PRELIMINARY PRODUCT INFORMATION

NEC

MOS INTEGRATED CIRCUIT

μPD784214Y,784215Y,784216Y

16/8-BIT SINGLE-CHIP MICROCONTROLLERS

The μPD784216Y is based on the μPD784216 with an I^2C bus control function appended, and is ideal for applications in audio-visual.

Flash memory versions, such as μPD78F4216Y, that 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 this manual when designing your system.

μPD784216, 784216Y Subseries User's Manual - Hardware: Planned
78K/IV Series User's Manual - Instruction : U10905E

FEATURES

- 78K/IV series
- Inherits peripheral functions of uPD78078Y subseries
- Pin-compatible with μPD784216 subseries
- Minimum instruction execution time
  160 ns (main system clock f_{XX} = 12.5 MHz)
  61 μs (subsystem clock f_{XT} = 32.768 kHz)
- I/O port: 86 pins
- Timer/counter: 16-bit timer/counter × 1 unit
  8-bit timer/counter × 6 units
- Serial interface: 3 channels
  UART/IOE (3-wire serial I/O): 2 channels
  CSI (3-wire serial I/O, multi-master supporting I^2C bus): 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 × 8 channels
- D/A converter: 8-bit resolution × 2 channels
- Supply voltage: V_{DD} = 1.8 to 5.5 V

APPLICATION FIELD

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

Unless contextually excluded, references in this document to μPD784216Y mean μPD784214Y, μPD784215Y, and μPD784216Y.

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.

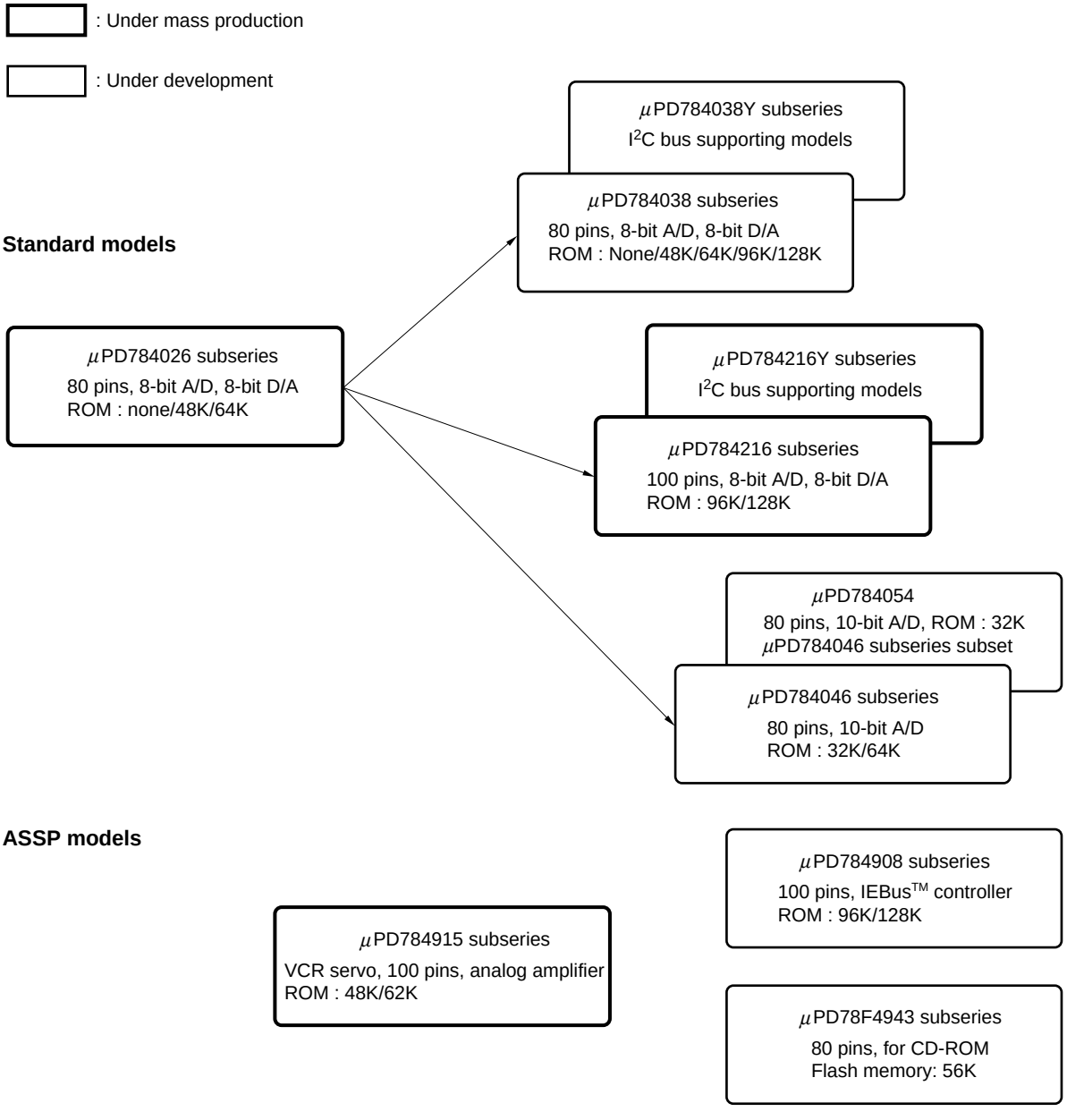
Document No. U11725EJ1V0PM00 (1st edition)
Date Published September 1996 P
Printed in Japan

ORDERING INFORMATION

Part Number	Package	Internal ROM (Bytes)	Internal RAM (Bytes)
μPD784214YGC-×××-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	96 K	3584
μPD784214YGF-×××-3BA	100-pin plastic QFP (14 × 20 mm)	96 K	3584
μPD784215YGC-×××-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	128 K	5120
μPD784215YGF-×××-3BA	100-pin plastic QFP (14 × 20 mm)	128 K	5120
μPD784216YGC-×××-7EA	100-pin plastic QFP (fine pitch) (14 × 14 mm)	128 K	8192
μPD784216YGF-×××-3BA	100-pin plastic QFP (14 × 20 mm)	128 K	8192

Remark ××× indicates a ROM code suffix.

78K/IV Series Product Development



FUNCTIONS (1/2)

Item \ Part Number		μPD784214Y	μPD784215Y	μPD784216Y
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		
	LEDs 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)

Item \ Part Number		μPD784214Y	μPD784215Y	μPD784216Y
Serial interface		UART/IOE (3-wire serial I/O): 2 channels (on-chip baud rate generator) CSI (3-wire serial I/O, I^2C bus supporting multi master): 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	Source	29 (internal: 20, external: 9) + BRK instruction		
	Software	BRK instruction		
	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)		

CONTENTS

1. DIFFERENCES AMONG MODELS IN μPD784216Y SUBSERIES

The only difference among the μPD784214Y, 784215Y, and 784216Y lies in the internal memory capacity.

The μPD78P4216Y is provided with a 128-KB 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 μPD784216Y Subseries

Part Number / Item	μPD784214Y	μPD784215Y	μPD784216Y	μPD78F4216Y
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

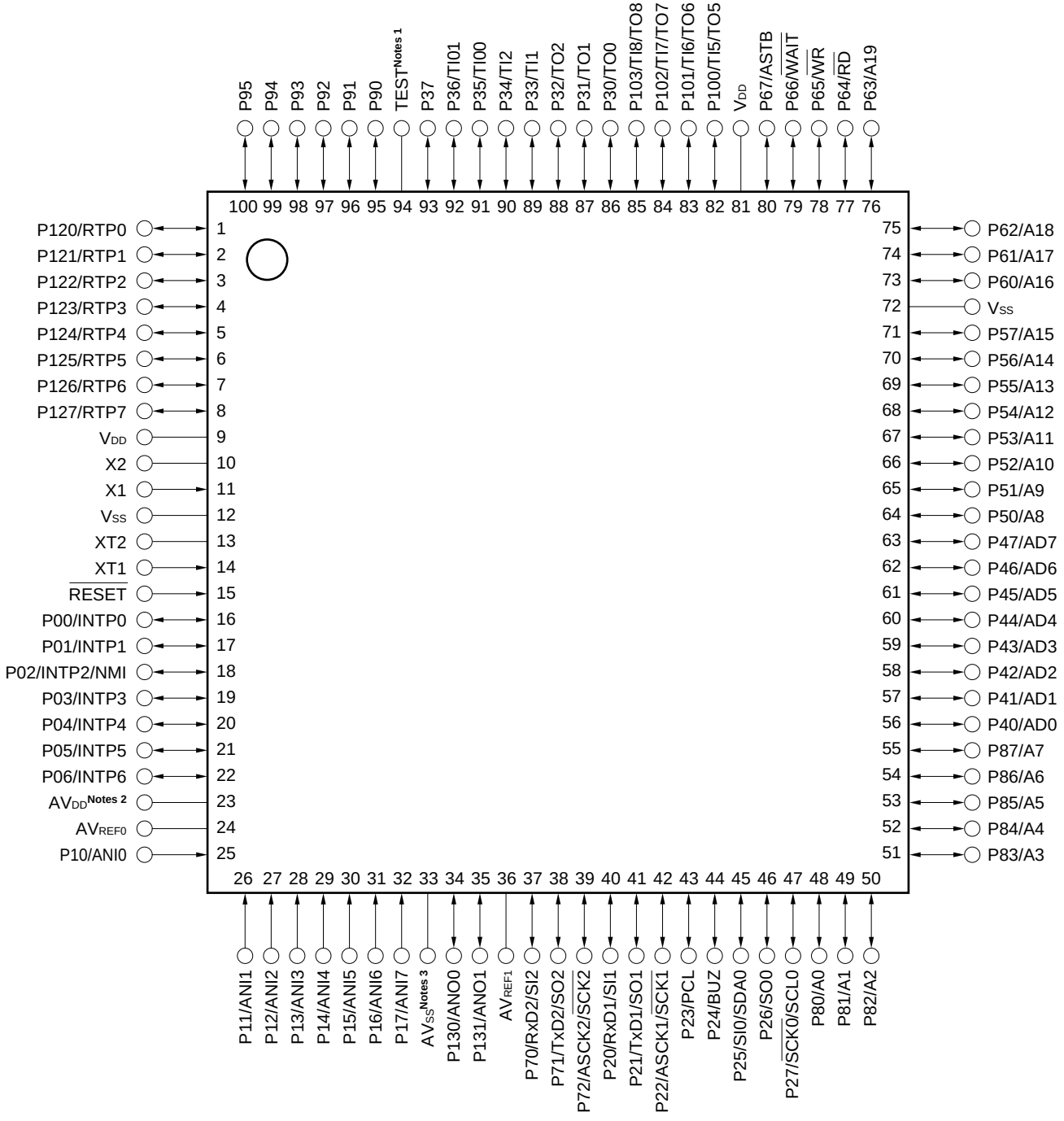
2. MAIN DIFFERENCES FROM μPD78078Y SUBSERIES

Item \ Series Name		μPD784216Y Subseries	μPD78078Y Subseries
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 (32.768 kHz)
Memory space		1 Mbytes	64 Kbytes
I/O port	Total	88	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, multi-master supporting I^2C bus) × 1 channel	• UART/IOE (3-wire serial I/O) × 1 channel • CSI (3-wire serial I/O, 2-wire serial I/O, I^2C bus) × 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 (14 × 20 mm) • ceramic WQFN (14 × 20 mm) (μPD78P078Y 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)**
  μPD784214YGC-xxx-7EA
  μPD784215YGC-xxx-7EA
  μPD784216YGC-xxx-7EA

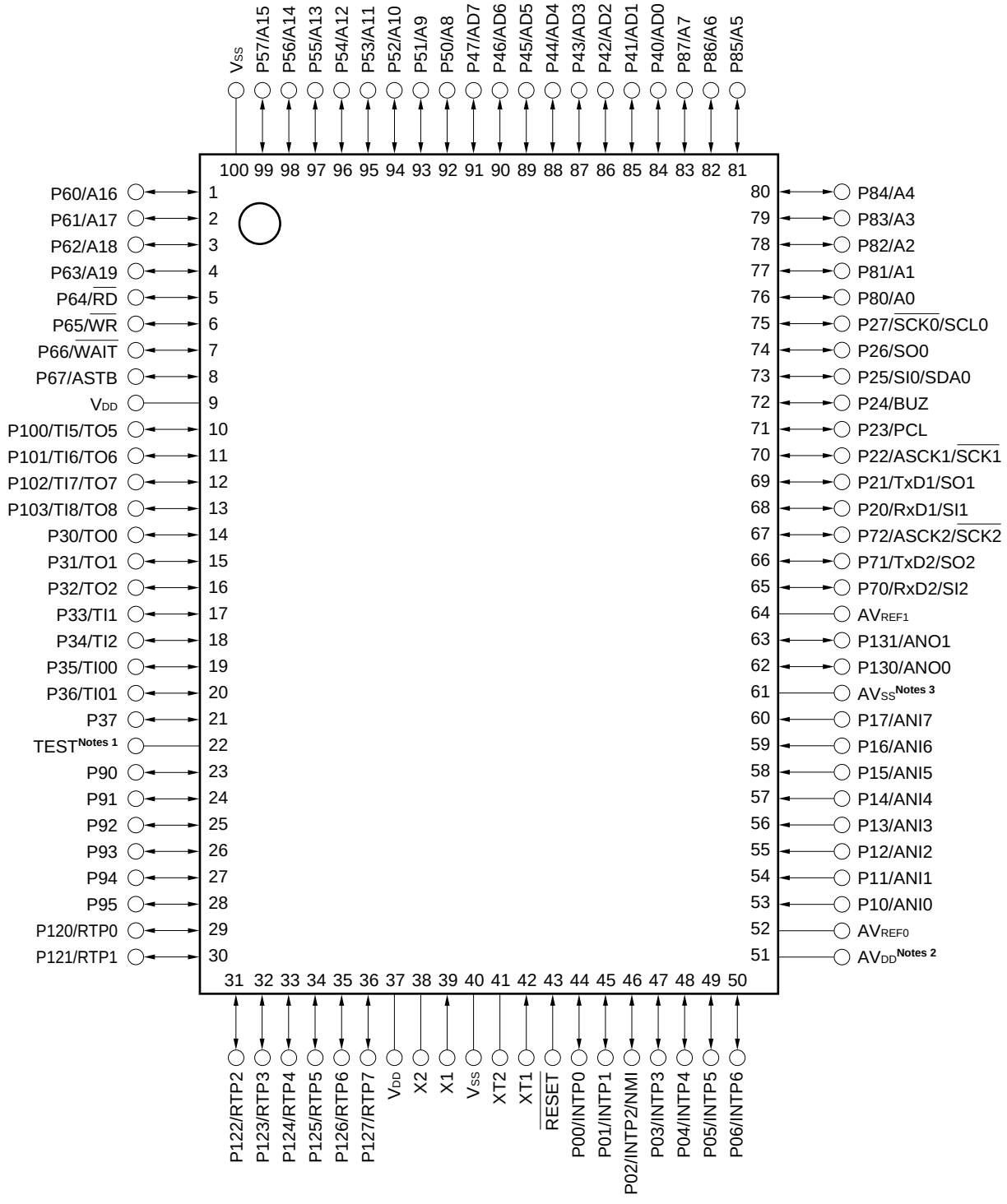


Notes 1. Directly connect the TEST pin to VSS.

