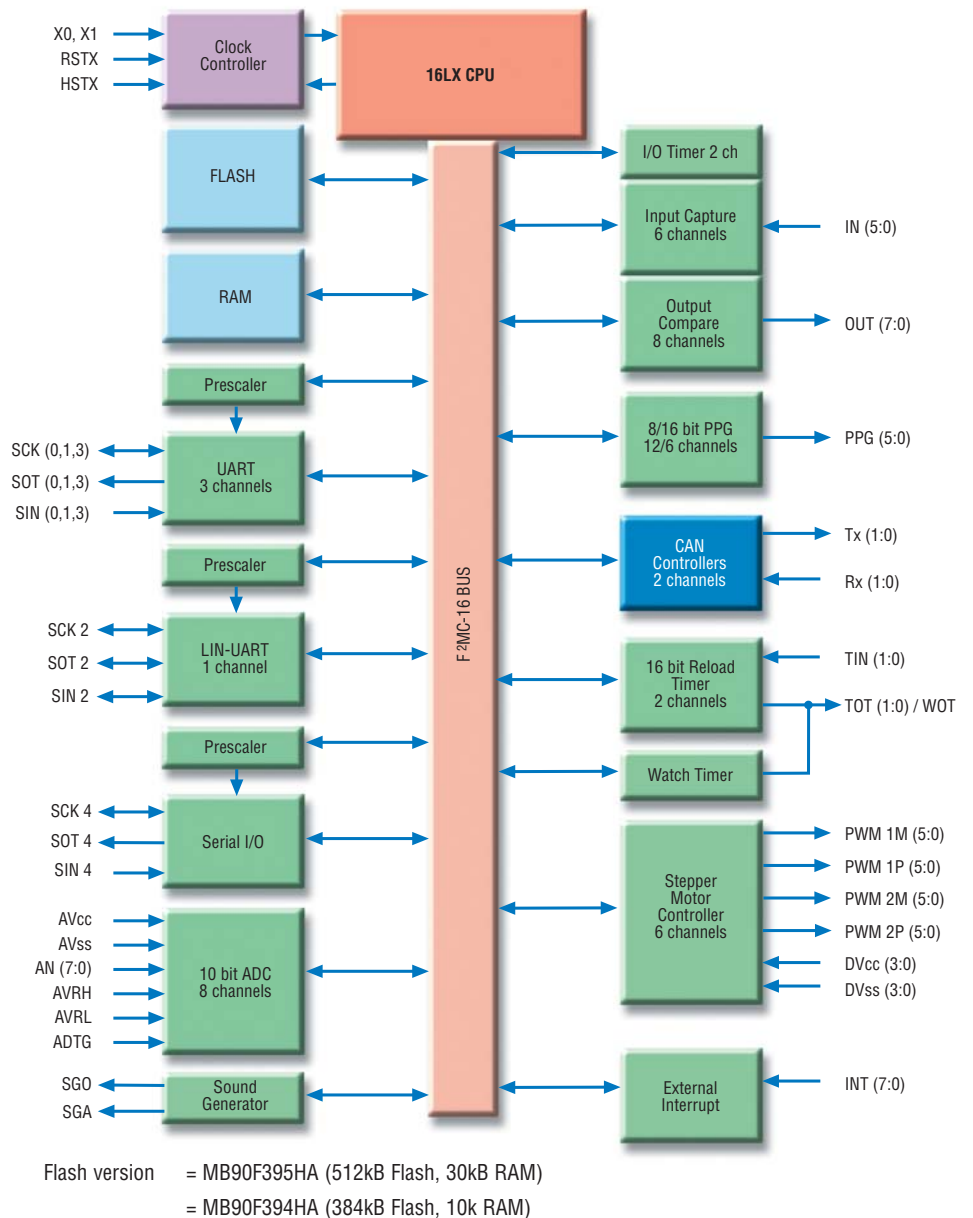
Shows the MB90390 series with 6 stepper motor controller-drivers, LIN-USART and full dual CAN performance.

16-BIT USB MICROCONTROLLERS

The **MB90330/335** series are a line-up of high-performance 16-bit MCUs (F²MC-16LX family) with built-in USB macros, supporting USB-Function and simplified USB-Minihost. This allows a USB device to act either as a USB-Host or as a USB-Function. In this way, USB peripheral devices can exchange data without the mediation of a PC. USB drivers are available free of charge.

Features

● Technology 0.35µm CMOS
● Max. 24MHz CPU clock
● Operation voltage 3.0-3.6V
● USB 2.0 compliant
● 12Mbps full-speed
● Up to 6 endpoints
● DMAC supported
● SIO
● 16-bit reload timer
● 16-bit pulse width counter
● 8 x external interrupts
● USB driver available free
   http://www.thesycon.de/eng/
   prod_usbfirmware.shtml
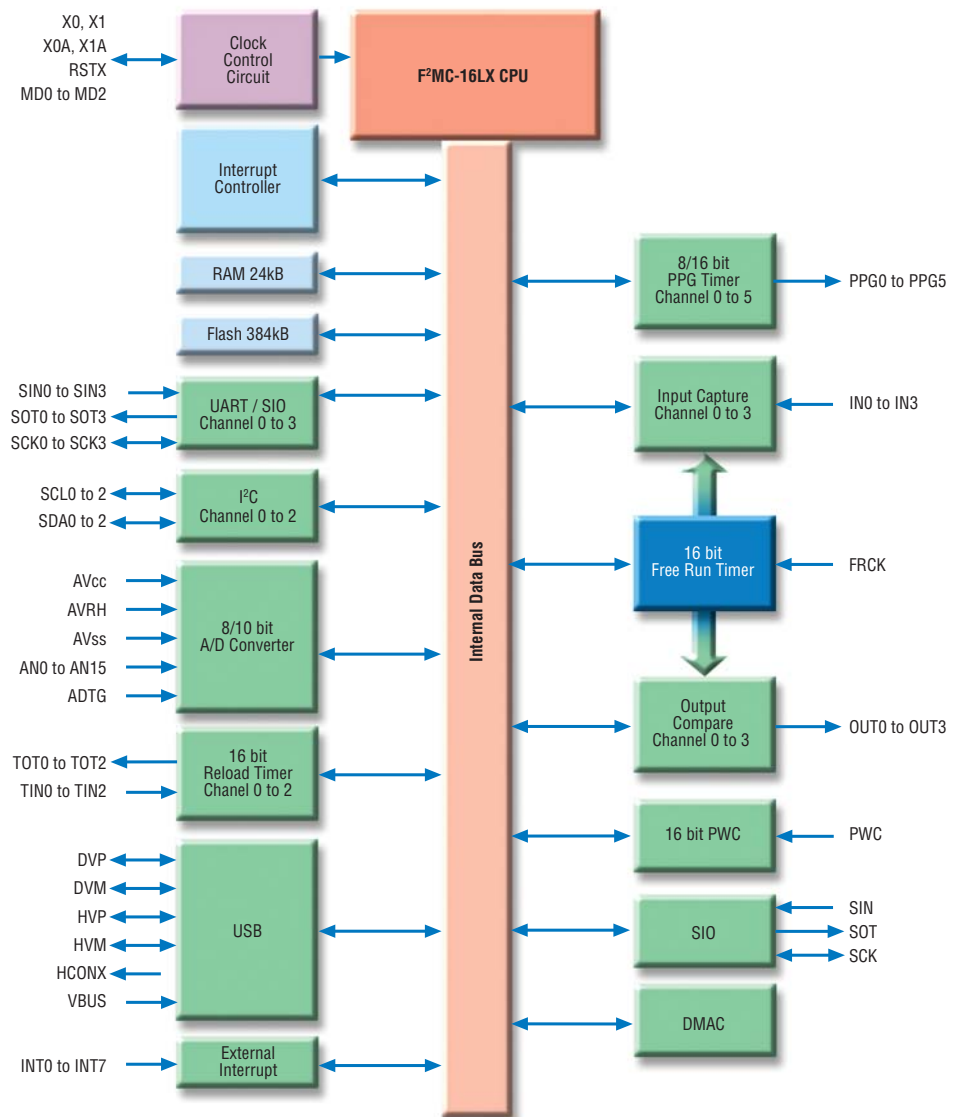
Shows the MB90F334 series with USB and USB Minihost function.

Product Line-up

Device	MB90F334	MB90333	MB90F337	MB90337
ROM density	384kBytes FLASH	256kBytes ROM	64kBytes FLASH	64kBytes ROM
RAM density	24kBytes	16kBytes	4kBytes	
Packaging	120-pin LQFP		64-pin LQFP	
A/D converter	8/10 bits, 16 channels		–	
UART	4 channels		2 channels	
I²C	3 channels		1 channel	
PPG timer	3 x 16-bit / 6 x 8-bit		2 x 16-bit / 4 x 8-bit	

16-BIT NEXT GENERATION 16FX

Fujitsu is introducing the next generation of 16-bit MCU, 16FX series

Fast

16FX series is based on an improved CPU with significantly increased internal Bus bandwidth. As a result, program execution is accelerated, as can be seen in the Dhrystone benchmark (Dhrystone 2.1 compared to MB90340 series). 16FX is about 3 times faster (depending on the memory model used) than 16LX at the same clock frequency. For example at 24MHz 16FX achieves more than 11 real MIPS (Dhrystone 2.1). The architecture improvement is particularly visible when handling large data structures (see memory model 'Large')

But that's not all. New technology and improved design allow for CPU frequencies well above 60MHz - thus allowing for processing performance ranges of 32-bit processors.

Efficient

16FX combines the advantages of 16 and 32-bit architectures. The C-code efficiency benefits from the 16-bit instruction set. Instruction Pipelining, a technique widely used in the 32-bit RISC world allows 16FX to reach RISC like performance. With instructions completed in less clock cycles the same performance is achieved with less power consumption (compared to Architectures without pipelining).
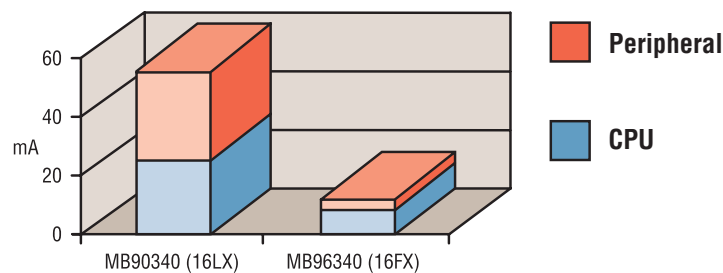
The 16-bit bus width again is an advantage for a low power

Performance Comparison 16LX and 16FX
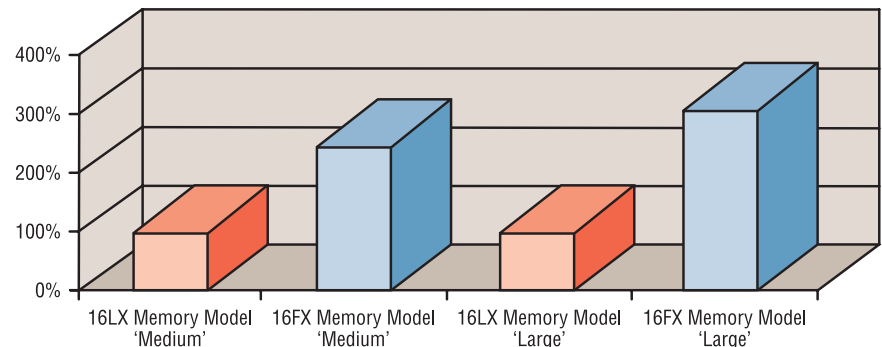
Graph 1 shows the performance ratio (Dhrystone 2.1) of 16FX compared to 16LX at 24MHz CPU frequency for different Memory Models. 16LX = 100%.

