

NEC

MOS INTEGRATED CIRCUIT

μ PD784214, 784215, 784216

16/8-BIT SINGLE-CHIP MICROCONTROLLERS

The μ PD784216 is a member of the μ PD784216 subseries of the 78K/IV series. Besides a high-speed and high-performance CPU, it features various peripheral hardware such as ROM, RAM, I/O ports, 8-bit resolution A/D and D/A converters, timer, serial interface, real-time output port, interrupts, etc.

A flash memory version, the μ PD78F4216, which can operate in the same voltage range as the mask ROM version, and various development tools are under development.

The functions are explained in detail in the following user's manuals. Be sure to read these manuals when designing your system.

μ PD784216, 784216Y Subseries User's Manual Hardware : Planned
78K/IV Series User's Manual Instructions : IEU-1386

FEATURES

- 78K/IV series
- Inherits peripheral functions of μ PD78078 subseries
- Pin-compatible with μ PD784216Y subseries
- Minimum instruction execution time
160 ns (main system clock $f_{xx} = 12.5$ MHz)
61 μ s (subsystem clock $f_{xt} = 32.768$ kHz)
- I/O port: 86 pins
- Timer/counter: 16-bit timer/counter $\times 1$ unit
8-bit timer/counter $\times 6$ units
- Serial interface: 3 channels
UART/IOE (3-wire serial I/O): 2 channels
CSI (3-wire serial I/O): 1 channel
- Standby function
HALT/STOP/IDLE mode
In power-saving mode: HALT/IDLE mode (with subsystem clock)
- Clock division function
- Watch timer: 1 channel
- Watchdog timer: 1 channel
- Clock output function
 f_{xx} , $f_{xx}/2$, $f_{xx}/2^2$, $f_{xx}/2^3$, $f_{xx}/2^4$, $f_{xx}/2^5$, $f_{xx}/2^6$, $f_{xx}/2^7$, f_{xt} selectable
- Buzzer output function
 $f_{xx}/2^{10}$, $f_{xx}/2^{11}$, $f_{xx}/2^{12}$, $f_{xx}/2^{13}$ selectable
- A/D converter: 8-bit resolution $\times 8$ channels
- D/A converter: 8-bit resolution $\times 2$ channels
- Supply voltage: $V_{DD} = 1.8$ to 5.5 V

APPLICATION FIELDS

Cellular telephones, PHS, cordless telephones, CD-ROM, AV systems

Unless mentioned otherwise, references in this document to the μ PD784216 refer to the μ PD784214, μ PD784215, and μ PD784216.

The information contained in this document is being issued in advance of the production cycle for the device. The parameters for the device may change before final production or NEC Corporation, at its own discretion, may withdraw the device prior to its production.

ORDERING INFORMATION

Part Number	Package	Internal ROM (Bytes)	Internal RAM (Bytes)
μPD784214GC-xxx-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	96 K	3584
μPD784214GF-xxx-3BA	100-pin plastic QFP (14 × 20 mm)	96 K	3584
μPD784215GC-xxx-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	128 K	5120
μPD784215GF-xxx-3BA	100-pin plastic QFP (14 × 20 mm)	128 K	5120
μPD784216GC-xxx-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	128 K	8192
μPD784216GF-xxx-3BA	100-pin plastic QFP (14 × 20 mm)	128 K	8192

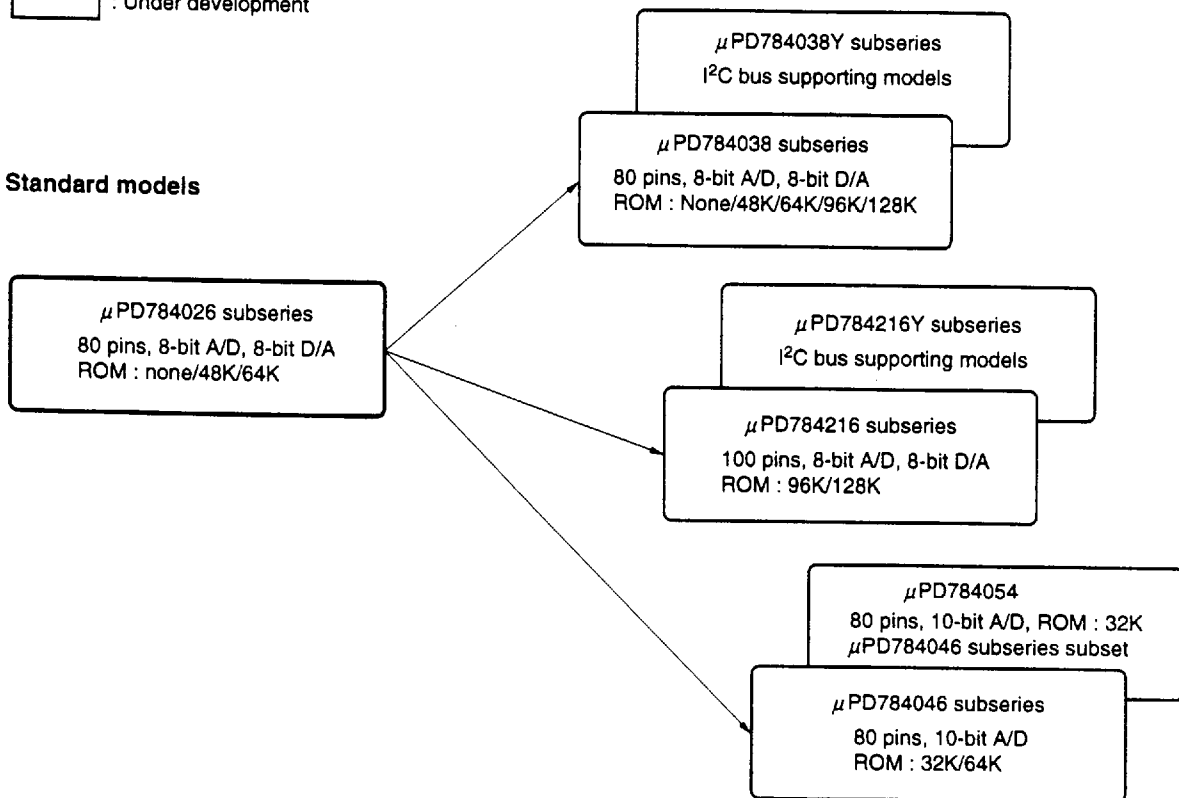
Remark xxx indicates a ROM code suffix.

78K/IV Series Product Development

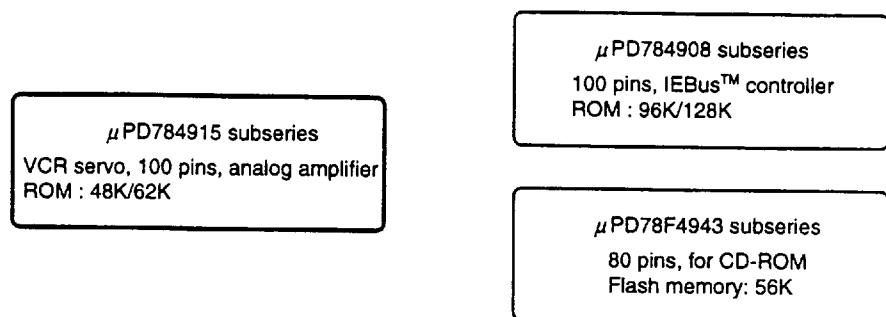
☐ : Under mass production

☐ : Under development

Standard models



ASSP models



FUNCTIONS (1/2)

Part Number		μPD784214	μPD784215	μPD784216
Item				
Number of basic instructions (mnemonics)		113		
General-purpose register		8 bits × 16 registers × 8 banks, or 16 bits × 8 registers × 8 banks (memory mapping)		
Minimum instruction execution time		• 160 ns/320 ns/640 ns/1280 ns/2560 ns (main system clock = 12.5 MHz) • 61 μs (subsystem clock = 32.768 kHz)		
Internal memory	ROM	96 KBytes	128 KBytes	
	RAM	3584 Bytes	5120 Bytes	8192 Bytes
Memory space		1 MB with program and data spaces combined		
I/O port	Total	86		
	CMOS input	8		
	CMOS I/O	72		
	N-ch open-drain I/O	6		
Pins with ancillary functions Note	Pins with pull-up resistor	70		
	LED direct drive output	22		
	Medium-voltage pin	6		
Real-time output port		4 bits × 2, or 8 bits × 1		
Timer/counter		16-bit timer/counter : Timer register × 1 Capture/compare register × 2	Pulse output • PWM/PPG output • Square wave output • One-shot pulse output	
		8-bit timer/counter 1 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	
		8-bit timer/counter 2 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	
		8-bit timer/counter 5 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	
		8-bit timer/counter 6 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	
		8-bit timer/counter 7 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	
		8-bit timer/counter 8 : Timer register × 1 Compare register × 1	Pulse output • PWM output • Square wave output	

Note The pins with ancillary functions are included in the I/O pins.

FUNCTIONS (2/2)

Part Number		μPD784214	μPD784215	μPD784216
Item				
Serial interface		• UART/IOE (3-wire serial I/O): 2 channels (on-chip baud rate generator) • CSI (3-wire serial I/O): 1 channel		
A/D converter		8-bit resolution × 8 channels		
D/A converter		8-bit resolution × 2 channels		
Clock output		Selectable from f_{xx} , $f_{xx}/2$, $f_{xx}/2^2$, $f_{xx}/2^3$, $f_{xx}/2^4$, $f_{xx}/2^5$, $f_{xx}/2^6$, $f_{xx}/2^7$, f_{XT}		
Buzzer output		Selectable from $f_{xx}/2^{10}$, $f_{xx}/2^{11}$, $f_{xx}/2^{12}$, $f_{xx}/2^{13}$		
Watch timer		1 channel		
Watchdog timer		1 channel		
Standby		• HALT/STOP/IDLE mode • In power-saving mode (with subsystem clock): HALT/IDLE mode		
Interrupt	Hardware	29 (internal: 20, external: 9)		
	Software	BRK instruction, BRKCS instruction, operand error		
	Non-maskable	Internal: 1, external: 1		
	Maskable	Internal: 19, external: 8		
		• 4 programmable priority levels • 3 service modes: vectored interrupt/macro service/context switching		
Supply voltage		$V_{DD} = 1.8$ to 5.5 V		
Package		100-pin plastic QFP (fine pitch) (14 × 14 mm) 100-pin plastic QFP (14 × 20 mm)		

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1. DIFFERENCES AMONG MODELS IN μPD784216 SUBSERIES

The only difference among the μPD784214, 784215, and 784216 lies in the internal memory capacity.

The μPD78F4216 is provided with a 128-KByte flash memory instead of the mask ROM of the above models.

These differences are summarized in Table 1-1.

Table 1-1. Differences among Models in μPD784216 Subseries

Part Number Item	μPD784214	μPD784215	μPD784216	μPD78F4216
Internal ROM	96 KBytes (mask ROM)	128 KBytes (mask ROM)		128 KBytes (Flash memory)
Internal RAM	3584 Bytes	5120 Bytes	8192 Bytes	
Internal memory size switching register (IMS)	None			Provided
V _{PP} pin	None			Provided

2. MAIN DIFFERENCES FROM μPD78078 SUBSERIES

Series Name		μPD784216 Subseries	μPD78078 Subseries
Item			
CPU		16-bit CPU	8-bit CPU
Minimum instruction execution time	With main system clock	160 ns (at 12.5 MHz)	400 ns (at 5.0 MHz)
	With subsystem clock	61 μs (at 32.768 kHz)	122 μs (at 32.768 kHz)
Memory space		1 Mbytes	64 Kbytes
I/O port	Total	86	88
	CMOS input	8	2
	CMOS I/O	72	78
	N-ch open-drain I/O	6	8
Pins with ancillary functions Note	Pins with pull-up resistor	70	86
	LED direct drive output	22	16
	Medium-voltage pin	6	8
Timer/counter		• 16-bit timer/counter × 1 unit • 8-bit timer/counter × 6 units	• 16-bit timer/counter × 1 unit • 8-bit timer/counter × 4 units
Serial interface		• UART/IOE (3-wire serial I/O) × 2 channels • CSI (3-wire serial I/O) × 1 channel	• UART/IOE (3-wire serial I/O) × 1 channel • CSI (3-wire serial I/O, 2-wire serial I/O, SBI) × 1 channel • CSI (3-wire serial I/O, 3-wire serial I/O with automatic transmit/receive function) × 1 channel
Interrupt	NMI pin	Provided	None
	Macro service	Provided	None
	Context switching	Provided	None
	Programmable priority	4 levels	None
Standby function		3 modes: HALT/STOP/IDLE	2 modes: HALT/STOP
Package		• 100-pin plastic QFP (fine pitch) (14 × 14 mm) • 100-pin plastic QFP (14 × 20 mm)	• 100-pin plastic QFP (fine pitch) (14 × 14 mm) • 100-pin plastic QFP (14 × 20 mm) • 100-pin ceramic WQFN (14 × 20 mm) (μPD78P078 only)

Note The pins with ancillary functions are included in the I/O pins.

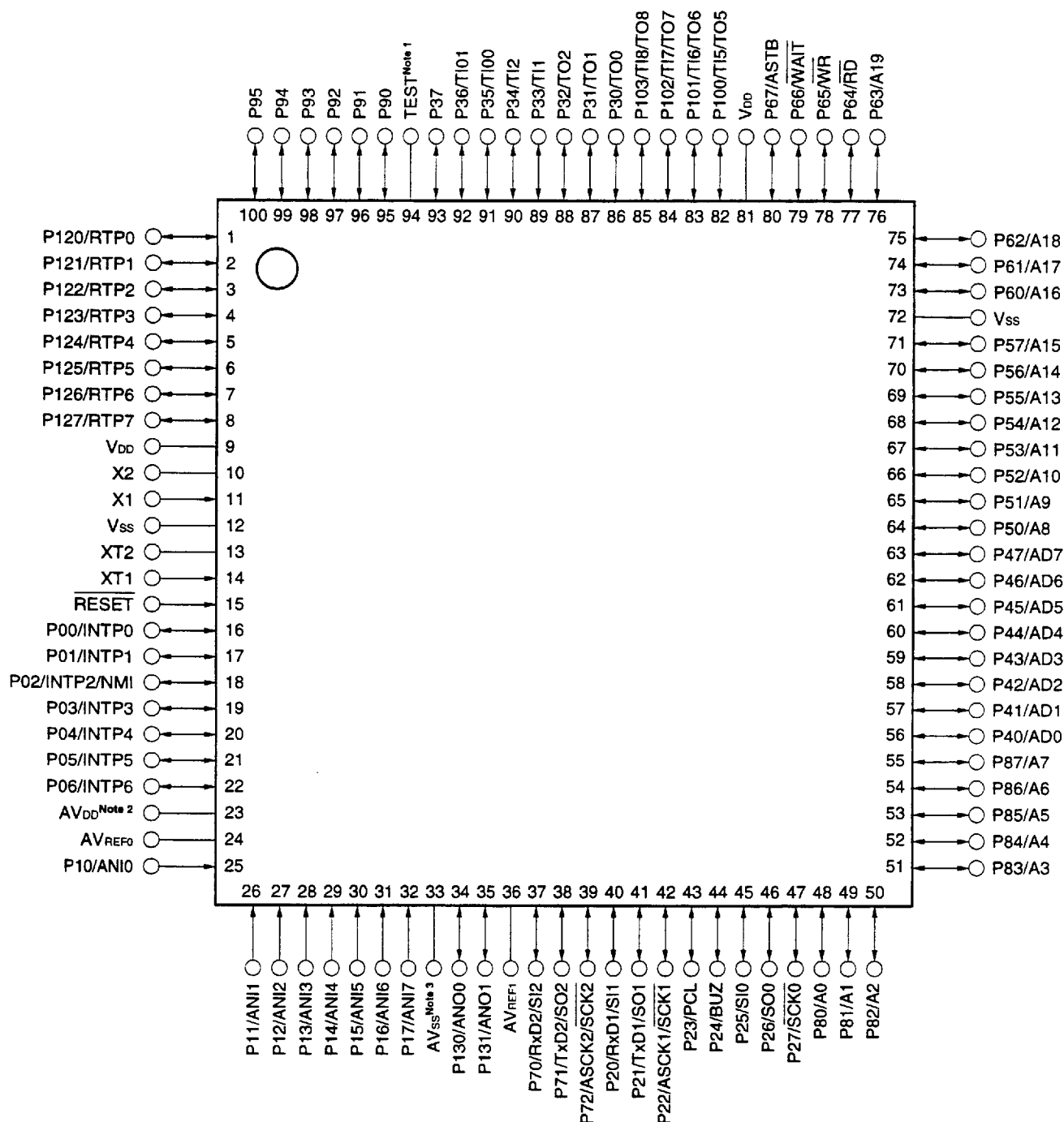
3. PIN CONFIGURATION (Top View)

- 100-pin plastic QFP (fine pitch) (14 × 14 mm)

μPD784214GC-xxx-7EA

μPD784215GC-xxx-7EA

μPD784216GC-xxx-7EA



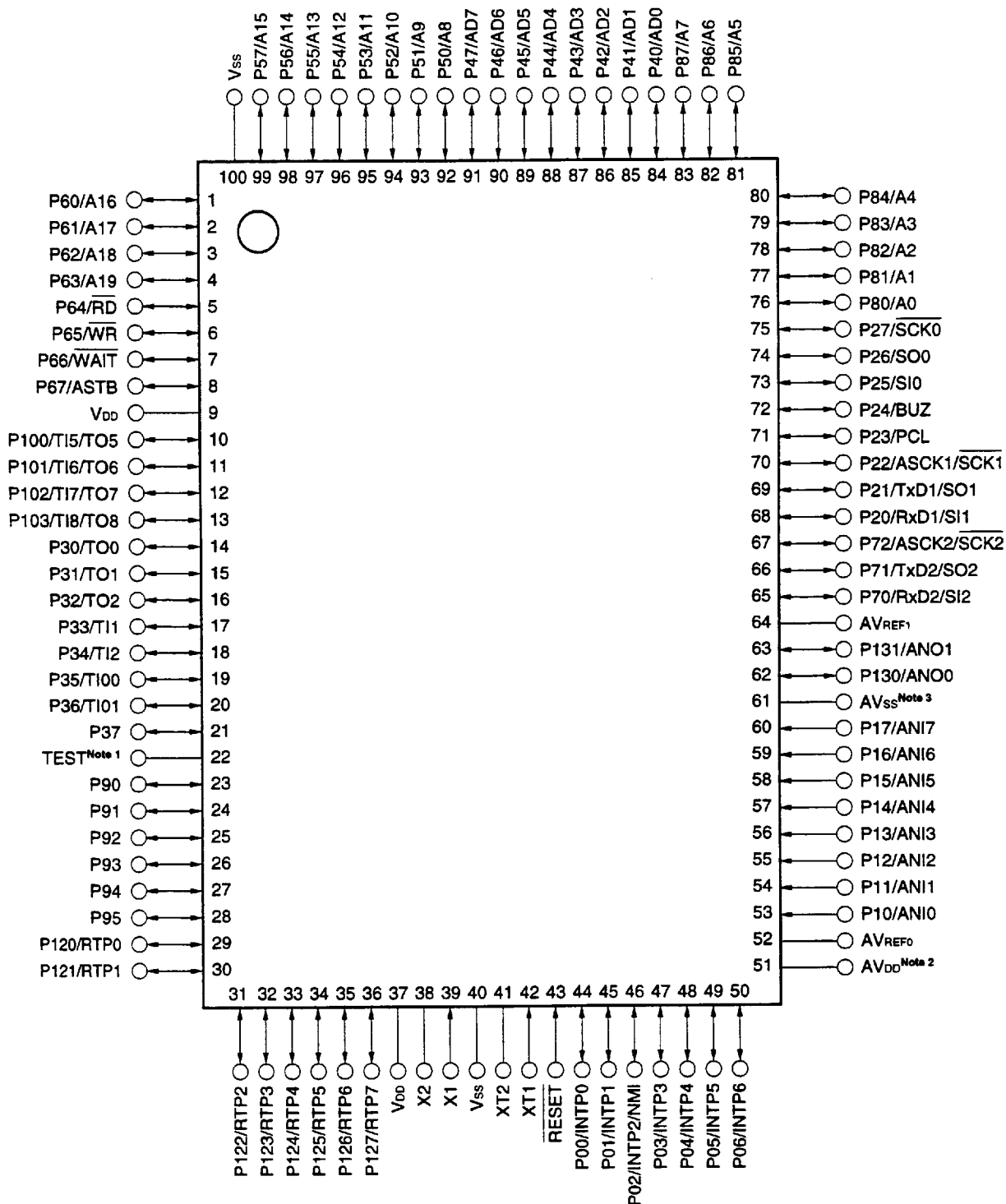
- Notes**
1. Directly connect the TEST pin to Vss.
 2. Connect the AVDD pin to VDD.
 3. Connect the AVSS pin to Vss.

