

## 8-BIT SINGLE-CHIP MICROCONTROLLER

## DESCRIPTION

The  $\mu$ PD78052Y, 78053Y, 78054Y, 78055Y, 78056Y, and 78058Y versions add the I<sup>2</sup>C bus control function to the  $\mu$ PD78052, 78053, 78054, 78055, 78056, and 78058, and are suitable for application in AV products.

Various peripheral hardware such as 8-bit resolution D/A converter, timer, serial interface, real-time output port and interrupt functions are incorporated.

The 78P058Y, a one-time PROM or EPROM version which can be operated in the same supply voltage as for the mask ROM version, and various development tools are also available.

Detailed function descriptions, etc., are provided in the following User's Manual. Be sure to read it when designing.

$\mu$ PD78054, 78054Y Subseries User's Manual : U11747E  
78K/0 Series User's Manual Instructions : U12326E

## FEATURES

- Internal high-capacity ROM and RAM
- External memory expansion space : 64 Kbytes

Part number	Item	Program memory (ROM)	Data memory		
			Internal High-Speed RAM	Internal Buffer RAM	Internal Expanded RAM
$\mu$ PD78052Y		16 Kbytes	512 bytes	32 bytes	No
$\mu$ PD78053Y		24 Kbytes	1024 bytes		
$\mu$ PD78054Y		32 Kbytes			
$\mu$ PD78055Y		40 Kbytes			
$\mu$ PD78056Y		48 Kbytes			
$\mu$ PD78058Y		60 Kbytes			1024 bytes

- Minimum instruction execution time can be varied from high-speed (0.4  $\mu$ s) to ultra-low-speed (122  $\mu$ s)
- I/O ports : 69 (N-ch open-drain : 4)
- 8-bit resolution A/D converter: 8 channels
- 8-bit resolution D/A converter: 2 channels
- Serial interface : 3 channels (I<sup>2</sup>C bus mode : 1 channel)
- Timer : 5 channels
- Supply voltage : V<sub>DD</sub> = 2.0 to 6.0 V

## APPLICATIONS

Cellular phones, pagers, printers, AV equipment, airconditioners, cameras, PPC, fuzzy home appliances, vending machines, etc.

The information in this document is subject to change without notice.

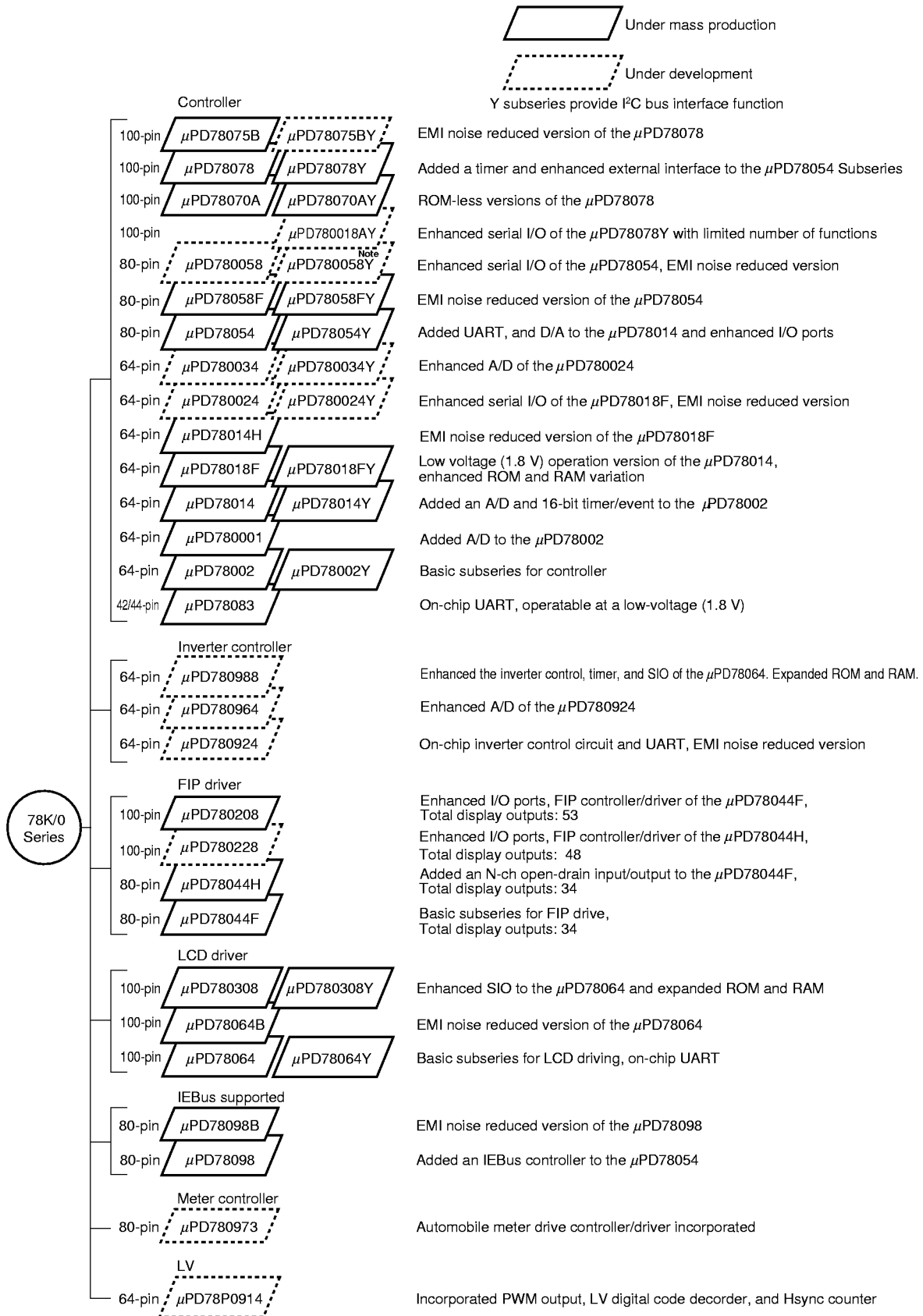
**★ ORDERING INFORMATION**

Part Number	Package
μPD78052YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)
μPD78053YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)
μPD78054YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)
μPD78055YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)
μPD78056YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)
μPD78058YGC-xxx-8BT	80-pin plastic QFP (14 x 14 mm)

**Remark** xxx indicates the ROM code suffix.

★ 78K/0 SERIES DEVELOPMENT

The following shows the 78K/0 Series products development. Subseries names are shown inside frames.



Note Under planning

The major functional differences among the subseries are shown below.

Function		ROM Capacity	Serial Interface	I/O	V <sub>DD</sub> MIN. Value	
Subseries Name						
Control	μPD78075BY	32 K to 40 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch	88	1.8 V	
	μPD78078Y	48 K to 60 K	With automatic transmit/receive function, 3-wire : 1 ch			
	μPD78070AY	—	3-wire/UART : 1 ch			
	μPD780018AY	48 K to 60 K	With automatic transmit/receive function, 3-wire : 1 ch Time division 3-wire : 1 ch I <sup>2</sup> C bus (multi master supported) : 1 ch	88	2.7 V	
	μPD780058Y	24 K to 60 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch With automatic transmit/receive function, 3-wire : 1 ch 3-wire/Time division UART : 1 ch	68		
	μPD78058FY	48 K to 60 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch With automatic transmit/receive function, 3-wire : 1 ch	69		
	μPD78054Y	16 K to 60 K	3-wire/UART : 1 ch			
	μPD780034Y	8 K to 32 K	UART : 1 ch 3-wire : 1 ch I <sup>2</sup> C bus (multi master supported) : 1 ch	51		
	μPD780024Y					
	μPD78018FY	8 K to 60 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch With automatic transmit/receive function, 3-wire : 1 ch			
	μPD78014Y	8 K to 32 K	3-wire/2-wire/SBI/I <sup>2</sup> C : 1 ch With automatic transmit/receive function, 3-wire : 1 ch	53		2.7 V
	μPD78002Y	8 K to 16 K	3-wire/2-wire/SBI/I <sup>2</sup> C : 1 ch			
LCD driver	μPD780308Y	48 K to 60 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch 3-wire/Time division UART : 1 ch 3-wire : 1 ch	57		2.0 V
	μPD78064Y	16 K to 32 K	3-wire/2-wire/I <sup>2</sup> C : 1 ch 3-wire/UART : 1 ch			

**Remark** The functions other than the serial interface are the same as those of Subseries products without the suffix Y.

OVERVIEW OF FUNCTION

Item		Product Name													
		μPD78052Y	μPD78053Y	μPD78054Y	μPD78055Y	μPD78056Y	μPD78058Y								
Internal Memory	ROM	16 Kbytes	24 Kbytes	32 Kbytes	40 Kbytes	48 Kbytes	60 Kbytes								
	High-speed RAM	512 bytes	1024 bytes												
	Buffer RAM	32 bytes													
	Expanded RAM	None					1024 bytes								
Memory space		64 Kbytes													
General registers		8 bits × 32 registers (8 bits × 8 registers × 4 banks)													
Minimum instruction execution time		On-chip minimum instruction execution time cycle modification function													
		When main system clock selected													
		0.4 μs/0.8 μs/1.6 μs/3.2 μs/6.4 μs/12.8 μs (@ 5.0-MHz operation)													
		When subsystem clock selected													
		122 μs (@ 32.768-kHz operation)													
Instruction set		<ul style="list-style-type: none"> <li>• 16-bit operation</li> <li>• Multiplication/division (8 bits × 8 bits, 16 bits ÷ 8 bits)</li> <li>• Bit manipulation (set, reset, test, boolean operation)</li> <li>• BCD adjustment, etc.</li> </ul>													
I/O ports		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding-right: 10px;">Total</td> <td style="text-align: right;">: 69</td> </tr> <tr> <td>• CMOS input</td> <td style="text-align: right;">: 2</td> </tr> <tr> <td>• CMOS I/O</td> <td style="text-align: right;">: 63</td> </tr> <tr> <td>• N-ch open-drain I/O</td> <td style="text-align: right;">: 4</td> </tr> </table>						Total	: 69	• CMOS input	: 2	• CMOS I/O	: 63	• N-ch open-drain I/O	: 4
Total	: 69														
• CMOS input	: 2														
• CMOS I/O	: 63														
• N-ch open-drain I/O	: 4														
A/D converter		• 8-bit resolution × 8 channels													
D/A converter		• 8-bit resolution × 2 channels													
Serial interface		<ul style="list-style-type: none"> <li>• 3-wire serial I/O/2-wire serial I/O mode/I<sup>2</sup>C bus mode selectable: 1 channel</li> <li>• 3-wire serial I/O mode (on-chip max. 32-byte automatic data transmit/receive function): 1 channel</li> <li>• 3-wire serial I/O/UART mode selectable : 1 channel</li> </ul>													
Timer		<ul style="list-style-type: none"> <li>• 16-bit timer/event counter : 1 channel</li> <li>• 8-bit timer/event counter : 2 channels</li> <li>• Watch timer : 1 channel</li> <li>• Watchdog timer : 1 channel</li> </ul>													
Timer output		3 (14-bit PWM output × 1)													
Clock output		19.5 kHz, 39.1 kHz, 78.1 kHz, 156 kHz, 313 kHz, 625 kHz, 1.25 MHz, 2.5 MHz, 5.0 MHz (@ 5.0-MHz operation with main system clock) 32.768 kHz (@ 32.768-kHz operation with subsystem clock)													
Buzzer output		1.2 kHz, 2.4 kHz, 4.9 kHz, 9.8 kHz (@ 5.0-MHz operation with main system clock)													
Vectored interrupt sources	Maskable	Internal interrupt : 13, external interrupt : 7													
	Non-maskable	Internal interrupt : 1													
	Software	1													
Test input		Internal : 1, external : 1													
Supply voltage		V <sub>DD</sub> = 2.0 to 6.0 V													
Operating ambient temperature		T <sub>A</sub> = -40 to +85°C													
Package		• 80-pin plastic QFP (14 × 14 mm)													

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1. PIN CONFIGURATION (TOP VIEW)

- 80-pin plastic QFP (14 × 14 mm)

μPD78052YGC-xxx-8BT

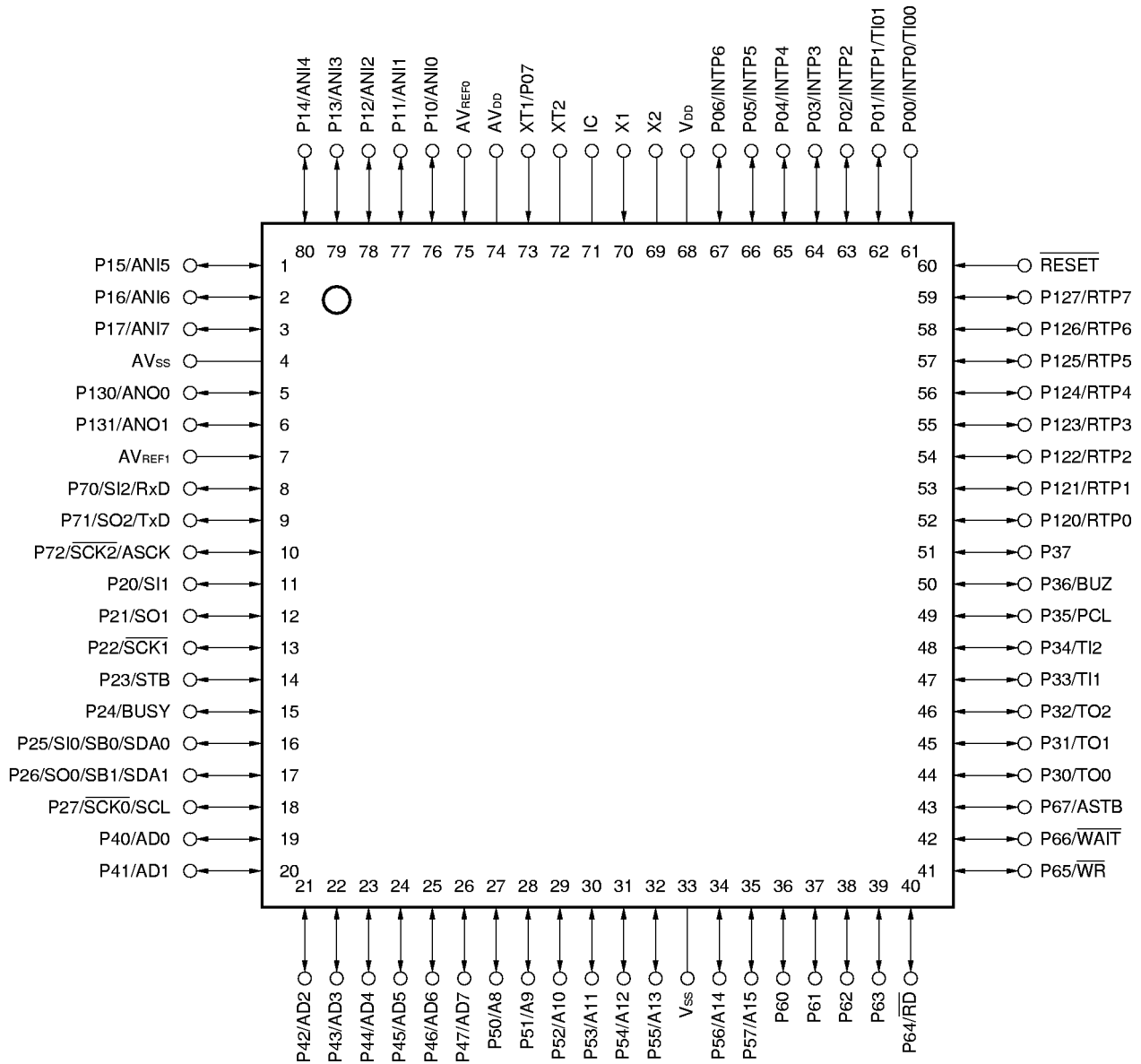
μPD78053YGC-xxx-8BT

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μPD78055YGC-xxx-8BT

μPD78056YGC-xxx-8BT

μPD78058YGC-xxx-8BT

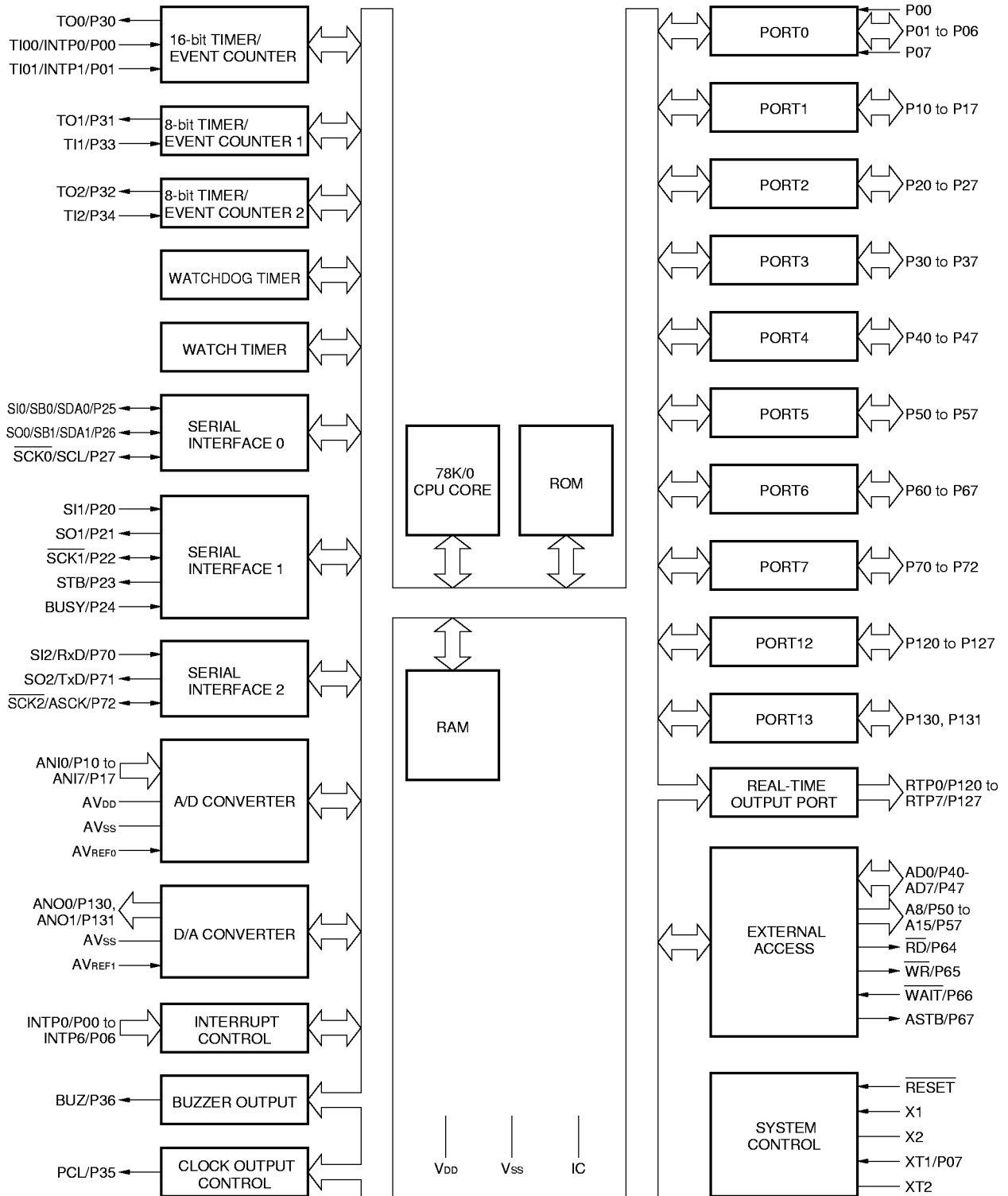


- Cautions**
1. IC (Internally Connected) pin should be connected directly to V<sub>SS</sub>.
  2. AV<sub>DD</sub> pin should be connected to V<sub>DD</sub> pin.
  3. AV<sub>SS</sub> pin should be connected to V<sub>SS</sub> pin.

A8 to A15	: Address Bus	PCL	: Programmable Clock
AD0 to AD7	: Address/Data Bus	RD	: Read Strobe
ANI0 to ANI7	: Analog Input	RESET	: Reset
ANO0, ANO1	: Analog Output	RTP0 to RTP7	: Real-Time Output Port
ASCK	: Asynchronous Serial Clock	RxD	: Receive Data
ASTB	: Address Strobe	SB0, SB1	: Serial Bus
AVDD	: Analog Power Supply	SCK0 to SCK2	: Serial Clock
AVREF0, AVREF1	: Analog Reference Voltage	SCL	: Serial Clock
AVSS	: Analog Ground	SDA0, SDA1	: Serial Data
BUSY	: Busy	SI0 to SI2	: Serial Input
BUZ	: Buzzer Clock	SO0 to SO2	: Serial Output
IC	: Internally Connected	STB	: Strobe
INTP0 to INTP6	: Interrupt from Peripherals	TI00, TI01	: Timer Input
P00 to P07	: Port0	TI1, TI2	: Timer Input
P10 to P17	: Port1	TO0 to TO2	: Timer Output
P20 to P27	: Port2	TxD	: Transmit Data
P30 to P37	: Port3	VDD	: Power Supply
P40 to P47	: Port4	VSS	: Ground
P50 to P57	: Port5	WAIT	: Wait
P60 to P67	: Port6	WR	: Write Strobe
P70 to P72	: Port7	X1, X2	: Crystal (Main System Clock)
P120 to P127	: Port12	XT1, XT2	: Crystal (Subsystem Clock)
P130, P131	: Port13		



2. BLOCK DIAGRAM



**Remark** The internal ROM and RAM capacity depends on the product.

### 3. PIN FUNCTIONS

#### 3.1 Port Pins (1/2)

Pin Name	I/O	Function		After Reset	Alternate Function
P00	Input	Port 0 8-bit I/O port	Input only	Input	INTP0/TI00
P01	Input/ output		Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.	Input	INTP1/TI01
P02					INTP2
P03					INTP3
P04					INTP4
P05					INTP5
P06					INTP6
P07 <sup>Note 1</sup>	Input		Input only	Input	XT1
P10 to P17	Input/ output	Port 1 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software. <sup>Note 2</sup>		Input	ANI0 to ANI7
P20	Input/ output	Port 2 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.	Input	SI1	
P21				SO1	
P22				SCK1	
P23				STB	
P24				BUSY	
P25				SI0/SB0/SDA0	
P26				SO0/SB1/SDA1	
P27				SCK0/SCL	
P30	Input/ output	Port 3 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.	Input	TO0	
P31				TO1	
P32				TO2	
P33				TI1	
P34				TI2	
P35				PCL	
P36				BUZ	
P37				—	
P40 to P47	Input/ output	Port 4 8-bit input/output port. Input/output can be specified in 8-bit unit. When used as an input port, on-chip pull-up resistor can be used by software. Test input flag (KRIF) is set to 1 by falling edge detection.		Input	AD0 to AD7

- Notes**
1. When using the P07/XT1 pins as an input port, set 1 in bit 6 (FRC) of the processor clock control register (PCC). On-chip feedback resistor of the subsystem clock oscillator should not be used.
  2. When using the P10/ANI0 to P17/ANI7 pins as the A/D converter analog input pins, set port 1 to the input mode. The pull-up resistor is disabled automatically.

