To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M37903S4CHP

16-BIT CMOS MICROCOMPUTER

DESCRIPTION

These are microcomputers designed with high-performance CMOS silicon gate technology. These microcomputers support the 7900 Series instruction set, which is enhanced and expanded instruction set and is upper-compatible with the 7700/7751 Series instruction set.

The CPU of these microcomputers is a 16-bit parallel processor that can also be switched to perform 8-bit parallel processing. Also, the bus interface unit of these microcomputers enhances the memory access efficiency to execute instructions fast. Therefore, these microcomputers are suitable for office, business, and industrial equipment controller that require high-speed processing of large data.

DISTINCTIVE FEATURES

<Microcomputer mode>

- Number of basic machine instructions 203
- Memory
  - ROM ..... External
  - RAM ..... 2048 bytes
- Instruction execution time
  - The fastest instruction at 26 MHz frequency ..... 38 ns
- Single power supply ..... 5 V ± 0.5 V
- Interrupts ..... 6 external sources, 15 internal sources, 7 levels
- Multi-functional 16-bit timer ..... 5 + 3
- Serial I/O (UART or Clock synchronous) 2
- 10-bit A-D converter ..... 8-channel inputs
- 8-bit D-A converter ..... 2-channel outputs
- Real-time output
  - .... 4 bits × 2 channels, or 6 bits × 1 channel + 2 bits × 1 channel
- 12-bit watchdog timer
- Programmable input/output (ports P0, P2–P8, P11) 65

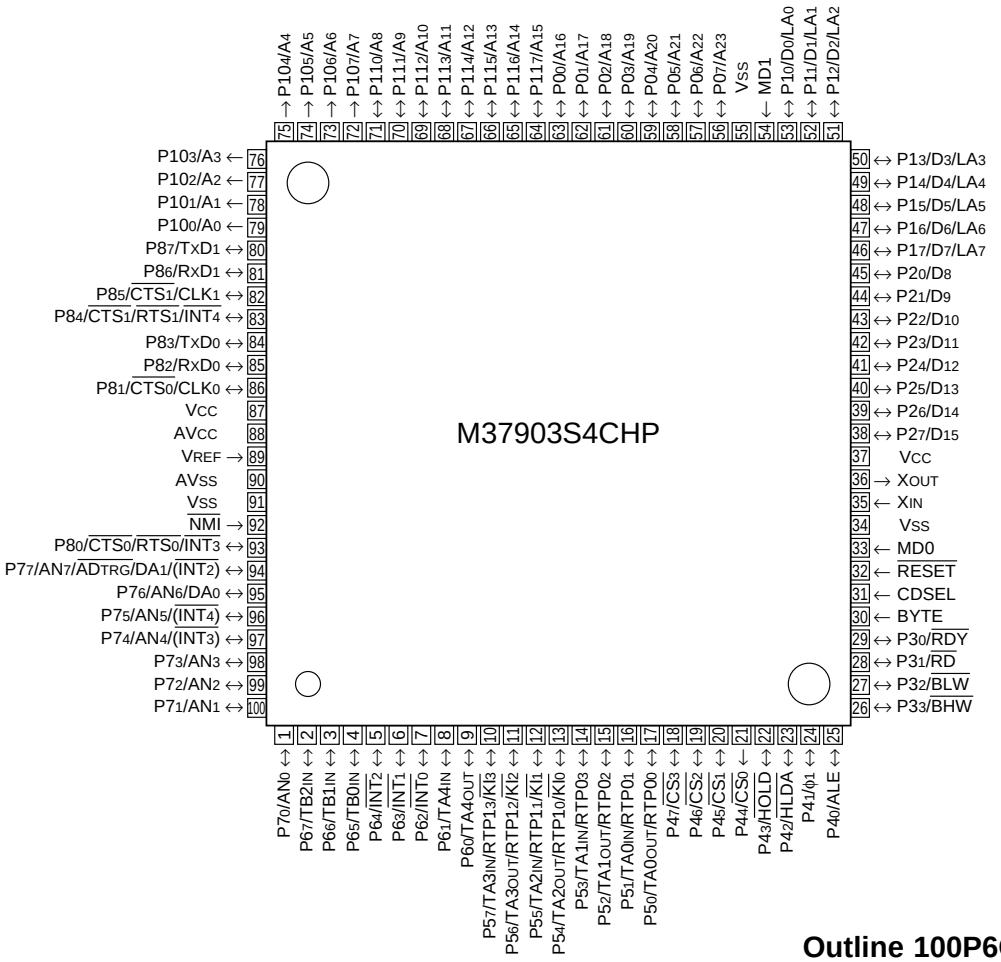
APPLICATION

Control devices for personal computer peripheral equipment such as CD-ROM drives, DVD-ROM drives, hard disk drives, high density FDD, printers