- 100-pin plastic QFP (14 × 20 mm)

μPD784214GF-xxx-3BA

μPD784215GF-xxx-3BA

μPD784216GF-xxx-3BA



Notes 1. Directly connect the TEST pin to V_{SS}.

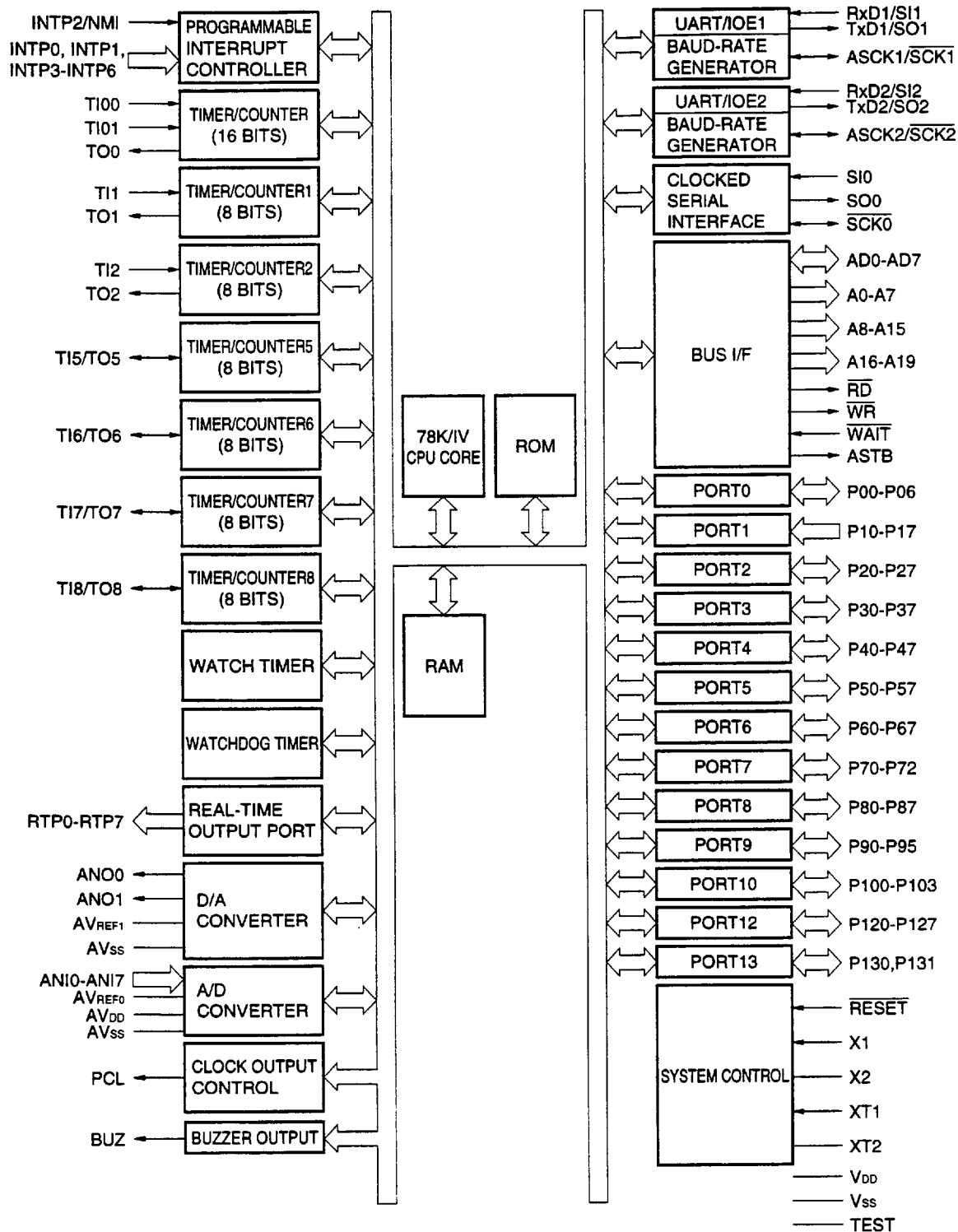
2. Connect the AV_{DD} pin to V_{DD}.

3. Connect the AV_{SS} pin to V_{SS}.

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A0 to A19	: Address Bus	P100 to P103	: Port10
AD0 to AD7	: Address/Data Bus	P120 to P127	: Port12
ANI0 to ANI7	: Analog Input	P130, P131	: Port13
ANO0, ANO1	: Analog Output	PCL	: Programmable Clock
ASCK1, ASCK2	: Asynchronous Serial Clock	$\overline{RD}$	: Read Strobe
ASTB	: Address Strobe	$\overline{RESET}$	: Reset
AVDD	: Analog Power Supply	RTP0 to RTP7	: Real-time Output Port
AVREF0, AVREF1	: Analog Reference Voltage	RxD1, RxD2	: Receive Data
AVSS	: Analog Ground	$\overline{SCK0}$ to $\overline{SCK2}$	: Serial Clock
BUZ	: Buzzer Clock	SI0 to SI2	: Serial Input
INTP0 to INTP6	: Interrupt from Peripherals	SO0 to SO2	: Serial Output
NMI	: Non-maskable Interrupt	TEST	: Test
P00 to P06	: Port0	TI00, TI01,	
P10 to P17	: Port1	TI1, TI2, TI5 to TI8	: Timer Input
P20 to P27	: Port2	TO0 to TO2, TO5 to TO8	: Timer Output
P30 to P37	: Port3	TxD1, TxD2	: Transmit Data
P40 to P47	: Port4	VDD	: Power Supply
P50 to P57	: Port5	VSS	: Ground
P60 to P67	: Port6	$\overline{WAIT}$	: Wait
P70 to P72	: Port7	$\overline{WR}$	: Write Strobe
P80 to P87	: Port8	X1, X2	: Crystal (Main System Clock)
P90 to P95	: Port9	XT1, XT2	: Crystal (Subsystem Clock)

4. BLOCK DIAGRAM



Remark The internal ROM and RAM capacities differ depending on the model.

5. PIN FUNCTION

5.1 Port Pins (1/2)

Pin Name	I/O	Alternate Function	Function
P00	I/O	INTP0	Port 0 (P0): • 7-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistors by software bit-wise.
P01		INTP1	
P02		INTP2/NMI	
P03		INTP3	
P04		INTP4	
P05		INTP5	
P06		INTP6	
P10 to P17	Input	ANI0 to ANI7	Port 1 (P1): • 8-bit input port
P20	I/O	RxD1/SI1	Port 2 (P2): • 8-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistors by software bit-wise.
P21		TxD1/SO1	
P22		ASCK1/SCK1	
P23		PCL	
P24		BUZ	
P25		SI0	
P26		SO0	
P27		SCK0	
P30	I/O	TO0	Port 3 (P3): • 8-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistors by software bit-wise.
P31		TO1	
P32		TO2	
P33		TI1	
P34		TI2	
P35		TI00	
P36		TI01	
P37		—	
P40 to P47	I/O	AD0 to AD7	Port 4 (P4): • 8-bit I/O port • Can be set in input or output mode bit-wise. • All pins set in input mode can be connected to internal pull-up resistors by software. • Can drive LEDs.
P50 to P57	I/O	A8 to A15	Port 5 (P5): • 8-bit I/O port • Can be set in input or output mode bit-wise. • All pins set in input mode can be connected to internal pull-up resistors by software. • Can drive LEDs.

5.1 Port Pins (2/2)

Pin Name	I/O	Alternate Function	Function
P60	I/O	A16	Port 6 (P6): • 8-bit I/O port • Can be set in input or output mode bit-wise. • All pins set in input mode can be connected to internal pull-up resistors by software.
P61		A17	
P62		A18	
P63		A19	
P64		$\overline{RD}$	
P65		$\overline{WR}$	
P66		WAIT	
P67		ASTB	
P70	I/O	RxD2/SI2	Port 7 (P7): • 3-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistor by software bit-wise.
P71		TxD2/SO2	
P72		ASCK2/SCK2	
P80 to P87	I/O	A0 to A7	Port 8 (P8): • 8-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistor by software bit-wise. • Interrupt control flag (KRIF) is set to 1 when falling edge is detected at a pin of this port.
P90 to P95	I/O	—	Port 9 (P9): • N-ch open-drain medium-voltage I/O port • 6-bit I/O port • Can be set in input or output mode bit-wise. • Can directly drive LEDs.
P100	I/O	TI5/TO5	Port 10 (P10): • 4-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistor by software bit-wise.
P101		TI6/TO6	
P102		TI7/TO7	
P103		TI8/TO8	
P120 to P127	I/O	RTP0 to RTP7	Port 12 (P12): • 8-bit I/O port • Can be set in input or output mode bit-wise. • Pins set in input mode can be connected to internal pull-up resistor by software bit-wise.
P130, P131	I/O	ANO0, ANO1	Port 13 (P13): • 2-bit I/O port • Can be set in input or output mode bit-wise.

5.2 Non-port Pins (1/2)

Pin Name	I/O	Alternate Function	Function
TI00	Input	P35	External count clock input to 16-bit timer register
TI01		P36	Capture trigger signal input to capture/compare register 00
TI1		P33	External count clock input to 8-bit timer register 1
TI2		P34	External count clock input to 8-bit timer register 2
TI5		P100/TO5	External count clock input to 8-bit timer register 5
TI6		P101/TO6	External count clock input to 8-bit timer register 6
TI7		P102/TO7	External count clock input to 8-bit timer register 7
TI8		P103/TO8	External count clock input to 8-bit timer register 8
TO0	Output	P30	16-bit timer output (shared by 14-bit PWM output)
TO1		P31	8-bit timer output (shared by 8-bit PWM output)
TO2		P32	
TO5		P100/TO5	
TO6		P101/TO6	
TO7		P102/TO7	
TO8		P103/TO8	
RxD1	Input	P20/SI1	Serial data input (UART1)
RxD2		P70/SI2	Serial data input (UART2)
TxD1	Output	P21/SO1	Serial data output (UART1)
TxD2		P71/SO2	Serial data output (UART2)
ASCK1	Input	P22/SCK1	Baud rate clock input (UART1)
ASCK2		P72/SCK2	Baud rate clock input (UART2)
SI0	Input	P25	Serial data input (3-wire serial clock I/O0)
SI1		P20/RxD1	Serial data input (3-wire serial clock I/O1)
SI2		P70/RxD2	Serial data input (3-wire serial clock I/O2)
SO0	Output	P26	Serial data output (3-wire serial I/O0)
SO1		P21/TxD1	Serial data output (3-wire serial I/O1)
SO2		P71/TxD2	Serial data output (3-wire serial I/O2)
SCK0	I/O	P27	Serial clock input/output (3-wire serial I/O0)
SCK1		P22/ASCK1	Serial clock input/output (3-wire serial I/O1)
SCK2		P72/ASCK2	Serial clock input/output (3-wire serial I/O2)
NMI	Input	P02/INTP2	Non-maskable interrupt request input
INTP0		P00	External interrupt request input
INTP1		P01	
INTP2		P02/NMI	
INTP3		P03	
INTP4		P04	
INTP5		P05	
INTP6		P06	

5.2 Non-port Pins (2/2)

Pin Name	I/O	Alternate Function	Function
PCL	Output	P23	Clock output (for trimming main system clock and subsystem clock)
BUZ	Output	P24	Buzzer output
RTP0 to RTP7	Output	P120 to P127	Real-time output port that outputs data in synchronization with trigger
AD0 to AD7	I/O	P40 to P47	Low-order address/data bus when external memory is connected
A0 to A7	Output	P80 to P87	Low-order address bus when external memory is connected
A8 to A15		P50 to P57	Middle-order address bus when external memory is connected
A16 to A19		P60 to P63	High-order address bus when external memory is connected
$\overline{RD}$	Output	P64	Strobe signal output for read operation of external memory
$\overline{WR}$		P65	Strobe signal output for write operation of external memory
$\overline{WAIT}$	Input	P66	To insert wait state(s) when external memory is accessed
ASTB	Output	P67	Strobe output to externally latch address information output to ports 4 through 6 and port 8 to access external memory
$\overline{RESET}$	Input	—	System reset input
X1	Input	—	Crystal connection for main system clock oscillation
X2	—		
XT1	Input	—	Crystal connection for subsystem clock oscillation
XT2	—		
ANI0 to ANI7	Input	P10 to P17	Analog voltage input for A/D converter
ANO0, ANO1	Output	P130, P131	Analog voltage output for D/A converter
AV _{REF0}	—	—	To apply reference voltage for A/D converter
AV _{REF1}			To apply reference voltage for D/A converter
AV _{DD}			Positive power supply for A/D converter. Connected to V _{DD} .
AV _{SS}			GND for A/D converter and D/A converter. Connected to V _{SS} .
V _{DD}			Positive power supply
V _{SS}			GND
TEST			Directly connect this pin to V _{SS} (this pin is for IC test).

5.3 Pin I/O Circuits and Recommended Connections of Unused Pins

Table 5-1 shows symbols indicating the I/O circuit types of the respective pins and the recommended connection of unused pins.

For the circuit diagram of each type of I/O circuit, refer to Figure 5-1.

Table 5-1. I/O Circuit Type of Respective Pins and Recommended Connections of Unused Pins (1/2)

Pin Name	I/O Circuit Type	I/O	Recommended Connections of Unused Pins
P00/INTP0	8-A	I/O	Input : Individually connected to V _{SS} via resistor Output: Open
P01/INTP1			
P02/INTP2/NMI			
P03/INTP3-P06/INTP6			
P10/ANI0-P17/ANI7	9	Input	Connected to V _{SS} or V _{DD}
P20/RxD1/SI1	10-A	I/O	Input : Individually connected to V _{SS} via resistor Output: Open
P21/TxD1/SO1			
P22/ASCK1/SCK1			
P23/PCL			
P24/BUZ			
P25/SI0			
P26/SO0			
P27/SCK0			
P30/TO0-P32/TO2	8-A		
P33/TI1, P34/TI2			
P35/TI00, P36/TI01			
P37			
P40/AD0-P47/AD7	5-A		
P50/A8-P57/A15			
P60/A16-P63/A19			
P64/RD			
P65/WR			
P66/WAIT			
P67/ASTB			
P70/RxD2/SI2	8-A		
P71/TxD2/SO2			
P72/ASCK2/SCK2			
P80/A0-P87/A7			
P90-P95	13-D		
P100/TI5/TO5	8-A		
P101/TI6/TO6			
P102/TI7/TO7			
P103/TI8/TO8			
P120/RTP0-P127/RTP7	12-A		
P130/ANO0, P131/ANO1			

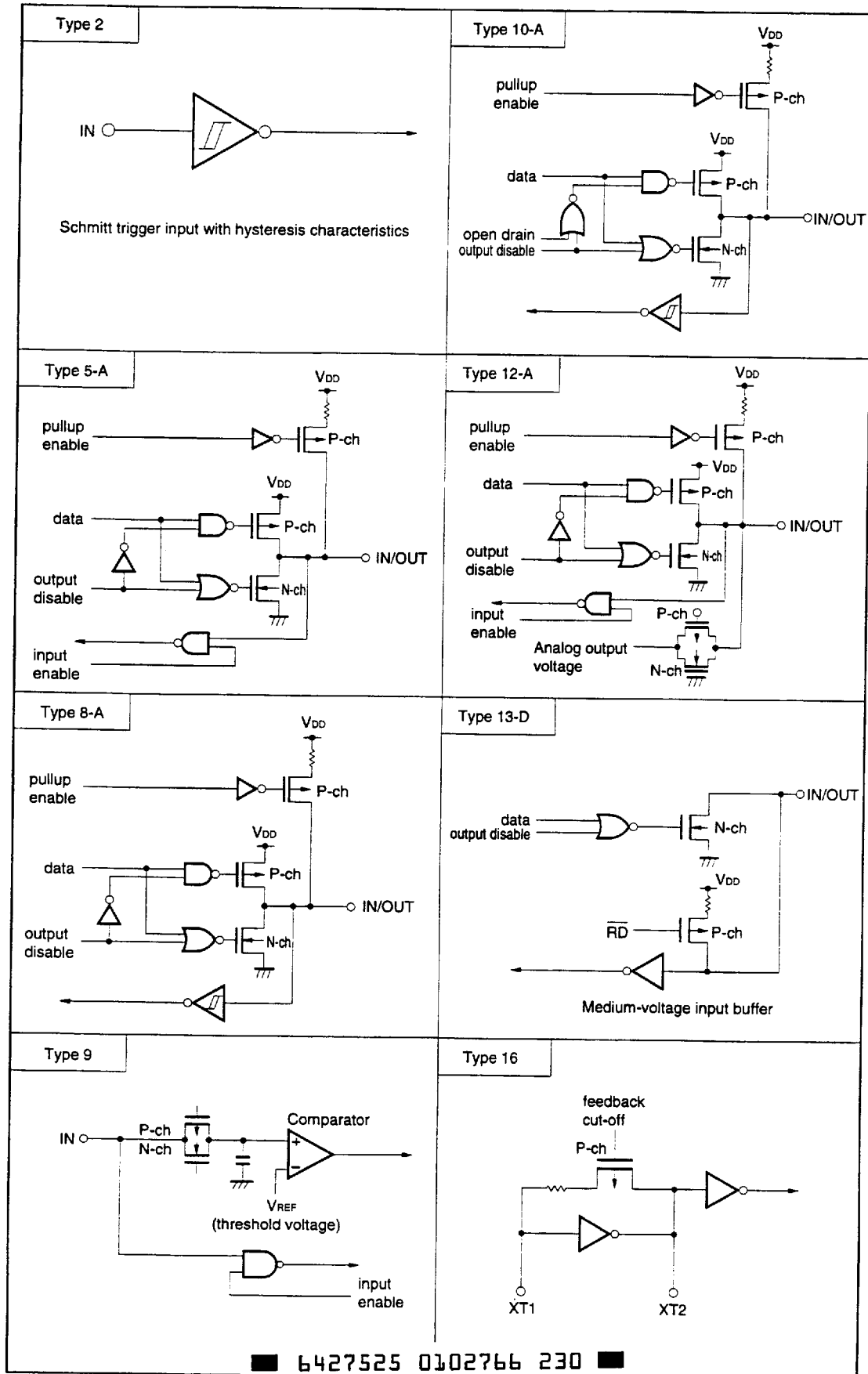
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Table 5-1. I/O Circuit Type of Respective Pins and Recommended Connections of Unused Pins (2/2)

Pin Name	I/O Circuit Type	I/O	Recommended Connections of Unused Pins
RESET	2	Input	—
XT1	16		Connected to V _{SS}
XT2		—	Open
AV _{REF0}	—		Connected to V _{SS}
AV _{REF1}			Connected to V _{DD}
AV _{DD}			
AV _{SS}			Connected to V _{SS}
TEST			Directly connected to V _{SS}

Remark Because the circuit type numbers are standardized among the 78K series products, they are not sequential in some models (i.e., some circuits are not provided).

Figure 5-1. Types of Pin I/O Circuits



6. CPU ARCHITECTURE

6.1 Memory Space

A memory space of 1 MByte can be accessed. Mapping of the internal data area (special function registers and internal RAM) can be specified by the LOCATION instruction. The LOCATION instruction must be always executed after RESET cancellation, and must not be used more than once.

(1) When LOCATION 0 instruction is executed

- Internal memory

The internal data area and internal ROM area are mapped as follows:

Part Number	Internal Data Area	Internal ROM Area
μPD784214	0F100H to 0FFFFH	00000H to 0F0FFH 10000H to 17FFFH
μPD784215	0EB00H to 0FFFFH	00000H to 0EAFFH 10000H to 1FFFFH
μPD784216	0DF00H to 0FFFFH	00000H to 0DEFFH 10000H to 1FFFFH

Caution The following areas that overlap the internal data area of the internal ROM cannot be used when the LOCATION 0 instruction is executed.

