MITSUBISHI

16-bit Microcontrollers

M16C Family

- High-speed processing
- Extensive lineup
- Highly stable Operation
- Simplified softwave development
- Suitable for use in various environments
- Abundant security functions
- Upward compatibilty
- Includes Flash ROM version
- Reduced design cycle time
- Many integrated peripherals

Maximized in every aspect, the M16C offers customers total system support.

The M16C is a high performance microcontrollers that takes all performance features demanded of embedded microcontrollers to the leading edge in the industry.

High-speed processing

The M16C microcontrollers can execute high-function instructions based on versatile addressing modes in two cycles(average for the M16C/80 instructions), providing more processing capability than 32-bit RISC microcomputers for control applications.

Extensive lineup

The M16C microcontrollers comes in an extensive lineup of M16C/20, M16C/60, andM16C/80 families, with various types available in each family.

Highly stable Operation

Thanks to its operation protect functions and anti-runaway instructions, the M16C microcontrollers is free of erratic operation (two to five times the malfunction tolerance of conventional models).

Simplified software development

Finally a microcontrollers designed with easy in mind, the M16C microcontrollers allows for excellent C language program size efficiency and easy assembler program integration.

Suitable for use in various environments

The M16C microcontrollers is available in various types, one with greatly reduced radiated noise (EMI), and one capable of operating over a wide temperature range(-40°C to+125°C).

Abundant security functions

The M16C microcontrollers is complete with ROM code protect functions, for both serial and parallel accesses.

Upward compatibility

The M16C microcontrollers has been developed to maintain compatibility of instructions, pins, and peripheral circuits, removing all worries of product discontinuance.

Includes Flash Rom version

The Flash Rom version broadens the scope of microcontrollers usage by allowing for program changes and use as a nonvolatile data area.

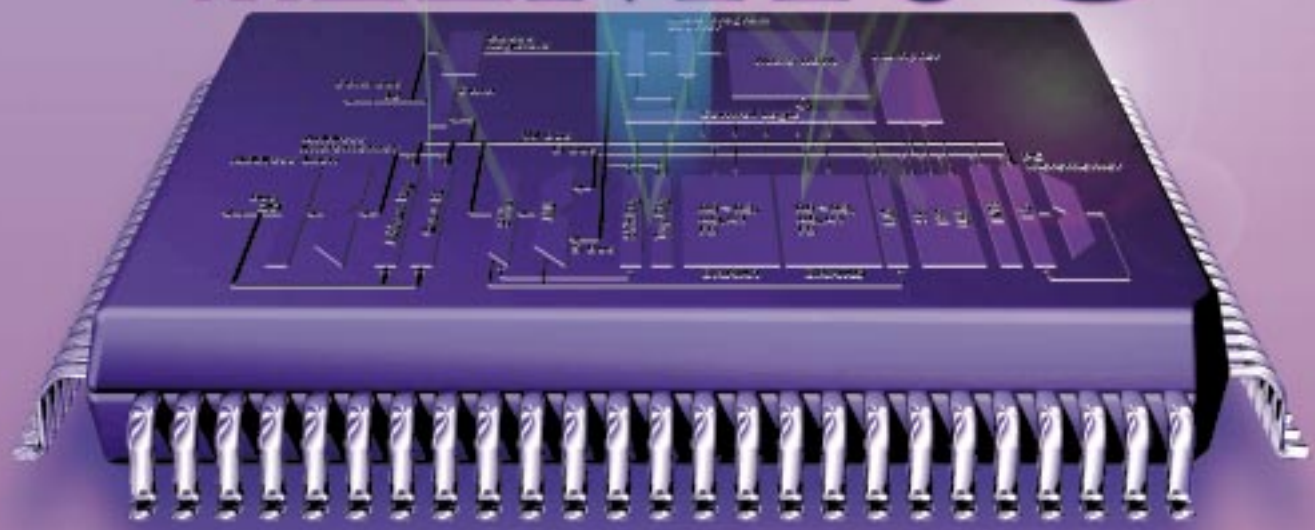
Reduced design cycle time

Improvements have been incorporated to counteract troubles that adversely affect the development period, such as ROM compression needed at a later stage of development to correct excessive program size, the need to redesign the PC board again and again for protection against EMS/EMI, and recovery from software bugs that occur after shipment.

Many integrated peripherals

With an extended lineup and ASSP products, the M16C microcontrollers offers all the necessary functions to meet customer needs.

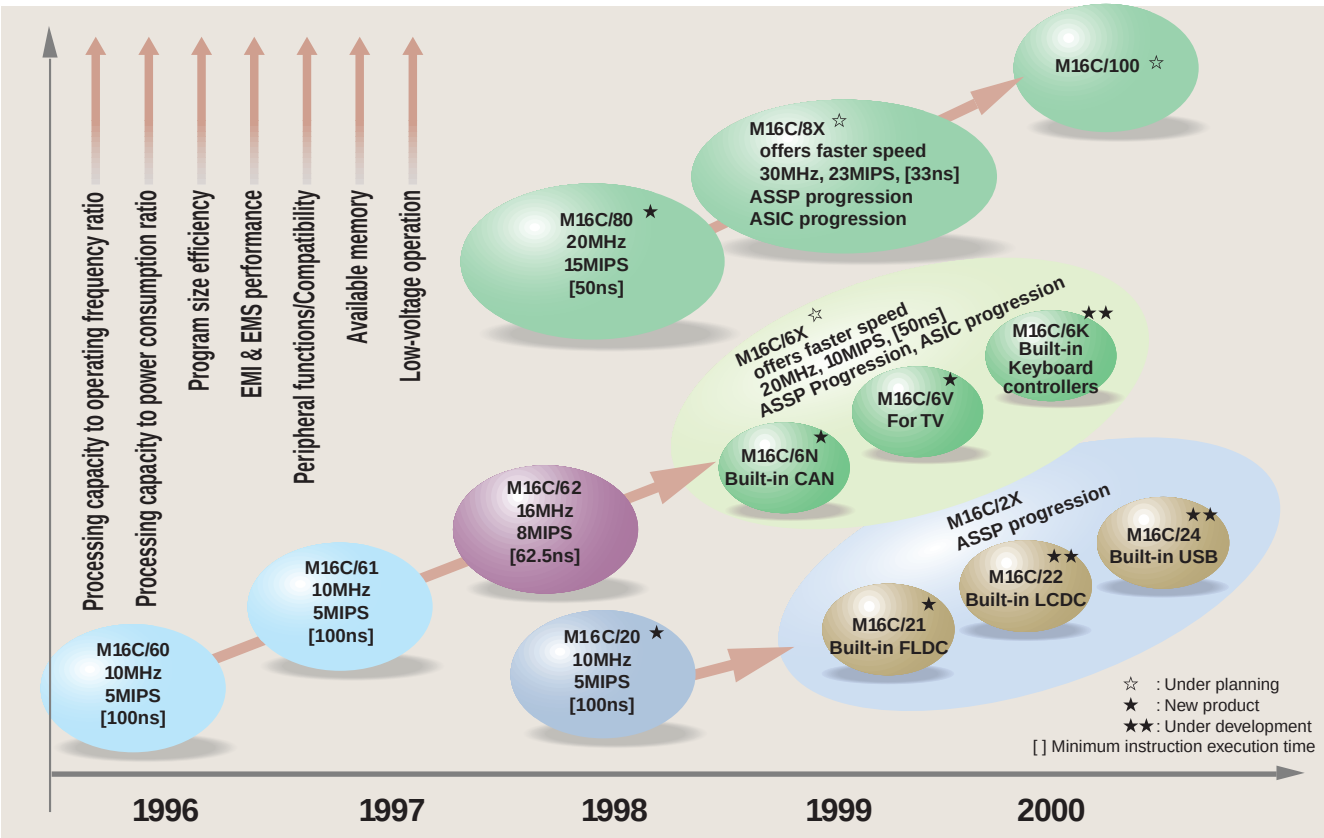
Best Select MCU M16C



The M16C is Mitsubishi's compact, cost-effective flagship 16-bit MCU that combines the advantages of both register and accumulator based architectures providing high speed processing with RISC-like performance. Targeted for a wide range of applications, the M16C features ultra-low power consumption, noise immunity and C programming efficiency, making the M16C the perfect choice for your design. In addition, on-chip functionality, such as 10-bit A-D converters, DMACs, UART channels, and Timers provide for a feature-rich set of peripheral functions all in one device.

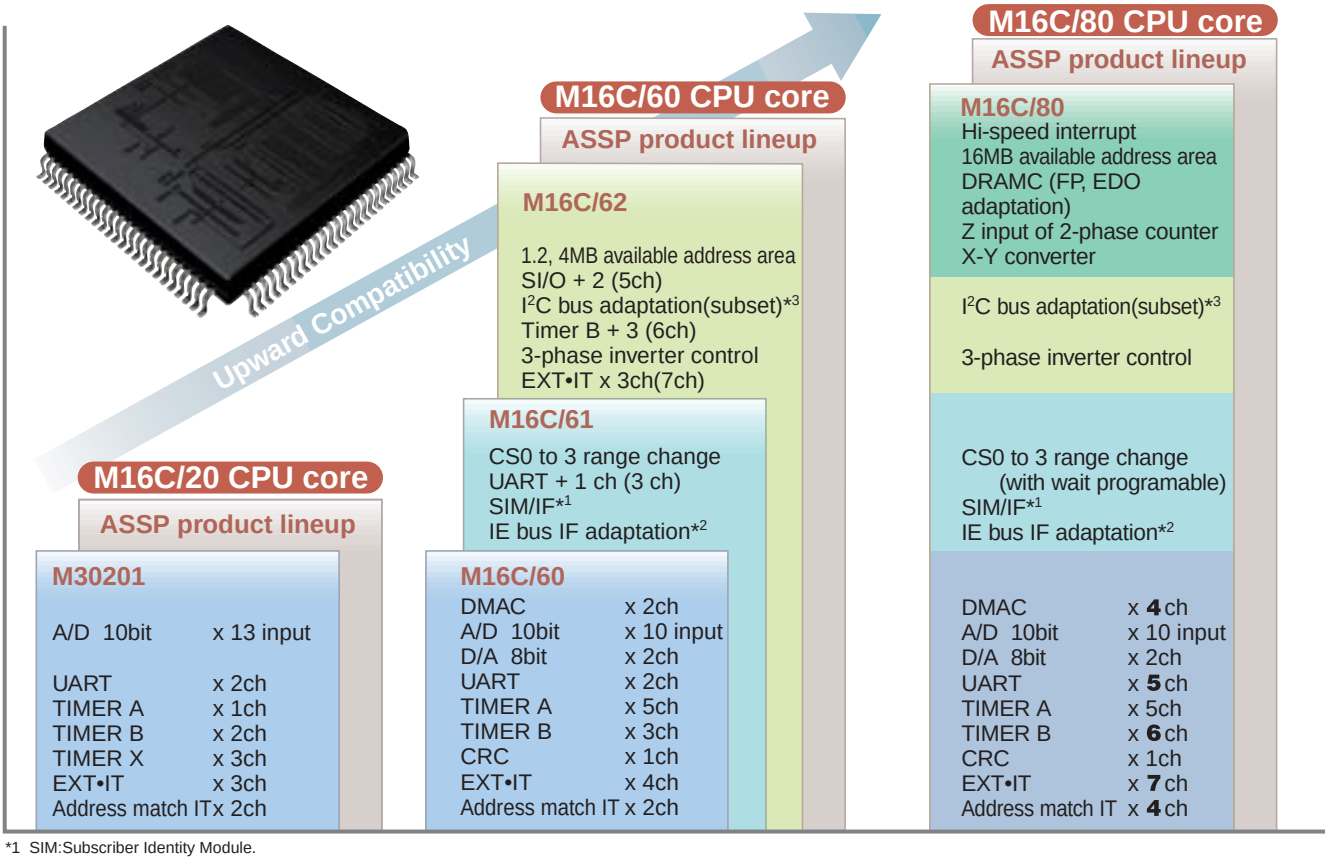
Features of the M16C family

M16C Family Road Map



MIPS value is given in VAXMIPS (default values before optimization of program) .
MIPS for the future chips are target figures.

Smooth Transition from Low to High End Models

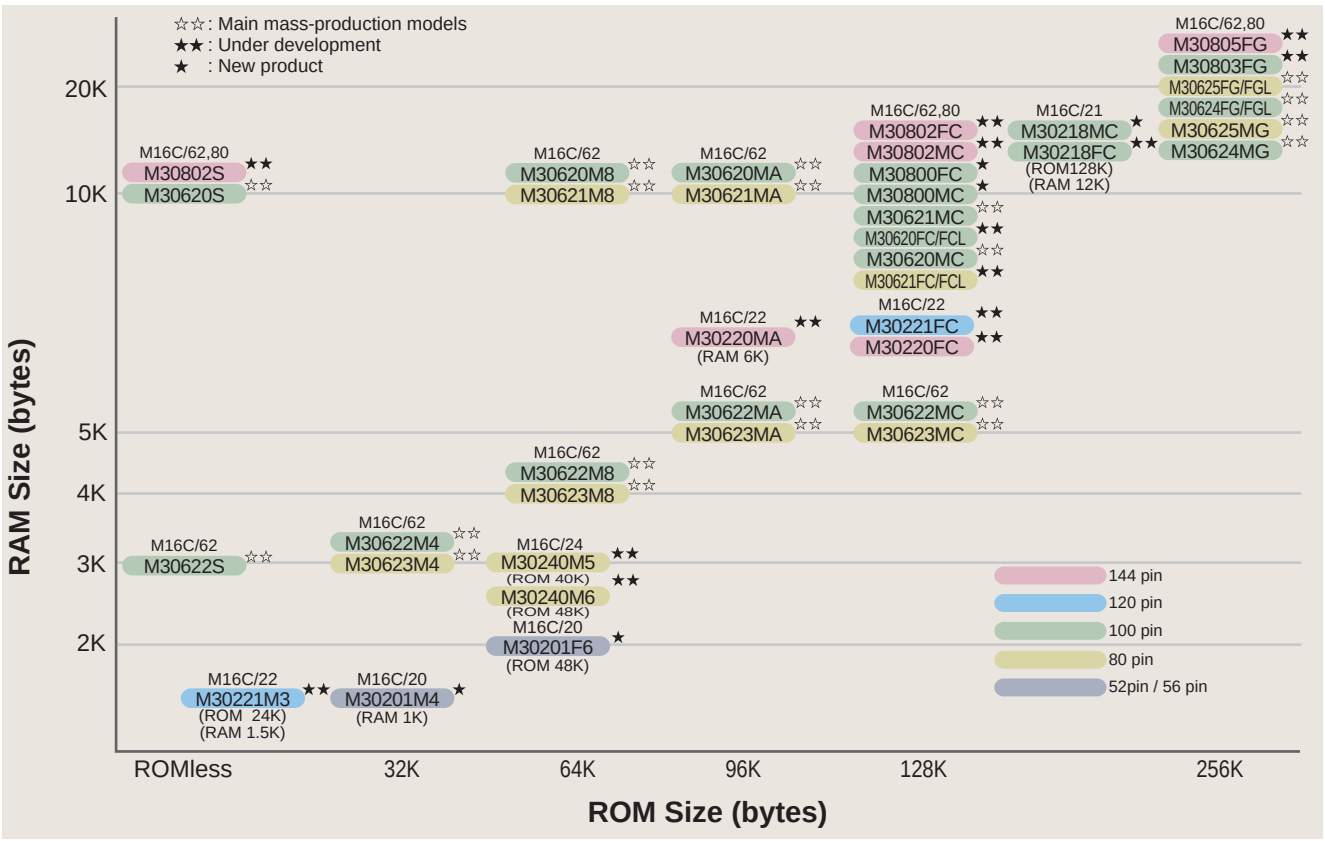


*1 SIM:Subscriber Identity Module.
*2 IE Bus is a trademark of NEC corporation.
*3 I²C BUS is a registered trademark of Philips.

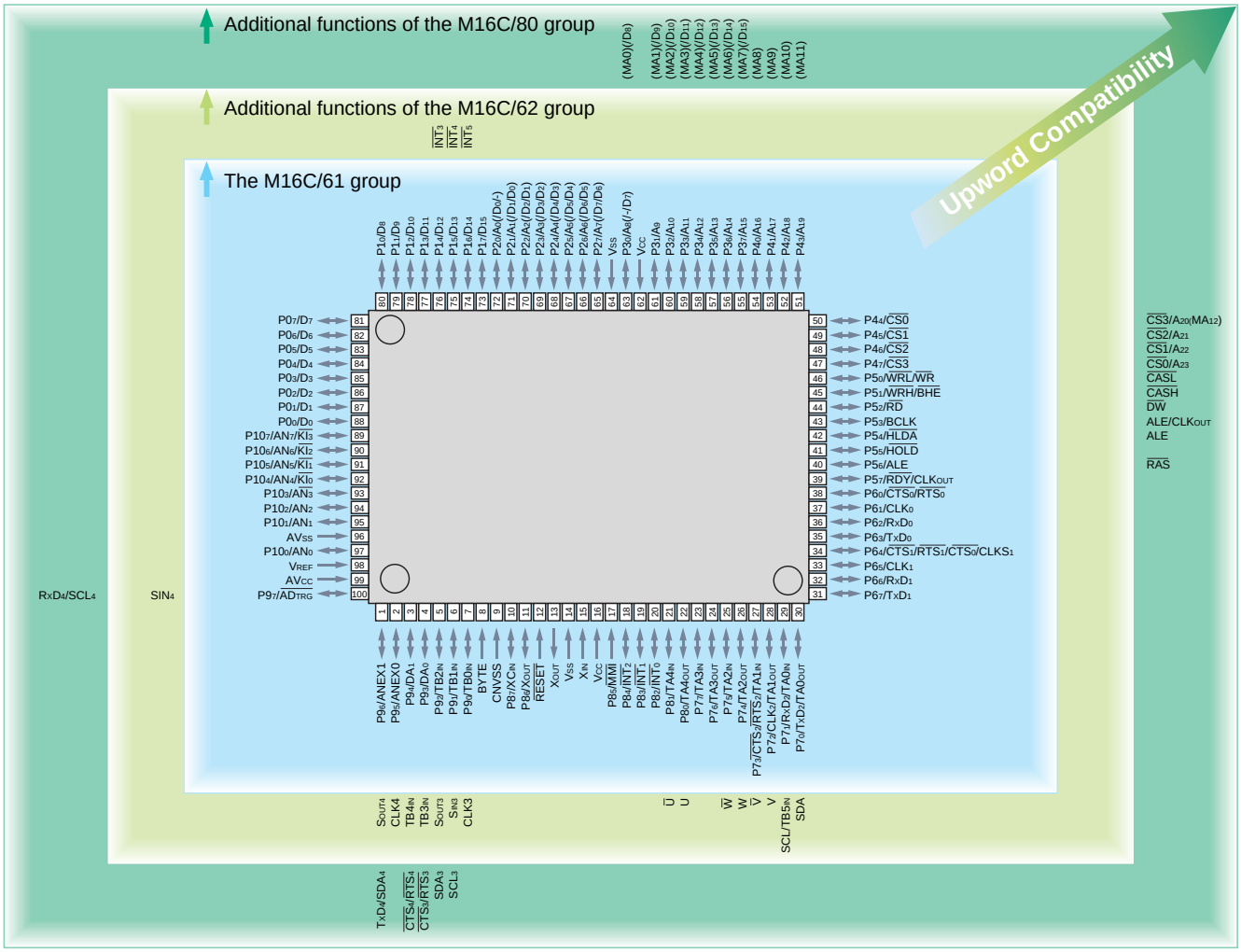
Wide Application Areas

Digital Audio Systems	MD, Car audio systems, VCD, Miniature stereo systems, Composite products	Low EMI noise, Large capacity RAM
Cellular Telephones/Telephones	ISDN, PDC, Caller ID, PHS, DECT, Modem card, GSM, PHS relay stations, AMPS	Ultra-low power consumption, Programming efficiency, Performance
Home Appliances	Computer-control microwave oven, Hot water dispensers, Air-conditioners indoor unit, Air-conditioners outdoor unit, Lighting equipment	Multifunctional peripheral functions
Cameras	Compact Cameras, Single-lens reflex cameras, Digital cameras	Low power consumption, Processing performance
Personal Computer Related Equipment	FAX, Dialer, Hand-writing tablet, Barcode reader, PPC, IC card, Monitor, Printer	Low power consumption, EMS resistance, Peripheral circuitry, Flash ROM
Automotives	Air bags AT, Suspension, Traction control, ABS, Navigation, Stability control, Motor-driven power steering, Engines	EMS resistance, Low EMI noise, Low power consumption, Processing performance
Storage Devices	MD data, CD-ROM 16,24,32 x speed, DVD ROM, DVD RAM, MO, HDD	Processing performance, Low power consumption, Flash ROM
VTR, TV	Low-end servomotors, Digital TVs, Digital VTRs, TELETEXT VTR	Peripheral circuitry, Low EMI noise, Low power consumption
Wireless Data Terminals	Text transfer radios, GPS, Digital pagers, Wireless terminals with large LCD, Middle to high-quality pocket calculator, PDA	Ultra-low power consumption, Ultra-low EMI noise
General Industrial Equipment	Vending machines, Various security equipment, Air conditioning systems, General-purpose controllers, Utility meter (watt-hour calculation), General-purpose inverters, AC servo motors	Processing performance, EMS resistance, Peripheral circuitry, Flash ROM

Wide ROM/RAM Selection

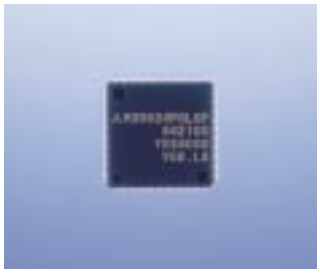


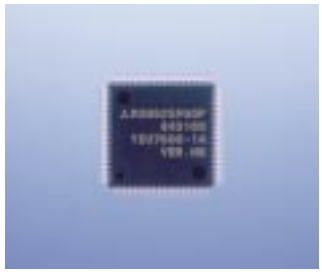
Pin compatible (Pin layouts are compatible to allow for easy upgrading between models across microcontroller groups.)