Operating Current at same Performance (5V)

Graph 2 compares 16FX operating current simulation result to 16LX typical values, both operating at 4MIps (Dhrystone 2.1) performance. 16FX achieves the performance at lower frequency with only 22% of the power consumption.

consumption result compared to 32-bit architectures, as the capacitance of the wider bus is higher, thus current consumption is higher for a 32-bit bus. The use of latest CMOS technology also translates into efficient use of silicon space (smaller chip) and lower power consumption.
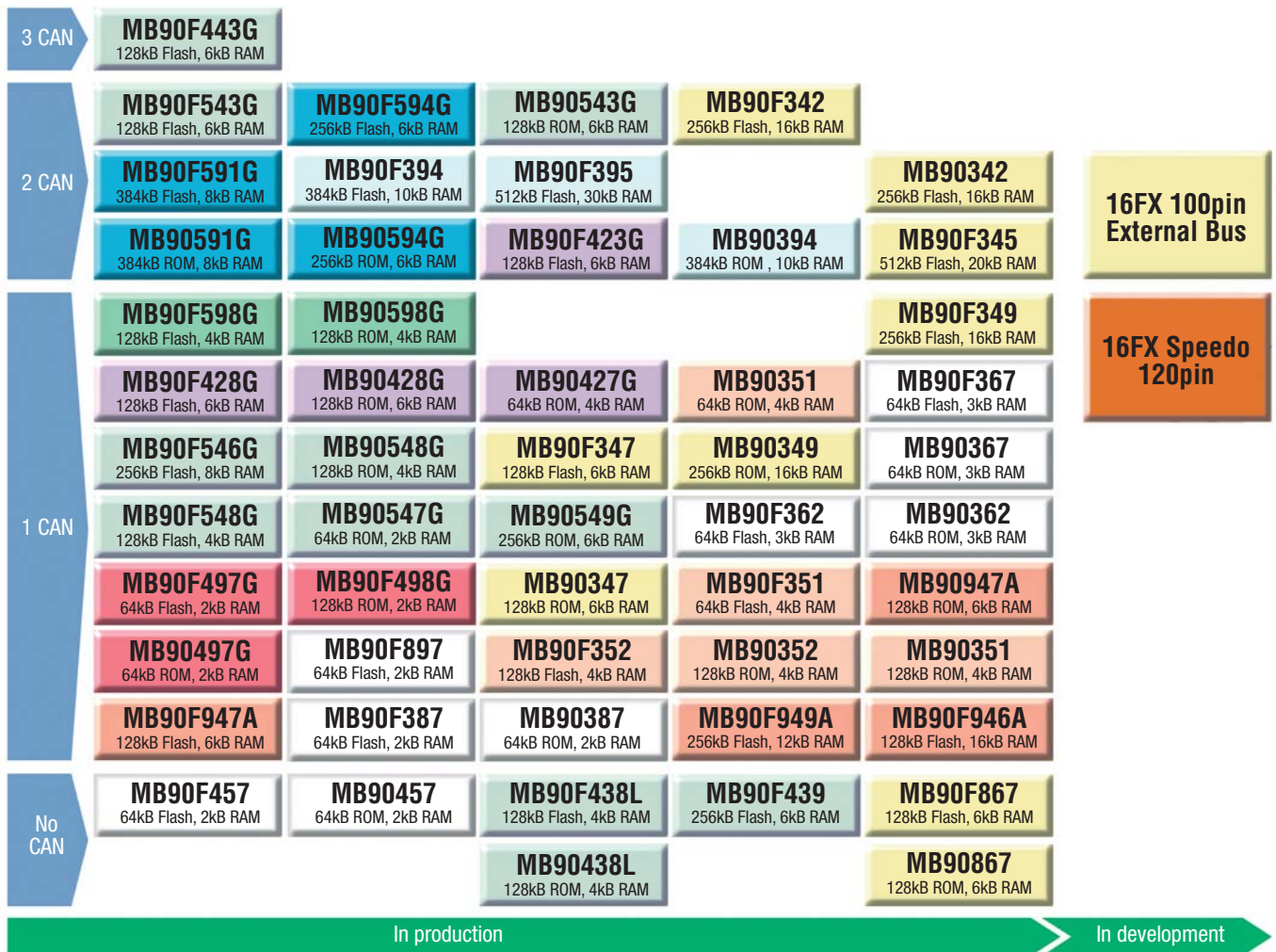
16FX specific power reduction features include a reduced internal CPU supply voltage, peripheral clock speed selectable independently from CPU speed and reduced number of clocks per instruction (CPI). The result is a 78% reduction in power consumption compared to 16LX at the same performance.
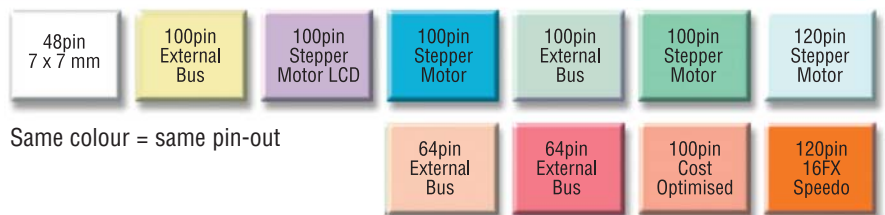
16LX compatible

The 16FX CPU uses all 16LX machine instructions. With the same instruction set, the Assembler and C-compiler are also unchanged when switching from LX to FX CPU. Quite a few of the 16LX peripherals can be found again on 16FX - making SW conversion from LX to FX an easy task. On the hardware side it is even easier. The first 16FX product is fully pin-compatible to the successful MB90340 (16LX) series. No need for a PCB change. You can even use the same Fujitsu Starter Kit (Flash-CAN-100P-340).

16-BIT LX LINE-UP

3 CAN	**MB90F443G** 128kB Flash, 6kB RAM				
2 CAN	**MB90F543G** 128kB Flash, 6kB RAM	**MB90F594G** 256kB Flash, 6kB RAM	**MB90543G** 128kB ROM, 6kB RAM	**MB90F342** 256kB Flash, 16kB RAM	
	MB90F591G 384kB Flash, 8kB RAM	**MB90F394** 384kB Flash, 10kB RAM	**MB90F395** 512kB Flash, 30kB RAM		**MB90342** 256kB Flash, 16kB RAM
	MB90591G 384kB ROM, 8kB RAM	**MB90594G** 256kB ROM, 6kB RAM	**MB90F423G** 128kB Flash, 6kB RAM	**MB90394** 384kB ROM, 10kB RAM	**MB90F345** 512kB Flash, 20kB RAM

16FX 100pin External Bus

16FX Speedo 120pin

1 CAN	**MB90F598G** 128kB Flash, 4kB RAM	**MB90598G** 128kB ROM, 4kB RAM			**MB90F349** 256kB Flash, 16kB RAM
	MB90F428G 128kB Flash, 6kB RAM	**MB90428G** 128kB ROM, 6kB RAM	**MB90427G** 64kB ROM, 4kB RAM	**MB90351** 64kB ROM, 4kB RAM	**MB90F367** 64kB Flash, 3kB RAM
	MB90F546G 256kB Flash, 8kB RAM	**MB90548G** 128kB ROM, 4kB RAM	**MB90F347** 128kB Flash, 6kB RAM	**MB90349** 256kB ROM, 16kB RAM	**MB90367** 64kB ROM, 3kB RAM
	MB90F548G 128kB Flash, 4kB RAM	**MB90547G** 64kB ROM, 2kB RAM	**MB90549G** 256kB ROM, 6kB RAM	**MB90F362** 64kB Flash, 3kB RAM	**MB90362** 64kB ROM, 3kB RAM
	MB90F497G 64kB Flash, 2kB RAM	**MB90F498G** 128kB ROM, 2kB RAM	**MB90347** 128kB ROM, 6kB RAM	**MB90F351** 64kB Flash, 4kB RAM	**MB90947A** 128kB ROM, 6kB RAM
	MB90497G 64kB ROM, 2kB RAM	**MB90F897** 64kB Flash, 2kB RAM	**MB90F352** 128kB Flash, 4kB RAM	**MB90352** 128kB ROM, 4kB RAM	**MB90351** 128kB ROM, 4kB RAM
	MB90F947A 128kB Flash, 6kB RAM	**MB90F387** 64kB Flash, 2kB RAM	**MB90387** 64kB ROM, 2kB RAM	**MB90F949A** 256kB Flash, 12kB RAM	**MB90F946A** 128kB Flash, 16kB RAM
No CAN	**MB90F457** 64kB Flash, 2kB RAM	**MB90457** 64kB ROM, 2kB RAM	**MB90F438L** 128kB Flash, 4kB RAM	**MB90F439** 256kB Flash, 6kB RAM	**MB90F867** 128kB Flash, 6kB RAM
			MB90438L 128kB ROM, 4kB RAM		**MB90867** 128kB ROM, 6kB RAM

In production → In development

16LX Flash microcontrollers compatibility overview.

Legend:
- 48pin 7 x 7 mm
- 100pin External Bus
- 100pin Stepper Motor LCD
- 100pin Stepper Motor
- 100pin External Bus
- 100pin Stepper Motor
- 120pin Stepper Motor
- 64pin External Bus
- 64pin External Bus
- 100pin Cost Optimised
- 120pin 16FX Speedo

Same colour = same pin-out

16-BIT SUPPORT TOOLS

16FX Tools

16FX is supported by Fujitsu's proven emulator for 32-bit FR series.

The Software tools (Softune Workbench) are free-of-charge for customers in Europe.

One evaluation chip covers a host of future 16FX products including features like:

- CAN with 32 message buffers per channel
- LCD controller
- Stepper motor controller
- LIN USART (SPI function)
- Enhanced PWM generators
- Up to 40 channels of 10-bit ADC
- Clock supervisor / HW watchdog
- Alarm comparator
- Safe E^2PROM emulation (relocatable base address of interrupt vector table)

MB2147-01 high-speed Emulator

Features

- Supports all Fujitsu 16LX microcontroller series
- Microcontroller operating frequency: max 25MHz
- Emulation memory: 1M x 4 area
- Fully Softune Workbench integrated user interface
- Simplified graphic interface operation execution using pull-down menu and buttons

Main unit and adaptor board of the 16LX high-speed emulator

- On-The-Fly function (commands can be run during microcontroller execution)
- Powerful trace function
- Displays source codes, variables, register, memory and trace on multi-windows
- Event trigger allows a wide range of conditions to be specified (code x 8 / data x 8)
- Sequential control in 4 conditions and 3 levels

- Performance measurement function (measurement of execution speed between two points, iteration count measurement)
- Code coverage measurement function (program execution coverage rate measurement)
- Host I/F (standard accessories): RS-232C (max 115kbps), LAN (10BASE-T, 100BASE-TX), USB 1.1
- LCD display for set-up and emulator status
- Menu keys for LCD dialogue
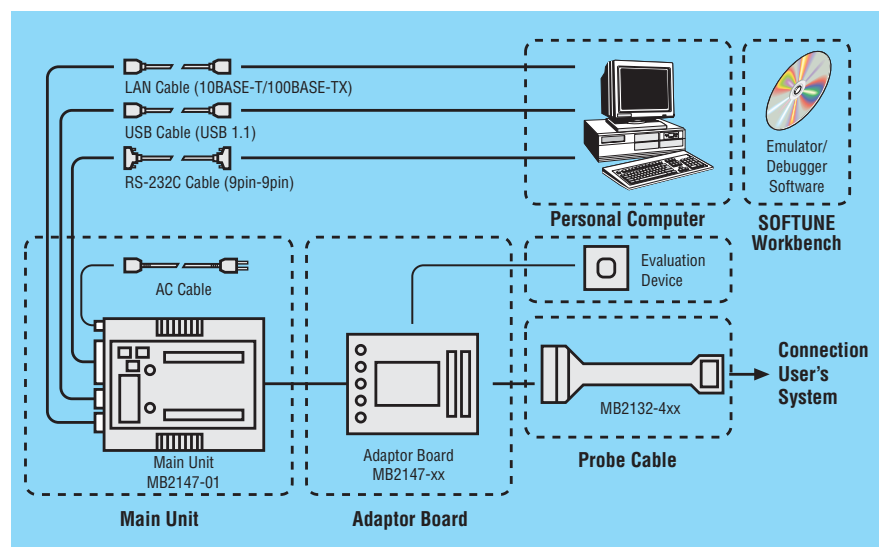
System configuration.

EVALUATION BOARDS

Fujitsu supports development engineers with low cost multi-functional evaluation boards for almost every Fujitsu 16-bit Flash microcontroller.

These Boards can be used stand-alone for software development and testing or as a simple target board to work with the emulator system. (Fujitsu in-circuit emulators require a target system that provides V_{cc} and GND, as well as a clock-circuit and reset). The boards allow the designer to start immediately with the software development.

Features

- In-Circuit serial Flash programming
- All resources available for evaluation
- All pins routed to connectors
- 8 user LEDs
- Reset button
- Crystal for main clock and for sub-clock where applicable
- 9 to 12V unstabilised external DC power supply usable
- English documentation and CD-ROM included

FLASH-CAN-64P-M09-V2 Evaluation Board
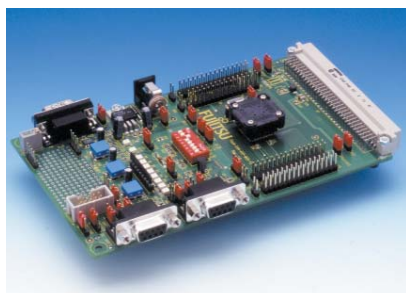
- 16LX series supported: MB90495G, MB90560, MB90565 and MB90460
- Fully supports 3 and 5V environment
- QFP-64 socket for device (with package code 'PFM') or emulator connection
- High-speed CAN driver and connector
- 4MHz main crystal
- Two UART interfaces (3 and 5V operating)
- Two buttons configurable for external interrupts
- Prototyping area
- 64-pin VG connector delivered with Flash microcontroller MB90F497

Order code:
FLASH-CAN-64P-M09-V2

FLASH-CAN-48P Evaluation Board
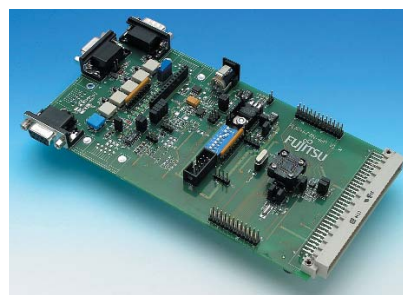
- 16LX series supported: MB90360, MB90385, MB90455 and MB90890
- One UART interface
- One LIN-transceiver
- One high-speed CAN transceiver
- 8 user LEDs, optional: alphanumeric standard LC-Display connectable instead of LEDs
- 5 user-buttons configurable for INT4, INT5, TIN0, IN0 and ADTG*
- 64-pin VG connector (same pin-out as Flash-CAN-64P-M09-V2)

Order code:
FLASH-CAN-48P-M26 with 48-pin QFP socket and MB90F387.