2. Connect the AVDD pin to VDD.

3. Connect the AVSS pin to VSS.

- **100-pin plastic QFP (14 × 20 mm)**
  μPD784214YGF-xxx-3BA
  μPD784215YGF-xxx-3BA
  μPD784216YGF-xxx-3BA



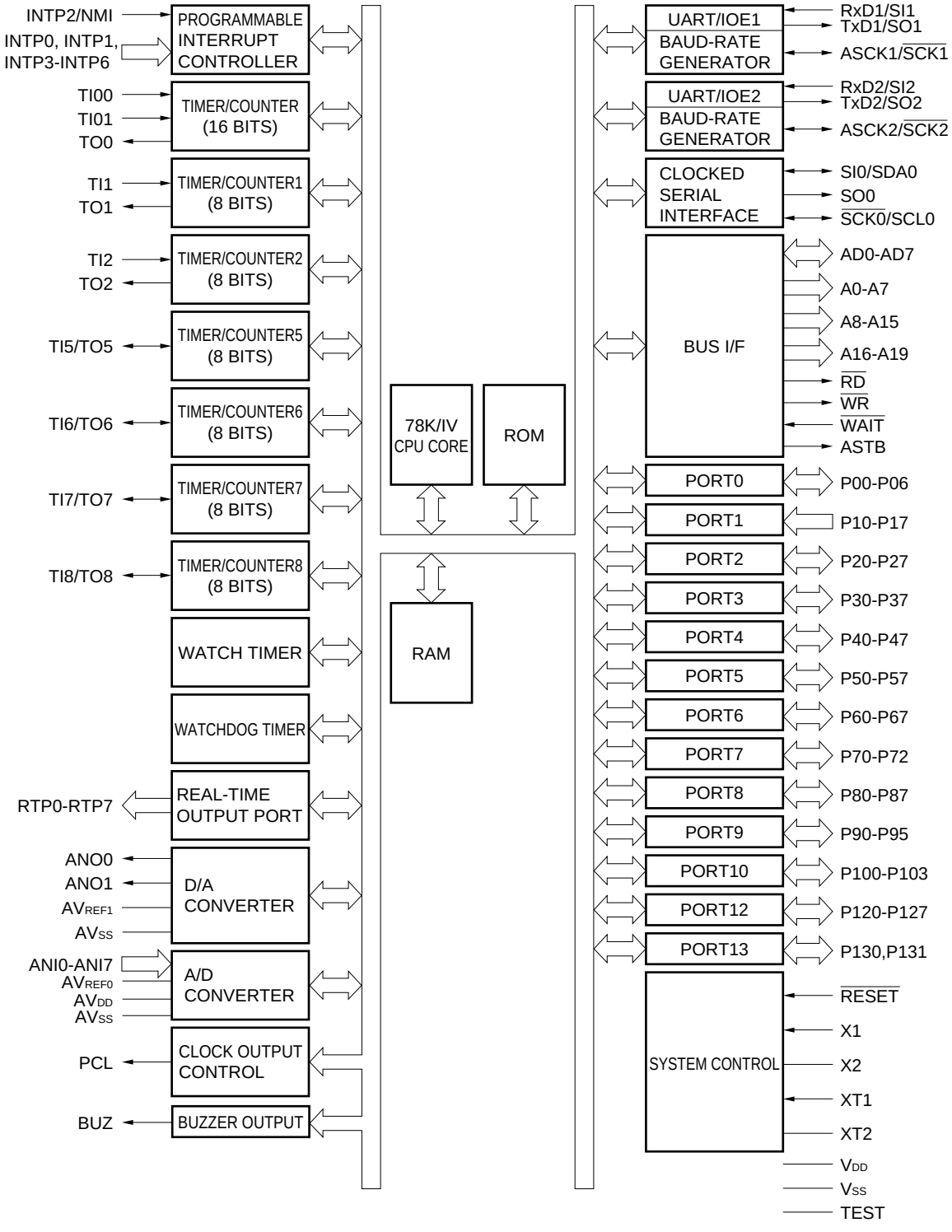
Notes 1. Directly connect the TEST pin to VSS.

2. Connect the AVDD pin to VDD.

3. Connect the AVSS pin to VSS.

P00-P06	: Port0
P10-P17	: Port1
P20-P27	: Port2
P30-P37	: Port3
P40-P47	: Port4
P50-P57	: Port5
P60-P67	: Port6
P70-P72	: Port7
T80-P87	: Port8
P90-P95	: Port9
P100-P103	: Port10
P120-P127	: Port12
P130, P131	: Port13
RTP0-RTP7	: Real-time Output Port
NMI	: Non-maskable Interrupt
INTP0-INTP6	: Interrupt from Peripherals
TI00, TI01	: Timer Input
TI1, TI2, TI5-TI8	: Timer Input
TO0-TO2, TO5-TO8	: Timer Output
SI0-SI2	: Serial Input
SO0-SO2	: Serial Output
SDA0	: Serial Data
$\overline{SCK0}$-$\overline{SCK2}$	: Serial Clock
SCL0	: Serial Clock
RxD1, RxD2	: Receive Data
TxD1, TxD2	: Transmit Data
ASCK1, ASCK2	: Asynchronous Serial Clock
PCL	: Programmable Clock
BUZ	: Buzzer Clock
AD0-AD7	: Address/Data Bus
A0-A19	: Address Bus
$\overline{RD}$	: Read Strobe
$\overline{WR}$	: Write Strobe
$\overline{WAIT}$	: Wait
ASTB	: Address Strobe
X1, X2	: Crystal (Main System Clock)
XT1, XT2	: Crystal (Subsystem Clock)
$\overline{RESET}$	: Reset
ANI0-ANI7	: Analog Input
ANO0, ANO1	: Analog Output
AV_{DD}	: Analog Power Supply
AV_{SS}	: Analog Ground
AV_{REF0}, AV_{REF1}	: Analog Reference Voltage
V_{DD}	: Power Supply
V_{SS}	: Ground
TEST	: Test

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/NM1	
P03		INTP3	
P04		INTP4	
P05		INTP5	
P06		INTP6	
P10-P17	Input	ANI0-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/$\overline{\text{SCK1}}$	
P23		PCL	
P24		BUZ	
P25		SI0/SDA0	
P26		SO0	
P27		$\overline{\text{SCK0}}$/SCL0	
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-P47	I/O	AD0-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-P57	I/O	A8-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	
P64		$\overline{RD}$	
P65		$\overline{WR}$	
P66		$\overline{WAIT}$	
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/$\overline{SCK2}$	
P80-P87	I/O	A0-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-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-P127	I/O	RTP0-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 Pins Other Than 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/TI5	
TO6		P101/TI6	
TO7		P102/TI7	
TO8		P103/TI8	
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	Intput	P22/$\overline{\text{SCK1}}$	Baud rate clock input (UART1)
ASCK2		P72/$\overline{\text{SCK2}}$	Baud rate clock input (UART2)
SI0	Input	P25/SDA0	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)
SDA0	I/O	P25/SI0	Serial data input/output (I^2C bus)
$\overline{\text{SCK0}}$	I/O	P27/SCL0	Serial clock input/output (3-wire serial I/O0)
$\overline{\text{SCK1}}$		P22/ASCK1	Serial clock input/output (3-wire serial I/O1)
$\overline{\text{SCK2}}$		P72/ASCK2	Serial clock input/output (3-wire serial I/O2)
SCL0		P27/$\overline{\text{SCK0}}$	Serial clock input/output (I^2C bus)
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 Pins Other Than 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-RTP7	Output	P120-P127	Real-time output port that outputs data in synchronization with trigger
AD0-AD7	I/O	P40-P47	Low-order address/data bus when external memory is connected
A0-A7	Output	P80-P87	Low-order address bus when external memory is connected
A8-A15		P50-P57	Middle-order address bus when external memory is connected
A16-A19		P60-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	—	To connect main system clock oscillation crystal
X2	—		
XT1	Input	—	To connect subsystem clock oscillation crystal
XT2	—		
ANI0-ANI7	Input	P10-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 I/O Circuit Type of Respective Pins 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)

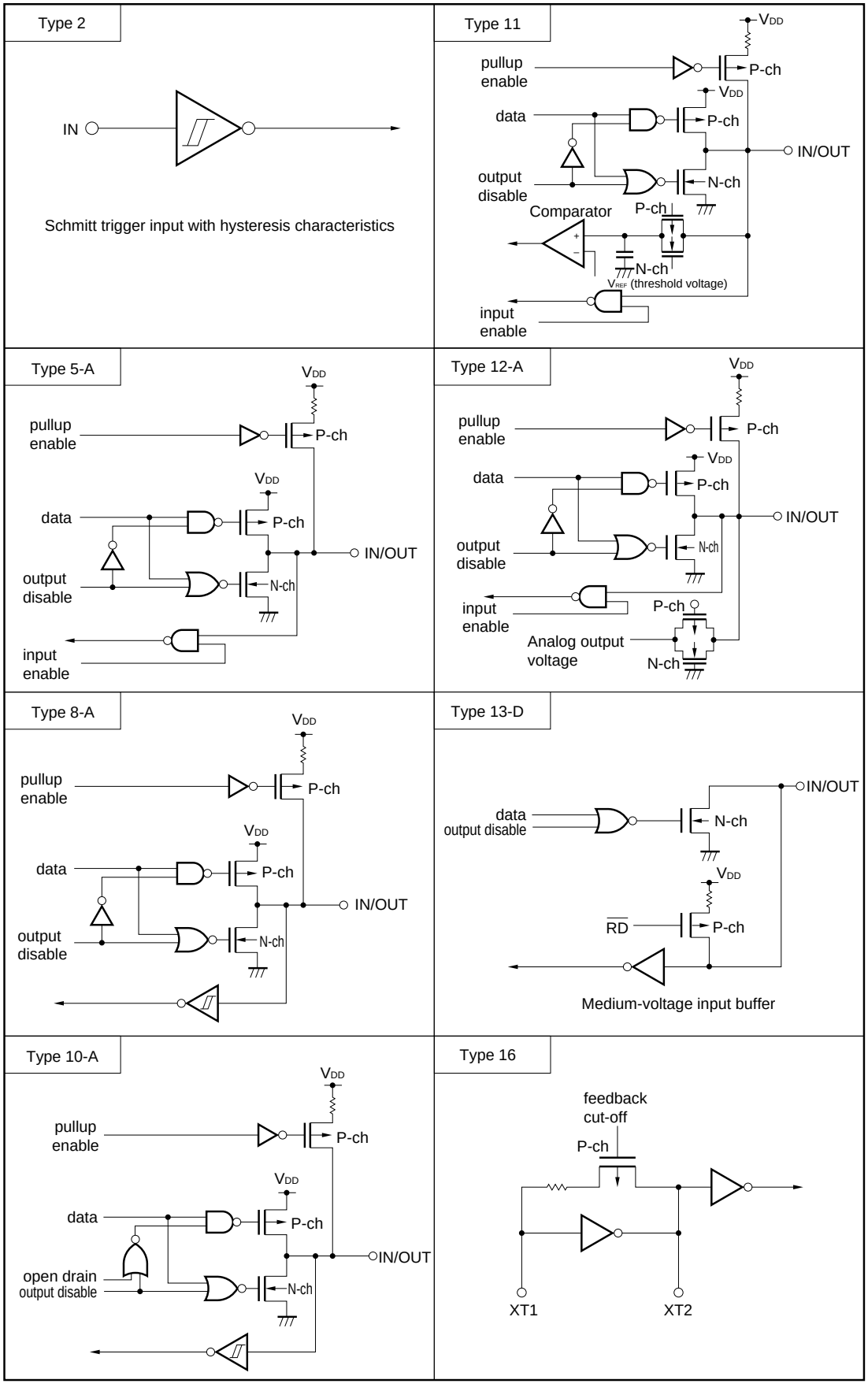
Pin Name	I/O Circuit Type	I/O	Recommended Connections of Unused Pins
P00/INTP0	8-A	I/O	Input : Individually connected to V_{SS} via resistor Output: Open
P01/INTP1			
P02/INTP2/NMI			
P03/INTP3-P06/INTP6			
P10/ANI0-P17/ANI7	11	Input	Connected to V_{SS} or V_{DD}
P20/RxD1/SI1	10-A	I/O	Input : Individually connected to V_{SS} via resistor Output: Open
P21/TxD1/SO1			
P22/ASCK1/$\overline{SCK1}$			
P23/PCL			
P24/BUZ			
P25/SDA0/SI0			
P26/SO0			
P27/SCL0/$\overline{SCK0}$			
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/$\overline{RD}$			
P65/$\overline{WR}$			
P66/$\overline{WAIT}$			
P67/ASTB			
P70/RxD2/SI2	8-A		
P71/TxD2/SO2			
P72/ASCK2/$\overline{SCK2}$			
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			
P130/ANO0, P131/ANO1	12-A		

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
$\overline{\text{RESET}}$	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 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
μPD784214Y	0F100H-0FFFFH	00000H-0F0FFH 10000H-17FFFH
μPD784215Y	0EB00H-0FFFFH	00000H-0EAFFH 10000H-1FFFFH
μPD784216Y	0DF00H-0FFFFH	00000H-0DEFFH 10000H-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
μPD784214Y	0F100H-0FFFFH (3840 Bytes)
μPD784215Y	0EB00H-0FFFFH (5376 Bytes)
μPD784216Y	0DF00H-0FFFFH (8448 Bytes)

- **External memory**

  The external memory is accessed in external memory expansion mode.