Control devices for office equipment such as copiers and facsimiles

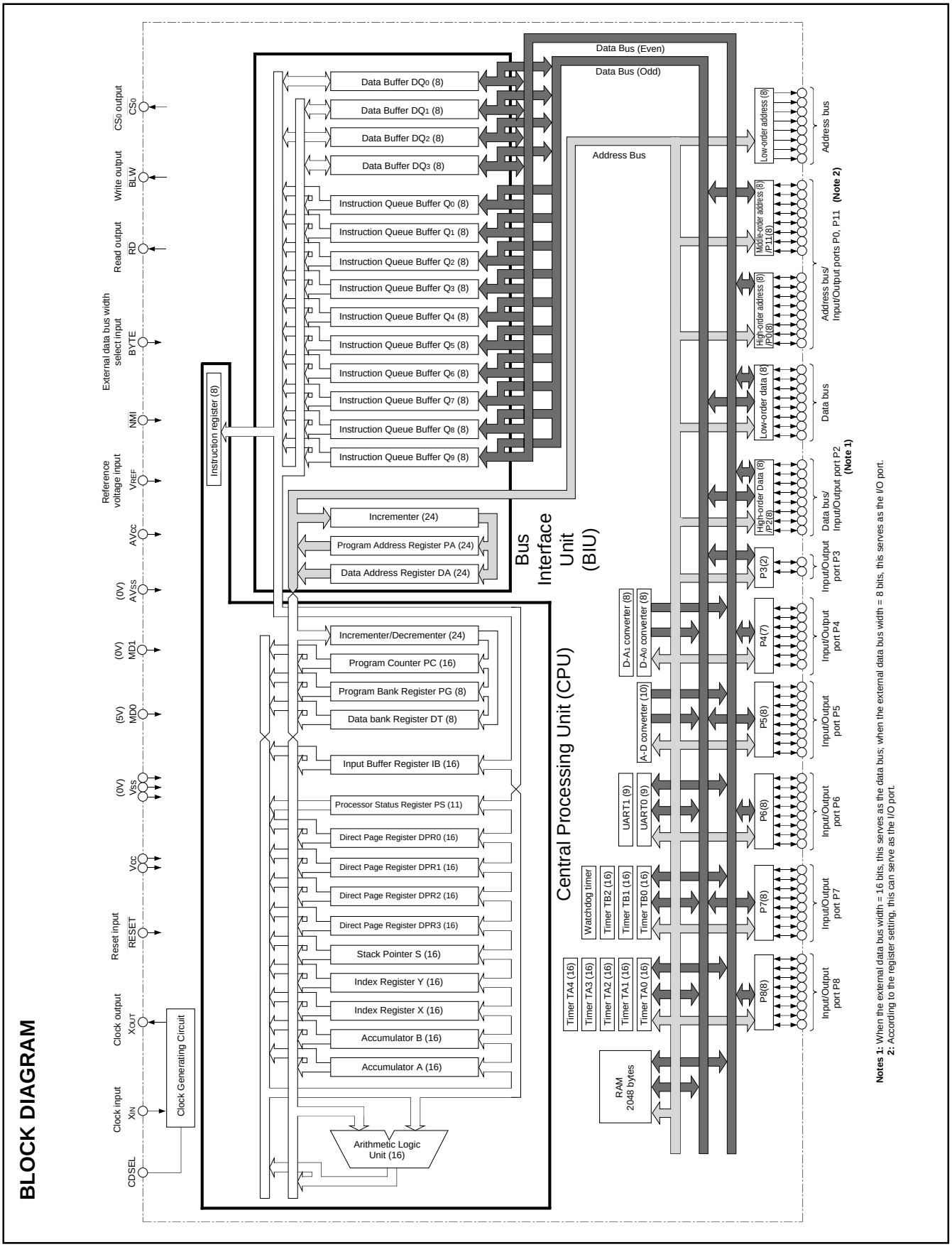
Control devices for industrial equipment such as communication and measuring instruments