3.1 Port Pins (2/2)

Pin Name	I/O	Function		After Reset	Alternate Function
P50 to P57	Input/output	Port 5 8-bit input/output port. LED can be driven directly. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.		Input	A8 to A15
P60	Input/output	Port 6 8-bit input/output port. Input/output can be specified bit-wise.	N-ch open-drain input/output port. On-chip pull-up resistor can be specified by mask option. LED can be driven directly.	Input	—
P61					
P62					
P63					
P64		When used as an input port, on-chip pull-up resistor can be used by software.	Input	$\overline{\text{RD}}$	
P65				$\overline{\text{WR}}$	
P66				$\overline{\text{WAIT}}$	
P67				ASTB	
P70	Input/output	Port 7 3-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.		Input	$\overline{\text{SI2/RxD}}$
P71					$\overline{\text{SO2/TxD}}$
P72					$\overline{\text{SCK2/ASCK}}$
P120 to P127	Input/output	Port 12 8-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.		Input	RTP0 to RTP7
P130, P131	Input/output	Port 13 2-bit input/output port. Input/output can be specified bit-wise. When used as an input port, on-chip pull-up resistor can be used by software.		Input	ANO0, ANO1

3.2 Non-port Pins (1/2)

Pin Name	I/O	Function	After Reset	Alternate Function
INTP0	Input	External interrupt request input for which the effective edge (rising edge, falling edge, or both rising edge and falling edge) can be specified.	Input	P00/TI00
INTP1				P01/TI01
INTP2				P02
INTP3				P03
INTP4				P04
INTP5				P05
INTP6				P06
SI0	Input	Serial interface serial data input.	Input	P25/SB0/SDA0
SI1				P20
SI2				P70/RxD
SO0	Output	Serial interface serial data output.	Input	P26/SB1/SDA1
SO1				P21
SO2				P71/TxD
SB0	Input/output	Serial interface serial data input/output.	Input	P25/SI0/SDA0
SB1				P26/SO0/SDA1
SDA0				P25/SI0/SB0
SDA1				P26/SO0/SB1
SCK0	Input/output	Serial interface serial clock input/ output	Input	P27/SCL
SCK1				P22
SCK2				P72/ASCK
SCL				P27/SCK0
STB	Output	Serial interface automatic transmit/receive strobe output.	Input	P23
BUSY	Input	Serial interface automatic transmit/receive busy input.	Input	P24
RxD	Input	Asynchronous serial interface serial data input.	Input	P70/SI2
TxD	Output	Asynchronous serial interface serial data output.	Input	P71/SO2
ASCK	Input	Asynchronous serial interface serial clock input.	Input	P72/SCK2
TI00	Input	External count clock input to the 16-bit timer (TM0)	Input	P00/INTP0
TI01		Capture trigger signal input to the capture register (CR00)		P01/INTP1
TI1		External count clock input to the 8-bit timer (TM1)		P33
TI2		External count clock input to the 8-bit timer (TM2)		P34
TO0	Output	16-bit timer (TM0) output (dual-function as 14-bit PWM output)	Input	P30
TO1		8-bit timer (TM1) output		P31
TO2		8-bit timer (TM2) output		P32
PCL	Output	Clock output (for main system clock, subsystem clock trimming).	Input	P35
BUZ	Output	Buzzer output.	Input	P36
RTP0 to RTP7	Output	Real-time output port by which data is output in synchronization with a trigger.	Input	P120 to P127
AD0 to AD7	Input/output	Low-order address/data bus at external memory expansion.	Input	P40 to P47
A8 to A15	Output	High-order address bus at external memory expansion.	Input	P50 to P57
RD	Output	External memory read operation strobe signal output.	Input	P64
WR		External memory write operation strobe signal output.		P65

3.2 Non-port Pins (2/2)

Pin Name	I/O	Function	After Reset	Dual-Function Pin
$\overline{\text{WAIT}}$	Input	Wait insertion at external memory access.	Input	P66
ASTB	Output	Strobe output which latches the address information output at port 4 and port 5 to access external memory.	Input	P67
ANI0 to ANI7	Input	A/D converter analog input.	Input	P10 to P17
ANO0, ANO1	Output	D/A converter analog output.	Input	P130, P131
AVREF0	Input	A/D converter reference voltage input.	—	—
AVREF1	Input	D/A converter reference voltage input.	—	—
AVDD	—	A/D converter analog power supply. Connect to V <sub>DD</sub>	—	—
AVSS	—	Ground potential of A/D converter and D/A converter. Connect to V <sub>SS</sub>	—	—
$\overline{\text{RESET}}$	Input	System reset input.	—	—
X1	Input	Main system clock oscillation crystal connection.	—	—
X2	—		—	—
XT1	Input	Subsystem clock oscillation crystal connection.	Input	P07
XT2	—		—	—
V <sub>DD</sub>	—	Positive power supply.	—	—
V <sub>SS</sub>	—	Ground potential.	—	—
IC	—	Internally connected. Connect directly to V <sub>SS</sub> .	—	—

**3.3 Pin I/O Circuits and Recommended Connection of Unused Pins**

The input/output circuit type of each pin and recommended connection of unused pins are shown in Table 3-1. For the input/output circuit configuration of each type, see Figure 3-1.

**Table 3-1. Input/Output Circuit Type of Each Pin (1/2)**

Pin Name	Input/output Circuit Type	I/O	Recommended Connection when Used		
P00/INTP0/TI00	2	Input	Connect to V <sub>SS</sub> .		
P01/INTP1/TI01	8-A	Input/output	Independently connect to V <sub>SS</sub> through resistor.		
P02/INTP2					
P03/INTP3					
P04/INTP4					
P05/INTP5					
P06/INTP6					
P07/XT1	16	Input	Connect to V <sub>DD</sub> .		
P10/ANI0 to P17/ANI7	11	Input/output	Independently connect to V <sub>DD</sub> or V <sub>SS</sub> through resistor.		
P20/SI1	8-A				
P21/SO1	5-A				
P22/ $\overline{\text{SCK1}}$	8-A				
P23/STB	5-A				
P24/BUSY	8-A				
P25/SI0/SB0/SDA0	10-A				
P26/SO0/SB1/SDA1					
P27/ $\overline{\text{SCK0/SCL}}$					
P30/TO0	5-A				
P31/TO1					
P32/TO2					
P33/TI1	8-A				
P34/TI2					
P35/PCL	5-A				
P36/BUZ					
P37					
P40/AD0 to P47/AD7	5-E				Independently connect to V <sub>DD</sub> through resistor.
P50/A8 to P57/A15	5-A				Independently connect to V <sub>DD</sub> or V <sub>SS</sub> through resistor.
P60 to P63	13-B				Independently connect to V <sub>DD</sub> through resistor.
P64/ $\overline{\text{RD}}$	5-A		Independently connect to V <sub>DD</sub> or V <sub>SS</sub> through resistor.		
P65/ $\overline{\text{WR}}$					
P66/ $\overline{\text{WAIT}}$					
P67/ASTB					

Table 3-1. Input/Output Circuit Type of Each Pin (2/2)

Pin Name	Input/output Circuit Type	I/O	Recommended Connection when Used
P70/SI2/RxD	8-A	Input/output	Independently connect to V <sub>DD</sub> or V <sub>SS</sub> through resistor.
P71/SO2/TxD	5-A		
P72/SCK2/ASCK	8-A		
P120/RTP0 to P127/RTP7	5-A		
P130/AN00 , P131/AN01	12-A		
RESET	2	Input	—
XT2	16	—	Leave open.
AVREF0	—		Connect to V <sub>SS</sub> .
AVREF1			Connect to V <sub>DD</sub> .
AVDD			
AVSS			Connect to V <sub>SS</sub> .
IC			Connect directly to V <sub>SS</sub> .

Figure 3-1. Pin Input/Output Circuits (1/2)

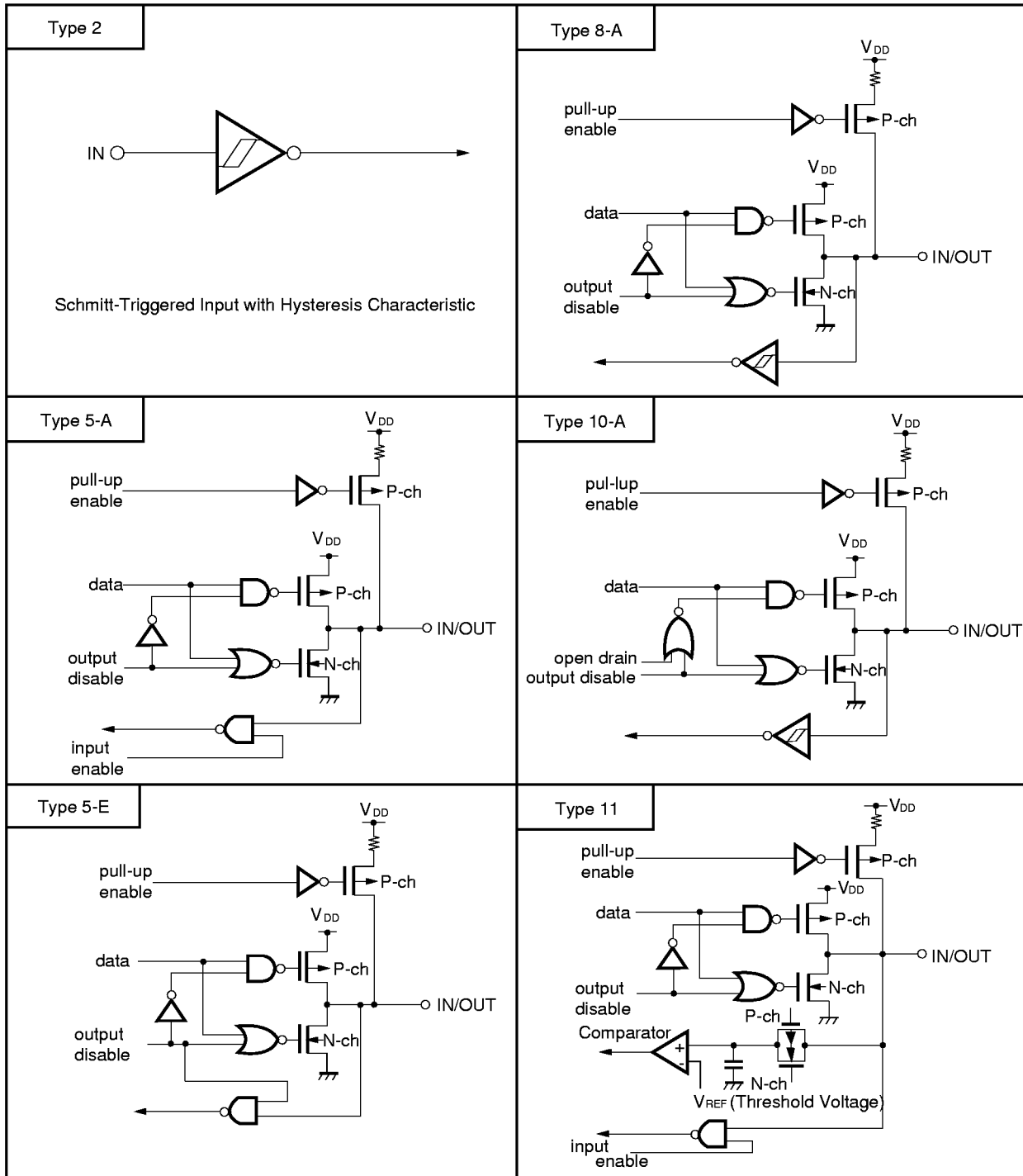
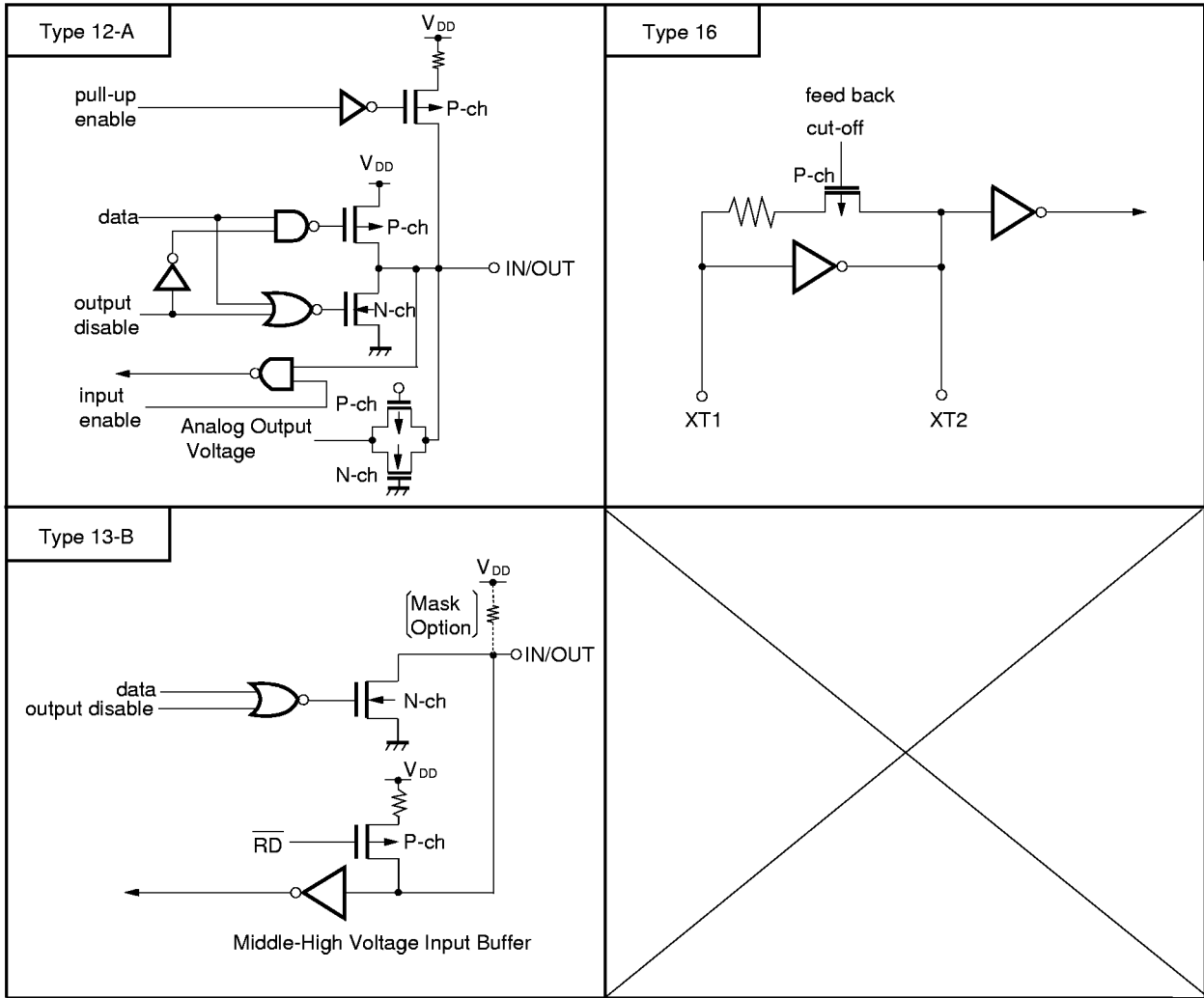




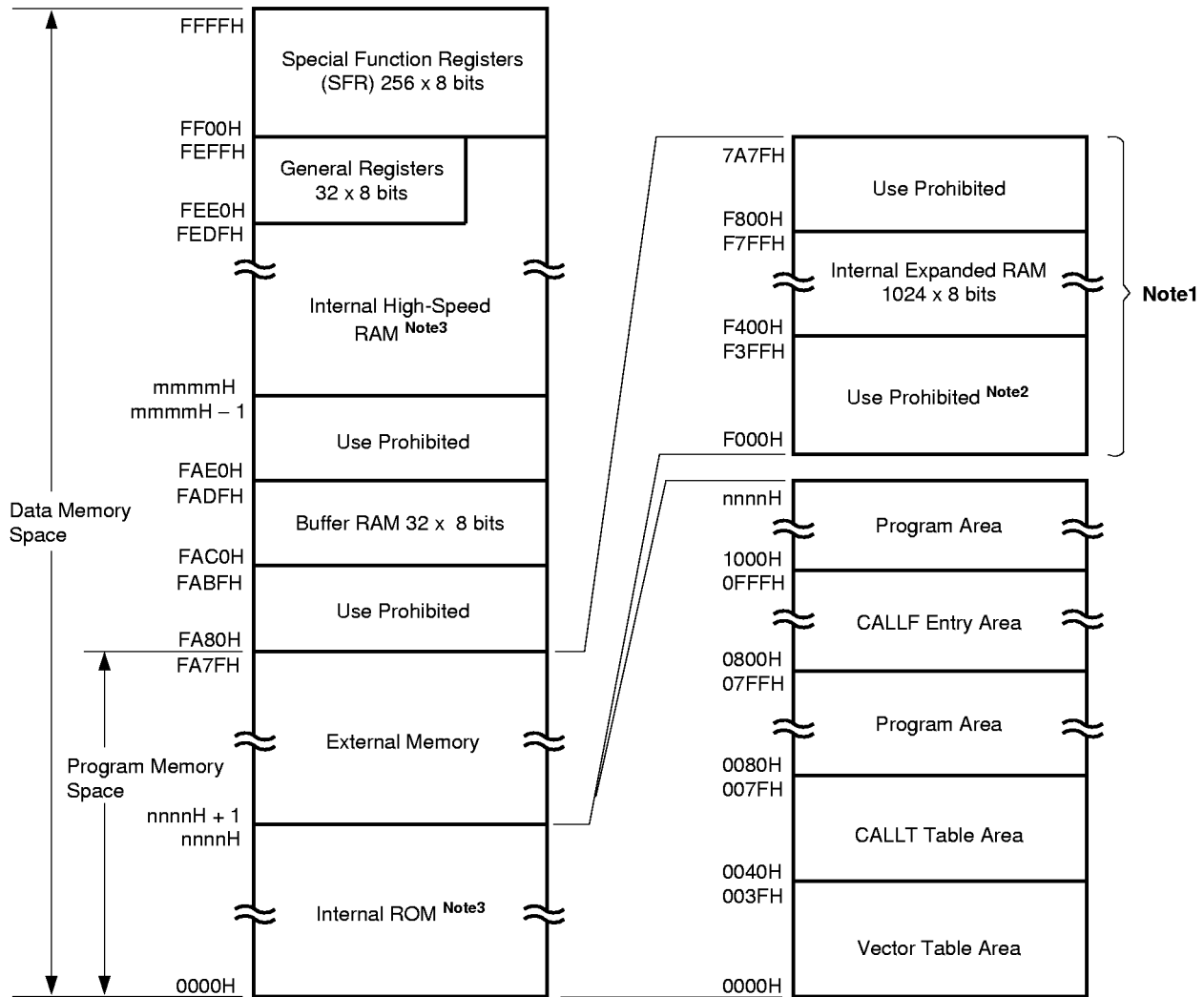
Figure 3-1. Pin Input/Output Circuits (2/2)



4. MEMORY SPACE

Figure 4-1 shows the μPD78052Y/78053Y/78054Y/78055Y/78056Y/78058Y memory map.

Figure 4-1. Memory Map



- Notes**
1. Provided in the μPD78058Y only
  2. When the external device expansion function is used with the μPD78058Y, set the internal ROM capacity to 56 Kbytes or less using the internal memory size switching register (IMS).
  3. The internal ROM capacity and internal high-speed RAM capacity depend on the products (see the next table).

Relevant Product Name	Internal ROM Last Address nnnnH	Internal High-Speed RAM First Address mmmH
μPD78052Y	3FFFH	FD00H
μPD78053Y	5FFFH	FB00H
μPD78054Y	7FFFH	
μPD78055Y	9FFFH	
μPD78056Y	BFFFH	
μPD78058Y	EFFFH	

5. PERIPHERAL HARDWARE FUNCTION FEATURES

5.1 Ports

The following 3 types of I/O ports are available.

• CMOS input (P00, P07)	: 2
• CMOS input/output (P01 to P06, port 1 to port 5, P64 to P67, port 7, port 12, port 13)	: 63
• N-channel open-drain input/output (P60 to P63)	: 4
<b>Total</b>	<b>: 69</b>

Table 5-1. Port Functions

Name	Pin Name	Function
Port 0	P00, P07	Dedicated input port pins
	P01 to P06	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 1	P10 to P17	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 2	P20 to P27	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 3	P30 to P37	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 4	P40 to P47	Input/output port pins. Input/output specifiable in 8-bit units. When used as input port pins, on-chip pull-up resistor can be used by software. Test input flag (KRIF) is set to 1 by falling edge detection.
Port 5	P50 to P57	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software. LED direct drive capability.
Port 6	P60 to P63	N-channel open-drain input/output port pins. Input/output specifiable bit-wise. On-chip pull-up resistor can be used by mask option. LED direct drive capability.
	P64 to P67	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 7	P70 to P72	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 12	P120 to P127	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.
Port 13	P130, P131	Input/output port pins. Input/output specifiable bit-wise. When used as input port pins, on-chip pull-up resistor can be used by software.

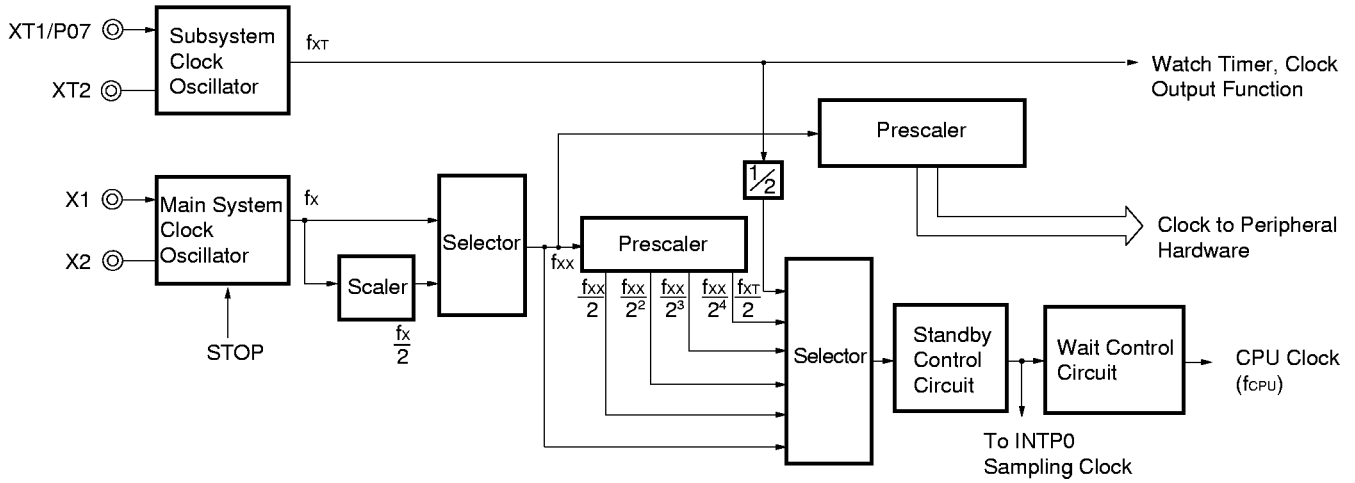
**5.2 Clock Generator**

Two types of generators, a main system clock generator and a subsystem clock generator, are available.

The minimum instruction execution time can also be changed.

- 0.4 μs/0.8 μs/1.6 μs/3.2 μs/6.4 μs/12.8 μs (@5.0-MHz operation with main system clock)
- 122 μs (@32.768-kHz operation with subsystem clock)

**Figure 5-1. Clock Generator Block Diagram**



**5.3 Timer/Event Counter**

5 timer/event counter channels are incorporated.