(2) When LOCATION 0FH instruction is executed

- **Internal memory**

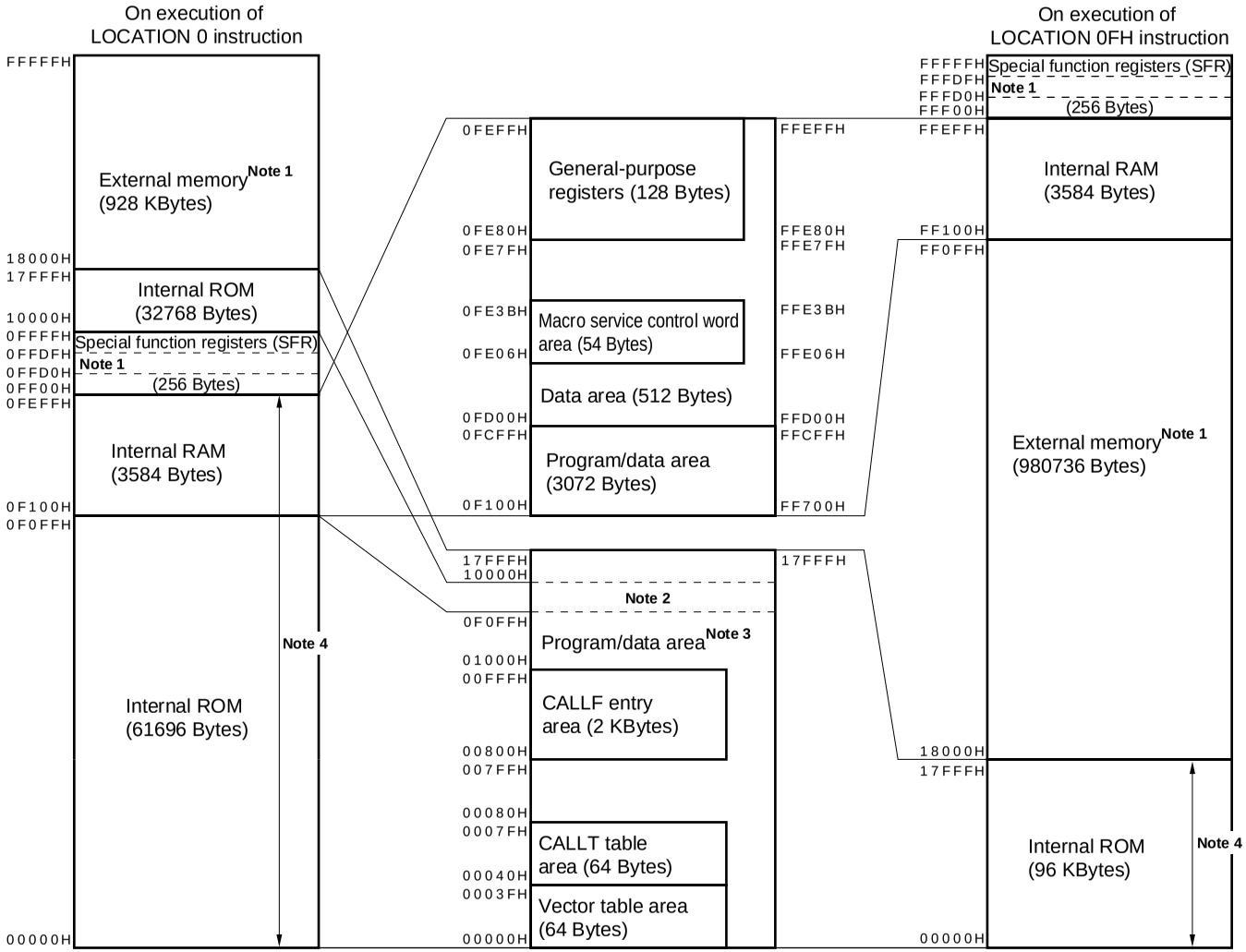
  The internal data area and internal ROM area are mapped as follows:

Part Number	Internal Data Area	Internal ROM Area
μPD784214Y	FF100H-FFFFFH	00000H-17FFFH
μPD784215Y	FEB00H-FFFFFH	00000H-1FFFFH
μPD784216Y	FDF00H-FFFFFH	00000H-1FFFFH

- **External memory**

  The external memory is accessed in external memory expansion mode.

Figure 6-1. Memory Map of μPD784214Y



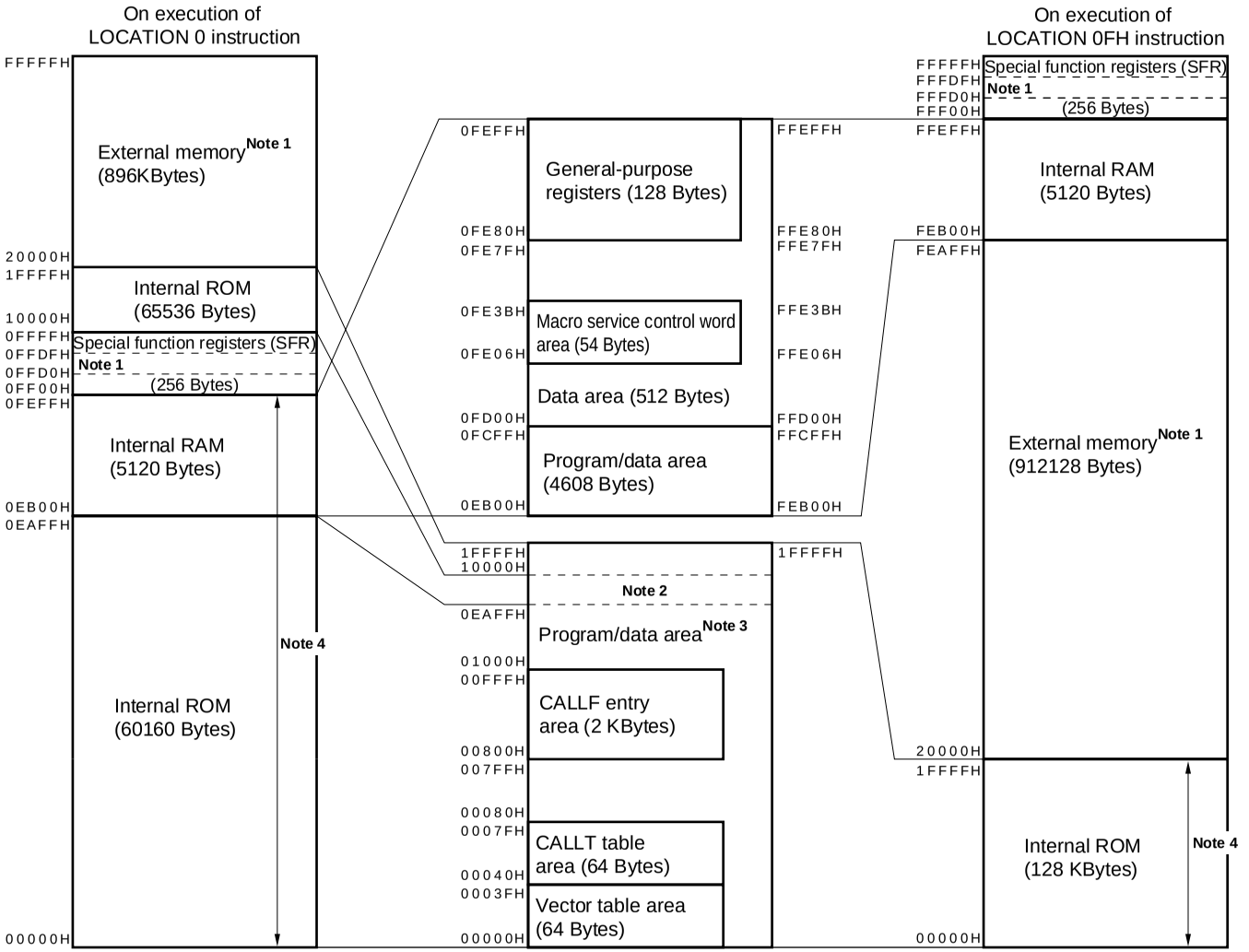
Notes 1. Accessed in external memory expansion mode.

2. This 3840-Byte area can be used as an internal ROM only when the LOCATION 0FH instruction is executed.

3. On execution of LOCATION 0 instruction: 94464 Bytes, on execution of LOCATION 0FH instruction: 98304 Bytes

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

Figure 6-2. Memory Map of μPD782157Y



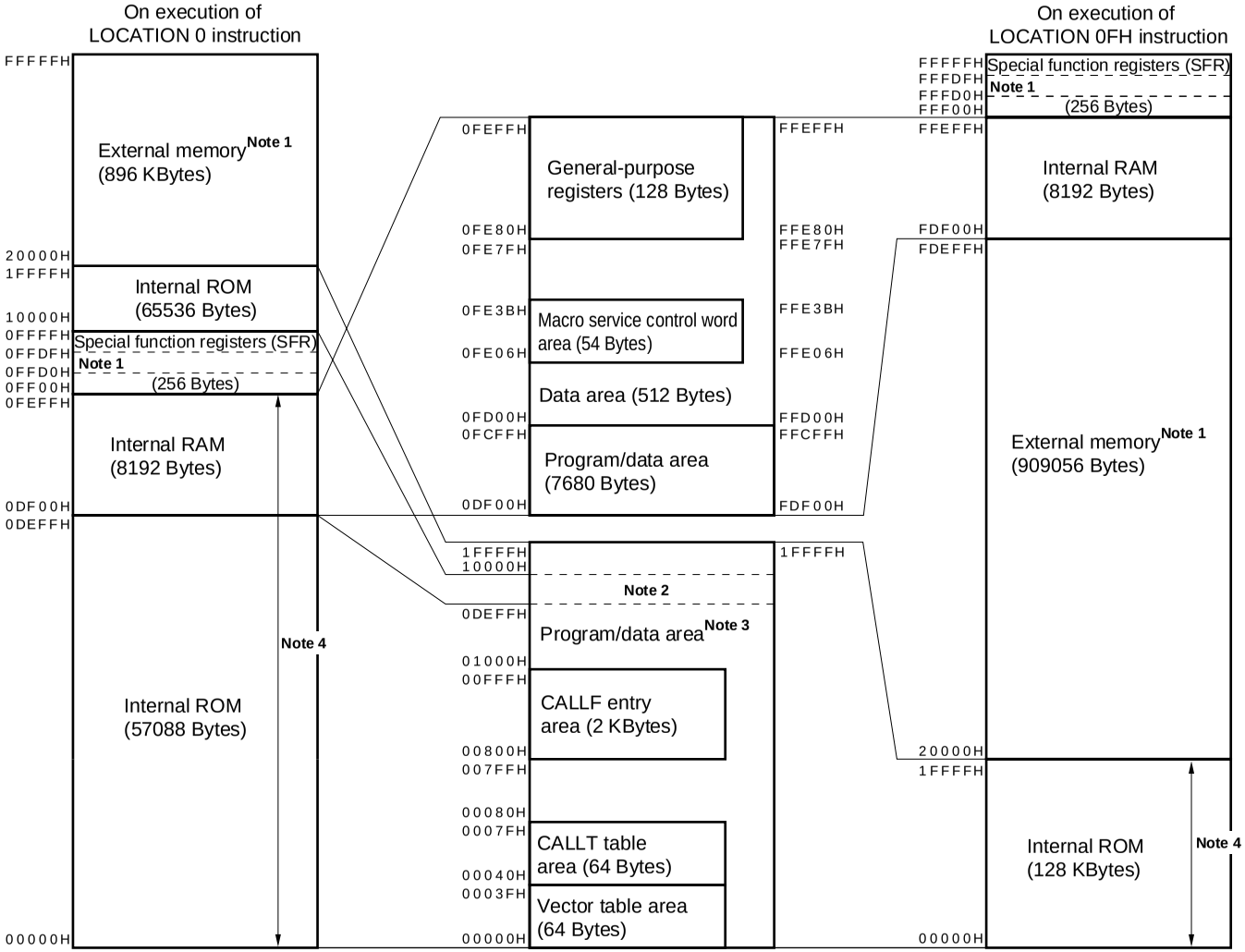
Notes 1. Accessed in external memory expansion mode.

2. This 5376-Byte area can be used as an internal ROM only when the LOCATION 0FH instruction is executed.

3. On execution of LOCATION 0 instruction: 125696 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.

Figure 6-3. Memory Map of μPD784216Y



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

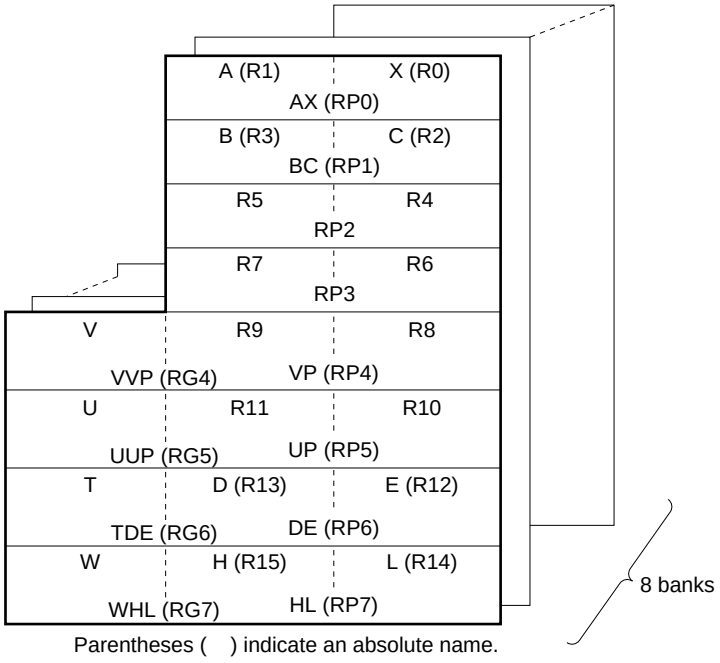
6.2.1 General-purpose registers

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 registers 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



Parentheses ( ) indicate an absolute name.

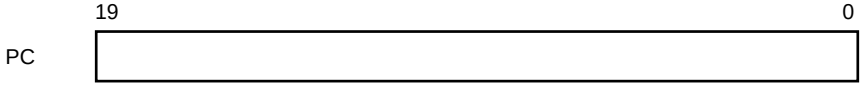
Caution Registers R4, R5, R6, R7, RP2, and RP3 can be used as X, A, C, B, AX, and BC registers, respectively, by setting the RSS bit of the PSW to 1. However, use this function only for recycling the program of the 78K/III Series.

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

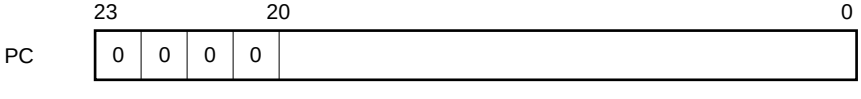
		15	14	13	12	11	10	9	8
PSW	PSWH	UF	RBS2	RBS1	RBS0	–	–	–	–
		7	6	5	4	3	2	1	0
	PSWL	S	Z	RSS[Note]	AC	IE	P/V	0	CY

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 μPD784216Y may be in the deadlock status. This deadlock status can be cleared only by inputting the $\overline{\text{RESET}}$ 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 $\overline{\text{RESET}}$ 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		○	○	—	
oFFoCH	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		○	○	—	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		○	○	○	
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			○	○	—	00H
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.