M37903S4CHP PIN CONFIGURATION (TOP VIEW)



Outline 100P6Q-A

BLOCK DIAGRAM



Notes 1: When the external data bus width = 16 bits, this serves as the data bus; when the external data bus width = 8 bits, this serves as the I/O port.
2: According to the register setting, this can serve as the I/O port.

FUNCTIONS (Microcomputer mode)

Parameter		Functions
Number of basic machine instructions		203
Instruction execution time		38 ns (the fastest instruction at f(f_{sys}) = 26 MHz)
External clock input frequency f(X_{IN})		26 MHz (Max.) **(Note)**
System clock frequency f(f_{sys})		26 MHz (Max.)
Memory size	ROM	External
	RAM	2048 bytes
Programmable input/output ports	P0, P2, P5–P8, P11	8-bit × 7 (Max.)
	P3	2-bit × 1 (Max.)
	P4	7-bit × 1 (Max.)
Multi-functional timers	TA0–TA4	16-bit × 5
	TB0–TB2	16-bit × 3
Serial I/O	UART0 and UART1	(UART or Clock synchronous serial I/O) × 2
A-D converter		10-bit successive approximation method × 1 (8 channels)
D-A converter		8-bit × 2
Watchdog timer		12-bit × 1
Chip-select wait control		Chip select area × 4 ($\overline{CS_0}$–$\overline{CS_3}$). A bus cycle type and bus width can be set for each chip select area.
Real-time output		4 bits × 2 channels; or 6 bits × 1 channel + 2 bits × 1 channel
Interrupts	Maskable interrupts	5 external types, 13 internal types. Each interrupt can be set to a priority level within the range of 0–7 by software.
	Non-maskable interrupts	1 external type, 2 internal types.
Clock generating circuit		Built-in (externally connected to a ceramic resonator or quartz crystal resonator).
Power supply voltage		5 V±0.5 V
Power dissipation		150 mW (at f(f_{sys}) = 26 MHz, Typ.)
Ports' input/output characteristics	Input/Output withstand voltage	5 V
	Output current	5 mA
Memory expansion		Up to 16 Mbytes. Note that bank FF_{16} is a reserved area.
Operating ambient temperature range		–20 to 85 °C
Device structure		CMOS high-performance silicon gate process
Package		100-pin plastic molded QFP

Note: When the X_{IN}-input-clock division select bit = "0", the maximum value = 52 MHz.

PIN DESCRIPTION (MICROCOMPUTER MODE)