- 16-bit timer/event counter : 1 channel
- 8-bit timer/event counter : 2 channels
- Watch timer : 1 channel
- Watchdog timer : 1 channel

**Table 5-2. Operation of Timer/Event Counter**

	16-Bit Timer/Event Counter	8-Bit Timer/Event Counter	Watch Timer	Watchdog Timer
<b>Operation mode</b>				
Interval timer	1 channel	2 channels	1 channel	1 channel
External event counter	1 channel	2 channels	—	—
<b>Function</b>				
Timer output	1 output	2 outputs	—	—
PWM output	1 output	—	—	—
Pulse amplitude measurement	2 inputs			
Square wave output	1 output	2 outputs	—	—
One-shot pulse output	1 output	—	—	—
Interrupt source	2	2	1	1
Test input	—	—	1 input	—

Figure 5-2. 16-Bit Timer/Event Counter Block Diagram

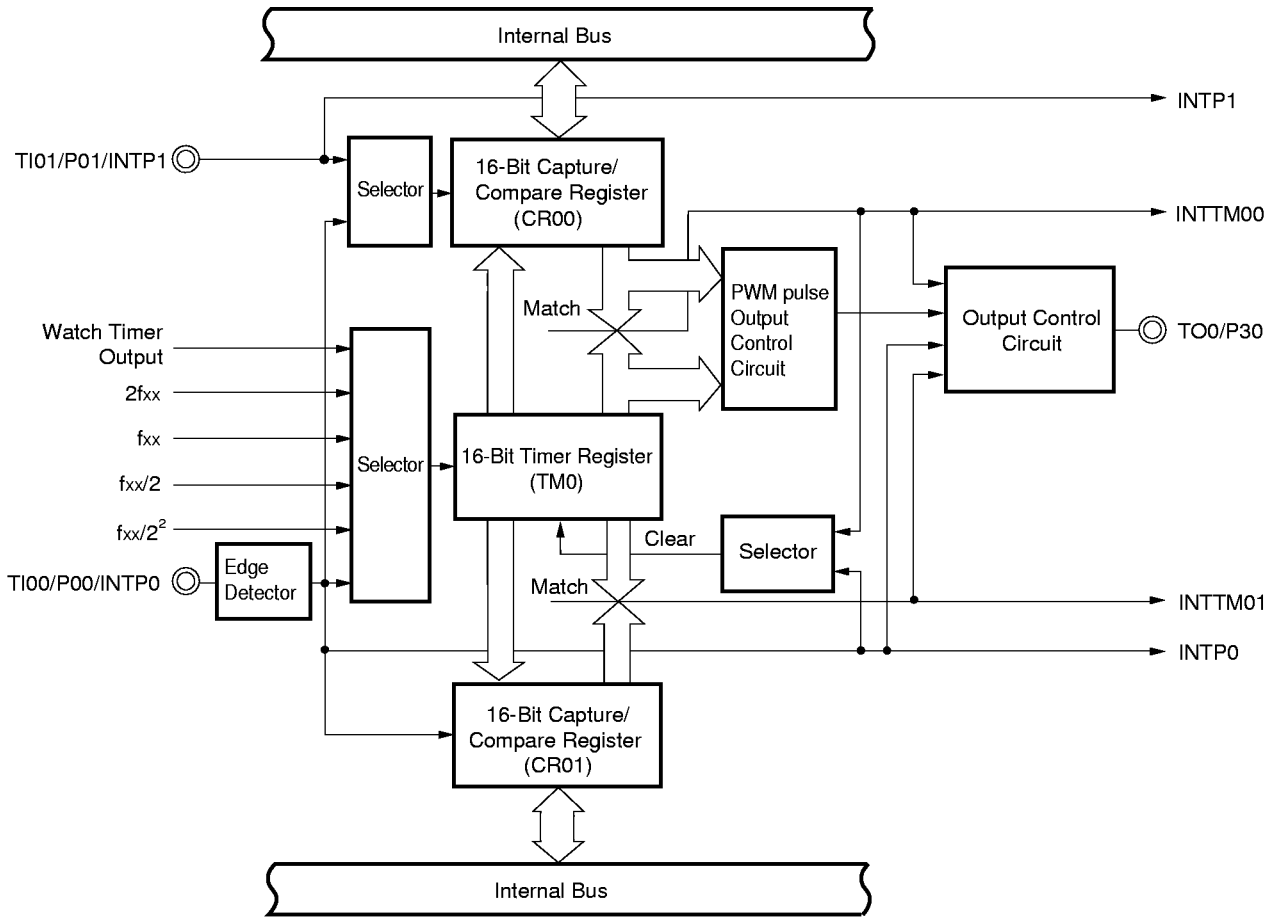


Figure 5-3. 8-Bit Timer/Event Counter Block Diagram

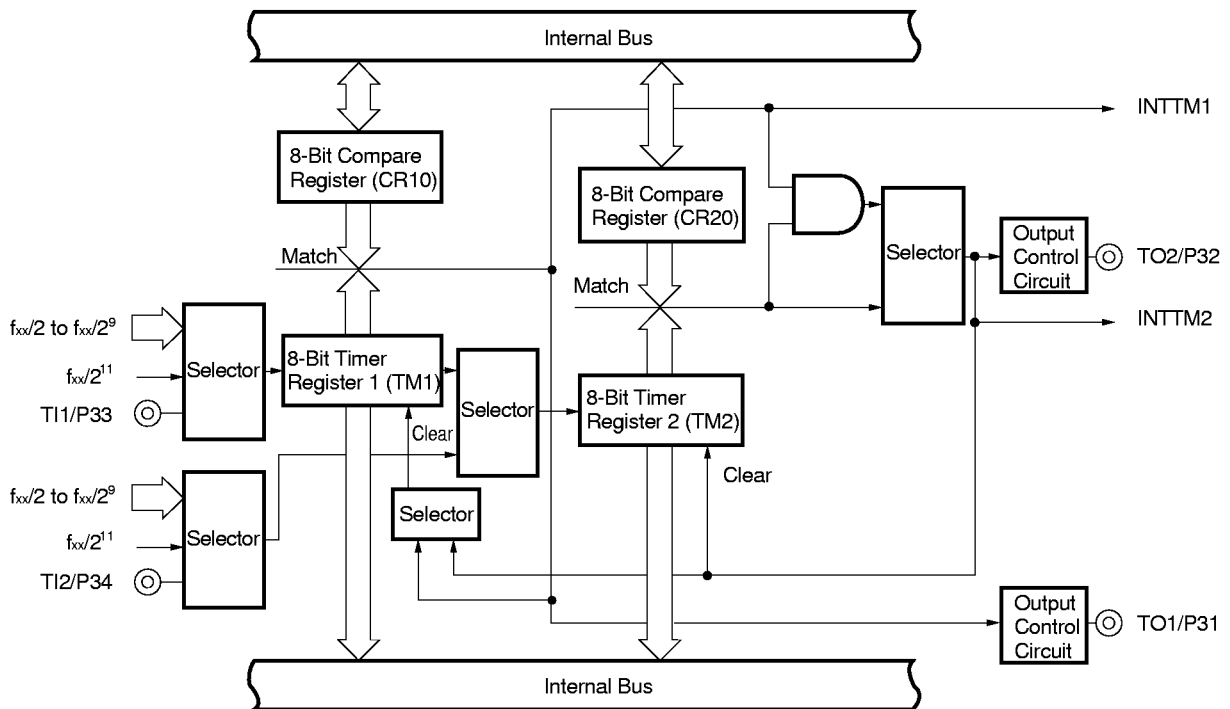


Figure 5-4. Watch Timer Block Diagram

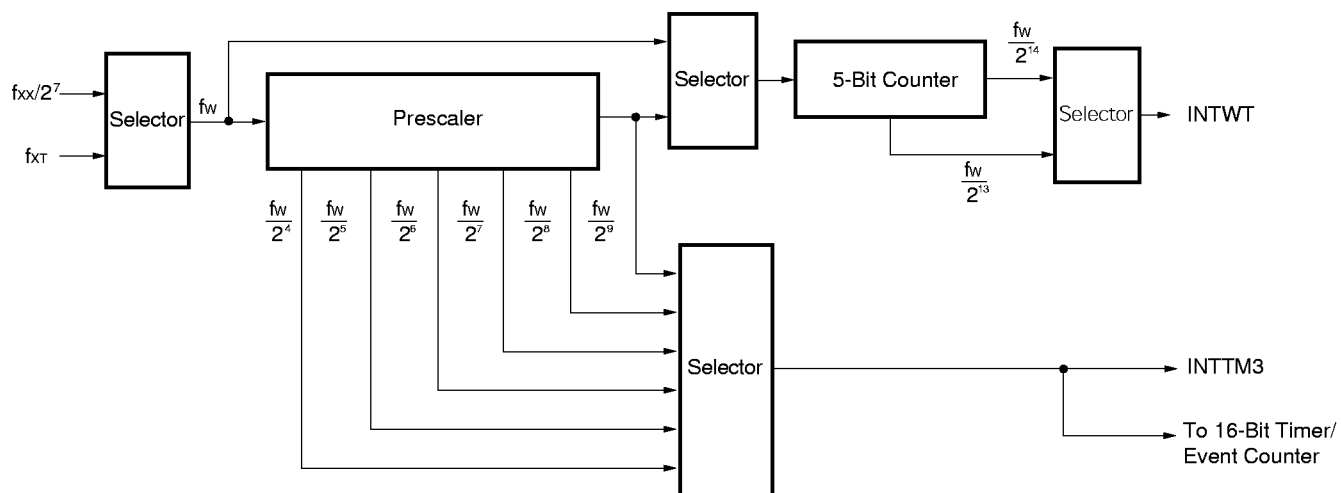
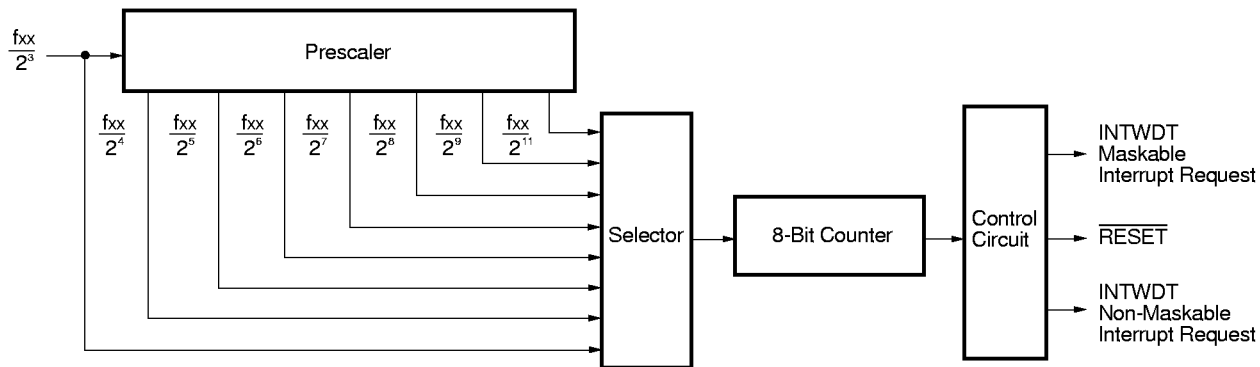


Figure 5-5. Watchdog Timer Block Diagram

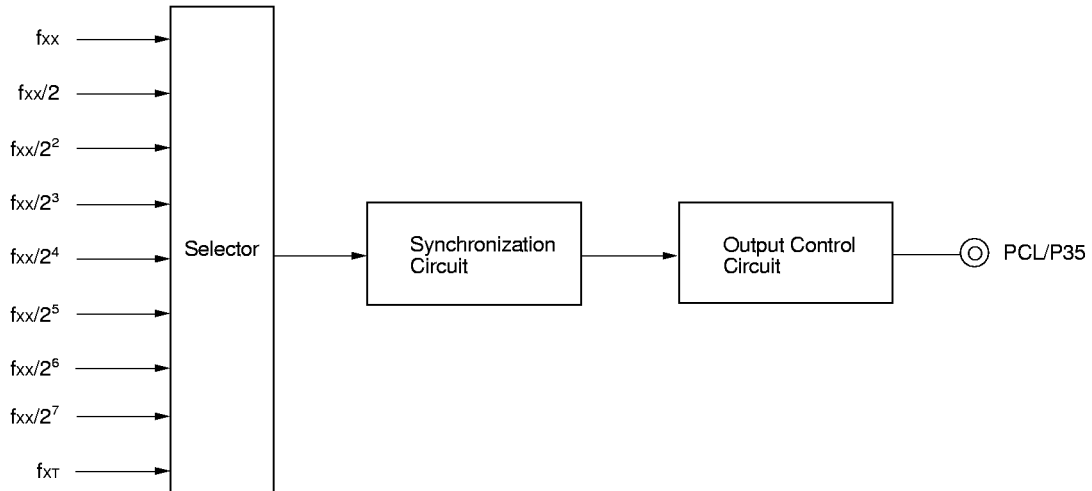


**5.4 Clock Output Control Circuit**

A clock with the following frequencies can be output as the clock output.

- 19.5 kHz/39.1 kHz/78.1 kHz/156 kHz/313 kHz/625 kHz/1.25 MHz/2.5 MHz/5.0 MHz (@5.0-MHz operation with main system clock)
- 32.768 kHz (@32.768-kHz operation with subsystem clock)

**Figure 5-6. Clock Output Control Circuit Block Diagram**

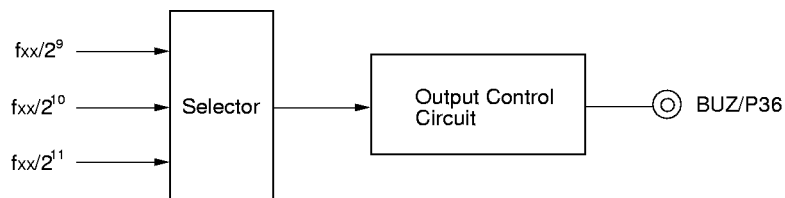


**5.5 Buzzer Output Control Circuit**

A clock with the following frequencies can be output as the buzzer output.

- 1.2 kHz/2.4 kHz/4.9 kHz/9.8 kHz (@5.0-MHz operation with main system clock)

**Figure 5-7. Buzzer Output Control Circuit Block Diagram**



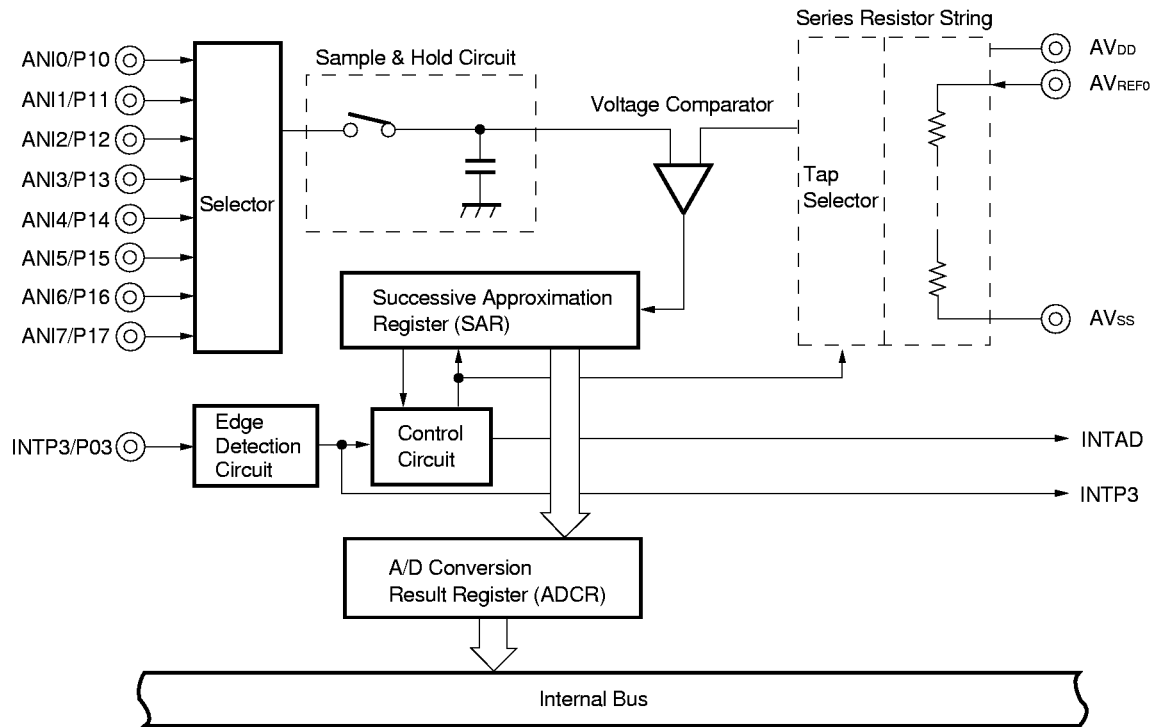
5.6 A/D Converter

An A/D converter of 8-bit resolution x 8 channels is incorporated.

The following two A/D conversion operation start-up methods are available.

- Hardware start
- Software start

Figure 5-8. A/D Converter Block Diagram

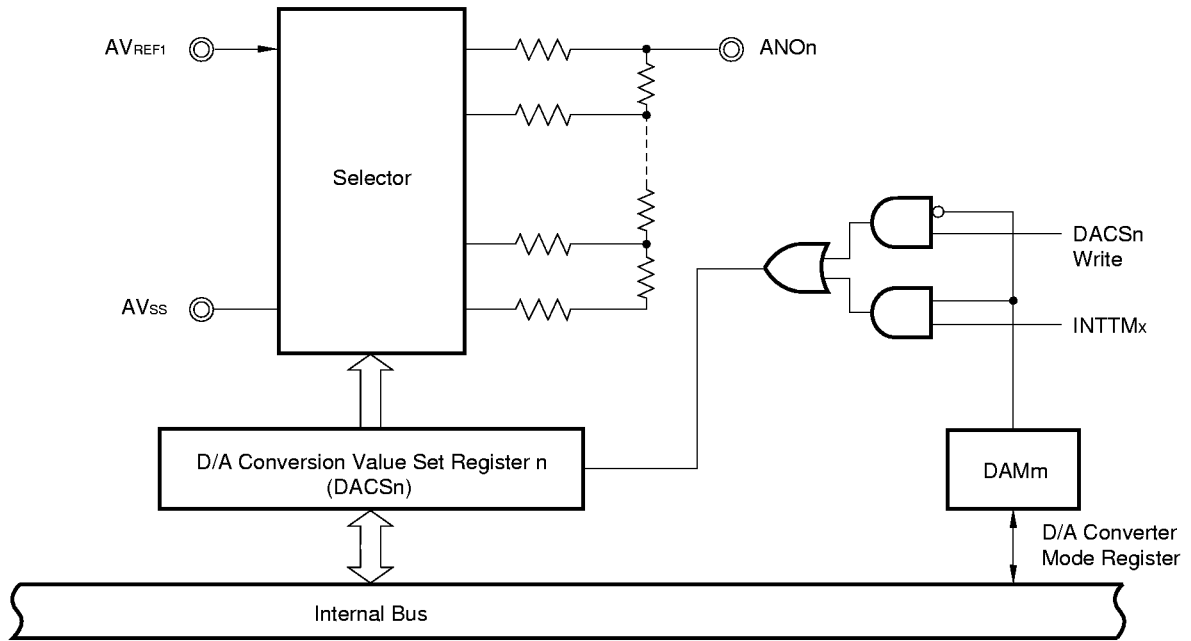




**5.7 D/A Converter**

A D/A converter of 8-bit resolution × 2 channels is available.  
Conversion method is R-2R resistor ladder method.

**Figure 5-9. D/A Converter Block Diagram**



n = 0, 1  
m = 4, 5  
x = 1, 2

**5.8 Serial Interfaces**

3 channels of the clocked serial interface are incorporated.

- Serial interface channel 0
- Serial interface channel 1
- Serial interface channel 2

**Table 5-3. Types and Functions of Serial Interface**

Function	Serial Interface Channel 0	Serial Interface Channel 1	Serial Interface Channel 2
3-wire serial I/O mode	○ (MSB/LSB first switchable)	○ (MSB/LSB first switchable)	○ (MSB/LSB first switchable)
3-wire serial I/O mode with auto-transmit/receive function	—	○ (MSB/LSB first switchable)	—
2-wire serial I/O mode	○ (MSB first)	—	—
I <sup>2</sup> C bus mode	○ (MSB first)	—	—
Asynchronous serial interface (UART) mode	—	—	○ (Dedicated baud rate generator incorporated)

Figure 5-10. Serial Interface Channel 0 Block Diagram

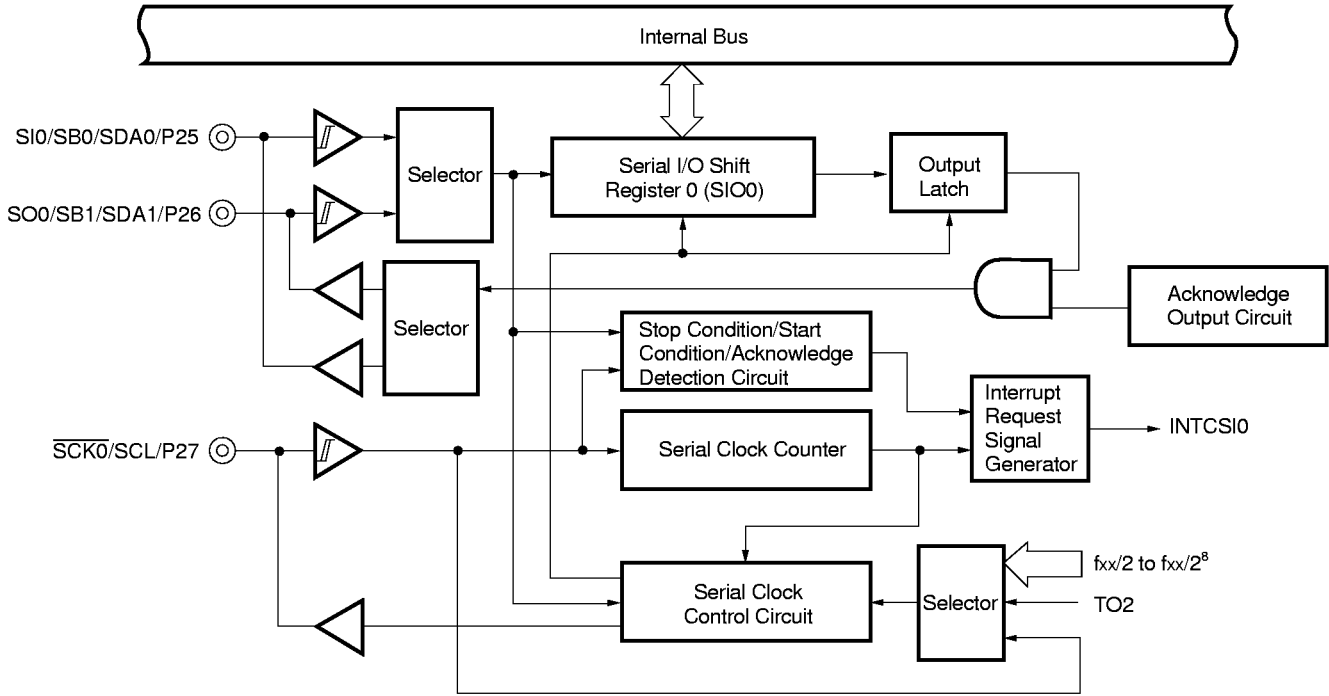


Figure 5-11. Serial Interface Channel 1 Block Diagram

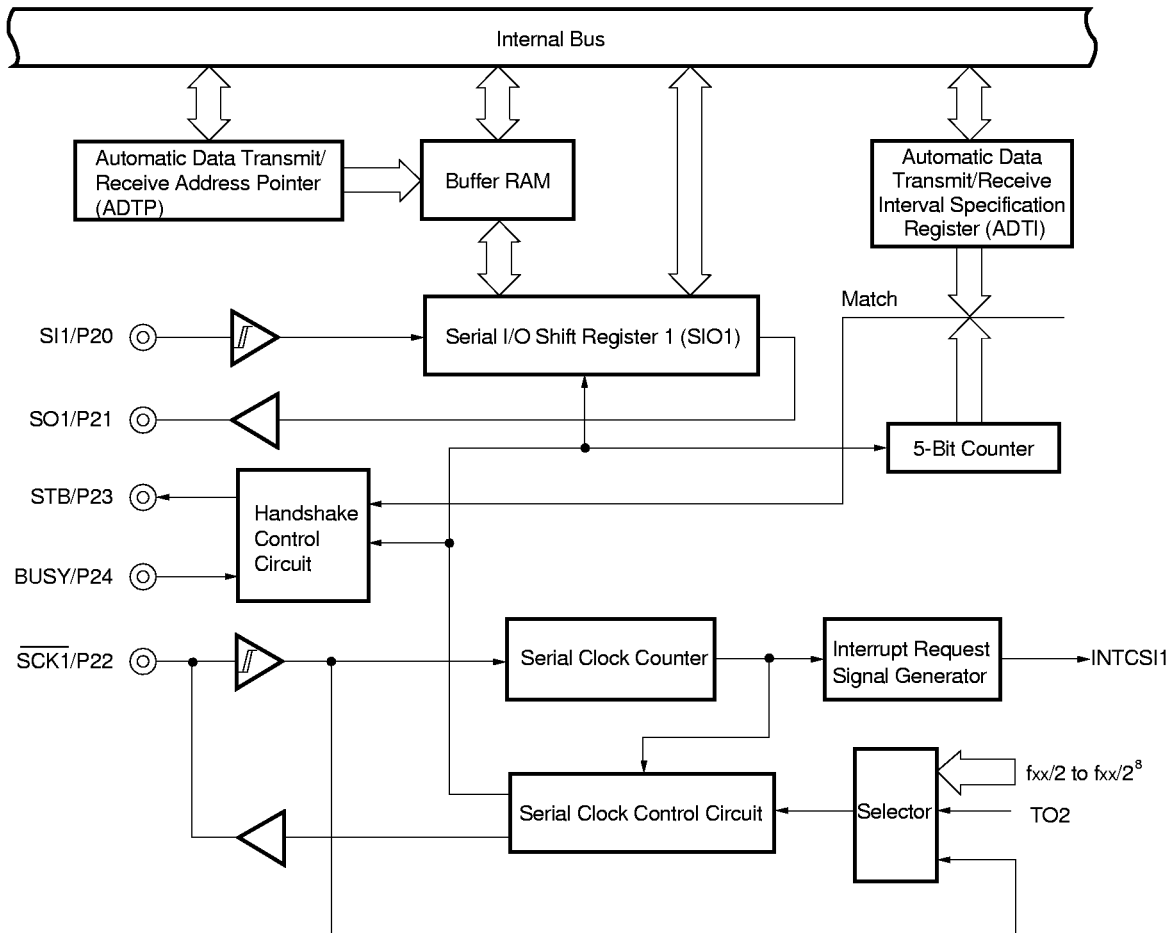
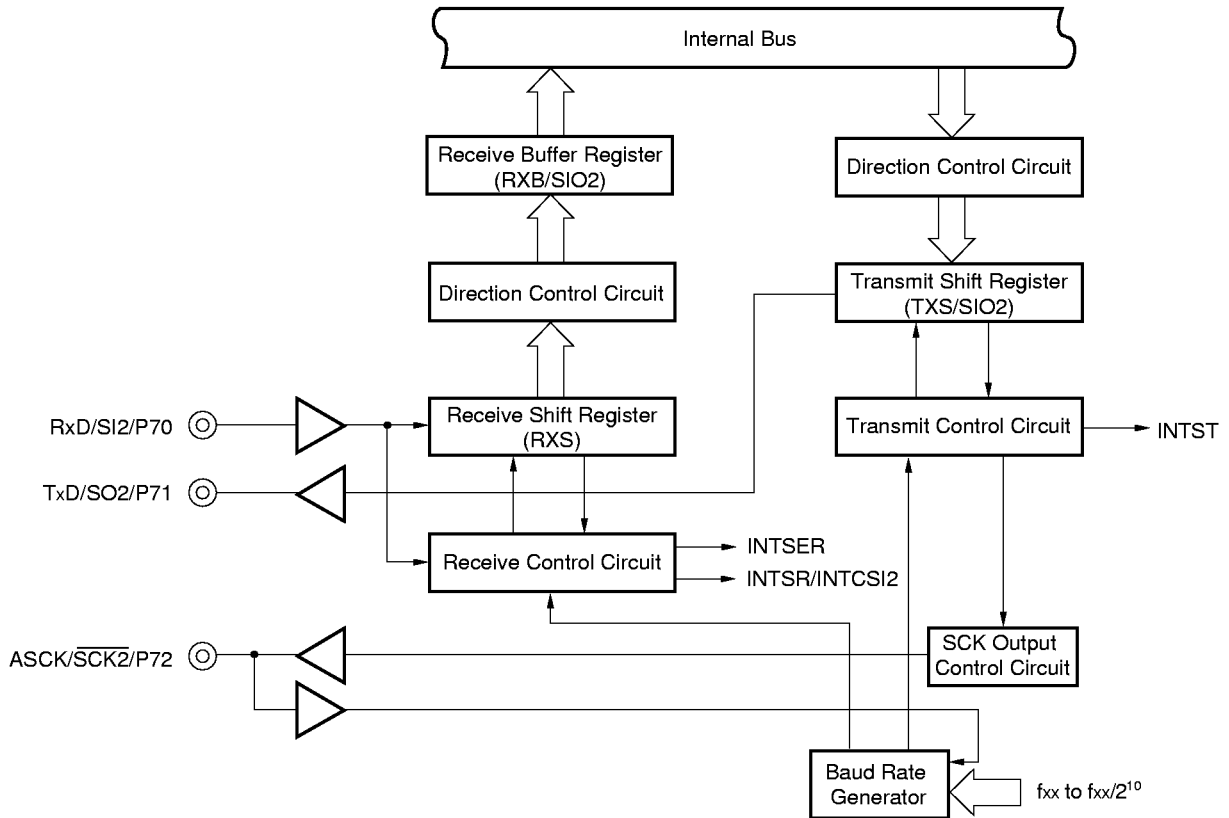