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	MK0	○	○	○	FFFFH
0FFADH	Interrupt mask flag register 0H	MK0H		○	○		
0FFAEH	Interrupt mask flag register 1L	MK1L	MK1	○	○	○	
0FFAFH	Interrupt mask flag register 1H	MK1H		○	○		
0FFB0H	I^2C bus control register	IICCL0		○	○	—	00H
0FFB2H	Prescaler mode register for serial clock	SPRM0		—	○	—	
0FFB4H	Slave address register	SVA0		○	○	—	

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	
0FFB6H	I^2C bus status register	IICS0	R/W	○	○	—	00H
0FFB8H	Serial shift register	IIC0		○	○	—	
0FFC0H	Standby control register	STBC		—	○	—	30H
0FFC2H	Watchdog timer mode register	WDM		—	○	—	00H
0FFC4H	Memory expansion mode register	MM		○	○	—	20H
0FFC7H	Programmable wait control register 1	PWC1		—	○	—	AAH
00FFCEH	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 (INTIIC0/INTCSI0)	CSIC0		○	○	—	
0FFE9H	Interrupt control register (INTSER1)	SERIC1		○	○	—	
0FFEAH	Interrupt control register (INTSR1/INTCSI1)	SRIC1		○	○	—	
0FFEBH	Interrupt control register (INTST1)	STIC1		○	○	—	
0FFECH	Interrupt control register (INTSER2)	SERIC2		○	○	—	
0FFEDH	Interrupt control register (INTSR2/INTCSI2)	SRIC2		○	○	—	
0FFEEH	Interrupt control register (INTST2)	STIC2		○	○	—	
0FFEFH	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

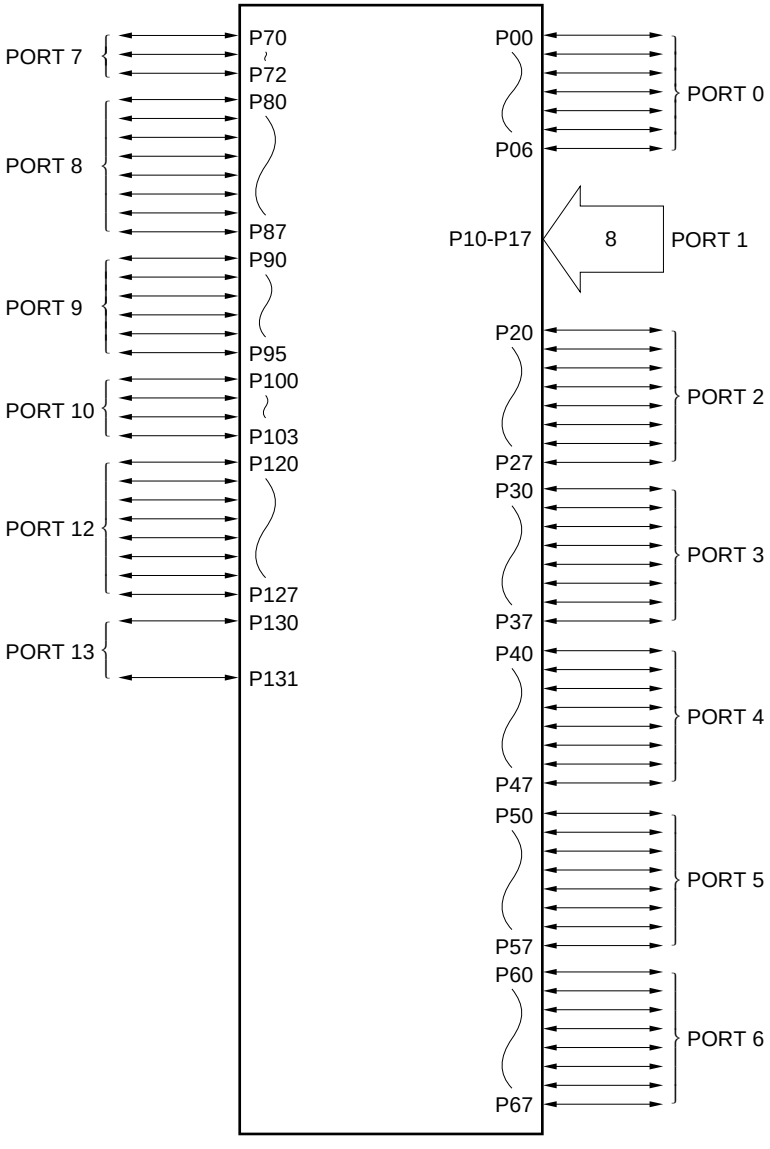


Table 7-1. Port Functions

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

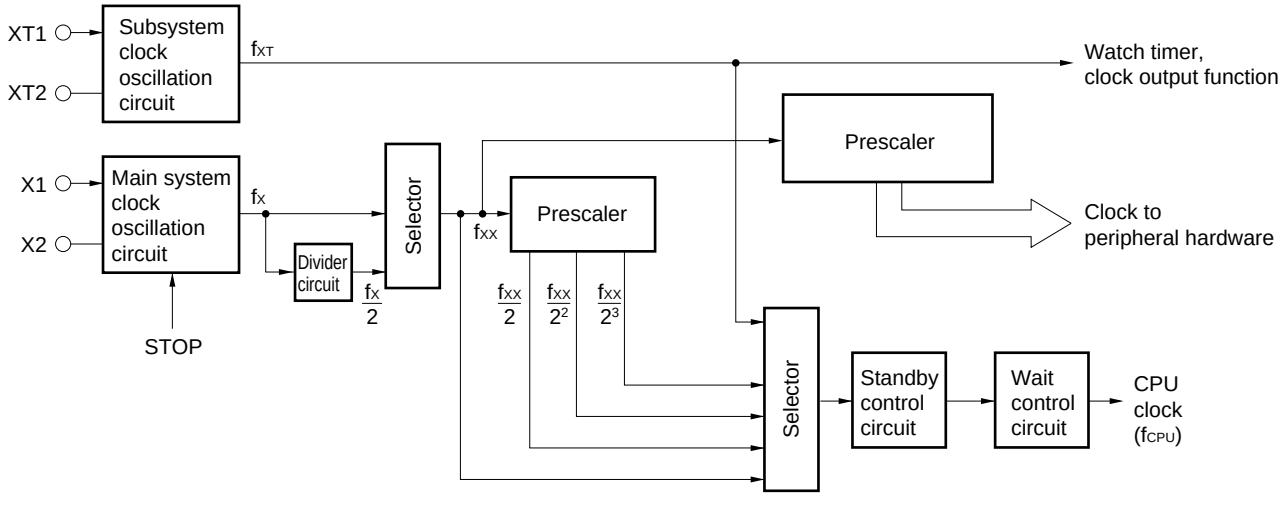
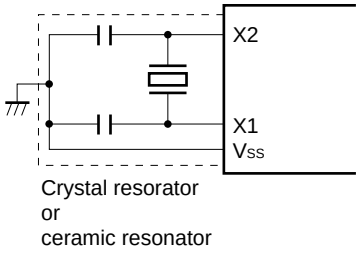


Figure 7-3. Example of Using Main System Clock Oscillation Circuit

(1) Crystal/ceramic oscillation



(2) External clock

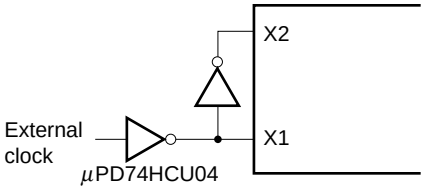
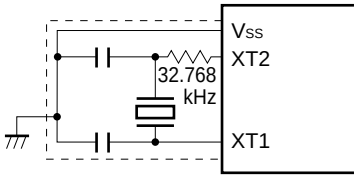
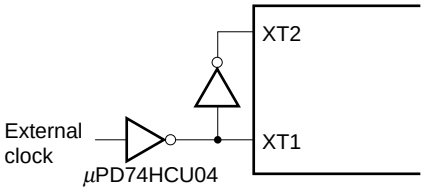


Figure 7-4. Example of Using Subsystem Clock Oscillation Circuit

(1) Crystal oscillation



(2) External clock



Caution When using the main system clock and subsystem clock oscillation circuit, 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 V_{SS}. Do not ground to a ground pattern through which a high current flows.**
- **Do not extract signals from the oscillation circuit.**

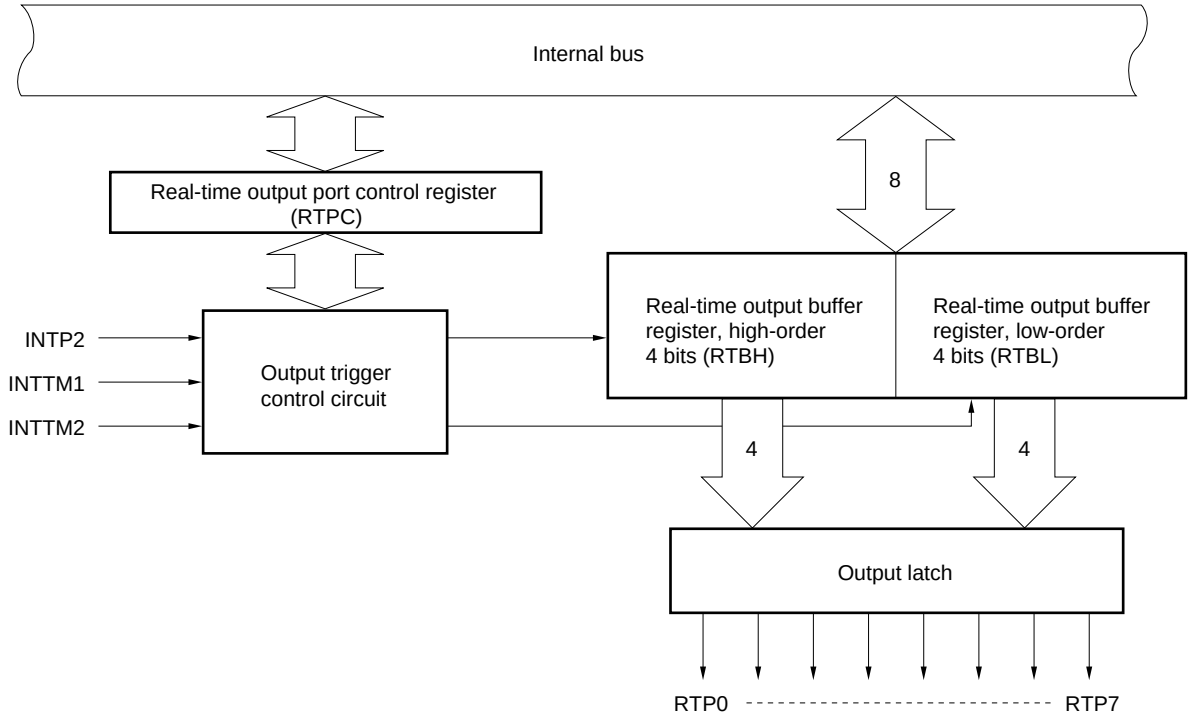
Note that the subsystem clock oscillation circuit has a low amplification factor to reduce the current consumption.

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 timers/counters are provided.

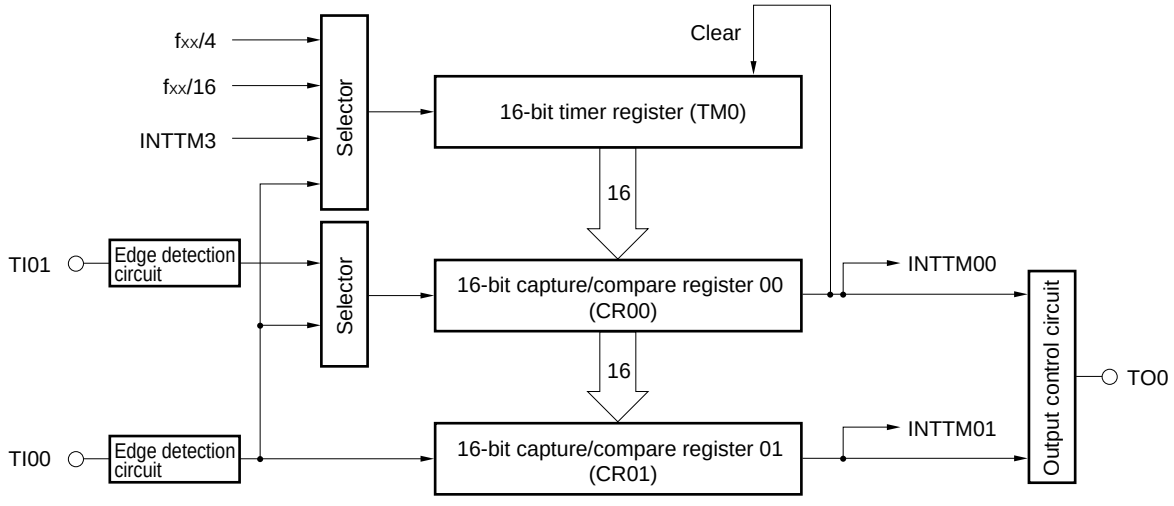
Because a total of eight interrupt requests are supported, these timers/counters and timer can be used as eight units of timers/counters.

Table 7-2. Operations of Timers/Counters

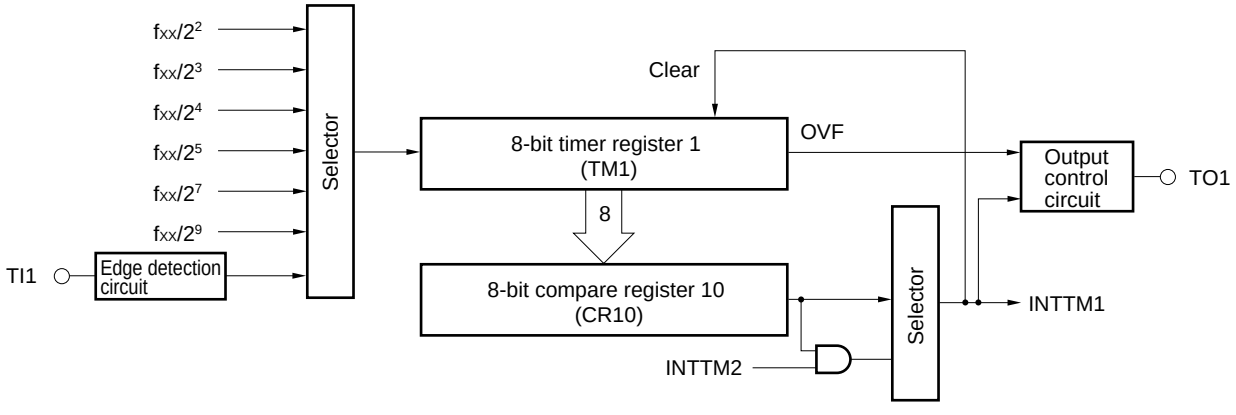
Item \ Name		16-Bit Timer/ Counter	8-Bit Timer/ Counter 1	8-Bit Timer/ Counter 2	8-Bit Timer/ Counter 5	8-Bit Timer/ Counter 6	8-Bit Timer/ Counter 7	8-Bit Timer/ Counter 8
Count width	8 bits	—	○	○	○	○	○	○
	16 bits	○	○		○		○	
Operation mode	Interval timer	1ch	1ch	1ch	1ch	1ch	1ch	1ch
	External event counter	○	○	○	○	○	○	○
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)