Part Number	Unusable Area
μPD784214	0F100H to 0FFFFH (3840 Bytes)
μPD784215	0EB00H to 0FFFFH (5376 Bytes)
μPD784216	0DF00H to 0FFFFH (8448 Bytes)

- External memory

The external memory is accessed in external memory expansion mode.

(2) When LOCATION 0FH instruction is executed

- Internal memory

The internal data area and internal ROM area are mapped as follows:

Part Number	Internal Data Area	Internal ROM Area
μPD784214	FF100H to FFFFFH	00000H to 17FFFH
μPD784215	FEB00H to FFFFFH	00000H to 1FFFFH
μPD784216	FDF00H to FFFFFH	00000H to 1FFFFH

- External memory

The external memory is accessed in external memory expansion mode.

Figure 6-1. Memory Map of μPD784214

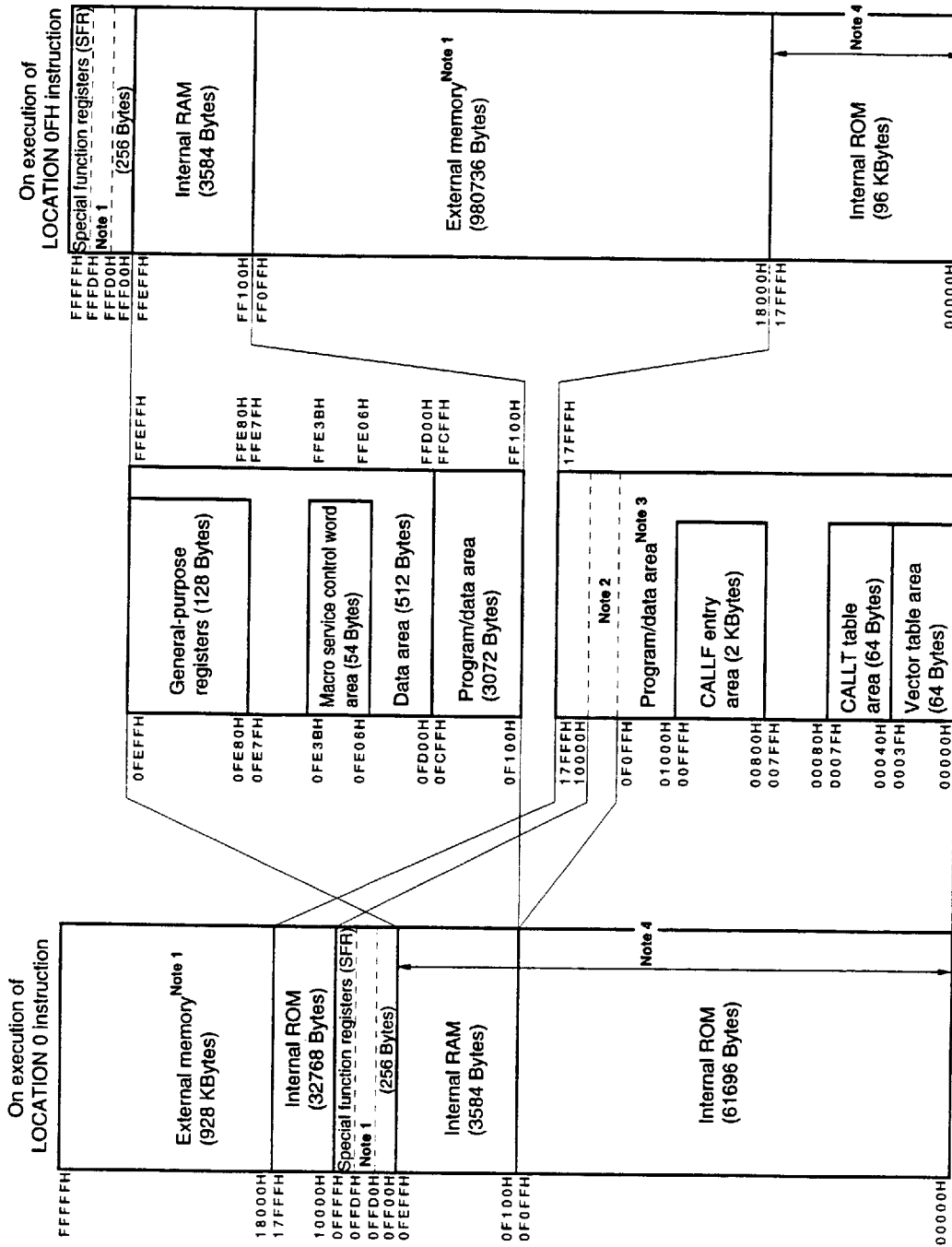


Figure 6-2. Memory Map of μPD784215

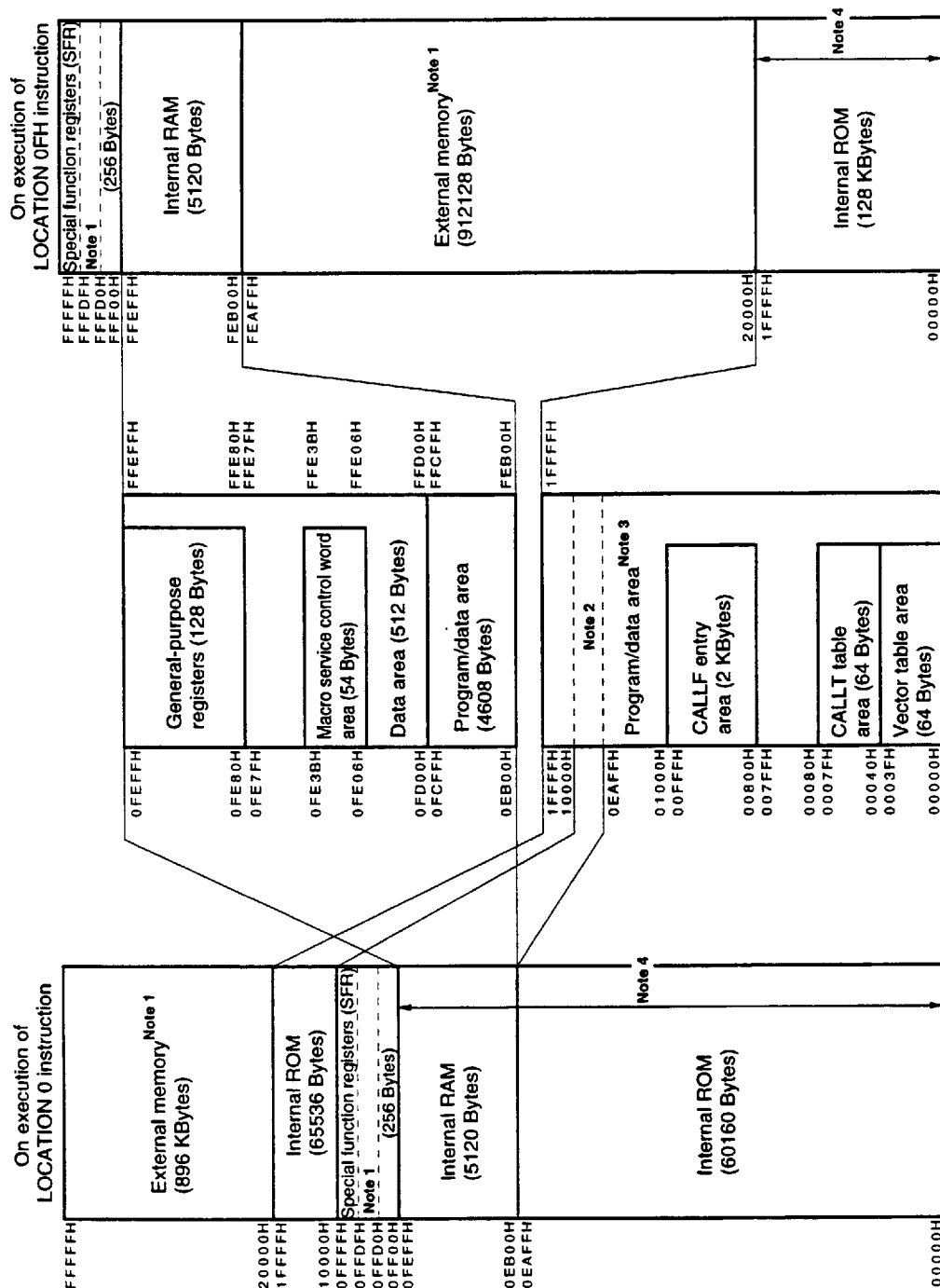
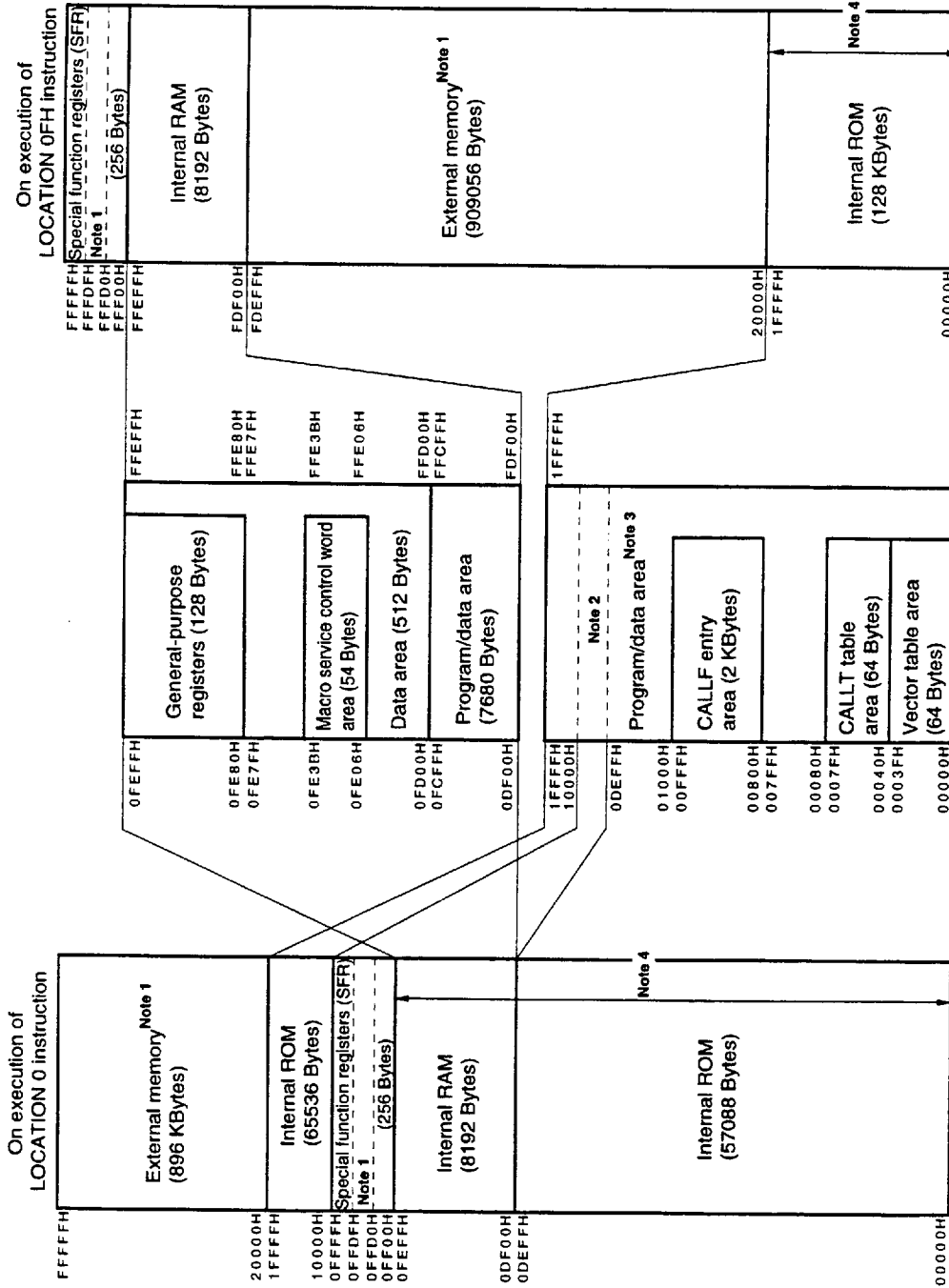


Figure 6-3. Memory Map of μPD784216



Notes 1. Accessed in external memory expansion mode.

2. This 8448-Byte area can be used as an internal ROM only when the LOCATION 0FH instruction is executed.

3. On execution of LOCATION 0 instruction: 122624 Bytes, on execution of LOCATION 0FH instruction: 131072 Bytes

4. Base area and entry area for reset or interrupt. However, the internal RAM area is not used as a reset entry area.

6.2 CPU Registers

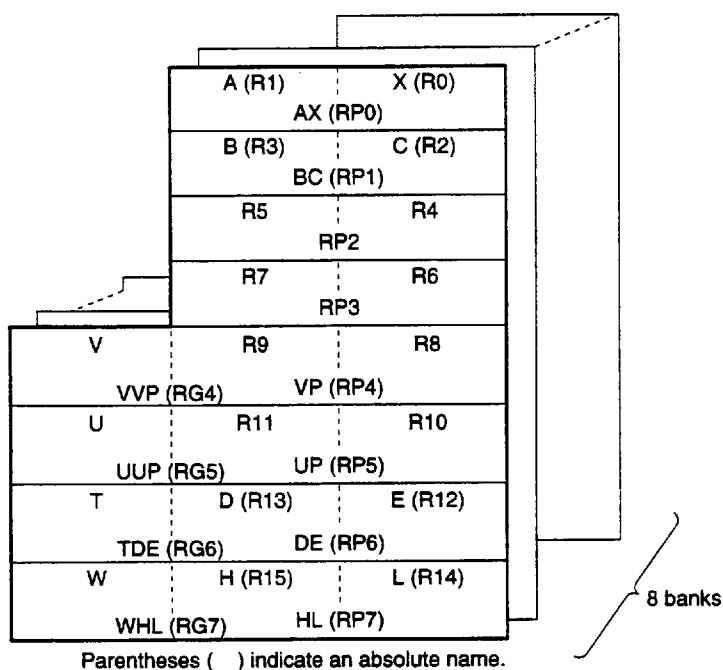
6.2.1 General-purpose registers

Sixteen 8-bit general-purpose registers are available. Two 8-bit registers can be also used in pairs as a 16-bit register. Of the 16-bit registers, four can be used in combination with an 8-bit register for address expansion as 24-bit address specification registers.

Eight banks of these register sets are available which can be selected by using software or the context switching function.

The general-purpose registers except V, U, T, and W registers for address expansion are mapped to the internal RAM.

Figure 6-4. General-Purpose Register Format



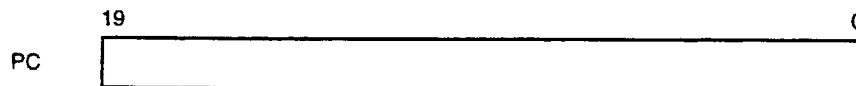
Caution Registers R4, R5, R6, R7, RP2, and RP3 can be used as X, A, C, B, AX, and BC registers, respectively, by setting the RSS bit of the PSW to 1. However, use this function only for recycling the program of the 78K/III Series.

6.2.2 Control registers

(1) Program counter (PC)

The program counter is a 20-bit register whose contents are automatically updated when the program is executed.

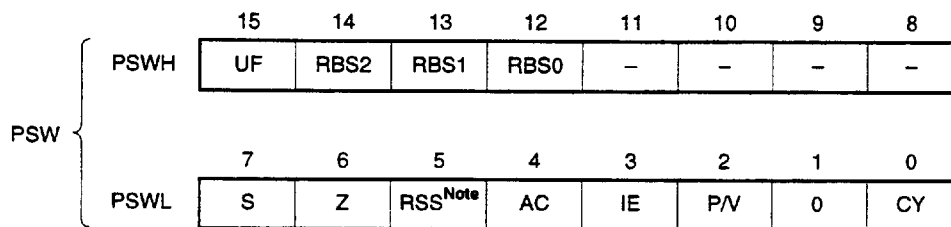
Figure 6-5. Program Counter (PC) Format



(2) Program status word (PSW)

This register holds the statuses of the CPU. Its contents are automatically updated when the program is executed.

Figure 6-6. Program Status Word (PSW) Format

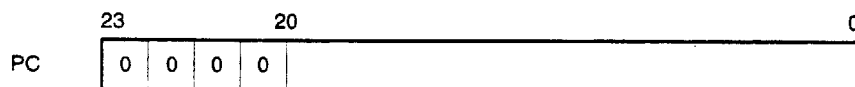


Note This flag is provided to maintain compatibility with the 78K/III Series. Be sure to clear this flag to 0, except when the software for the 78K/III Series is used.

(3) Stack pointer (SP)

This is a 24-bit pointer that holds the first address of the stack. Be sure to write 0 to the higher 4 bits of this pointer.

Figure 6-7. Stack Pointer (SP) Format



6.2.3 Special function registers (SFRs)

The special function registers, such as the mode registers and control registers of the internal peripheral hardware, are registers to which special functions are allocated. These registers are mapped to a 256-Byte space of addresses 0FF00H through 0FFFFH **Note**.

Note On execution of the LOCATION 0 instruction. FFF00H through FFFFFH on execution of the LOCATION 0FH instruction.

Caution Do not access an address in this area to which no SFR is allocated. If such an address is accessed by mistake, the μPD784216 may be in the deadlock status. This deadlock status can be cleared only by inputting the RESET signal.

Table 6-1 lists the special function registers (SFRs). The meanings of the symbols in this table are as follows:

- Symbol Symbol indicating an SFR. This symbol is reserved for NEC's assembler (RA78K4). It can be used as a bit type sfr variable by the #pragma sfr command with the C compiler (CC78K4).
- R/W Indicates whether the SFR is read-only, write-only, or read/write.
R/W : Read/write
R : Read-only
W : Write-only
- Bit units for manipulation .. Bit units in which the value of the SFR can be manipulated.
SFRs that can be manipulated in 16-bit units can be described as the operand sfrp of an instruction. To specify the address of this SFR, describe an even address.
SFRs that can be manipulated in 1-bit units can be described as the operand of a bit manipulation instruction.
- At reset Indicates the status of the register when the RESET signal has been input.

Table 6-1. Special Function Register (SFR) List (1/4)

Address ^{Note 1}	Special Function Register (SFR) Name	Symbol	R/W	Bit Units for Manipulation			At Reset
				1 bit	8 bits	16 bits	
0FF00H	Port 0	P0	R/W	○	○	—	00H ^{Note 2}
0FF01H	Port 1	P1	R	○	○	—	
0FF02H	Port 2	P2	R/W	○	○	—	
0FF03H	Port 3	P3		○	○	—	
0FF04H	Port 4	P4		○	○	—	
0FF05H	Port 5	P5		○	○	—	
0FF06H	Port 6	P6		○	○	—	
0FF07H	Port 7	P7		○	○	—	
0FF08H	Port 8	P8		○	○	—	
0FF09H	Port 9	P9		○	○	—	
0FF0AH	Port 10	P10		○	○	—	
0FF0CH	Port 12	P12		○	○	—	
0FF0DH	Port 13	P13		○	○	—	
0FF10H	16-bit timer register	TM0	R	—	—	○	0000H
0FF11H							
0FF12H	Capture/compare register 00 (16-bit timer/counter)	CR00	R/W	—	—	○	
0FF13H							
0FF14H	Capture/compare register 01 (16-bit timer/counter)	CR01		—	—	○	
0FF15H							
0FF16H	Capture/compare control register 0	CRC0		○	○	—	00H
0FF18H	16-bit timer mode control register	TMC0		○	○	—	
0FF1AH	16-bit timer output control register	TOC0		○	○	—	
0FF1CH	Prescaler mode register 0	PRM0		—	○	—	
0FF20H	Port mode register 0	PM0	R/W	○	○	—	FFH
0FF22H	Port mode register 2	PM2		○	○	—	
0FF23H	Port mode register 3	PM3		○	○	—	
0FF24H	Port mode register 4	PM4		○	○	—	
0FF25H	Port mode register 5	PM5		○	○	—	
0FF26H	Port mode register 6	PM6		○	○	—	
0FF27H	Port mode register 7	PM7		○	○	—	
0FF28H	Port mode register 8	PM8		○	○	—	
0FF29H	Port mode register 9	PM9		○	○	—	
0FF2AH	Port mode register 10	PM10		○	○	—	
0FF2CH	Port mode register 12	PM12		○	○	—	
0FF2DH	Port mode register 13	PM13		○	○	—	

Notes 1. When the LOCATION 0 instruction is executed. Add "F0000H" to this value when the LOCATION 0FH instruction is executed.