Figure 5-12. Serial Interface Channel 2 Block Diagram

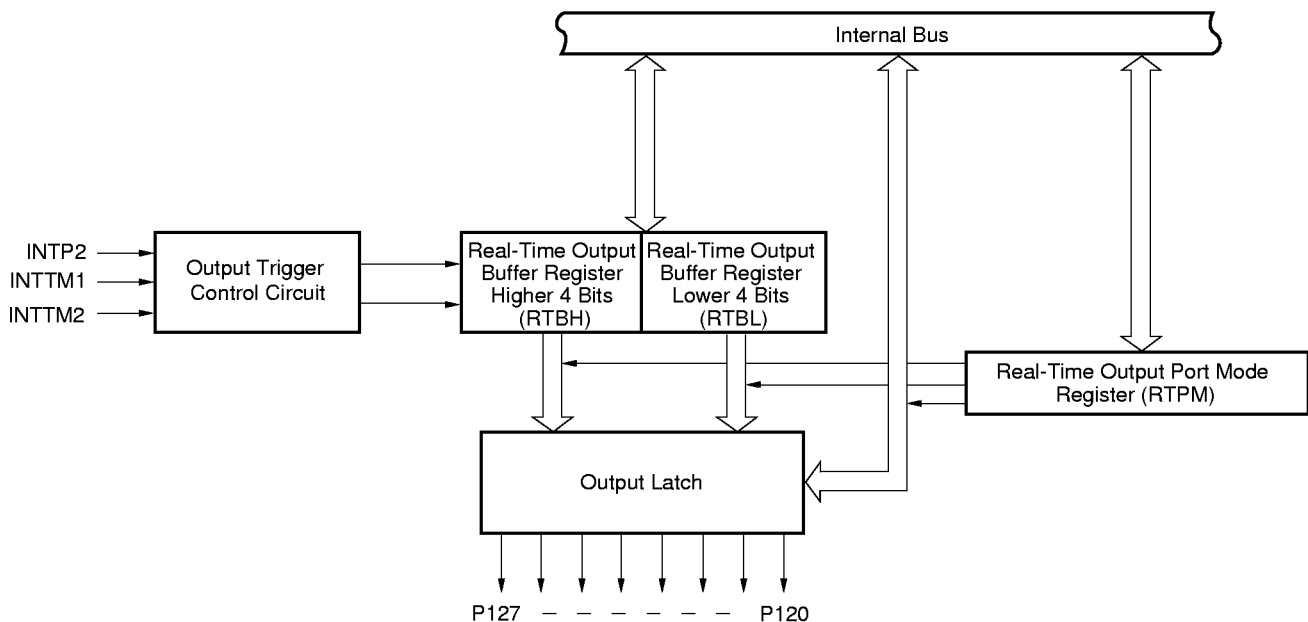


5.9 Real-time Output Port Functions

Data set previously in the real-time output buffer register is transferred to the output latch by hardware concurrently with timer interrupt or external interrupt generation in order to output to off-chip. This is a real-time output function. Pins used to output data to off-chip are called real-time output ports.

By using a real-time output port, a signal which has no jitter can be output. This is most applicable to control stepping motors, etc.

Figure 5-13. Real-Time Output Port Block Diagram



6. INTERRUPT FUNCTIONS AND TEST FUNCTIONS

6.1 Interrupt Functions

There are interrupt functions, 22 sources of three different types, as shown below.

- Non-maskable interrupt: 1
- Maskable interrupts: 20
- Software interrupt: 1

The following table shows the interrupt source list.

Table 6-1. Interrupt Source List (1/2)

Interrupt Type	Default <sup>Note 1</sup> Priority	Interrupt Source		Internal/ External	Vector Table Address	Basic Configuration Type <sup>Note 2</sup>			
		Name	Trigger						
Non-maskable	—	INTWDT	Watchdog timer overflow (watchdog timer mode 1 selected)	Internal	0004H	(A)			
Maskable	0	INTWDT	Watchdog timer overflow (interval timer mode selected)			External	0006H	(B)	
	1	INTP0	Pin input edge detection	(C)					
	2	INTP1		(D)					
	3	INTP2		(D)					
	4	INTP3		(D)					
	5	INTP4		(D)					
	6	INTP5		(D)					
	7	INTP6		(D)					
	8	INTCSI0		End of serial interface channel 0 transfer	Internal			0014H	(B)
	9	INTCSI1	End of serial interface channel 1 transfer						
	10	INTSER	Generation of serial interface channel 2 UART receive error						
	11	INTSR	End of serial interface channel 2 UART reception	001AH					
		INTCSI2	End of serial interface channel 2 3-wire transfer						
	12	INTST	End of serial interface channel 2 UART transmission	001CH					

- Notes
1. The default priority is a priority order when two or more maskable interrupt requests are generated simultaneously. 0 is the highest order and 18, the lowest.
  2. Basic configuration types (A) to (E) correspond to (A) to (E) in Figure 6-1, respectively.

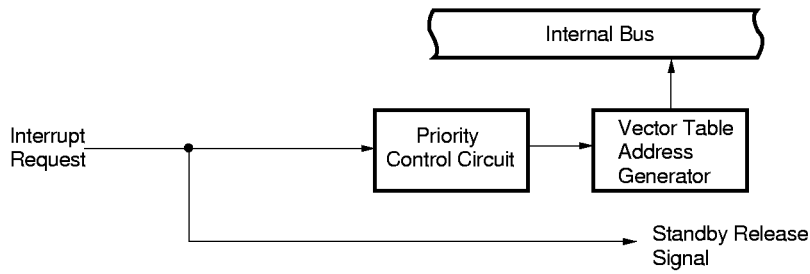
Table 6-1. Interrupt Source List (2/2)

Interrupt Type	Default <sup>Note 1</sup> Priority	Interrupt Source		Internal/ External	Vector Table Address	Basic Configuration Type <sup>Note 2</sup>
		Name	Trigger			
Maskable	13	INTTM3	Reference time interval signal from watch timer	Internal	001EH	(B)
	14	INTTM00	Generation of match signal of 16-bit timer register and capture/compare register (CR00)		0020H	
	15	INTTM01	Generation of match signal of 16-bit timer register and capture/compare register (CR01)		0022H	
	16	INTTM1	Generation of match signal of 8-bit timer/event counter 1		0024H	
	17	INTTM2	Generation of match signal of 8-bit timer/event counter 2		0026H	
	18	INTAD	End of conversion by A/D converter		0028H	
Software	—	BRK	BRK instruction execution	—	003EH	(E)

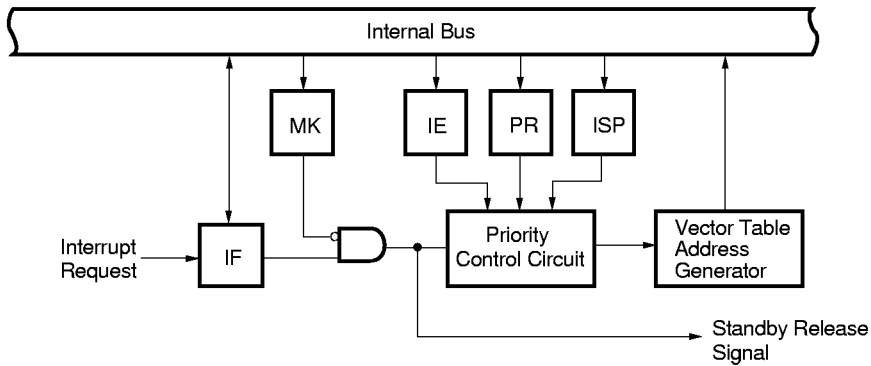
- Notes
1. The default priority is a priority order when two or more maskable interrupts are generated simultaneously. 0 is the highest order and 18, the lowest.
  2. Basic configuration types (A) to (E) correspond to (A) to (E) in Figure 6-1, respectively.

Figure 6-1. Interrupt Function Basic Configuration(1/2)

(A) Internal non-maskable interrupt



(B) Internal maskable interrupt



(C) External maskable interrupt (INTP0)

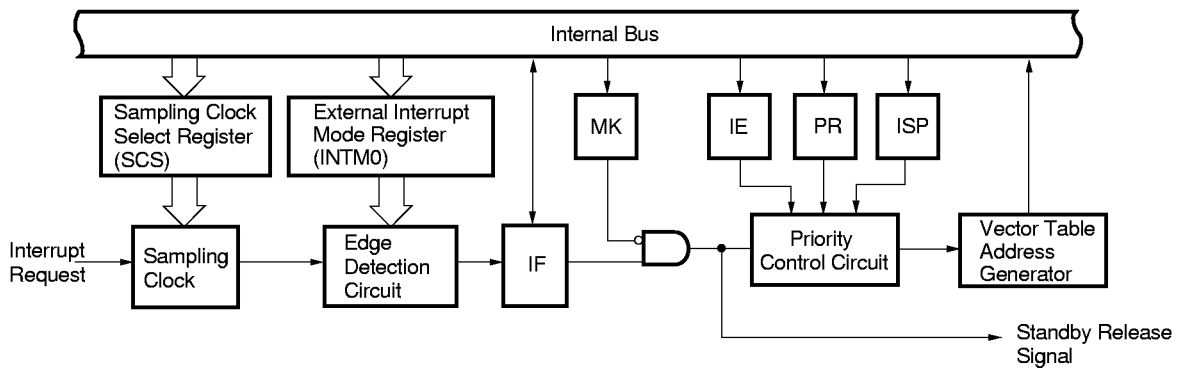
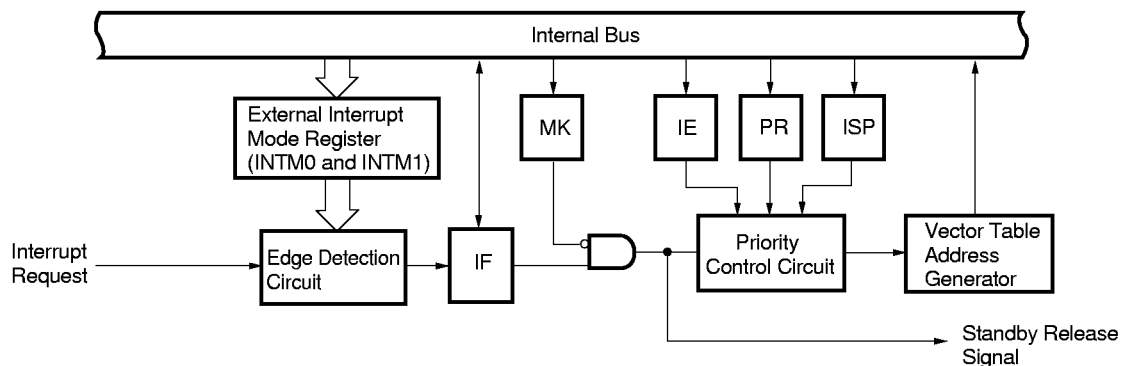
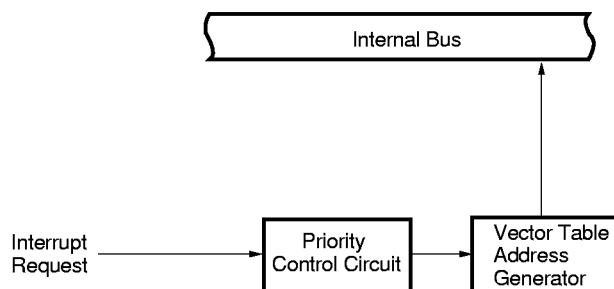


Figure 6-1. Interrupt Function Basic Configuration(2/2)

(D) External maskable interrupt (except INTP0)



(E) Software interrupt



- IF : Interrupt request flag
- IE : Interrupt enable flag
- ISP : In-service priority flag
- MK : Interrupt mask flag
- PR : Priority specification flag

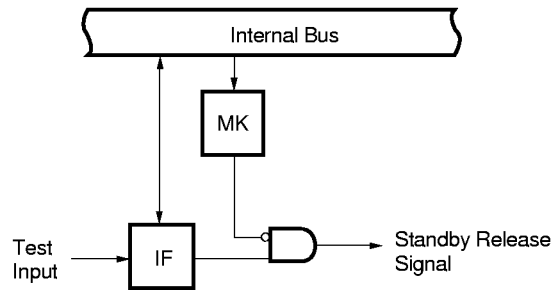
6.2 Test Functions

There are two test functions as shown in Table 6-2.

Table 6-2. Test Input Source List

Test Input Source		Internal/External
Name	Trigger	
INTWT	Watch timer overflow	Internal
INTPT4	Port 4 falling edge detection	External

Figure 6-2. Test Function Basic Configuration



IF : Test input flag

MK : Test mask flag



7. EXTERNAL DEVICE EXPANSION FUNCTIONS

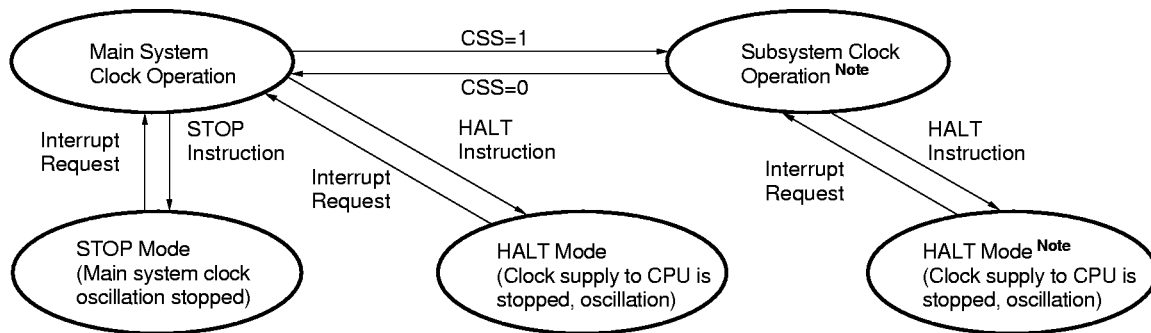
The external device expansion functions connect external devices to areas other than the internal ROM, RAM, and SFR. Ports 4 to 6 are used for external device connection.

8. STANDBY FUNCTION

There are the following two standby functions to reduce the system current consumption.

- HALT mode : The CPU operating clock is stopped.  
The average current consumption can be reduced by intermittent operation in combination with the normal operating mode.
- STOP mode : The main system clock oscillation is stopped. The whole operation by the main system clock is stopped, so that the system operates with ultra-low current consumption using only the subsystem clock.

Figure 8-1. Standby Function



**Note** The current consumption can be reduced by stopping the main system clock. When the CPU is operating on the subsystem clock, set bit 7 (MCC) of processor clock control register (PCC) to stop the main system clock. The STOP instruction cannot be used.

**Caution** When the main system clock is stopped and the system is operated by the subsystem clock, the subsystem clock should be switched again to the main system clock after the oscillation stabilization time is secured by the program.

9. RESET FUNCTION

There are the following two reset methods.

- External reset input by  $\overline{\text{RESET}}$  pin
- Internal reset by watchdog time runaway time detection

10. INSTRUCTION SET

(1) 8-bit instructions

MOV, XCH, ADD ADDC, SUB, SUBC, AND, OR, XOR, CMP, MULU, DIVUW, INC, DEC, ROR, ROL, RORC, ROLC, ROR4, ROL4, PUSH, POP, DBNZ

Second Operand First Operand	#byte	A	r Note	sfr	saddr	laddr16	PSW	[DE]	[HL]	[HL + Byte] [HL + B] [HL + C]	\$addr16	1	None
A	ADD ADDC SUB SUBC AND OR XOR CMP		MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV	MOV XCH	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP	MOV XCH ADD ADDC SUB SUBC AND OR XOR CMP		ROR ROL RORC ROLC	
r	MOV	MOV ADD ADDC SUB SUBC AND OR XOR CMP											INC DEC
B, C											DBNZ		
sfr	MOV	MOV											
saddr	MOV ADD ADDC SUB SUBC AND OR XOR CMP	MOV									DBNZ		INC DEC
!addr16		MOV											
PSW	MOV	MOV											PUSH POP
[DE]		MOV											
[HL]		MOV											ROR4 ROL4
[HL + Byte] [HL + B] [HL + C]		MOV											
X													MULU
C													DIVUW

★

Note Except r = A

**(2) 16-bit instructions**

MOV, XCHW, ADDW, SUBW, CMPW, PUSH, POP, INCW, DECW

Second Operand First Operand	#word	AX	rp <sup>Note</sup>	sfrp	saddrp	laddr16	SP	None
AX	ADDW SUBW CMPW		MOVW XCHW	MOVW	MOVW	MOVW	MOVW	
rp	MOVW	MOVW <sup>Note</sup>						INCW DECW PUSH POP
sfrp	MOVW	MOVW						
saddrp	MOVW	MOVW						
laddr16		MOVW						
SP	MOVW	MOVW						

**Note** Only when rp = BC, DE, or HL

**(3) Bit manipulate instructions**

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

Second Operand First Operand	A.bit	sfr.bit	saddr.bit	PSW.bit	[HL].bit	CY	\$addr16	None
A.bit						MOV1	BT BF BTCLR	SET1 CLR1
sfr.bit						MOV1	BT BF BTCLR	SET1 CLR1
saddr.bit						MOV1	BT BF BTCLR	SET1 CLR1
PSW.bit						MOV1	BT BF BTCLR	SET1 CLR1
[HL].bit						MOV1	BT BF BTCLR	SET1 CLR1
CY	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1	MOV1 AND1 OR1 XOR1			SET1 CLR1 NOT1

**(4) Call instruction/branch instructions**

CALL, CALLF, CALLT, BR, BC, BNC, BZ, BNZ, BT, BF, BTCLR, DBNZ

Second Operand First Operand	AX	!addr16	!addr11	[addr5]	\$addr16
Basic instruction	BR	CALL BR	CALLF	CALLT	BR BC BNC BZ BNZ
Compound instruction					BT BF BTCLR DBNZ

**(5) Other instructions**

ADJBA, ADJBS, BRK, RET, RETI, RETB, SEL, NOP, EI, DI, HALT, STOP

11. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T<sub>A</sub> = 25°C)

Parameter	Symbol	Test Conditions		Rating	Unit
Supply voltage	V <sub>DD</sub>			-0.3 to +7.0	V
	AV <sub>DD</sub>			-0.3 to V <sub>DD</sub> + 0.3	V
	AV <sub>REF0</sub>			-0.3 to V <sub>DD</sub> + 0.3	V
	AV <sub>REF1</sub>			-0.3 to V <sub>DD</sub> + 0.3	V
	AV <sub>SS</sub>			-0.3 to +0.3	V
Input voltage	V <sub>I1</sub>	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P72, P120 to P127, P130, P131, X1, X2, XT2, RESET		-0.3 to V <sub>DD</sub> + 0.3	V
	V <sub>I2</sub>	P60 to P63	N-ch Open-drain	-0.3 to +16	V
Output voltage	V <sub>O</sub>			-0.3 to V <sub>DD</sub> + 0.3	V
Analog input voltage	V <sub>AN</sub>	P10 to P17	Analog input pin	AV <sub>SS</sub> - 0.3 to AV <sub>REF0</sub> + 0.3	V
Output current high	I <sub>OH</sub>	1 pin		-10	mA
		P01 to P06, P30 to P37, P56, P57, P60 to P67, P120 to P127 total		-15	mA
		P10 to P17, P20 to P27, P40 to P47, P50 to P55, P70 to P72, P130, P131 total		-15	mA
Output current low	I <sub>OL</sub> <b>Note 2</b>	1 pin	Peak value	30	mA
			r.m.s. value	15	mA
		P50 to P55 total	Peak value	100	mA
			r.m.s. value	70	mA
		P56, P57, P60 to P63 total	Peak value	100	mA
			r.m.s. value	70	mA
		P10 to P17, P20 to P27, P40 to P47, P70 to P72, P130, P131 total	Peak value	50	mA
			r.m.s. value	20	mA
P01 to P06, P30 to P37, P64 to P67, P120 to P127 total	Peak value	50	mA		
	r.m.s. value	20	mA		
Operating ambient temperature	T <sub>A</sub>			-40 to +85	°C
Storage temperature	T <sub>stg</sub>			-65 to +150	°C

**Note** The r.m.s. should be calculated as follows: [r.m.s.] = [Peak value] × √duty

**Caution** If any of the parameters exceed the absolute maximum ratings, even momentarily, device reliability may be impaired. The absolute maximum ratings are values that may physically damage the product. Be sure to use the product within the ratings.

**Remark** The characteristics of dual-function pins and port pins are the same unless otherwise specified.

Main System Clock Oscillation Circuit Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

Resonator	Recommended Circuit	Parameter	Test Conditions	MIN.	TYP.	MAX.	Unit
Ceramic resonator		Oscillator frequency (f <sub>x</sub> ) <b>Note 1</b>	V <sub>DD</sub> = Oscillator voltage range	1.0		5.0	MHz
		Oscillation stabilization time <b>Note 2</b>	After V <sub>DD</sub> reaches oscillation voltage range MIN.			4	ms
Crystal resonator		Oscillator frequency (f <sub>x</sub> ) <b>Note 1</b>		1.0		5.0	MHz
		Oscillation stabilization time <b>Note 2</b>	V <sub>DD</sub> = 4.5 to 6.0 V			10	ms
						30	
External clock		X1 input frequency (f <sub>x</sub> ) <b>Note 1</b>		1.0		5.0	MHz
		X1 input high/low level width (t <sub>xH</sub> , t <sub>xL</sub> )			85		500

**Notes** 1. Indicates only oscillation circuit characteristics. Refer to “AC Characteristics” for instruction execution time.