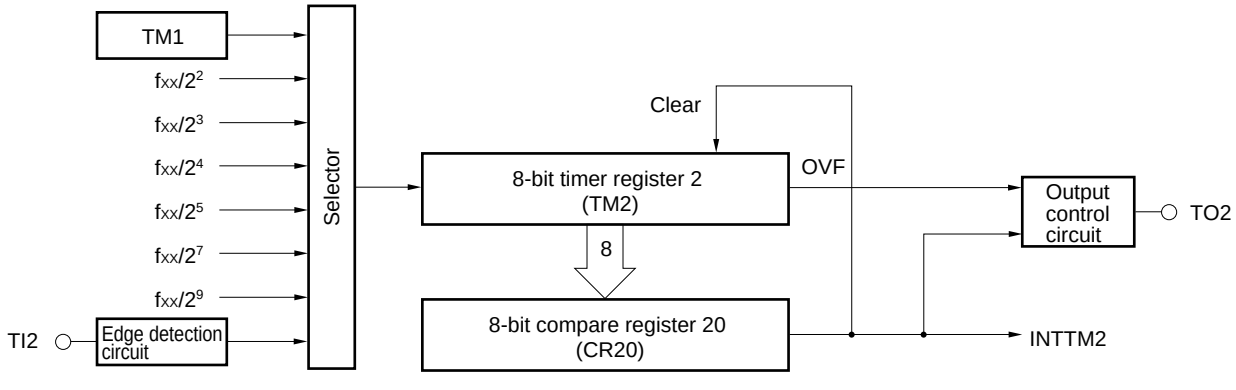
16-bit timer/counter



8-bit timer/counter 1



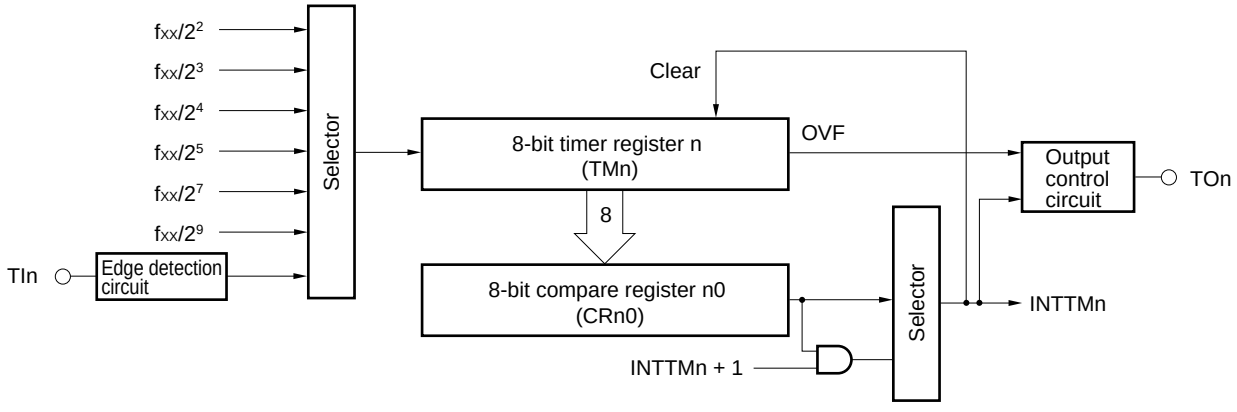
8-bit timer/counter 2



Remark OVF: overflow flag

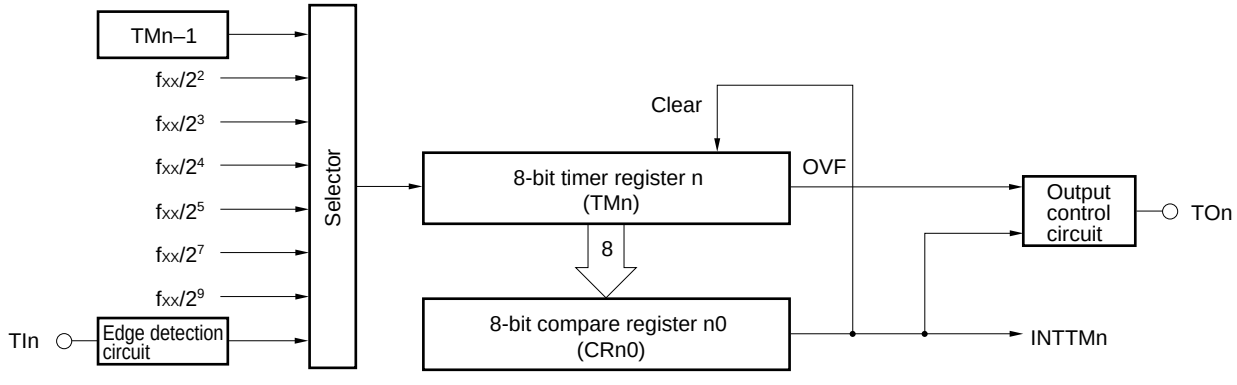
Figure 7-6. Block Diagram of Timers/Counters (2/2)

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).

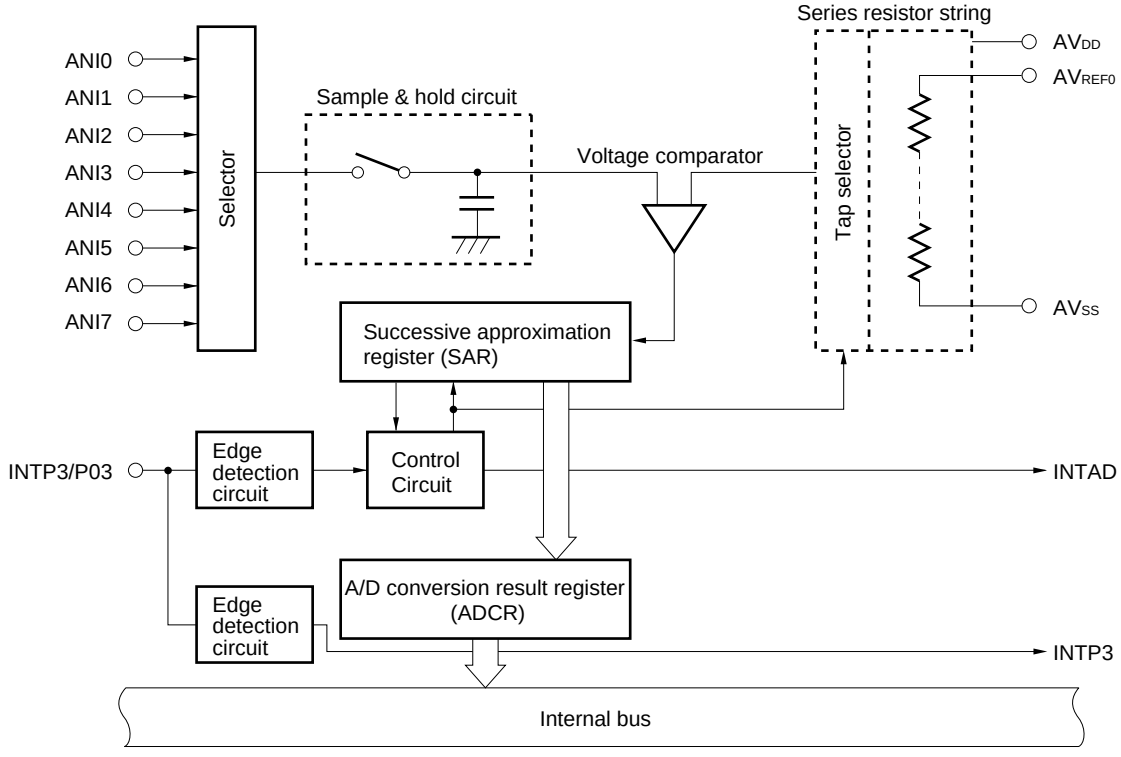
This A/D converter is of successive approximation type and the result of conversion is stored to an 8-bit A/D conversion result register (ADCR).

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.

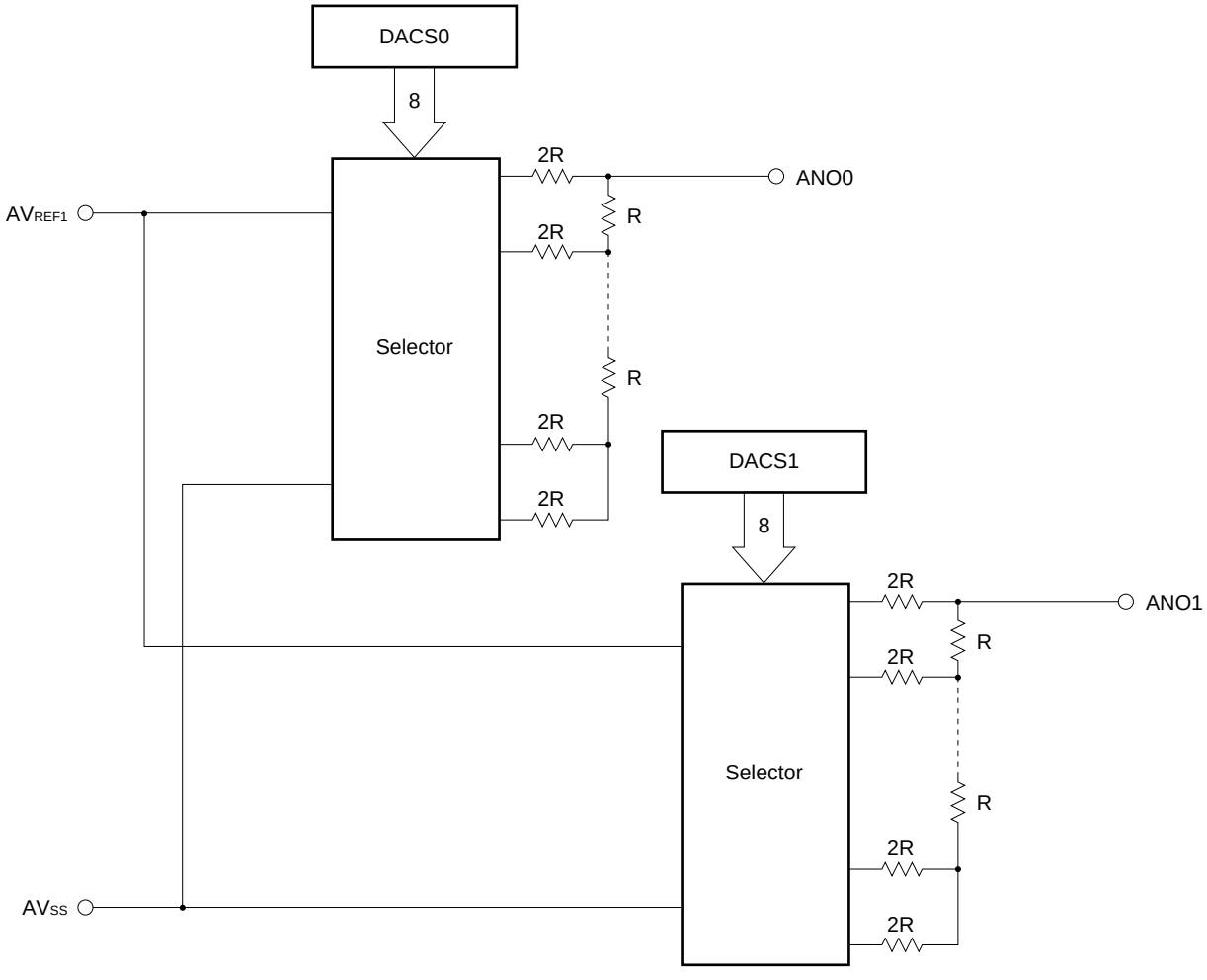
The conversion method is of R-2R resistor ladder type.

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

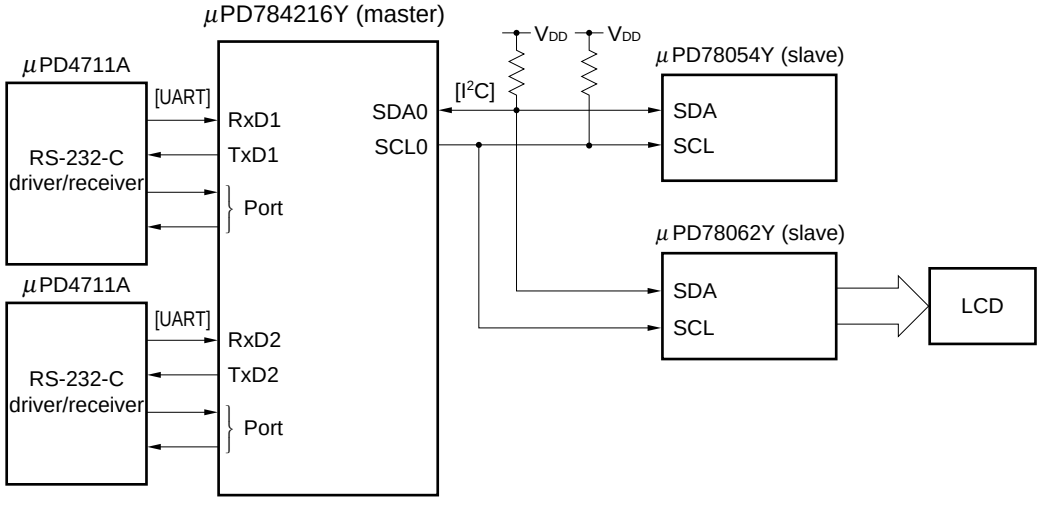
Three independent serial interface channels are provided.

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

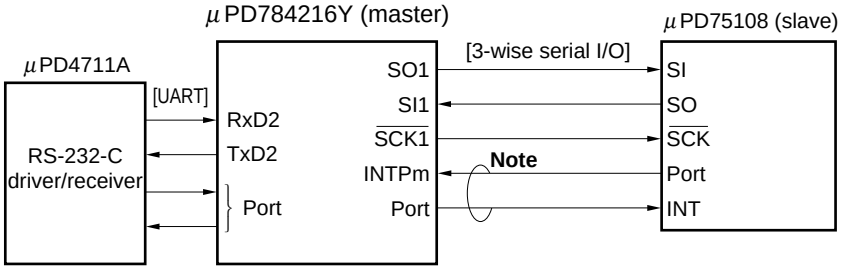
Therefore, communication with an external system and local communication within the system can be simultaneously executed (refer to **Figure 7-9**).