2. Because each port is initialized to input mode at reset, "00H" is not actually read. The output latch is initialized to "0".

Table 6-1. Special Function Register (SFR) List (2/4)

Address Note	Special Function Register (SFR) Name	Symbol		R/W	Bit Units for Manipulation			At Reset
					1 bit	8 bits	16 bits	
0FF30H	Pull-up resistor option register 0	PU0		R/W	○	○	—	00H
0FF32H	Pull-up resistor option register 2	PU2			○	○	—	
0FF33H	Pull-up resistor option register 3	PU3			○	○	—	
0FF37H	Pull-up resistor option register 7	PU7			○	○	—	
0FF38H	Pull-up resistor option register 8	PU8			○	○	—	
0FF3AH	Pull-up resistor option register 10	PU10			○	○	—	
0FF3CH	Pull-up resistor option register 12	PU12			○	○	—	
0FF40H	Clock output control register	CKS			○	○	—	
0FF42H	Port function control register	PF2			○	○	—	
0FF4EH	Pull-up resistor option register	PUO			○	○	—	
0FF50H	8-bit timer register 1	TM1	TM1W	R	—	○	○	0000H
0FF51H	8-bit timer register 2	TM2			—	○		
0FF52H	Compare register 10 (8-bit timer/counter 1)	CR10	CR1W	R/W	—	○	○	
0FF53H	Compare register 20 (8-bit timer/counter 2)	CR20			—	○		
0FF54H	8-bit timer mode control register 1	TMC1	TMC1W	R/W	○	○	○	
0FF55H	8-bit timer mode control register 2	TMC2			○	○		
0FF56H	Prescaler mode register 1	PRM1	PRM1W		—	○	○	
0FF57H	Prescaler mode register 2	PRM2			—	○		
0FF60H	8-bit timer register 5	TM5	TM5W	R	—	○	○	
0FF61H	8-bit timer register 6	TM6			—	○		
0FF62H	8-bit timer register 7	TM7	TM7W		—	○	○	
0FF63H	8-bit timer register 8	TM8			—	○		
0FF64H	Compare register 50 (8-bit timer/counter 5)	CR50	CR5W	R/W	—	○	○	
0FF65H	Compare register 60 (8-bit timer/counter 6)	CR60			—	○		
0FF66H	Compare register 70 (8-bit timer/counter 7)	CR70	CR7W		—	○	○	
0FF67H	Compare register 80 (8-bit timer/counter 8)	CR80			—	○		
0FF68H	8-bit timer mode control register 5	TMC5	TMC5W		○	○	○	
0FF69H	8-bit timer mode control register 6	TMC6			○	○		
0FF6AH	8-bit timer mode control register 7	TMC7	TMC7W		○	○	○	
0FF6BH	8-bit timer mode control register 8	TMC8			○	○		
0FF6CH	Prescaler mode register 5	PRM5	PRM5W		—	○	○	
0FF6DH	Prescaler mode register 6	PRM6			—	○		
0FF6EH	Prescaler mode register 7	PRM7	PRM7W		—	○	○	
0FF6FH	Prescaler mode register 8	PRM8			—	○		
0FF70H	Asynchronous serial interface mode register 1	ASIM1			○	○	—	
0FF71H	Asynchronous serial interface mode register 2	ASIM2			○	○	—	
0FF72H	Asynchronous serial interface status register 1	ASIS1			○	○	—	
0FF73H	Asynchronous serial interface status register 2	ASIS2			○	○	—	

Note When the LOCATION 0 instruction is executed. Add "F0000H" to this value when the LOCATION 0FH instruction is executed.

■ 6427525 0102775 243 ■

Table 6-1. Special Function Register (SFR) List (3/4)

Address ^{Note}	Special Function Register (SFR) Name	Symbol	R/W	Bit Units for Manipulation			At Reset
				1 bit	8 bits	16 bits	
0FF74H	Transmit shift register 1	TXS1	W	—	○	—	FFH
	Receive buffer register 1	RXB1	R	—	○	—	
0FF75H	Transmit shift register 2	TXS2	W	—	○	—	
	Receive buffer register 2	RXB2	R	—	○	—	
0FF76H	Baud rate generator control register 1	BRGC1	R/W	—	○	—	00H
0FF77H	Baud rate generator control register 2	BRGC2		—	○	—	
0FF7AH	Oscillation mode select register	CC		○	○	—	
0FF80H	A/D converter mode register	ADM		○	○	—	
0FF81H	A/D input select register	ADIS		○	○	—	
0FF83H	A/D conversion result register	ADCR	R	—	○	—	Undefined
0FF84H	D/A conversion value setting register 0	DACS0	R/W	○	○	—	00H
0FF85H	D/A conversion value setting register 1	DACS1		○	○	—	
0FF86H	D/A converter mode register 0	DAM0		○	○	—	
0FF87H	D/A converter mode register 1	DAM1		○	○	—	
0FF8CH	External bus type select register	EBTS		○	○	—	
0FF90H	Serial operation mode register 0	CSIM0		○	○	—	
0FF91H	Serial operation mode register 1	CSIM1		○	○	—	
0FF92H	Serial operation mode register 2	CSIM2		○	○	—	
0FF94H	Serial I/O shift register 0	SIO0		—	○	—	
0FF95H	Serial I/O shift register 1	SIO1		—	○	—	
0FF96H	Serial I/O shift register 2	SIO2		—	○	—	
0FF98H	Real-time output buffer register L	RTBL		—	○	—	
0FF99H	Real-time output buffer register H	RTBH		—	○	—	
0FF9AH	Real-time output port mode register	RTPM		○	○	—	
0FF9BH	Real-time output port control register	RTPC		○	○	—	
0FF9CH	Watch timer mode control register	WTM		○	○	—	
0FFA0H	External interrupt rising edge enable register	EGP0		○	○	—	
0FFA2H	External interrupt falling edge enable register	EGN0		○	○	—	
0FFA8H	In-service priority register	ISPR	R	○	○	—	
0FFA9H	Interrupt select control register	SNMI	R/W	○	○	—	
0FFAAH	Interrupt mode control register	IMC		○	○	—	80H
0FFACH	Interrupt mask flag register 0L	MK0L		○	○	○	FFFFH
0FFADH	Interrupt mask flag register 0H	MK0H		○	○	○	
0FFAEH	Interrupt mask flag register 1L	MK1L		○	○	○	
0FFAFH	Interrupt mask flag register 1H	MK1H		○	○	○	

Note When the LOCATION 0 instruction is executed. Add "F0000H" to this value when the LOCATION 0FH instruction is executed.

Table 6-1. Special Function Register (SFR) List (4/4)

Address Note	Special Function Register (SFR) Name	Symbol	R/W	Bit Units for Manipulation			At Reset
				1 bit	8 bits	16 bits	
0FFC0H	Standby control register	STBC	R/W	—	○	—	30H
0FFC2H	Watchdog timer mode register	WDM		—	○	—	00H
0FFC4H	Memory expansion mode register	MM		○	○	—	20H
0FFC7H	Programmable wait control register 1	PWC1		—	○	—	AAH
0FFCEH	Clock status register	PCS		—	○	—	32H
0FFCFH	Oscillation stabilization time specification register	OSTS		—	○	—	00H
0FFD0H- 0FFDFH	External SFR area	—		○	○	—	—
0FFE0H	Interrupt control register (INTWDT)	WDTIC		○	○	—	43H
0FFE1H	Interrupt control register (INTP0)	PIC0		○	○	—	
0FFE2H	Interrupt control register (INTP1)	PIC1		○	○	—	
0FFE3H	Interrupt control register (INTP2)	PIC2		○	○	—	
0FFE4H	Interrupt control register (INTP3)	PIC3		○	○	—	
0FFE5H	Interrupt control register (INTP4)	PIC4		○	○	—	
0FFE6H	Interrupt control register (INTP5)	PIC5		○	○	—	
0FFE7H	Interrupt control register (INTP6)	PIC6		○	○	—	
0FFE8H	Interrupt control register (INTCSI0)	CSIC0		○	○	—	
0FFE9H	Interrupt control register (INTSER1)	SERIC1		○	○	—	
0FFEAH	Interrupt control register (INTSR1/INTCSI1)	SRIC1		○	○	—	
0FEBH	Interrupt control register (INTST1)	STIC1		○	○	—	
0FFECH	Interrupt control register (INTSER2)	SERIC2		○	○	—	
0FFEDH	Interrupt control register (INTSR2/INTCSI2)	SRIC2		○	○	—	
0FEEH	Interrupt control register (INTST2)	STIC2		○	○	—	
0FEEFH	Interrupt control register (INTTM3)	TMIC3		○	○	—	
0FFF0H	Interrupt control register (INTTM00)	TMIC00		○	○	—	
0FFF1H	Interrupt control register (INTTM01)	TMIC01		○	○	—	
0FFF2H	Interrupt control register (INTTM1)	TMIC1		○	○	—	
0FFF3H	Interrupt control register (INTTM2)	TMIC2		○	○	—	
0FFF4H	Interrupt control register (INTAD)	ADIC		○	○	—	
0FFF5H	Interrupt control register (INTTM5)	TMIC5		○	○	—	
0FFF6H	Interrupt control register (INTTM6)	TMIC6		○	○	—	
0FFF7H	Interrupt control register (INTTM7)	TMIC7		○	○	—	
0FFF8H	Interrupt control register (INTTM8)	TMIC8		○	○	—	
0FFF9H	Interrupt control register (INTWT)	WTIC		○	○	—	
0FFFAH	Interrupt control register (INTKR)	KRIC		○	○	—	

Note When the LOCATION 0 instruction is executed. Add "F0000H" to this value when the LOCATION 0FH instruction is executed.

7. PERIPHERAL HARDWARE FUNCTIONS

7.1 Ports

The ports shown in Figure 7-1 are provided to make various control operations possible. Table 7-1 shows the function of each port. Ports 0, 2 through 8, 10, 12 can be connected to internal pull-up resistors by software when inputting.

Figure 7-1. Port Configuration

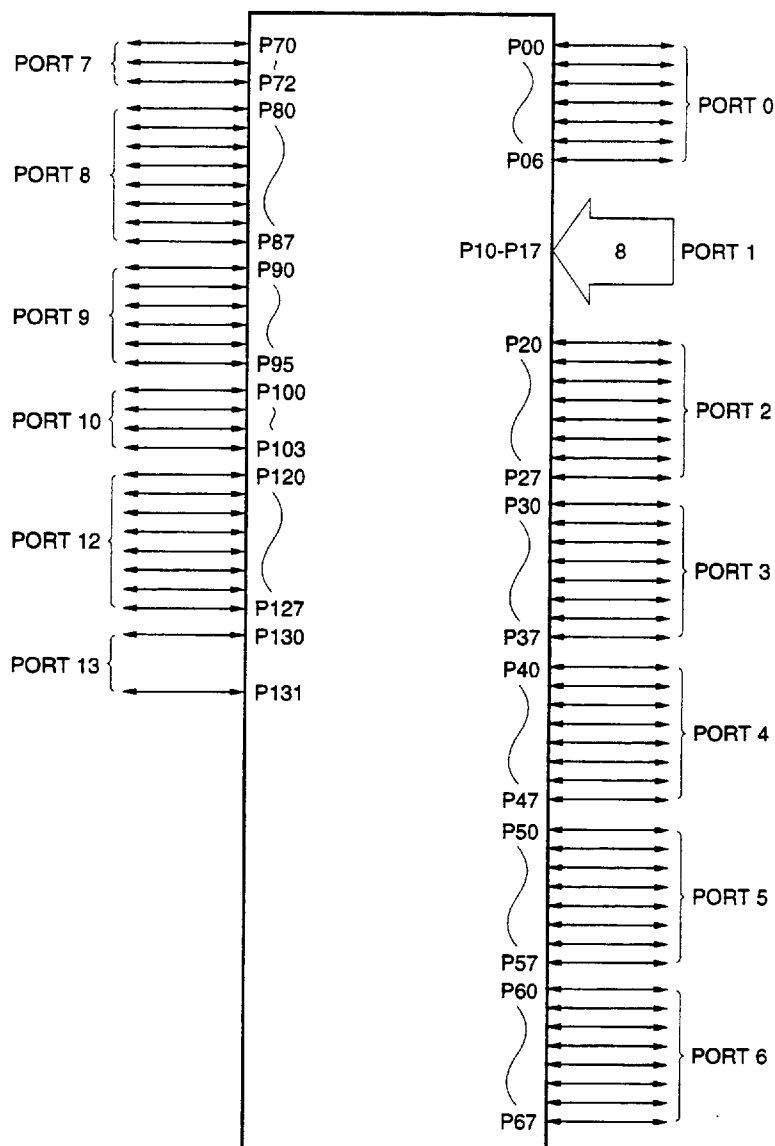


Table 7-1. Port Functions

Port Name	Pin Name	Function	Specification of Pull-up Resistor Connection by Software
Port 0	P00-P06	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 1	P10-P17	• Input port	—
Port 2	P20-P27	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 3	P30-P37	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 4	P40-P47	• Can be set in input or output mode bit-wise • Can directly drive LEDs	Can be specified in 1-port units
Port 5	P50-P57	• Can be set in input or output mode bit-wise • Can directly drive LEDs	Can be specified in 1-port units
Port 6	P60-P67	• Can be set in input or output mode bit-wise	Can be specified in 1-port units
Port 7	P70-P72	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 8	P80-P87	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 9	P90-P95	• N-ch open-drain I/O port • Can be set in input or output mode bit-wise • Can directly drive LEDs	—
Port 10	P100-P103	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 12	P120-P127	• Can be set in input or output mode bit-wise	Can be specified bit-wise
Port 13	P130, P131	• Can be set in input or output mode bit-wise	—

7.2 Clock Generation Circuit

An on-chip clock generation circuit necessary for operation is provided. This clock generation circuit has a divider circuit. If high-speed operation is not necessary, the internal operating frequency can be lowered by the divider circuit to reduce the current consumption.

Figure 7-2. Block Diagram of Clock Generation Circuit

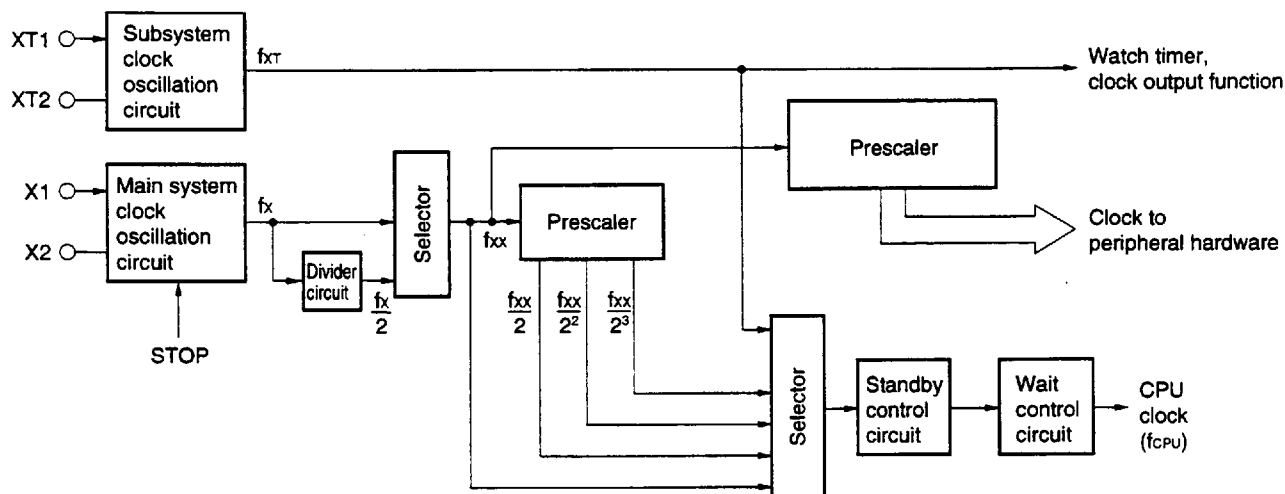
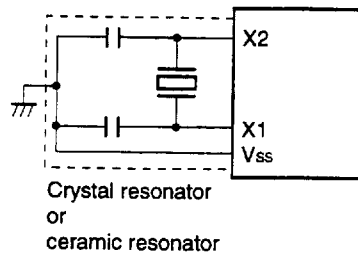


Figure 7-3. Example of Using Main System Clock Oscillation Circuit

(1) Crystal/ceramic oscillation



(2) External clock

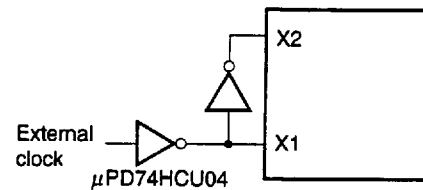
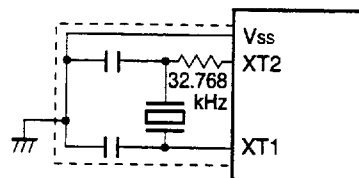
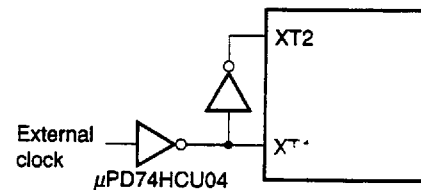


Figure 7-4. Example of Using Subsystem Clock Oscillation Circuit

(1) Crystal oscillation



(2) External clock



Caution When using the main system clock and subsystem clock oscillation circuits, wire the dotted portions in Figures 7-3 and 7-4 as follows to avoid adverse influence from wiring capacitance.

- Keep the wiring length as short as possible.
- Do not cross the wiring with other signal lines.
- Do not route the wiring in the vicinity of lines through which a high alternating current flows.
- Always keep the potential at the ground point of the capacitor in the oscillation circuit the same as Vss. Do not ground to a ground pattern through which a high current flows.
- Do not extract signals from the oscillation circuit.

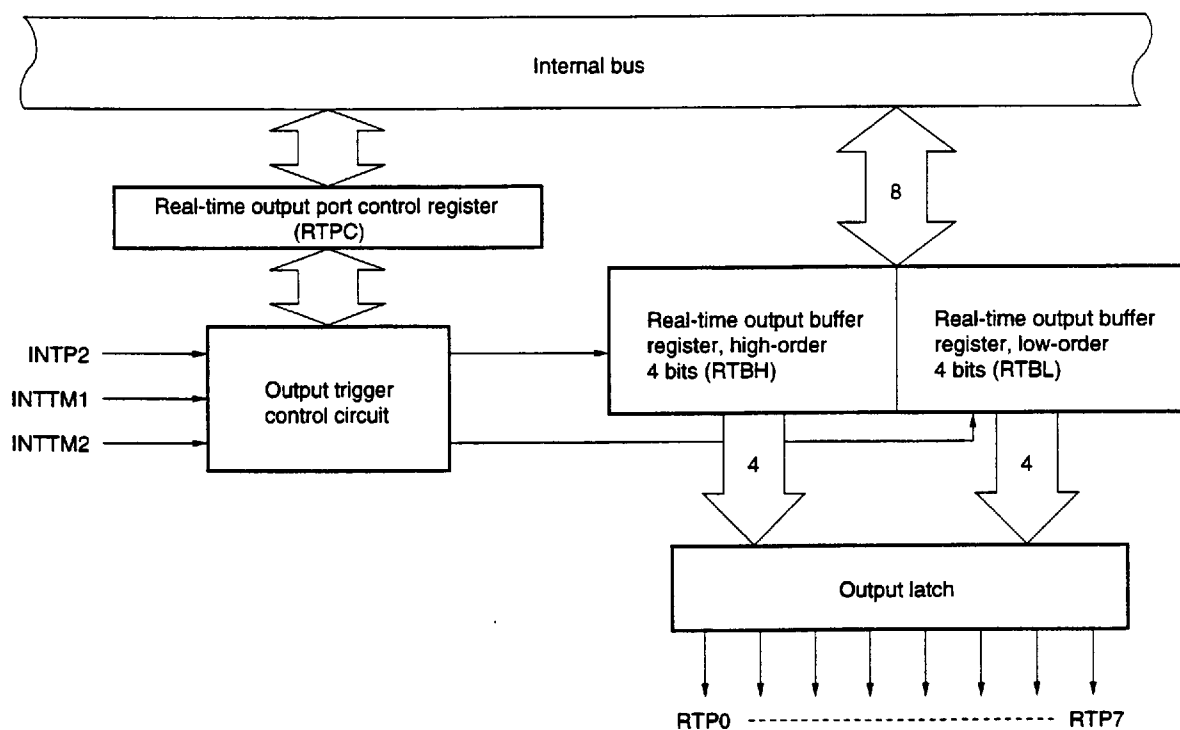
Note that the subsystem clock oscillation circuit has a low amplification factor to reduce the current consumption.