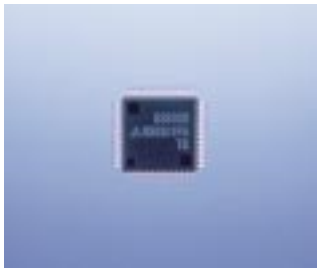
Package Lineup (Available in extensive lineup to meet various application needs)

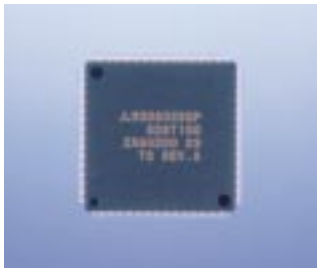

100P6S-A (0.65mm pitch)

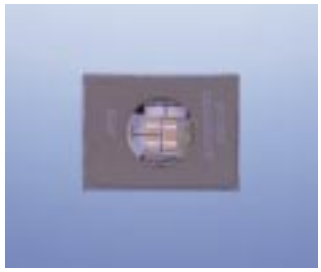

100P6Q-A (0.5mm pitch)


80P6S-A


52P4B


56P6S-A (0.65mm pitch)


144P6Q-A (0.5mm pitch)


100D0

Outline of functional performance

Item	M16C/80	M16C/60	M16C/20
Number of basic instructions	106	91	91
Shortest instruction execution time	50ns(f(XIN)=20MHz)	100ns (f(XIN)=10MHz) 62.5ns (f(XIN)=16MHz M16C/62 only)	100ns (f(XIN)=10MHz)
Memory capacity	ROM: 128Kbytes (ROM-less/Flash version 256Kbytes under development) RAM: 10Kbytes (Flash version 20Kbytes under development)	ROM: ROM-less/32K/64K/96K/128K/256Kbytes 256Kbytes (Flash version) RAM: 3K/4K/5K/10K/20Kbytes 20Kbytes (Flash version)	ROM: 32Kbytes 48Kbytes (Flash version) RAM: 1Kbytes 2Kbytes (Flash version)
Power supply voltage	MASK Version 4.0 to 5.5V (f(XIN)=20MHz) Flash Version 4.2 to 5.5V (f(XIN)=20MHz) MASK, Flash 5V version 2.7 to 5.5V (f(XIN)=10MHz) under planning Flash 3V version under development	M16C/61, M16C/60 4.0V to 5.5V (f(XIN)=10MHz) M16C/62 (MASK, Flash 5V version) 4.2V to 5.5V(f(XIN)=16MHz) M16C/62 (Flash 3Vversion) 2.7V to 3.6V(f(XIN)=10MHz) M16C/61, M16C/60 2.7V to 5.5V (f(XIN)=7MHz 1wait) M16C/62 (MASK, Flash 5V version) 2.7V to 5.5V (f(XIN)=10MHz, 1wait) M16C/62 (Flash 3V version) 2.4V to 3.6V (f(XIN)=7MHz) (2.2V target of limit)	MASK, Flash version 4.0V to 5.5V (f(XIN)=10MHz) MASK version 2.7V to 5.5V(f(XIN)=7MHz, 1wait)
Power consumption	225mW (5V f(XIN)=20MHz) MASK version	25.5mW (Vcc=3V, f(XIN)=10MHz, 1wait)	MASK version 18mW(3V f(XIN)=7MHz, 1wait)
Operating temperature	-40˚C to +85˚C (-40˚C to +125˚C currently under consideration)	-40˚C to +85˚C (-40˚C to +125˚C available)	-40˚C to +85˚C (-40˚C to +125˚C available)
Element construction	CMOS Silicon gate	CMOS Silicon gate	CMOS Silicon gate
Package	100-pin plastic mold (144-pin plastic mold under development)	100-pin/80-pin plastic mold	52-pin/56-pin plastic mold

Note: Products under development are subject to specification changes.

Item	M16C/80	M16C/62	M16C/61	M16C/60	M16C/20
I/O port					
8 bits x 13, 7 bits x 2, 5 bits x 1 (144-pin package)	123 I/O	-	-	-	-
8 bits x 10, 7 bits x 1	87 I/O	87 I/O	87 I/O	87 I/O	-
8 bits x 3, 6 bits x 2, 5 bits x 1, 2 bits x 1 (including LED drive port, 8 bits)	-	-	-	-	43 I/O
Input port					
1 bit x 1 (NMI input)	✓	✓	✓	✓	-
Timer					
Timer A	5	5	5	5	1
Timer mode	✓	✓	✓	✓	✓
Event counter mode (cascade connect possible)	✓	✓	✓	✓	✓
One-shot timer mode (delayed one-shot possible)	✓	✓	✓	✓	✓
Pulse width modulation (PWM) mode	✓	✓	✓	✓	✓
Timer B	6	6	3	3	2
Timer mode	✓	✓	✓	✓	✓
Event counter mode	✓	✓	✓	✓	✓
Pulse period/Pulse width measuring mode	✓	✓	✓	✓	✓
3-phase PWM output mode	✓	✓	-	-	-
Timer X	-	-	-	-	3
Timer mode	-	-	-	-	✓
Event counter mode (cascade connect possible)	-	-	-	-	✓
One-shot timer mode (delayed one-shot possible)	-	-	-	-	✓
Pulse period/Pulse width measuring mode	-	-	-	-	✓
Pulse width modulation (PWM) mode	-	-	-	-	✓
Serial I/O					
CMOS output SI/O (UART/Clock synchronization)	4ch	2ch	2ch	2ch	1ch
CLK polarity selection	✓	✓	✓	✓	✓
CLK phase selection	✓	-	-	-	-
CMOS/Nch open-drain output selection	✓	✓	✓	✓	✓
LSB first/MSB first selection	✓	✓	✓	✓	✓
Continuous reception mode	✓	✓	✓	✓	✓
Transmission interrupt mode selection	✓	✓	✓	✓	✓
Transfer clock multiple-pin output	✓	✓	✓	✓	✓
SIM applicable	✓	-	-	-	-
IE bus applicable	✓	-	-	-	-
I^2C bus applicable	✓	-	-	-	-
Nch open-drain output SI/O (UART/Clock synchronization)	1ch	1ch	1ch	-	-
CLK polarity selection	✓	✓	✓	-	-
CLK phase selection	✓	-	-	-	-
LSB first/MSB first selection	✓	✓	✓	-	-
Continuous reception mode	✓	✓	✓	-	-
Transmission interrupt mode selection	✓	✓	✓	-	-
SIM applicable	✓	✓	✓	-	-
IE bus applicable	✓	✓	✓	-	-
I^2C bus applicable	✓	✓	-	-	-
CMOS output SI/O (Clock synchronization only)	-	2ch	-	-	-
CMOS output SI/O (for UART only)	-	-	-	-	1ch

Item	M16C/80	M16C/62	M16C/61	M16C/60	M16C/20
CRC calculation circuit					
CRC calculation circuit (Generator polynomial: $X^{16}+X^{12}+X^5+1$)	1	1	1	1	-
X-Y conversion circuit					
16 bits x 16 bits X-Y conversion circuit	1	-	-	-	-
Watchdog timer					
Watchdog timer with prescaler (15 bits)	1	1	1	1	1
A-D converter					
10-bit A-D converter	(8+2)ch	(8+2)ch *1	(8+2)ch	(8+2)ch	(8+5)ch
One-shot A-D conversion	✓	✓	✓	✓	✓
Repeat A-D conversion	✓	✓	✓	✓	✓
Single sweep A-D conversion	✓	✓	✓	✓	✓
Repeat sweep A-D conversion (Conversion cycle stacking ON/OFF)	✓	✓	✓	✓	✓
Sample & Hold function (Sampling time: 3 cycles)	✓	✓	✓	✓	✓
8-bit A-D/10-bit A-D selection function (28 cycles/33 cycles)	✓	✓	✓	✓	✓
External triggered A-D conversion start function	✓	✓	✓	✓	-
External operation amplifier connection function	✓	✓	✓	✓	-
Analog input pin expansion function	✓	✓	✓	✓	✓
Vref connect/disconnect selection	✓	✓	✓	✓	✓
D-A converter					
8-bit D-A converter	2ch	2ch	2ch	2ch	-
DMAC					
DMAC	4ch *2	2ch	2ch	2ch	-
Single transfer	✓	✓	✓	✓	-
Repeat transfer	✓	✓	✓	✓	-
Number of DMA request factors	24	16	16	15	-
DRAMC					
DRAMC	1ch	-	-	-	-
EDO applicable	✓	-	-	-	-
First page applicable	✓	-	-	-	-
CAS before RAS refresh	✓	-	-	-	-
Self refresh	✓	-	-	-	-
Interrupt					
Number of internal interrupts	29	25	20	17	9
Number of external interrupts	8	8	5	5	3
Number of software interrupts	4	4	4	4	4
Number of interrupt levels	7	7	7	7	7
High-speed interrupts (internal / external)	1 *3	-	-	-	-
Clock generating circuit					
XIN	1ch	1ch	1ch	1ch	1ch
Maximum operation frequency 10MHz (no wait)	✓	✓	✓	✓	✓
Maximum operation frequency 16MHz (no wait)	✓	✓	-	-	-
Maximum operation frequency 20MHz (no wait)	✓	-	-	-	-
XCIN (Subclock)	1ch	1ch	1ch	1ch	1ch
Maximum operation frequency 50KHz	✓	✓	✓	✓	✓
External bus					
16M-byte addressing space	✓	-	-	-	-
Address area expansion (1.2Mbytes / 4Mbytes)	-	✓	-	-	-
Chip select output (CS0 / CS1 / CS2 / CS3)	✓	✓	✓	✓	-
(RD,BHE,WR) / (RD,WRH,WRL) selection	✓	✓	✓	✓	-
Multiplex bus / Separate bus selection	✓	✓	✓	✓	-
Number of address bus switch (16 / 20)	✓	✓	✓	✓	-
Data bus width selection (8bits / 16bits)	✓	-	-	-	-
Variable 1 to 3 wait cycles insert selection	✓	-	-	-	-
Wait insert selection	-	✓	✓	✓	-

*1: M30622MCT and M30623MCT support 24 + 2 ch.
*2: Internal registers are used partly.
*3: Only one line of external or internal interrupt can be set.

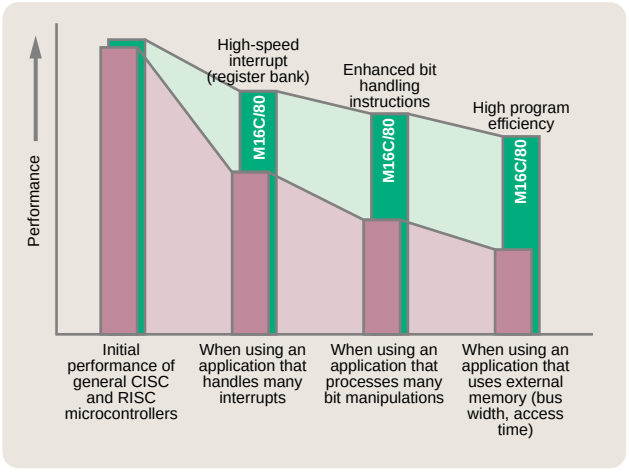
The 80 series for the dawn of a new age

CPU performance of the M16C/80

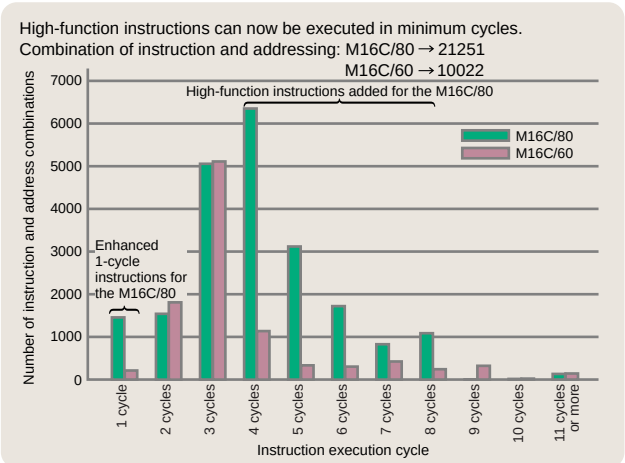
The performance of the M16C/80 is maintained even under varying program conditions.

1. **Fewer instruction cycles** even at low frequency.
2. **High-speed interrupt hardware** efficiently processes frequents multiple interrupts.
3. Multiple high speed bit manipulation processing due to **bit instructions and X-Y converter**.
4. No bus collisions when operating with external memory because of **high instruction efficiency**.
5. **High speed sum-of-products operation** (as in DSP) using a multiplier circuit.

CPU processing capabilities matched to the actual application needs



Instruction Cycle Distribution



Abundant 1-cycle execution instructions

Addressing modes executable in one cycle have been added for the frequently used instructions of the M16C/80.

Instructions that have 1-cycle execution addressing (39 instructions out of 106 instructions)

Classification	Instructions	Function
Arithmetic operation 12 out of 29 instructions	ABS	ABSolute
	ADC	ADdition with Carry
	ADCF	ADdition Carry Flag
	ADD	ADDition
	CMP	CoMPare
	DEC	DECrement
	EXTS	EXTend Sign
	EXTZ	EXTend Zero
	INC	INCrement
	NEG	NEGate
	SBB	SuBtract with Borrow
	SUB	SUBtract

Classification	Instructions	Function
Logic operation 5 out of 5 instructions	AND	AND
	NOT	NOT
	OR	OR
	TST	TeST
	XOR	eXclusibe OR
Transfer 3 out of 3 instructions	MOV	MOVe
	PUSH	PUSH
	PUSHM	PUSH Multiple
Bit manipulation 5 out of 14 instructions	BCLR	Bit CLeaR
	NOT	Bit NOT
	BNTST	Bit Not TeST
	BSET	Bit SET
	BTST	Bit TeST

Classification	Instructions	Function
Shift 5 out of 5 instructions, when shifting one bit	ROLC	ROtate to Left with Carry
	RORC	ROtate to Right with Carry
	ROT	ROTate
	SHA	SHift Arithmetic
	SHL	SHift Logical
Other	FCLR	Flag register CLeaR
	FSET	Flag register SET
	INDEX	INDEX Type
	INTO	INTerrupt on Overflow
	JCnd	Jump on Condition
	LDC	LoaD Control register
	NOP	No Operation
	PUSHC	PUSH Control register
	SCCnd	Store Condition on Condition

- Register to register
- Register to memory
- Immediate to register
- Immediate to memory

These addressing modes can be executed in one cycle.

Enhanced 32-bit instructions

The 32-bit operations executed by the following instructions of the M16C/80 have been enhanced.

Classification	Function	Addressing modes
ADD	ADDition	Immediate to register, Immediate to memory, Register to register, Register to memory, Memory to register, Memory to memory
SUB	SUBtract	Immediate to register, Immediate to memory, Register to register, Register to memory, Memory to register, Memory to memory
CMP	CoMPare	Immediate to register, Immediate to memory, Register to register, Register to memory, Memory to register, Memory to memory
MOV	MOVe	Immediate to register, Immediate to memory, Register to register, Register to memory, Memory to register, Memory to memory
PUSH	PUSH	Immediate, Register, Memory
SHA	SHift Arithmetic	Register, Memory (R2R0 register only for the M16C/62)
SHL	SHift Logical	Register, Memory (R2R0 register only for the M16C/62)

Processing Performance & Program Size Efficiency

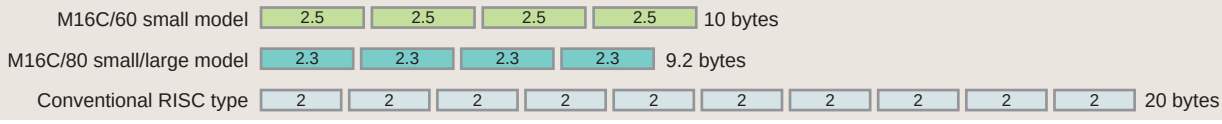
Comparison of M16C/80 With Conventional RISC Microcontroller

Program size comparison image for large models

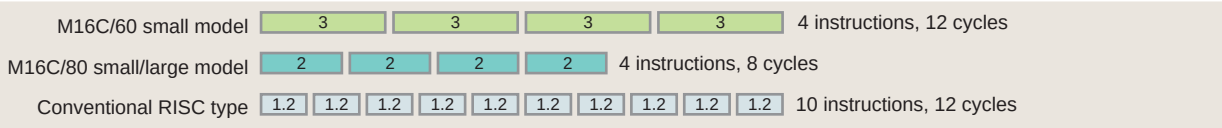
[With M16C, large models are 16 Mbytes program models for both data area and program area.]

	M16C/60 Small model	M16C/80 Small & large model	Conventional RISC type
1. Comparison of avg. number of executed instructions required for same processing	4	4	10
2. Avg. number of executed cycles	3	2	1.2
3. Avg. number of executed instruction bytes	2.5	2.3	2

Comparison of program size



Execution processing comparison

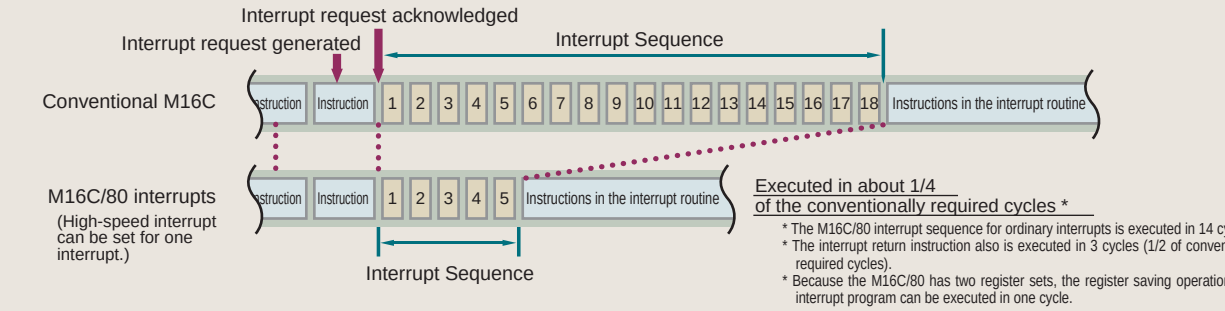


With M16C/60, small models are program models with data area within 64 K-bytes and program area within 1 M-byte.

High-speed interrupts

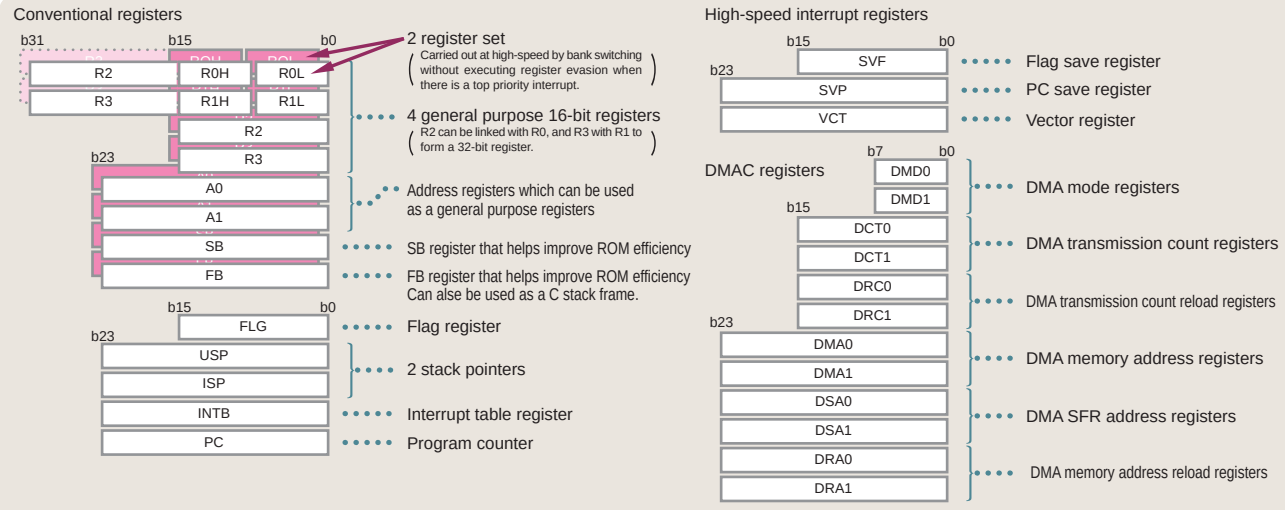
Highest interrupt response speed among comparable classed microcontrollers

Processing capability has been increased by speeding up interrupt acknowledge and return.



Register Configuration

The M16C Series offers addressing between register and register, register and memory, and memory and memory, thus providing greater program freedom.



Instruction Set Assignment

Instruction Set Assignment

M16C instructions use four formats: zero, short, quick and general.

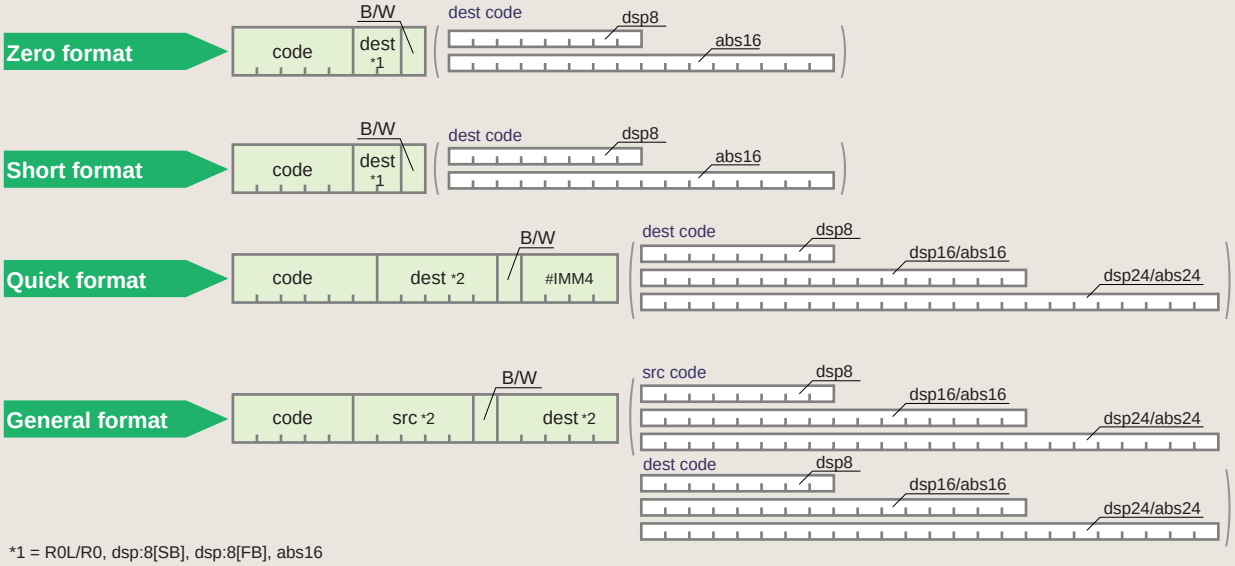
Zero Format & Short Format

The zero and short formats are used frequently with programs which use 8-bit registers.

Make it possible to create compact programs.

Quick Format & General format

Quick and general formats not only operate 8-bit registers, but offer an excellent selection of addressing options that enable unrestricted 16-bit register and memory operations.