Figure 7-9. Example of Serial Interface

(a) UART + I^2C



(b) UART + 3-wire serial I/O



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

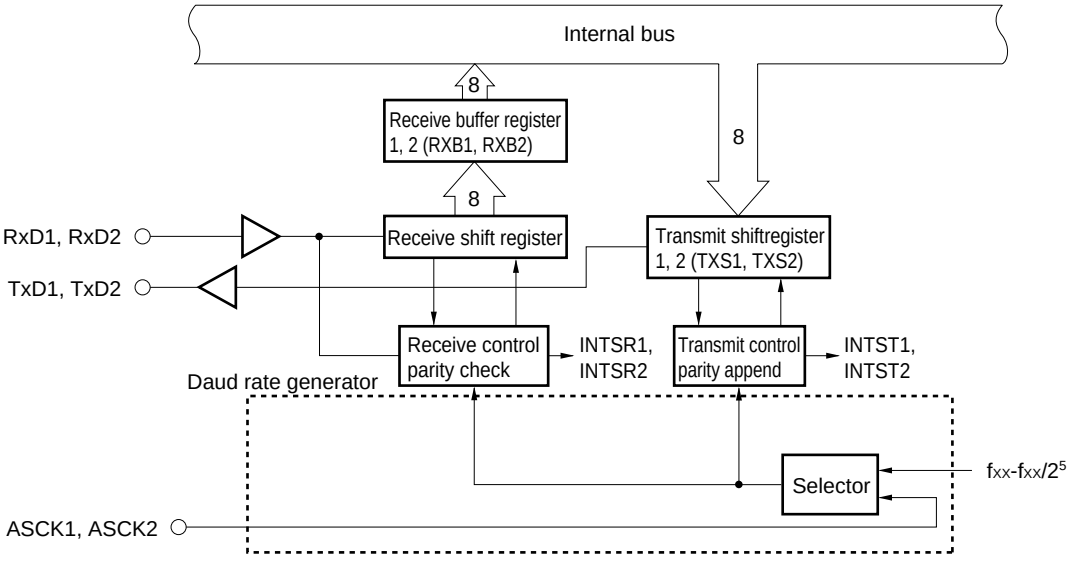
In this mode, data of 1 byte following the start bit is transferred or received.

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

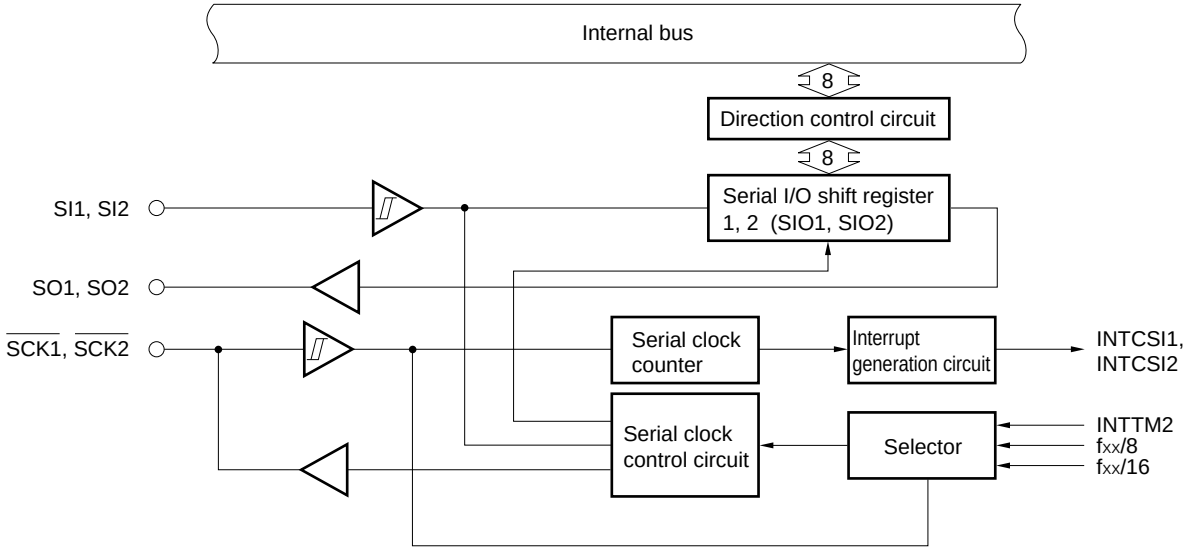


(2) 3-wire serial I/O mode

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

This mode is used to communicate with a device having the conventional clocked serial interface. Basically, communication is established by using three lines: serial clocks ($\overline{SCK1}$ and $\overline{SCK2}$), serial data inputs (SI1 and SI2), and serial data outputs (SO1 and SO2). To connect two or more devices, a handshake line is necessary.

Figure 7-11. Block Diagram in 3-wire Serial I/O 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.

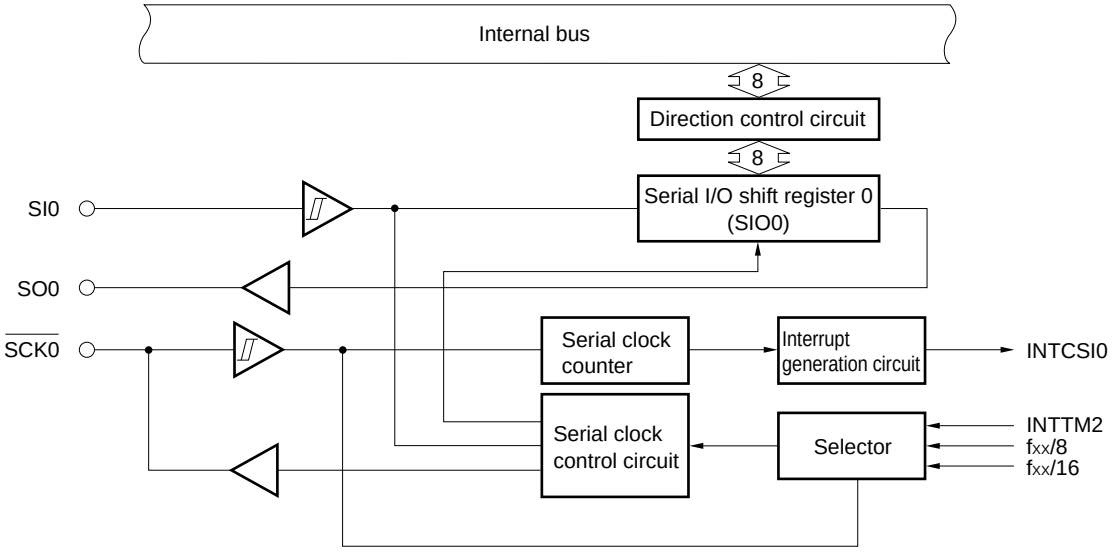
(1) 3-wire serial I/O mode

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 ($\overline{SCK0}$) 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-Wise Serial I/O Mode



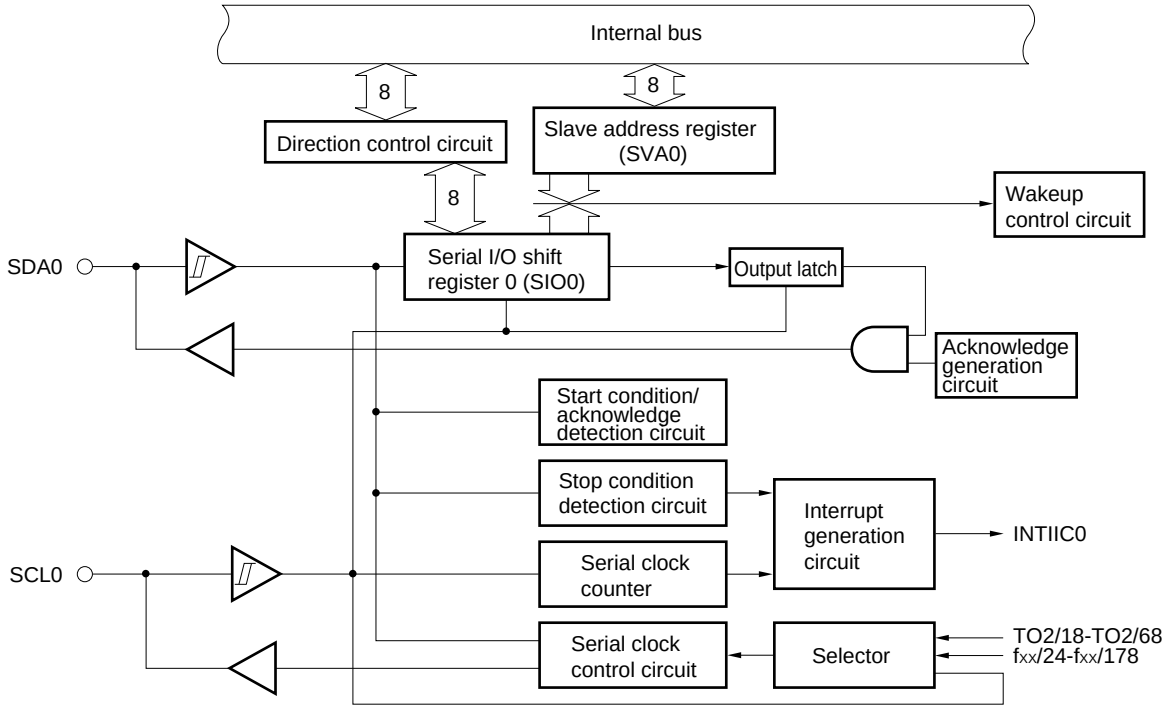
(2) I^2C (Inter IC) bus mode

This mode is to communicate with devices conforming to the I^2C bus format.

This mode is to transfer 8-bit data with two or more devices by using two lines: serial clock (SCL0) and serial data bus (SDA0).

During transfer, a “start condition”, “data”, and “stop condition” can be output onto the serial data bus. During reception, these data can be automatically detected by hardware.

Figure 7-13. Block Diagram in I²C Bus Mode

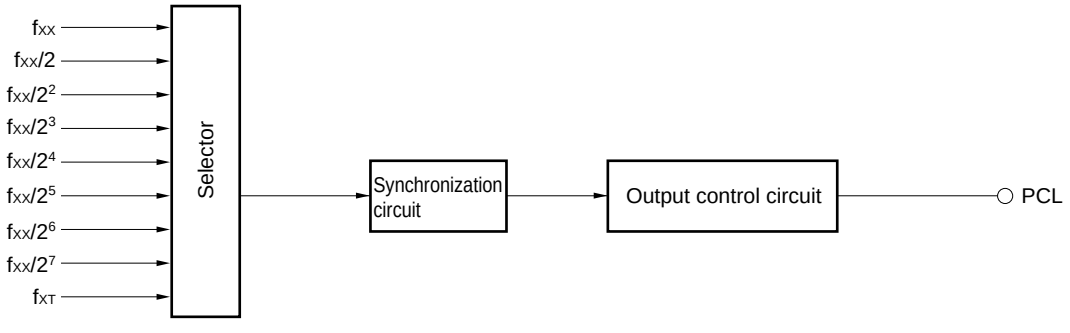


7.8 Clock Output Function

Clocks of the following frequencies can be 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 7-14. Block Diagram of Clock Output Function

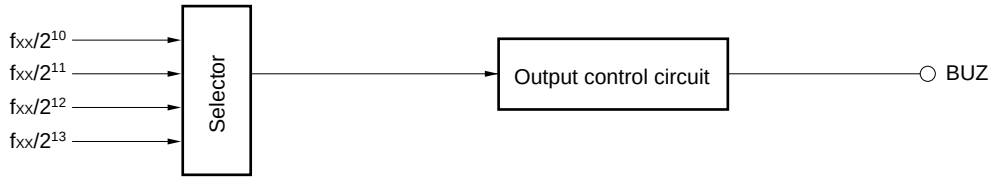


7.9 Buzzer Output Function

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 7-15. 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.

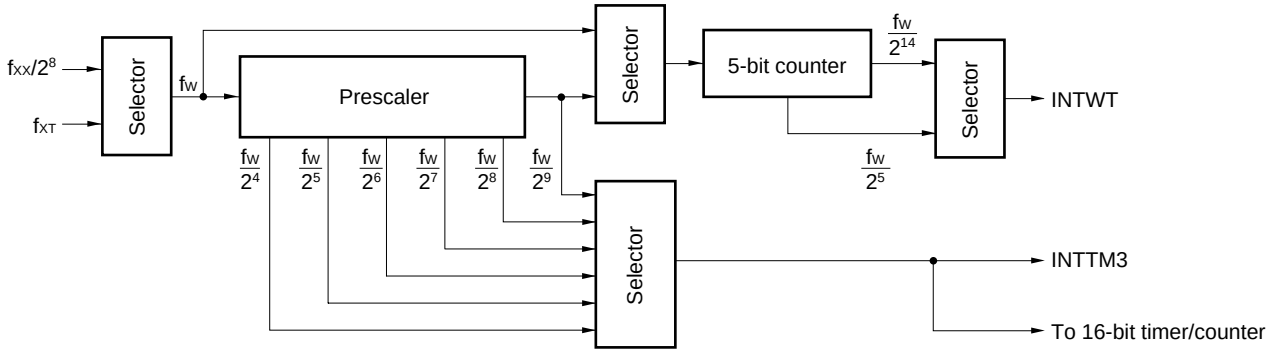
(1) Watch timer

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.