Pin	Name	Input/ Output	Functions
Vcc, Vss	Power supply input	—	Apply 5 V±0.5 V to Vcc, and 0 V to Vss.
MD0	MD0	Input	Connect this pin to VCC.
MD1	MD1	Input	Connect this pin to Vss.
$\overline{\text{RESET}}$	Reset input	Input	The microcomputer is reset when VSS-level voltage is applied to this pin.
XIN	Clock input	Input	These are input and output pins of the internal clock generating circuit. Connect a ceramic or quartz- crystal resonator between the XIN and XOUT pins. When an external clock is used, the clock source should be connected to the XIN pin, and the XOUT pin should be left open.
XOUT	Clock output	Output	
BYTE	External data bus width select input	Input	This pin determines whether the external data bus has an 8-bit width or 16-bit width for the memory expansion mode or microprocessor mode. The width is 16 bits when VSS-level voltage is input, and 8 bits when VCC-level voltage is applied. When BYTE = Vss level, by the register setting, the external data bus for each of areas $\overline{\text{CS}}_1$ to $\overline{\text{CS}}_3$ can have a width of 8 bits.
CDSEL	Clock division select input	Input	This pin determines the XIN-input-clock division select bit's **(Note)** state at reset and the input level at pin XIN.
AVcc, AVss	Analog power supply input	—	Power supply input pins for the A-D converter and the D-A converter. Connect AVcc to Vcc, and AVss to Vss externally.
VREF	Reference voltage input	Input	This is the reference voltage input pin for the A-D converter and the D-A converter.
$P0_0/A_{16}$–$P0_7/A_{23}$	Address (high-order) output	Output	Address (A_{16}–A_{23}) is output. These pins also function as I/O port pins according to the register setting.
$P1_0/D_0$–$P1_7/D_7$	Data (low-order) I/O	I/O	The low-order 8 bits of data (D_0–D_7) are input/output. When the external data bus has an 8-bit width, address (LA_0–LA_7) output and data (D_0–D_7) input/output can be performed with the time-sharing method, according to the register setting.
$P2_0/D_8$–$P2_7/D_{15}$	I/O port P2, Data (high-order) I/O	I/O	■ When 8-bit external data bus is used Port P2 is an 8-bit I/O port. This port has an I/O direction register, and each pin can be programmed for input or output. These pins enter the input mode at reset. ■ When 16-bit external data bus is used The high-order 8 bits of data (D_8–D_{15}) are input or output.
$P3_0$–$P3_3$	I/O port P3	I/O	$P3_0$ functions as an input pin of $\overline{\text{RDY}}$; and $P3_1$,$P3_2$, $P3_3$ function as the output pins of $\overline{\text{RD}}$, $\overline{\text{BLW}}$, $\overline{\text{BHW}}$, respectively. $P3_0$ also functions as an I/O port pin according to the register setting. When the external data bus has a width of 8 bits, the $\overline{\text{BHW}}$ pin functions as an I/O port pin ($P3_3$).
$P4_0$–$P4_7$	I/O port P4	I/O	$P4_0$–$P4_4$ function as output or input pins of ALE, ϕ_1, $\overline{\text{HLDA}}$, $\overline{\text{HOLD}}$, $\overline{\text{CS}}_0$, and $P4_5$–$P4_7$ as I/O port pins, respectively. According to the register setting, $P4_0$–$P4_3$ also function as I/O port pins, and $P4_5$–$P4_7$ as output pins of $\overline{\text{CS}}_1$–$\overline{\text{CS}}_3$.
$P5_0$–$P5_7$	I/O port P5	I/O	Port P5 is an 8-bit I/O port. This port has an I/O direction register, and each pin can be programmed for input or output. These pins enter the input mode at reset. These pins also function as I/O pins for timers A0–A3, output pins for the real-time output, and input pins for the key-input interrupt.
$P6_0$–$P6_7$	I/O port P6	I/O	Port P6 is an 8-bit I/O port. This port has an I/O direction register, and each pin can be programmed for input or output. These pins enter the input mode at reset. These pins also function as I/O pins for timer A4, input pins for external interrupt inputs $\overline{\text{INT}}_0$–$\overline{\text{INT}}_2$, and input pins for timers B0–B2.
$P7_0$–$P7_7$	I/O port P7	I/O	Port P7 is an 8-bit I/O port. This port has an I/O direction register, and each pin can be programmed for input or output. These pins enter the input mode at reset. These pins also function as input pins for the A-D converter, output pins for the D-A converter, and input pins for $\overline{\text{INT}}_2$, $\overline{\text{INT}}_3$, and $\overline{\text{INT}}_4$.
$P8_0$–$P8_7$	I/O port P8	I/O	Port P8 is an 8-bit I/O port. This port has an I/O direction register, and each pin can be programmed for input or output. These pins enter the input mode at reset. These pins also function as I/O pins for UART0, UART1, and input pins for $\overline{\text{INT}}_3$ and $\overline{\text{INT}}_4$.
$P10_0/A_0$–$P10_7/A_7$	Address (low-order) output	Output	Address (A_0–A_7) is output.
$P11_0/A_8$–$P11_7/A_{15}$	Address (middle-order) output	Output	Address (A_8–A_{15}) is output. Also, these pins function as I/O port pins according to the register setting.
$\overline{\text{NMI}}$	Non-maskable interrupt	Input	This pin is for a non-maskable interrupt.

Note: The XIN-input-clock division select bit is used to determine whether the input clock to pin XIN is to be divided or not.