*1 = R0L/R0, dsp:8[SB], dsp:8[FB], abs16
*2 = R0L/R0/R2R0, R1L/R1/R3R1, R0H/R2, R1H/R3, A0, A1, [A0], [A1], dsp:8[A0], dsp:8[A1], dsp:8[SB], dsp:8[FB], dsp:16[A0], dsp:16[A1], dsp:16[SB], dsp:16[FB], dsp:24[A0], dsp:24[A1], abs16, abs24
#IMM4 = immediate

The M16C CPU provides generic addressing for necessary instructions, thus enabling extreme freedom when creating programs (For example, memory-memory computation without using a register is possible). However you can largely enhance usage efficiency of the program memory by shortening frequently used instructions and addressing modes.

Addressing inside ▭ boxes is emphasized.

Shortened Instructions

Instruction format using fewer bytes for expressing frequently used instructions.

SRC \ DST	R0L/R0/R2R0	R0H/R2	R1L/R1/R3R1	R1H/R3	A0/A1	[A0]/[A1]	dsp8[A0]/dsp8[A1]	dsp16[A0]/dsp16[A1]	dsp8[SB]/dsp8[FB]	dsp16[SB]	abs16	dsp24[A0]/dsp24[A1]	dsp16[FB]	abs24
R0L/R0/R2R0					●				●		●			
R0H/R2														
R1L/R1/R3R1														
R1H/R3														
A0/A1														
[A0]/[A1]														
dsp8[A0]/dsp8[A1]														
dsp16[A0]/dsp16[A1]														
dsp8[SB]/dsp8[FB]	●				●									
dsp16[SB]														
abc16	●				●									
IMM	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp24[A0]/dsp24[A1]														
dsp16[FB]														
abs24														

Generic Instructions

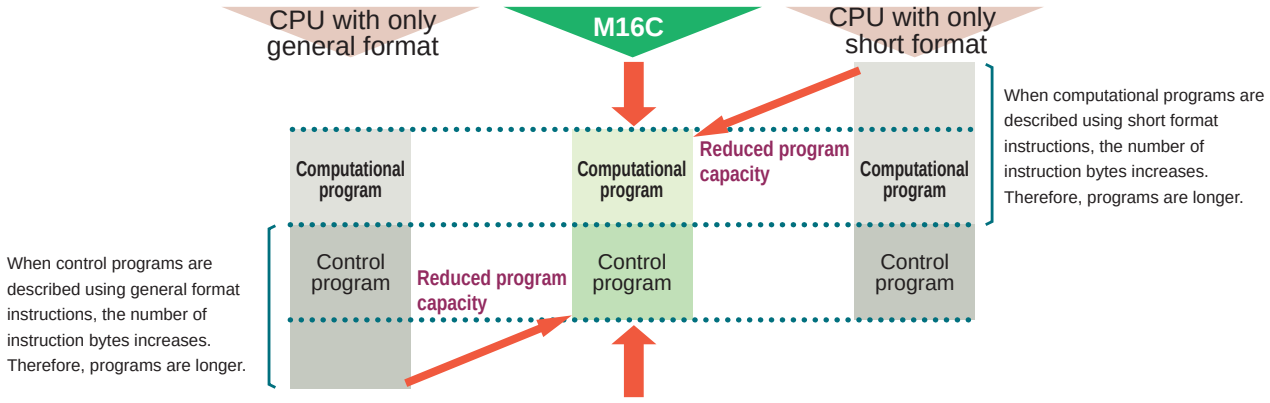
Instruction format with good orthogonality made possible by combination of addressing.

SRC \ DST	R0L/R0/R2R0	R0H/R2	R1L/R1/R3R1	R1H/R3	A0/A1	[A0]/[A1]	dsp8[A0]/dsp8[A1]	dsp16[A0]/dsp16[A1]	dsp8[SB]dsp8[FB]	dsp16[SB]	abs16	dsp24[A0]/dsp24[A1]	dsp16[FB]	abs24
R0L/R0/R2R0	●	●	●	●	●	●	●	●	●	●	●	●	●	●
R0H/R2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
R1L/R1/R3R1	●	●	●	●	●	●	●	●	●	●	●	●	●	●
R1H/R3	●	●	●	●	●	●	●	●	●	●	●	●	●	●
A0/A1	●	●	●	●	●	●	●	●	●	●	●	●	●	●
[A0]/[A1]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp8[A0]/dsp8[A1]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp16[A0]/dsp16[A1]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp8[SB]/dsp8[FB]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp16[SB]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
abs16	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IMM	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp24[A0]/dsp24[A1]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
dsp16[FB]	●	●	●	●	●	●	●	●	●	●	●	●	●	●
abs24	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Instruction Set (1)

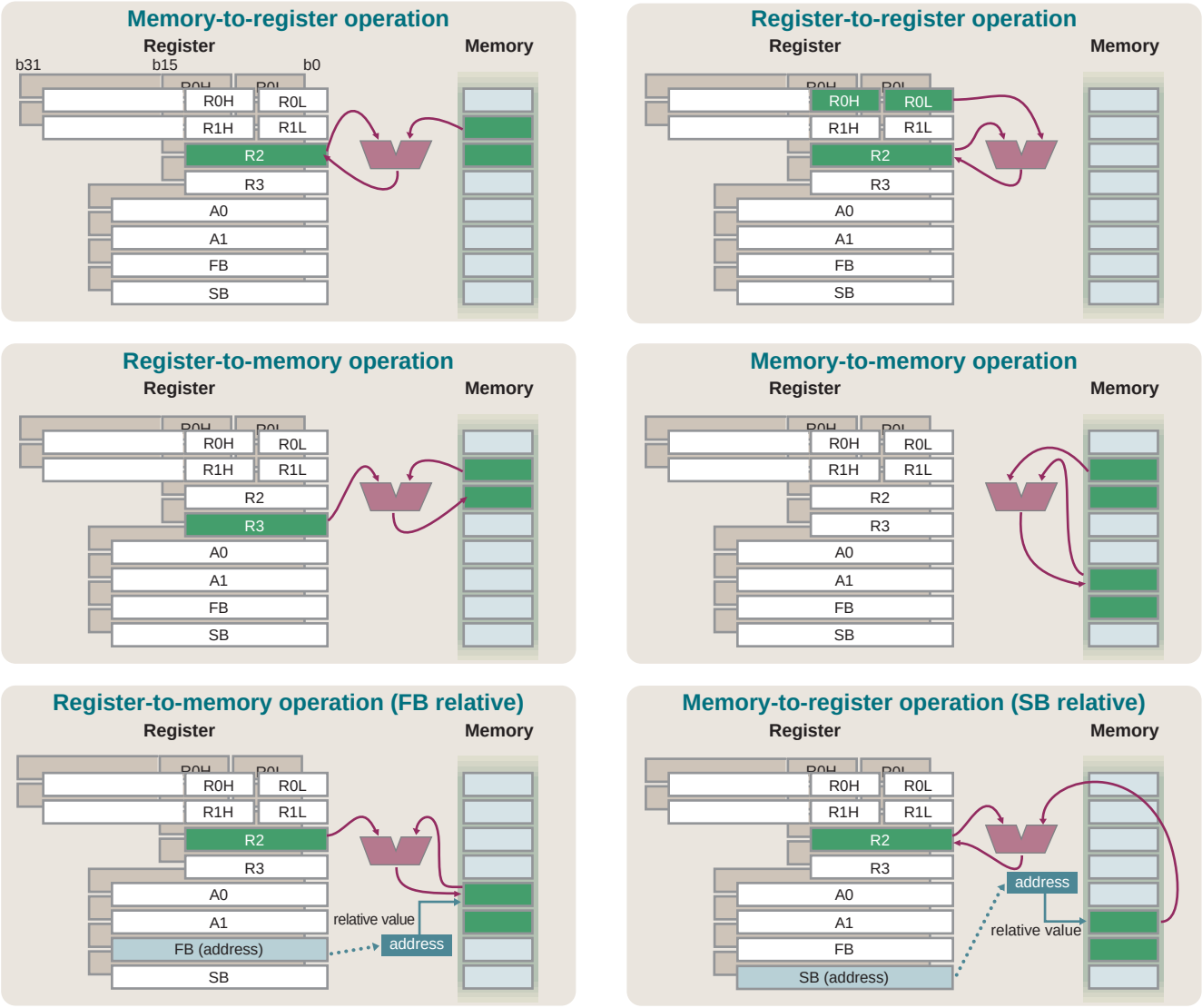
Programming Efficiency

The M16C achieves highly compact program size both with computational programs and control-oriented programs because both highly flexible general format instructions and low-byte short format instructions are available.



Because programs are highly efficient, the most compact programs in the industry can be created regardless of the ratio of computational processing to control processing.

M16C addressing is not only possible for register-based operations but also for direct memory access. Moreover, the M16C supports memory access by absolute address, indirect address, relative address, stack and other addressing modes.



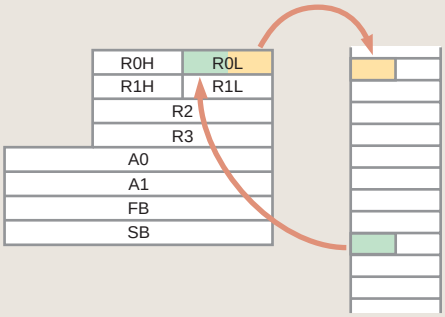
Instruction Set (2)

● Transfer Instructions

Transfer instructions are available for every use including 4-bit transfers, continuous data transfers and conditional transfers.

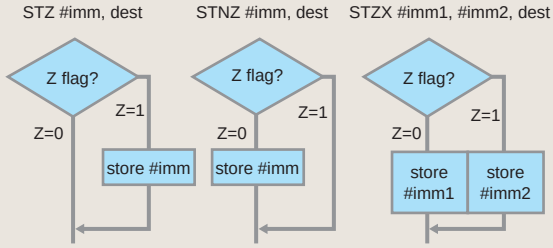
MOVHH (MOVe High to High nibble)
MOVHL (MOVe High to Low nibble)
MOVLH (MOVe Low to High nibble)
MOVLL (MOVe Low to Low nibble)

Function: Transfers 4 bits of data from register-to-register or to/from memory.

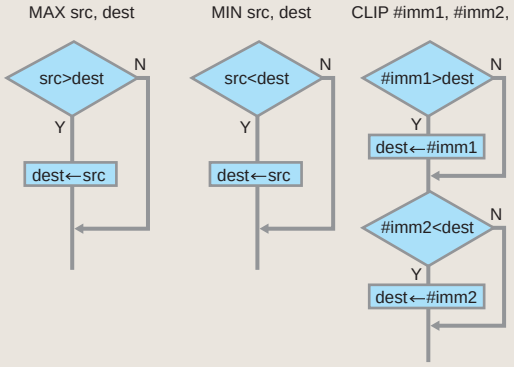


STZ (STore on Zero)
STNZ (STore on Not Zero)
STZX (STore on Zero or eXchange)

Function: Stores immediate data from the Z graph in R0L, R0H or memory.

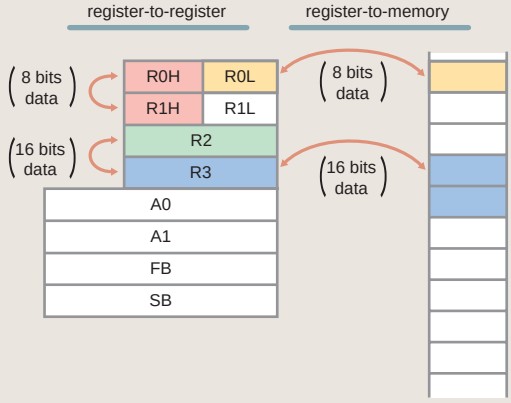


MAX (MAX select) Function: Maximum value selection
MIN (MIN select) Function: Minimum value selection
CLIP (CLIP) Function: Maximum value and minimum value selection



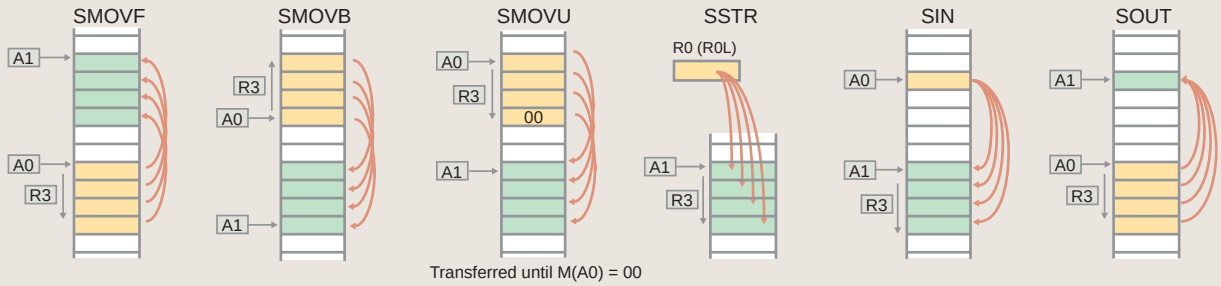
XCHG (eXCHanGe)

Function: Exchanges data between registers or between a register and memory.



SMOVF (String MOVe Forward)
SMOVB (String MOVe Backward)
SMOVU (String MOVe Unequal)
SSTR (String SToRe)
SIN (String INput)
SOUT (String OUTput)

Function: Transfer data continuously. (Can also execute interrupt instructions while executing other instructions.)



Transferred until M(A0) = 00

Instruction Set (3)

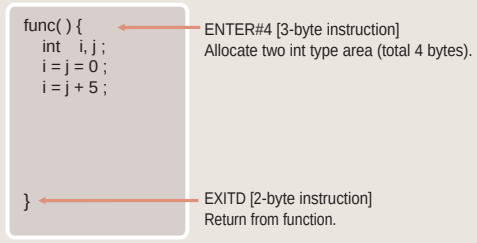
● C Language / RTOS Exclusive Instructions

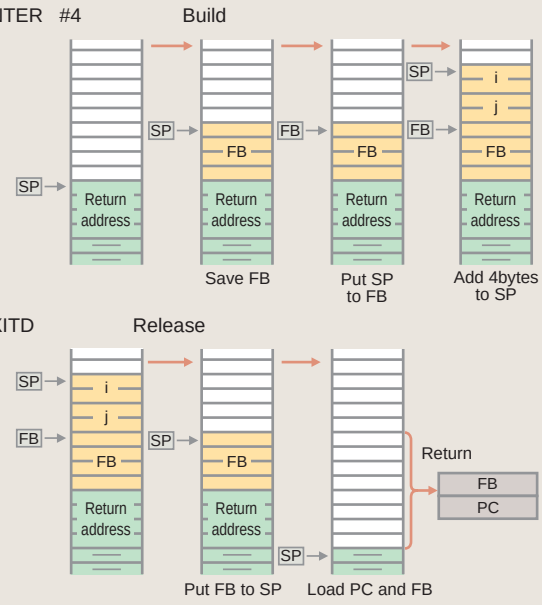
Even with C language, it is possible to develop highly efficient small size programs.

ENTER (ENTER function)

EXITD (EXITD function)

Function : Build and deallocate stack frame

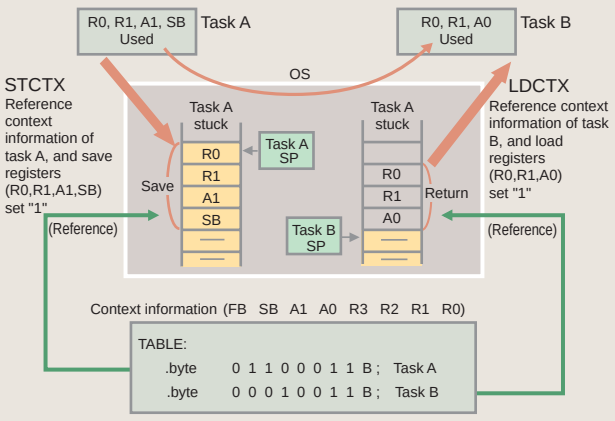




STCTX (STore ConTeXt)

LDCTX (LoaD ConTeXt)

Function: Batch save / batch restore for specified registers



● Branch Instructions

Branch instructions can be executed according to branch distance and usage, while requiring only the minimum amount of program space.

JMP.length (JuMP)

Function: Unconditional branch

1. JMP.S (Smallest code branch instruction) (1byte)
   Branch to the PC relative address value from +2 to +9
2. JMP.B (2bytes)
   Branch to the PC relative address value from -128 to +127
3. JMP.W (3bytes)
   Branch to the PC relative address value from -32768 to +32767
4. JMP.A (4bytes)
   Branch to the 20-bit absolute address value

The branch distance specifier (.S, .B, .W, or .A) can be omitted.

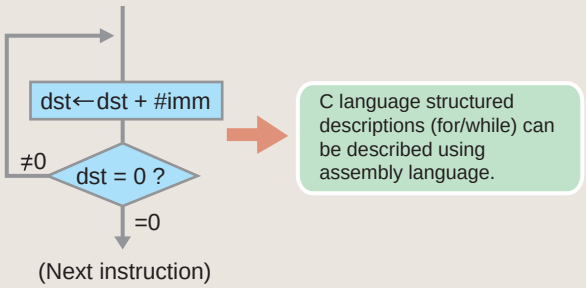
→ The assembler selects the appropriate branch distance specifier.

ADJNZ (ADdition then Jump on Not Zero)

SBJNZ (SuBstruct then Jump on Not Zero)

Function: Add & conditional branch
Subtract & conditional branch

ex. ADJNZ #imm,dst,label (imm: -8~+7)



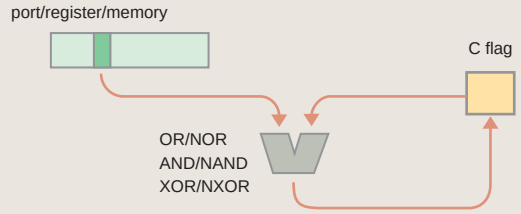
Instruction Set (4)

● Bit Instructions

The M16C offers excellent data manipulation in bit units, including bit logic operations, conditional bit transfers, etc.

BAND (Bit AND carry flag)
BNAND (Bit Not AND carry flag)
BOR (Bit OR carry flag)
BNOR (Bit Not OR carry flag)
BXOR (Bit eXclusive OR carry flag)
BNXOR (Bit Not eXclusive OR carry flag)

Function: Bit operation



BMcnd (Bit Move condition)

(BMEQ/Z , BMNE/NZ , BMPZ , BMN , BMGEU/C , BMGTU , BMLEU , BMLTU/NC , BMGE , BMGT , BMLE , BMLT , BMO , BMNO)

Function: Transfers true/false value based on test condition.

The wide range of transfer destinations includes all bits in the C flag and registers and memory.

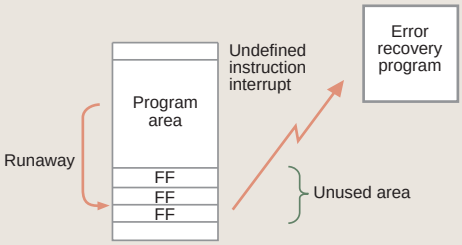
ex1	ex2	ex3
BMGTU dst True/false condition > 0 If true: dst ←1 If false: dst ← 0	BMLEU dst True/false condition≦0 If true: dst ←1 If false: dst← 0	BMEQ dst True/false condition =0 If true: dst ←1 If false: dst← 0

● Other

The M16C also has effective error recovery.

BRK (BReaK)
UND (UNDefined instruction)

Simple instruction codes for program error recovery in unused areas of the program memory are accomplished using the break code (00_{16}) or the undefined instruction (FF_{16}).



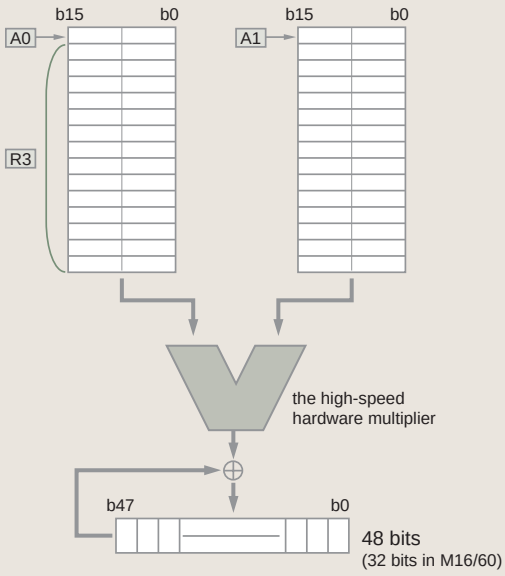
● High Level Operation Instructions

The M16C supports sum of products operation.