7.3 Real-Time Output Port

The real-time output function is to transfer data set in advance to the real-time output buffer register to the output latch as soon as the timer interrupt or external interrupt has occurred in order to output the data to an external device. The pins that output the data to the external device constitute a port called a real-time output port.

Because the real-time output port can output signals without jitter, it is ideal for controlling a stepping motor.

Figure 7-5. Block Diagram of Real-Time Output Port



7.4 Timer/Counter

One unit of 16-bit timers/counters and six units of 8-bit timers/counters are provided.

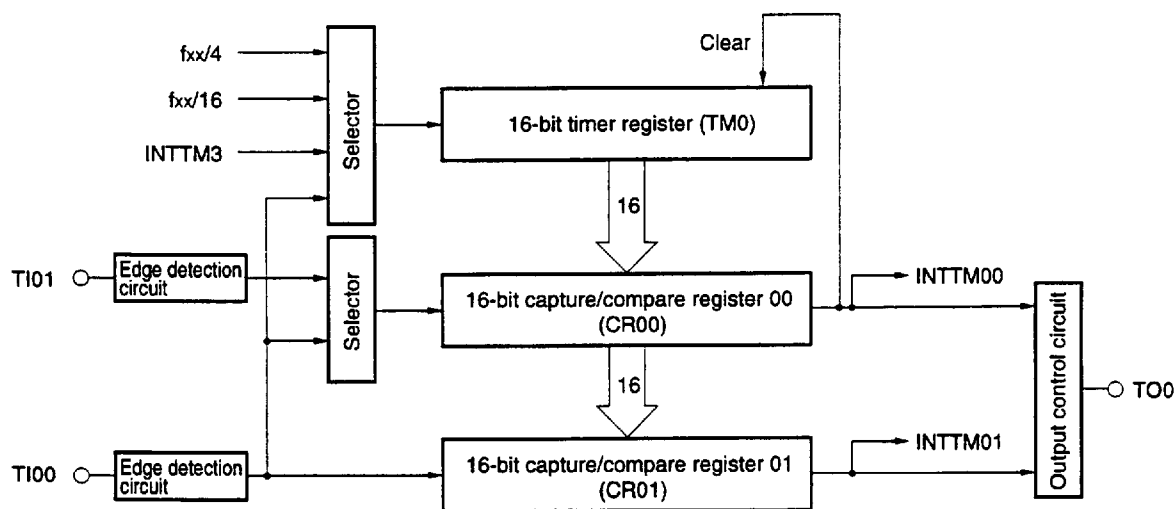
Because a total of eight interrupt requests are supported, these timers/counters can be used as eight units of timers/counters.

Table 7-2. Operations of Timers/Counters

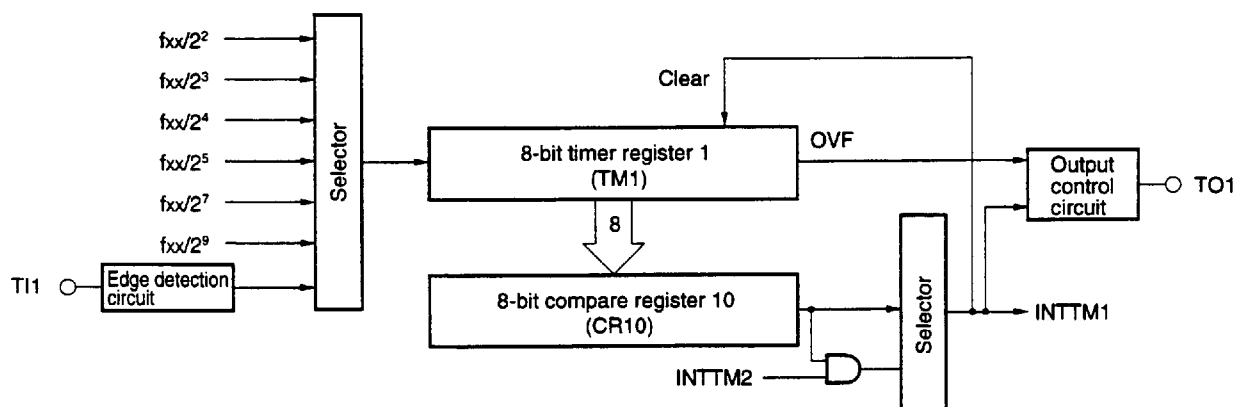
Name		16-Bit Timer/ Counter	8-Bit Timer/ Counter 1	8-Bit Timer/ Counter 2	8-Bit Timer/ Counter 5	8-Bit Timer/ Counter 6	8-Bit Timer/ Counter 7	8-Bit Timer/ Counter 8
Item	Count width	8 bits	—	○	○	○	○	○
	16 bits	○	○		○		○	
Operation mode	Interval timer	1ch	1ch	1ch	1ch	1ch	1ch	1ch
	External event counter	○	○	○	○	○	○	○
Function	Timer output	1ch	1ch	1ch	1ch	1ch	1ch	1ch
	PPG output	○	—	—	—	—	—	—
	PWM output	○	○	○	○	○	○	○
	Square wave output	○	○	○	○	○	○	○
	One-shot pulse output	○	—	—	—	—	—	—
	Pulse width measurement	2 inputs	—	—	—	—	—	—
	Number of interrupt requests	2	1	1	1	1	1	1

Figure 7-6. Block Diagram of Timers/Counters (1/2)

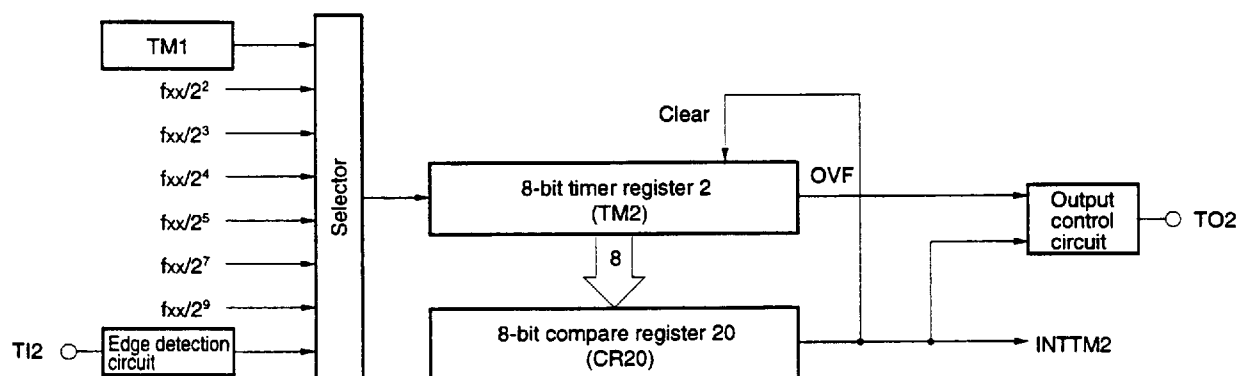
16-bit timer/counter



8-bit timer/counter 1



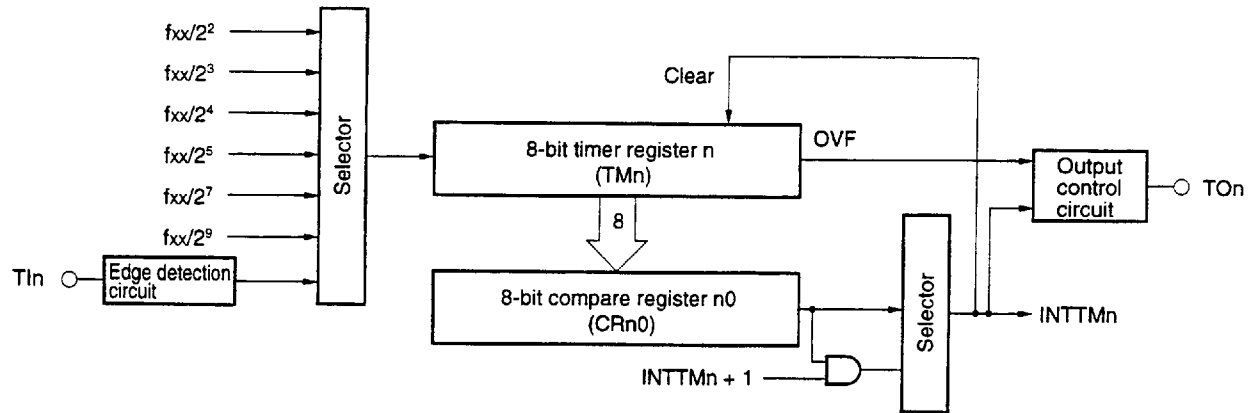
8-bit timer/counter 2



Remark OVF: overflow flag

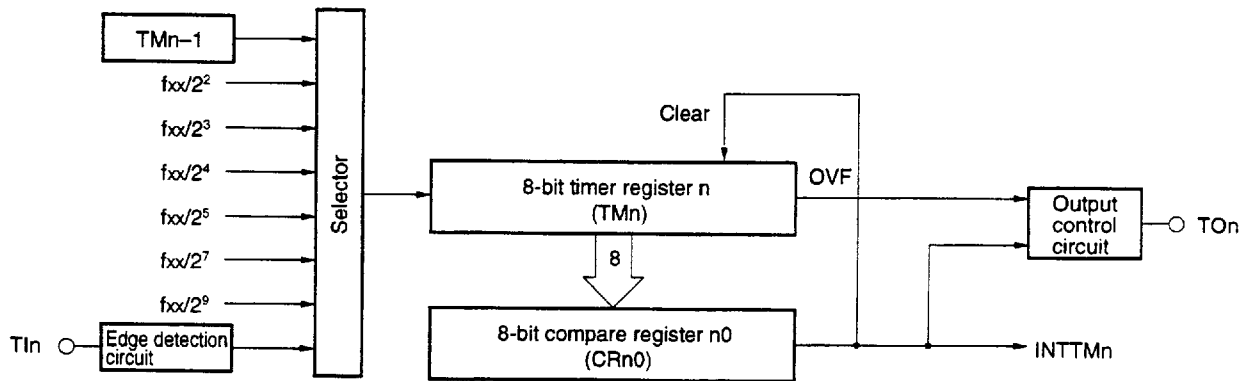
Figure 7-6. Block Diagram of Timers/Counters (2/2)

8-bit timer/counter 5, 7



Remark n= 5, 7

8-bit timer/counter 6, 8



Remark n= 6, 8

7.5 A/D Converter

An A/D converter converts an analog input variable into a digital signal. This microcontroller is provided with an A/D converter with a resolution of 8 bits and 8 channels (ANI0 through ANI7).

This A/D converter is of successive approximation type and the result of conversion is stored to an 8-bit A/D conversion result register (ADCR).

The A/D converter can be started in the following two ways:

- Hardware start

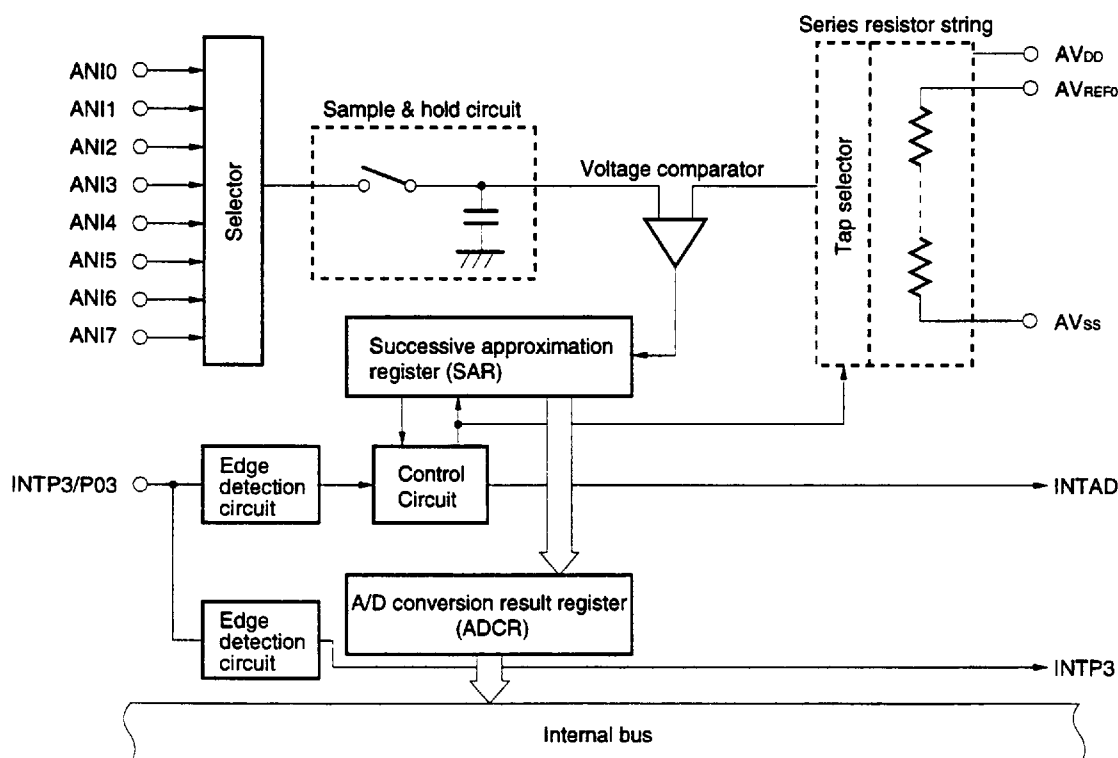
Conversion is started by trigger input (P03).

- Software start

Conversion is started by setting the A/D converter mode register.

One analog input channel is selected from ANI0 through ANI7 for A/D conversion. When A/D conversion is started by means of hardware start, conversion is stopped after it has been completed. When conversion is started by means of software start, A/D conversion is repeatedly executed, and each time conversion has been completed, an interrupt request (INTAD) is generated.

Figure 7-7. Block Diagram of A/D Converter



7.6 D/A Converter

A D/A converter converts an input digital signal into an analog voltage. This microcontroller is provided with a voltage output type D/A converter with a resolution of 8 bits and two channels.

The conversion method is of R-2R resistor ladder type.

D/A conversion is started by setting DACE0 of the D/A converter mode register 0 (DAM0) and DACE1 of the D/A converter mode register 1 (DAM1).

The D/A converter operates in the following two modes:

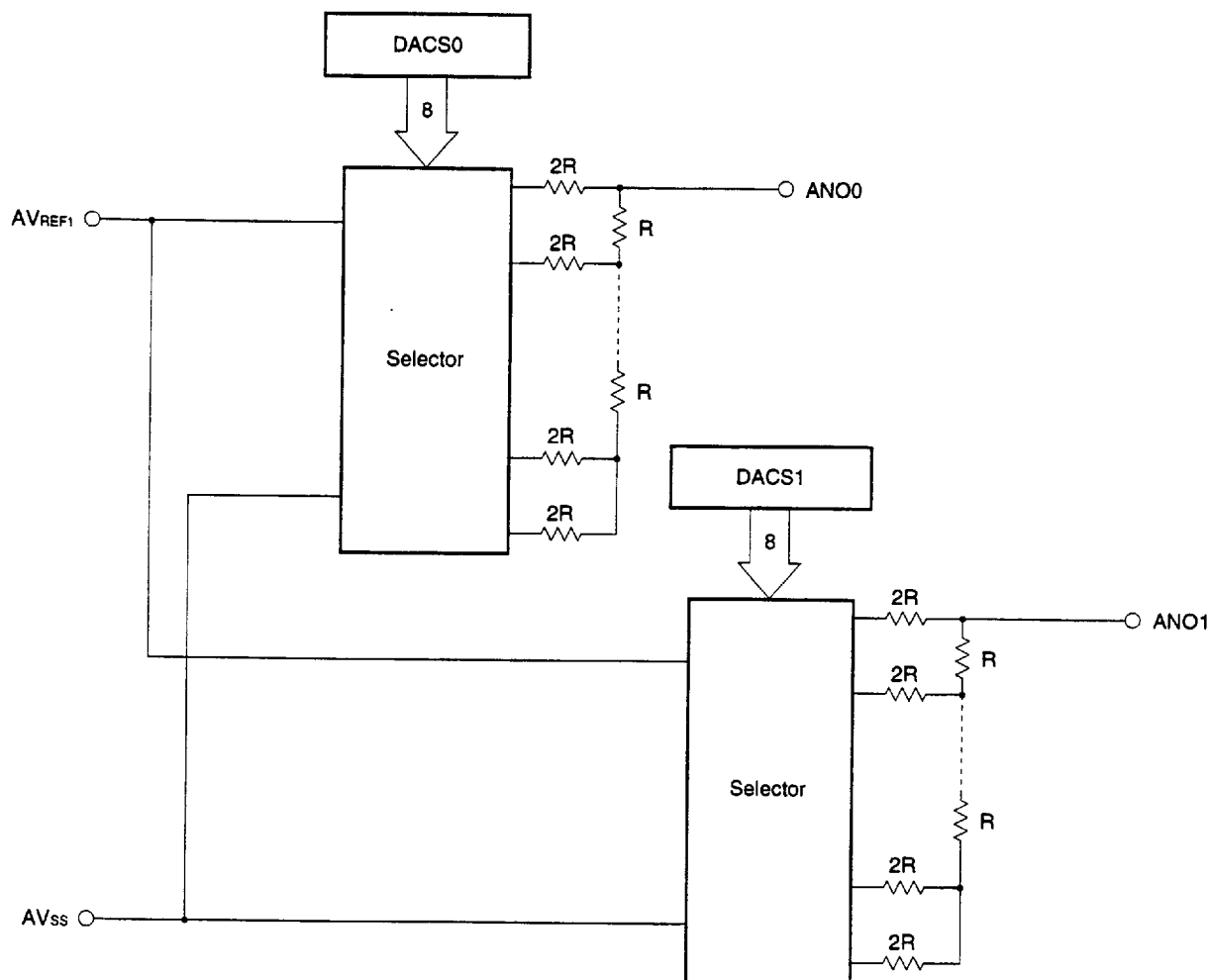
- Normal mode

The converter outputs an analog voltage immediately after it has completed D/A conversion.

- Real-time output mode

The converter outputs an analog voltage in synchronization with an output trigger after it has completed D/A conversion.

Figure 7-8. Block Diagram of D/A Converter



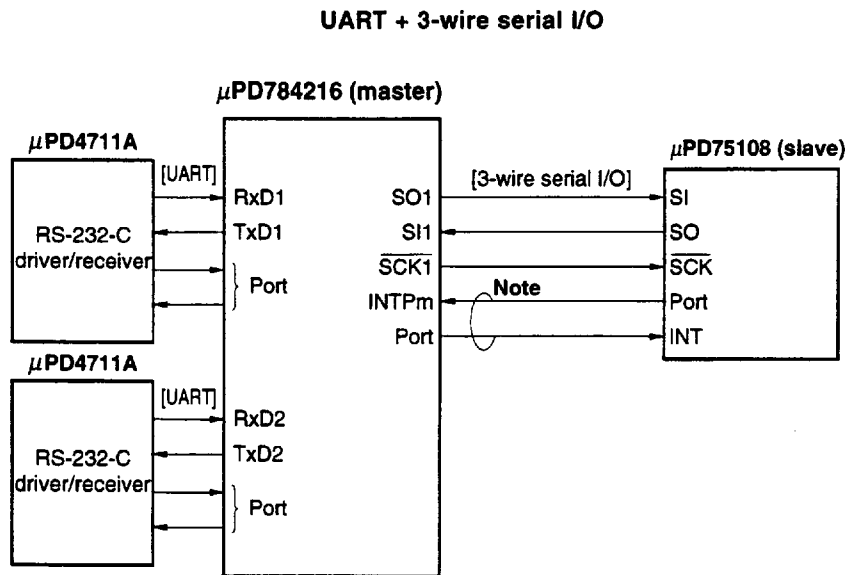
7.7 Serial Interface

Three independent serial interface channels are provided.