BASIC FUNCTION BLOCKS

The M37903S4CHP has the same function as that of the M37903F8CHP except for the following. Therefore, refer to the datasheet of the M37903F8CHP.

- The memory allocation of the M37903S4CHP differs from that of the M37903F8CHP.
- The M37903S4CHP operates only in the microprocessor mode.

MEMORY

Figure 1 shows the memory map. The address space is 16 Mbytes from addresses 0_{16} to $FFFFFF_{16}$. The address space is divided into 64-Kbyte units called banks. The banks are numbered from 0_{16} to FF_{16}. Bank FF_{16} is a reserved area for the development support tool. Therefore, do not use bank FF_{16}.

Internal RAM is assigned as shown in Figure 1.

Addresses $FFC0_{16}$ to $FFFF_{16}$ contain the RESET and the interrupt vector addresses, and the interrupt vectors are stored there. For these addresses, use the ROM.

For details, refer to the section on interrupts.

Assigned to addresses 0_{16} to FF_{16} are peripheral devices such as I/O ports, A-D converter, D-A converter, UART, timers, interrupt control registers, etc. Figures 2 and 3 show the location of SFRs.

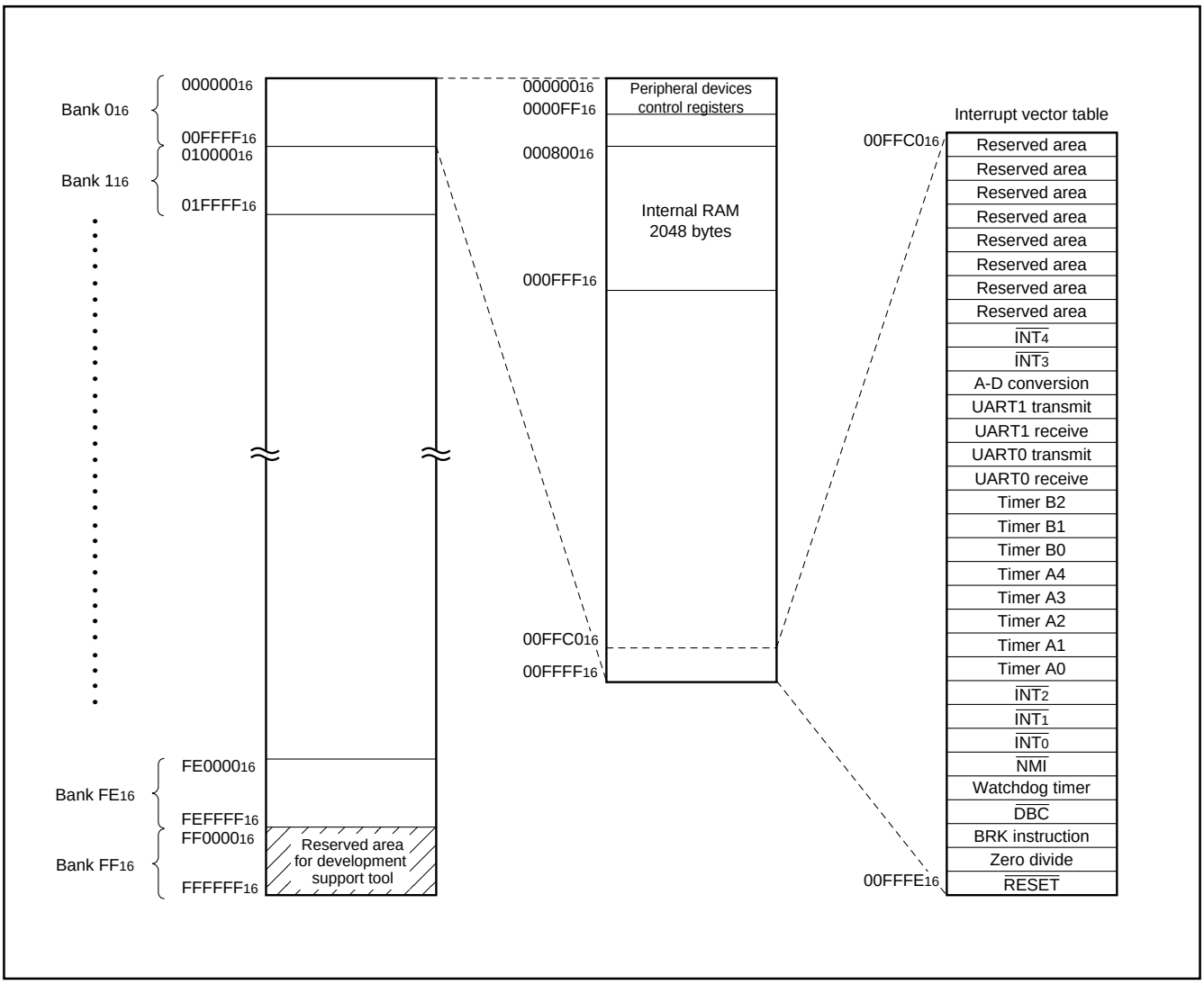


Fig. 1 Memory map of M37903S4CHP

Address (Hexadecimal notation)	
000000₁₆	
000001₁₆	
000002₁₆	Port P0 register
000003₁₆	Port P1 register
000004₁₆	Port P0 direction register
000005₁₆	Port P1 direction register
000006₁₆	Port P2 register
000007₁₆	Port P3 register
000008₁₆	Port P2 direction register