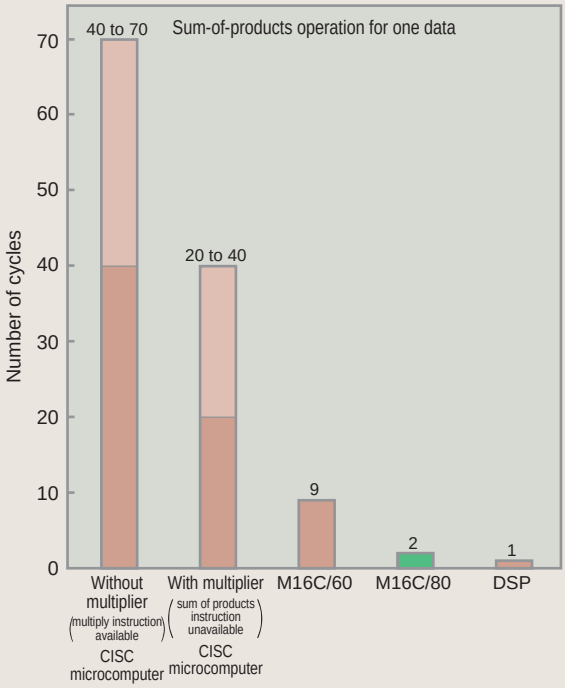
RMPA (Repeat MultiPle and Accumulate)

Function: Sum operations

High-speed hardware multiplier

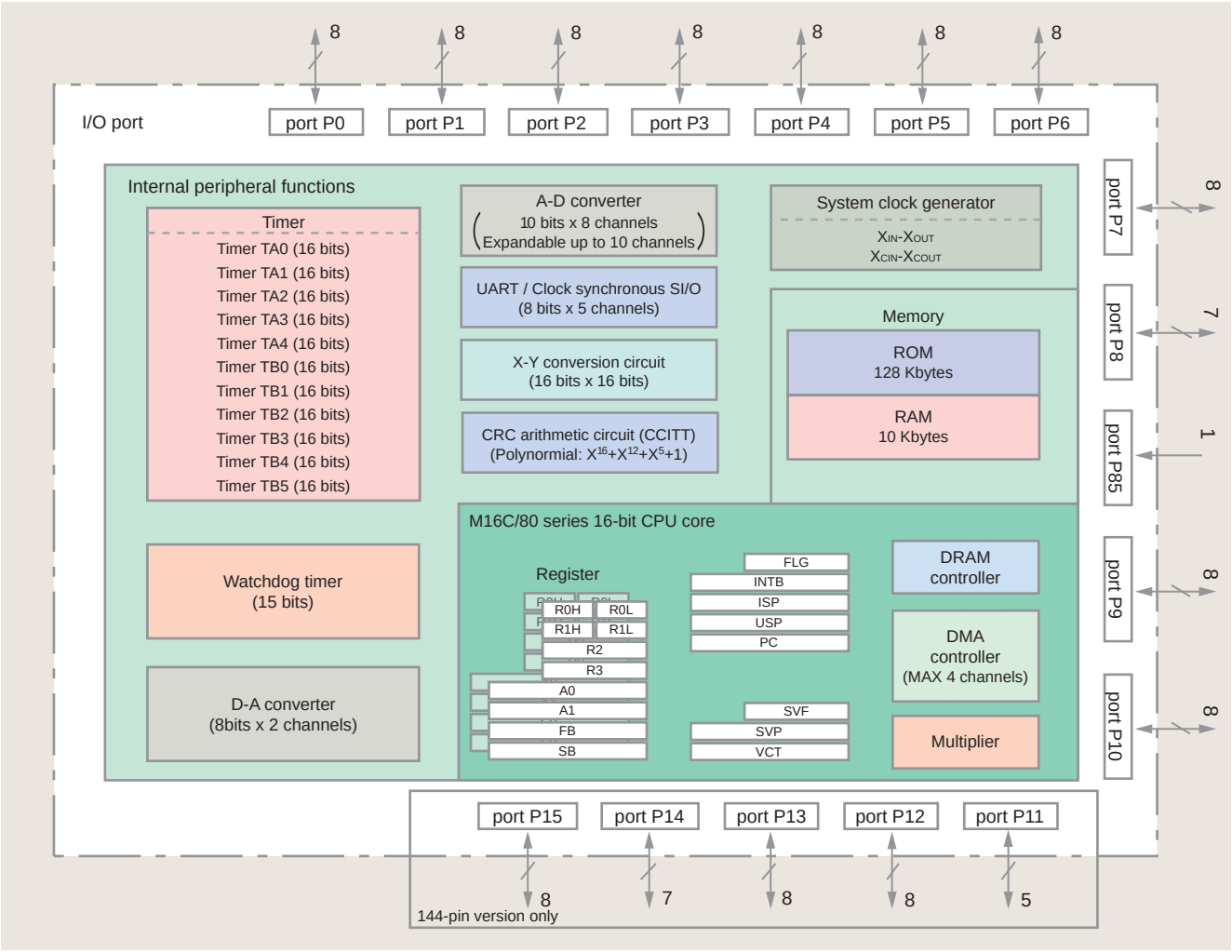


The sum of products operation for one value can be executed in two cycles by using the high-speed hardware multiplier. Interrupts can be executed even when this operation is under way.

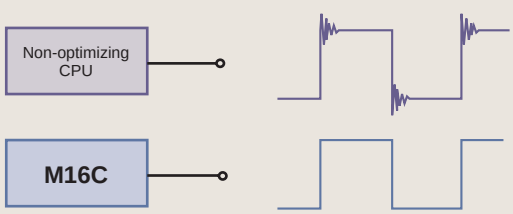


Extensive Peripheral Circuitry (1)

Block Diagram (M16C / 80)

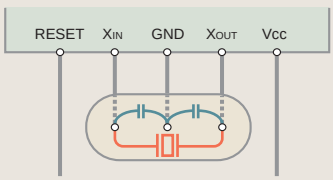


Output Impedance Optimization



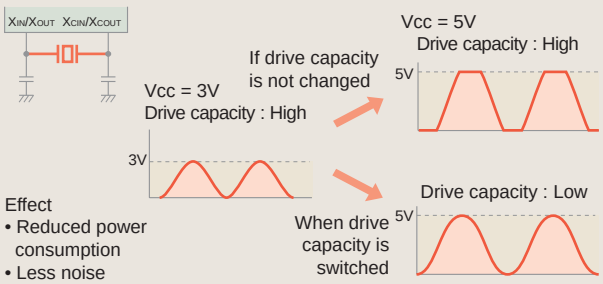
Even when using an external bus, EMI noise is kept to a minimum.

Oscillator Pin Layout

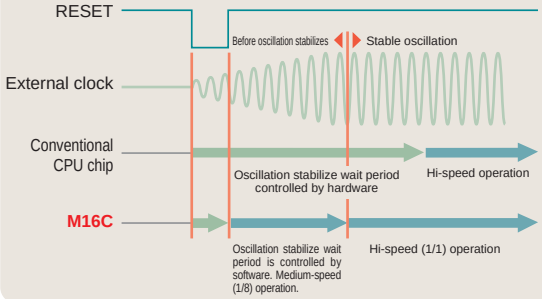


- Easily connected to 3-pin oscillator
- Pin layout avoiding power/ground shorts (XIN - GND - XOUT - Vcc)
- Laid out with static signal line on both ends of the oscillator
- Easy noise prevention

Oscillator Drive Capacity Switching



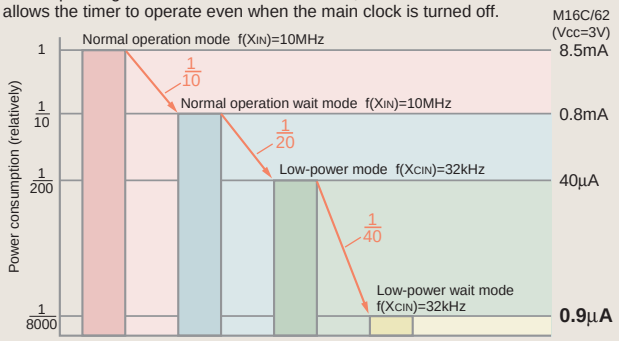
No Wait For Oscillation to Stabilize



Extensive Peripheral Circuitry (2)

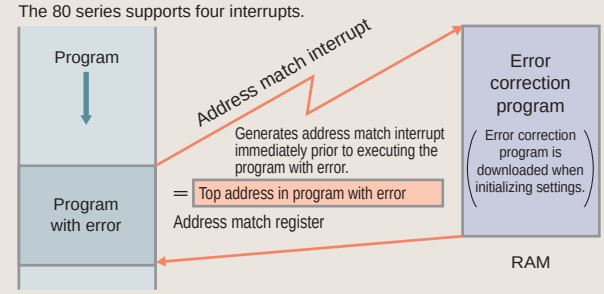
Extensive Power Management

The clock generator contains two switchable circuits, one for the main clock, and one for the subclock. This clock switchover helps to reduce the device's power consumption and noise (power mode switchover). Also, a main clock divide function (divided by 1, 2, 4, 8, or 32), a clock supply to peripheral circuits on/off function, and a VREF and A-D converter disconnect function are included, allowing the device's power consumption to be reduced by software when operating in normal mode. What's more, a new function is included that allows the timer to operate even when the main clock is turned off.



ROM Correction

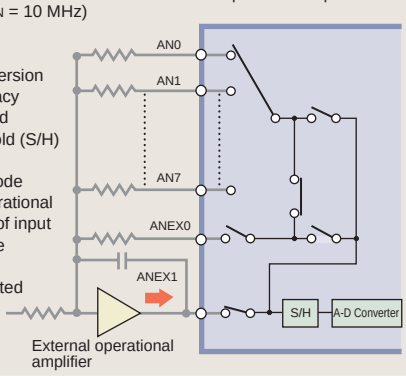
The M16C can correct program errors after masking.
The 80 series supports four interrupts.



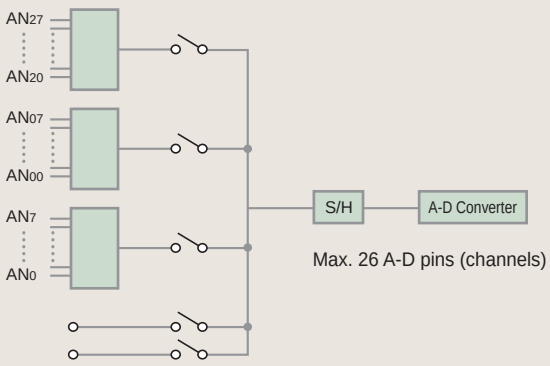
10-Bit A-D Converter with Hi-Speed Sample & Hold

(1) Conversion speed (XIN = 10 MHz)
10 bits : 3.3µ sec.
8 bits : 2.8µ sec.
(2) 10-bit sequential conversion system ±3 LSB accuracy
(3) Equipped with hi-speed (3-cycle) Sample & Hold (S/H)
(4) 10 input channels
(5) Operation amplifier mode
With one external operational amplifier, the number of input signal channels can be increased to 8.
(6) Vref can be disconnected when not used.

New function : External operational amplifier mode



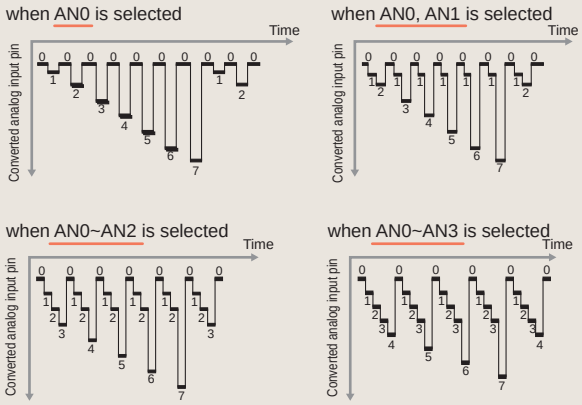
Multiple Channel A-D Input (on enhanced versions)



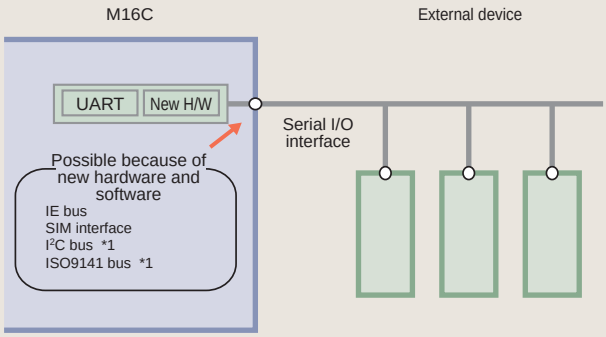
Max. 26 A-D pins (channels)

A-D Converter

Sweep mode can be selected from either the simple sweep mode or the center point sweep mode.



Configurable SIO Interface (M16C/61, M16C/62 and M16C/80)



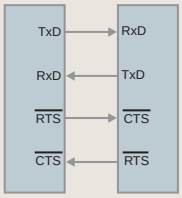
*1: For M16C/62 and 80 only

UART Function

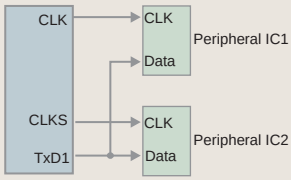
2-way data communications can be done

With one UART circuit, two peripheral ICs can be connected.
(Only for clock synchronized serial mode)

(1) M16C/80 (2) M16C/80

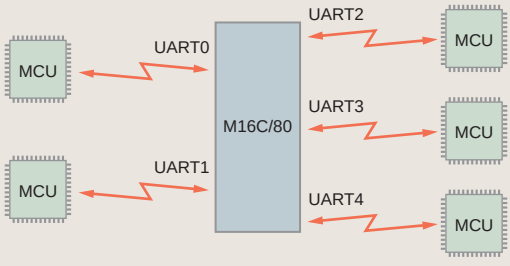


Example application



UART / Clock synchronous SI/O

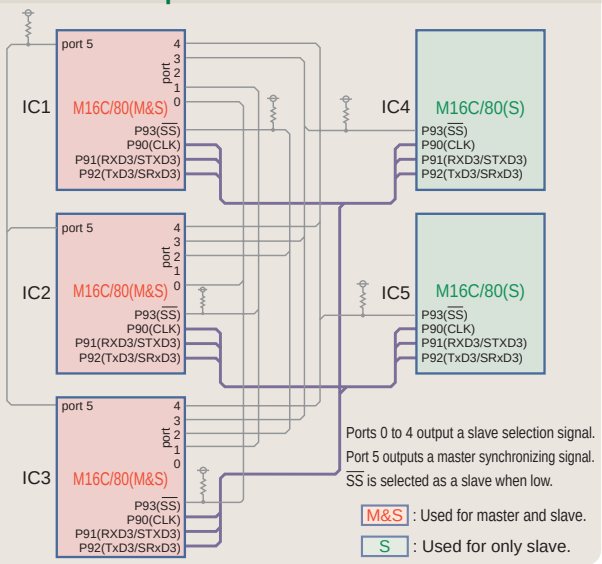
2-way data communications is possible.



The M16C/80 contains five lines of UART and clock-synchronous SI/O.

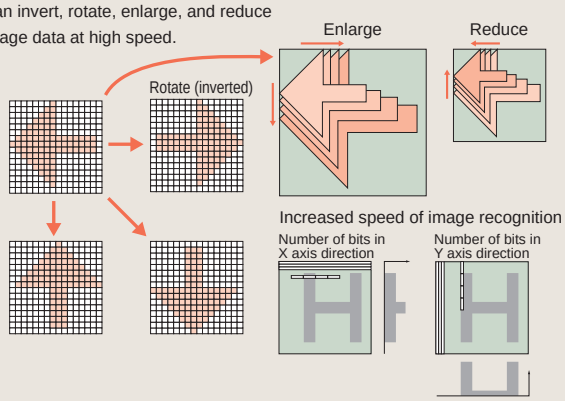
Extensive Peripheral Circuitry (3)

Special serial function



X-Y data converter

Can invert, rotate, enlarge, and reduce image data at high speed.



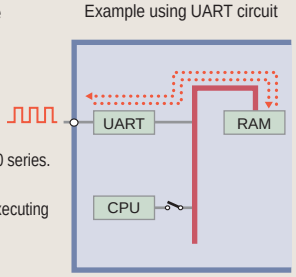
DMA

Hi-speed data transfer is possible without going through the CPU.

Functions

- Transfers from one address to one or multiple addresses (1 M byte available space).
- Transfers from multiple addresses to one address (1 M byte available space).
- Number of data sets transferred : 64 k words
- 2 built-in channels (DMA0 & DMA1)
  Extended to maximum four channels in the 80 series.
  Transfer to/from memory is done by linking.
- Runs in cycle steal mode. (CPU runs while executing the DMA.)

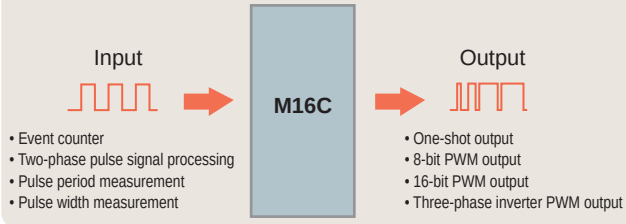
Example using UART circuit



Applications

- Automatic serial I/O transfer
- Motor drive by microstepping
- Multiple channel (max. 32 channels) PWM output

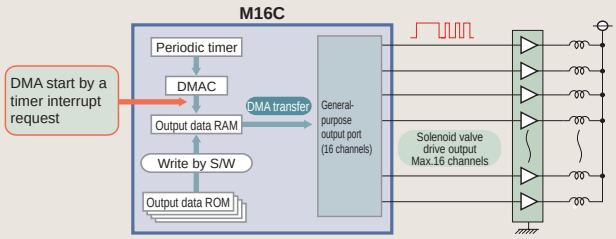
High-function timer



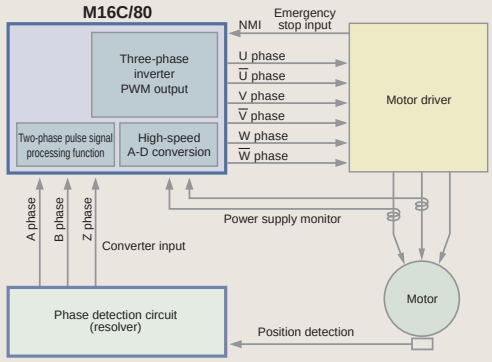
Multiple Channel (max. 64 channels) PWM Application Using DMA

Solenoid valve control (Chopper control)

- The timer interrupt request is set in the DMA start mode.
- Transfer data from the output data RAM is sent to the output port.
  → As the timer interrupt is generated, data output is then read from the port periodically.



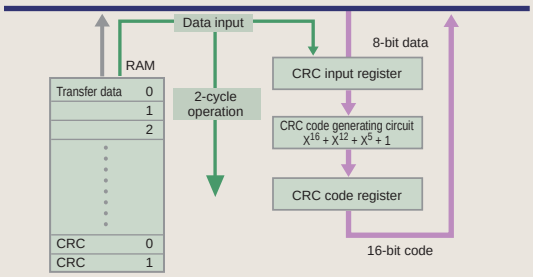
Three-phase inverter PWM output (for motor control systems)



CRC (Cyclic Redundancy Check)

CRC is used to improve reliability in, communication data, for example.

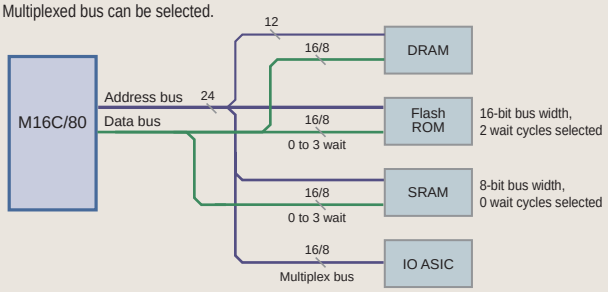
- CRC operation requires 2 cycles. The hardware is built-in.
- Generated multiple variable expression: $X^{16} + X^{12} + X^5 + 1$ (CCITT-conforming)
- Error detection is more efficient than parity or check sum.



External Bus Connection

16 MB linear addressing space

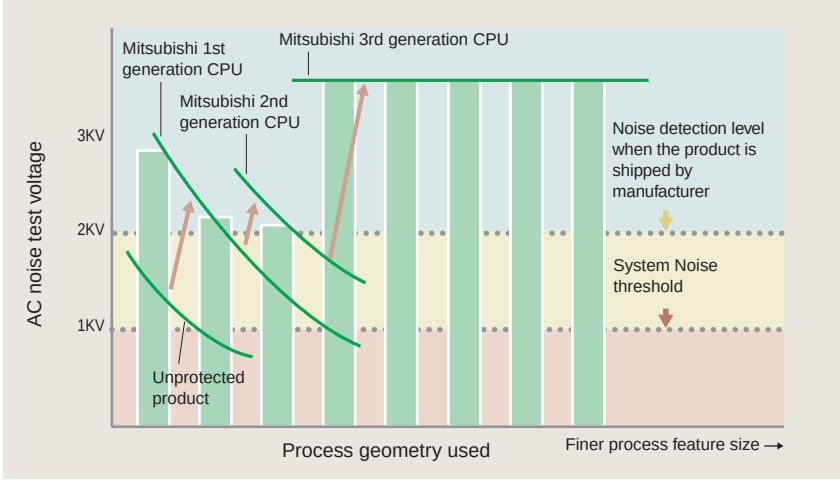
The external bus width can be selected between 8 bits and 16 bits for each external area (CS area).
Wait control can also be selected between 0 to 3 wait cycles for each area.
Contains a DRAM controller allowing for connection to DRAM (EDO, FP, and self-refresh supported).
Multiplexed bus can be selected.

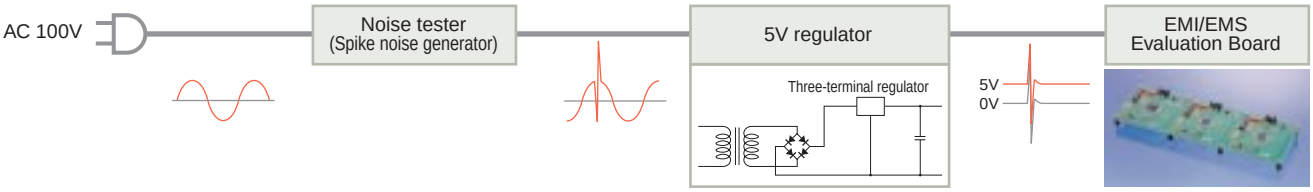


Design Enhancements and Countermeasures

● Noise Immunity(EMS)

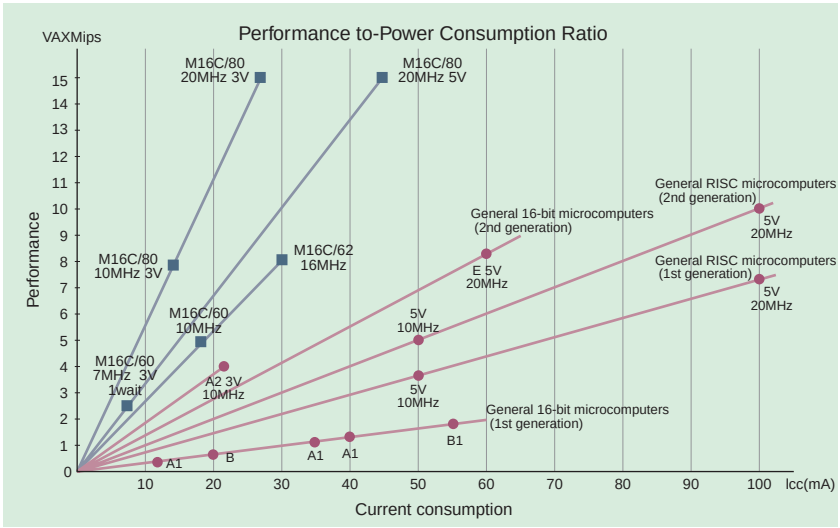
As microcontrollers achieve higher performance and functional capabilities, they are used in more products such as automobiles, electric ranges, vending machines and security systems. Thus, CPUs are increasingly used in applications which demand reliable operation. However, the smaller these microcontrollers chips get, the more susceptible to noise they become. To maintain noise immunity, the M16C has suitable noise filters in all the necessary places. The overall pin layout has also been designed to minimize noise, such as placing a GND between oscillator pins.





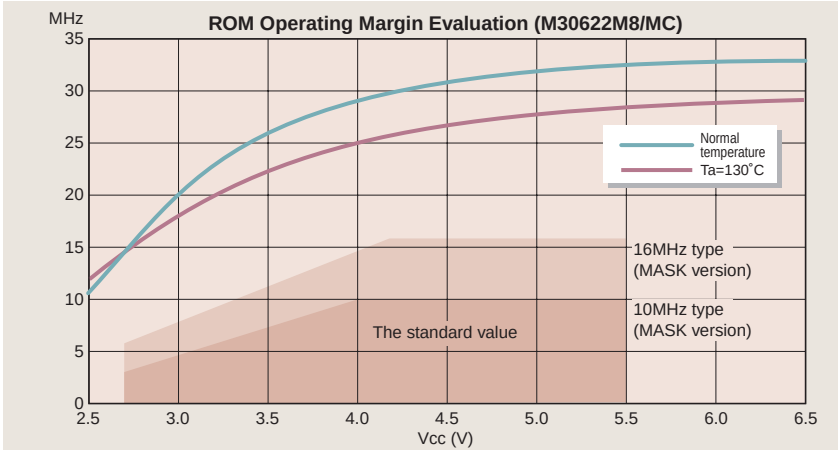
● Performance to-Power Consumption Ratio

Because of the new architecture and layout and wiring efforts, the wiring length is shorter than in earlier CPUs. This greatly reduces power consumption and boosts processing performance. Also, internal temperature rise is kept low, so the M16C can be used in high temperature environments (using the -40 to +125°C version).