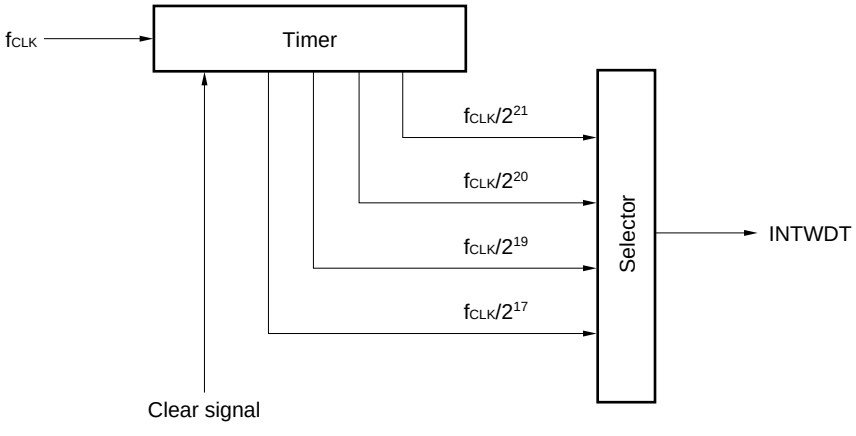
Figure 7-16. Block Diagram of Watch Timer



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 7-17. 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, 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 request, 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	—	—
		Operand error	If result of exclusive OR between operands byte and $\overline{\text{byte}}$ is not FFH when MOV STBC, #byte or MOV WDM, #byte 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	INTIIC0	End of I^2C bus transfer by CSI0	Internal	
		INTCSI0	End of 3-wire transfer by CSI0		
	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 transfer 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 transfer 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 timer/counter 1	Occurrence of coincidence signal of 8-bit		
	19	INTTM2 timer/counter 2	Occurrence of coincidence signal of 8-bit		
	20	INTAD	End of conversion by A/D converter		
	21	INTTM5 timer/counter 5	Occurrence of coincidence signal of 8-bit		
	22	INTTM6 timer/counter 6	Occurrence of coincidence signal of 8-bit		
	23	INTTM7 timer/counter 7	Occurrence of coincidence signal of 8-bit		
	24	INTTM8 timer/counter 8	Occurrence of coincidence signal of 8-bit		
	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

8.2 Vectored Interrupt

Execution branches to a servicing routing 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

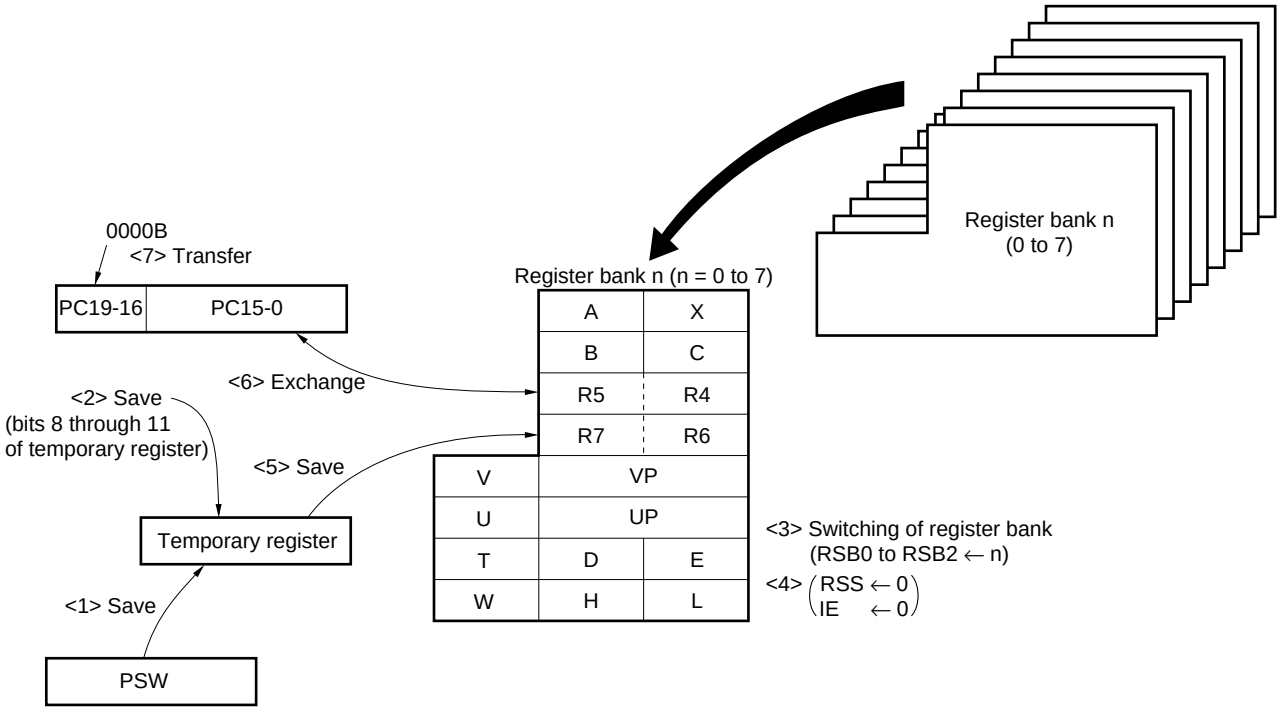
Interrupt Source	Vector Table Address	Interrupt Source	Vector Table Address
BRK instruction	003EH	INTST1	001CH
Operand error	003CH	INTSER2	001EH
NMI	0002H	INSR2	0020H
INTWDT (non-maskable)	0004H	INTCSI2	
INTWDT (maskable)	0006H	INTST2	0022H
INTP0	0008H	INTTM3	0024H
INTP1	000AH	INTTM00	0026H
INTP2	000CH	INTTM01	0028H
INTP3	000EH	INTTM1	002AH
INTP4	0010H	INTTM2	002CH
INTP5	0012H	INTAD	002EH
INTP6	0014H	INTTM5	0030H
INTIIC0	0016H	INTTM6	0032H
INTCSI0		INTTM7	0034H
INTSER1	0018H	INTTM8	0036H
INTSR1	001AH	INTWT	0038H
INTCSI1		INTKR	003AH

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

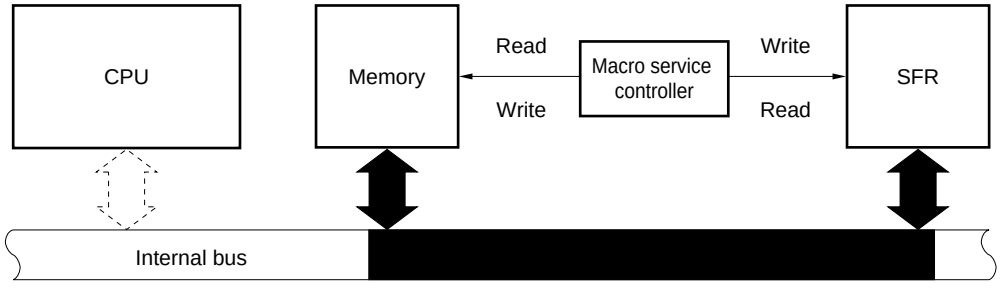


8.4 Macro Service

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.

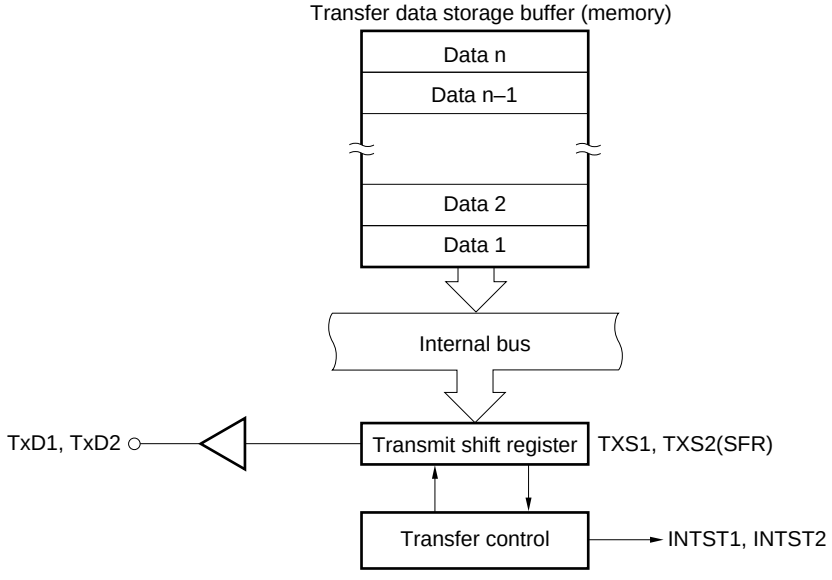
Because this function does not save or restore the status of the CPU, or load data, data can be transferred at high speeds.

Figure 8-2. Macro Service



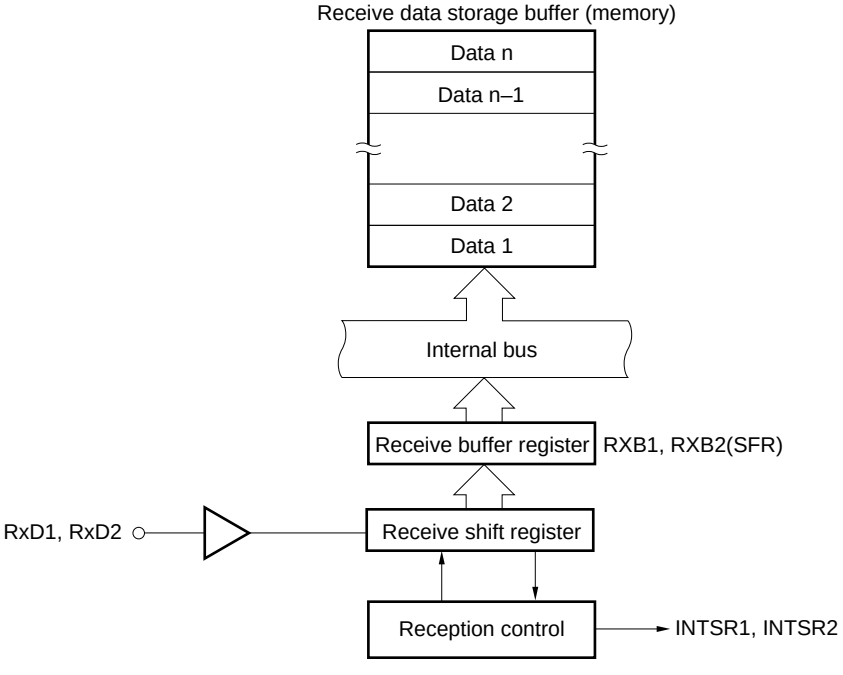
8.5 Application Example of Macro Service

(1) Transmission of serial interface



Each time macro service request 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 request INTST1 and INTST2 are generated.

(2) Reception of serial interface



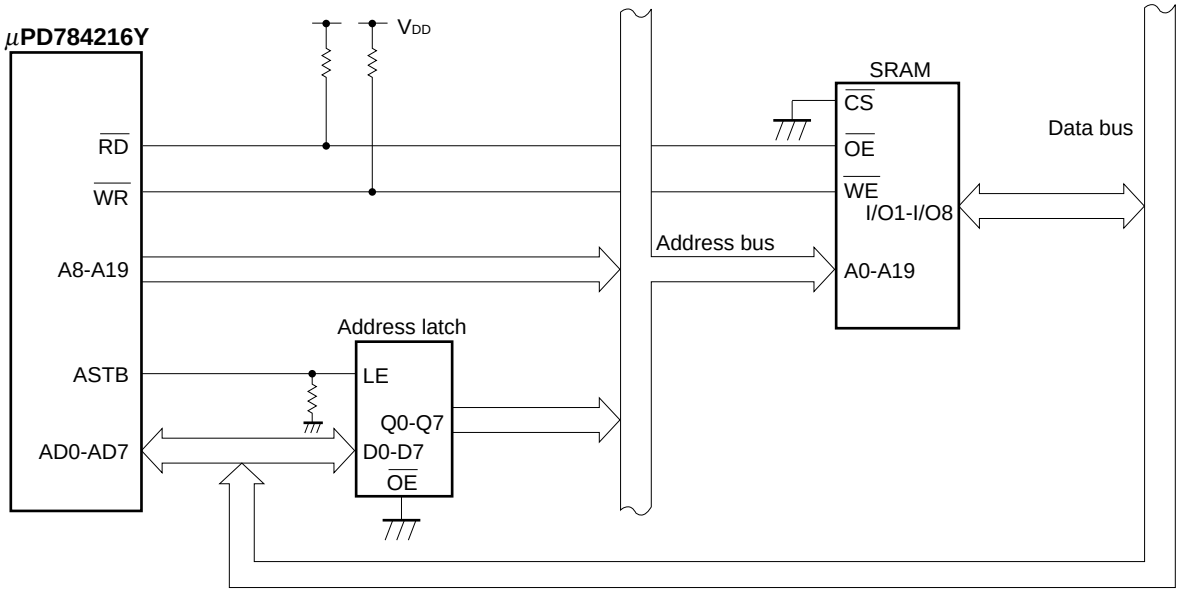
Each time macro service request INTSR1 and INTSR2 are generated, the receive data is transferred from RXB1 and RXB2 to memory. When data n (last byte) has been transferred to memory (when the receive data storage buffer has become full), vectored interrupt request INTSR1 and INTSR2 are generated.

9. LOCAL BUS INTERFACE

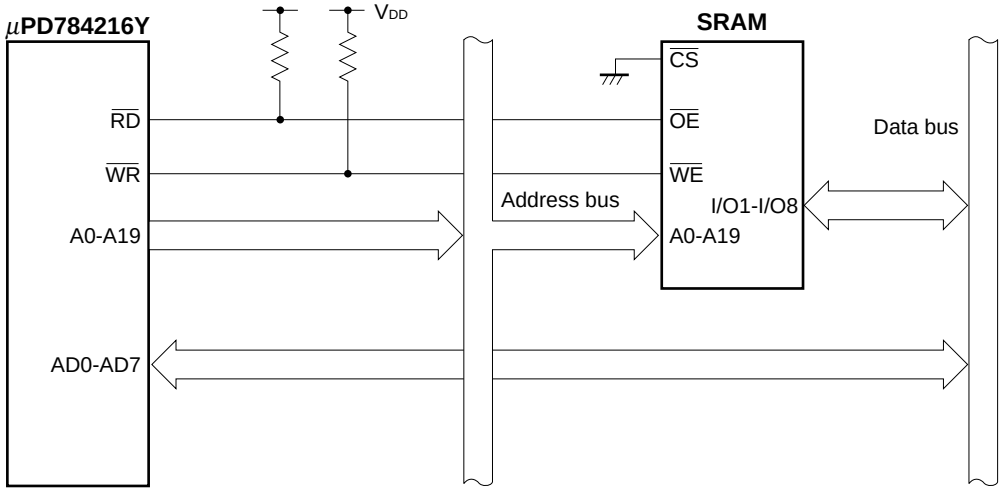
The local bus interface can connect an external memory or I/O (memory mapped I/O) and support a memory space of 1 MByte (refer to **Figure 9-1**).

Figure 9-1. Example of Local Bus Interface

(1) Multiplexed bus mode



(2) Separate bus mode



9.1 Memory Expansion

External program and data memory can be connected in two stages: 256K bytes 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.