000009₁₆	Port P3 direction register
00000A₁₆	Port P4 register
00000B₁₆	Port P5 register
00000C₁₆	Port P4 direction register
00000D₁₆	Port P5 direction register
00000E₁₆	Port P6 register
00000F₁₆	Port P7 register
000010₁₆	Port P6 direction register
000011₁₆	Port P7 direction register
000012₁₆	Port P8 register
000013₁₆	
000014₁₆	Port P8 direction register
000015₁₆	
000016₁₆	Port P10 register
000017₁₆	Port P11 register
000018₁₆	Port P10 direction register
000019₁₆	Port P11 direction register
00001A₁₆	
00001B₁₆	
00001C₁₆	
00001D₁₆	
00001E₁₆	A-D control register 0
00001F₁₆	A-D control register 1
000020₁₆ 000021₁₆	A-D register 0
000022₁₆ 000023₁₆	A-D register 1
000024₁₆ 000025₁₆	A-D register 2
000026₁₆ 000027₁₆	A-D register 3
000028₁₆ 000029₁₆	A-D register 4
00002A₁₆ 00002B₁₆	A-D register 5
00002C₁₆ 00002D₁₆	A-D register 6
00002E₁₆ 00002F₁₆	A-D register 7
000030₁₆	UART0 transmit/receive mode register
000031₁₆	UART0 baud rate register (BRG0)
000032₁₆ 000033₁₆	UART0 transmit buffer register
000034₁₆	UART0 transmit/receive control register 0
000035₁₆	UART0 transmit/receive control register 1
000036₁₆ 000037₁₆	UART0 receive buffer register
000038₁₆	UART1 transmit/receive mode register
000039₁₆	UART1 baud rate register (BRG1)
00003A₁₆ 00003B₁₆	UART1 transmit buffer register
00003C₁₆	UART1 transmit/receive control register 0
00003D₁₆	UART1 transmit/receive control register 1
00003E₁₆ 00003F₁₆	UART1 receive buffer register