FLASH-CAN-64P-350 Evaluation Board
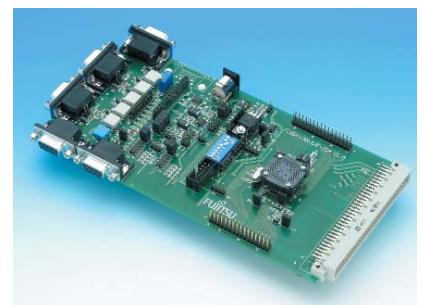
- 16LX series supported: MB90350 series with package code 'PFM'
- MB90350 series: MB90F351 & MB90F352
- Two UART interfaces
- Two LIN-transceivers
- One high-speed CAN transceiver
- 8 user LEDs, optional: alphanumeric standard LC-Display connectable
- 5 user buttons configurable for INT10, INT11, IN0, IN1, TIN1*
- QFP-64 socket
- 96-pin VG connector
- Delivered with MB90F352PFM

Order code:
FLASH-CAN-64P-350

EVALUATION BOARDS

## FLASH-CAN-100P-340
Evaluation Board

- 16LX series supported: MB90340, MB90865. Version 1.1 onward also MB90800, MB90945 package code 'PF'
- MB90340 series: MB90V340, MB90F34x
- 16FX series MB96F340 support planned
- Two UART interfaces
- Two LIN-transceivers
- Two high-speed CAN transceivers
- 8 user LEDs, optional: alphanumeric standard LC-Display connectable instead of LEDs
- 5 user-buttons configurable for INT0, INT1, TIN1, IN0 and ADTG/TIN0*
- QFP-100 socket for device (with package code 'PF') or emulator connection
- 96-pin VG connector
- Delivered with Flash microcontroller MB90F34x

Order code:
FLASH-CAN-100P-340

FLASH-CAN120-390
Evaluation Board

- 16LX series supported: MB90390
- 5 and 3V internal power supply available
- 5 MHz main crystal
- Two UART interfaces (3 and 5V operating)
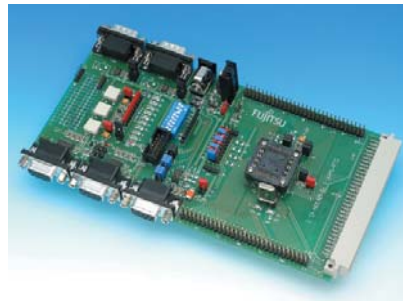
- LIN-transceiver
- Two high-speed CAN transceiver
- Two buttons configurable for external interrupts
- Prototyping area
- QFP-120 socket for device or emulator connection
- Delivered with Flash microcontroller MB90F394H

Order code:
FLASH-CAN120-390

FLASH-CAN-100P-M06
Evaluation Board

- 16LX series supported: MB90420, MB90435, MB90440, MB90540, MB90550, MB90545, MB90580, MB90590, MB90595
- 100-pin QFP socket for device (package code 'PF') or emulator connection
- Two high-speed CAN drivers
- RST, HST push-button
- Delivered with Flash Microcontroller MB90F598G and two 50-pin socket connectors

Order code:
FLASH-CAN-100P-M06

SK-90820-80PFM-562
Evaluation Board for motor control series
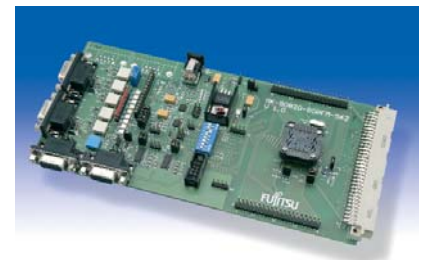
- 16LX series supported: MB90820 in 'PFM' package
- 80-pin socket for device (package code PFM) or In-circuit emulator connection
- 9-12V unregulated external DC power supply usable
- 5V internal power supply, Power-LED
- In-Circuit serial Flash programming
- All resources available for evaluation
- All pins routed to connectors
- 4 MHz main-crystal
- Two UART interfaces
- Two LIN interfaces
- 8 User LEDs, optional: alphanumeric standard LC-Display connectable instead of LEDs
- Reset-Button, Reset-LED
- 5 User-buttons
- 96-pin VG connector
- Delivered with Flash Microcontroller MB90F823.This microcontroller contains a 'burn-in' boot loader for programming the flash

Order code:
SK-90820-80PFM-562

The functions assigned to user buttons may vary depending on which MCU is used.

INTRODUCTION TO THE FR FAMILY - 32-BIT RISC ARCHITECTURE

The Fujitsu RISC (FR) architecture is a 32-bit microprocessor core that is dedicated to resolving the twin demands of high performance coupled with low cost, which are needed by today's high-end automotive, consumer and telecom applications. Designed from the outset to be optimised for embedded applications, the CPU has 16-bit instructions, enabling maximum performance from low-cost, half-word external memory or else allowing double instruction fetches for each bus cycle. The CPU employs a five-stage pipeline, a 32 x 32 multiplier, a barrel shifter and a bit search unit which finds the first 1, 0 or change in a data word in a single cycle.

The CPU has eight dedicated 32-bit registers: program counter, processor status, interrupt table base register, return pointer, system and user stack pointers and two for multiply/divide result. There are sixteen 32-bit, general-purpose registers arranged as a single bank. The functions of R13 to R15 are reserved as virtual accumulator, frame pointer and stack pointer respectively. The instruction set contains bit manipulation instructions and data moving instructions, which are very helpful in supporting the on-chip peripheral blocks.

FR CPU Core Block Diagram
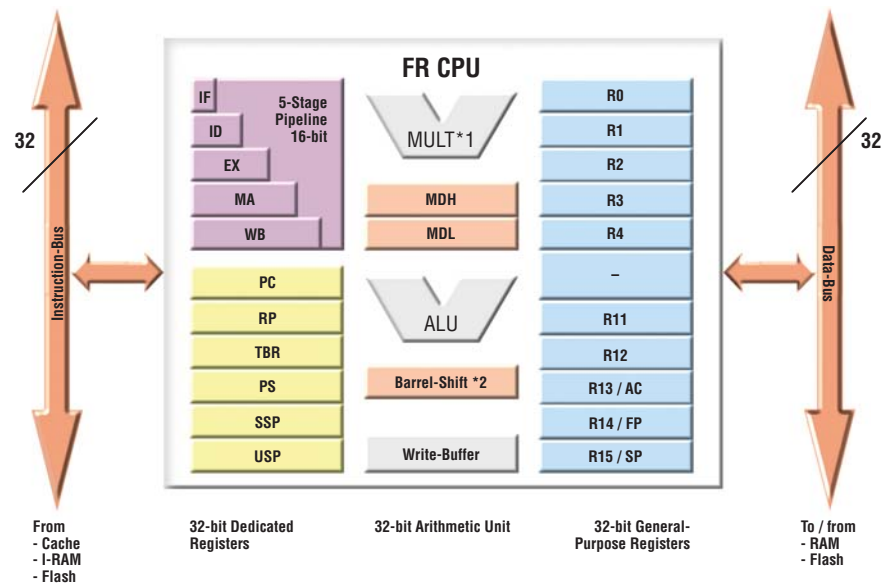
*1: 32-bit x 32-bit: 5 clock cycles, 16-bit x 16-bit: 3 clock cycles. *2: 1 cycle. IF: Instruction Fetch ID: Instruction Decode EX: Execution MA: Memory Access WB: Write Back PC: Program Counter RP: Return Pointer TBR: Table Base Register PS: Program Status SSP: System Stack Pointer USP: User Stack Pointer AC: Accumulator FP: Frame Pointer SP: Stack Pointer.

Although the FR is a RISC, it contains a number of extended instructions, which help assembly level programming, often unavoidable in embedded applications. An example is the store of half of the register bank to memory.

Blocks that require fast access are connected to the FR-core within a 32-bit Harvard Bus system. These units are the internal RAM, the DMA-controller and the bit search unit. Resources that require simple control or status access, such as UARTs, timers, etc., are hooked up on a 16-bit peripheral bus known as the

R-Bus. The external bus gives the user the opportunity to access external memory or other memory-mapped devices on the target application, supporting up to 8 fully configurable chip-select areas.
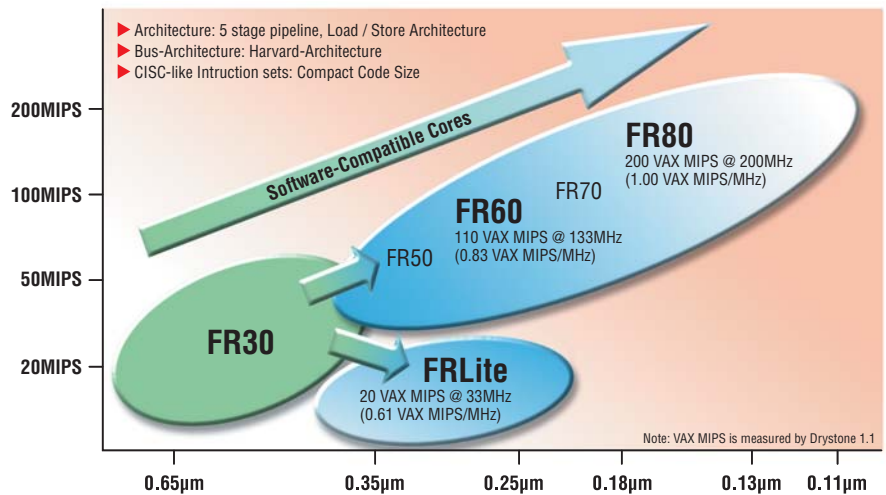
INTRODUCTION TO THE FR FAMILY - 32-BIT RISC ARCHITECTURE

Fujitsu has developed a suite of FR cores from FRLite to FR80 – for different performance requirements. The FRLite core has been designed with the target of reducing die size, power consumption and the design turnaround time.

This core closes the performance- and cost-gap between today's 16LX and FR controllers. By also being offered with the same resources it eases the migration from the 16LX CISC world into the FR RISC domain. Most of the current families are based on the FR60 core family containing the FR50 and FR70 core variants.

FR80 is used for high-speed processor type devices requiring both instruction and data cache.

FR 32-bit RISC Core Performance Road Map

▶ Architecture: 5 stage pipeline, Load / Store Architecture
▶ Bus-Architecture: Harvard-Architecture
▶ CISC-like Intruction sets: Compact Code Size

Software-Compatible Cores

200MIPS	
100MIPS	**FR80** 200 VAX MIPS @ 200MHz (1.00 VAX MIPS/MHz)
	FR70
	FR60 110 VAX MIPS @ 133MHz (0.83 VAX MIPS/MHz)
50MIPS	FR50
	FR30
20MIPS	**FRLite** 20 VAX MIPS @ 33MHz (0.61 VAX MIPS/MHz)

Note: VAX MIPS is measured by Drystone 1.1

0.65µm   0.35µm   0.25µm   0.18µm   0.13µm   0.11µm

From FRLite's low power/low cost technology to FR80's optimised performance, the FR core roadmap offers a wide range of software-compatible cores dedicated to embedded applications.

MB91270 AUTOMOTIVE SERIES

The FRLite series **MB91270** (based on EVA device MB91V280) includes 100-pin devices (MB91270) for automotive body control and other 5V CAN applications.