- Asynchronous serial interface (UART)/3-wire serial I/O (IOE) × 2
- Clocked serial interface (CSI) × 1
- 3-wire serial I/O (IOE)

Therefore, communication with an external system and local communication within the system can be simultaneously executed (refer to **Figure 7-9**).

Figure 7-9. Example of Serial Interface



Note Handshake line

7.7.1 Asynchronous serial interface/3-wire serial I/O (UART/IOE)

Two channels of serial interfaces that can select an asynchronous serial interface mode and 3-wire serial I/O mode are provided.

(1) Asynchronous serial interface mode

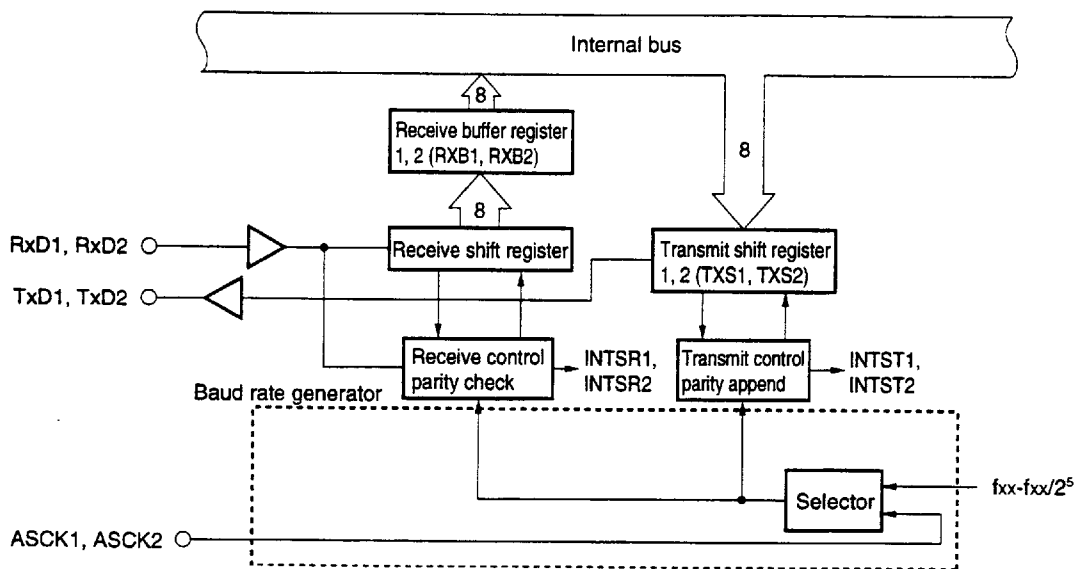
In this mode, data of 1 byte following the start bit is transmitted or received.

Because an on-chip baud rate generator is provided, a wide range of baud rates can be set.

Moreover, the clock input to the ASCK pin can be divided to define a baud rate.

When the baud rate generator is used, a baud rate conforming to the MIDI standard (31.25 kbps) can be also obtained.

Figure 7-10. Block Diagram in Asynchronous Serial Interface Mode



7.7.2 Clocked serial interface (CSI)

In this mode, the master device starts transfer by making the serial clock active and communicates 1-byte data in synchronization with this clock.

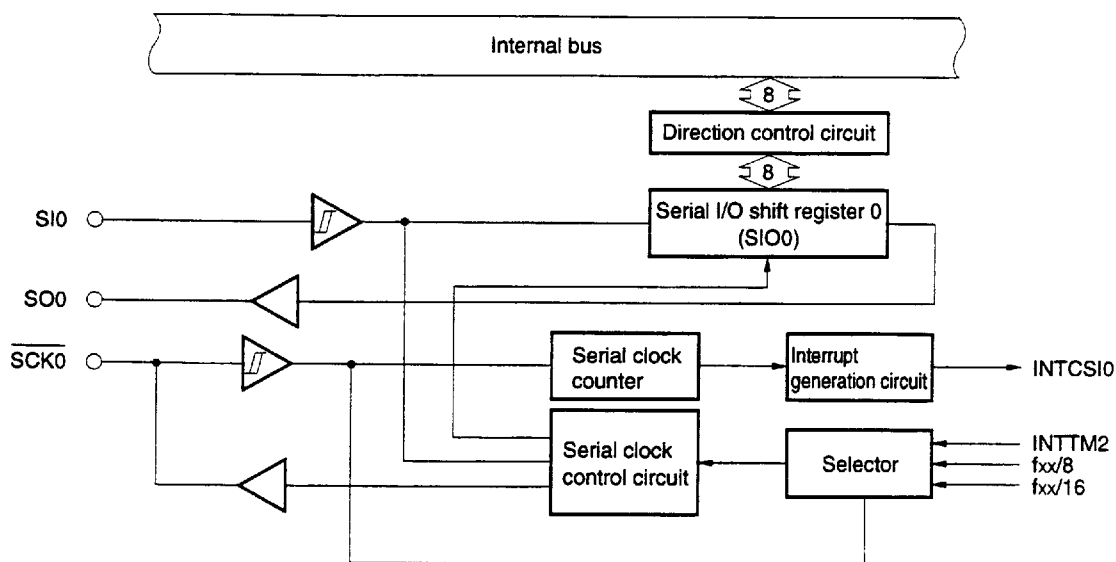
• 3-wire serial I/O mode

This mode is to communicate with devices having the conventional clocked serial interface.

Basically, communication is established in this mode with three lines: one serial clock ($\overline{\text{SCK0}}$) and two serial data (SI0 and SO0) lines.

Generally, a handshake line is necessary to check the reception status.

Figure 7-12. Block Diagram in 3-wire Serial I/O Mode

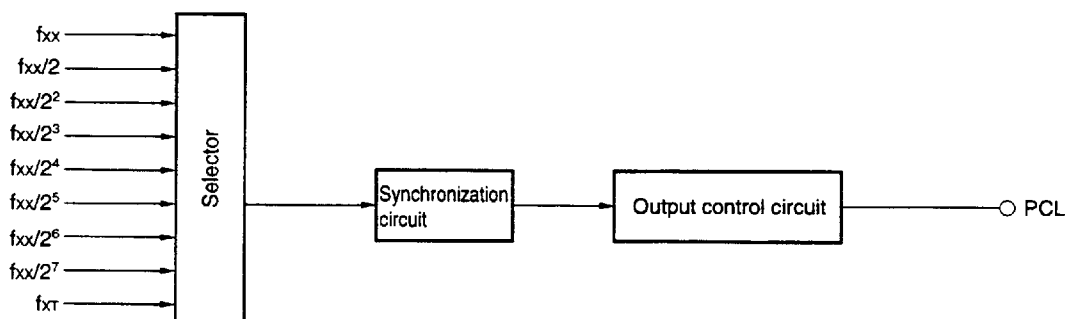


7.8 Clock Output Function

Clocks of the following frequencies can be output as clock output.

- 97.7 kHz/195 kHz/391 kHz/781 kHz/1.56 MHz/3.13 MHz/6.25 MHz/12.5 MHz (main system clock: 12.5 MHz)
- 32.768 kHz (subsystem clock: 32.768 kHz)

Figure 7-13. Block Diagram of Clock Output Function

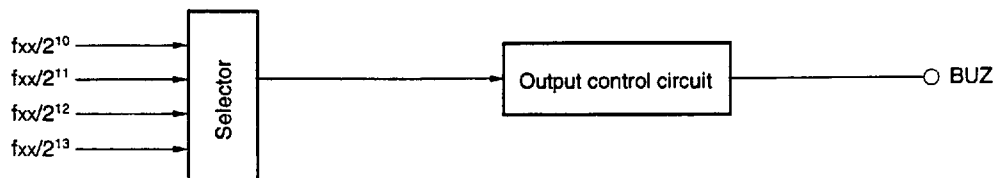


7.9 Buzzer Output Function

Clocks of the following frequencies can be output as buzzer output.

- 1.5 kHz/3.1 kHz/6.1 kHz/12.2 kHz (main system clock: 12.5 MHz)

Figure 7-14. Block Diagram of Buzzer Output Function



7.10 Edge Detection Function

The interrupt input pins (INTP0, INTP1, NMI/INTP2, INTP3 through INTP6) are used not only to input interrupt requests but also to input trigger signals to the internal hardware units. Because these pins operate at an edge of the input signal, they have a function to detect an edge. Moreover, a noise reduction circuit is also provided to prevent erroneous detection due to noise.

Pin Name	Detectable Edge	Noise Reduction
NMI	Either or both of rising and falling edges	By analog delay
INTP0 through INTP6		

7.11 Watch Timer

The watch timer has the following functions:

- Watch timer
- Interval timer

The watch timer and interval timer functions can be used at the same time.

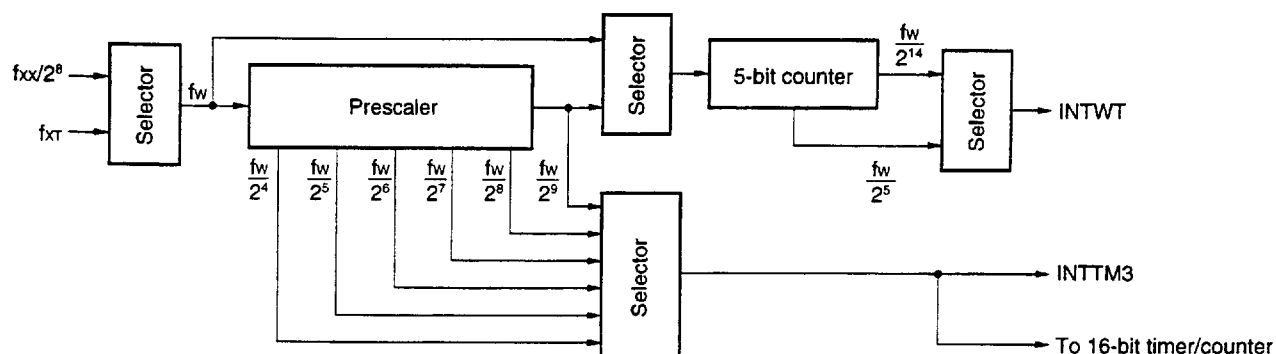
(1) Watch timer

The watch timer sets the WTIF flag of the interrupt control register (WTIC) at time intervals of 0.5 seconds by using the 32.768-kHz subsystem clock.

(2) Interval timer

The interval timer generates an interrupt request (INTTM3) at predetermined time intervals.

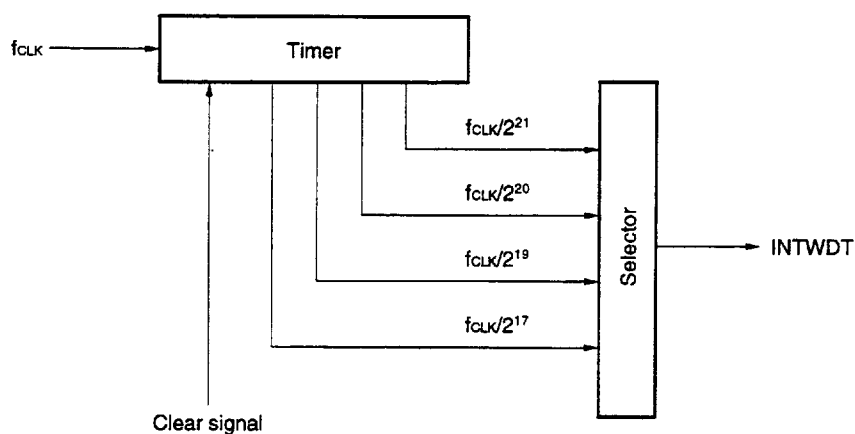
Figure 7-15. Block Diagram of Watch Timer



7.12 Watchdog Timer

A watchdog timer is provided to detect a hang up of the CPU. This watchdog timer generates a non-maskable or maskable interrupt unless it is cleared by software within a specified interval time. Once enabled to operate, the watchdog timer cannot be stopped by software. Whether the interrupt by the watchdog timer or the interrupt input from the NMI pin takes precedence can be specified.

Figure 7-16. Block Diagram of Watchdog Timer



Remark f_{CLK} : Internal system clock (f_{xx} to $f_{xx}/8$)

8. INTERRUPT FUNCTION

As the servicing in response to an interrupt request, the three types shown in Table 8-1 can be selected by program.

Table 8-1. Servicing of Interrupt Request

Servicing Mode	Entity of Servicing	Servicing	Contents of PC and PSW
Vectored interrupt	Software	Branches and executes servicing routine (servicing is arbitrary)	Saves to and restores from stack
Context switching		Automatically switches register bank, branches and executes servicing routine (servicing is arbitrary)	Saves to or restores from fixed area in register bank
Macro service	Firmware	Executes data transfer between memory and I/O (servicing is fixed)	Retained

8.1 Interrupt Sources

Table 8-2 shows the interrupt sources available. As shown, interrupts are generated by 29 types of sources, execution of the BRK instruction, BRKCS instruction, or an operand error.

The priority of interrupt servicing can be set to four levels, so that nesting can be controlled during interrupt servicing and that which of the two or more interrupts that simultaneously occur should be serviced first. When the macro service function is used, however, nesting always proceeds.

The default priority is the priority (fixed) of the service that is performed if two or more interrupt requests, having the same priority, simultaneously generate (refer to **Table 8-2**).

Table 8-2. Interrupt Sources

Type	Default Priority	Source		Internal/ External	Macro Service
		Name	Trigger		
Software	—	BRK instruction	Instruction execution	—	—
		BRKCS instruction	Instruction execution		
		Operand error	If result of exclusive OR between operands byte and byte is not FFH when MOV STBC, #byte instruction, MOV WDM, #byte instruction, or LOCATION instruction is executed		
Non-maskable	—	NMI	Pin input edge detection	External	—
		INTWDT	Overflow of watchdog timer	Internal	
Maskable	0 (highest)	INTWDT	Overflow of watchdog timer	Internal	○
	1	INTP0	Pin input edge detection	External	
	2	INTP1			
	3	INTP2			
	4	INTP3			
	5	INTP4			
	6	INTP5			
	7	INTP6			
	8	INTCSI0	End of 3-wire transfer by CSI0	Internal	
	9	INTSER1	Occurrence of UART reception error in ASI1		
	10	INTSR1	End of UART reception by ASI1		
		INTCSI1	End of 3-wire transfer by CSI1		
	11	INTST1	End of UART transmission by ASI1		
	12	INTSER2	Occurrence of UART reception error in ASI2		
	13	INTSR2	End of UART reception by ASI2		
		INTCSI2	End of 3-wire transfer by CSI2		
	14	INTST2	End of UART transmission by ASI2		
	15	INTTM3	Reference time interval signal from watch timer		
	16	INTTM00	Signal indicating coincidence between 16-bit timer register and capture/compare register (CR00)		
	17	INTTM01	Signal indicating coincidence between 16-bit timer register and capture/compare register (CR01)		
	18	INTTM1	Occurrence of coincidence signal of 8-bit timer/counter 1		
	19	INTTM2	Occurrence of coincidence signal of 8-bit timer/counter 2		
	20	INTAD	End of conversion by A/D converter		
	21	INTTM5	Occurrence of coincidence signal of 8-bit timer/counter 5		
	22	INTTM6	Occurrence of coincidence signal of 8-bit timer/counter 6		
	23	INTTM7	Occurrence of coincidence signal of 8-bit timer/counter 7		
	24	INTTM8	Occurrence of coincidence signal of 8-bit timer/counter 8		
	25	INTWT	Overflow of watch timer		
	26 (lowest)	INTKR	Detection of falling edge of port 8	External	

Remark ASI : Asynchronous Serial Interface
 CSI : Clocked Serial Interface

■ 6427525 0102794 1T5 ■

8.2 Vectored Interrupt

Execution branches to a servicing routine by using the memory contents of a vector table address corresponding to the interrupt source as the address of the branch destination.

So that the CPU performs interrupt servicing, the following operations are performed:

- On branching: Saves the status of the CPU (contents of PC and PSW) to stack
- On returning : Restores the status of the CPU (contents of PC and PSW) from stack

To return to the main routine from an interrupt service routine, the RETI instruction is used.

The branch destination address is in a range of 0 to FFFFH.

Table 8-3. Vector Table Address

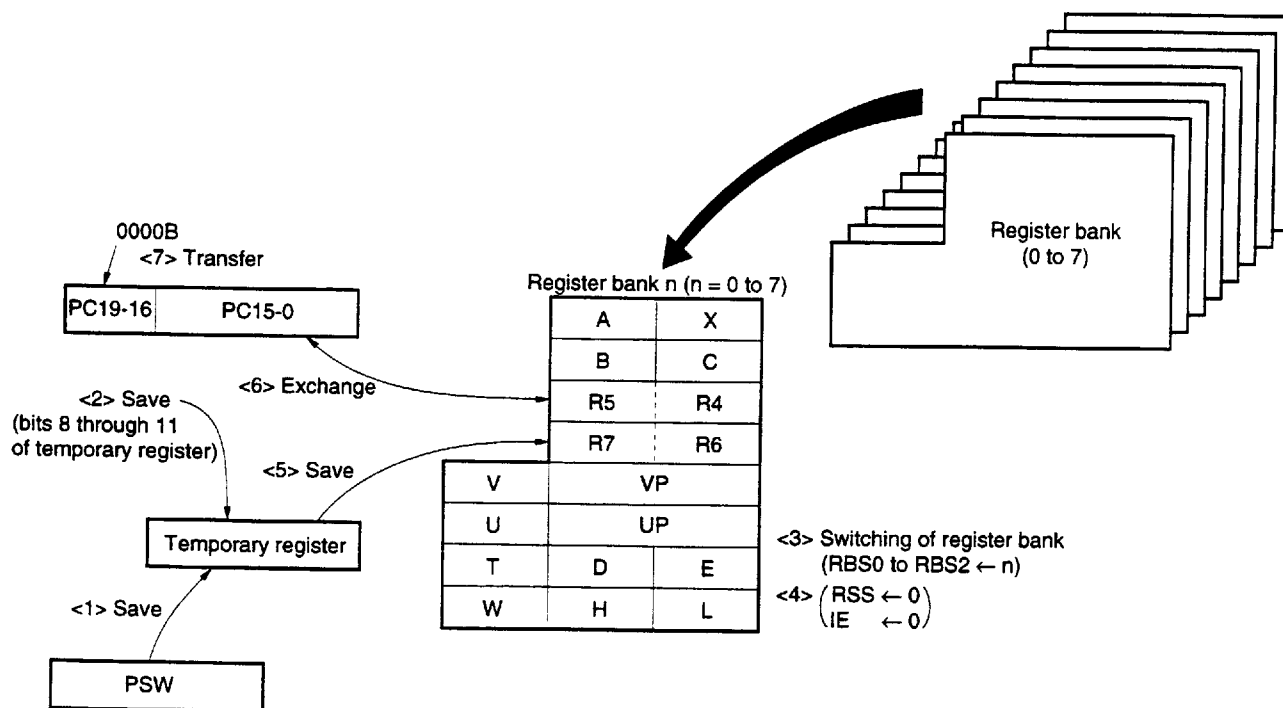
Interrupt Source	Vector Table Address	Interrupt Source	Vector Table Address
BRK instruction	003EH	INTSER2	001EH
Operand error	003CH	INSR2	0020H
NMI	0002H	INTCSI2	
INTWDT (non-maskable)	0004H	INTST2	0022H
INTWDT (maskable)	0006H	INTTM3	0024H
INTP0	0008H	INTTM00	0026H
INTP1	000AH	INTTM01	0028H
INTP2	000CH	INTTM1	002AH
INTP3	000EH	INTTM2	002CH
INTP4	0010H	INTAD	002EH
INTP5	0012H	INTTM5	0030H
INTP6	0014H	INTTM6	0032H
INTCSI0	0016H	INTTM7	0034H
INTSER1	0018H	INTTM8	0036H
INTSR1	001AH	INTWT	0038H
INTCSI1		INTKR	003AH
INTST1	001CH		

8.3 Context Switching

When an interrupt request is generated or when the BRKCS instruction is executed, a predetermined register bank is selected by hardware. Context switching is a function that branches execution to a vector address stored in advance in the register bank, and to stack the current contents of the program counter (PC) and program status word (PSW) to the register bank.