2. Time required to stabilize oscillation after reset or STOP mode release.

**Cautions** 1. When using the main system clock oscillator, wiring in the area enclosed with the broken line should be carried out as follows to avoid adverse effects from wiring capacitance.

- Wiring should be as short as possible.
- Wiring should not cross other signal lines.
- Wiring should not be placed close to a varying high current.
- The potential of the oscillator capacitor ground should be the same as V<sub>SS</sub>.
- Do not ground wiring to a ground pattern in which a high current flows.
- Do not fetch a signal from the oscillator.

2. When the main system clock is stopped and the system is operated by the subsystem clock, the subsystem clock should be switched again to the main system clock after the oscillation stabilization time is secured by the program.

Subsystem Clock Oscillation Circuit Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

Resonator	Recommended Circuit	Parameter	Test Conditions	MIN.	TYP.	MAX.	Unit
Crystal resonator		Oscillator frequency (f <sub>XT</sub> ) <b>Note 1</b>		32	32.768	35	kHz
		Oscillation stabilization time <b>Note 2</b>	V <sub>DD</sub> = 4.5 to 6.0 V		1.2	2	s
External clock		XT1 input frequency (f <sub>XT</sub> ) <b>Note 1</b>		32		100	kHz
		XT1 input high/low level width (t <sub>XTH</sub> , t <sub>XTL</sub> )		5		15	μs

**Notes** 1. Indicates only oscillation circuit characteristics. Refer to **AC Characteristics** for instruction execution time.

★ 2. Time required to stabilize oscillation after V<sub>DD</sub> reaches MIN. in the oscillation voltage range.

**Cautions** 1. When using the subsystem clock oscillator, wiring in the area enclosed with the broken line should be carried out as follows to avoid an adverse effect from wiring capacitance.

- Wiring should be as short as possible.
- Wiring should not cross other signal lines.
- Wiring should not be placed close to a varying high current.
- The potential of the oscillator capacitor ground should be the same as VSS.
- Do not ground wiring to a ground pattern in which a high current flows.
- Do not fetch a signal from the oscillator.

2. The subsystem clock oscillation circuit is a circuit with a low amplification level, more prone to misoperation due to noise than the main system clock. When using the subsystem clock, pay special attention to wiring as described above.

**Recommended Oscillator Constant**

(1) μPD78052Y, 78053Y, 78054Y, 78055Y, 78056Y

**Main System Clock: Ceramic Resonator (T<sub>A</sub> = -40 to +85°C)**

Manufacturer	Product Name	Frequency (MHz)	Recommended Circuit constant		Oscillator Voltage range		Remarks
			C1 (pF)	C2 (pF)	MIN. (V)	MAX. (V)	
Murata Mfg. Co., Ltd.	CSA5.00MG	5.00	30	30	2.0	6.0	
	GST5.00MGW	5.00	On-chip	On-chip	2.0	6.0	Capacitor on chip
Kyocera Corp.	KBR-5.0MSA	5.00	33	33	2.0	6.0	Lead type
	KBR-5.0MKS	5.00	On-chip	On-chip	2.0	6.0	Capacitor on chip, lead type
	KBR-5.0MWS	5.00	On-chip	On-chip	2.0	6.0	Capacitor on chip, lead type
	PBRC 5.00A	5.00	33	33	2.0	6.0	Chip type
TDK Corp.	CCR4.0MC3	4.00	On-chip	On-chip	2.0	6.0	Capacitor on chip
	CCR5.0MC3	5.00	On-chip	On-chip	2.0	6.0	Capacitor on chip

**Main System Clock: Crystal Resonator (T<sub>A</sub> = -10 to +70°C)**

Manufacturer	Product Name	Frequency (MHz)	Recommended Circuit Constant			Oscillator Voltage Range	
			C1 (pF)	C2 (pF)	R1 (kΩ)	MIN. (V)	MAX. (V)
Daishinku Corp.	SMD-49	3.579545	27	27	1.5	2.0	6.0

**Subsystem Clock: Crystal Resonator (T<sub>A</sub> = -10 to +70°C)**

Manufacturer	Product Name	Frequency (MHz)	Recommended Circuit Constant			Oscillator Voltage Range	
			C3 (pF)	C4 (pF)	R2 (kΩ)	MIN. (V)	MAX. (V)
Daishinku Corp.	DT-38 (1TA252E00)	32.768	27	20	330	2.0	6.0

★ **Caution** The oscillation circuit constants and oscillation voltage range indicate conditions for stable oscillation. However, they do not guarantee accuracy of the oscillation frequency. If the application circuit requires accuracy of the oscillation frequency, it is necessary to set the oscillation frequency in the application circuit. For this, it is necessary to directly contact the manufacturer of the resonator being used.



(2) μPD78058Y

Main System Clock: Ceramic Resonator (T<sub>A</sub> = -40 to +85°C)

Manufacturer	Product Name	Frequency (MHz)	Recommended Circuit constant		Oscillator Voltage range		Remarks
			C1 (pF)	C2 (pF)	MIN. (V)	MAX. (V)	
Kyocera Corp.	PBRC4.19A	4.19	33	33	2.0	6.0	
	PBRC4.19B	4.19	On-chip	On-chip	2.0	6.0	Capacitor on chip
	KBR-4.19MSA	4.19	33	33	2.0	6.0	
	KBR-4.19MKS	4.19	On-chip	On-chip	2.0	6.0	Capacitor on chip
	PBRC4.91A	4.91	33	33	2.0	6.0	
	PBRC4.91B	4.91	On-chip	On-chip	2.0	6.0	Capacitor on chip
	KBR-4.91MSA	4.91	33	33	2.0	6.0	
	KBR-4.91MKS	4.91	On-chip	On-chip	2.0	6.0	Capacitor on chip

★ **Caution** The oscillation circuit constants and oscillation voltage range indicate conditions for stable oscillation. However, they do not guarantee accuracy of the oscillation frequency. If the application circuit requires accuracy of the oscillation frequency, it is necessary to set the oscillation frequency in the application circuit. For this, it is necessary to directly contact the manufacturer of the resonator being used.

Capacitance (T<sub>A</sub> = 25°C, V<sub>DD</sub> = V<sub>SS</sub> = 0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Input capacitance	C <sub>IN</sub>	f = 1 MHz Measured pins returned to 0 V.				15	pF
Input/output capacitance	C <sub>IO</sub>	f = 1 MHz Measured pins returned to 0 V.	P01 to P06, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P72, P120 to P127, P130, P131			15	pF
			P60 to P63			20	pF

**Remark** The characteristics of the dual-function pins and port pins are the same unless otherwise specified.

DC Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX	Unit	
Input voltage, high	V <sub>IH1</sub>	P10 to P17, P21, P23, P30 to P32, P35 to P37, P40 to P47, P50 to P57, P64 to P67, P71, P120 to P127, P130, P131	V <sub>DD</sub> = 2.7 to 6.0 V	0.7 V <sub>DD</sub>		V <sub>DD</sub>	V
				0.8 V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH2</sub>	P00 to P06, P20, P22, P24 to P27, P33, P34, P70, P72, $\overline{\text{RESET}}$	V <sub>DD</sub> = 2.7 to 6.0 V	0.8 V <sub>DD</sub>		V <sub>DD</sub>	V
				0.85 V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH3</sub>	P60 to P63 (N-ch open-drain)	V <sub>DD</sub> = 2.7 to 6.0 V	0.7 V <sub>DD</sub>		15	V
				0.8 V <sub>DD</sub>		15	V
	V <sub>IH4</sub>	X1, X2	V <sub>DD</sub> = 2.7 to 6.0 V	V <sub>DD</sub> - 0.5		V <sub>DD</sub>	V
				V <sub>DD</sub> - 0.2		V <sub>DD</sub>	V
	V <sub>IH5</sub>	XT1/P07, XT2	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	0.8 V <sub>DD</sub>		V <sub>DD</sub>	V
			2.7 V ≤ V <sub>DD</sub> < 4.5 V	0.9 V <sub>DD</sub>		V <sub>DD</sub>	V
2.0 V ≤ V <sub>DD</sub> < 2.7 V <sup>Note</sup>			0.9 V <sub>DD</sub>		V <sub>DD</sub>	V	
Input voltage, low	V <sub>IL1</sub>	P10 to P17, P21, P23, P30 to P32, P35 to P37, P40 to P47, P50 to P57, P64 to P67, P71, P120 to P127, P130, P131	V <sub>DD</sub> = 2.7 to 6.0 V	0		0.3 V <sub>DD</sub>	V
				0		0.2 V <sub>DD</sub>	V
	V <sub>IL2</sub>	P00 to P06, P20, P22, P24 to P27, P33, P34, P70, P72, $\overline{\text{RESET}}$	V <sub>DD</sub> = 2.7 to 6.0 V	0		0.2 V <sub>DD</sub>	V
				0		0.15 V <sub>DD</sub>	V
	V <sub>IL3</sub>	P60 to P63	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	0		0.3 V <sub>DD</sub>	V
			2.7 V ≤ V <sub>DD</sub> < 4.5 V	0		0.2 V <sub>DD</sub>	V
				0		0.1 V <sub>DD</sub>	V
	V <sub>IL4</sub>	X1, X2	V <sub>DD</sub> = 2.7 to 6.0 V	0		0.4	V
				0		0.2	V
	V <sub>IL5</sub>	XT1/P07, XT2	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	0		0.2 V <sub>DD</sub>	V
2.7 V ≤ V <sub>DD</sub> < 4.5 V			0		0.1 V <sub>DD</sub>	V	
2.0 V ≤ V <sub>DD</sub> < 2.7 V <sup>Note</sup>			0		0.1 V <sub>DD</sub>	V	
Output voltage, high	V <sub>OH</sub>	V <sub>DD</sub> = 4.5 to 6.0 V, I <sub>OH</sub> = -1 mA	V <sub>DD</sub> - 1.0			V	
		I <sub>OH</sub> = -100 μA	V <sub>DD</sub> - 0.5			V	
Output voltage, low	V <sub>OL1</sub>	P50 to P57, P60 to P63	V <sub>DD</sub> = 4.5 to 6.0 V, I <sub>OL</sub> = 15 mA		0.4	2.0	V
		P01 to P06, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P64 to P67, P70 to P72, P120 to P127, P130, P131	V <sub>DD</sub> = 4.5 to 6.0 V, I <sub>OL</sub> = 1.6 mA			0.4	V
	V <sub>OL2</sub>	SB0, SB1, $\overline{\text{SCK0}}$	V <sub>DD</sub> = 4.5 to 6.0 V, open-drain, pulled-up (R = 1 KΩ)			0.2 V <sub>DD</sub>	V
	V <sub>OL3</sub>	I <sub>OL</sub> = 400 μA				0.5	V

**Note** For use the P07/XT1 pin as P07, input the reverse phase of P07 to the XT2 pin.

**Remark** The characteristics of dual-function pins and port pins are the same unless otherwise specified.

DC Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.7 to 6.0 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Input leakage current, high	I <sub>LH1</sub>	V <sub>IN</sub> = V <sub>DD</sub>	P00 to P06, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P72, P120 to P127, P130, P131, $\overline{\text{RESET}}$			3	μA
	I <sub>LH2</sub>		X1, X2, XT1/P07, XT2			20	μA
	I <sub>LH3</sub>	V <sub>IN</sub> = 15 V	P60 to P63			80	μA
Input leakage current, low	I <sub>LIL1</sub>	V <sub>IN</sub> = 0 V	P00 to P06, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P72, P120 to P127, P130, P131, $\overline{\text{RESET}}$			-3	μA
	I <sub>LIL2</sub>		X1, X2, XT1/P07, XT2			-20	μA
	I <sub>LIL3</sub>		P60 to P63			-3 <sup>Note 1</sup>	μA
Output leakage current, high	I <sub>LOH</sub>	V <sub>OUT</sub> = V <sub>DD</sub>				3	μA
Output leakage current, low	I <sub>LOL</sub>	V <sub>OUT</sub> = 0 V				-3	μA
Mask option pull-up resistor	R <sub>1</sub>	V <sub>IN</sub> = 0 V, P60 to P63		20	40	90	kΩ
Software pull-up resistor <sup>Note 2</sup>	R <sub>2</sub>	V <sub>IN</sub> = 0 V, P01 to P06, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P72, P120 to P127, P130, P131	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	15	40	90	kΩ
			2.7 V ≤ V <sub>DD</sub> < 4.5 V	20		500	kΩ

- Notes**
1. If no pull-up resistor is connected in P60 to P63 (specified with mask option), a -200 μA (MAX.) low-level input leak current flows only during the 1.5-clock interval (no wait interval) during which a read instruction is executed for port 6 (P6) and port mode register (PM6).  
The leak current is -3 μA (MAX.) at all times other than the 1.5-clock interval during which the read instruction is executed.
  2. A software pull-up resistor can be used only in the range of V<sub>DD</sub> = 2.7 to 6.0 V.

**Remark** The characteristics of dual-function pins and port pins are the same unless otherwise specified.

DC Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX	Unit	
Power supply current <b>Note 5</b>	I <sub>DD1</sub>	5.0 MHz Crystal oscillation operating mode (f <sub>XX</sub> = 2.5 MHz) <b>Note 3</b>	V <sub>DD</sub> = 5.0 V ±10 % <b>Note 1</b>		4	12	mA
			V <sub>DD</sub> = 3.0 V ±10 % <b>Note 2</b>		0.6	1.8	mA
			V <sub>DD</sub> = 2.2 V ±10 % <b>Note 2</b>		0.35	1.05	mA
		5.0 MHz Crystal oscillation operating mode (f <sub>XX</sub> = 5.0 MHz) <b>Note 4</b>	V <sub>DD</sub> = 5.0 V ±10 % <b>Note 1</b>		6.5	19.5	mA
			V <sub>DD</sub> = 3.0 V ±10 % <b>Note 2</b>		0.8	2.4	mA
	I <sub>DD2</sub>	5.0 MHz Crystal oscillation HALT mode (f <sub>XX</sub> = 2.5 MHz) <b>Note 3</b>	V <sub>DD</sub> = 5.0 V ±10 %		1.4	4.2	mA
			V <sub>DD</sub> = 3.0 V ±10 %		0.5	1.5	mA
			V <sub>DD</sub> = 2.2 V ±10 %		280	840	μA
		5.0 MHz Crystal oscillation HALT mode (f <sub>XX</sub> = 5.0 MHz) <b>Note 4</b>	V <sub>DD</sub> = 5.0 V ±10 %		1.6	4.8	mA
			V <sub>DD</sub> = 3.0 V ±10 %		0.65	1.95	mA
	I <sub>DD3</sub>	32.768 kHz Crystal oscillation operating mode <b>Note 6</b>	V <sub>DD</sub> = 5.0 V ±10 %		60	120	μA
			V <sub>DD</sub> = 3.0 V ±10 %		32	64	μA
			V <sub>DD</sub> = 2.2 V ±10 %		24	48	μA
I <sub>DD4</sub>	32.768 kHz Crystal oscillation HALT mode <b>Note 6</b>	V <sub>DD</sub> = 5.0 V ±10 %		25	55	μA	
		V <sub>DD</sub> = 3.0 V ±10 %		5	15	μA	
		V <sub>DD</sub> = 2.2 V ±10 %		2.5	12.5	μA	
I <sub>DD5</sub>	XT1 = V <sub>DD</sub> STOP mode When feedback resistor is used	V <sub>DD</sub> = 5.0 V ±10 %		1	30	μA	
		V <sub>DD</sub> = 3.0 V ±10 %		0.5	10	μA	
		V <sub>DD</sub> = 2.2 V ±10 %		0.3	10	μA	
I <sub>DD6</sub>	XT1 = V <sub>DD</sub> STOP mode When feedback resistor is unused	V <sub>DD</sub> = 5.0 V ±10 %		0.1	30	μA	
		V <sub>DD</sub> = 3.0 V ±10 %		0.05	10	μA	
		V <sub>DD</sub> = 2.2 V ±10 %		0.05	10	μA	

- Notes**
1. The on-chip pull-up resistor, AV<sub>REF0</sub>, AV<sub>REF1</sub>, AV<sub>DD</sub> current, and port current are not included.
  2. Operation with main system clock f<sub>XX</sub> = f<sub>X</sub>/2 (when oscillation mode selection register (OSMS) is set to 00H)
  3. Operation with main system clock f<sub>XX</sub> = f<sub>X</sub> (when OSMS is set to 01H)
  4. When the main system clock operation is halted.
  5. Operating in high-speed mode (when the processor clock control register (PCC) is set to 00H.)
  6. Operating in low-speed mode (when PCC is set to 04H)

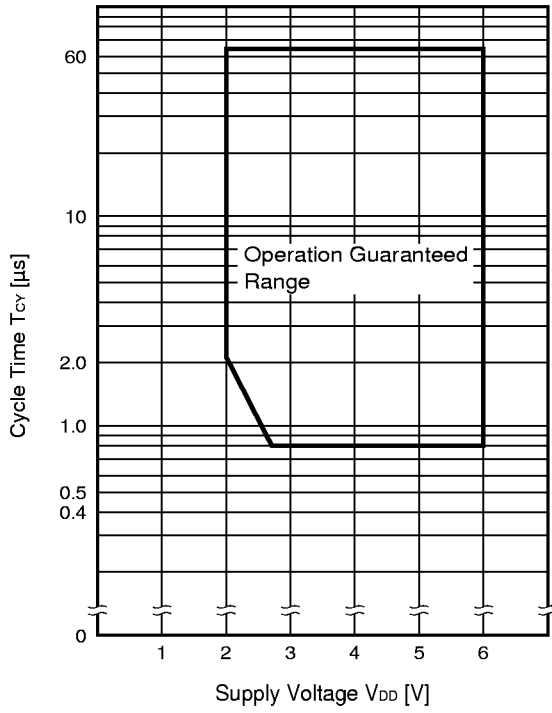
AC Characteristics

(1) Basic Operation (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

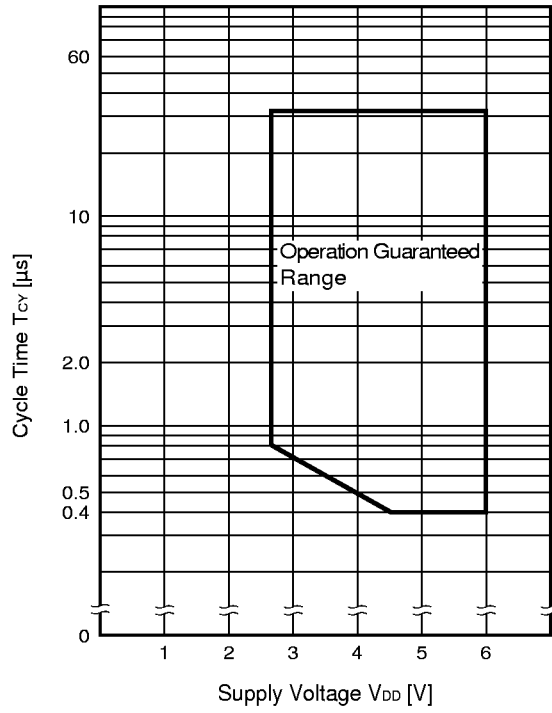
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit	
Cycle time (Min. instruction execution time)	T <sub>cy</sub>	Operating on main system clock (f <sub>xx</sub> = 2.5 MHz) <sup>Note 1</sup>	V <sub>DD</sub> = 2.7 to 6.0 V	0.8		64	μs
				2.2		64	μs
		Operating on main system clock (f <sub>xx</sub> = 5.0 MHz) <sup>Note 2</sup>	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	0.4		32	μs
			2.7 V ≤ V <sub>DD</sub> < 4.5 V	0.8		32	μs
		Operating on sub system clock	40 <sup>Note 3</sup>	122	125	μs	
TI00 input high-/low-level width	t <sub>TIH00</sub> , t <sub>TIL00</sub>	3.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	2/f <sub>sam</sub> + 0.1 <sup>Note 4</sup>			μs	
		2.7 V ≤ V <sub>DD</sub> < 3.5 V	2/f <sub>sam</sub> + 0.2 <sup>Note 4</sup>			μs	
			2/f <sub>sam</sub> + 0.5 <sup>Note 4</sup>			μs	
TI01 input high-/low-level width	t <sub>TIH01</sub> , t <sub>TIL01</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	10			μs	
			20			μs	
TI1, TI2 input frequency	f <sub>TI1</sub>	V <sub>DD</sub> = 4.5 to 6.0 V	0		4	MHz	
			0		275	kHz	
TI1, TI2 input high-/low-level width	t <sub>TIH1</sub> , t <sub>TIL1</sub>	V <sub>DD</sub> = 4.5 to 6.0 V	100			ns	
			1.8			μs	
Interrupt request input high-/ low-level width	t <sub>INTH</sub> , t <sub>INTL</sub>	INTP0	3.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	2/f <sub>sam</sub> + 0.1 <sup>Note 4</sup>		μs	
			2.7 V ≤ V <sub>DD</sub> < 3.5 V	2/f <sub>sam</sub> + 0.2 <sup>Note 4</sup>		μs	
				2/f <sub>sam</sub> + 0.5 <sup>Note 4</sup>		μs	
			INTP1 to INTP6, KR0 to KR7	V <sub>DD</sub> = 2.7 to 6.0 V	10		μs
				20		μs	
RESET low level width	t <sub>RSL</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	10			μs	
			20			μs	

- Notes**
1. Main system clock f<sub>xx</sub> = f<sub>x</sub>/2 operation (when an oscillation mode selection register (OSMS) is set to 00H)
  2. Main system clock f<sub>xx</sub> = f<sub>x</sub> operation (when OSMS is set to 01H)
  3. On an external clock. When a crystal resonator is used, the minimum value is 114 μs.
  4. In combination with bits 0 (SCS0) and 1 (SCS1) of sampling clock selection register, f<sub>sam</sub> is selectable between f<sub>xx</sub>/2<sup>N</sup>, f<sub>xx</sub>/32, f<sub>xx</sub>/64, and f<sub>xx</sub>/128 (when N = 0 to 4).

$T_{CY}$  vs  $V_{DD}$  (At  $f_{xx} = f_x/2$  main system clock operation)



$T_{CY}$  vs  $V_{DD}$  (At  $f_{xx} = f_x$  main system clock operation)



## (2) Read/write Operation

(a) When MCS = 1, PCC2 to PCC0 = 000B ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 4.5$  to  $6.0$  V)

Parameter	Symbol	Test Conditions	MIN.	MAX.	Unit
ASTB high-level width	$t_{ASTH}$		$0.85t_{CY} - 50$		ns
Address setup time	$t_{ADS}$		$0.85t_{CY} - 50$		ns
Address hold time	$t_{ADH}$		50		ns
Data input time from address	$t_{ADD1}$			$(2.85 + 2n)t_{CY} - 80$	ns
	$t_{ADD2}$			$(4 + 2n)t_{CY} - 100$	ns
Data input time from $\overline{RD}\downarrow$	$t_{RDD1}$			$(2 + 2n)t_{CY} - 100$	ns
	$t_{RDD2}$			$(2.85 + 2n)t_{CY} - 100$	ns
Read data hold time	$t_{RDH}$		0		ns
$\overline{RD}$ low-level width	$t_{RDL1}$		$(2 + 2n)t_{CY} - 60$		ns
	$t_{RDL2}$		$(2.85 + 2n)t_{CY} - 60$		ns
$\overline{WAIT}\downarrow$ input time from $\overline{RD}\downarrow$	$t_{RDWT1}$			$0.85t_{CY} - 50$	ns
	$t_{RDWT2}$			$2t_{CY} - 60$	ns
$\overline{WAIT}\downarrow$ input time from $\overline{WR}\downarrow$	$t_{WRWT}$			$2t_{CY} - 60$	ns
$\overline{WAIT}$ low-level width	$t_{WTL}$		$(1.15 + 2n)t_{CY}$	$(2 + 2n)t_{CY}$	ns
Write data setup time	$t_{WDS}$		$(2.85 + 2n)t_{CY} - 100$		ns
Write data hold time	$t_{WDH}$		20		ns
$\overline{WR}$ low-level width	$t_{WRL}$		$(2.85 + 2n)t_{CY} - 60$		ns
$\overline{RD}\downarrow$ delay time from $\overline{ASTB}\downarrow$	$t_{ASTRD}$		25		ns
$\overline{WR}\downarrow$ delay time from $\overline{ASTB}\downarrow$	$t_{ASTWR}$		$0.85t_{CY} + 20$		ns
ASTB $\uparrow$ delay time from $\overline{RD}\uparrow$ in external fetch	$t_{RDAST}$		$0.85t_{CY} - 10$	$1.15t_{CY} + 20$	ns
Address hold time from $\overline{RD}\uparrow$ in external fetch	$t_{RDADH}$		$0.85t_{CY} - 50$	$1.15t_{CY} + 50$	ns
Write data output time from $\overline{RD}\uparrow$	$t_{RDWD}$		40		ns
Write data output time from $\overline{WR}\downarrow$	$t_{RDWD}$		0	50	ns
Address hold time from $\overline{WR}\uparrow$	$t_{WRADH}$		$0.85t_{CY}$	$1.15t_{CY} + 40$	ns
$\overline{RD}\uparrow$ delay time from $\overline{WAIT}\uparrow$	$t_{WTRD}$		$1.15t_{CY} + 40$	$3.15t_{CY} + 40$	ns
$\overline{WR}\uparrow$ delay time from $\overline{WAIT}\uparrow$	$t_{WTWR}$		$1.15t_{CY} + 30$	$3.15t_{CY} + 30$	ns

**Remarks 1.** MCS: Oscillation mode selection register (OSMS) bit 0**2.** PCC2 to PCC0: Processor clock control register (PCC) bit 2 to 0**3.**  $t_{CY} = T_{CY}/4$ **4.** n indicates number of waits.