● High Operating Temperature

The M16C can be employed in equipment with high temperatures such as automobiles and electric ranges.



M16C/62 temperature, operating voltage and operating frequency (These characteristics will be improved even more with future products like the M16C/80.)

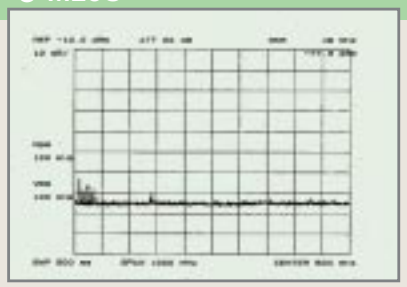
Reduced Noise Emission (EMI)

● EMI

Microcontroller chips are being used more and more in products which utilize microsignals such as cellular telephones and FM text duplex radios. But, the requirement for reduced noise emission is growing and Europe has already introduced a CE Mark regulation. The problem is that noise emission tends to increase as products are downsized.
This is why the M16C has been designed to minimize switching noise by optimizing transistor size, drastically shortening wiring, and more. These efforts have successfully reduced noise emission to a maximum of 20 dB.

Condition : Oscillation frequency 10MHz Supply voltage 5V	How to measurement: Vcc pin (The direct measurement to GND-Vcc) PORT (The direct measurement to GND-PORT) XOUT (The direct measurement to GND-XOUT)

● M16C

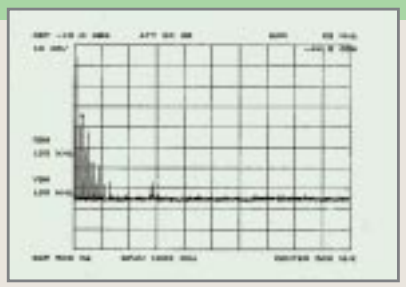


Vcc pin

Because Vcc and GND are wired throughout the entire system, the M16C is designed to reduce noise.

PORT

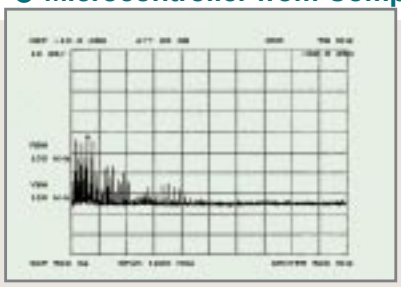
EMI reduction in multiple-wire I/O ports can be expensive. With the M16C, this noise is significantly reduced.



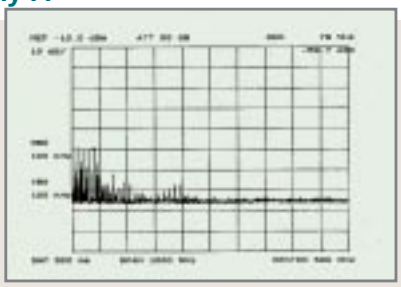
XOUT

EMI noise from the oscillator is localized. Therefore, PC board noise reduction is comparatively easy. The M16C is designed to keep the high harmonic component as small as possible.

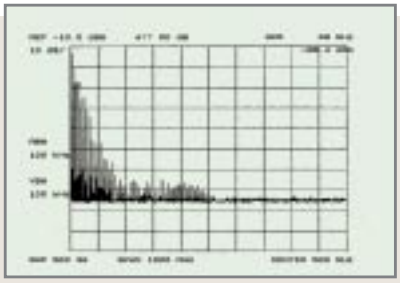
● Microcontroller from Company A



Vcc pin

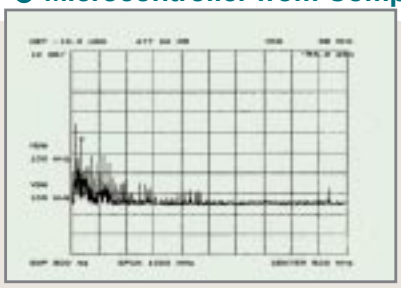


PORT

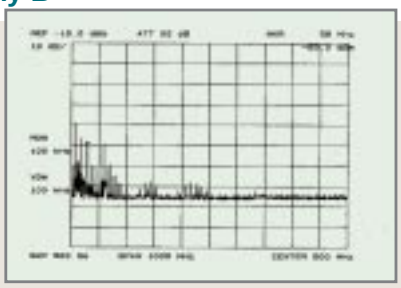


XOUT

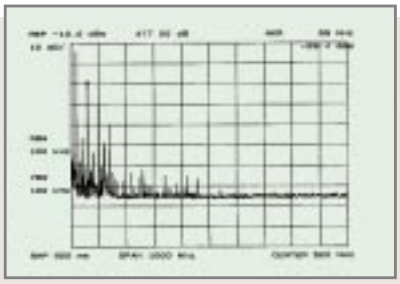
● Microcontroller from Company B



Vcc pin

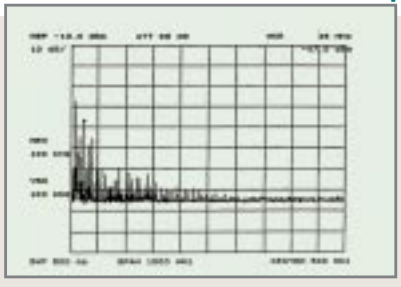


PORT

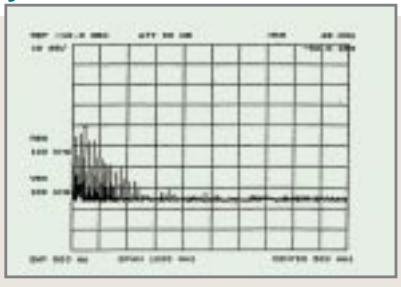


XOUT

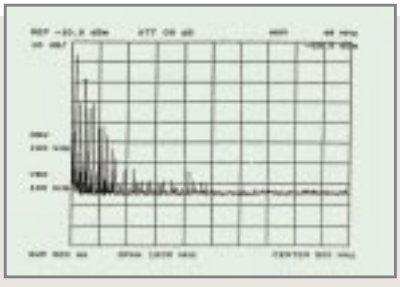
● Microcontroller from Company C



Vcc pin



PORT



XOUT

M16C family with built-in Flash memory

Features

1. Fast write/erase performance

The 256 KB flash memory can be erased and written in only 8 seconds (when using serial rewrite mode). This helps to greatly reduce the write load during mass-production.

2. High reliability

The high data retention reliability, erase reliability, and write reliability all help to prevent troubles after the device has been mounted in place.

3. Writable/erasable many times

Products will be added to this family that can be repeatedly written and erased more than 100 times.

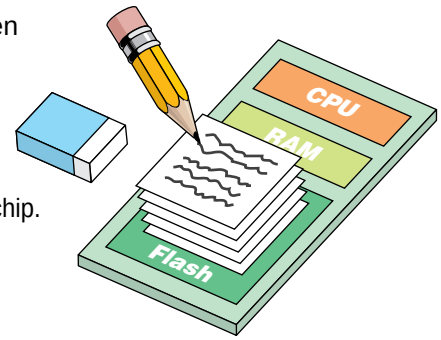
4. ROM code protect function

A high security function is incorporated.

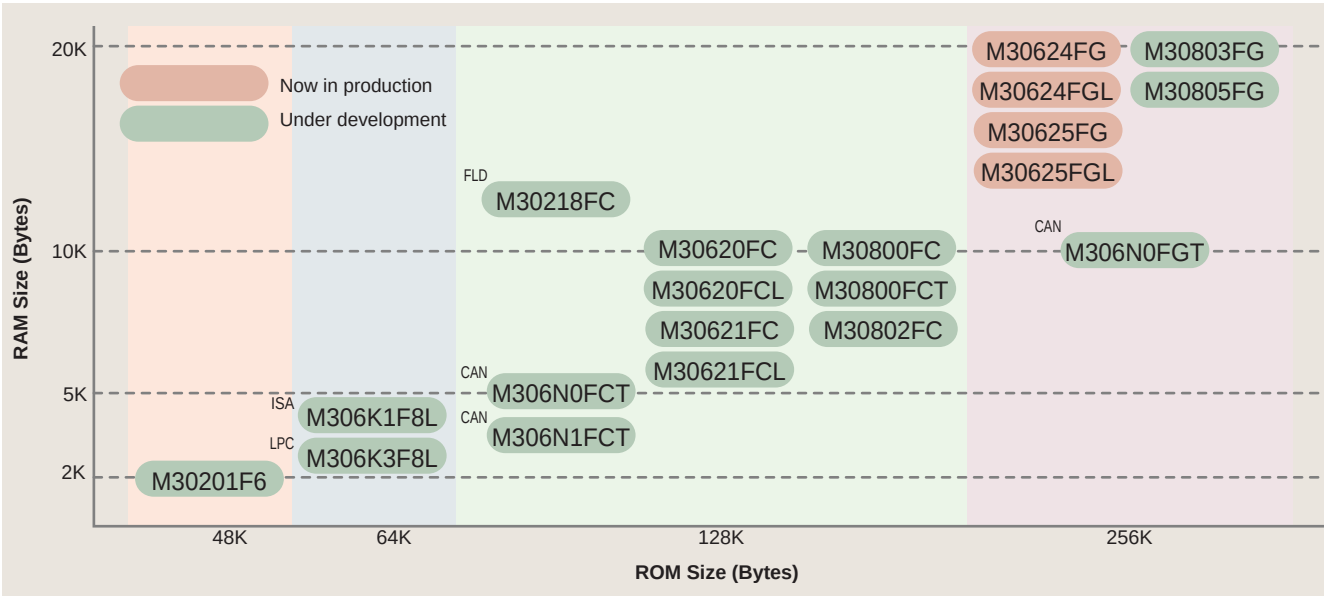
5. Online program (CPU rewrite mode) supported

Various interrupt processing can be executed even while programing the chip.

6. High-speed programmer supported



Flash Memory Progression



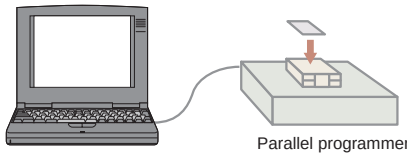
Specifications

Product series name	M16C/80	M16C/62	
Supply voltage and maximum operation frequency	4.2 to 5.5V 20MHz 2.7 to 5.5V 10MHz (Under planning)	4.2 to 5.5V 16MHz 2.7 to 5.5V 10MHz 1wait	2.7 to 3.6V 10MHz 2.4 to 3.6V 7MHz (2.2V target of limit)
Package	0.5mm-pitch 100-pin QFP 0.65mm-pitch 100-pinQFP 0.5mm-pitch 144-pinQFP	0.5mm-pitch 100-pin QFP 0.65mm-pitch 100-pin QFP 0.65mm-pitch 80-pin QFP	
Rewrite voltage	5V single power supply	5V single power supply	3V single power supply
Number of times the chip is programmed and erased	100 times (Note1)		
Erase prevention function	Each block protected by lock bit against erroneous erasure		
Rewrite mode	Parallel I/O mode, Serial I/O mode, CPU rewrite mode		
Security function	ROM code protect (Parallel I/O mode) / ID code protect (Serial I/O mode)		
Serial rewrite time	about 8 seconds (256 Kbytes), about 4 seconds (128 Kbytes)		

Note 1: Products will be available that can be repeatedly written and erased more than 100 times.
Note 2: Supports parallel input/output mode, serial input/output mode, and CPU rewrite mode. CAN programing will also be supported in the future.
Note 3: Parallel I/O mode.

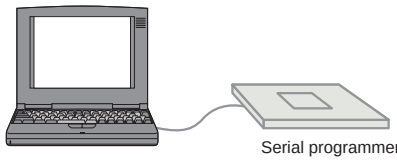
Parallel I/O mode

Using a parallel programmer, the internal flash of the microcontroller memory can be rewritten without requiring any other tool.

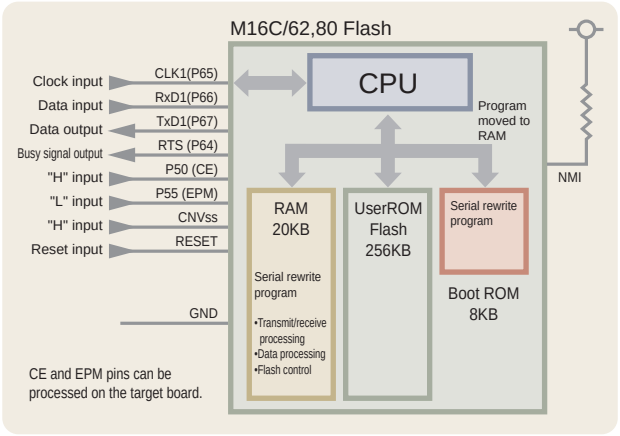


Serial I/O mode

Using a serial programmer, the internal flash of the microcontroller memory can be rewritten while being mounted on-board.



Pins used during serial rewrite

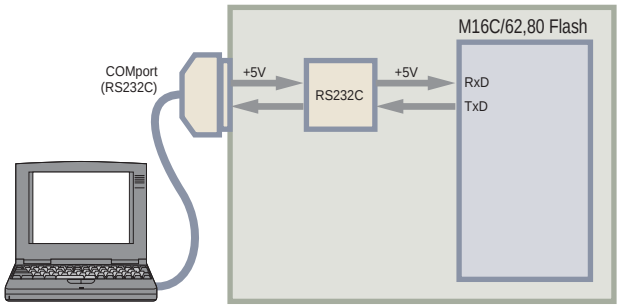


CPU rewrite mode

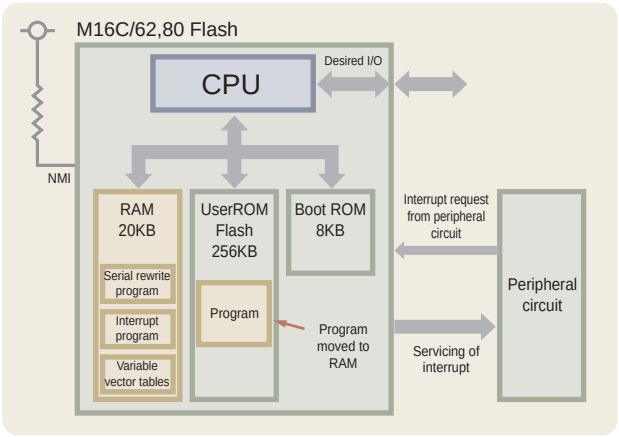
The user area is erased and program using the flash rewrite program created by the customer.

(1) Any desired interface such as UART, I2C bus, or IE bus can be selected.

(2) The program can be executed easily even while rewriting the flash memory. Since the M16C allows the interrupt vector table to be located in any desired area, the interrupt handling routine and interrupt vector table can be located in the RAM area. This allows you to use interrupts even while rewriting the flash memory.

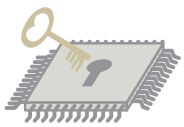


Example of memory allocation when peripheral circuit control program is built in



Protect function

The ROM code protect function (for parallel rewrite) and ID code protect function (for serial rewrite) prevent memory contents from being illegally copied or rewritten by any third party.



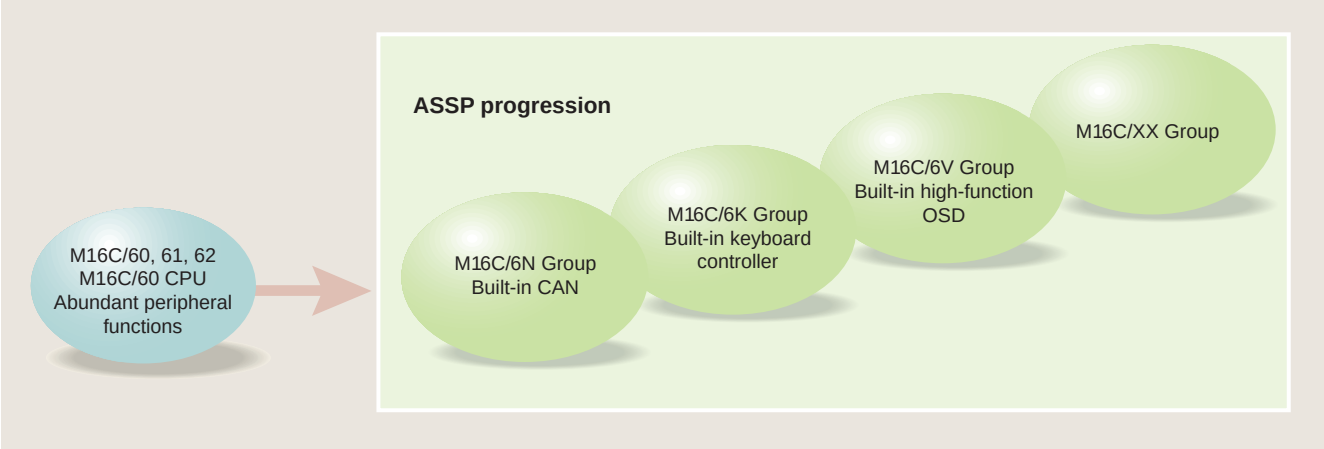
Maker	Product Name	Writing System
Yokogawa Digital Computer Corporation	AF200	serial
SUNNY GIKEN INC.	MFW-1	serial & parallel
	SFW-62SA	serial
Mitsubishi Semiconductor Systems Corporation	MSA0655-G01	serial
	MSA0655-G02	serial

Under development other 3rd party tools

M16C/6N	M16C/6K	M16C/20	M16C/21
4.2 to 5.5V 20MHz 1wait 4.2 to 5.5V 16MHz	3.0 to 3.6V 8MHz 1wait	4.0 to 5.5V 10MHz	4.0 to 5.5V 10MHz
0.65mm-pitch 100-pin QFP	0.4mm-pitch 144-pin TQFP 0.5mm-pitch 100-pin QFP	52-pin DIP 0.5mm-pitch 56-pin QFP	0.65mm-pitch 100-pin QFP
5V single power supply	3V single power supply	5V (Vcc) / 12V (Vpp)	5V (Vcc) / 12V (Vpp)
100 times (Note 1)		100 times	100 times
Each block protected by lock bit against erroneous erasure		—	
(Note 2)	(Note 3)	Parallel I/O mode, Serial I/O mode, CPU rewrite mode.	
ROM code protect (Parallel I/O mode) /ID code protect (Serial I/O mode)	ID code protect (Serial I/O mode)	ROM code protect (Parallel I/O mode) / ID code protect (Serial I/O mode)	ID code protect (Serial I/O mode)
about 8 seconds (256 Kbytes), about 4 seconds (128 Kbytes)	—	about 5 seconds (48 Kbytes)	about 11 seconds (128 Kbytes)

Highly reliable M16C/60 series

Expansion of M16C/60 series lineup (1) — *CAN / Keyboard / OSD*



M16C/6N Group

In addition to the M16C/62 CPU and abundant peripheral functions, this series of 16-bit microcontrollers incorporates the CAN function.

Applications: Automobiles and FA equipment

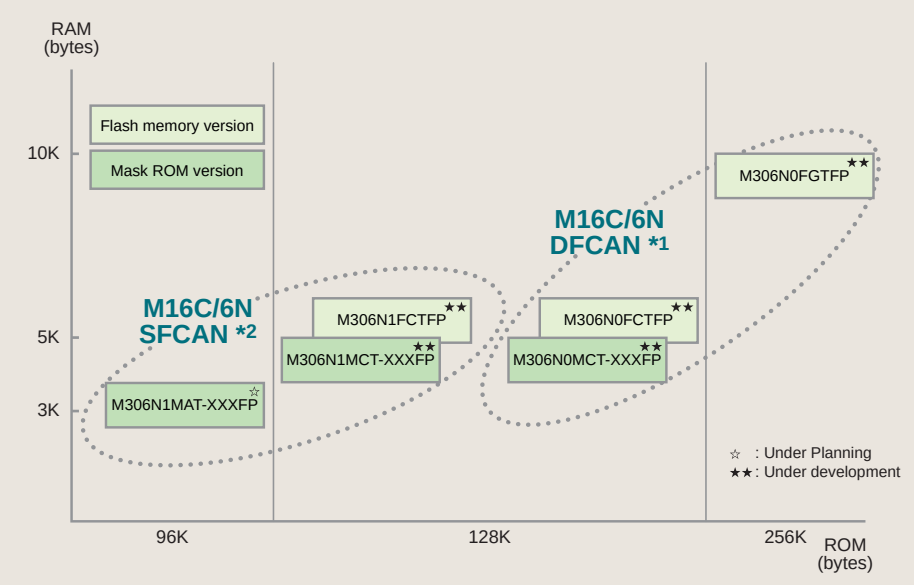
M16C/6N Built-in DFCAN *1
Full CAN x 2

M16C/6N Built-in SFCAN *2
Full CAN x 1
(Clock-synchronous serial I/O 1ch rewrite)
Ring oscillator x 1
(with oscillation-off detection)

M16C/62

Clock-synchronous serial I/O•UART	x 3
Clock-synchronous serial I/O	x 2
TimerA	x 5
TimerB	x 6
CRC	x 1
EXT•IT	x 8
Address match•IT	x 2
(Includes other peripheral functions)	

*1 Double Full CAN
*2 Single Full CAN



M306N0, M306N1

Main functions added from M16C/62 to M16C/6N	
Full CAN specification	2.0B x 2ch (M306N0FCT/MCT/FGT)
CAN protocol	2.0B x 1ch (M306N1FCT/MCT/MAT)
Transfer BRP	Maximum 1.25Mbps (X_{IN}=20MHz)
Bit timing	PH2=2, SJW=1 can be set
Number of transmit/receive slots	16 (transmit/receive operation can be set as desired)
Acceptance filter	3 types
Time stamp	Receive time can be automatically recorded
Automatic transmission	Data present in transmit slot is automatically sent out (maximum 16)
Automatic reception	Data with up to 16 types of ID is automatically received in receive slot (without filtering)
Automatic response	When receiving remote frames, data frame is automatically responded (maximum 16)
One-shot transmission	Retry transmission can be disabled
CAN error counter readout	Transmit and receive error counters can be read
CAN sleep/wakeup function	✓
Ring oscillator (with oscillation-off detection)	✓
OSEK/VDX applicable *3	✓
Package	0.65mm-pitch 100-pin QFP (100P6S-A)

* This product is under development and its specifications are subject to change.
*3: M16C/6N compatible products of OSEK/VDX are available from Vector Japan.