As with all FRLite series, MB91270 offers:

- FRLite 32-bit RISC CPU, load/store architecture, 5-stage pipeline
- Operation frequency: 32MHz
- Instructions compatible with FR families
- Access to flash memory without wait states
- DMA
- Various timer and counter functions
- Operating voltage: 5V
- CMOS 0.35µm technology

In addition, the following feature set is available:

- ADC
- Flash: up to 512kB
- RAM: up to 48kB
- CAN
- LIN-USART
- I²C
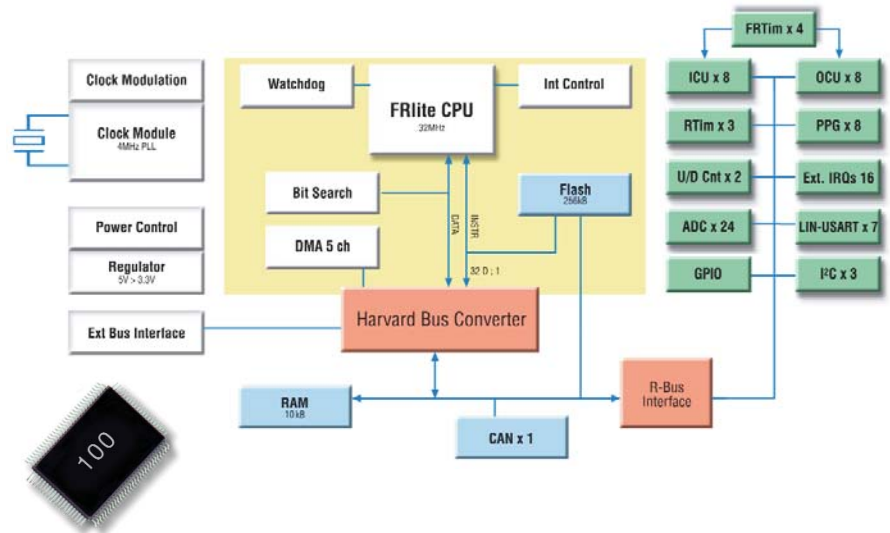
Automotive body control MCU with 1 x CAN and 7 x LIN (pin compatible to 16-bit MB90340 series).

MB91F272, the first device in this series, is pin-compatible to the successful 16-bit MB90340 series and offers the following features (see block diagram):

- Flash: 256kB
- RAM: 10kB
- CAN: (1 channel, 32 message buffers)
- LIN-USART: (7 channels)
- I²C: (3 channels)
- 10-bit ADC: (24 channels)

- Various timer and counter functions:
  - 16-bit PPG (8 channels)
  - 16-bit reload timer (3 channels)
  - 16-bit free running timer (4 channels)
  - Output compare (8 channels)
  - Input capture (8 channels)
  - 16-bit up/down counter (2 channels)
- External Interrupts: 16 channels

For evaluation and software development, the MB90340 starter-kit Flash-CAN-100P-340 is available together with the adaptor ADA-91270-90340-100PFV.

MB91360G AUTOMOTIVE SERIES

MB91360G series with up to 3 FULL-CAN Interfaces and 768kB Single Voltage Flash Memory

Created in Fujitsu's 0.35µm CMOS embedded flash process, MB91360G devices with on-chip Flash memory and CAN are ideal for a wide range of automotive and industrial applications. MB91360G parts are being used in high-end instrumentation systems today, where special on-chip features such as stepper motor controllers, real-time clock, sound generator, high current LED drivers and PPGs for light dimmers, are important.

Some versions contain up to 5 million transistors in 160 logical blocks. The FR CPU clocks at up to 64MHz internally and is supported by instruction RAM and up to 32kB data RAM. All devices have a built-in Flash memory with 10 years' data retention and a minimum of 10,000 erase-cycles. Different programming algorithms can be used such as in-circuit programming, EPROM programmers or serial programming using the internal boot-ROM (including a security function).

In addition to the special features, a number of general-purpose peripheral blocks are available such as serial communication interfaces, 10-bit A/D and D/A converters, input capture and output compare, reload timers, external interrupts and many more. Power down management features include individual clock-gear functions, sleep and stop modes and reset generation if the voltage drops below a defined threshold plus over/under voltage detection interrupt.

EMC will be more important for the functionality and security of electronic devices. All members of the MB91360 family will therefore be equipped with a new clock modulator unit, which drastically reduces the EME (electromagnetic emission) and helps in-getting designs EMI-approved.

The modulation of the internal operation clock reduces the noise by spreading the energy of the MCU over a wide frequency range.

Features

- 32-bit core CPU; max. 64MHz/ 15.6ns internal cycle time from 4MHz oscillator
- 0.35µm CMOS technology
- Internal voltage regulator
- Supports 3V MCU core from 5V supply, offering low EMI and low power consumption figures
- Built-in clock modulator for EMC optimisation
- CAN 2.0B protocol controllers:
  - 16 message buffers, each individually programmable for transmit or receive
  - 11 or 29 identifier bits
  - Full identifier bit compare/full mask/compare against 1 of 2 mask registers
  - Ability to group buffers into flexible multi-level configuration
  - Readable error counter

- Up to 768kB Flash memory; supports automatic programming, 10,000 erase cycles, 10-year data retention time, no second programming voltage required
- 4kB instruction RAM
- up to 32kB static data RAM
- 5 channels DMA, external and internal channels with 16 sources
- Internal boot ROM
- Up to 8 external interrupts
- Power-down reset if supply voltage falls below pre-set threshold
- Under/over voltage detection
- ADC: up to 16 channel analogue inputs, resolution 10-bit
- DAC: up to 2 channel analogue outputs, resolution 10-bit
- ICU (Input Capture) 16-bit
- OCU (Output Compare) 16-bit
- Programmable pulse generator 16-bit
- Stepper motor controller
- UART full duplex up to 115kBaud (LIN optional)
- I²C Bus controller up to 400kHz
- Synchronous serial I/O up to 1Mbit/s
- Re-load timer 16-bit
- LED driving port
- Sound generator
- Real-time watch timer
- Same emulation system for entire series
- Different package options from 120 to 208-pin (QFP)

MB91360G AUTOMOTIVE SERIES

The **MB91360G** series offers devices with the same FR50 core, but with different peripheral and package options. The available devices are shown in the table on page 44. Two example block diagrams (MB91F362G and MB91F376G) are shown here.

MB91F362G offers over 20 on-chip peripherals including 3 CAN controllers, external bus interface and stepper-motor controllers. The package used for the MB91F362G is a QFP208.

The latest addition to the MB91360G family is the **MB91F376G**. It is a powerful device for all kinds of automotive and industrial applications, where motor-control, multiple CAN-buses and many kinds of serial interfaces are required. This device is useful for single-chip applications and is therefore housed in a compact QFP120 package. It is fully compatible to MB91F366G, but offers 768kB of flash memory.

For the other members of the MB91F360G series, please see the table on page 44.
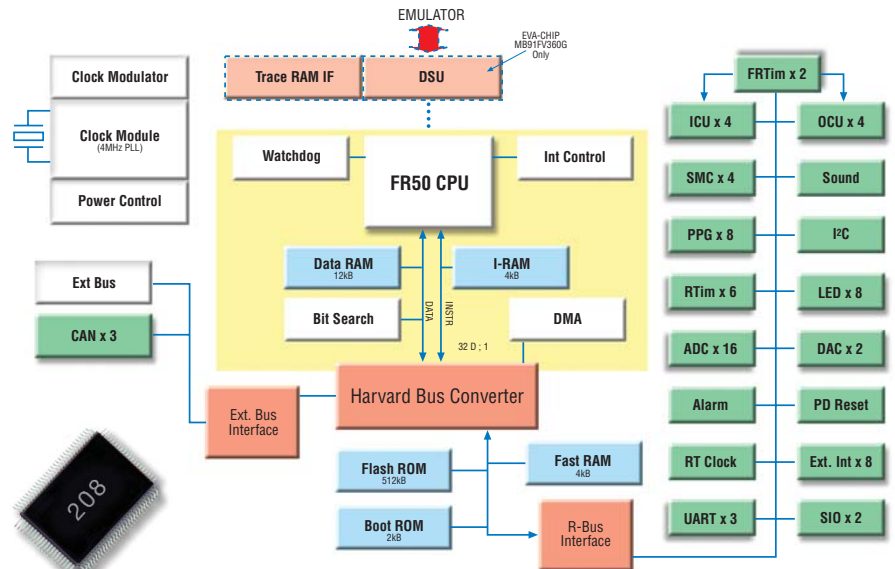
MB91F362G featuring 3 x CAN and more than 20 other on-chip peripherals.
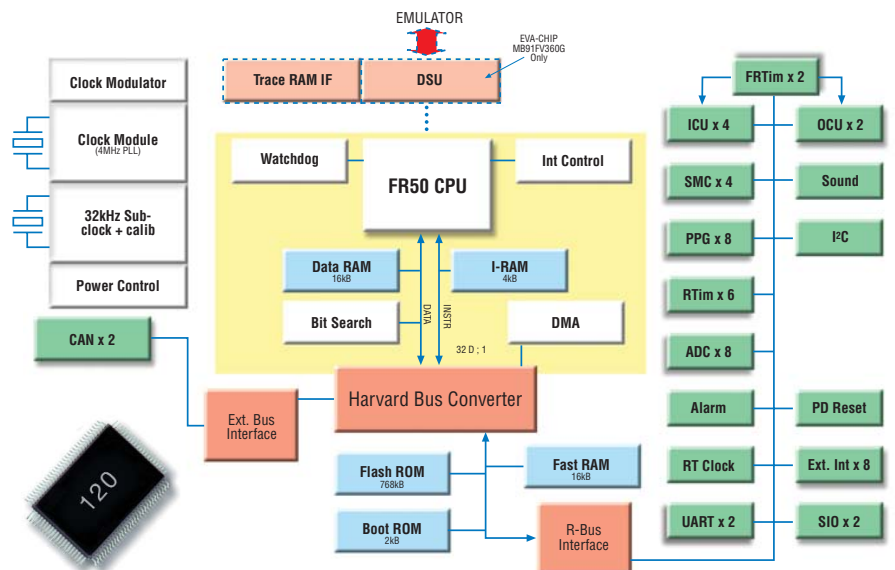
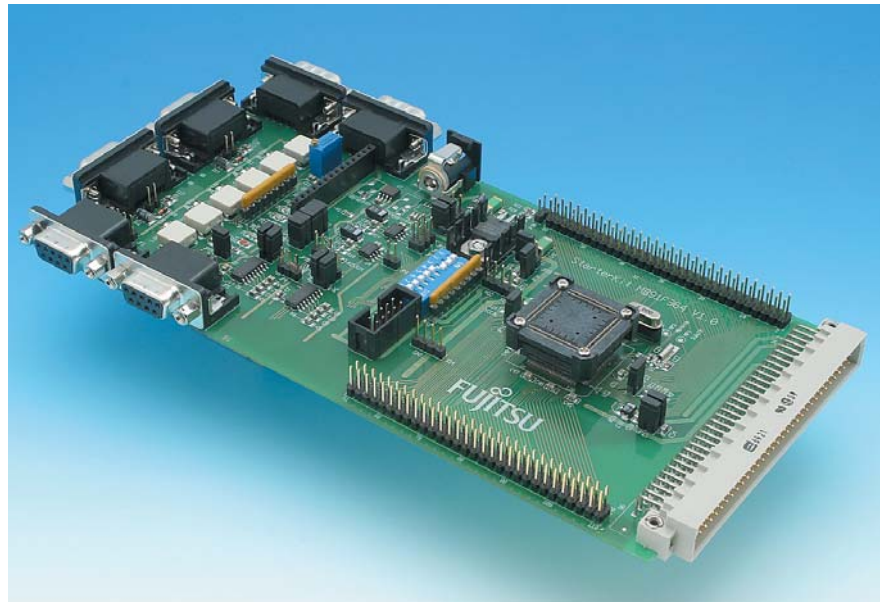MB91F376G identical to F366G, but featuring 768kB of on-chip flash memory.

STARTERKITS MB91360/364

The MB91360 starterkits (STARTERKIT MB91360 and STARTERKIT MB91364) are stand-alone application boards that allow easy evaluation and demonstration of almost all features of the MB91360 microcontroller series. Along with the supplied Windows-based development tools, they can be used as a system for user program developments.

The boards can be configured as targets for the MB91360 emulation system, or as stand-alone evaluation boards. All peripheral functions are available on external pin-headers in order to design and effectively test the cost and time of user-applications. For some resource functions, additional hardware is already present on the board (e.g. CAN- and UART-transceivers, LEDs, Buttons, etc.).

MB91364 Starterkit - low cost multi-functional evaluation board.

Features of STARTERKIT MB91360

- Footprint QFP208 for MB91F362G (or emulation socket), surrounded by headers for other adaptors
- 4MHz or 32kHz crystal selectable
- DC power-supply circuit (incl. test pins for Vcc, GND, power-LED and switch)
- 512kB external SRAM available for user code and data
- External 16550 UART (supports transfer-rates up to 115.2kBaud)
- 3 Resets ('Monitor' = Flash monitor, 'User' = external RAM, 'Flash' = User Flash Area)

- 2 MAX232 + DB9 (female) connectors for monitor and internal UART
- CAN transceiver and DB9 (male) for internal CAN0
- External interrupt 0 and 1 connected to buttons for user interaction
- Various jumpers for individual configuration
- 2 x 16 char LCD (on Port G)
- 8 LEDs (on Port J)
- External bus and all resources logically grouped on pin-headers
- Area for extensions (2.54mm grid)
- Stand-alone configuration features built-in monitor debugger (in Flash)
- Software example projects for various applications

Features STARTERKIT MB91364

- Supports 32-bit MB91F364G with LQFP-120 package
- 9 to 12V unstabilised external DC power supply
- 5V internal power supply available
- In-circuit serial Flash programming
- All resources available for evaluation
- 4MHz main crystal
- 2 UART interfaces / 2 LIN-transceivers
- One high-speed CAN transceiver
- 8 user LEDs
- Reset-, Break-, NMI-Buttons
- Two buttons configurable for external interrupts
- 96-pin VG connector

MB91460 AUTOMOTIVE SERIES (UNDER DEVELOPMENT)

The FR-based **MB91460** series will offer devices for car dashboard, car body control, car infotainment and with the upcoming revision B of the EVA device also FlexRay applications, e.g. in the chassis area. It is a successor of the well-established MB91360G series.