(b) Except when MCS = 1, PCC2 to PCC0 = 000B (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

(1/2)

Parameter	Symbol	Test Conditions	MIN.	MAX.	Unit
ASTB high-level width	t <sub>ASTH</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	t <sub>cy</sub> - 80		ns
			t <sub>cy</sub> - 150		ns
Address setup time	t <sub>ADS</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	t <sub>cy</sub> - 80		ns
			t <sub>cy</sub> - 150		ns
Address hold time	t <sub>ADH</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0.4t <sub>cy</sub> - 10		ns
			0.37t <sub>cy</sub> - 40		ns
Data input time from address	t <sub>ADD1</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		(3 + 2n)t <sub>cy</sub> - 160	ns
				(3 + 2n)t <sub>cy</sub> - 320	ns
	t <sub>ADD2</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		(4 + 2n)t <sub>cy</sub> - 200	ns
				(4 + 2n)t <sub>cy</sub> - 300	ns
Data input time from $\overline{RD}\downarrow$	t <sub>RDD1</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		(1.4 + 2n)t <sub>cy</sub> - 70	ns
				(1.37 + 2n)t <sub>cy</sub> - 120	ns
	t <sub>RDD2</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		(2.4 + 2n)t <sub>cy</sub> - 70	ns
				(2.37 + 2n)t <sub>cy</sub> - 120	ns
Read data hold time	t <sub>RDH</sub>		0		ns
$\overline{RD}$ low-level width	t <sub>RDL1</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	(1.4 + 2n)t <sub>cy</sub> - 20		ns
			(1.37 + 2n)t <sub>cy</sub> - 20		ns
	t <sub>RDL2</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	(2.4 + 2n)t <sub>cy</sub> - 20		ns
			(2.37 + 2n)t <sub>cy</sub> - 20		ns
$\overline{WAIT}\downarrow$ input time from $\overline{RD}\downarrow$	t <sub>RDWT1</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		t <sub>cy</sub> - 100	ns
				t <sub>cy</sub> - 200	ns
	t <sub>RDWT2</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		2t <sub>cy</sub> - 100	ns
				2t <sub>cy</sub> - 200	ns
$\overline{WAIT}\downarrow$ input time from $\overline{WR}\downarrow$	t <sub>WRWT</sub>	V <sub>DD</sub> = 2.7 to 6.0 V		2t <sub>cy</sub> - 100	ns
				2t <sub>cy</sub> - 200	ns
$\overline{WAIT}$ low-level width	t <sub>WTL</sub>		(1 + 2n)t <sub>cy</sub>	(2 + 2n)t <sub>cy</sub>	ns
Write data setup time	t <sub>WDS</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	(2.4 + 2n)t <sub>cy</sub> - 60		ns
			(2.37 + 2n)t <sub>cy</sub> - 100		ns
Write data hold time	t <sub>WDH</sub>		20		ns
$\overline{WR}$ low-level width	t <sub>WRL</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	(2.4 + 2n)t <sub>cy</sub> - 20		ns
			(2.37 + 2n)t <sub>cy</sub> - 20		ns
$\overline{RD}\downarrow$ delay time from $\overline{ASTB}\downarrow$	t <sub>ASTRD</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0.4t <sub>cy</sub> - 30		ns
			0.37t <sub>cy</sub> - 50		ns
$\overline{WR}\downarrow$ delay time from $\overline{ASTB}\downarrow$	t <sub>ASTWR</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	1.4t <sub>cy</sub> - 30		ns
			1.37t <sub>cy</sub> - 50		ns

- Remarks**
1. MCS: Oscillation mode selection register (OSMS) bit 0
  2. PCC2 to PCC0: Processor clock control register (PCC) bit 2 to 0
  3. t<sub>cy</sub> = T<sub>cy</sub>/4
  4. n indicates the number of waits.



(b) Except when MCS = 1, PCC2 to PCC0 = 000B (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

(1/2)

Parameter	Symbol	Test Conditions	MIN.	MAX.	Unit
ASTB↑ delay time from RD↑ in external fetch	t <sub>RDAST</sub>		t <sub>cy</sub> - 10	t <sub>cy</sub> + 20	ns
Address hold time from RD↑ in external fetch	t <sub>RDADH</sub>		t <sub>cy</sub> - 50	t <sub>cy</sub> + 50	ns
Write data output time from RD↑	t <sub>RDWD</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0.4t <sub>cy</sub> - 20		ns
			0.37t <sub>cy</sub> - 40		ns
Write data output time from WR↓	t <sub>WRWD</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0	60	ns
			0	120	ns
Address hold time from WR↑	t <sub>WRADH</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	t <sub>cy</sub>	t <sub>cy</sub> + 60	ns
			t <sub>cy</sub>	t <sub>cy</sub> + 120	ns
RD↑ delay time from WAIT↑	t <sub>WTRD</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0.6t <sub>cy</sub> + 180	2.6t <sub>cy</sub> + 180	ns
			0.63t <sub>cy</sub> + 350	2.63t <sub>cy</sub> + 350	ns
WR↑ delay time from WAIT↑	t <sub>WTWR</sub>	V <sub>DD</sub> = 2.7 to 6.0 V	0.6t <sub>cy</sub> + 120	2.6t <sub>cy</sub> + 120	ns
			0.63t <sub>cy</sub> + 240	2.63t <sub>cy</sub> + 240	ns

- Remarks**
1. MCS: Oscillation mode selection register (OSMS) bit 0
  2. PCC2 to PCC0: Processor clock control register (PCC) bit 2 to 0
  3. t<sub>cy</sub> = T<sub>cy</sub>/4
  4. n indicates number of waits.

(3) Serial Interface (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V)

(a) Serial interface channel 0

(i) 3-wire serial I/O mode ( $\overline{\text{SCK0}}$ ... Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK0}}$ cycle time	t <sub>KCY1</sub>	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	800			ns
		2.7 V ≤ V <sub>DD</sub> < 4.5 V	1600			ns
			3200			ns
$\overline{\text{SCK0}}$ high-/low-level width	t <sub>KH1</sub> , t <sub>KL1</sub>	V <sub>DD</sub> = 4.5 to 6.0 V	t <sub>KCY1</sub> /2 - 50			ns
			t <sub>KCY1</sub> /2 - 100			ns
SIO setup time (to $\overline{\text{SCK0}}$ ↑)	t <sub>SIK1</sub>	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	100			ns
		2.7 V ≤ V <sub>DD</sub> < 4.5 V	150			ns
			300			ns
SIO hold time (from $\overline{\text{SCK0}}$ ↑)	t <sub>KSI1</sub>		400			ns
SO0 output delay time from $\overline{\text{SCK0}}$ ↓	t <sub>KSO1</sub>	C = 100 pF <b>Note</b>			300	ns

**Note** C is the load capacitance of  $\overline{\text{SCK0}}$ , SO0 output line.

(ii) 3-wire serial I/O mode ( $\overline{\text{SCK0}}$ ... External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK0}}$ cycle time	t <sub>KCY2</sub>	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	800			ns
		2.7 V ≤ V <sub>DD</sub> < 4.5 V	1600			ns
			3200			ns
$\overline{\text{SCK0}}$ high-/low-level width	t <sub>KH2</sub> , t <sub>KL2</sub>	4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	400			ns
		2.7 V ≤ V <sub>DD</sub> < 4.5 V	800			ns
			1600			ns
SIO setup time (to $\overline{\text{SCK0}}$ ↑)	t <sub>SIK2</sub>		100			ns
SIO hold time (from $\overline{\text{SCK0}}$ ↑)	t <sub>KSI2</sub>		400			ns
SO0 output delay time from $\overline{\text{SCK0}}$ ↓	t <sub>KSO2</sub>	C = 100 pF <b>Note</b>			300	ns
$\overline{\text{SCK0}}$ rise, fall time	t <sub>R2</sub> , t <sub>F2</sub>	When using external device expansion function			160	ns
		When not using external device expansion function			1000	ns

**Note** C is the load capacitance of SO0 output line.

(iii) 2-wire serial I/O mode ( $\overline{\text{SCK0}}$ ... Internal clock output)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK0}}$ cycle time	$t_{\text{KCY3}}$	R = 1 kΩ, C = 100 pF <b>Note</b>	V <sub>DD</sub> = 2.7 to 6.0 V	1600			ns
				3200			ns
$\overline{\text{SCK0}}$ high-level width	$t_{\text{KH3}}$		V <sub>DD</sub> = 2.7 to 6.0 V	$t_{\text{KCY3}}/2 - 160$			ns
				$t_{\text{KCY3}}/2 - 190$			ns
$\overline{\text{SCK0}}$ low-level width	$t_{\text{KL3}}$		V <sub>DD</sub> = 4.5 to 6.0 V	$t_{\text{KCY3}}/2 - 50$			ns
				$t_{\text{KCY3}}/2 - 100$			ns
SB0, SB1 setup time (to $\overline{\text{SCK0}}\uparrow$ )	$t_{\text{SIK3}}$		4.5 V ≤ V <sub>DD</sub> ≤ 6.0 V	300			ns
			2.7 V ≤ V <sub>DD</sub> < 4.5 V	350			ns
				400			ns
SB0, SB1 hold time (from $\overline{\text{SCK0}}\uparrow$ )	$t_{\text{KSI3}}$			600			ns
SB0, SB1 output delay time from $\overline{\text{SCK0}}\downarrow$	$t_{\text{KSO3}}$			0		300	ns

**Note** R and C are the load resistance and load capacitance of the  $\overline{\text{SCK0}}$ , SB0, and SB1 output line.

(iv) 2-wire serial I/O mode ( $\overline{\text{SCK0}}$ ... External clock input)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK0}}$ cycle time	$t_{\text{KCY4}}$	V <sub>DD</sub> = 2.7 to 6.0 V		1600			ns
				3200			ns
$\overline{\text{SCK0}}$ high-level width	$t_{\text{KH4}}$	V <sub>DD</sub> = 2.7 to 6.0 V		650			ns
				1300			ns
$\overline{\text{SCK0}}$ low-level width	$t_{\text{KL4}}$	V <sub>DD</sub> = 2.7 to 6.0 V		800			ns
				1600			ns
SB0, SB1 setup time (to $\overline{\text{SCK0}}\uparrow$ )	$t_{\text{SIK4}}$			100			ns
SB0, SB1 hold time (from $\overline{\text{SCK0}}\uparrow$ )	$t_{\text{KSI4}}$			$t_{\text{KCY4}}/2$			ns
SB0, SB1 output delay time from $\overline{\text{SCK0}}\downarrow$	$t_{\text{KSO4}}$	R = 1 kΩ, C = 100 pF <b>Note</b>	V <sub>DD</sub> = 4.5 to 6.0 V	0		300	ns
				0		500	ns
$\overline{\text{SCK0}}$ rise, fall time	$t_{\text{R4}}, t_{\text{F4}}$	When using external device expansion function				160	ns
		When not using external device expansion function				1000	ns

**Note** R and C are the load resistance and load capacitance of the  $\overline{\text{SCK0}}$ , SB0, and SB1 output line.

(v) I<sup>2</sup>C Bus mode (SCL...Internal clock output)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
SCL cycle time	t <sub>KCY5</sub>	R = 1 kΩ C = 100pF <sup>Note</sup>	V <sub>DD</sub> = 2.7 to 6.0 V	10			μs
				20			μs
SCL high-level width	t <sub>KH5</sub>		V <sub>DD</sub> = 2.7 to 6.0 V	t <sub>KCY5</sub> - 160			ns
				t <sub>KCY5</sub> - 190			ns
SCL low-level width	t <sub>KL5</sub>		V <sub>DD</sub> = 4.5 to 6.0 V	t <sub>KCY5</sub> - 50			ns
				t <sub>KCY5</sub> - 100			ns
SDA0, SDA1 setup time (to SCL↑)	t <sub>SIK5</sub>		V <sub>DD</sub> = 2.7 to 6.0 V	200			ns
				300			ns
SDA0, SDA1 hold time (to SCL↓)	t <sub>KSI5</sub>			0			ns
SDA0, SDA1 output delay time from SCL↓	t <sub>KSO5</sub>		V <sub>DD</sub> = 4.5 to 6.0 V	0		300	ns
				0		500	ns
SCL↑→SDA0, SDA1↓ or SCL↑→SDA0, SDA1↑	t <sub>KSB</sub>			200			ns
SDA0, SDA1↓→SCL↓	t <sub>SBK</sub>			400			ns
SDA0, SDA1 high-level width	t <sub>SBH</sub>			500			ns

**Note** R and C are the load resistance and load capacitance of the  $\overline{\text{SCK0}}$ , SB0, and SB1 output line.

(vi) I<sup>2</sup>C Bus mode (SCL...External clock input)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
SCL cycle time	t <sub>KCY6</sub>			1000			ns
SCL high-/low-level width	t <sub>KH6</sub> , t <sub>KL6</sub>			400			ns
SDA0, SDA1 setup time (to SCL↑)	t <sub>SIK6</sub>			200			ns
SDA0, SDA1 hold time (to SCL↓)	t <sub>KSI6</sub>			0			ns
SCL↓→SDA0, SDA1 output delay time	t <sub>KSO6</sub>	R = 1 kΩ, C = 100 pF <sup>Note</sup>	V <sub>DD</sub> = 4.5 to 6.0 V	0		300	ns
				0		500	ns
SCL↑→SDA0, SDA1↓ or SCL↑→SDA0, SDA1↑	t <sub>KSB</sub>			200			ns
SDA0, SDA1↓→SCL↓	t <sub>SBK</sub>			400			ns
SDA0, SDA1 high-level width	t <sub>SBH</sub>			500			ns
SCL rise, fall time	t <sub>RB</sub> , t <sub>FB</sub>	When using external device expansion function				160	ns
		When not using external device expansion function				1000	ns

**Note** R and C are the load resistance and load capacitance of the SDA0, SDA1 output line.

(b) Serial interface channel 1

(i) 3-wire serial I/O mode ( $\overline{\text{SCK1}}$ ... Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK1}}$ cycle time	$t_{\text{KCY7}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$		800		ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
$\overline{\text{SCK1}}$ high-/low-level width	$t_{\text{KH7}}, t_{\text{KL7}}$	$V_{\text{DD}} = 4.5 \text{ to } 6.0 \text{ V}$	$t_{\text{KCY7}}/2 - 50$			ns
			$t_{\text{KCY7}}/2 - 100$			ns
SI1 setup time (to $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{SIK7}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	100			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	150			ns
			300			ns
SI1 hold time (from $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{KSI7}}$		400			ns
SO1 output delay time from $\overline{\text{SCK1}}\downarrow$	$t_{\text{KSO7}}$	$C = 100 \text{ pF}$ <sup>Note</sup>			300	ns

**Note** C is the load capacitance of the  $\overline{\text{SCK1}}$  and SO1 output lines.

(ii) 3-wire serial I/O mode ( $\overline{\text{SCK1}}$ ... External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK1}}$ cycle time	$t_{\text{KCY8}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	800			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
$\overline{\text{SCK1}}$ high-/low-level width	$t_{\text{KH8}}, t_{\text{KL8}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	400			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	800			ns
			1600			ns
SI1 setup time (to $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{SIK8}}$		100			ns
SI1 hold time (from $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{KSI8}}$		400			ns
SO1 output delay time from $\overline{\text{SCK1}}\downarrow$	$t_{\text{KSO8}}$	$C = 100 \text{ pF}$ <sup>Note</sup>			300	ns
$\overline{\text{SCK1}}$ rise, fall time	$t_{\text{R8}}, t_{\text{F8}}$	When using external device expansion function			160	ns
		When not using external device expansion function			1000	ns

**Note** C is the load capacitance of the SO1 output line.

(iii) 3-wire serial I/O mode with automatic transmit/receive function ( $\overline{\text{SCK1}}$ ...Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK1}}$ cycle time	$t_{\text{KCY9}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	800			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
$\overline{\text{SCK1}}$ high-/low-level width	$t_{\text{KH9}}$	$V_{\text{DD}} = 4.5 \text{ to } 6.0 \text{ V}$	$t_{\text{KCY9}}/2 - 50$			ns
	$t_{\text{KL9}}$		$t_{\text{KCY9}}/2 - 100$			ns
SI1 setup time (to $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{SIK9}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	100			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	150			ns
			300			ns
SI1 hold time (from $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{KSI9}}$		400			ns
SO1 output delay time from $\overline{\text{SCK1}}\downarrow$	$t_{\text{KSO9}}$	$C = 100 \text{ pF}$ Note			300	ns
STB $\uparrow$ from $\overline{\text{SCK1}}\uparrow$	$t_{\text{SBD}}$		$t_{\text{KCY9}}/2 - 100$		$t_{\text{KCY9}}/2 + 100$	ns
Strobe signal high-level width	$t_{\text{SBW}}$	$V_{\text{DD}} = 2.7 \text{ to } 6.0 \text{ V}$	$t_{\text{KCY9}} - 30$		$t_{\text{KCY9}} + 30$	ns
			$t_{\text{KCY9}} - 60$		$t_{\text{KCY9}} + 60$	ns
Busy signal setup time (to busy signal detection timing)	$t_{\text{BYS}}$		100			ns
Busy signal hold time (from busy signal detection timing)	$t_{\text{BYH}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	100			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	150			ns
			200			ns
$\overline{\text{SCK1}}\downarrow$ from busy inactive	$t_{\text{SPS}}$				$2t_{\text{KCY9}}$	ns

Note C is the load capacitance of the  $\overline{\text{SCK1}}$ , SO1 output line.

(iv) 3-wire serial I/O mode with automatic transmit/receive function ( $\overline{\text{SCK1}}$ ...External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK1}}$ cycle time	$t_{\text{KCY10}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	800			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
$\overline{\text{SCK1}}$ high-/low-level width	$t_{\text{KH10}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	400			ns
	$t_{\text{KL10}}$	$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	800			ns
			1600			ns
SI1 setup time (to $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{SIK10}}$		100			ns
SI1 hold time (from $\overline{\text{SCK1}}\uparrow$ )	$t_{\text{KIS10}}$		400			ns
SO1 output delay time from $\overline{\text{SCK1}}\downarrow$	$t_{\text{KSO10}}$	$C = 100 \text{ pF}$ Note			300	ns
$\overline{\text{SCK1}}$ rise, fall time	$t_{\text{R10}}$ $t_{\text{F10}}$	When using external device expansion function			160	ns
		When not using external device expansion function			1000	ns

Note C is the load capacitance of the SO1 output line.

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(c) Serial interface channel 2

(i) 3-wire serial I/O mode ( $\overline{\text{SCK2}}$ ... Internal clock output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
$\overline{\text{SCK2}}$ cycle time	$t_{\text{KCY11}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	800			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
$\overline{\text{SCK2}}$ high-/low-level width	$t_{\text{KH11}}$	$V_{\text{DD}} = 4.5 \text{ to } 6.0 \text{ V}$	$t_{\text{KCY11}}/2 - 50$			ns
	$t_{\text{KL11}}$		$t_{\text{KCY11}}/2 - 100$			ns
SI2 setup time (to $\overline{\text{SCK2}}\uparrow$ )	$t_{\text{SIK11}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	100			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	150			ns
			300			ns
SI2 hold time (to $\overline{\text{SCK2}}\uparrow$ )	$t_{\text{KSH11}}$		400			ns
SO2 output delay time from $\overline{\text{SCK2}}\downarrow$	$t_{\text{KSO11}}$	$C = 100 \text{ pF}$ <sup>Note</sup>			300	ns

**Note** C is the load capacitance of the  $\overline{\text{SCK2}}$ , SO2 output line.

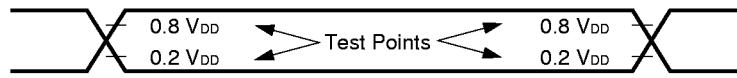
(ii) UART mode (Dedicated baud rate generator output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate		$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$			78125	bps
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$			39063	bps
					19531	bps

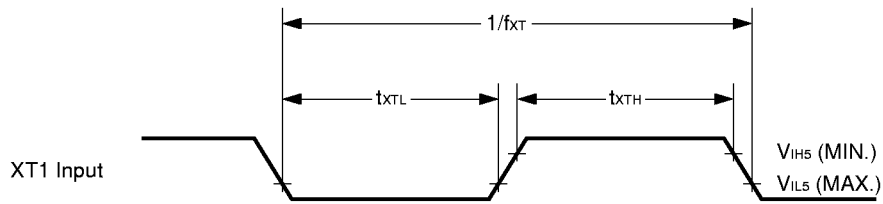
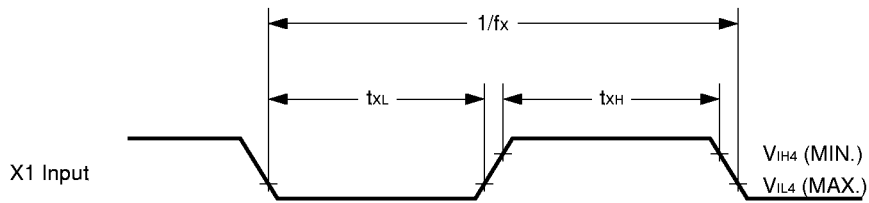
(iii) UART mode (External clock input)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
ASCK cycle time	$t_{\text{KCY12}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	800			ns
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	1600			ns
			3200			ns
ASCK high-/low-level width	$t_{\text{KH12}}$	$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$	400			ns
	$t_{\text{KL12}}$	$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$	800			ns
			1600			ns
Transfer rate		$4.5 \text{ V} \leq V_{\text{DD}} \leq 6.0 \text{ V}$			39063	bps
		$2.7 \text{ V} \leq V_{\text{DD}} < 4.5 \text{ V}$			19531	bps
					9766	bps
ASCK rise, fall time	$t_{\text{R12}}, t_{\text{F12}}$	$V_{\text{DD}} = 4.5 \text{ to } 6.0 \text{ V}$ , when not using external device expansion function.			1000	ns
					160	ns

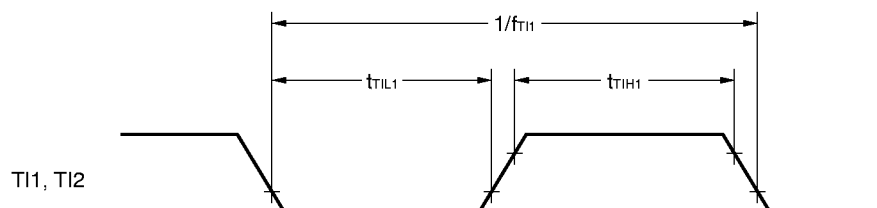
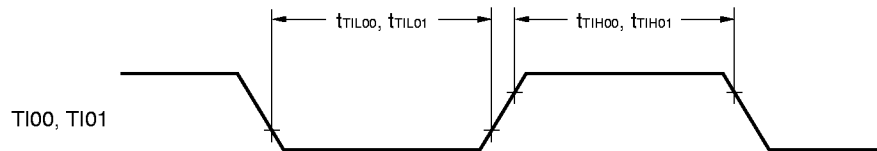
AC Timing Test Point (Excluding X1, XT1 Input)