Expansion of M16C/60 series lineup (2)

M16C/6V Group

In addition to the M16C/60 CPU and abundant peripheral functions, this group of 16-bit microcontrollers incorporates a high-function display circuit (OSD).

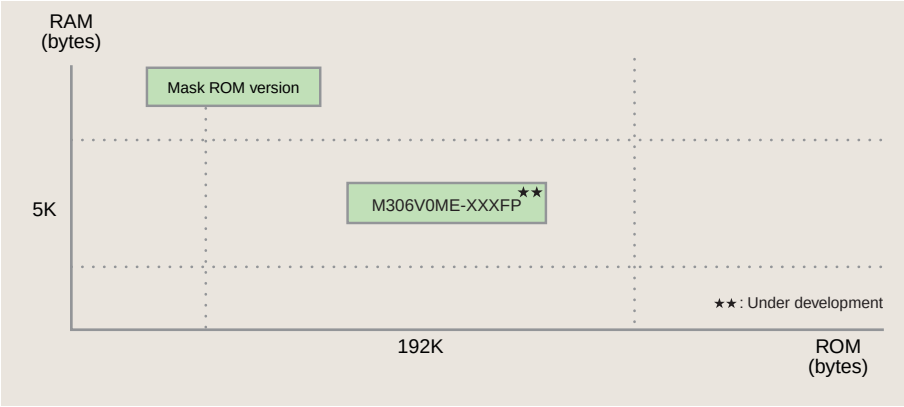
Applications: TV with closed caption

M16C/6V

High-function display circuit (OSD).	x 1
Data slicer	x 1
HSYNC counter	x 1
I²C bus applicable (Rewritten from CRC, EXT IT 1ch circuit)	

M16C/60

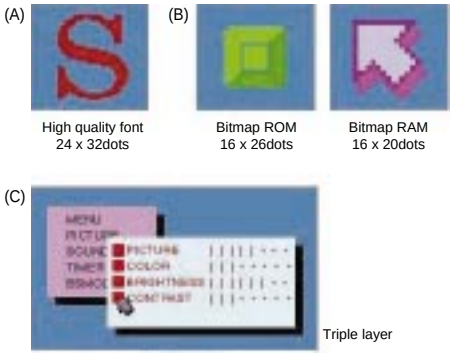
Clock-synchronous serial I/O•UART	x 2
TimerA	x 5
TimerB	x 3
CRC	x 1
EXT•IT	x 4
Address match•IT	x 2
(Includes other peripheral functions)	



M306V0

Main functions added from M16C/60 to M16C/6V	
High-function OSD	1 circuit
High quality display	✓ (A)
Bitmap display	✓ (B)
Triple layer display	✓ (C)
Closed caption data slicer	1 circuit
Package	0.65mm-pitch 100-pin QFP (100P6S-A)

* This product is under development and its specifications are subject to change.



M16C/6K Group

In addition to the M16C/62 CPU and abundant peripheral functions, this group of 16-bit microcontrollers incorporates versatile interfaces.

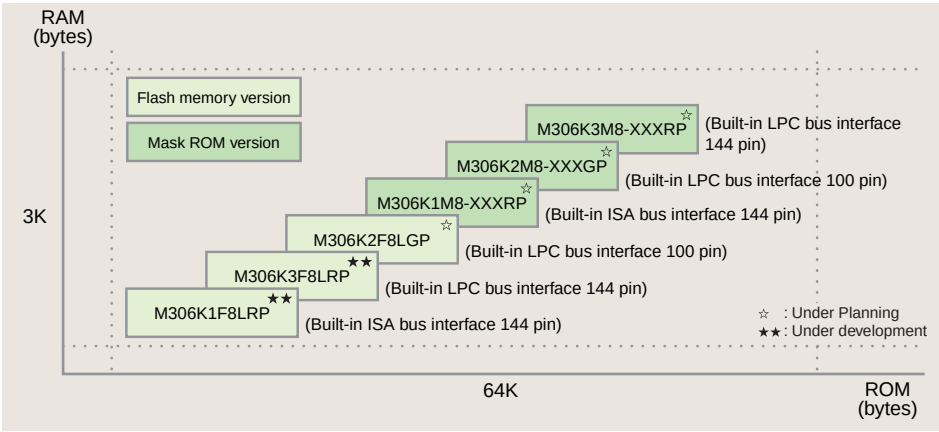
Applications: Notebook PC, etc.

M16C/6K

Host bus interface (ISA/LPC bus interface)	x 4
I²C/SMBUS interface	x 2
H/W PS2 interface	x 3
Key input interrupt	8 lines x 2
EXT•IT	+5 (13)

M16C/62

Clock-synchronous serial I/O•UART	x 3
Clock-synchronous serial I/O	x 2
TimerA	x 5
TimerB	x 6
EXT•IT	x 8
Address match•IT	x 2
(Includes other peripheral functions)	



M306K1, M306K2, M306K3

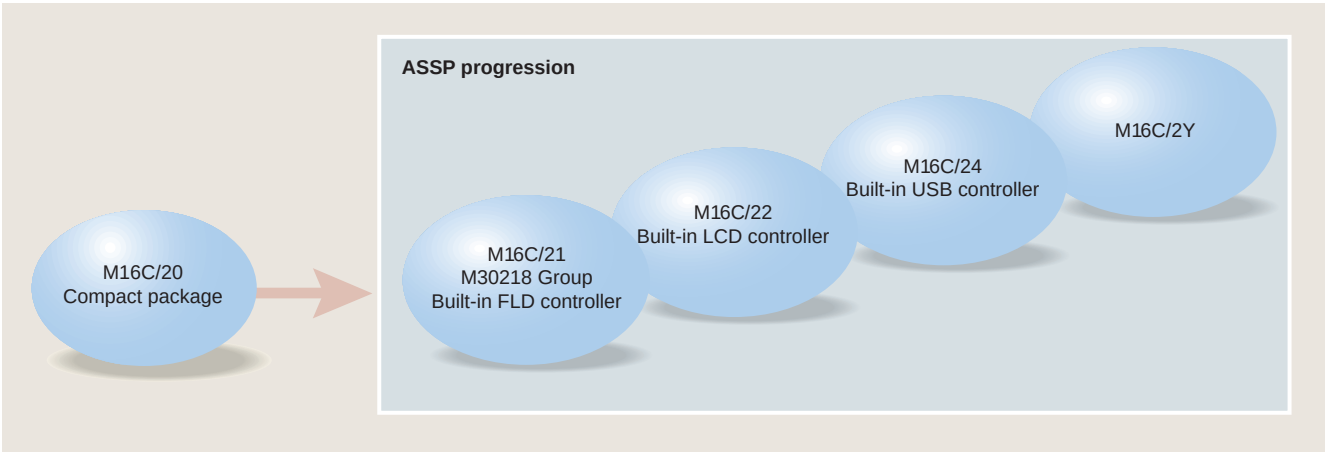
Main functions added from M16C/62 to M16C/6K		
Supply voltage		3.0V to 3.6V (8MHz 1wait)
I²C/SMBus interface		2ch
H/W PS2 interface		3ch
Host bus interface		4ch (M306K1F8L/M8 : ISA bus interface) (M306K2F8L/M8 : LPC bus interface) (M306K3F8L/M8 : LPC bus interface)
Comparator circuit		8ch (Can be used mainly for keyboard control)
PWM output circuit		4ch (14bits)
I/O port		129 lines
Package	0.4mm-pitch 144-pin TQFP (144PFB-A)	M306K1F8L/M8, M306K3F8L/M8
	0.5mm-pitch 100-pin QFP (100P6Q-A)	M306K2F8L/M8

* This product is under development and its specifications are subject to change.

M16C/20 Series

Expansion of M16C/20 series lineup

FLD / LCD / USB



M30218 Group

In addition to the M16C/60 CPU and abundant peripheral functions, this group of 16-bit microcontrollers incorporates a fluorescent display tube (FLD) control function.

Applications: Consumer product and Audio equipment

M30218

Fluorescent display tube controller

Usable for universal grids

Absolute maximum withstand voltage of fluorescent display tube output port

VCC - 50 V industry first

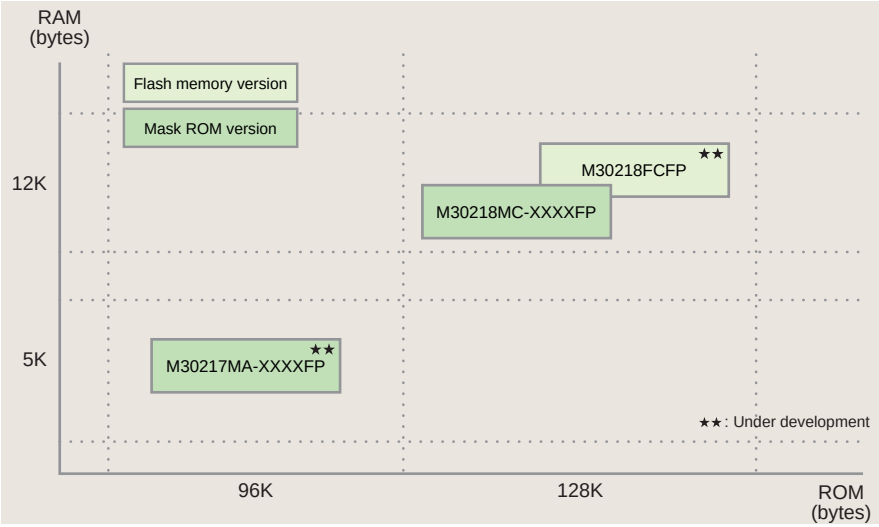
SI/O with automatic transfer function x 1

EXT•IT +2 (6)

M16C/60

Clock-synchronous serial I/O•UART	x 2
TimerA	x 5
TimerB	x 3
CRC	x 1
EXT•IT	x 4
Address match•IT	x 2

(Includes other peripheral functions)



M30218, M30217

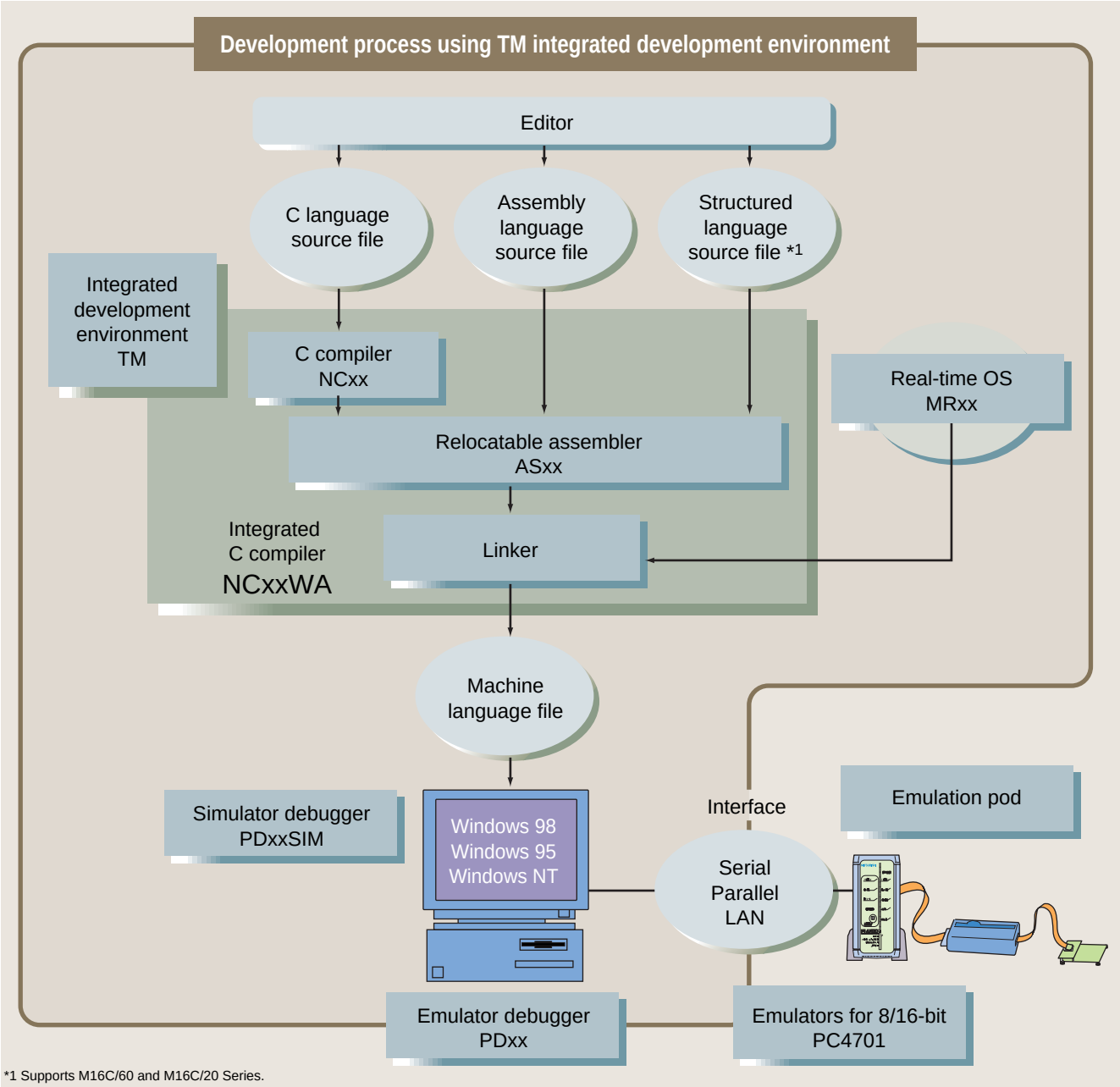
Main functions added from M16C/60 to M30218 Group			
I/O port	8 bits x 6 (including 12 high voltage tolerant output ports)		48 lines
Output port	8 bits x 5 (High voltage tolerant output ports)		40 lines
Serial I/O	CMOS output serial I/O		2ch
	SI/O with automatic transfer function (Clock-synchronous)		1ch
	8-bit serial I/O mode		✓
	Automatic transfer serial I/O mode		✓
	Maximum number of automatically transferred bytes		256
	CMOS/Nch open-drain output selection		✓
	LSB/MSB first selection		✓
	SBUSY/SSTB putput selection		✓
External input interrupt			6ch
FLD controller	Control pin (high voltage tolerant open-drain 52 lines, CMOS 4 lines)		56 lines
	16 timing normal mode		✓
	16 timing grayscale display mode		✓
	32 timing mode		✓
	Digit waveform output function		✓
	M35501 modulation function		✓
	TOff segment presence function		✓
	Grayscale display function		✓
	Key scan	Digit-based key scan	✓
		Segment-based key scan	✓
Package			0.65mm-pitch 100-pin QFP (100P6S-A)

* This product is under development and its specifications are subject to change.

Development Support Tools

Programming Environment

Mitsubishi Electric supports your programming environment with high-performance C compilers, featuring a broad range of functions for developing embedded systems, as well as assemblers capable of assembling macro description.



Integrated C compiler NCxxWA

- Includes TM integrated development environment and ASxx assembler.
- Compliance with ANSI* standards
- Very high code efficiency, comparable to assembler
- #pragma extension provides various ROMable features
- Specifiable near/far variables
- Stack size calculation utility

*ANSI: American National Standards Institute

Assembler ASxx

- Generates optimized code with effective use of MCU instruction sets
- Complete macro descriptions
- Convenient utility functions
- Supports standard object formats:
  IEEE-695
  Motorola S format
  Intel HEX format

* The numbers represented by xx found in product codes varies according to MCU family and series.

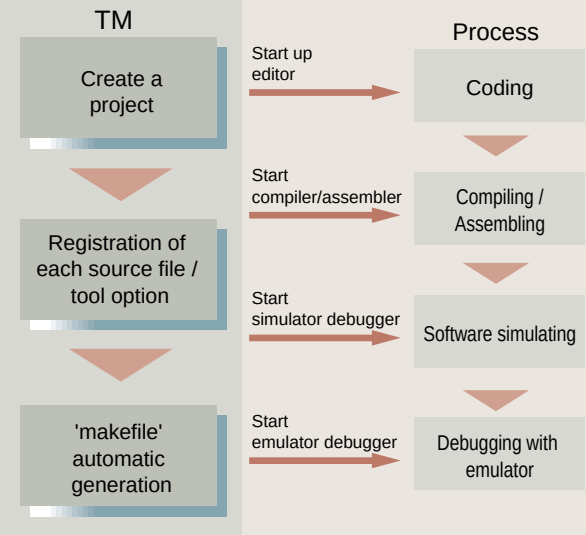
Integrated Development Environment TM

The Mitsubishi TM integrated development environment improves downstream process productivity by integrating an editor, compiler, assembler and other tools used for software development. TM is packaged in the integrated C compiler NCxxWA.

TM Features

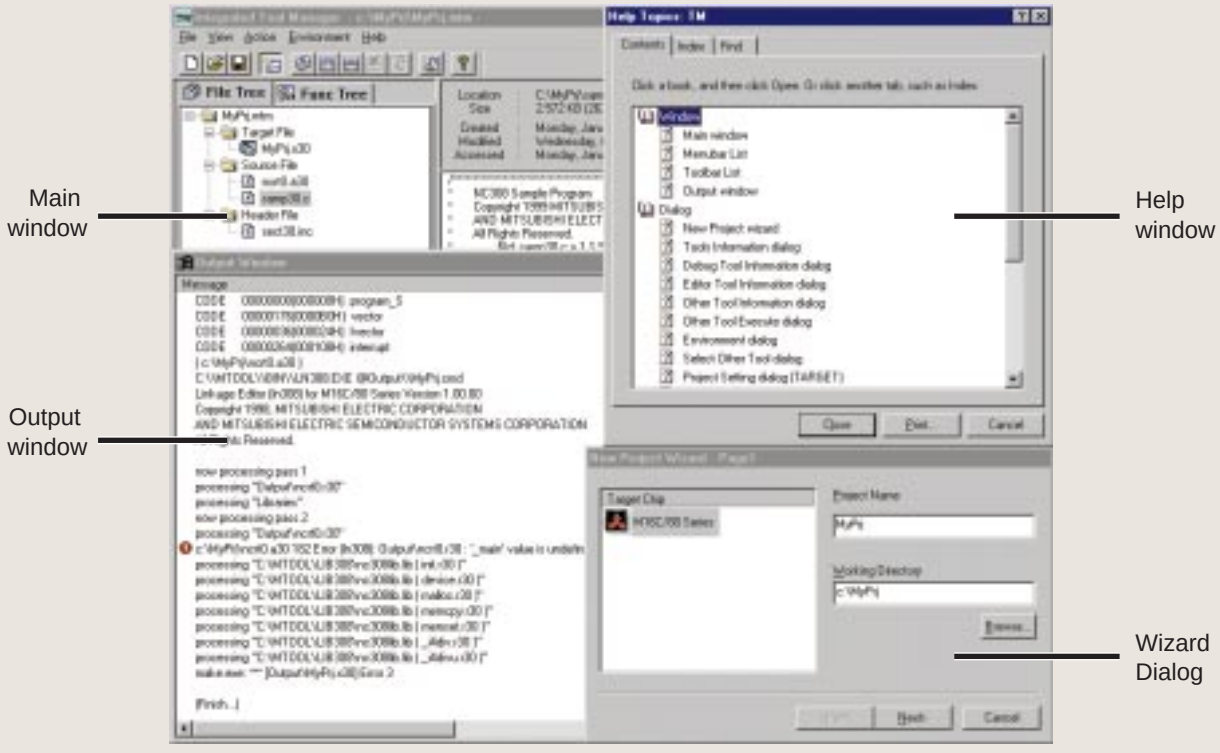
- Seamless Tool Operations from Editor to Debugger
  TM will invoke all necessary software tools and control them from its user interface.
- High Operability under Windows
  TM GUI provides easy source file registration, tool option setting, and tool operation control.
- Automatic 'makefile' Function
  Automatic generation of 'makefile' depending on relation of specified source files.
- Integrated Cross Tool Help Function
  TM windows provide help screens for all tools.
- PDF Manuals
  TM can start up Acrobat Reader* from the main window to reference PDF manuals.

TM Development Process



*Acrobat Reader is a trademark of Adobe Systems Incorporated.

TM Window Image



* The numbers represented by xx found in product codes varies according to MCU family and series.

Powerful Debugging Functions for Real-time OS

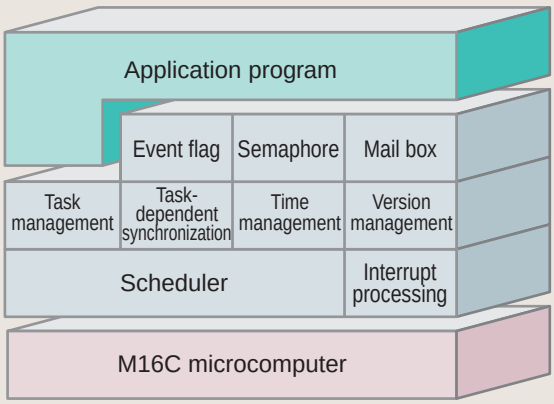
Mitsubishi Electric provides Real-time OS, in compliance with µITRON specifications, supporting development of real-time control systems as well as the debugging functions.

Real-time OS MRxx

- Compliance with Japan standard µITRON V.3.0 spec.*
- Strong real-time characteristics and more compact size
- Memory pooling function
- Specifying data made easier with configurator.
- Excellent interfaces with C language and assembler language
- Real-time OS dedicated debug function works with PC4701M and PC4701HS emulator systems.

* The µTRON architecture standard developed by Dr. Ken Sakamura at the University of Tokyo.

Kernel configuration of Real-time OS



* The Kernel configuration varies according to MCU family and series.

The PDxx controls PC4701 emulators from Windows on a PC in order to debug application programs and target systems. It provides Real-time OS dedicated debug functions by combining the PC4701M and PC4701HS emulators.