Features

The following maximum feature set is supported by the first EVA device MB91V460:

- 32-bit Fujitsu RISC MCU, load/store architecture, 5-stage pipeline
- Maximum clock frequency: 100MHz
- Up to 4MB embedded flash
- Up to 128kB RAM
- BootROM 4kB
- Optional instruction cache: 4kB
- 32kHz sub-clock
- Embedded Debug Support (EDSU)
- CAN: up to 6 channels with up to 128 message buffers each
- LIN-UART: up to 16 channels (4 channels with 16 Byte FIFO)
- 400kHz I²C: up to 4 channels
- Input Capture: 16-bit x 8 channels
- Output compare: 16-bit x 8 channels
- Reload timer: 16-bit x 8 channels
- PPG: 16-bit x 16 channels
- Pulse frequency modulator (1 channel)
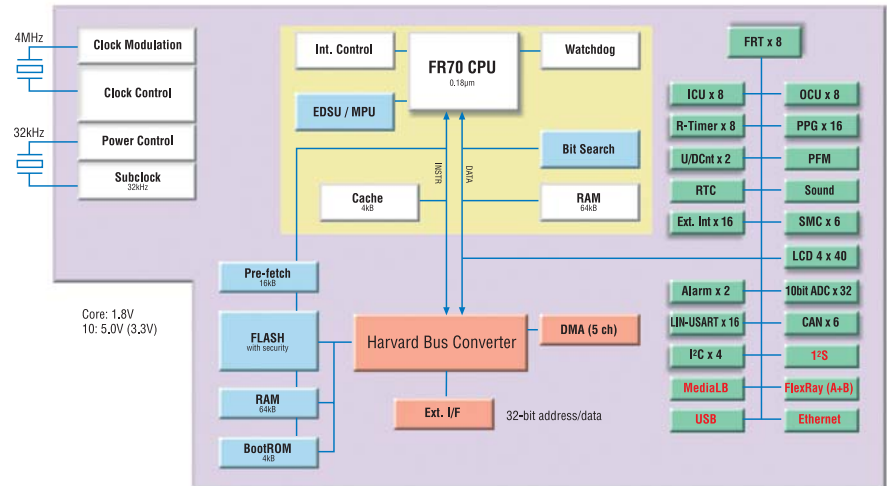
MB91460 Maximum Feature Set supported by EVA Device MB91V460.
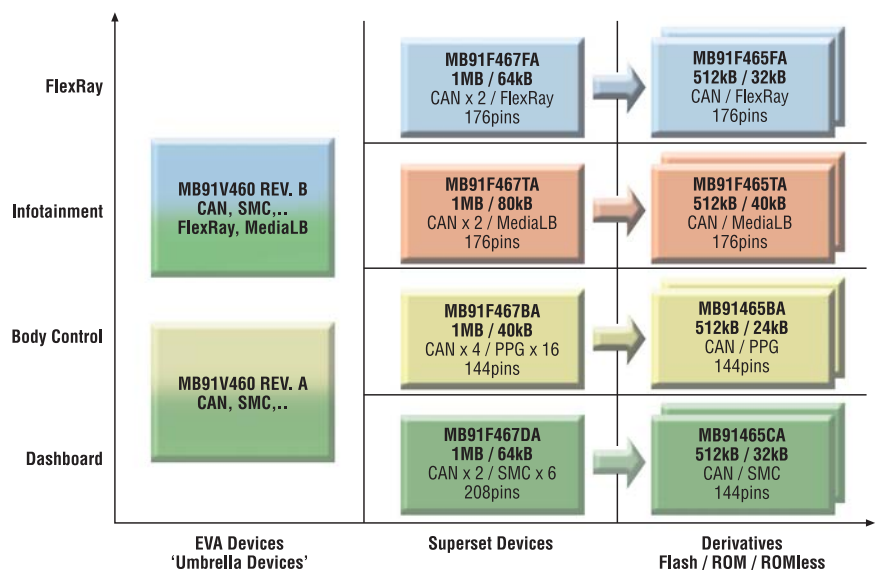
MB91460 Line-up.

- Up/down counter: 2 channels
- Sound generator
- Real-time clock
- SDRAM/FCRAM interface
  - Up to 32-bit address output
  - 8-bit, 16-bit or 32-bit data input/output
  - Built-in pre-fetch buffer

- Supports asynchronous SRAM, ROM/Flash, burst mode and page mode ROM/Flash
- SDRAM (FCRAM™ type, programmable CAS latency, number of banks)
- DMA controller: 5 channels

MB91460 AUTOMOTIVE SERIES (UNDER DEVELOPMENT)

- External interrupts: up to 16 channels + NMI
- 10-bit A/D converter: Up to 32 channels, 3μs conversion time
- SMC: up to 6 channels
- Alarm comparator: up to 2 channels
- LCD support (4 x 40)
- Revision B of the EVA device will support devices with the following additional features:
  - FlexRay (dual channel)
  - MediaLB
  - I²S
  - Ethernet and USB are under discussion
- Operating temperature range: -40 to +105°C (125°C on demand)
- Operating power supply voltage range: 3 or 5V
- 0.18μm embedded flash technology

The diagram on the following page shows the future development of the MB91460 series.

In addition to the EVA devices flash products will be developed for various applications in the car. The target applications are dashboard, body control, infotainment and FlexRay applications. The first devices will contain a superset of features offered for the related application. Smaller derivatives of these superset devices will follow. Please contact Fujitsu for details.

MB91F467DA is the first flash device to be available of the MB91460 series. It can be considered a successor of MB91F362G, now offering an extended feature set. Its primary target application is instrumentation, but its rich feature mix makes it suitable for various other applications as well.

Features of MB91F467DA

- 1088kB of flash memory directly connected to the CPU core via an advanced prefetch / caching system. The device includes Fujitsus Flash Security Feature (Read-out protection)
- 64kB of RAM, separated into 32kB of dedicated data RAM and 32kB of RAM, which can be used for data and instructions.

- SMC: (stepper motor controller) 6 channels
- CAN: 3 channels with 32 message buffers each
- LIN-UART: 5 channels, (4 channels are equipped with transmit and receive FIFOs)
- External Bus interface, which supports various memories, but can also be used to connect Fujitsu Graphic Display Controllers or the new FlexRay ASSP series

Please see the block diagram for details.
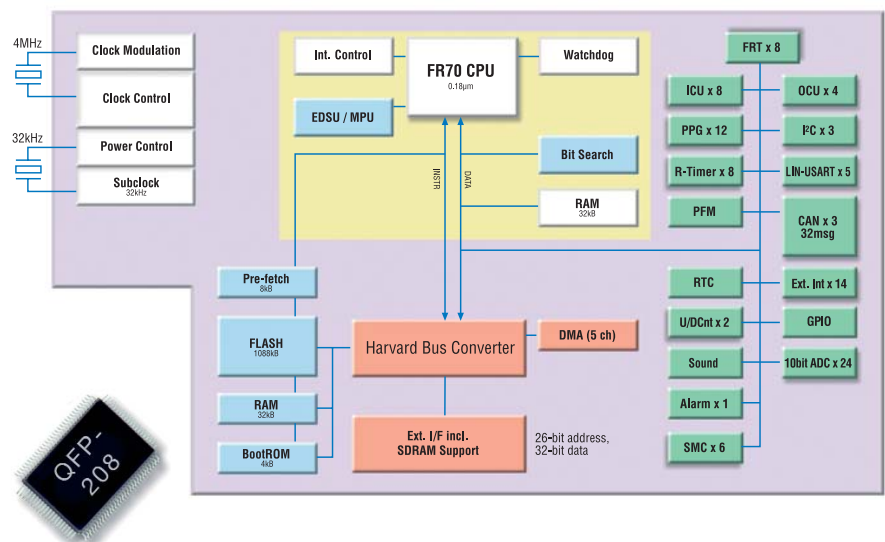
MB91F467DA block diagram.

MICROCONTROLLERS

# MB91460 AUTOMOTIVE SERIES (UNDER DEVELOPMENT)

A starterkit in two variants (combined with the FlexRay ASSP and without it) is currently available: **SK-91F467D-FLEXRAY** or **SK-91F467D-208PFV**

MB91F464AA is a 100-pin device developed for various body control applications.

Features

- 416kB Flash
- 16kB RAM,
- CAN 1 channel, 32 message buffers
- LIN-UART: 5 channels
- 10-bit ADC: 21 channels
- RTC module, which can operate based on the external 4MHz or 32kHz crystals
- Various timers

Please see the block diagram for the other features.
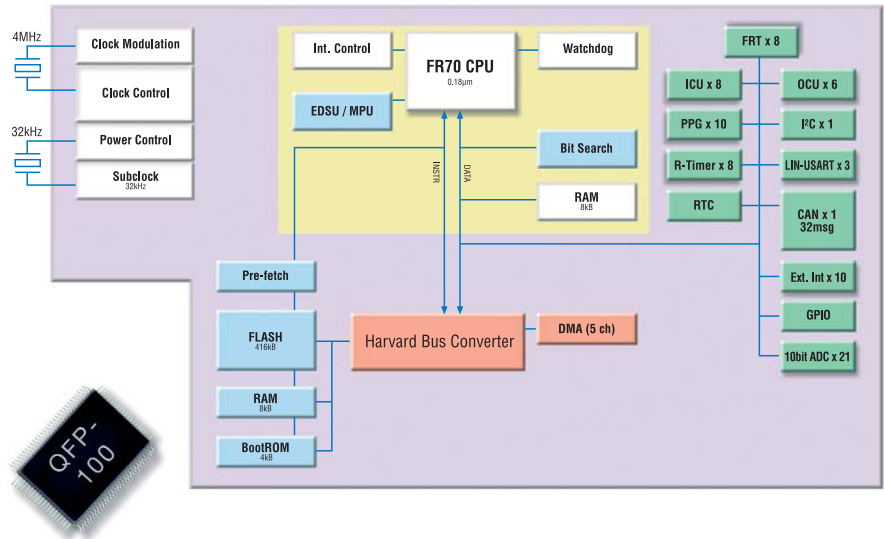
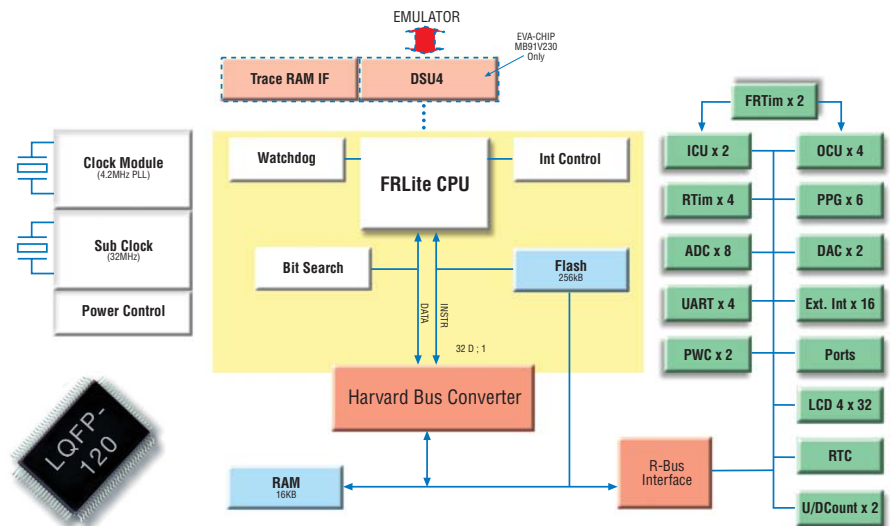*MB91F464AA block diagram.*

MB91230 LCD CONTROL SERIES

The **MB91230** series of embedded controllers is based on the FRLite 32-bit RISC CPU core.

The operating voltage of the L variant ranges from 3.0 to 3.6V, down to 2.2V (min.) at real-time clock mode.

With an externally connected low-price 4.2MHz oscillator, the operating frequency can be programmed from 2.1 to 33.6MHz resulting in a current consumption of 12 to 50mA.
In addition to the FRLite CPU core, and various timer and communication units, the MB91230 series features LCD controller (4COM, 32 SEG) that can directly drive Liquid Crystal displays.

MB91F233 featuring an LCD controller.