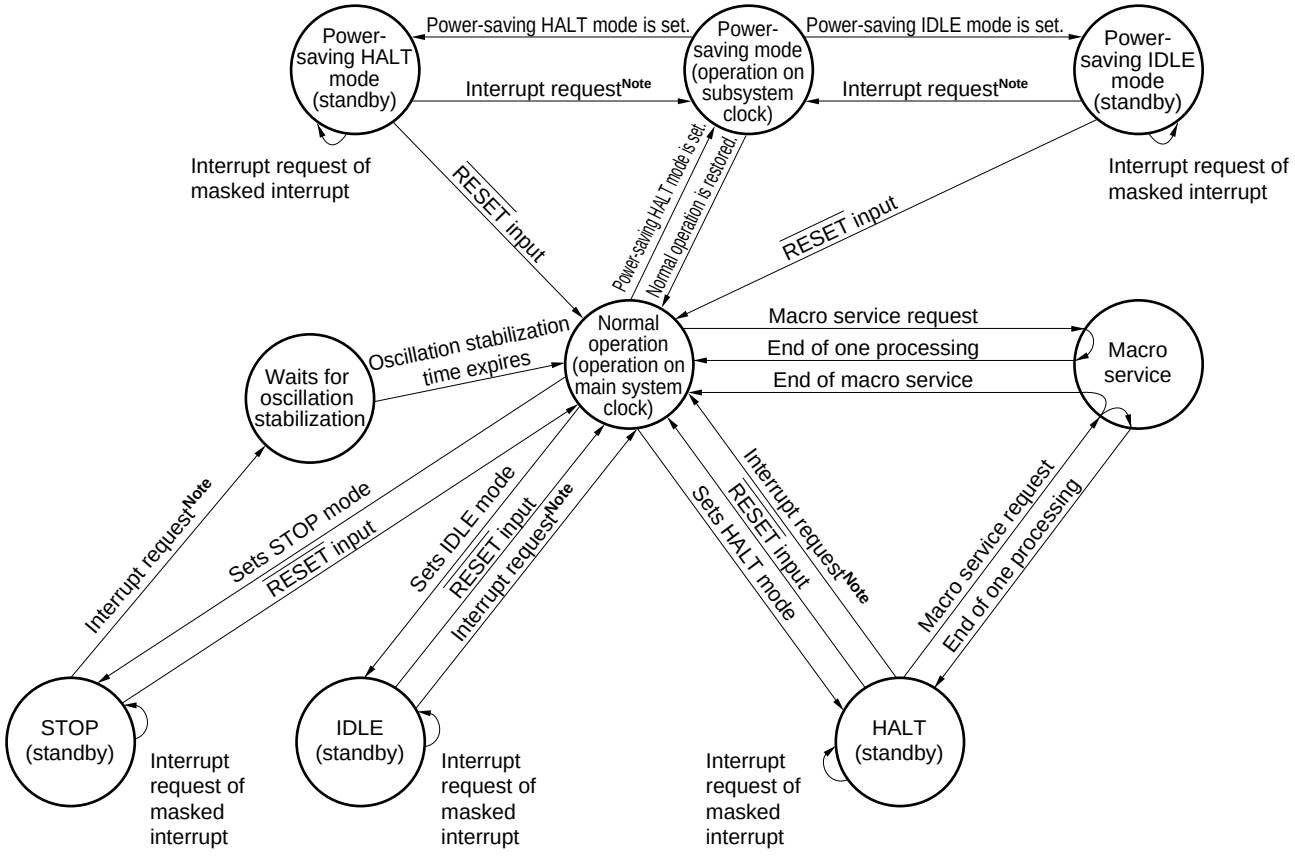
10. STANDBY FUNCTION

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 consumption 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 consumption 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



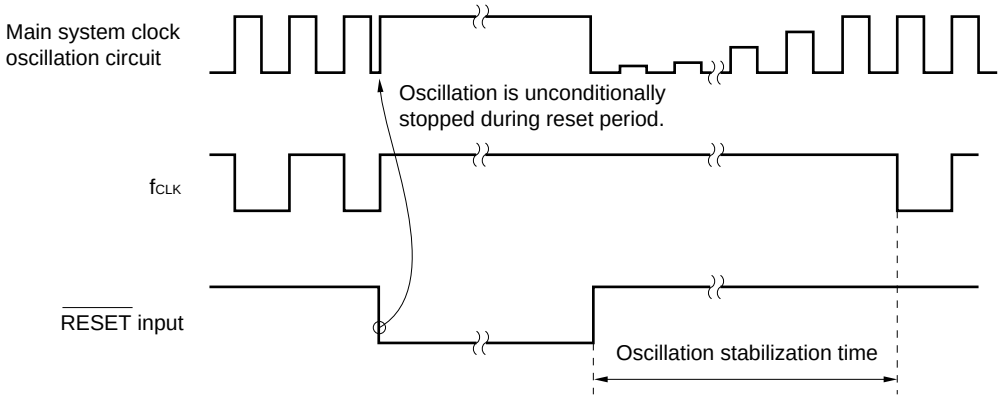
Note Only interrupt requests that are not masked

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.

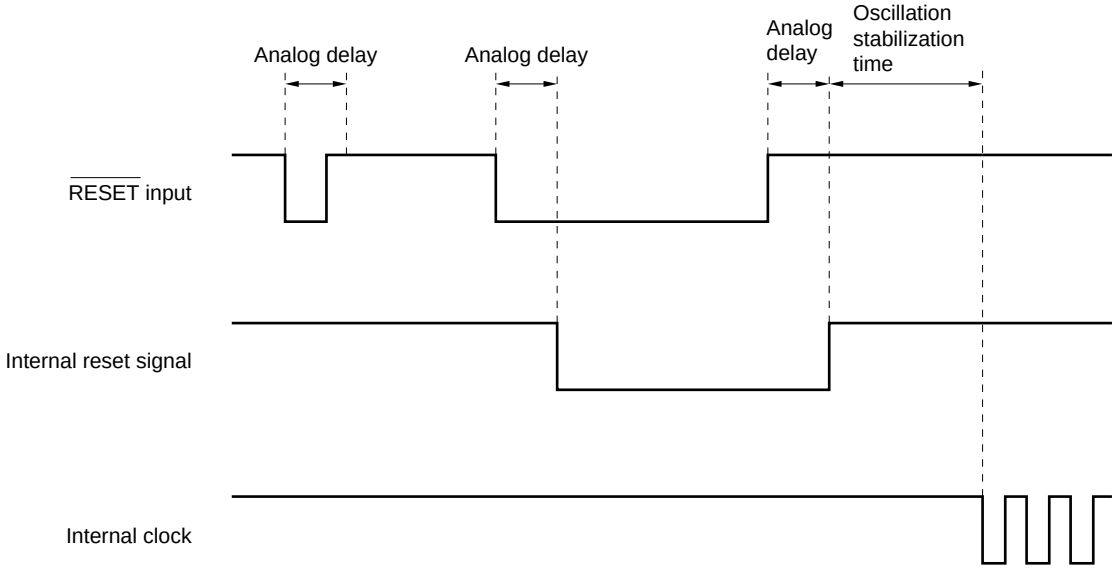
When the $\overline{\text{RESET}}$ signal goes high, the reset status is cleared, oscillation stabilization time (41.9 ms at 12.5 MHz) elapses, the contents of the reset vector table are set to the program counter (PC), execution branches to an address set to the PC, and program execution is started 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, DBNZ, PUSH, POP, MOVM, XCHM, CMPME, CMPMNE, CMPMNC, CMPMC, MOVBK, XCHBK, CMPBKE, CMPBKNE, CMPBKNC, CMPBKC, CHIKL, CHKLA

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

First Operand \ Second Operand	#byte	A	r r'	saddr saddr'	sfr	!addr16 !!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 6] (XCH)[Note 6] (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 6] (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
!addr16 !!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] MOVM[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 XCHM, CMPME, CMPMNE, CMPMNC, and CMPMC are the same as that of MOVM.

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, MULUW, 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

First Operand \ Second 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 1,3]	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 MULUW 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

First Operand \ Second Operand	#imm24	WHL	rg rg'	saddrg	!!addr24	mem1	[%saddrg]	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
saddrg		(MOVG)	MOVG						
!!addr24		(MOVG)	MOVG						
mem1		MOVG							
[%saddrg]		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. Bit Manipulation Instructions

First Operand \ Second 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, BNV, BPO, BV, BPE, BP, BN, BLT, BGE, BLE, BGT, BNH, BH, BF, BT, BTCLR, BFSET, DBNZ

Table 12-5. Call and Return/Branch Instructions

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											

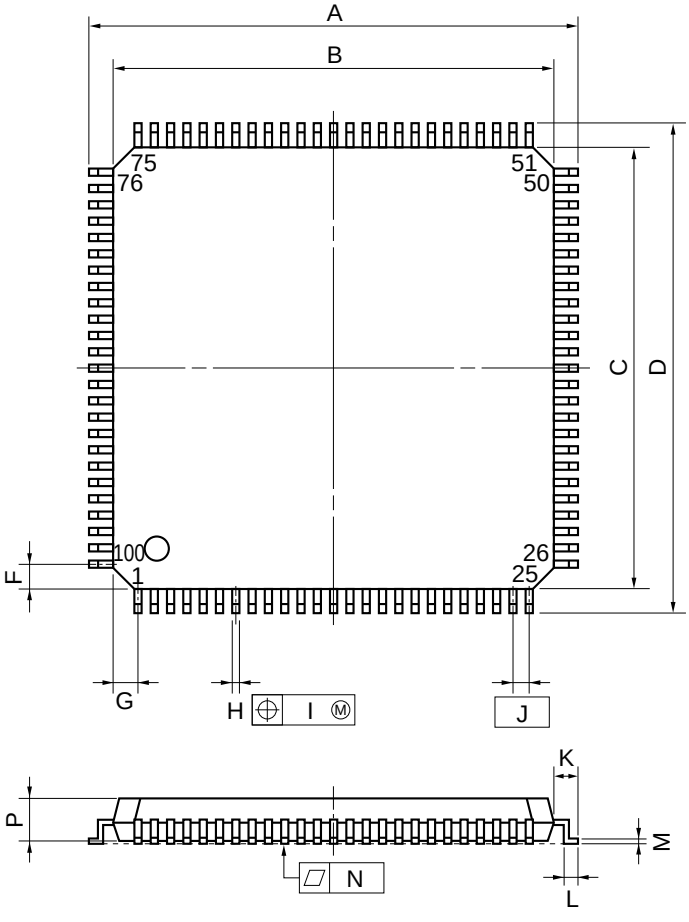
Note The operands of BNZ, BNE, BZ, BE, BNC, BNL, BL, BNV, BPO, BV, BPE, BP, BN, BLT, BGE, BLE, BGT, BNH, and BH are the same as BC.

(6) Other instructions

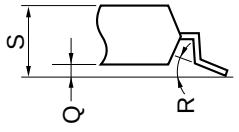
ADJBA, ADJBS, CVTBW, LOCATION, SEL, NOT, EI, DI, SWRS

13. PACKAGE DRAWINGS

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



detail of lead end



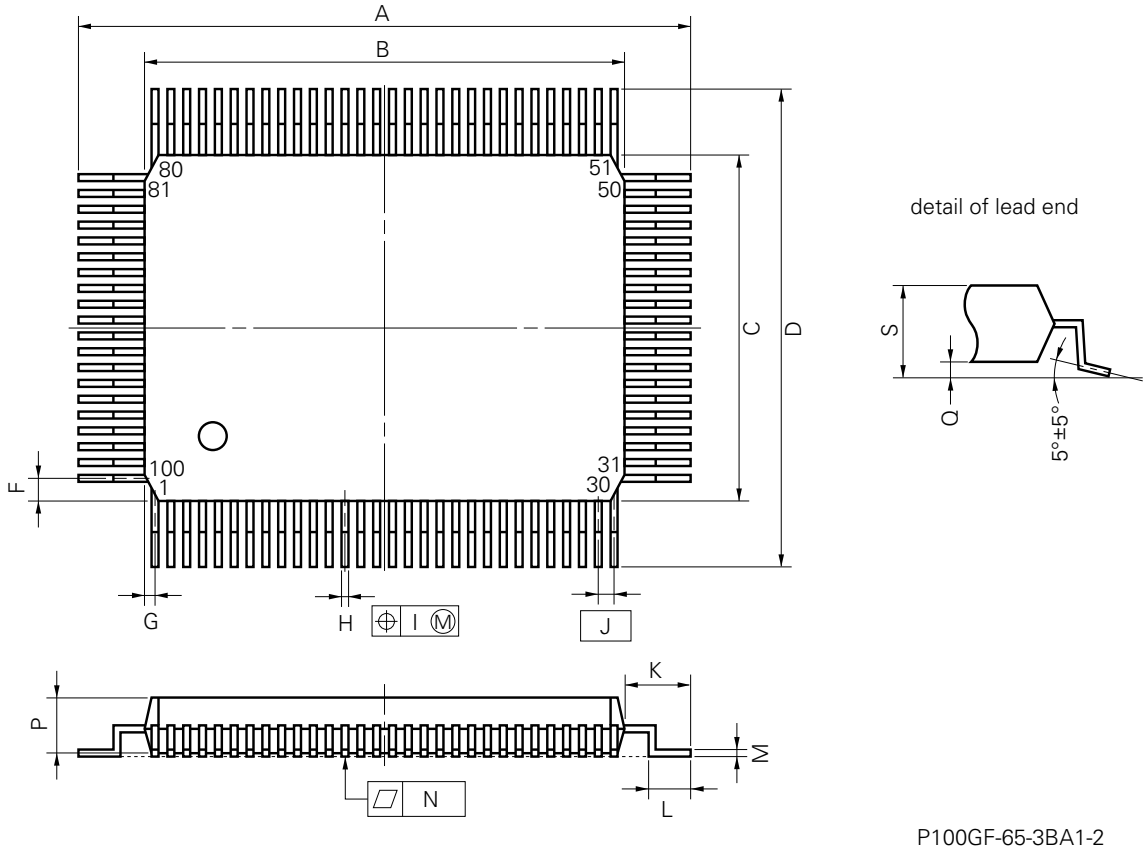
NOTE

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)



P100GF-65-3BA1-2

NOTE

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

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 μPD784216Y.

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

Pending	Dedicated flash writer

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 μPD784216Y 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) (14 × 14 mm) common to μPD784216Y subseries
EP-78064GF-R	Emulation probe for 100-pin plastic QFP (14 × 20 mm) common to μPD784216Y subseries
EV-9500GC-100	Adapter mounted on board of target system created for 100-pin plastic QFP (fine pitch) (14 × 14 mm)
EV-9200GF-100	Socket mounted on board of target system created for 100-pin plastic QFP (14 × 20 mm)
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 μPD784216Y 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
- IMB 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
μPD784214Y, 784215Y, 784216Y Preliminary Product Information	U11725J	This document
μPD78F4216Y Preliminary Product Information	Planned	Planned
μPD784216, 784216Y Subseries User's Manual - Hardware	Planned	Planned
μPD784216Y Subseries Special Function Register Table	Planned	–
78K/IV Series User's Manual - Instruction	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 tools (User's Manuals)

Document Name		Document No.	
		Japanese	English
RA78K Series Assembler Package	Operation	EEU-809	EEU-1399
	Language	EEU-815	EEU-1404
RA78K Series Structured Assembler Preprocessor		EEU-817	EEU-1402
CC78K Series C Compiler	Operation	EEU-656	EEU-1280
	Language	EEU-655	EEU-1284
CC78K Series Library Source File		EEU-777	–
PG-1500 PROM Programmer		EEU-651	EEU-1335
PG-1500 Controller - PC-9800 Series (MS-DOS) Base EEU-704		EEU-1291	
PG-1500 Controller - IBM PC Series (PC DOS) Base		EEU-5008	U10540E
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 component user open interface specification	U10092J	U10092E
ID78K4 Integrated Debugger	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 Semiconductor Device Package Manual	C10943X	
Semiconductor Device Mounting Technology Manual	U10535J	10535E
Quality Grades on NEC Semiconductor Devices	IEI-620	IEI-1209
NEC Semiconductor Device Reliability/Quality Control System	U10983J	U10983E
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	MEI-604	–

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.

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS device behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

Regional Information

Some information contained in this document may vary from country to country. Before using any NEC product in your application, please contact the NEC office in your country to obtain a list of authorized representatives and distributors. They will verify:

- Device availability
- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

In addition, trademarks, registered trademarks, export restrictions, and other legal issues may also vary from country to country.

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Fax: 02-719-5951

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