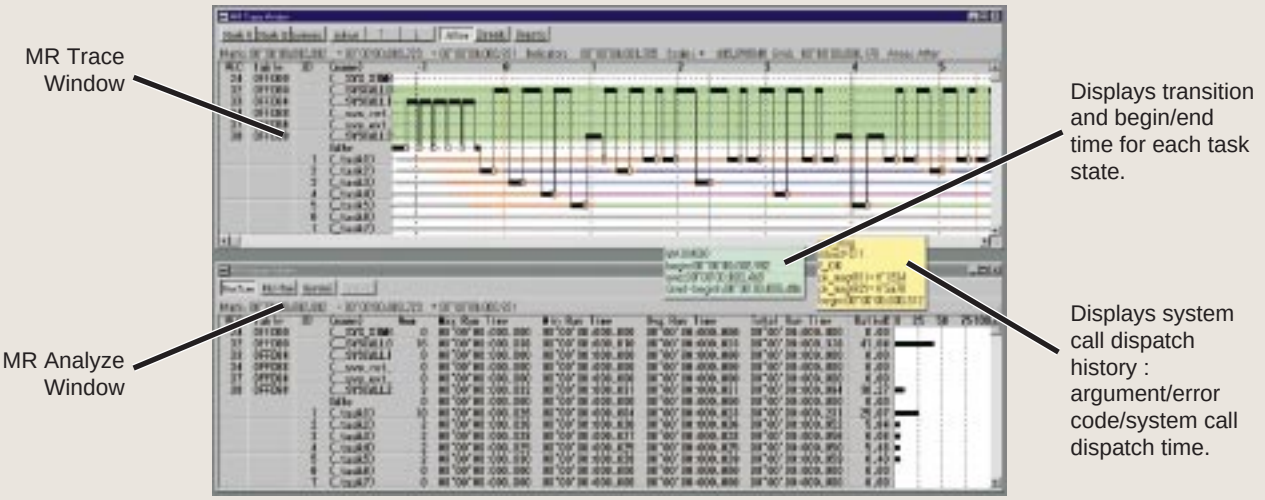
Real-time OS Dedicated Debug Functions

• MR Trace Window

Measures and graphically displays the task execution history of programs using MR30.
The history of interrupt processing, task state transition, and system call dispatch can also be displayed.

• MR Analyze Window

Displays results of statistical processing of measured data in specified areas.
Data is provided in the following display modes:
(1) Interrupt processing/CPU occupation status per task
(2) Ready status time per task
(3) List of system call dispatch histories
(extracts and displays according to specified conditions)



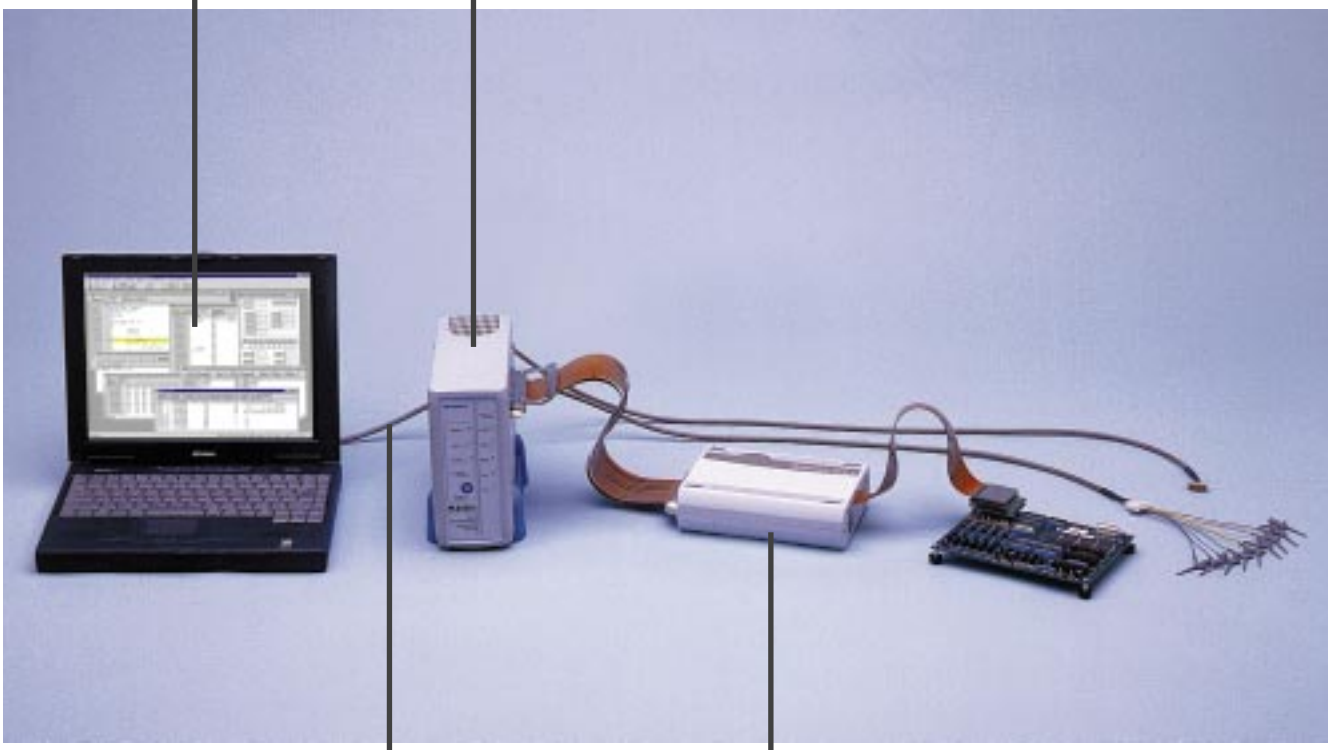
* The numbers represented by xx found in product codes varies according to MCU family and series.

8-bit and 16-bit Common Emulator Systems

The PC4701 emulator system meets your needs for a flexible development environment, improving debugging efficiency in your application programs. This system can even support future MCUs, simply by changing the emulation pod.

Emulator Debugger PDxx

- Easy operation with Windows 98, Windows 95 and Windows NT 4.0.
- Using PDxx with the PC4701M and PC4701HS provides the customer with enhanced functions such as real-time tracing and C0 coverage.
- Supports high-speed parallel, serial and LAN interfaces.
- Various source-level debugging functions
- Improved real-time OS debugging functions. (Refer to page 25)
- Real-time RAM monitor
- Supports customization function. (Refer to page 28)



Communications Interfaces

- RS-232C serial interface
- LPT parallel interface
- Dedicated parallel interface
- LAN interface
  (Supports 10Base-5 and 10Base-T connectors)

* Available communications interfaces depend on emulator type (Refer to page 27).
* Parallel interface board (sold separately) is required when using dedicated parallel interface.

Emulation pod

- Supports high-speed clock
- Supports low input voltages
- Flexible cable
- Easy connection to target systems
- Compliant with international standards

* The numbers represented by xx found in product codes varies according to MCU family and series.

Emulator PC4701

- Emulator main unit works for Mitsubishi's 8-bit and 16-bit MCUs
- Compliant with international standards (UL/FCC standard and CE marking)
- Real-time RAM monitor comes standard
- High-speed downloading

* The download speed varies according to user's host machine and condition of LAN communication.

New Emulator PC4701M

PC4701M offers a rich array of features such as state transition break, real-time trace, and C0 coverage measurement in addition to basic debugging features for user development and evaluation of large-scale program. It also saves desk space with a built-in power supply and a printer port for connecting a notebook PC.
Additionally, the license to download latest version of PDxx emulator debuggers from the tool homepage is bundled with PC4701M.

PC4701 Emulator Specifications

Specificatons		PC4701M	PC4701HS	PC4701L
Applicable MCU		M16C Family (16-bit), 7700 Family (16-bit), 740 Family (8-bit)		
Software break		64 addresses		
Hardware break		6 points (Bus detection, Interrupt, External trace signal)		1 point (Bus detection)
Hardware break condition		AND, OR, State transition		None
Exception event detection		Access protect		None
Real-time trace		32K cycles *1 (Bus, 8-bit external trace signal, 40-bit time stamp), Recording can be started or stopped according to events. Can be used for performance analysis and overhead measurement		None
Real-time RAM monitor		1024 bytes (Data, Access or not, Final access result)		
Time measurement		Measures from RUN to STOP and 4 other intervals (ø count / 16MHz clock count) Max./Min. measurement time / Cumulative time / Pass count are available.		Measures from RUN to STOP (ø count / 16MHz clock count)
C0 coverage		Available		None
Interface	Serial	RS-232C (Up to 38.4 kbps)		
	Parallel	LPT Parallel *1	Mitsubishi proprietary parallel interface *2	
	LAN	None	10Base-T, 10Base-5	None
Event output		Break signals is one point and Event signals is 6 points		None
External trace input		8 signals with TTL levels		None
Power supply		Built-in	External	Built-in
Emulator debugger		License bundled *3	optional	
External Dimensions		[Width] 112mm, [Depth] 242mm, [Height] 197mm (PC4701HS: without PC4701P power supply unit)		
Weight		2.7kg	2.3kg (without PC4701P power supply unit)	2.5kg
Overseas standards		US UL Safety Standards (UL1950), also accepted in Canada		US UL Safety Standards (UL 1244) also accepted in Canada
		US EMI Standards (FCC part 15 Class A)		
		CE marking [EN60950, EN55022, EN50082-1, EN61000-3-2]	CE marking [EN55022, EN50082-1, EN61000-3-2]	CE marking [EN60950, EN50081-1, EN50082-1]

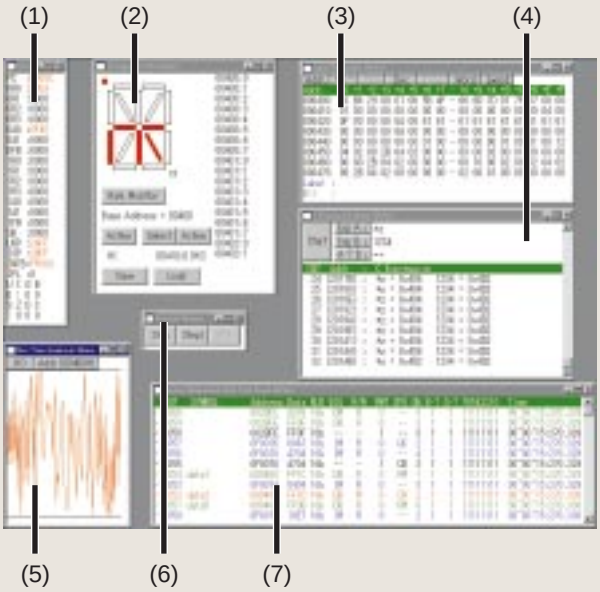
*1. The PDxx emulator debuggers released or upgraded later than March 1999 up come with 32K cycle-tracing function.
*2. Printer port (supports ECP, EPP, Byte/compatibility and Nibble/compatibility modes.)
*3. PCA4202G02 parallel interface board (optional) is required.
*4. Product includes the right to download latest emulator debugger version from our homepage without charge.

Easy-to-Operate Emulator Debugger & Simulator Debugger

Mitsubishi's PDxx emulator debugger and PDxxSIM simulator debugger offer a rich array of debugging functions and a superb window-based user interface. Additionally, both debuggers support customization allowing you to add their original windows and commands.

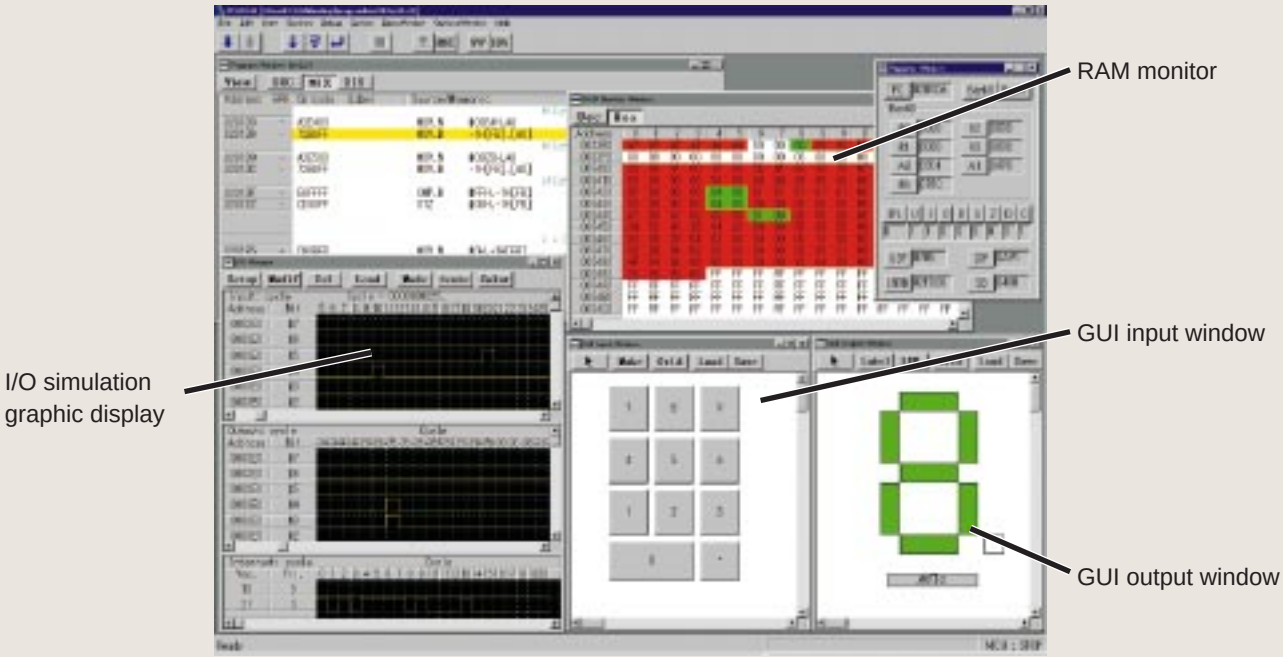
PDxx/PDxxSIM Customization Functions

- CBxx Custom Builder
  Provides the user with the ability to add windows and commands to the debuggers.
- Easy creation of original windows and commands
  using C language subset script language with debugger.
- Sample windows with source files, including:
  (1) Slim register window
  (2) 18 segmented-LED window
  (3) Dump window with label/bit symbol display
  (4) C expression break window
  (5) Graphic run-time memory
  (6) Animation execution window
  (7) RTT window with source reference, etc.



Simulator Debugger PDxxSIM

- Independent target development and program evaluation
- Machine cycle count function
- I/O, interrupt simulator function
- Target input/output functions provided as a new GUI
- RAM monitor display
- C and assembly source-level debugging functions



* The numbers represented by xx found in product codes varies according to MCU family and series.

Accessory Tools

Mitsubishi offers various accessories, such as converters, to support a wide selection of product packages. Although a probe can be difficult to mount, depending on the position of the MCU, proper selection of the following accessories can make it easier for the user to mount MCUs.

Probe Direction Rotation Board

- FLX100-T/FLX64-T
  Rotates direction of emulation pod probe by 90 degrees counter clockwise.
- FLX100-R/FLX64-R
  Rotates direction of emulation pod probe by 180 degrees.
- Double layering of probe direction rotation boards allows height adjustments.

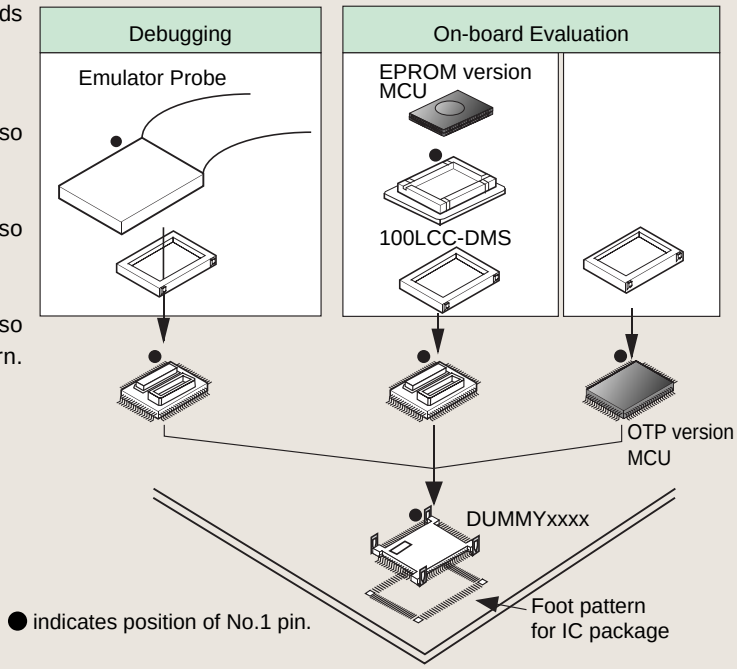
[FLX100-T]

[FLX100-R]

QFP Package Accessories

Select from the following accessories to meet the needs of target systems.

- DUMMYxxxx (Dummy IC)
  For both debugging and on-board evaluation. Can also be used with OTP version MCU (see figure at right).
- DIRECTxxxx (Direct Dummy)
  For both debugging and on-board evaluation. Also applicable as actual MCU on-board foot pattern.
- FLX-xxxNxx
  For both debugging and on-board evaluation. Also applicable as actual MCU on-board foot pattern. Adjustable height.



List of Accessories

Accessory Type		Product Name	Applicable MCU
Probe Direction Rotation Board	64-pin 90 degrees rotation	FLX64-T	M16C/20 Group
	64-pin 180 degrees rotation	FLX64-R	M16C/20 Group
	100-pin 90 degrees rotation	FLX100-T	M16C/60 Series, M16C/21 Group
	100-pin 180 degrees rotation	FLX100-R	M16C/60 Series, M16C/21 Group
QFP Package Accessories	80-pin 0.65mm-pitch QFP	DIRECT80S	M16C/60 Series
		100LCC-80QSB	M16C/60 Series
	100-pin 0.5mm-pitch LQFP	FLX-100NSD	M16C/60 Series
		100LCC-QSD	M16C/80 Series, M16C/60 Series
	100-pin 0.65mm-pitch QFP	DUMMY100S	M16C/80 Series, M16C/60 Series, M16C/21 Group
		DIRECT100S	M16C/60 Series, M16C/21 Group
		FLX-100NRB	M16C/60 Series, M16C/21 Group
		100LCC-DMS	M16C/80 Series
	144-pin 0.5mm-pitch LQFP	FLX-144NSD	M16C/80 Series

* The numbers represented by xx found in product codes varies according to MCU family and series.

Mitsubishi Tools

M16C/80 Series Tools

Series	Group	C Compiler	Real-time OS	Simulator Debugger	Emulator Debugger	Emulator	Emulation Pod
M16C/80	M16C/80	NC308WA *1	MR308 *2	PD308SIM	PD308	PC4701 *3	M30800T-RPD-E

*1. NC308WA includes TM (Integrated Development Environment), NC308 (C Compiler) and AS308 (Assembler).
*2. MR308 is the generic name for both real-time OS development kit (MR308K) and mass production contract (MR308S).
*3. PC4701 is the generic name for PC4701M, PC4701HS and PC4701L.

M16C/60 and M16C/20 Series Tools

Series	Group	C Compiler	Real-time OS	Simulator Debugger	Emulator Debugger	Emulator	Emulation Pod	Pod Probe
M16C/60	M16C/61	NC30WA *1	MR30 *2	PD30SIM *3	PD30 *3	PC4701 *4	M30610T-RPD-E	
	M16C/62						M30620T-RPD-E [Max.10MHz,Vcc=2.7 to 5.5V] or M30620TB-RPD-E [Max.16MHz,Vcc=4.8 to 5.2V]	
	M16C/6V						M306V0T-RPD-E	
	M16C/6K						M306K1T-RPD-E ★★	
	M16C/6N						M306N0T-RPD-E ★★	
M16C/20	M16C/20						M30200T-RPD-E	M30201T-PRB
	M16C/21							M30218T-PRB
	M16C/24							M30240T-PRB ★★

*1. NC30WA includes TM (Integrated Development Environment) ,NC30 (C Compiler) and AS30 (Assembler).
*2. MR30 is the generic name for both real-time OS development kit (MR30K) and mass production contract (MR30S).
*3. PDB30 and PDB30SIM have been changed to PD30 and PD30SIM, respectively.
*4. PC4701 is the generic name for PC4701M, PC4701HS and PC4701L.
★★ Under development

Emulator Option

Option Type	Product Name
PC4701HS/PC4701L parallel interface board for IBM PC/AT compatibles	PCA4202G02

Programmers and Adapters

Series	ROM Type	Package Type	Package Name	Programmer	Programming Adapter
M16C/80	Flash memory	100-pin 0.65mm-pitch QFP	100P6S-A	Third party flash programmer	
		100-pin 0.5mm-pitch LQFP	100P6Q-A		
		144-pin 0.5mm-pitch LQFP	144P6Q-A		
M16C/60	OTP or EPROM	80-pin 0.65mm-pitch QFP	80P6S-A	R4945/R4945A *1	PCA7413F-80
		100-pin 0.65mm-pitch QFP	100P6S-A		PCA7412F-100
		100-pin 0.65mm-pitch LCC	100D0		PCA7412L-100
		100-pin 0.5mm-pitch LQFP	100P6Q-A		PCA7412G-100
	Flash memory	80-pin 0.65mm-pitch QFP	80P6S-A	Third party flash programmer	
		100-pin 0.65mm-pitch QFP	100P6S-A		
		100-pin 0.5mm-pitch LQFP	100P6Q-A		
		144-pin 0.4mm-pitch TQFP	144PFB-A		
M16C/20	Flash memory	52-pin 1.778mm-pitch SDIP	52P4B	R4945/R4945A *1 or Third party flash programmer *2	PCA7302F1S-52
		56-pin 0.5mm-pitch QFP	56P6S-A		PCA7302F1F-56
		100-pin 0.65mm-pitch QFP	100P6S-A		PCA7302F1F-100
	OTP EPROM	80-pin 0.8mm-pitch QFP	80P6N-A	R4945/R4945A *1	PCA7302E1F-80
		80-pin 0.8mm-pitch LCC	80D0		PCA7302E1L-80

*1 R4945 and R4945A are products of ADVANTEST Corporation.
*2.Programming adapter is unnecessary when using third party flash programmer.