Clock Timing



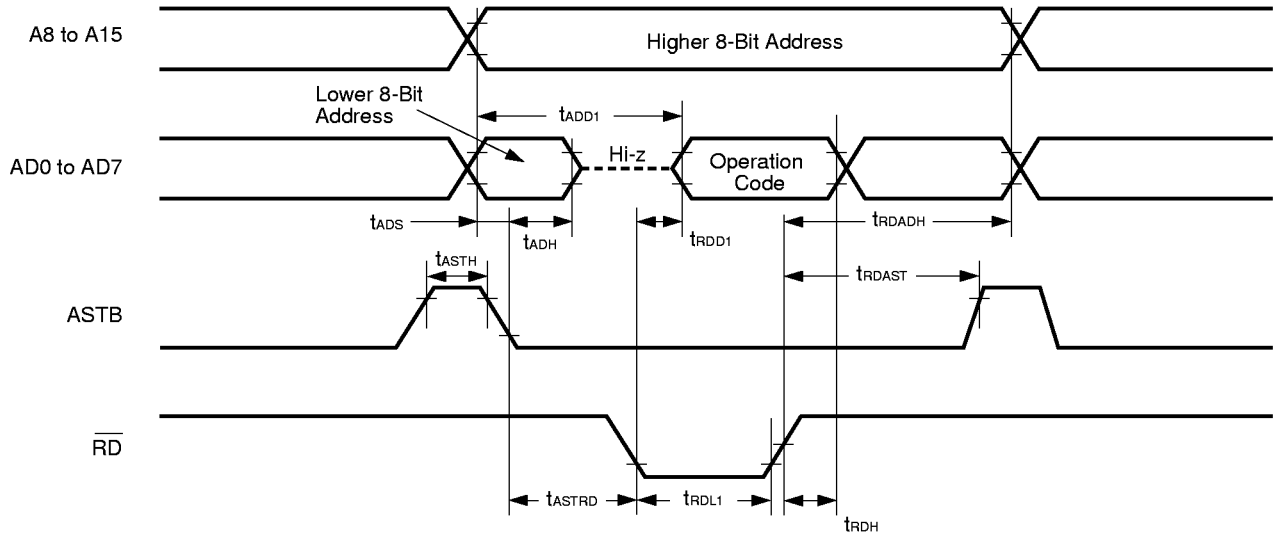
TI Timing



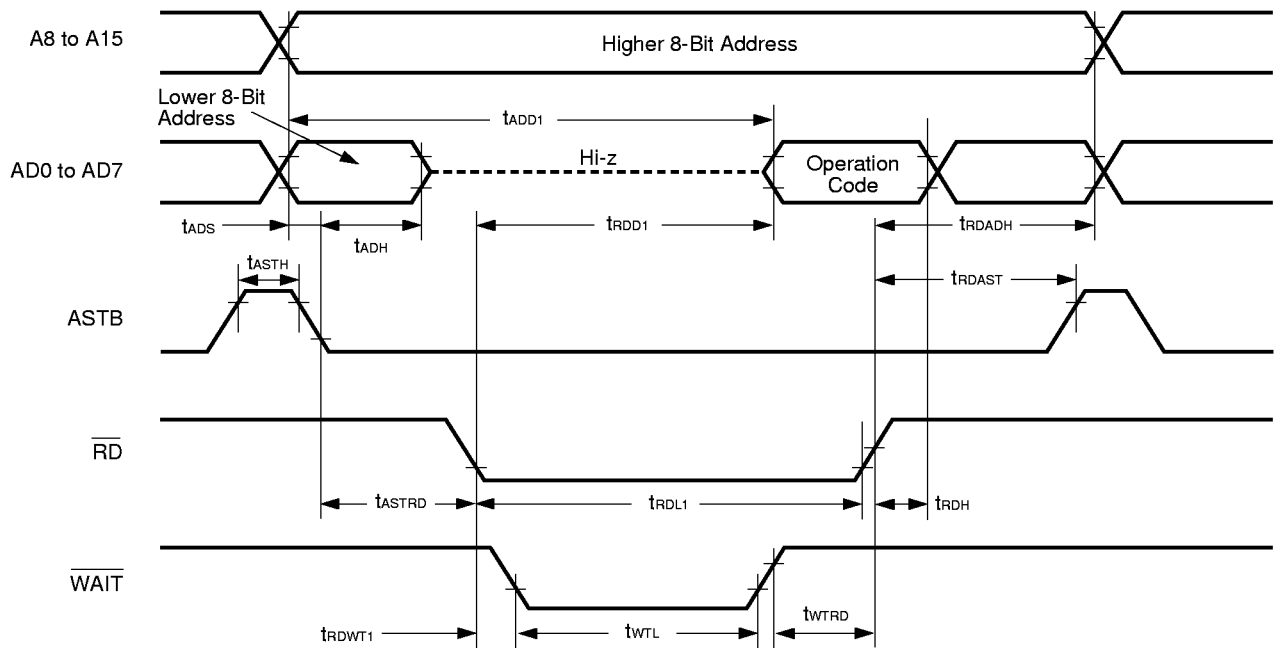


Read/Write Operation

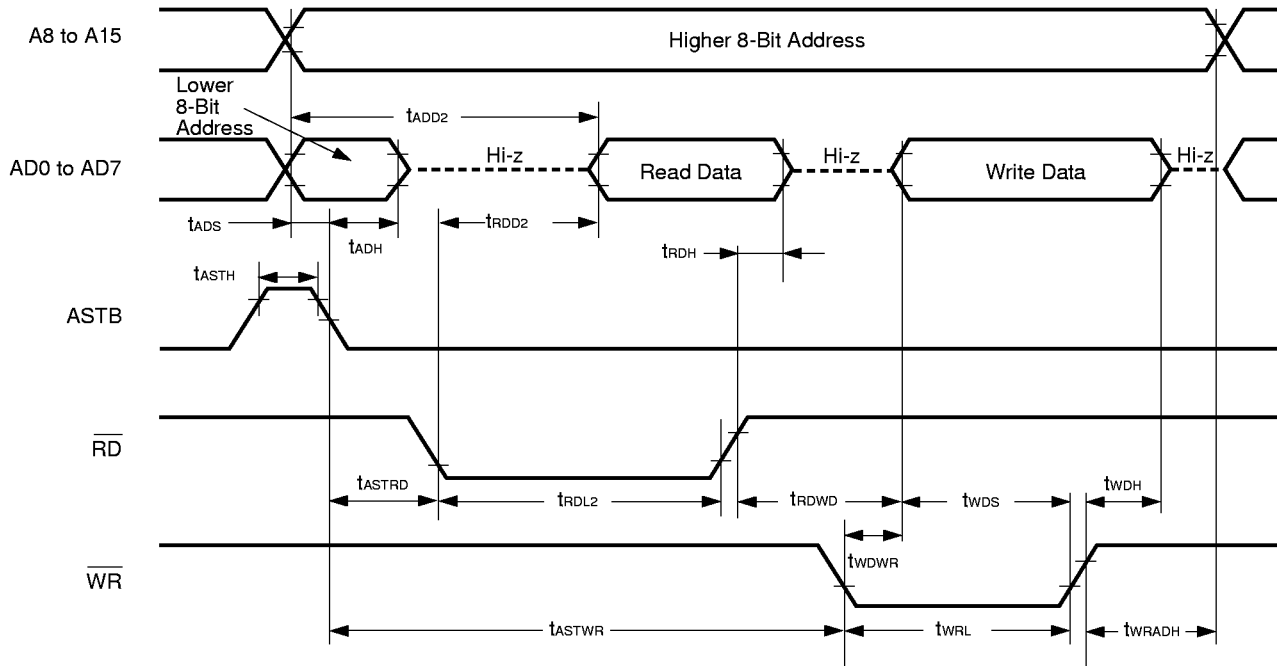
External Fetch (No Wait) :



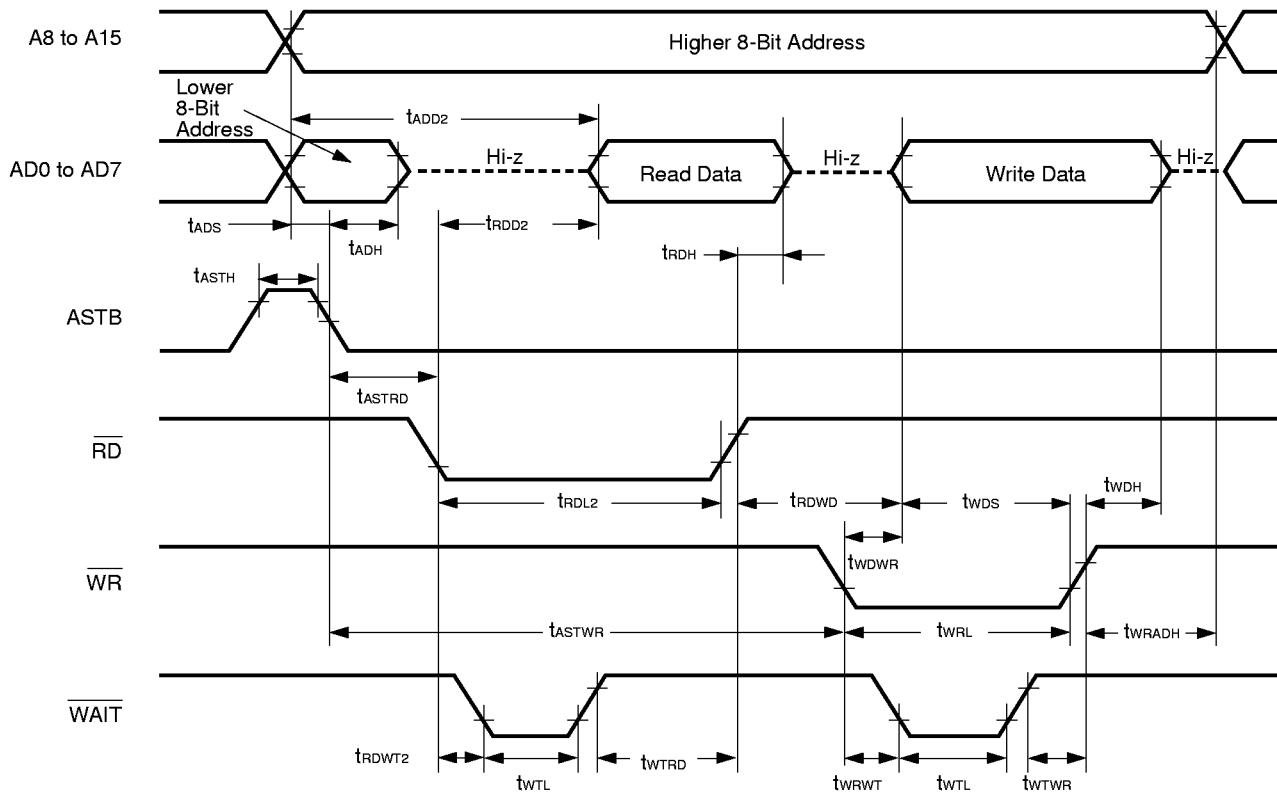
External Fetch (Wait Insertion) :



External Data Access (No Wait) :

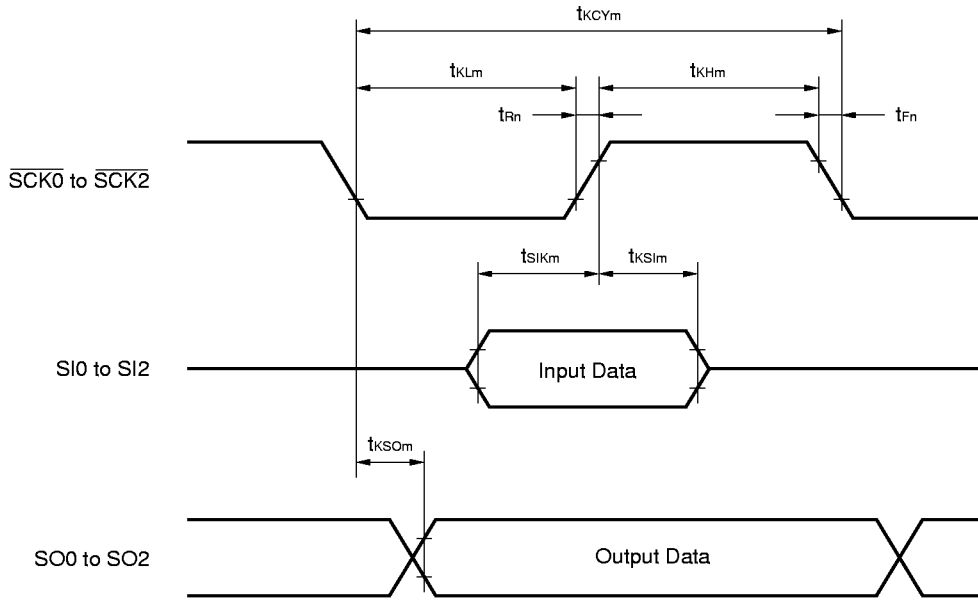


External Data Access (Wait Insertion) :



Serial Transfer Timing

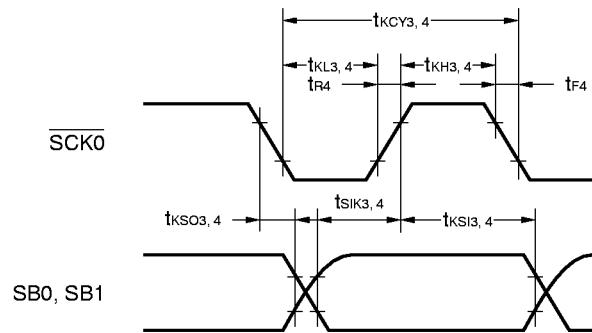
3-wire Serial I/O Mode :



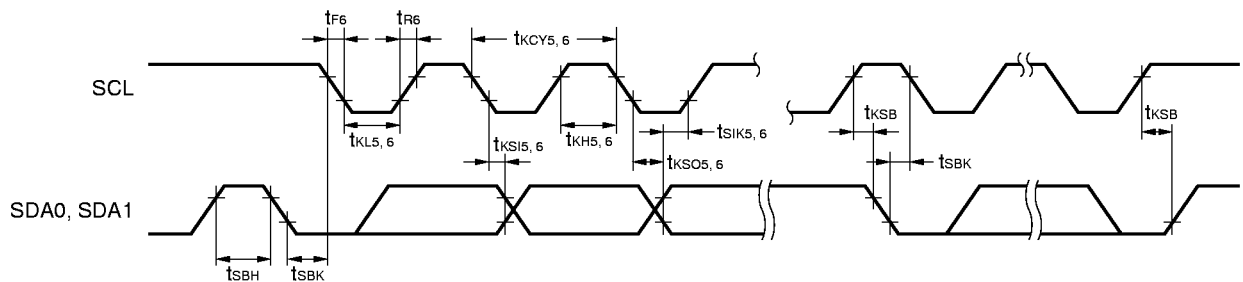
$m = 1, 2, 7, 8, 11$

$n = 2, 8$

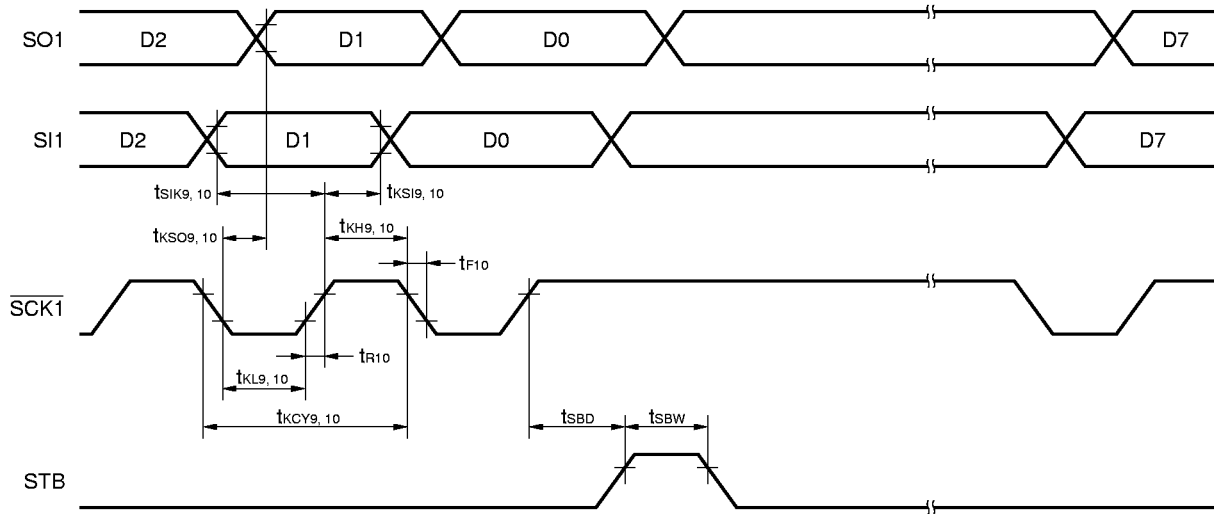
2-wire Serial I/O Mode :



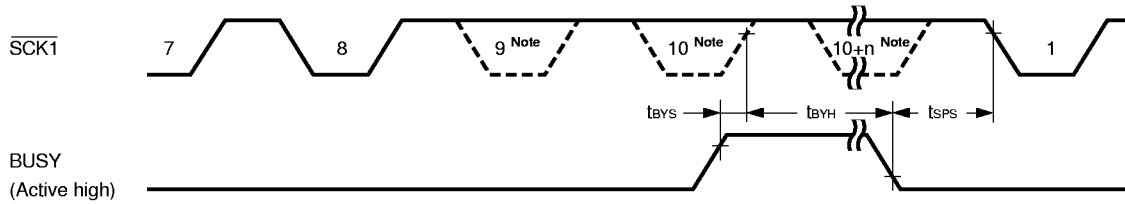
I<sup>2</sup>C Bus Mode:



**3-wire Serial I/O Mode with Automatic Transmit/Receive Function :**

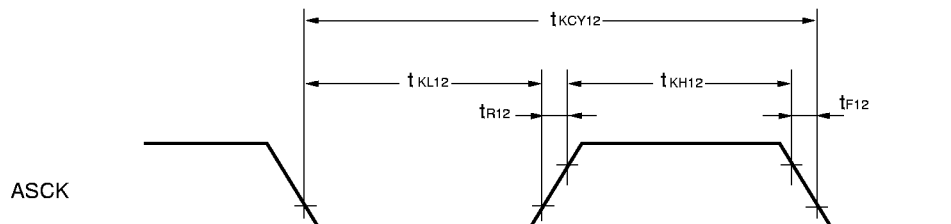


**3-wire Serial I/O Mode with Automatic Transmit/Receive Function (Busy processing) :**



**Note** The signal is not actually driven low here; it is shown as such to indicate the timing.

**UART Mode (External Clock Input) :**



**A/D Converter Characteristics (T<sub>A</sub> = -40 to +85°C, AV<sub>DD</sub> = V<sub>DD</sub> = 2.0 to 6.0 V, AV<sub>SS</sub> = V<sub>SS</sub> = 0 V)**

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Resolution			8	8	8	bit
★ Overall error <sup>Note</sup>		2.7 V ≤ AV <sub>REF0</sub> ≤ AV <sub>DD</sub>			±0.6	%
		2.0 V ≤ AV <sub>REF0</sub> < 2.7 V			±1.4	%
Conversion time	t <sub>CONV</sub>		19.1		200	μs
Sampling time	t <sub>SAMP</sub>		12/f <sub>XX</sub>			μs
Analog input voltage	V <sub>IAN</sub>		AV <sub>SS</sub>		AV <sub>REF0</sub>	V
Reference voltage	AV <sub>REF0</sub>		2.0		AV <sub>DD</sub>	V
Resistance between AV <sub>REF0</sub> and AV <sub>SS</sub>	R <sub>AIREF0</sub>		4	14		kΩ

**Note** Overall error excluding quantization error (±1/2 LSB). It is indicated as a ratio to the full-scale value.

f<sub>XX</sub> : Main system clock frequency (f<sub>x</sub> or f<sub>x</sub>/2)

f<sub>x</sub> : Main system clock oscillation frequency

**D/A Converter Characteristics (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.0 to 6.0 V, AV<sub>SS</sub> = V<sub>SS</sub> = 0 V)**

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Resolution					8	bit
Overall error		R = 2 MΩ <sup>Note1</sup>			1.2	%
		R = 4 MΩ <sup>Note1</sup>			0.8	%
		R = 10 MΩ <sup>Note1</sup>			0.6	%
Settling time		C=30pF <sup>Note1</sup>	4.5 V ≤ AV <sub>REF1</sub> ≤ 6.0 V		10	μs
			2.7 V ≤ AV <sub>REF1</sub> < 4.5 V		15	μs
			2.0 V ≤ AV <sub>REF1</sub> < 2.7 V		20	μs
Output resistance	R <sub>O</sub>	DACS0, DACS1 = 55H <sup>Note 2</sup>		10		kΩ
Analog reference voltage	AV <sub>REF1</sub>		2.0		V <sub>DD</sub>	V
AV <sub>REF1</sub> current	I <sub>REF1</sub>	<b>Note2</b>			1.5	mA

**Notes** 1. R and C denote D/A converter output pin load resistance and load capacitance, respectively.

2. Value for one D/A converter channel

DACS0, DACS1: D/A conversion value setting register.

**Data Memory Stop Mode Low Supply Voltage Data Retention Characteristics (T<sub>A</sub> = -40 to +85°C)**

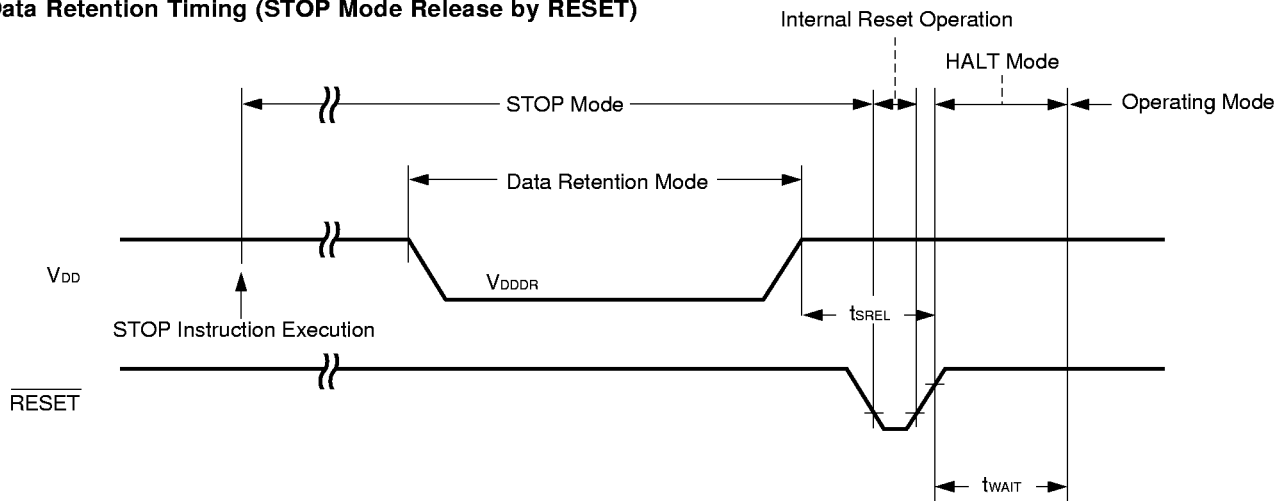
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Data retention power supply voltage	V <sub>DDDR</sub>		1.8		6.0	V
Data retention power supply current	I <sub>DDDR</sub>	V <sub>DDDR</sub> = 1.8 V Subsystem clock stop and feedback resistor disconnected		0.1	10	μA
Release signal set time	t <sub>SREL</sub>		0			μs
Oscillation stablilation wait time	t <sub>WAIT</sub>	Release by $\overline{\text{RESET}}$		2 <sup>17</sup> /f <sub>x</sub>		ms
		Release by interrupt request		<b>Note</b>		ms

**Note** In combination with bits 0 to 2 (OSTS0 to OSTS2) of oscillation stabilization time selection register (OSTS), selection of 2<sup>12</sup>/f<sub>xx</sub> and 2<sup>14</sup>/f<sub>xx</sub> to 2<sup>17</sup>/f<sub>xx</sub> is possible.