Address (Hexadecimal notation)	
000040₁₆	Count start register
000041₁₆	
000042₁₆	One-shot start register
000043₁₆	
000044₁₆	Up-down register
000045₁₆	Timer A clock division select register
000046₁₆ 000047₁₆	Timer A0 register
000048₁₆ 000049₁₆	Timer A1 register
00004A₁₆ 00004B₁₆	Timer A2 register
00004C₁₆ 00004D₁₆	Timer A3 register
00004E₁₆ 00004F₁₆	Timer A4 register
000050₁₆ 000051₁₆	Timer B0 register
000052₁₆ 000053₁₆	Timer B1 register
000054₁₆ 000055₁₆	Timer B2 register
000056₁₆	Timer A0 mode register
000057₁₆	Timer A1 mode register
000058₁₆	Timer A2 mode register
000059₁₆	Timer A3 mode register
00005A₁₆	Timer A4 mode register
00005B₁₆	Timer B0 mode register
00005C₁₆	Timer B1 mode register
00005D₁₆	Timer B2 mode register
00005E₁₆	Processor mode register 0
00005F₁₆	Processor mode register 1
000060₁₆	Watchdog timer register
000061₁₆	Watchdog timer frequency select register
000062₁₆	Particular function select register 0
000063₁₆	Particular function select register 1
000064₁₆	Particular function select register 2
000065₁₆	Reserved area **(Note)**
000066₁₆	Reserved area **(Note)**
000067₁₆	Reserved area **(Note)**
000068₁₆	
000069₁₆	
00006A₁₆	
00006B₁₆	
00006C₁₆	
00006D₁₆	
00006E₁₆	$\overline{INT_3}$ interrupt control register
00006F₁₆	$\overline{INT_4}$ interrupt control register
000070₁₆	A-D conversion interrupt control register
000071₁₆	UART0 transmit interrupt control register
000072₁₆	UART0 receive interrupt control register
000073₁₆	UART1 transmit interrupt control register
000074₁₆	UART1 receive interrupt control register
000075₁₆	Timer A0 interrupt control register
000076₁₆	Timer A1 interrupt control register
000077₁₆	Timer A2 interrupt control register
000078₁₆	Timer A3 interrupt control register
000079₁₆	Timer A4 interrupt control register
00007A₁₆	Timer B0 interrupt control register
00007B₁₆	Timer B1 interrupt control register
00007C₁₆	Timer B2 interrupt control register
00007D₁₆	$\overline{INT_0}$ interrupt control register
00007E₁₆	$\overline{INT_1}$ interrupt control register
00007F₁₆	$\overline{INT_2}$ interrupt control register

Note: Do not write to this address.

Fig. 2 Location of SFRs (1)

Address (Hexadecimal notation)	
000080₁₆	$\overline{CS_0}$ control register L
000081₁₆	$\overline{CS_0}$ control register H
000082₁₆	$\overline{CS_1}$ control register L
000083₁₆	$\overline{CS_1}$ control register H
000084₁₆	$\overline{CS_2}$ control register L
000085₁₆	$\overline{CS_2}$ control register H
000086₁₆	$\overline{CS_3}$ control register L
000087₁₆	$\overline{CS_3}$ control register H
000088₁₆	
000089₁₆	
00008A₁₆	Area $\overline{CS_0}$ start address register
00008B₁₆	
00008C₁₆	Area $\overline{CS_1}$ start address register
00008D₁₆	
00008E₁₆	Area $\overline{CS_2}$ start address register
00008F₁₆	
000090₁₆	Area $\overline{CS_3}$ start address register
000091₁₆	
000092₁₆	Port function control register
000093₁₆	
000094₁₆	External interrupt input control register
000095₁₆	External interrupt input read-out register
000096₁₆	D-A control register
000097₁₆	
000098₁₆	D-A register 0
000099₁₆	D-A register 1
00009A₁₆	Reserved area **(Note)**
00009B₁₆	
00009C₁₆	Reserved area **(Note)**
00009D₁₆	Reserved area **(Note)**
00009E₁₆	Reserved area **(Note)**
00009F₁₆	
0000A0₁₆	Real-time output control register
0000A1₁₆	
0000A2₁₆	Pulse output data register 0
0000A3₁₆	
0000A4₁₆	Pulse output data register 1
0000A5₁₆	
0000A6₁₆	Reserved area **(Note)**
0000A7₁₆	
0000A8₁₆	
0000A9₁₆	
0000AA₁₆	
0000AB₁₆	
0000AC₁₆	Serial I/O pin control register
0000AD₁₆	
0000AE₁₆	
0000AF₁₆	
0000B0₁₆	
0000B1₁₆	
0000B2₁₆	
0000B3₁₆	
0000B4₁₆	
0000B5₁₆	
0000B6₁₆	
0000B7₁₆	
0000B8₁₆	
0000B9₁₆	
0000BA₁₆	Reserved area **(Note)**
0000BB₁₆	Reserved area **(Note)**
0000BC₁₆	Clock control register
0000BD₁₆	Reserved area **(Note)**
0000BE₁₆	Reserved area **(Note)**
0000BF₁₆	Reserved area **(Note)**