Operationg Environment for Software Tools

Product Type	Product Name	Host Machine (OS)
C compiler	NC308WA	IBM PC/AT compatibles (Windows 98, Windows 95, Windows NT 4.0)
	NC30WA	
Real-time OS	MR308	
	MR30	
Simulator Debugger	PD308SIM	
	PD30SIM	
Emulator Debugger	PD308	
	PD30	

Third Party Tools

Cross Tools

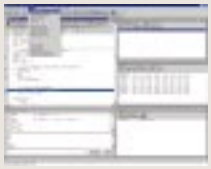
EWM16C
Integrated development environment (EW EMBEDDED WORKBENCH)

U.S. and Canada: IAR Systems Software Inc.
E-mail: info@iar.com
URL: http://www.iar.com/
Europe: IAR Systems AB
E-mail: info@iar.se
URL: http://www.iar.se/

osCAN M16C
Real-time OS

Vector Informatik GmbH
Overseas:
E-mail : can@vector-informatik.de
URL : http://www.vector-informatik.de/

EDE
Embedded development environment



TASKING Inc.
International Headquarters:
E-mail : sales@tasking-us.com
URL : http://www.tasking.com/
European Headquarters:
E-mail : sales_nl@tasking.com
URL : http://www.tasking.com/

RTXC
Real-time OS

U.S. and Canada:Embedded System Products, Inc.
Overseas:
E-mail : sales@rtxc.com
URL : http://www.rtxc.com/
Europe:Embedded System Products, Inc.
E-mail : euro@rtxc.com
URL : http://www.rtxc.com/

OPENplus
IDE for Embedded Real-Time System

Gaio Technology Co., Ltd.
Overseas:
E-mail : gaio@gol.com
URL : http://www.gaio.com/
Japan:
E-mail : sales@gaio.co.jp
URL : http://www.gaio.co.jp/

9-Bit Solution
9-Bit Asynchronous Serial Communication Network

Overseas: Cimetrics Technology
E-mail : info@cimetrics.com
URL : http://www.cimetrics.com/
Japan: A.I.Corporation
E-mail : sales@aicp.co.jp
URL : http://www.aicp.co.jp/

Emulators

AD250, AD200-S86/S89
Emulator advice

U.S. and Canada: Orion Instruments, Inc.
URL : http://www.oritools.com/
Europe : Ashling Microsystems Limited
URL : http://www.ashling.com/
Other countries:
Yokogawa Digital Computer Corporation
E-mail : info@advice.ydc.co.jp

Ultra-M16C
Emulator

International Headquarters:
Ashling Microsystems Ltd.
E-mail : sales.ie@ashling.com
URL : http://www.ashling.com/
U.S. and Canada: Orion Instruments, Inc.
E-mail : sales.usa@ashling.com
URL : http://www.ashling.com/

EMUL M16C-PC
Emulator

Nohau Corporation
E-mail : sales@nohau.com
URL : http://www.nohau.com/

MultiSTAC M16C/60,61,62,6N,80
MultiSTAC Series Emulator

Sophia Systems and Technology Corporation
E-mail : sales@sophia.com
URL : http://www.sophia.com/

Programmers

AF200
Flash Programmer

Yokogawa Digital Computer Corporation
U.S. and Canada: Orion Instruments, Inc.
URL : http://www.oritools.com/
Europe : Ashling Microsystems Limited
URL : http://www.ashling.com/
Japan : Yokogawa Digital Computer Corporation
URL : http://www.ydc.co.jp/index_e.html

EFP-I
Flash Programmer for M16C/62

Asia and Oseania : Suisei Electronics System Co., Ltd.
Dealer is Mitsubishi Electric Corporation
URL : http://www.suisei.co.jp/
E-mail : support@apl.mesc.co.jp

MFW-1
Multi functions Flash Writer

SUNNY GIKEN INC.
URL : http://www.sunnygiken.co.jp/english/
E-mail : support@apl.mesc.co.jp

SFW-62SA
Very Compact Flash Writer

SUNNY GIKEN INC.
URL : http://www.sunnygiken.co.jp/english/
E-mail : support@apl.mesc.co.jp

Hardware and software cosimulator for the M16C

● MPU emulator section

MPU emulator section

- Can simulate in units of instruction words
- All of the standard M16C/61 CPU and peripheral equipment are written in C language and put into a simulation model

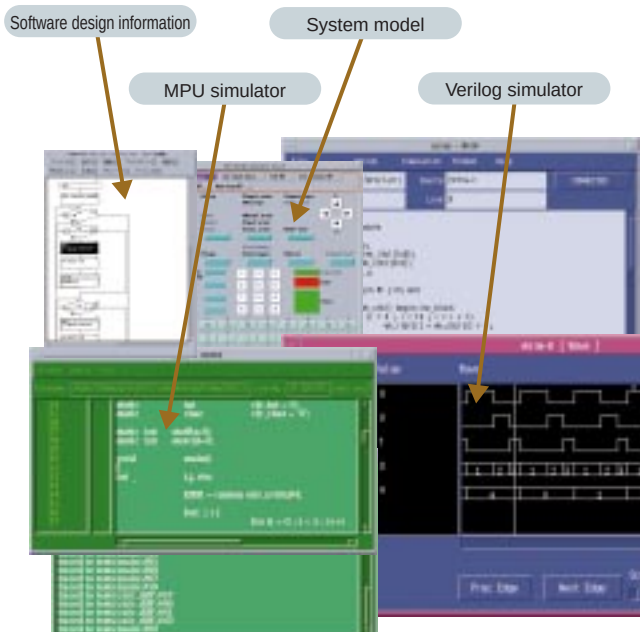
Verilog simulator section

- The Verilog HDL description of the ASIC section is converted into C language and operated in cooperation with Asim-G kernel (will be materialized in single kernel)
- Operations are event-driven.

● Asim-G M16C model from Gaio Technology

- Cosimulation environment with both MPU simulator and Verilog simulator included
- Capable of simultaneous simulation of software, CASE design information, ASIC, and mechanical
- GUI interface for easy operation by microcomputer engineers
- Fast simulation speed of up to 50 us per instruction (for the ASIC section with about 40 to 50k gates)

● Asim-G operation screen



Evaluation Tools

PC card type flash programmer

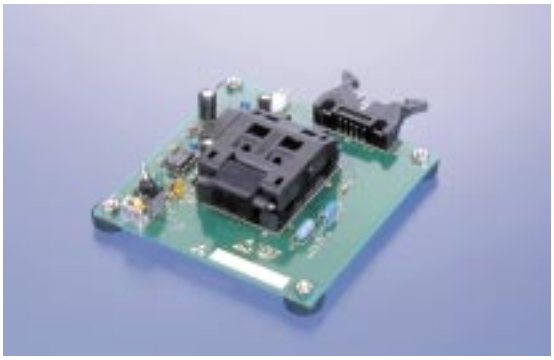
The PC card type flash programmer for the M16C is a compact flash programmer based on PCMCIA standards for PC card interfaces. This product can download a programming file to PC in a moment. (Other products have to spend a few minutes when a programming file of 256KB size download.) This product can cut very loss time. This flash programmer is available in three types of products: Serial I/O mode, CAN, and M3BUS.

(Products that support Serial I/O mode)
[Features]
• Capable of writing at high speed using Serial I/O mode
  256 Kbytes written in about 8 seconds
  256 Kbytes erased in about 1 second
[Ordering information]
Products usable with M30624FG(L)FP/GP
  Order: MSCH-APP-H; Specification: MSA0655-G01
Products usable with M30624FG(L)FP/GP, M30201F6(T)SP/FP
  Order: MSCH-APP-H; Specification: MSA0655-G02

(Products that support CAN)
[Features]
• Capable of writing using CAN protocol
• Can write to microcomputers on CAN network
• System-dependent transfer speed can be set
• Usable with M306N0FCTFP, M306N0FGTFP, M306N1FCTFP

(Products that support M3BUS (based on IE_Bus)
• Capable of writing using M3BUS
  Communication speed mode 1 (about 17 KB/second) only is supported
  256 Kbytes written in about 4 minutes
  256 Kbytes erased in about several seconds

IC socket type programming board

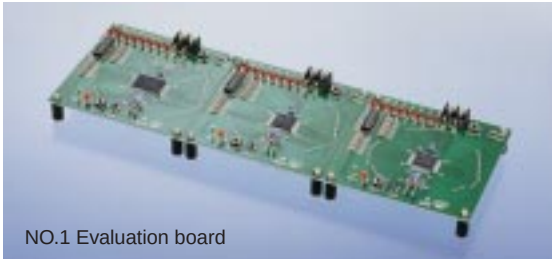


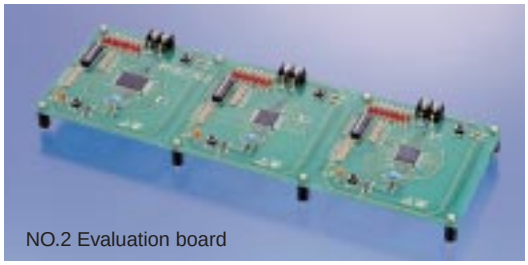
The IC socket type programming board is designed to write and erase the internal flash memory of the MCU as a single unit using Serial I/O mode. When used in combination with a PC card type flash programmer, this board allows you to erase and write to the internal flash memory at high speed.

[Features]
• Operates with single 5 V power supply
• Switchable between 5 V/3.3 V version MCUs
[Ordering information]
0.65mm-pitch 100-pin version Order: MSCH-APP-H; specification: MSA0656-G01
0.5mm-pitch 100-pin version Order: MSCH-APP-H; specification: MSA0656-G02
0.65mm-pitch 80-pin version Order: MSCH-APP-H; specification: MSA0656-G03
0.5mm-pitch 144-pin version Order: MSCH-APP-H; specification: MSA0656-G04 (under development)
*Other packages will also be supported in the near future.

EMS/EMI Evaluation Board

Standards do not stipulate EMS or EMI testing methods for microcomputer chips. Mitsubishi developed the Evaluation Board for evaluating Mitsubishi products using in-house standards.


NO.1 Evaluation board


NO.2 Evaluation board

M16C MiniEmulator

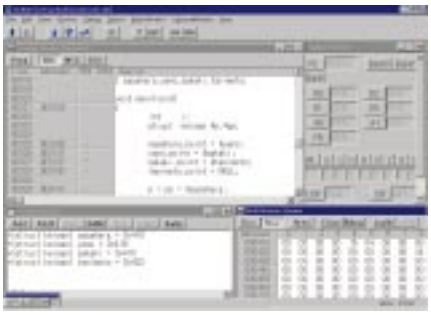
M16C MiniEmulator is available at low cost, yet provides highly efficient debugging environment. The application program can be evaluated simply by connecting MiniEmulator to your board.

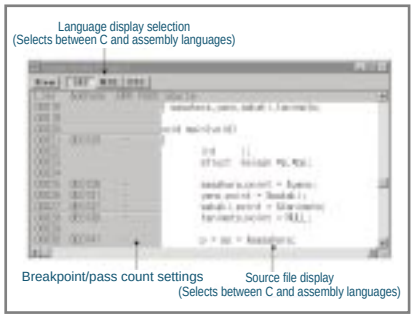
[Features]
- Contains 240 Kbytes program memory and 19 Kbytes RAM
- Operates as easily as Mitsubishi development tools
- Can be connected to your board after mounting a 100-pin LCC socket on it

[Functions]
- Source debugging in C language and assembly language
- Go break function with pass count
- RAM trace function

[Kit composition]
- MiniEmulator, compiler, debugger, communication cable, manual, dedicated programming software

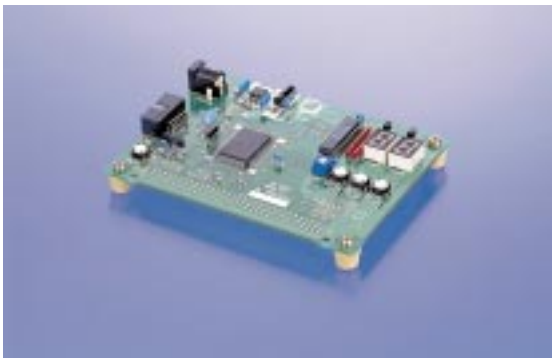
[Ordering information]
3 V, 10 MHz version Order: MSCH-APP-H; Specification: MSA0652-G01
5 V, 16 MHz version Order: MSCH-APP-H; Specification: MSA0652-G02





M16C Starter Kit 2

M16C Starter Kit 2 is an M16C evaluation set, with the compiler, debugger, and MCU board included in a single package. It is ideally suited for evaluating the CPU performance of the M16C and learning how the program runs. The debugger included in this set operates as easily as Mitsubishi development tools that are used in actual development, so that it can also be used to learn about development tools.



[Features]
- Contains 240 Kbytes program memory and 19 Kbytes RAM
- Operates as easily as Mitsubishi development tools

[Kit composition]
- MCU board, compiler, debugger, communication cable, manual, dedicated programming software

[Ordering information]
3 V,10 MHz version Order: MSCH-APP-H; Specification: MSA0654-G01
5 V,16 MHz version Order: MSCH-APP-H; Specification: MSA0654-G02

M16C/62 Flash Demo Set

M16C/62 Flash Demo Set is compact, lightweight demonstration set that will help you experience the speed at which flash memory is written and erased. It contains the M30624FGLFP and can be driven by a battery.

[Features]
- Contains the M30624FGLFP
  Can write 256 Kbytes in about 8 seconds and erase 256 Kbytes in about 1 second.
- Compact and lightweight, with the programmer and target packaged in one set

[Kit composition]
- Flash programmer board incorporating M30624FGLFP x 1
- Programming target board incorporating M30624FGLFP x 1

M16C/21 FLD Demo Set

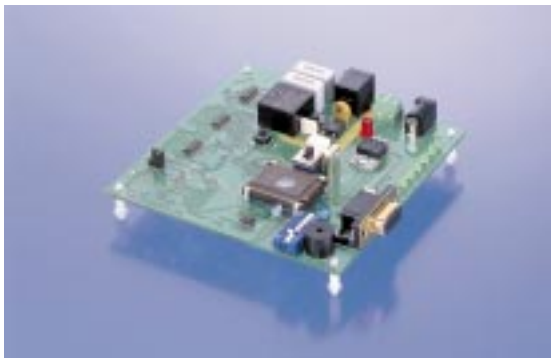
M16C/21 FLD Demo Set contains a high voltage tolerant microcomputer, the M16C/21, and materializes high-quality display using a fluorescent display tube (FLD). It also can rewrite the internal flash memory on-board, so that not only can you actually feel the brightness of display by demonstration, but can also actually control the FLD after installing a program.

[Composition]
• Power supply: Single 5 V
• FLD: 52 lines (16 grid lines, 36 segment lines)
• Clock: X_{IN} 10 MHz, X_{CIN} 32 KHz
• Input switch: 2 x 4 key matrix
Caution: This demonstration set is not a mass-production item.

DTMF/Modem Demo Board

DTMF/Modem Demo Board is a demonstration set that has materialized the tone pulse input/output (DTMF)/modem functions by using the M16C's peripheral functions. This demonstration set uses the M16C and software library to materialize the DTMF/modem functions.

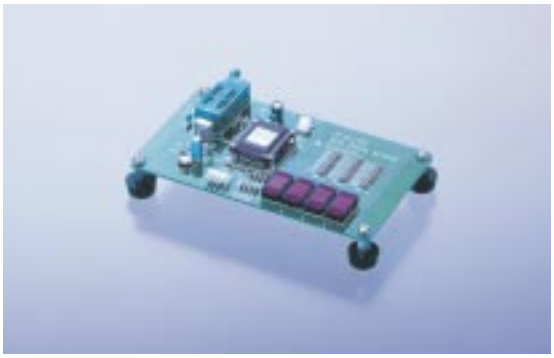
[Composition]
• Power supply: Single 5V
• MCU board, RS232C cable, Control software
[Features]
• Modem functions based on ITU standard V.23 (V.22 under development)



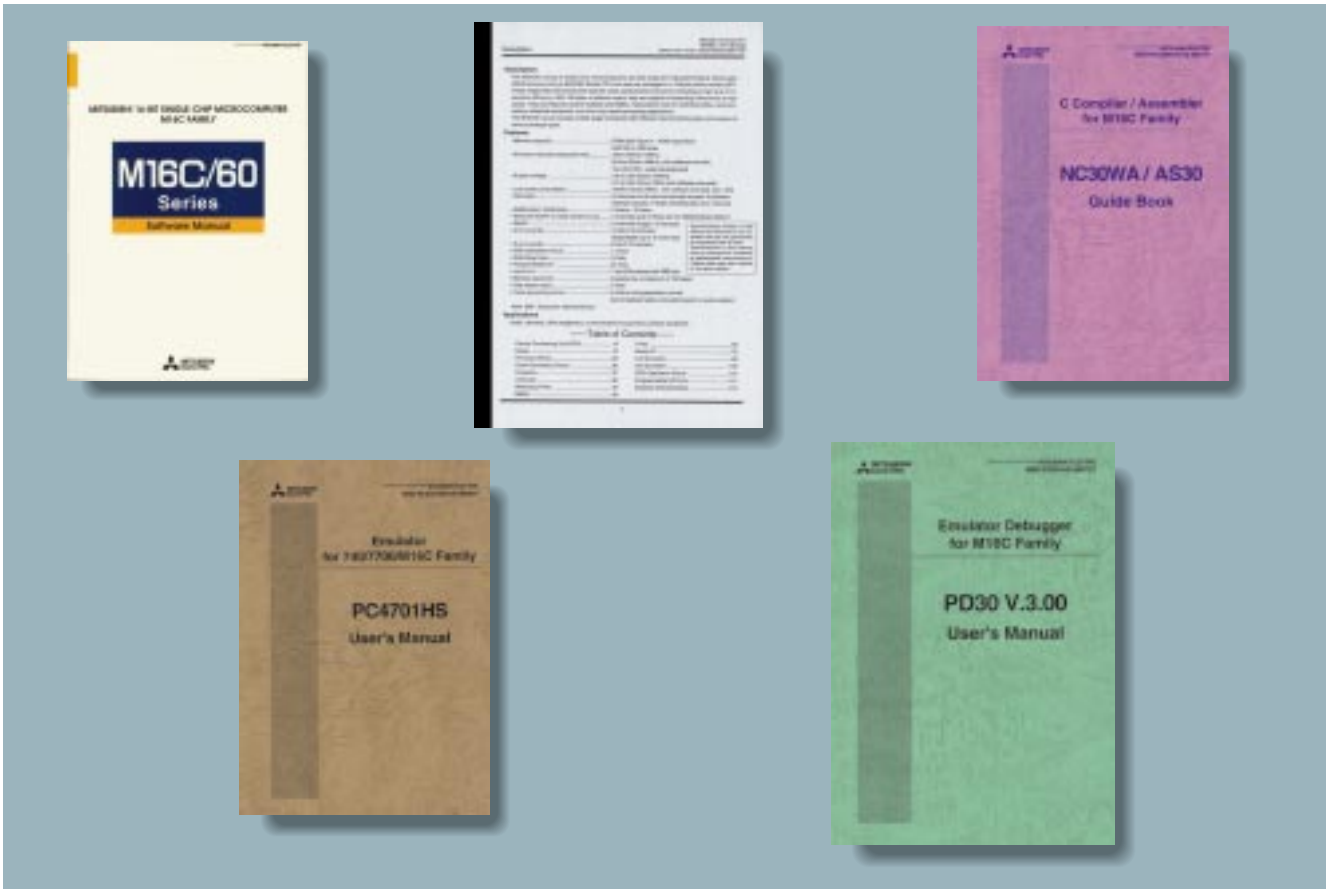
ROM Correction Function

The M16C has address match interrupts. Using the address match interrupts and an external memory such as an E^2PROM, it is possible to easily correct ROM errors or change specifications. This board demonstrates the ROM correction function by changing the operation of the LED display when various E^2PROMs are installed.

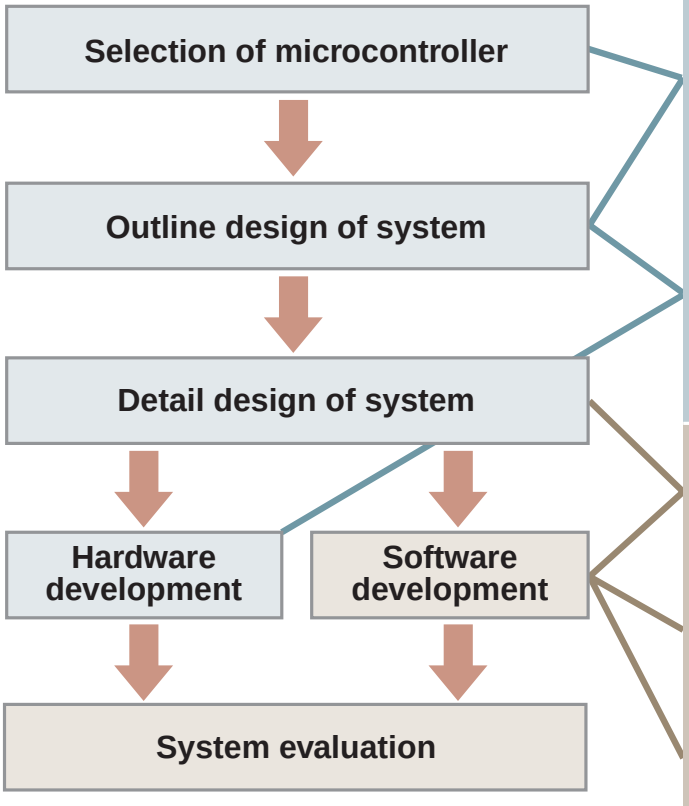
[Demonstration board configuration]
• Clock: X_{IN} 10 MHz
• E^2PROM (M6M80021P)
• LED lamps
[Selectable functions]
• Preinstalled E^2PROM



Related Documents



Usage
(Microcontroller development flow)



	Type of document	Contents
Hardware	Data sheet and data book	Hardware specification (pin assignment, memory map, specifications of peripheral functions, electrical characteristics, timing charts)
	User's manual	Detailed description about hardware specifications, operation, and application examples (connection with peripherals, relationship with software)
Software	Programming manual	Method for creating programs using assembly and C languages
	Software manual	Detailed description about operation of each instruction (assembly language)
	Sample program collection	Sample program collection using assembly language

MCU	Documents	Publication No.
For M16C/80 Series	Software Manual M16C/80 series	H-BH529-C
	Application note M16C/80 series(sample program collection)	Under production
	Application note M16C/80 series(C language)	Under production
	Application note M16C/80 series(Assembly language)	Under production
For M16C/80 group	Data sheet M16C/80 group	PDF only
	User's manual M16C/80 group	Under production
For M16C/61 group	Data sheet M16C/61 group	H-BH529-C
	User's manual M16C/61 group	H-BH529-C
For M16C/62 group	Data sheet M16C/62 group	H-BH529-C
	User's manual M16C/62 group	H-BH529-C
	Application note M16C/62 group (Three-phase inverter PWM control)	PDF only
	Application note M16C/62 group(I²C-Bus)	PDF only
For M16C/60,M16C/20 Series	Software Manual M16C/60,M16C/20 series	H-BH529-C
	Application note M16C/60,M16C/20 series (sample program collection)	H-BH529-C
	Application note M16C/60,M16C/20 series(C language)	H-BH529-C
	Application note M16C/60,M16C/20 series(Assembly language)	H-BH529-C
	Application note M16C/60,M16C/20 series(Flash)	Under production
For M16C/6K group	Data sheet M16C/6K group	Under production
For M16C/6N group	Data sheet M16C/6N group	Under production
	User's manual M16C/6N group	Under production
	Application note M16C/6N group	Under production
For M16C/6V group	Data sheet M306V0ME-XXXFP,M306V0EEFP	Under production
	Application note M16C/6V group	Under production
For M30201 group	Data sheet M30201 group	H-BH529-C
	User's manual M30201 group	H-BH529-C
For M30218 group	Data sheet M30218 group	Under production

M16C website address: Some of these documents are available as PDF files and may be downloaded from the following website:
http://www.infomicom.mesc.co.jp/M16C/mctope.htm

H-CJ581-A KI-9908 Printed in Japan (ROD)

New publication effective Aug. 1999.
Specifications subject to change without notice.