Features

- Process technology: CMOS 0.35µm
- Supply voltage: MB91F233: 4.0 to 5.5V (external) 3.0 to 3.6V (internal) MB91F233L: 3.0 to 3.6V
- Operating frequency: 33.6MHz
- Power consumption: 50mA (MB91232), 80mA (MB91F233)
- Memory: 256kB flash memory (only MB91F233) 192kB ROM (only MB91232) 16kB RAM (MB91F233 and MB91232)
- LCD controller: 4 COM, 32 SEG
- A/D converter: 10-bits (4 ch x 2 units)

- D/A converter: 8-bits (2 ch)
- Clock output function
- Real-time clock
- UART communication function
- Timer function: PPG, up/down counter, reload timer, free-running timer, watch timer, PWC timer, U-timer, Watchdog timer function, ICU, OCU
- 98 I/O ports
- Low-power consumption mode: Sleep, Stop, and Timer modes
- Package: 120-pin LQFP

A dedicated starterkit (STARTERKITMB91230) is available for this device.

# MB91260/265 3-PHASE MOTOR CONTROL SERIES

With its high-speed MAC (multiply/accumulate) unit, multi-function timer and 3 high-speed (1.2µs) A/D converter units, this embedded flash microcontroller is optimal for 3-phase motor control applications.

The multi-function timer consists of a free-running timer (up/down), output compare and input capture units, 16-bit PPG timer units and a waveform generator.

The MAC unit executes 16-bit x 16-bit multiplications and the calculation of a 40-bit sum in a single cycle of its 32MHz clock. As an added feature 64 word X- and Y-RAMs are built in. MB91F264 features 256kB embedded flash and 8kB RAM and comes in a 100-pin package. MB91F267 features 128kB embedded dual-operation Flash and 4kB RAM plus 1 channel of CAN with a 64-pin package.

Features

- Process technology: CMOS 0.35µm
- Supply voltage: 4.0 to 5.5V
- Operating frequency: 32MHz
- UART communication function MB91F264 including dedicated resources for motor control
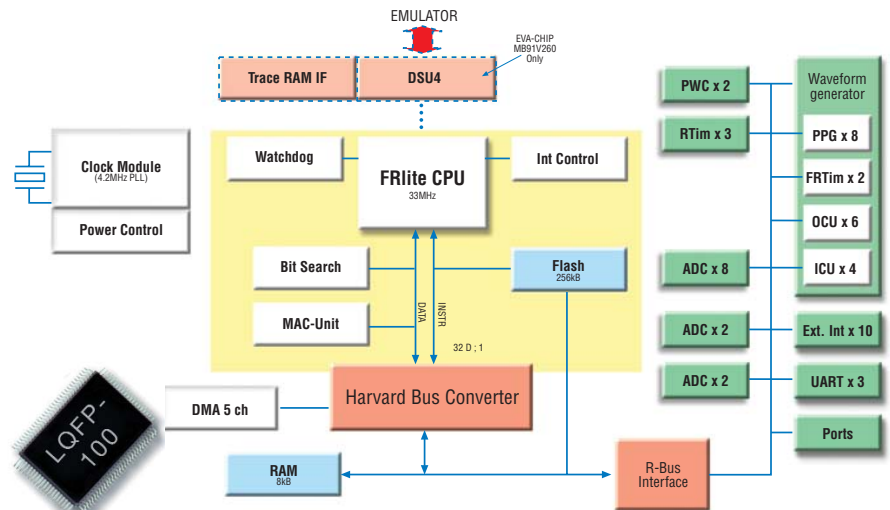
MB91F264 including dedicated resources for motor control.

- Timer function: PPG, up/down counter, reload timer, free-running timer, watch timer, PWC timer, U-timer, Watchdog timer function, ICU, OCU
- Waveform generator (for motor drive)
- Low-power consumption mode: Sleep, Stop, and Timer modes

	MB91F264	MB91F267
Package	LQFP-100	LQFP-64
A/D	2 ch 2 units, 8 ch 1 unit	4 ch 1 unit, 7 ch 1 unit
USART	3 ch	2 ch
PWC	2 ch	1 ch
Ext. Int	10 ch + NMI	8 ch + NMI
RTim	3 ch	3 ch
PPG	8 ch 16-bit (16 ch 8-bit)	4 ch 16-bit (8 ch 8-bit)
CAN	-	1 ch

MB91301 SERIES

The **MB91301** series features a powerful device based on the FR65E core fabricated in 0.25μm CMOS technology.

This SDRAM controller embedded MCU MB91302A is developed as a successor to MB91101. Operation is available at a maximum frequency of 68MHz. A 4kB instruction cache guarantees high-speed code execution. The external bus interface is compatible with a wide variety of memories, from asynchronous SRAM to page-mode and burst-mode flash. The SDRAM controller also supports FCRAM™. Five externally controllable DMA channels support many transfer modes thereby ensuring efficient transfer of data within the device. The supply voltage is 3.3V.
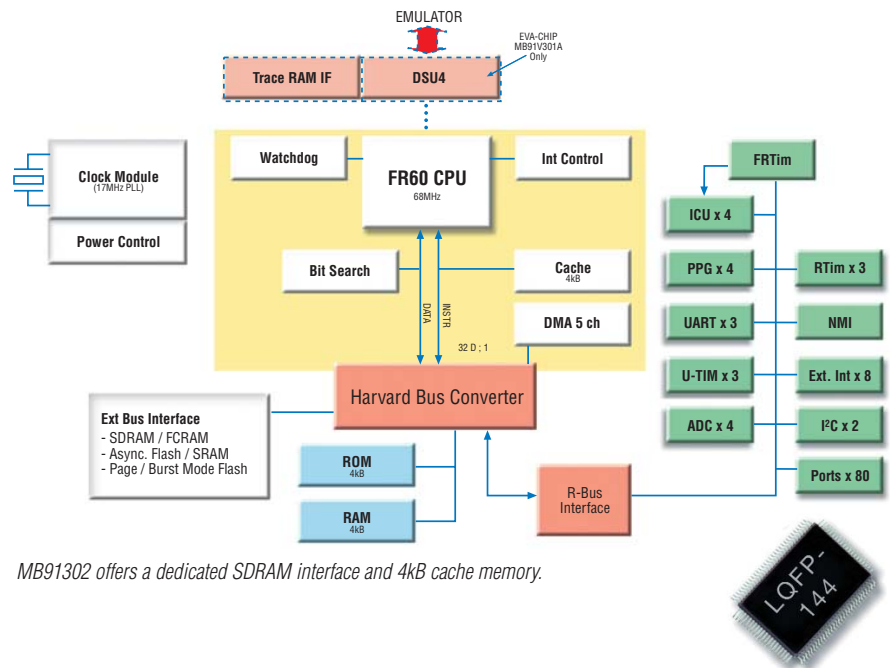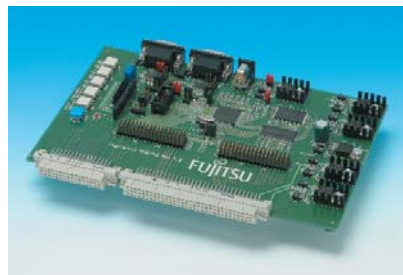

MB91302 offers a dedicated SDRAM interface and 4kB cache memory.

STARTERKIT MB91302

The 'STARTERKITMB91302' is a multifunctional starterkit for the Fujitsu 32-bit Flash microcontroller MB91302 series. It can be used stand-alone for software development and testing or as a target board to work with the emulator system. The board enables designers to start immediately with the software development before their own final target systems are available.

MB91302 starterkit - low cost multi-functional evaluation board.

Features

- Supports MB91302 series in FPT-144P-M12 package
- On-board 64Mbit Flash and 64Mbit SDRAM

- In-Circuit serial Flash programming
- Integrated Softune Workbench monitor debugger
- All 144 pins routed to connectors
- 15MHz main-crystal
- Two UART interfaces (UART0, 1)

- 8 User LEDs, optional: alphanumeric standard LC-Display connectable instead of LEDs
- Reset and interrupt buttons
- Graphic controller board support (bus connection and power supply)
- Graphic controller boards are available for Fujitsu GDCs: Scarlet, Cremson and Jasmine

MB91350A SERIES

This series of single-chip embedded flash microcontrollers includes feature-rich devices for digital home appliances and other 3.3V embedded control applications. The devices run at an operating frequency of up to 50MHz. In addition to various timers, the devices include several serial communication interfaces (up to 5 USART, 3 SIO and also an I²C interface). A/D and D/A converters support the processing of analogue signals.

The series includes MB91F353A housed in a 120-pin package and MB91F355A with more features in a 176-pin package.

A dedicated Starterkit with the following features is available for MB91350A Series.

- Supports MB91350A Series in FPT-176P-M02 package
- On-board Flash, SRAM and FRAM™
- In-Circuit serial Flash programming
- Integrated Softune Workbench monitor debugger
- All 176 pins routed to connectors
- Two UART Interfaces (UART0, 1)
- 8 User LEDs, optional: alphanumeric standard LC-Display connectable instead of LEDs
- Reset and Interrupt buttons
- Graphic controller board support (bus connection and power supply)
- Graphic controller boards are available for Fujitsu GDCs: Scarlet, Cremson and Jasmine
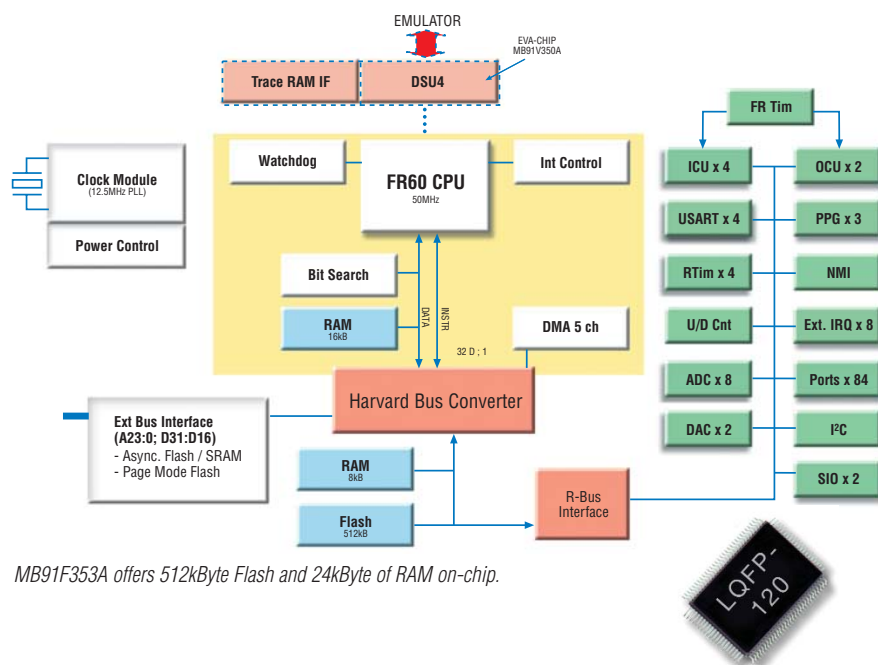
MB91F353A offers 512kByte Flash and 24kByte of RAM on-chip.

	MB91F353A	MB91F355A
Package	LQFP-120	LQFP-176
ICU	4	4
OCU	2	8
RTim	4	4
U/D counter	1	2
ADC	8	12
DAC	2	3
PPG	3	6
NMI	1	1
Ext. IRQ	8	16
I/O ports	84	141
I²C	1	1
SIO	2	3
USART	4	5

FR SERIES IN-CIRCUIT EMULATOR

The **MB2198** is Fujitsu's emulation system for 32-bit RISC FR architecture microcontrollers.

It makes use of the DSU (Debug Support Unit) integrated within the FR evaluation devices, to provide a powerful debugging environment without compromising full system operating speed.

The system comprises the MB2198-01 emulation unit, which connects to the host PC via RS232, integrated (10BASE-F, 10BASE-F+) LAN or USB Interface. The MB91VxxxCR FR evaluation device plugs into a pod or adaptor board and this, depending on the family, then plugs into either a suitable IC socket located on the target hardware, or connects to a header board and NQ-PACK on the target hardware.

MB2198 Fujitsu's emulation system for 32-bit RISC architecture.