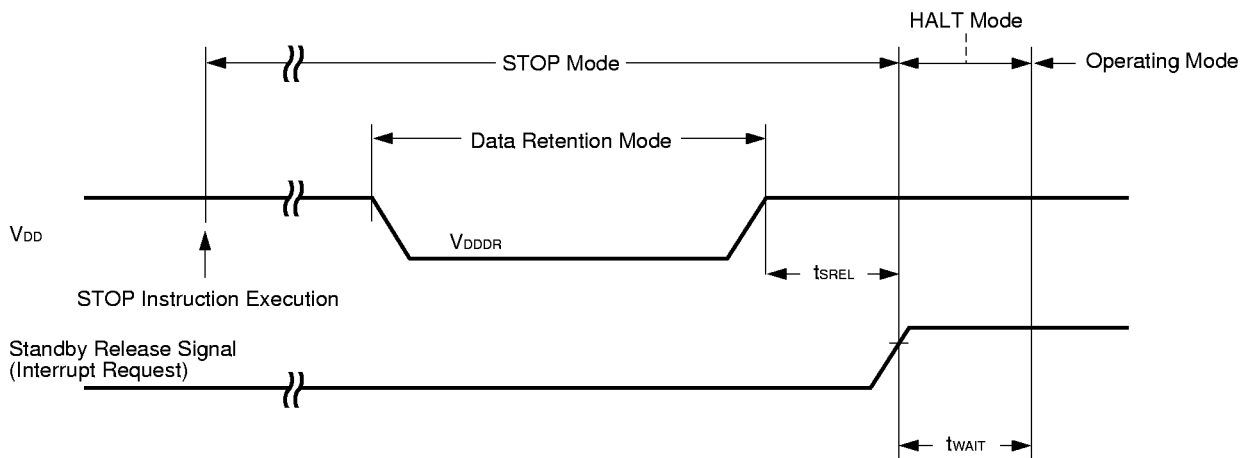
f<sub>xx</sub> : Main system clock frequency (f<sub>x</sub> or f<sub>x</sub>/2)

f<sub>x</sub> : Main system clock oscillation frequency

**Data Retention Timing (STOP Mode Release by  $\overline{\text{RESET}}$ )**



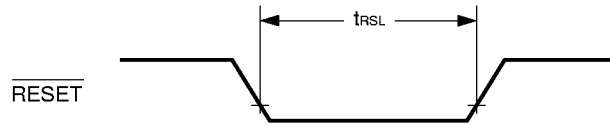
**Data Retention Timing (Standby Release Signal: STOP Mode Release by Interrupt Request Signal)**



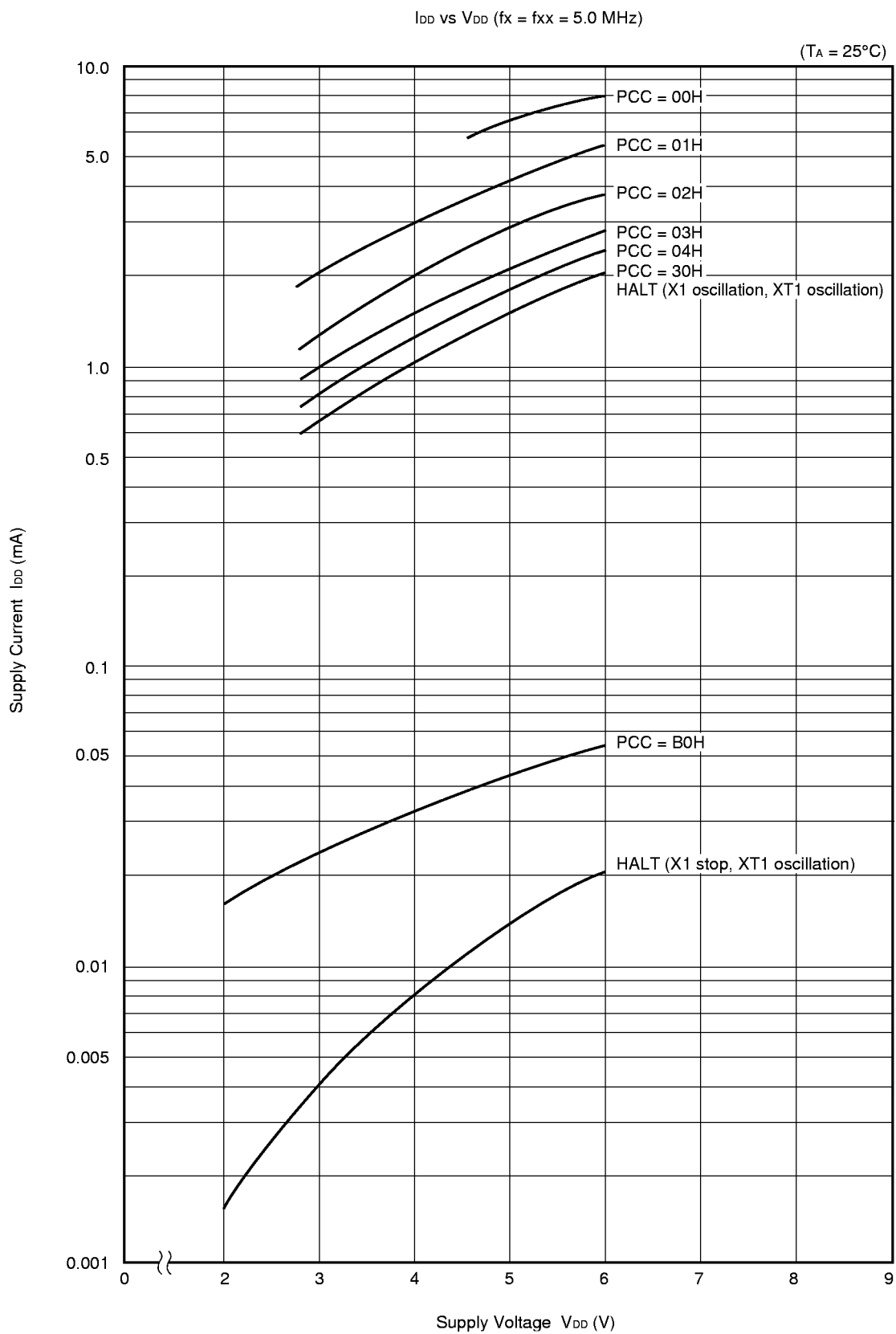
Interrupt Request Input Timing



$\overline{\text{RESET}}$  Input Timing



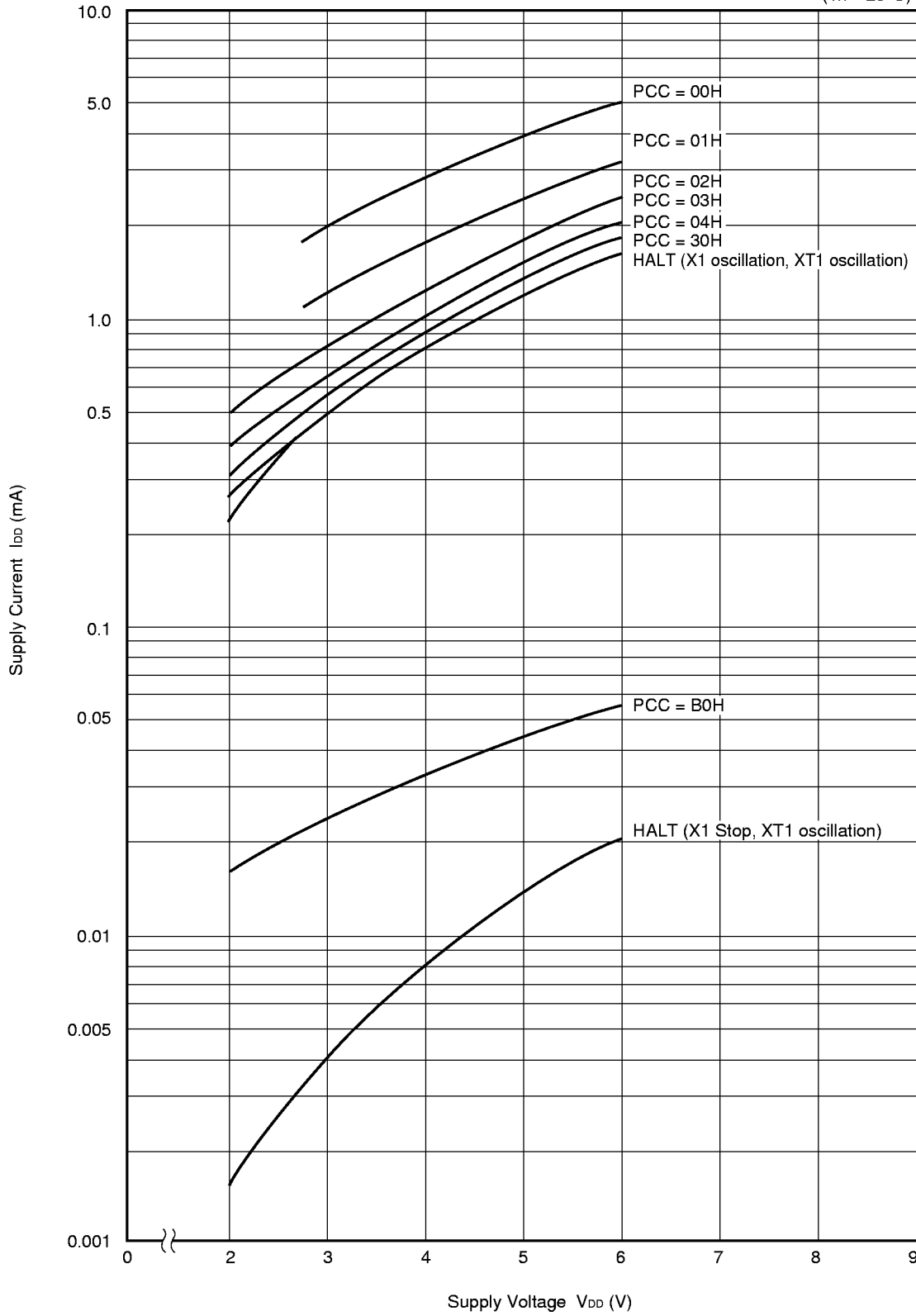
12. CHARACTERISTIC CURVES (REFERENCE VALUE)





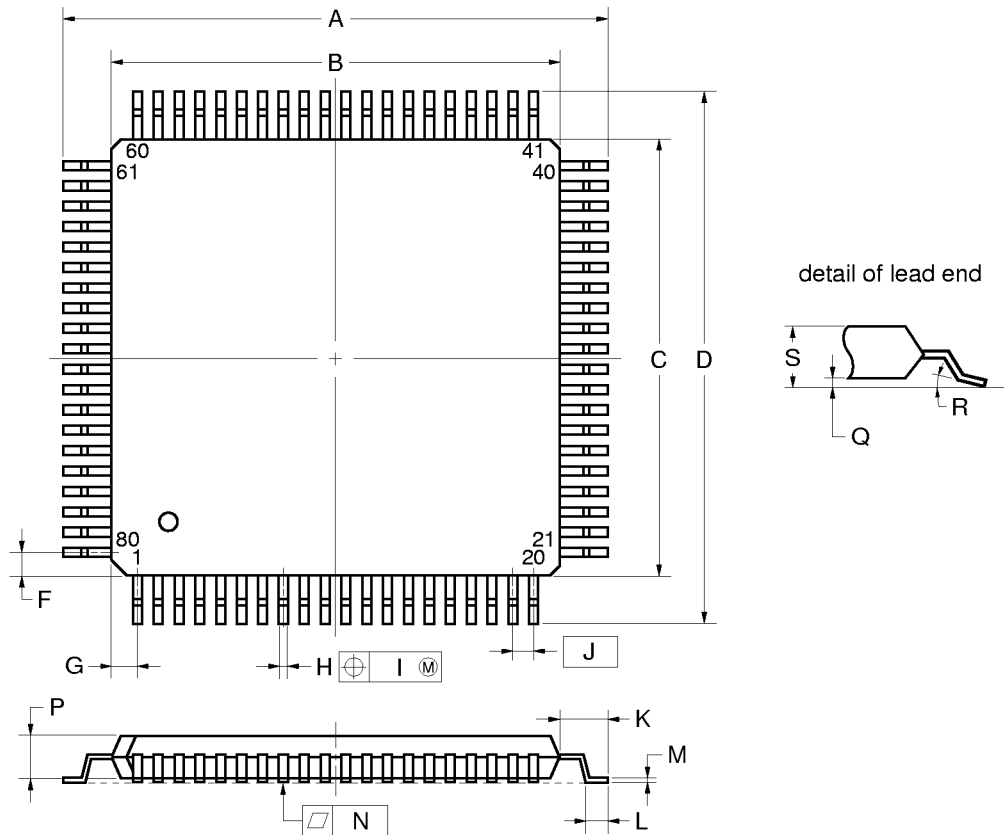
$I_{DD}$  vs  $V_{DD}$  ( $f_x = 5.0$  MHz,  $f_{xx} = 2.5$  MHz)

( $T_A = 25^\circ\text{C}$ )



★ 13. PACKAGE DRAWING

80 PIN PLASTIC QFP (14×14)



NOTE

Each lead centerline is located within 0.13 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	17.20±0.20	0.677±0.008
B	14.00±0.20	0.551 <sup>+0.009</sup> <sub>-0.008</sub>
C	14.00±0.20	0.551 <sup>+0.009</sup> <sub>-0.008</sub>
D	17.20±0.20	0.677±0.008
F	0.825	0.032
G	0.825	0.032
H	0.32±0.06	0.013 <sup>+0.002</sup> <sub>-0.003</sub>
I	0.13	0.005
J	0.65 (T.P.)	0.026 (T.P.)
K	1.60±0.20	0.063±0.008
L	0.80±0.20	0.031 <sup>+0.009</sup> <sub>-0.008</sub>
M	0.17 <sup>+0.03</sup> <sub>-0.07</sub>	0.007 <sup>+0.001</sup> <sub>-0.003</sub>
N	0.10	0.004
P	1.40±0.10	0.055±0.004
Q	0.125±0.075	0.005±0.003
R	3° <sup>+7°</sup> <sub>-3°</sub>	3° <sup>+7°</sup> <sub>-3°</sub>
S	1.70 MAX.	0.067 MAX.

P80GC-65-8BT

**Remark** Dimensions and materials of ES product are the same as those of mass-production products.

★ 14. RECOMMENDED SOLDERING CONDITIONS

This product should be soldered and mounted under the conditions recommended in the table below.

For a detailed description of recommended soldering conditions, refer to the information document **Semiconductor Device Mounting Technology Manual (C10535E)**.

For soldering methods and conditions other than those recommended below, contact an NEC sales representative.

Table 14-1. Surface Mounting Type Soldering Conditions

- μPD78052YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)
- μPD78053YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)
- μPD78054YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)
- μPD78055YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)
- μPD78056YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)
- μPD78058YGC-xxx-8BT : 80-pin plastic QFP (14 × 14 mm)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235 °C, Duration: 30 sec. max. (at 210°C or above), Number of times: Twice max.	IR35-00-2
VPS	Package peak temperature: 215 °C, Duration: 40 sec. max. (at 200°C or above), Number of times: Twice max.	VP15-00-2
Wave soldering	Solder bath temperature : 260°C max., Duration : 10 sec. max., Number of times: once, Preheating temperature : 120°C max. (package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 300°C max. Duration: 3 sec. max. (per pin row)	—

**Caution** Avoid as much as possible combining two or more soldering methods (except for the partial heating method).

**APPENDIX A. DEVELOPMENT TOOLS**

The following development tools are available for system development using μPD78054Y subseries.

**Language Processing Software**

RA78K/0 <small>Notes 1, 2, 3, 4</small>	78K/0 series common assembler package
CC78K/0 <small>Notes 1, 2, 3, 4</small>	78K/0 series common C compiler package
DF78054 <small>Notes 1, 2, 3, 4</small>	Device file common to μPD78054 subseries
CC78K/0-L <small>Notes 1, 2, 3, 4</small>	78K/0 series common C compiler library source file

**PROM Writing Tools**

PG-1500	PROM programmer
PA-78P054GC PA-78P054KK-T	Programmer adapters connected to PG-1500
PG-1500 controller <small>Notes 1, 2</small>	PG-1500 control program

**Debugging Tools**

IE-78000-R	In-circuit emulator common to 78K/0 series
★ IE-78000-R-A	In-circuit emulator common to 78K/0 series (for integrated debugger)
IE-78000-R-BK	Break board common to 78K/0 series
IE-780308-R-EM	Emulation board common to μPD780308 subseries
★ IE-78000-R-SV3	Interface adapter and cable when using EWS for the host machine (for IE-78000-R-A)
★ IE-78000-98-IF-B	Interface adapter when using the PC-9800 series (except for notebook computers) for the host machine (for IE-78000-R-A)
★ IE-78000-98N-IF	Interface adapter and cable when using the PC-9800 series notebook computers for the host machine (for IE-78000-R-A)
★ IE-78000-PC-IF-B	Interface adapter when using IBM/PC AT™ and its compatibles for the host machine (for IE-78000-R-A)
EP-78230GC-R	Emulation probe common to μPD78234 subseries
EV-9200GC-80	Socket to be mounted in the target system board manufactured for 80-pin plastic QFP (GC-8BT type)
SM78K0 <small>Notes 5, 6, 7</small>	System simulator common to 78K/0 series
★ ID78K0 <small>Notes 4, 5, 6, 7</small>	Integrated debugger for IE-78000-R-A
SD78K/0 <small>Notes 1, 2</small>	Screen debugger for IE-78000-R
★ DF78054 <small>Notes 1, 2, 4, 5, 6, 7</small>	Device file common to μPD78054 subseries

- Notes**
1. PC-9800 series (MS-DOS™) based
  2. IBM PC/AT and compatible computer (PC DOS™/IBM DOS™/MS-DOS) based
  3. HP9000 series 300™ (HP-UX™) based
  4. HP9000 series 700™ (HP-UX) based, SPARCstation™ (Sun OS™) based, EWS4800 series (EWS-UX/V) based
  5. PC-9800 series (MS-DOS + Windows™) based
  6. IBM PC/AT and compatible computer (PC DOS/IBM DOS/MS-DOS + Windows) based
  7. NEWS™ (NEWS-OS™) based

**Real-Time OS**

RX78K/0 <small>Notes 1, 2, 3, 4</small>	Real-time OS for 78K/0 series
MX78K0 <small>Notes 1, 2, 3, 4</small>	OS for 78K/0 series

**Fuzzy Inference Development Support System**

FE9000 <small>Note 1/</small> FE9200 <small>Note 5</small>	Fuzzy knowledge data creation tool
FT9080 <small>Note 1/</small> FT9085 <small>Note 2</small>	Translator
FI78K0 <small>Notes 1, 2</small>	Fuzzy inference module
FD78K0 <small>Notes 1, 2</small>	Fussy inference debugger

**Notes** 1. PC-9800 series (MS-DOS) based

2. IBM PC/AT and its compatible computers (PC DOS/IBM DOS/MS-DOS) based

3. HP9000 series 300 (HP-UX) based

4. HP9000 series 700 (HP-UX) based, SPARCstation (Sun OS) based, EWS4800 series (EWS-UX/V) based

5. IBM PC/AT and its compatible computers (PC DOS/IBM DOS/MS-DOS + Windows) based

**Remarks** 1. For third party development tools, see the **78K/0 Series Selection Guide (U11126E)**.

2. RA78K/0, CC78K/0, SM78K0, ID78K0, SD78K/0, and RX78K/0 are used in combination with DF78054.

## APPENDIX B. RELATED DOCUMENTS

## Device Related Documents

Document Name		Document No. (English)	Document No. (Japanese)
★	μPD78052Y, 78053Y, 78054Y, 78055Y, 78056Y, 78058Y Data Sheet	This document	U10906J
★	μPD78P058Y Data Sheet	U10907E	U10907J
	μPD78054 and μPD78054Y Subseries User's Manual	IEU-1356	U11747J
	78K/0 Series User's Manual Instructions	U12326E	U12326J
	78K/0 Series Instruction Set	-	U10904J
	78K/0 Series Instruction Table	-	U10903J
	μPD78054Y Special Function Register Table	-	U10087J
	78K/0 Series Application Note	Basics (III)	U10182E
		U10182E	U10182J

## Development Tool Related Documents (User's Manual)

Document Name		Document No. (English)	Document No. (Japanese)
	RA78K Series Assembler Package	Operation	EEU-1399
		Language	EEU-1404
	RA78K Series Structured Assembler Preprocessor	EEU-1402	U12323J
★	CC78K0 C Assembler Package	Operation	U11802E
★		Assembly Language	U11801E
★		Structured Assembly Language	U11789E
	CC78K Series C Compiler	Operation	EEU-1280
		Language	EEU-1284
★	CC78K0 C Compiler	Operation	U11517E
★		Language	U11518E
	CC78K/0 C Compiler Application Note	Programming Know-How	EEA-1208
	CC78K Series Library Source File	U12322E	U12322J
	PG-1500 PROM Programmer	U11940E	U11940J
	PG-1500 Controller PC-9800 Series (MS-DOS) Based	EEU-1291	EEU-704
	PG-1500 Controller IBM PC Series (PC DOS) Based	U10540E	EEU-5008
	IE-78000-R	U11376E	U11376J
	IE-78000-R-A	U10057E	U10057J
	IE-78000-R-BK	EEU-1427	EEU-867
	IE-780308-R-EM	U11362E	U11362J
	EP-78230	EEU-1515	EEU-985
	SM78K0 System Simulator WIndows based	Reference	U10181E
	SM78K Series System Simulator	External Part User Open Interface Specifications	U10092E
	SD78K/0 Screen Debugger	Introduction	-
	PC-9800 Series (MS-DOS) Based	Reference	-
	SD78K/0 Screen Debugger	Introduction	U10539E
	IBM PC/AT (PC DOS) Based	Reference	U11279E
★	ID78K0 Integrated Debugger EWS based	Reference	-
★	ID78K0 Integrated Debugger PC based	Reference	U11539E
★	ID78K0 Integrated Debugger Windows based	Guide	U11649E

**Caution** The above documents are subject to change without notice. For design purpose, etc., be sure to use the latest document.

**Embedded Software Documents (User's Manual)**

Document Name		Document No. (English)	Document No. (Japanese)
78K/0 Series Real Time OS	Basics	U11537E	U11537J
	Installation	U11536E	U11536J
MX78K0: OS for 78K/0 Series	Basic	U12257E	U12257J
Fuzzy Knowledge Data Creation Tools		EEU-1438	EEU-829
78K/0, 78K/II, 87AD Series Fuzzy Inference Development Support System Translator		EEU-1444	EEU-862
78K/0 Series Fuzzy Inference Development Support System Fuzzy Inference Module		EEU-1441	EEU-858
78K/0 Series Fuzzy Inference Development Support System Fuzzy Inference Debugger		EEU-1458	EEU-921

**Other Documents**

Document Name	Document No. (English)	Document No. (Japanese)
IC Package Manual	C10943X	
Semiconductor Device Mounting Technology Manual	C10535E	C10535J
Quality Grades on NEC Semiconductor Device	C11531E	C11531J
NEC Semiconductor Device Reliability/Quality Control System	C10983E	C10983J
Guide to Prevent Damage for Semiconductor Devices by Electrostatic Discharge (ESD)	C11892E	C11892J
Guide to Quality Assurance for Semiconductor Devices	MEI-1202	C11893J
Microcomputer-related Product Guide, Third Party Products	-	U11416J

**Caution** The above related documents are subject to change without notice. For design purpose, etc., be sure to use the latest documents.

## 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 devices 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.

**NEC Electronics Inc. (U.S.)**

Santa Clara, California  
 Tel: 800-366-9782  
 Fax: 800-729-9288

**NEC Electronics (Germany) GmbH**

Duesseldorf, Germany  
 Tel: 0211-65 03 02  
 Fax: 0211-65 03 490

**NEC Electronics (UK) Ltd.**

Milton Keynes, UK  
 Tel: 01908-691-133  
 Fax: 01908-670-290

**NEC Electronics Italiana s.r.l.**

Milano, Italy  
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 Fax: 02-66 75 42 99

**NEC Electronics (Germany) GmbH**

Benelux Office  
 Eindhoven, The Netherlands  
 Tel: 040-2445845  
 Fax: 040-2444580

**NEC Electronics (France) S.A.**

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 Tel: 01-30-67 58 00  
 Fax: 01-30-67 58 99

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 Fax: 01-504-2860

**NEC Electronics (Germany) GmbH**

Scandinavia Office  
 Taebly, Sweden  
 Tel: 08-63 80 820  
 Fax: 08-63 80 388

**NEC Electronics Hong Kong Ltd.**

Hong Kong  
 Tel: 2886-9318  
 Fax: 2886-9022/9044

**NEC Electronics Hong Kong Ltd.**

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 Seoul, Korea  
 Tel: 02-528-0303  
 Fax: 02-528-4411

**NEC Electronics Singapore Pte. Ltd.**

United Square, Singapore 1130  
 Tel: 253-8311  
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**NEC Electronics Taiwan Ltd.**

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