The branch address is in a range of 0 to FFFFH.

Figure 8-1. Context Switching Operation When Interrupt Request Is Generated

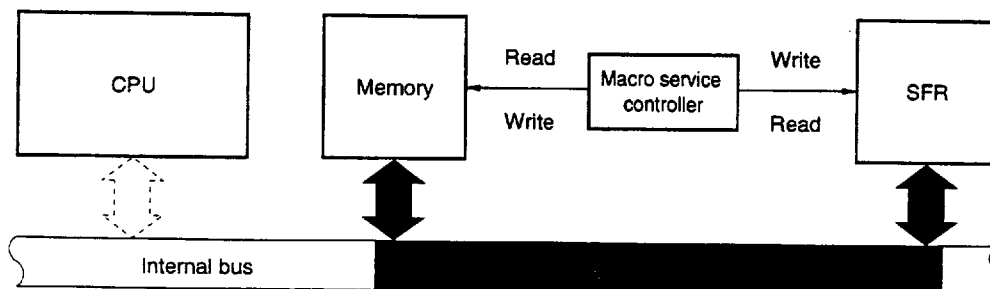


8.4 Macro Service

This function is to transfer data between memory and a special function register (SFR) without intervention by the CPU. A macro service controller accesses the memory and SFR in the same transfer cycle and directly transfers data without loading it.

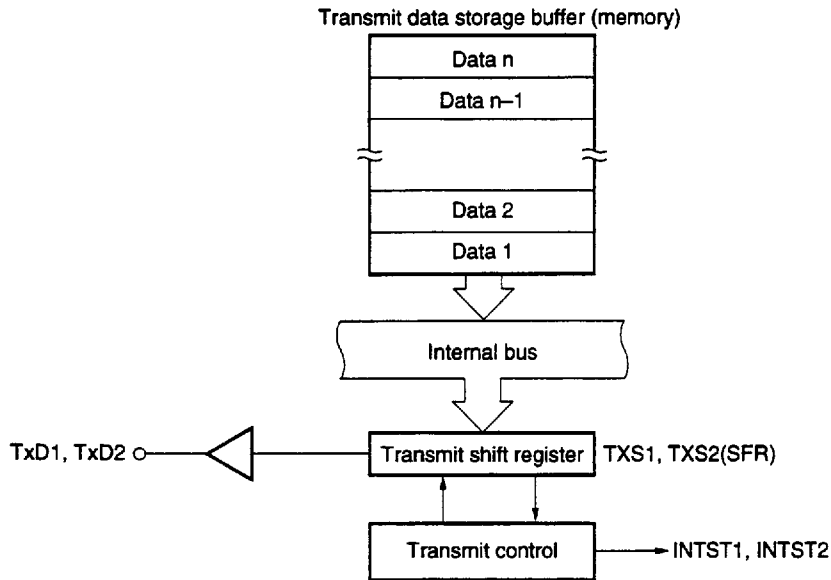
Because this function does not save or restore the status of the CPU, or load data, data can be transferred at high speeds.

Figure 8-2. Macro Service



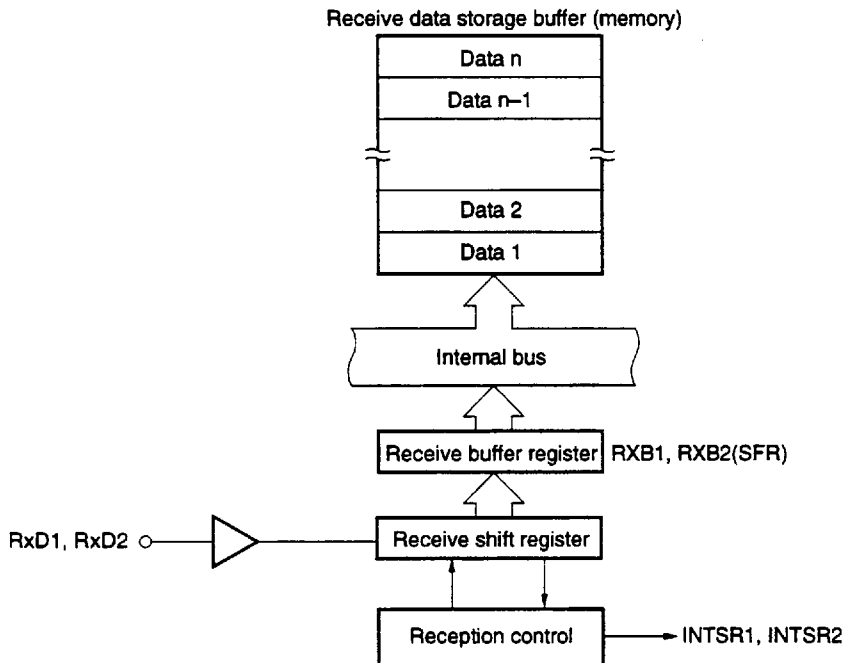
8.5 Application Example of Macro Service

(1) Transmission of serial interface



Each time macro service requests INTST1 and INTST2 are generated, the next transmit data is transferred from memory to TXS1 and TXS2. When data n (last byte) has been transferred to TXS1 and TXS2 (when the transmit data storage buffer has become empty), vectored interrupt requests INTST1 and INTST2 are generated.

(2) Reception of serial interface



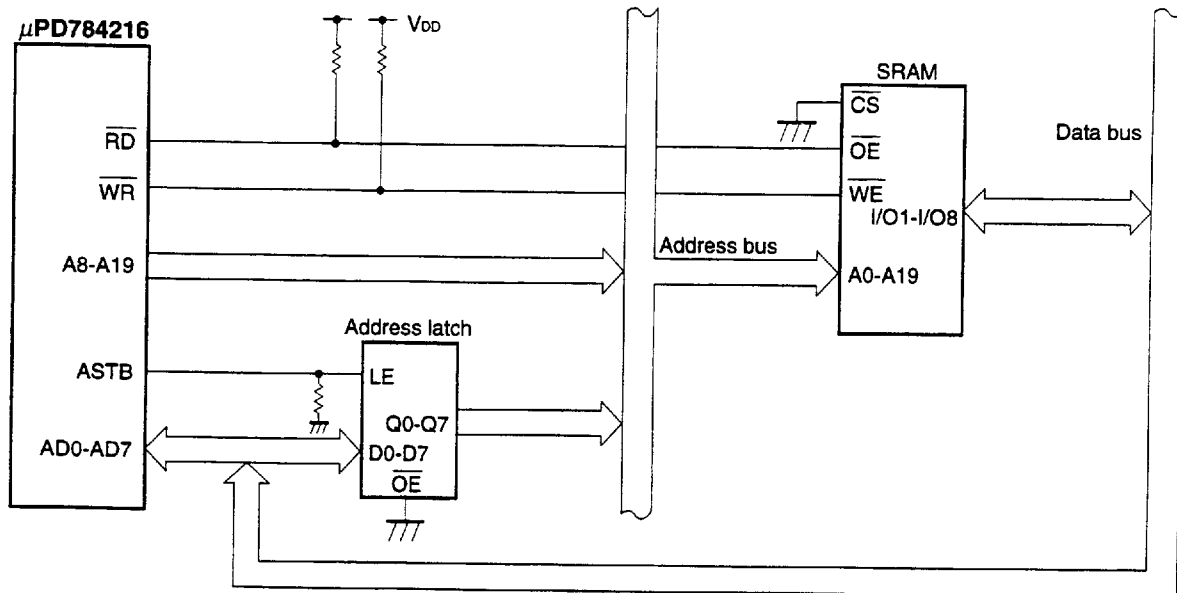
Each time macro service requests INTSR1 and INTSR2 are generated, the receive data is transferred from RXB1 and RXB2 to memory. When data n (last byte) has been transferred to memory (when the receive data storage buffer has become full), vectored interrupt requests INTSR1 and INTSR2 are generated.

9. LOCAL BUS INTERFACE

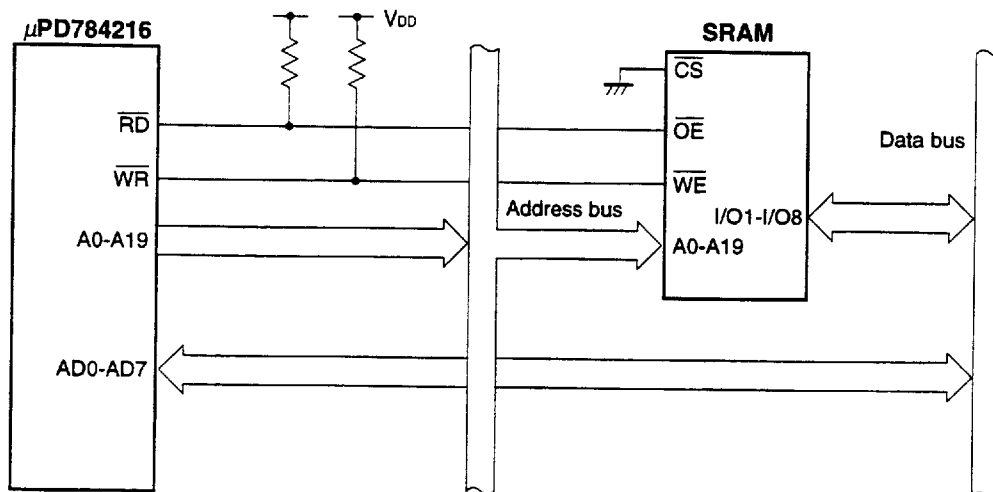
The local bus interface can connect an external memory or I/O (memory mapped I/O) and support a memory space of 1 MByte (refer to Figure 9-1).

Figure 9-1. Example of Local Bus Interface

(1) Multiplexed bus mode



(2) Separate bus mode



9.1 Memory Expansion

External program memory and data memory can be connected in two stages: 256 Kbytes and 1 Mbytes.

To connect the external memory, ports 4 through 6 and port 8 are used.

The external memory can be connected in the following two modes:

- Multiplexed bus mode: The external memory is connected by using a time-division address/data bus. The number of ports used when the external memory is connected can be reduced in this mode.
- Separate bus mode : The external memory is connected by using an address bus and data bus independent of each other. Because an external latch circuit is not necessary, this mode is useful for reducing the number of components and mounting area on the printed wiring board.

9.2 Programmable Wait

Wait state(s) can be inserted to the memory space (00000H through FFFFFH) while the $\overline{RD}$ and $\overline{WR}$ signals are active.

In addition, there is an address wait function that extends the active period of the ASTB signal to gain the address decode time.

10. STANDBY FUNCTION

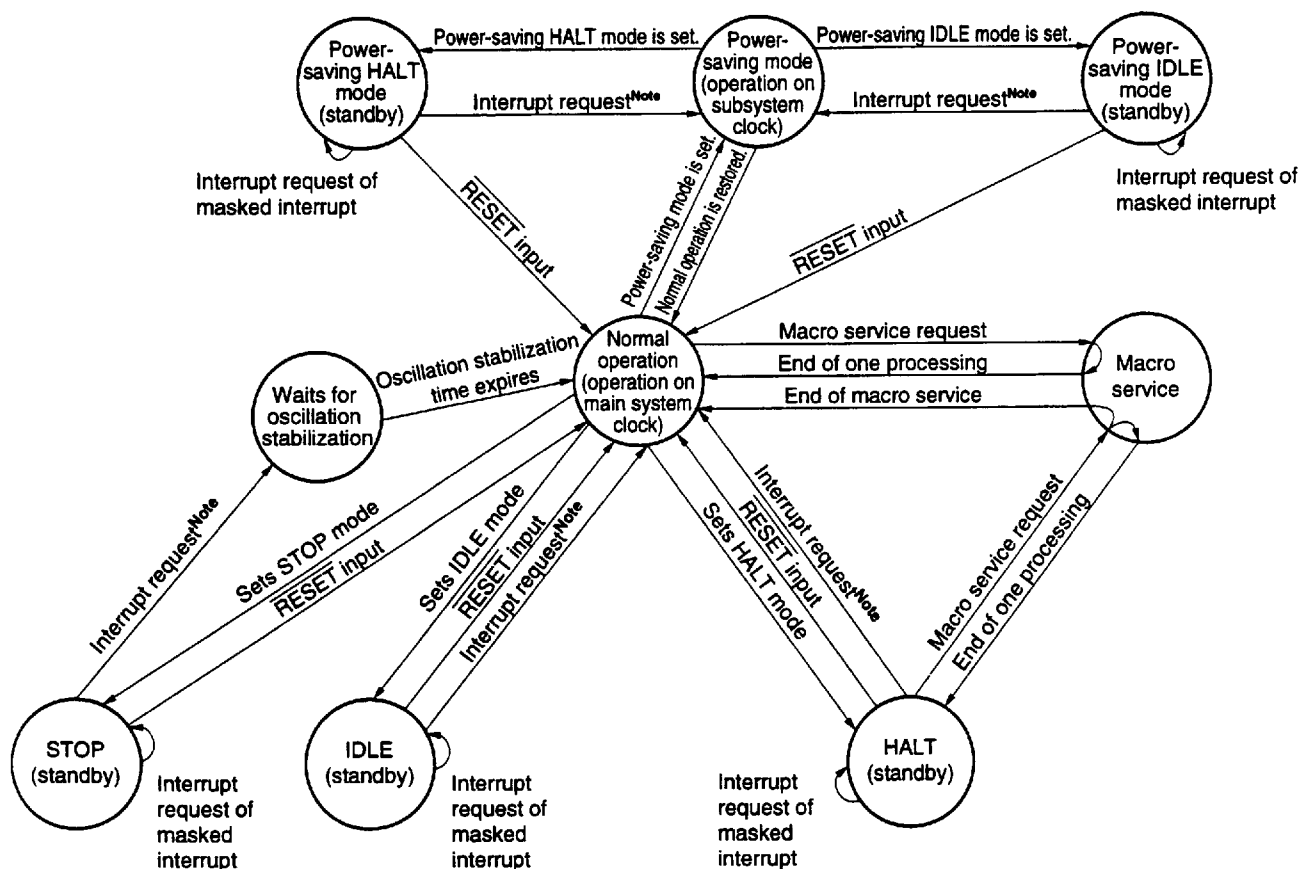
This function is to reduce the power dissipation of the chip, and can be used in the following modes:

- HALT mode : Stops supply of the operating clock to the CPU. This mode is used in combination with the normal operation mode for intermittent operation to reduce the average power dissipation.
- IDLE mode : Stops the entire system with the oscillation circuit continuing operation. The power dissipation in this mode is close to that in the STOP mode. However, the time required to restore the normal program operation from this mode is almost the same as that from the HALT mode.
- STOP mode : Stops the main system clock and thereby to stop all the internal operations of the chip. Consequently, the power dissipation is minimized with only leakage current flowing.
- Power-saving mode : The main system clock is stopped with the subsystem clock used as the system clock. The CPU can operate on the subsystem clock to reduce the current consumption.
- Power-saving HALT mode: This is a standby function in the power-saving mode and stops the operation clock of the CPU, to reduce the power dissipation of the entire system.
- Power-saving IDLE mode : This is a standby function in the power-saving mode and stops the entire system except the oscillation circuit, to reduce the power dissipation of the entire system.

These modes are programmable.

The macro service can be started from the HALT mode.

Figure 10-1. Transition of Standby Status



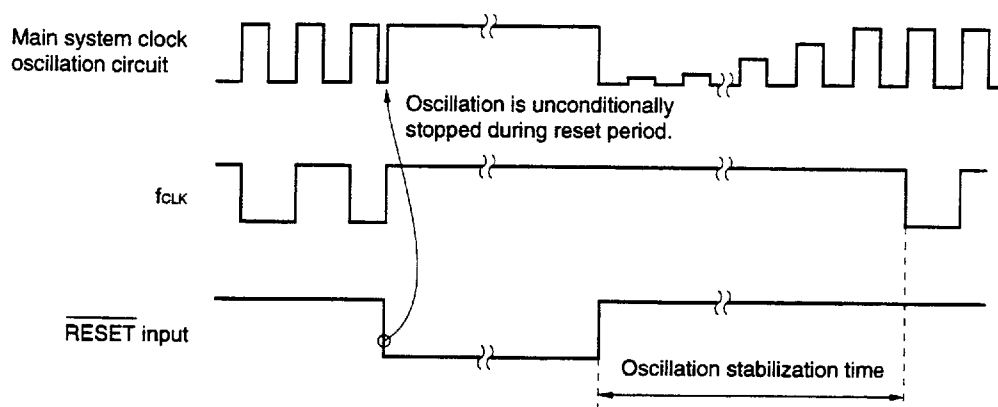
Note Only interrupt requests that are not masked

11. RESET FUNCTION

When a low-level signal is input to the $\overline{\text{RESET}}$ pin, the system is reset, and each hardware unit is initialized (reset). During the reset period, oscillation of the main system clock is unconditionally stopped. Consequently, the current consumption of the entire system can be reduced.

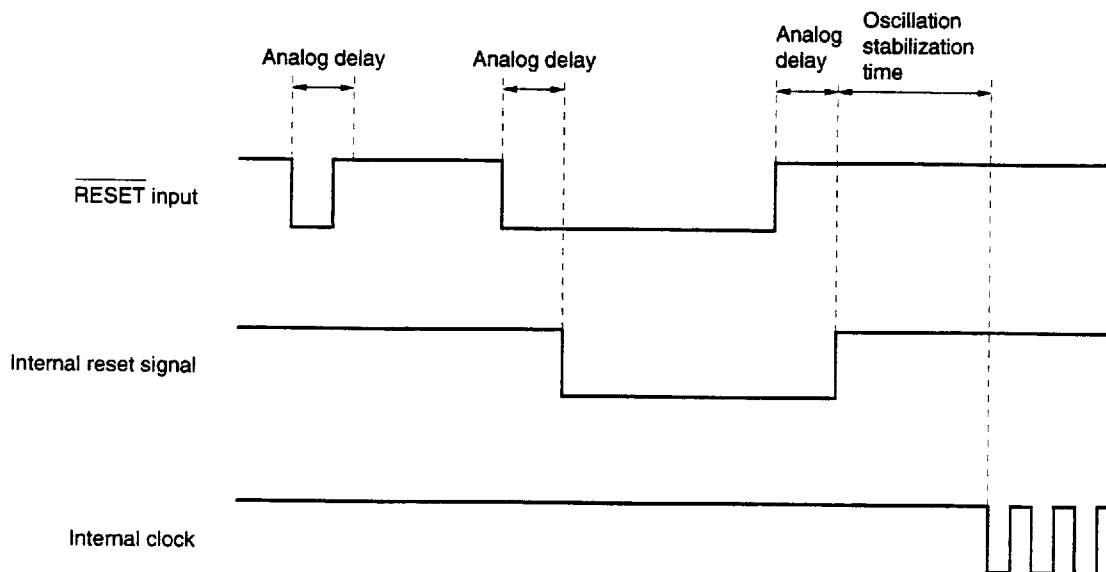
When the $\overline{\text{RESET}}$ signal goes high, the reset status is cleared, oscillation stabilization time (41.9 ms at 12.5 MHz) elapses, the contents of the reset vector table are set to the program counter (PC), execution branches to an address set to the PC, and program execution is started from that branch address. Therefore, the program can be reset and started from any address.

Figure 11-1. Oscillation of Main System Clock during Reset Period



The $\overline{\text{RESET}}$ input pin has an analog delay noise rejection circuit to prevent malfunctioning due to noise.