Features

- Source level debugging
- Real-time trace
- 5 hardware breakpoints and 8,192 software breakpoints

32-BIT FR PRODUCT LINE-UP

Overview of 32-bit Families

Series	Device Part Number	Package (pin)	Operating voltage: Vcc 3V system or 5V system (V)	Max. internal clock frequency (MHz)	Clock	Memory Type	ROM (Byte)	RAM (Byte)	Cache (kByte)	External Interupts (ch)	External Bus	A/D converter (bit x ch)	D/A converter (bit x ch)	16-bit timer (ch)	Input capture (ch)	Output compare (ch)
MB91101	MB91101A	100	3 or 5	50	1	No ROM/External ROM	–	2kB	1	5	Yes	10-bit x 4	–	3	–	–
MB91230	MB91233L	120	3	33.6	2	Mask	256kB	16kB	–	16	–	10-bit x 8	8-bit x 2	4	16-bit x 2	16-bit x 4
	MB91F233	120	3	33.6	2	Flash	256kB	16kB	–	16	–	10-bit x 8	8-bit x 2	4	16-bit x 2	16-bit x 4
	MB91F233L	120	3	33.6	2	Flash	256kB	16kB	–	16	–	10-bit x 8	8-bit x 2	4	16-bit x 2	16-bit x 4
MB91260B	MB91263B	100	5	33	1	Mask	128kB	8kB	–	10	–	10-bit x 12	–	3	16-bit x 4	16-bit x 6
	MB91F264B	100	5	33	1	Flash	256kB	8kB	–	10	–	10-bit x 12	–	3	16-bit x 4	16-bit x 6
MB91265	MB91266	64	5	33	1	Mask	64kB	2kB	–	8	–	10-bit x 11	–	3	16-bit x 4	16-bit x 6
	MB91F267	64	5	33	1	Flash	128kB	4kB	–	8	–	10-bit x 11	–	3	16-bit x 4	16-bit x 6
	MB91F267N	64	5	33	1	Flash	128kB	4kB	–	8	–	10-bit x 11	–	3	16-bit x 4	16-bit x 6
MB91270	MB91F272	100	5	32	2	Flash	256kB	10kB	–	16	Yes	10-bit x 24	–	3	16-bit x 8	16-bit x 8
	MB91F272S	100	5	32	1	Flash	256kB	10kB	–	16	Yes	10-bit x 24	–	3	16-bit x 8	16-bit x 8
MB91301	MB91302A	144	3	68	1	Mask	4kB	4kB	4	9	Yes	10-bit x 4	–	3	16-bit x 4	–
	MB91302A-020	144	3	68	2	No ROM/External ROM	–	4kB	4	9	Yes	10-bit x 4	–	3	16-bit x 4	–
MB91350A	MB91351A	120	3	50	2	Mask	384kB	24kB	–	9	Yes	10-bit x 8	8-bit x 2	4	16-bit x 4	16-bit x 2
	MB91352A	120	3	50	2	Mask	384kB	16kB	–	9	Yes	10-bit x 8	8-bit x 2	4	16-bit x 4	16-bit x 2
	MB91353A	120	3	50	2	Mask	512kB	24kB	–	9	Yes	10-bit x 8	8-bit x 2	4	16-bit x 4	16-bit x 2
	MB91F353A	120	3	50	2	Flash	512kB	24kB	–	9	Yes	10-bit x 8	8-bit x 2	4	16-bit x 4	16-bit x 2
	MB91354A	176	3	50	2	Mask	384kB	16kB	–	17	Yes	10-bit x 12	8-bit x 3	4	16-bit x 4	16-bit x 8
	MB91355A	176	3	50	2	Mask	512kB	24kB	–	17	Yes	10-bit x 12	8-bit x 3	4	16-bit x 4	16-bit x 8
	MB91F355A	176	3	50	2	Flash	512kB	24kB	–	17	Yes	10-bit x 12	8-bit x 3	4	16-bit x 4	16-bit x 8
	MB91F356B	176	3	50	2	Flash	256kB	24kB	–	17	Yes	10-bit x 12	8-bit x 3	4	16-bit x 4	16-bit x 8
MB91360	MB91F362GB	208	5	64	1	Flash	512kB	20kB	–	8	Yes	10-bit x 16	10-bit x 2	6	16-bit x 4	16-bit x 4
	MB91F364G	120	5	64	1	Flash	256kB	16kB	–	8	–	10-bit x 12	10-bit x 2	3	16-bit x 4	16-bit x 2
	MB91F365GB	120	5	64	1	Flash	512kB	36kB	–	8	–	10-bit x 8	10-bit x 2	6	16-bit x 4	16-bit x 2
	MB91F366GB	120	5	64	2	Flash	512kB	36kB	–	8	–	10-bit x 8	–	6	16-bit x 4	16-bit x 2
	MB91366GA	120	5	64	2	Mask	512kB	36kB	–	8	–	10-bit x 8	–	6	16-bit x 4	16-bit x 2
	MB91F367GB	120	5	64	1	Flash	512kB	36kB	–	8	–	10-bit x 8	–	3	16-bit x 4	16-bit x 2
	MB91F368GB	120	5	64	2	Flash	512kB	36kB	–	8	–	10-bit x 8	–	3	16-bit x 4	16-bit x 2
	MB91F369GA	160	5	64	1	Flash	512kB	36kB	–	8	Yes	10-bit x 10	–	6	-	-
	MB91F376G	120	5	64	2	Flash	768kB	36kB	–	8	–	10-bit x 8	–	6	16-bit x 4	16-bit x 2
MB91460	MB91461*	176	3	80	1	No ROM/External ROM	–	64kB	4	16	Yes	10-bit x 13	–	4	16-bit x 4	16-bit x 4
	MB91F467DA	208	3 to 5	96	2	Flash	1088kB	64kB	–	14	Yes	10-bit x 24	–	8	16-bit x 8	16-bit x 4
	MB91F464AA *	100	3 to 5	tbd	2	Flash	416kB	16kB	–	10	–	10-bit x 21	–	8	16-bit x 8	16-bit x 6

Note: * Under development.

Timer PPG timer (ch)	PWM timer (ch)	PWC timer (ch)	Up/Down counter (ch)	I²C (ch)	Serial communication (ch)	UART/ SIO (ch)	CAN (ch)	USB Host (ch)	USB function (ch)	IE Bus	LCDC (seg x com)	Inverter	DMAC (ch)	Note	Evaluation device
–	16-bit x 4	–	–	–	3	3 / –	–	–	–	–	–	–	8	DRAM I/F	MB91V101A
16-bit x 6	–	8-bit x 2	8-bit x 2	–	4	4 / –	–	–	–	–	32 x 4	–	–	–	MB91V230
16-bit x 6	–	8-bit x 2	8-bit x 2	–	4	4 / –	–	–	–	–	32 x 4	–	–	–	MB91V230
16-bit x 6	–	8-bit x 2	8-bit x 2	–	4	4 / –	–	–	–	–	32 x 4	–	–	–	MB91V230
16-bit x 8	–	16-bit x 2	–	–	3	3 / –	–	–	–	–	–	–	5	–	MB91V260B
16-bit x 8	–	16-bit x 2	–	–	3	3 / –	–	–	–	–	–	–	5	–	MB91V260B
16-bit x 4	–	16-bit x 1	–	–	2	2 / –	–	–	–	–	–	–	5	–	MB91V265
16-bit x 4	–	16-bit x 1	–	–	2	2 / –	–	–	–	–	–	–	5	–	MB91V265
16-bit x 4	–	16-bit x 1	–	–	2	2 / –	1	–	–	–	–	–	5	–	MB91V265
16-bit x 8	–	–	8-bit x 2	3	7	7 / –	1	–	–	–	–	–	5	CAN: 32Msg	MB91V280
16-bit x 8	–	–	8-bit x 2	3	7	7 / –	1	–	–	–	–	–	5	-buffer LIN	MB91V280
16-bit x 4	–	–	–	2	3	3 / –	–	–	–	–	–	–	5	SDRAM I/F	MB91V301A
16-bit x 4	–	–	–	2	3	3 / –	–	–	–	–	–	–	5	ProgramLoader	MB91V301A
16-bit x 3	–	–	8-bit x 1	1	6	4 / 2	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 3	–	–	8-bit x 1	1	6	4 / 2	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 3	–	–	8-bit x 1	1	6	4 / 2	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 3	–	–	8-bit x 1	1	6	4 / 2	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 6	–	–	8-bit x 2	1	8	5 / 3	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 6	–	–	8-bit x 2	1	8	5 / 3	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 6	–	–	8-bit x 2	1	8	5 / 3	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 6	–	–	8-bit x 2	1	8	5 / 3	–	–	–	–	–	–	5	–	MB91V350A
16-bit x 8	16-bit x 8	–	–	1	5	3 / 2	3	–	–	–	–	–	5	SMC Sound generotor	MB91FV360GA
16-bit x 4	–	–	–	1	4	2 / 2	1	–	–	–	–	–	5	-	MB91FV360GA
16-bit x 8	–	–	–	1	4	2 / 2	2	–	–	–	–	–	5	Sound generotor	MB91FV360GA
16-bit x 8	–	–	–	1	4	2 / 2	2	–	–	–	–	–	5	Sound generotor	MB91FV360GA
16-bit x 8	–	–	–	1	4	2 / 2	2	–	–	–	–	–	5	Sound generotor	MB91FV360GA
16-bit x 4	–	–	–	1	3	1 / 2	2	–	–	–	–	–	5	-	MB91FV360GA
16-bit x 4	–	–	–	1	3	1 / 2	2	–	–	–	–	–	5	-	MB91FV360GA
16-bit x 4	–	–	–	1	3	1 / 2	2	–	–	–	–	–	5	Sound generotor	MB91FV360GA
16-bit x 8	–	–	–	1	4	2 / 2	2	–	–	–	–	–	5	Sound generotor	MB91FV360GA
16-bit x 8	–	–	–	3	7	7 / -	2	–	–	–	–	–	5	CAN:32Msg-buffer LIN	MB91V460
16-bit x 12	–	–	–	3	5	5/-	3	–	–	–	–	–	5	"CAN:32Msg-buffer LIN	MB91V460
16-bit x 10	–	–	–	1	3	3/-	1	–	–	–	–	–	5	"CAN:32Msg-MB91V460	MB91V460

INTEGRATED SOFTWARE DEVELOPMENT ENVIRONMENT - 'SOLUTIONS FOR V'

Fujitsu's Softune Workbench offers a development environment integrated with the C/C++ compiler, assembler, linker, debugger and editor.

Softune can be used on its own in the development of embedded software for microcontrollers. Fujitsu's 'Solutions for V' can provide an even more advanced program development environment for designers who need to develop high quality embedded software for example for in-vehicle electrical equipment.

The development environment offered by Solutions for V allows the use of CASE tools, consulting and contracted development with UML (Unified Modelling Language), and state charts in the upstream and downstream phases.

State-transition charts are commonly used in the development of in-vehicle equipment, and Softune enables direct connection to CASE tools such as Statemate MAGNUM, RiMC (Rhapsody in MicroC), and ZIPC.

'Solutions for V' tools examples

Upstream Case tool Statemate MAGNUM

I-Logix's Statemate MAGNUM describes the static structure of a control system using an activity chart, which is an extended version of a data flowchart, and describes the system operation using a state chart. A state chart is an extended state-transition chart that enables the hierarchical deployment of the state, the expression
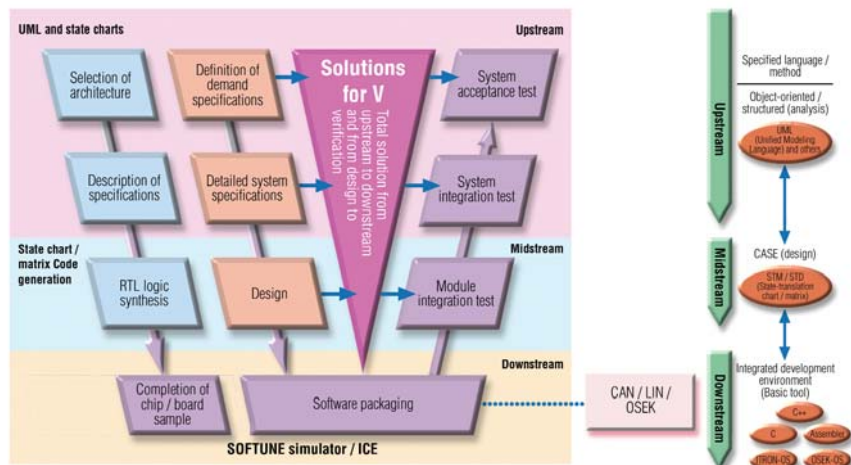
Solutions for V block diagram.

of parallelism, and the expression of time, allowing complex system operations to be described easily.

The tool features high descriptive capability and enables the simulation of a specification model for which the specifications are still incomplete.

Following the confirmation of operation, it can generate a C code able to achieve the same operation as the specifications, and can also execute the C code on a prototype for verification purposes.

Midstream Case tool ZIPC

ZIPC from CATS CO. LTD. is a CASE tool that supports software development in the midstream stage using 'Extended-Hierarchy State-Transition-Matrix Design Method

Version 2.0.' By using the state-transition matrix, it enables the creation of designs with no missing data. Because ZIPC is equipped with functions for editing the state-transition matrix, for debugging OSEK, ITRON (REALOS), and others in the design stage, and for automatically generating C-source code, it contributes to the improvement of software quality and reduction of development man-hours.

It uses a converter for linkage to upstream Statemate MAGNUM, and uses state-transition animation and break-point setting during C-source generation and debugging for connection to downstream Softune.

SOFTUNE – FUJITSU's INTEGRATED SOFTWARE DEVELOPMENT PACKAGE

Fujitsu offers its complete range of MCU Software Tools as part of an integrated package called Softune Workbench, which operates under Windows 95/98, Windows NT4.0, Windows 2000, and Windows XP. This standard package can be used for all Fujitsu MCUs and includes:

ANSI C/C++ Compiler*
Macro Assembler
Linker
Simulator
Emulator
C/C++ Checker*
C/C++ Analyser*

* C++ is only available for 32-bit MCUs.