Address (Hexadecimal notation)	
0000C0₁₆	
0000C1₁₆	
0000C2₁₆	
0000C3₁₆	
0000C4₁₆	
0000C5₁₆	
0000C6₁₆	
0000C7₁₆	
0000C8₁₆	
0000C9₁₆	
0000CA₁₆	
0000CB₁₆	
0000CC₁₆	
0000CD₁₆	
0000CE₁₆	
0000CF₁₆	
0000D0₁₆	
0000D1₁₆	
0000D2₁₆	
0000D3₁₆	
0000D4₁₆	
0000D5₁₆	
0000D6₁₆	
0000D7₁₆	
0000D8₁₆	
0000D9₁₆	
0000DA₁₆	
0000DB₁₆	
0000DC₁₆	
0000DD₁₆	
0000DE₁₆	
0000DF₁₆	
0000E0₁₆	
0000E1₁₆	
0000E2₁₆	
0000E3₁₆	
0000E4₁₆	
0000E5₁₆	
0000E6₁₆	
0000E7₁₆	
0000E8₁₆	
0000E9₁₆	
0000EA₁₆	
0000EB₁₆	
0000EC₁₆	
0000ED₁₆	
0000EE₁₆	
0000EF₁₆	
0000F0₁₆	
0000F1₁₆	
0000F2₁₆	
0000F3₁₆	
0000F4₁₆	
0000F5₁₆	
0000F6₁₆	
0000F7₁₆	
0000F8₁₆	
0000F9₁₆	
0000FA₁₆	
0000FB₁₆	
0000FC₁₆	
0000FD₁₆	
0000FE₁₆	
0000FF₁₆	

Note: Do not write to this address.

Fig. 3 Location of SFRs (2)

ELECTRICAL CHARACTERISTICS

As for the following, the M37903S4CHP is the same as the M37903F8CHP. Therefore, for the following, refer to the datasheet of the M37903F8CHP.

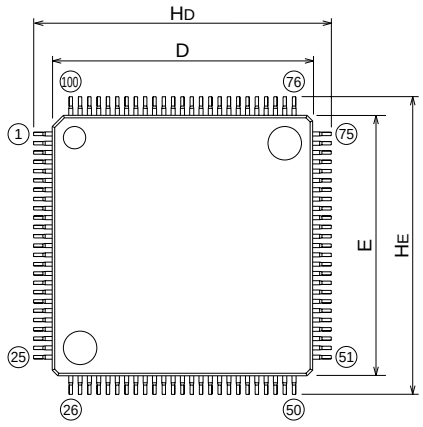
- ABSOLUTE MAXIMUM RATINGS
- RECOMMENDED OPERATING CONDITIONS
- DC ELECTRICAL CHARACTERISTICS
- A-D CONVERTER CHARACTERISTICS
- D-A CONVERTER CHARACTERISTICS
- TIMING REQUIREMENTS
- SWITCHING CHARACTERISTICS

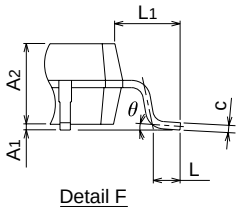
PACKAGE OUTLINE

100P6Q-A

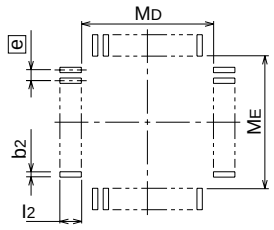
Plastic 100pin 14×14mm body LQFP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
LQFP100-P-1414-0.50	–		Cu Alloy





Detail F



Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	1.7
A_1	0	0.1	0.2
A_2	–	1.4	–
b	0.13	0.18	0.28
c	0.105	0.125	0.175
D	13.9	14.0	14.1
E	13.9	14.0	14.1
e	–	0.5	–
H_D	15.8	16.0	16.2
H_E	15.8	16.0	16.2
L	0.3	0.5	0.7
L_1	–	1.0	–
y	–	–	0.1
θ	0°	–	10°
b_2	–	0.225	–
l_2	1.0	–	–
M_D	–	14.4	–
M_E	–	14.4	–

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RENESAS
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Revision History	M37903S4CHP Datasheet

Rev. No.	Revision Description	Rev. date
1.0	First Edition	001004