Figure 11-2. Accepting Reset Signal



12. INSTRUCTION SET

- (1) 8-bit instructions (The instructions in parentheses are combinations realized by describing A as r)
 MOV, XCH, ADD, ADDC, SUB, SUBC, AND, OR, XOR, CMP, MULU, DIVUW, INC, DEC, ROR, ROL, RORC,
 ROLC, SHR, SHL, ROR4, ROL4, DBNZ, PUSH, POP, MOVW, XCHW, CMPME, CMPMNE, CMPMNC,
 CMPMC, MOVBK, XCHBK, CMPBKE, CMPBKNE, CMPBKNC, CMPBKC, CHKL, CHKLA

Table 12-1. Instruction List by 8-Bit Addressing

Second Operand First Operand	#byte	A	r r'	saddr saddr'	sfr	laddr16 !!addr24	mem [saddrp] [%saddrg]	r3 PSWL PSWH	[WHL+] [WHL-]	n	None Note 2
A	(MOV) ADD Note 1	(MOV) (XCH) (ADD) Note 1	MOV XCH (ADD) Note 1	(MOV) Note 5 (XCH) Note 5 (ADD) Note 1,6	MOV (XCH) (ADD) Note 1	(MOV) (XCH) ADD Note 1	MOV XCH ADD Note 1	MOV	(MOV) (XCH) (ADD) Note 1		
r	MOV ADD Note 1	(MOV) (XCH) (ADD) Note 1	MOV XCH ADD Note 1	MOV XCH ADD Note 1	MOV XCH ADD Note 1	MOV XCH				ROR Note 3	MULU DIVUW INC DEC
saddr	MOV ADD Note 1	(MOV) Note 5 (ADD) Note 1	MOV ADD Note 1	MOV XCH ADD Note 1							INC DEC DBNZ
sfr	MOV ADD Note 1	MOV (ADD) Note 1	MOV ADD Note 1								PUSH POP CHKL CHKLA
laddr16 !!addr24	MOV	(MOV) ADD Note 1	MOV								
mem [saddrp] [%saddrg]		MOV ADD Note 1									
mem3											ROR4 ROL4
r3 PSWL PSWH	MOV	MOV									
B, C											DBNZ
STBC, WDM	MOV										
[TDE+] [TDE-]		(MOV) (ADD) Note 1 MOVW Note 4							MOVBK Note 5		

- Notes**
1. The operands of ADDC, SUB, SUBC, AND, OR, XOR, and CMP are the same as that of ADD.
 2. Either the second operand is not used, or the second operand is not an operand address.
 3. The operands of ROL, RORC, ROLC, SHR, and SHL are the same as that of ROR.
 4. The operands of XCHW, CMPME, CMPMNE, CMPMNC, and CMPMC are the same as that of MOVW.
 5. The operands of XCHBK, CMPBKE, CMPBKNE, CMPBKNC, and CMPBKC are the same as that of MOVBK.
 6. The code length of some instructions having saddr2 as saddr in this combination is short.

(2) 16-bit instructions (The instructions in parentheses are combinations realized by describing AX as rp)

MOVW, XCHW, ADDW, SUBW, CMPW, MULW, DIVUX, INCW, DECW, SHRW, SHLW, PUSH, POP, ADDWG, SUBWG, PUSHU, POPU, MOVTBLW, MACW, MACSW, SACW

Table 12-2. Instruction List by 16-Bit Addressing

Second Operand First Operand	#word	AX	rp rp'	saddrp saddrp'	sfrp	!addr16 !!addr24	mem [saddrp] [%saddrg]	[WHL+]	byte	n	None ^{Note 2}
AX	(MOVW) ADDW ^{Note 1}	(MOVW) (XCHW) (ADD) ^{Note 1}	(MOVW) (XCHW) (ADDW) ^{Note 1}	(MOVW) ^{Note 3} (XCHW) ^{Note 3} (ADDW) ^{Note 1,2}	MOVW (XCHW) (ADDW) ^{Note 1}	(MOVW) XCHW	MOVW XCHW	(MOVW) (XCHW)			
rp	MOVW ADDW ^{Note 1}	(MOVW) (XCHW) (ADDW) ^{Note 1}	MOVW XCHW ADDW ^{Note 1}	MOVW XCHW ADDW ^{Note 1}	MOVW XCHW ADDW ^{Note 1}	MOVW				SHRW SHLW	MULW ^{Note 4} INCW DECW
saddrp	MOVW ADDW ^{Note 1}	(MOVW) ^{Note 3} (ADDW) ^{Note 1}	MOVW ADDW ^{Note 1}	MOVW XCHW ADDW ^{Note 1}							INCW DECW
sfrp	MOVW ADDW ^{Note 1}	MOVW (ADDW) ^{Note 1}	MOVW ADDW ^{Note 1}								PUSH POP
!addr16 !!addr24	MOVW	(MOVW)	MOVW						MOVTBLW		
mem [saddrp] [%saddrg]		MOVW									
PSW											PUSH POP
SP	ADDWG SUBWG										
post											PUSH POP PUSHU POPU
[TDE+]		(MOVW)						SACW			
byte											MACW MACSW

- Notes**
1. The operands of SUBW and CMPW are the same as that of ADDW.
 2. Either the second operand is not used, or the second operand is not an operand address.
 3. The code length of some instructions having saddrp2 as saddrp in this combination is short.
 4. The operands of MULW and DIVUX are the same as that of MULW.

(3) 24-bit instructions (The instructions in parentheses are combinations realized by describing WHL as rg)

MOVG, ADDG, SUBG, INCG, DECG, PUSH, POP

Table 12-3. Instruction List by 24-Bit Addressing

Second Operand First Operand	#imm24	WHL	rg rg'	saddr	!!addr24	mem1	[%saddr]	SP	None Note
WHL	(MOVG) (ADDG) (SUBG)	(MOVG) (ADDG) (SUBG)	(MOVG) (ADDG) (SUBG)	(MOVG) ADDG SUBG	(MOVG)	MOVG	MOVG	MOVG	
rg	MOVG ADDG SUBG	(MOVG) (ADDG) (SUBG)	MOVG ADDG SUBG	MOVG	MOVG				INCG DECG PUSH POP
saddr		(MOVG)	MOVG						
!!addr24		(MOVG)	MOVG						
mem1		MOVG							
[%saddr]		MOVG							
SP	MOVG	MOVG							INCG DECG

Note Either the second operand is not used, or the second operand is not an operand address.

(4) Bit manipulation instructions

MOV1, AND1, OR1, XOR1, SET1, CLR1, NOT1, BT, BF, BTCLR, BFSET

Table 12-4. Instruction List by Bit Manipulation Instruction Addressing

Second Operand First Operand	CY	saddr.bit sfr.bit A.bit X.bit PSWL.bit PSWH.bit mem2.bit !addr16.bit !!addr24.bit	/saddr.bit /sfr. bit /A.bit /X.bit /PSWL.bit /PSWH.bit /mem2.bit /!addr16.bit /!!addr24.bit	None ^{Note}
CY		MOV1 AND1 OR1 XOR1	AND1 OR1	NOT1 SET1 CLR1
saddr.bit sfr.bit A.bit X.bit PSWL.bit PSWH.bit mem2.bit !addr16.bit !!addr24.bit	MOV1			NOT1 SET1 CLR1 BF BT BTCLR BFSET

Note Either the second operand is not used, or the second operand is not an operand address.

(5) Call and return/branch instructions

CALL, CALLF, CALLT, BRK, RET, RETI, RETB, RETCS, RETCSB, BRKCS, BR, BNZ, BNE, BZ, BE, BNC, BNL, BC, BL, BNZ, BPO, BV, BPE, BP, BN, BLT, BGE, BLE, BGT, BNH, BH, BF, BT, BTCLR, BFSET, DBNZ

Table 12-5. Instruction List by Call and Return/Branch Instruction Addressing

Operand of Instruction Address	\$addr20	!addr20	!addr16	!!addr20	rp	rg	[rp]	[rg]	!addr11	[addr5]	RBn	None
Basic instruction	BC ^{Note} BR	CALL BR	CALL BR RETCS RETCSB	CALL BR	CALL BR	CALL BR	CALL BR	CALL BR	CALLF	CALLF	BRKCS	BRK RET RETI RETB
Compound instruction	BF BT BTCLR BFSET DBNZ											

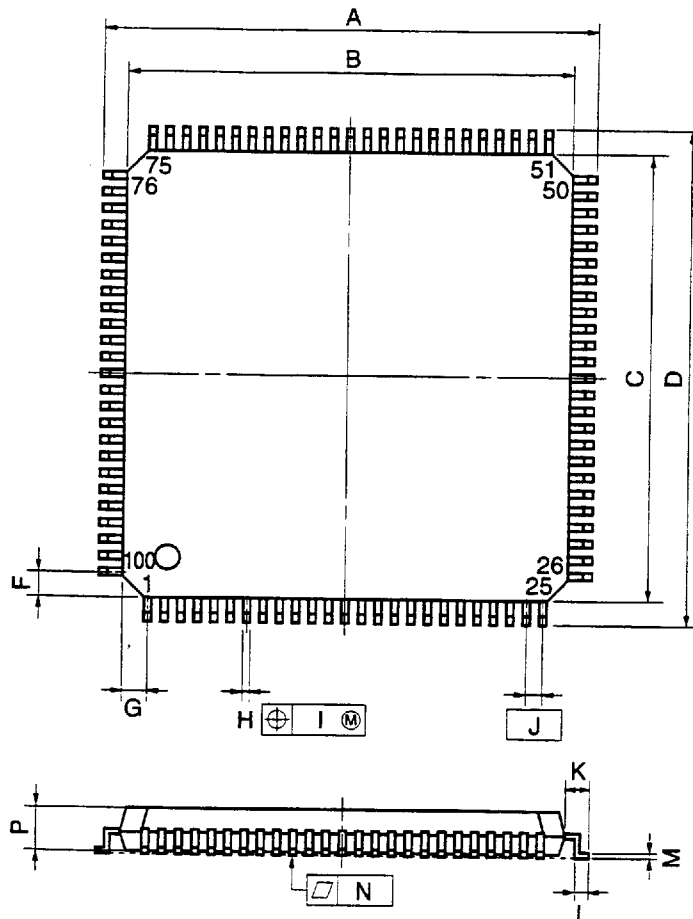
Note The operands of BNZ, BNE, BZ, BE, BNC, BNL, BL, BNZ, BPO, BV, BPE, BP, BN, BLT, BGE, BLE, BGT, BNH, and BH are the same as that of BC.

(6) Other instructions

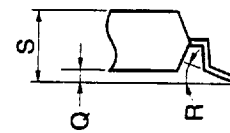
ADJBA, ADJBS, CVTBW, LOCATION, SEL, NOT, EI, DI, SWRS

13. PACKAGE DRAWINGS

100 PIN PLASTIC QFP (FINE PITCH) (□14)



detail of lead end



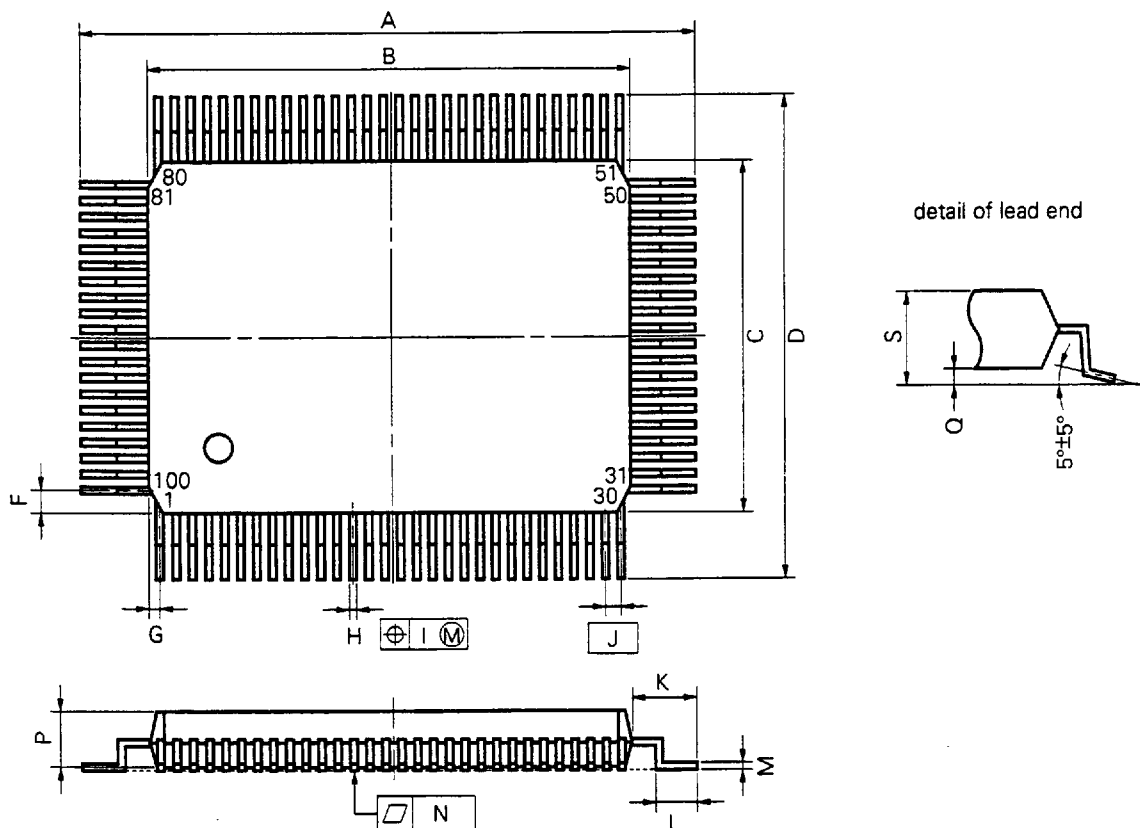
NOTE

Each lead centerline is located within 0.10 mm (0.004 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	16.0±0.2	0.630±0.008
B	14.0±0.2	0.551 ^{+0.009} _{-0.008}
C	14.0±0.2	0.551 ^{+0.009} _{-0.008}
D	16.0±0.2	0.630±0.008
F	1.0	0.039
G	1.0	0.039
H	0.22 ^{+0.05} _{-0.04}	0.009±0.002
I	0.10	0.004
J	0.5 (T.P.)	0.020 (T.P.)
K	1.0±0.2	0.039 ^{+0.009} _{-0.008}
L	0.5±0.2	0.020 ^{+0.008} _{-0.009}
M	0.17 ^{+0.03} _{-0.07}	0.007 ^{+0.001} _{-0.003}
N	0.10	0.004
P	1.45	0.057
Q	0.125±0.075	0.005±0.003
R	5°±5°	5°±5°
S	1.7 MAX.	0.067 MAX.

P100GC-50-7EA-2

100 PIN PLASTIC QFP (14 × 20)



NOTE

Each lead centerline is located within 0.15 mm (0.006 inch) of its true position (T.P.) at maximum material condition.

P100GF-65-3BA1-2

ITEM	MILLIMETERS	INCHES
A	23.6±0.4	0.929±0.016
B	20.0±0.2	0.795 ^{+0.009} _{-0.008}
C	14.0±0.2	0.551 ^{+0.009} _{-0.008}
D	17.6±0.4	0.693±0.016
F	0.8	0.031
G	0.6	0.024
H	0.30±0.10	0.012 ^{+0.004} _{-0.005}
I	0.15	0.006
J	0.65 (T.P.)	0.026 (T.P.)
K	1.8±0.2	0.071 ^{+0.008} _{-0.009}
L	0.8±0.2	0.031 ^{+0.009} _{-0.008}
M	0.15 ^{+0.10} _{-0.05}	0.006 ^{+0.004} _{-0.003}
N	0.10	0.004
P	2.7	0.106
Q	0.1±0.1	0.004±0.004
S	3.0 MAX.	0.119 MAX.

APPENDIX A. DEVELOPMENT TOOLS

The following development tools are available for supporting development of a system using the μPD784216.

Language processor software

RA78K4 Note 1	Assembler package common to 78K/IV series
CC78K4 Note 1	C compiler package common to 78K/IV series
CC78K4-L Note 1	C compiler library source file common to 78K/IV series

Flash memory writing tool

Flashpro	Dedicated flash writer. Flashpro is a product of Naitou Densei Machidaseisakusho Co., Ltd.
PA-FLASH100GC (provisional name)	Adapter for flash writing.
PA-FLASH100GF (provisional name)	Adapter for flash writing is a product of Naitou Densei Machidaseisakusho Co., Ltd.

Debugging tool

IE-784000-R	In-circuit emulator common to 78K/IV series
IE-784000-R-BK	Break board common to 78K/IV series
IE-784218-R-EM1 IE-784000-R-EM	Emulation board for evaluation of μPD784216 subseries
IE-70000-98-IF-B	Interface adapter when PC-9800 series (except notebook type) is used as host machine
IE-70000-98N-IF	Interface adapter and cable when notebook type PC-9800 series is used as host machine
IE-70000-PC-IF-B	Interface adapter when IBM PC/AT™ is used as host machine
IE-78000-R-SV3	Interface adapter and cable when EWS is used as host machine
EP-78064GC-R	Emulation probe for 100-pin plastic QFP (fine pitch) (GC-7EA type) common to μPD784216 subseries
EP-78064GF-R	Emulation probe for 100-pin plastic QFP (GF-3BA type) common to μPD784216 subseries
TGC-100SDW	Adapter mounted on board of target system created for 100-pin plastic QFP (fine pitch) (GC-7EA type). Product of Tokyo Eletech Corporation.
EV-9200GF-100	Socket mounted on board of target system created for 100-pin plastic QFP (GF-3BA type)
SM78K4 Note 2	System simulator common to 78K/IV series
ID78K4 Note 2	Integrated debugger for IE-784000-R
DF784218 Note 3	Device file for μPD784216 subseries

Real-time OS

RX78K/IV Note 3	Real-time OS for 78K/IV series
MX78K4 Note 4	OS for 78K/IV series

Remark RA78K4, CC78K4, SM78K4, and ID78K4 are used in combination with DF784218.

- Notes.**
1. • PC-9800 series (MS-DOS™) base
 - IBM PC/AT and compatible machine (PC DOS™, Windows™, MS-DOS, IBM DOS™) base
 - HP9000 series 700™ (HP-UX™) base
 - SPARCstation™ (SunOS™) base
 - NEWS™ (NEWS-OS™) base
 2. • PC-9800 series (MS-DOS+Windows) base
 - IBM PC/AT and compatible machine (PC DOS, Windows, MS-DOS, IBM DOS) base
 - HP9000 series 700 (HP-UX) base
 - SPARCstation (SunOS) base
 3. • PC-9800 series (MS-DOS) base
 - IBM PC/AT and compatible machine (PC DOS, Windows, MS-DOS, IBM DOS) base
 - HP9000 series 700 (HP-UX) base
 - SPARCstation (SunOS) base
 4. • PC-9800 series (MS-DOS) base
 - IBM PC/AT and compatible machine (PC DOS, Windows, MS-DOS, IBM DOS) base

APPENDIX B. RELATED DOCUMENTS

Documents related to device

Document Name	Document No.	
	Japanese	English
μPD784214, 784215, 784216 Preliminary Product Information	U11813J	This document
μPD78F4216 Preliminary Product Information	U11825J	Planned
μPD784216, 784216Y Subseries User's Manual Hardware	Planned	Planned
μPD784216 Subseries Special Function Register Table	Planned	—
78K/IV Series User's Manual Instructions	U10905J	IEU-1386
78K/IV Series Instruction Table	U10594J	—
78K/IV Series Instruction Set	U10595J	—
78K/IV Series Application Note Software Basics	U10095J	U10095E

Documents related to development tool (User's Manual)

Document Name		Document No.	
		Japanese	English
RA78K4 Assembler Package	Operation	U11334J	U11334E
	Language	U11162J	—
RA78K Series Structured Assembler Preprocessor		EEU-817	EEU-1402
CC78K4 Series	Operation	EEU-960	—
	Language	EEU-961	—
CC78K Series Library Source File		EEU-777	—
IE-784000-R		EEU-5004	EEU-1534
IE-784218-R-EM1		Planned	—
EP-78064		EEU-934	EEU-1469
SM78K4 System Simulator Windows Base	Reference	U10093J	U10093E
SM78K Series System Simulator	External Part User Open Interface Specifications	U10092J	U10092E
ID78K4 Integrated Debugger Windows Base	Reference	U10440J	U10440E

Caution The contents of the above related documents are subject to change without notice. Be sure to use the latest edition of a document for designing.

Documents related to embedded software (User's Manual)

Document Name		Document No.	
		Japanese	English
78K/IV Series Real-Time OS	Basics	U10603J	—
	Installation	U10604J	—
	Debugger	U10364J	—
78K/IV Series OS MX78K4		Planned	—

Other documents

Document Name		Document No.	
		Japanese	English
IC Package Manual		C10943X	
Semiconductor Device Mounting Technology Manual		C10535J	C10535E
Quality Grades on NEC Semiconductor Devices		C11531J	C11531E
NEC Semiconductor Device Reliability/Quality Control System		C10983J	C10983E
Electrostatic Discharge (ESD) Test		MEM-539	—
Guide to Quality Assurance for Semiconductor Devices		MEI-603	MEI-1202
Guide to Microcontroller-Related Products by Third Parties		U11416J	—

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