At the user interface, the Softune Workbench provides easy access to all the tools with improved performance and more features. With this, the designer can concentrate on coding and debugging with improved efficiency but without knowledge of how to start the compiler or linker, etc.

Operational Features

- Simple menu-based, mouse-driven operations
  - GUI language tools
  - Automatic compiling and linking of associated pre-input files
  - Dialogue boxes to facilitate selection of tool options and project settings
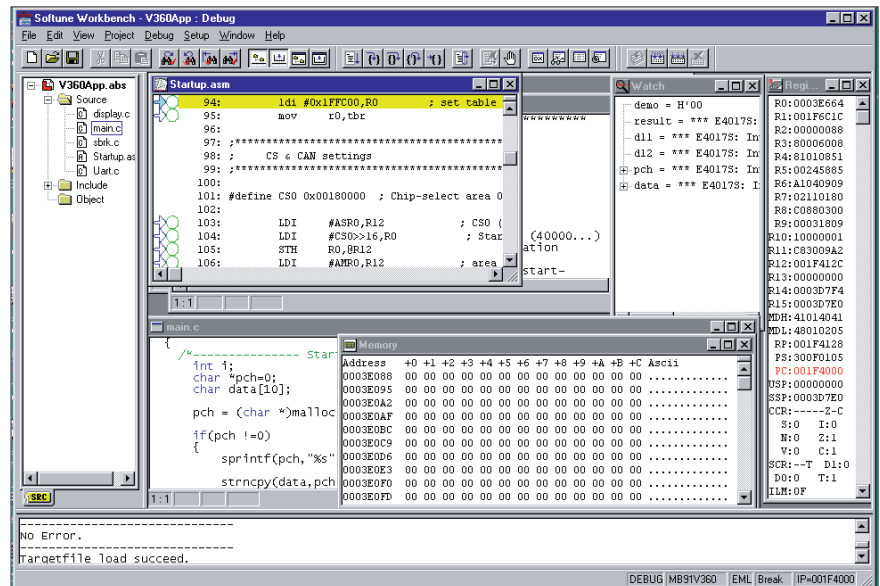
Softune Workbench – user interface Softune GUI simplifies system development.

- Automatic start by linking editor, compiler, assembler, linker and debugger
- JError jump to error by simple double click, allowing editor to point automatically to errors
- Selection of built-in editor with syntax highlighting feature, or user's own preferred editor
- On-line compiler and assembler manual help display
- Customisable environment
- Set-up Wizard for debugging environment
- Save / Restore debugging environment

Debugger Features

- Source-level debugging (C, Assembler or Mixed) / Files appear as designed
- Breakpoints Code/Data (6 HW, 65536 SW) possible on every source-line

- Navigate functions: Go, Go to line, Step, Step out, Step over, Call function, Reset
- Watch (Variables): Automatic update (x sec), Format (Hex, Bin, etc.), Structures
- View of global and local variables
- Register Window: configurable, updated = red
- Memory Window: format, symbolic edit, direct edit, ASCII
- Dis-assembler Window and in-line assembler
- Trace Window (various display modes) including backtrace function
- Misc: Stack follower, time measurement, vector display
- Simulator: I/O-Port stimulus and logging, Interrupt simulation
- Tool-control: command Input, log-files and batch files

ACCEMIC MDE MONITOR DEBUGGER

Fujitsu Microelectronics offers a Monitor Debugger for its 16LX and FR series that allows the debugging of single-chip, MCU embedded applications. The Accemic Monitor Debugger allows downloading of the debugger kernel and the application into the embedded Flash memory of the MCU. The monitor kernel can be started directly to load new programs and execute them under control. There is also the option to start the user application directly after reset and enter debug mode on demand.

A special feature of this debugger is the processor status window, which shows all internal peripherals of the MCU, including pin status and direction. Detailed peripheral windows allow the user to check and modify peripheral settings. Beside the usual available debug functionalities, on-line monitoring, powerful messaging functions can be linked to the application in order to send data and messages to the PC screen.

A well as a standard version, a professional version is also available, offering more powerful features. This version supports up to 16 breakpoints and the Multiprocessor/Multicore debugging

feature allows different processors in a CAN network to be controlled at the same time. With the Accemic HSCI option several communication channels to the target MCU can be used: CAN, UART asynchronous mode, UART synchronous mode, emulation of serial communication via free I/O ports.

Accemic is a Munich-based third party supplier to Fujitsu.

A demonstration version of the Accemic MDE can be downloaded from the Fujitsu Microelectronics Europe (www.fme.gsdc.de/gsdc.htm) or the Accemic (www.accemic.com) web site.

Main Features

- Memory usage
  - ROM: 8kByte monitor Kernel size +256 Byte configuration data
  - RAM: 128 Byte used by Kernel
- Two hardware breakpoints
- Single Step, Step-In, Step-Out, Step-Over functions
- CALL function
- Target message Window
- Debugging on C-Source code or Assembler level
- Dedicated Debug Windows
  - Source Window

- Mixed mode view for C-Source and Assembler view
- Watch Window
- Memory Window
- Stack Window
- Interrupt vector table
- CPU core register Window
- Peripheral status Window
- Processor status Window shows register contents of the internal MCU peripherals
- Browser Window
  - Interrupts, Functions, Units, Local/Global Variables, I/O Registers
- On-line help
- Supported devices:
  - MB90330 & MB90340 Series
  - MB90350 & MB90385 Series
  - MB90390 & MB90425 Series
  - MB90435 & MB90455 Series
  - MB90460 & MB90470 Series
  - MB90495 & MB90520 Series
  - MB90540/545 Series
  - MB90560/565 Series
  - MB90570 & MB90580 Series
  - MB90590/595 Series
  - MB90800 & MB90820 Series
  - MB90945 Series
  - MB91350 Series, MB91270/280 Series
  - MB91F364G, MB91F376G,
  - MB91460 Series

Debugger order numbers - MonDebugger16LX-ACC. and MonDebuggerFR-ACC
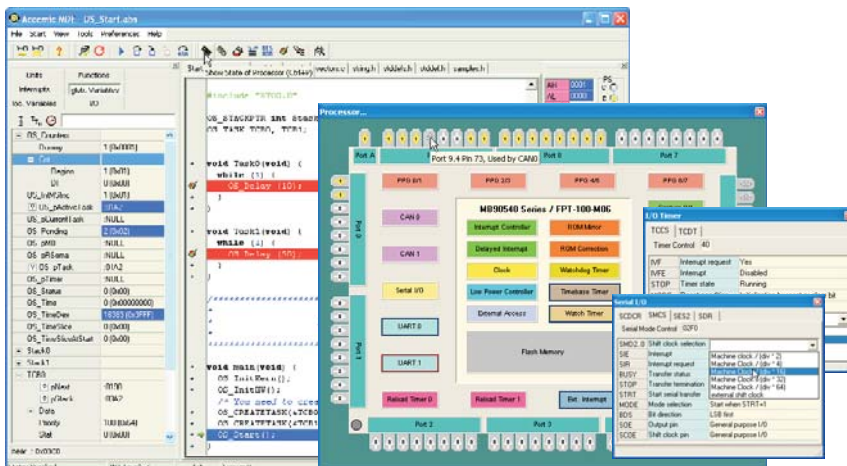
GALEP IV UNIVERSAL SERIAL/PARALLEL MCU PROGRAMMER

Conitec's new fourth generation GALEP IV is a professional palm-sized field programmer with universal I/O capability. It supports almost all Fujitsu Microcontrollers of F^{2}MC-8L, F^{2}MC-16LX and FR families.

Galep IV uses a highly integrated FPGA and each socket pin carries a separate universal pin-driver. Via special programming adapters, Fujitsu MCUs can be programmed parallel or serial In-Circuit (ISP). For serial in-circuit programming both serial synchronous (high speed) and asynchronous programming via RS232 is supported.

GALEP IV is a professional palm-sized field programmer with universal I/O capability.

Features

- Unlimited free software updates via Internet
- Editor included, Load and Save in binary, intel-hex, motorola-s or Jedec file formats.
- Dual power: AC adapter or intern. batteries : 6 recharg. NiMH batteries (AAA/600mAh.)
- Socket converters available for most component packages
- Support for low voltage devices down to 1.3V
- Pocket-sized, ultra-portable format: only 80 x 115 x 33mm
- Simple PC printer port connection
- Supports ISP programming
- Supports remote control

- Allows design of own software programming interface by offering API interface
- Supports autoprogram mode via batchfile execution

Galep IV – ISP Adapter

- Supports Fujitsu 8L, 16LX and FR series
- Target power supply by Galep (max 200mA) or external source selectable
- Target system control signals provided (Target Control Connector) v flexible design provides for easy implementation of future devices

System Requirements

- Pentium Processor
  - 32-bit Windows OS (Win95 /98 /ME /NT4 /2000 /XP)

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www.conitec.net/

REAL-TIME OPERATING SYSTEMS

OSEK/VDX OS Targeted for Automotive Applications

OSEK/VDX is an operating system targeted for automotive applications. It consists of three parts, the OSEK kernel, the communications interface and the network management. Mainly automotive controller networks using CAN interfaces will employ the OSEK operating system. The FR series microcontrollers is supported with optimised drivers for the Fujitsu CAN controller.

OSEK-OS defines the task types 'Basic' and 'Extended'. Basic tasks cannot have a waiting state and so are suitable for those which run completely after each activation. Extended tasks can react to events; they can have a waiting state. OSEK-OS also defines four conformance classes:

- BCC1 – basic tasks, single activation
- BCC2 – basic tasks, multiple activation
- ECC1 – basic and extended tasks, single activation
- ECC2 – basic and extended tasks, multiple activation

The FR series OSEK without CAN driver and network management requires 3.2kB ROM for class ECC1 (standard status)

Further information:
www.vector-informatic.com

embOS OS Targeted for Embedded Applications

embOS* is a real-time operating system for embedded applications designed to offer the benefits of a fully featured multi-tasking system even for hard real-time applications using minimal resources.

All functions of embOS have been placed in individual modules to ensure that only the functions needed are actually linked into the application program, leaving maximum room for the user-program.

Features

- Pre-emptive multi-tasking
- Priority-controlled scheduling
- Round robin scheduling
- Intertask communication
- Software timer
- Minimum interrupt latency
- Fast & efficient
- Small footprint (can be used in single-chip mode)
- Easy-to-use start project
- Versatile
- Support directly by developers
- System analysis via UART
- Profiling support
- TCP/IP- and other network stacks available

Developing applications with embOS

embOS is available in source or object code form. Both come with a ready to go start project:

The first multi-task program is running within five minutes. The start application and usable samples are supplied in source code form. Libraries for all memory models and initialisation of the controller in 'C'-source are included to tailor the system to any application.

Check out the free full-functional trial version, which can be downloaded from the website: www.segger.com

TCP/IP stacks for embOS

As connectivity and Internet became a major issue even in embedded systems, embOS is designed to support TCP/IP and other network stacks. We offer a fully-featured, 100% RFC-compliant TCP/IP stack, that runs on any supported 16 or 32-bit target CPU. It provides virtually all of the protocols, link layers, interfaces and device drivers that are required for networking connectivity applications.

*embOS is a product of Segger

www.segger.de

REAL-TIME OPERATING SYSTEMS

EUROS Enhanced Universal Real-Time Operating System

EUROS is an innovative real-time operating system characterised by short response times, robustness, scalability and flexibility. The primary aim of EUROS development was to create a uniform, hardware-independent operating system for real-time and embedded applications which takes into account the growing complexity and diversity of processor architectures, in order to make software engineering as economical as possible. It separates the user software from the hardware so that the application can easily be ported to state-of-the-art hardware.

www.euros-embedded.com

Key Features

- Supports Fujitsu F²MC-16LX and FR series
- Unlimited number of system objects (tasks, mailboxes, signals, events, semaphores, drivers)
- Up to 256 priorities
- Synchronous and asynchronous system calls
- Memory management supports fixed and variable size memory blocks
- Waiting on multiple objects
- Flexible open driver interface
- Priority-based scheduler with round robin support
- Named system objects organised in clusters (hierarchical object trees)
- Re-entrant ANSI compatible C runtime library
- Generic graphic library
- TCP/IP network stack (BSD4.4 socket interface)
- Web server, FTP server, SMTP client, BOOTP client
- PPP, Ethernet
- CAN / CANopen
- MS-DOS™ compatible file system
- IDE hard disk drivers
- Floppy disk drivers
- Ramdisk, FTL for Flashdisks
- IrDA (IrLAP, IrLMP, IrComm)
- Profibus (slave)
- IEEE1394 (Firewire™)

EUROSvm Euros Virtual Machine

EUROSvm is an implementation of the Java Virtual Machine Specification V1.2. It has been designed for real-time and embedded systems and offers unparalleled support for this target domain. Among the extraordinary features of EUROSvm are:

- Hard real-time execution
- Minimal footprint
- ROMable code
- Native code support
- Dynamic linking
- Fast execution

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