

# MOS INTEGRATED CIRCUIT

## $\mu$ PD703014A, 703014AY, 703015A, 703015AY, 703017A, 703017AY

V850/SA1™

### 32-/16-BIT SINGLE-CHIP MICROCONTROLLER

#### DESCRIPTION

The  $\mu$ PD703014A, 703014AY, 703015A, 703015AY, 703017A, and 703017AY (V850/SA1) are 32-/16-bit single-chip microcontrollers that include the CPU core of the V850 Family™, and peripheral functions such as ROM/RAM, timer/counters, serial interfaces, an A/D converter, a timer, and a DMA controller.

In addition to its high real-time responsiveness and one-clock-pitch execution of instructions, the V850/SA1 includes a hardware multiplier for multiplication instructions, saturation instructions, and bit manipulation instructions, all of which are instructions suited to digital servo control applications. As a real-time control system, this device provides a high-level cost performance ideal for applications ranging from low-power camcorders and other AV equipment to portable telephone equipment such as cellular phones and personal handyphone systems (PHS).

Detailed function descriptions are provided in the following user's manuals. Be sure to read them before designing.

V850/SA1 User's Manual Hardware: U12768E  
V850 Family™ User's Manual Architecture: U10243E

#### FEATURES

- Number of instructions: 74
- Minimum instruction execution time:
  - 59 ns (@ 17 MHz operation with main system clock (f<sub>xx</sub>))
  - 50 ns (@ 20 MHz operation with main system clock (f<sub>xx</sub>))
  - 30.5  $\mu$ s (@ 32.768 kHz operation with subsystem clock (f<sub>XT</sub>))
- General-purpose registers: 32 bits  $\times$  32 registers
- Instruction set:
  - Signed multiplication, saturation operations, 32-bit shift instructions, bit manipulation instructions, load/store instructions
- Memory space:
  - 16 MB linear address space
  - Memory block allocation function: 2 MB per block
- External bus interface: 16-bit data bus  
Address bus: Separate output enabled
- Internal memory
  - Mask ROM: 64 KB ( $\mu$ PD703014A, 703014AY)  
128 KB ( $\mu$ PD703015A, 703015AY)  
256 KB ( $\mu$ PD703017A, 703017AY)
  - RAM: 4 KB  
( $\mu$ PD703014A, 703014AY, 703015A, 703015AY)  
8 KB ( $\mu$ PD703017A, 703017AY)
- Interrupts and exception
  - External: 8, internal: 23, exception: 1
- I/O lines Total: 85
- Timer/counters
  - 16-bit timer: 2 channels
  - 8-bit timer: 4 channels
- Watch timer: 1 channel
- Watchdog timer: 1 channel
- Serial interface (SIO)
  - Asynchronous serial interface (UART)
  - Clocked serial interface (CSI)
  - I<sup>2</sup>C bus interface  
( $\mu$ PD703014AY, 703015AY, 703017AY)
- A/D converter: 12 channels
- DMA controller: 3 channels
- RTP: 8 bits  $\times$  1 channel or 4 bits  $\times$  2 channels
- Power-saving functions: HALT/IDLE/STOP modes
- Packages: 100-pin plastic LQFP (14  $\times$  14)  
121-pin plastic FBGA (12  $\times$  12)

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.  
Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

**APPLICATIONS**

- Low-power portable devices  
Cellular phones, PHSs, and camcorders

**\*ORDERING INFORMATION**

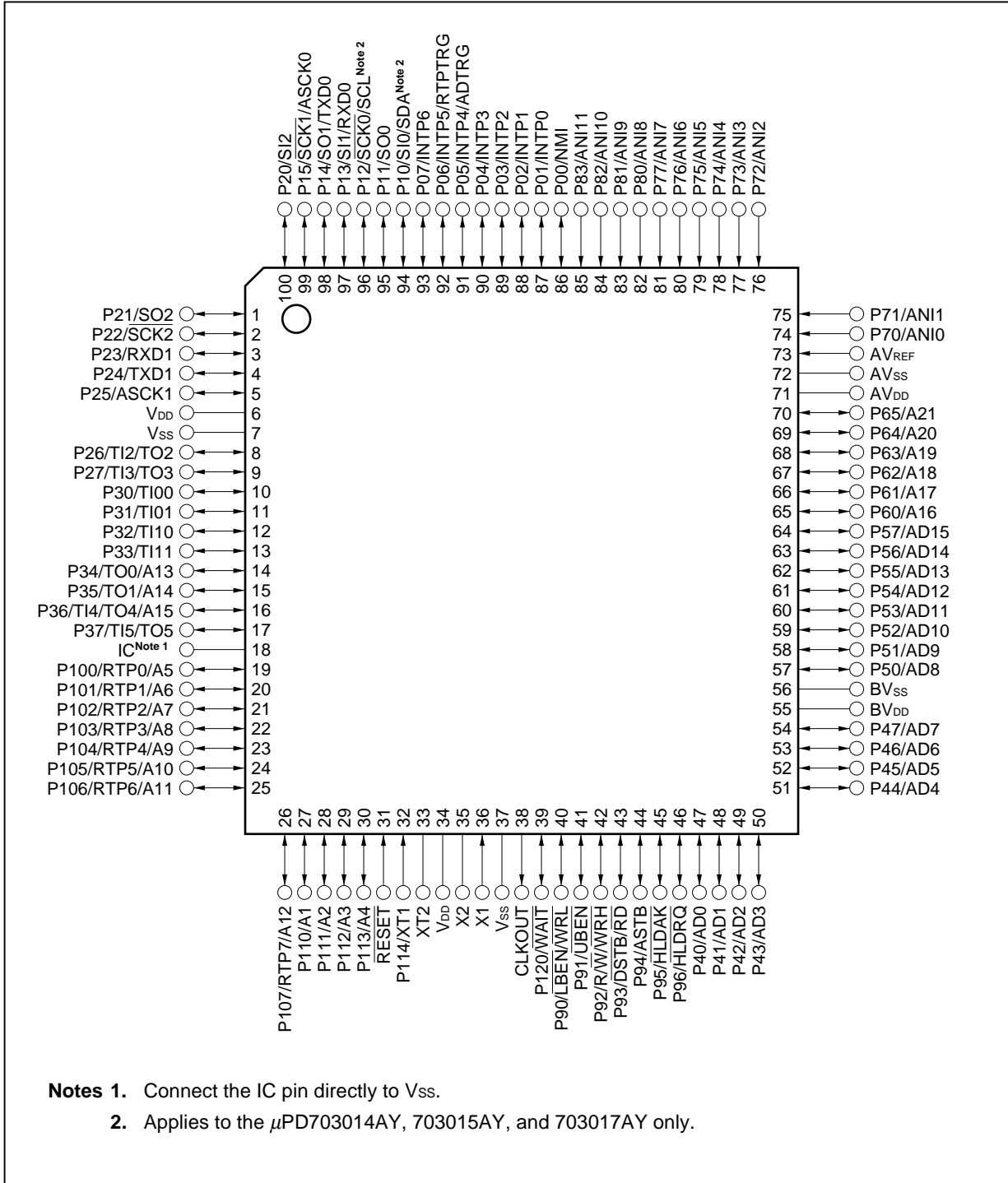
Part Number	Package	Internal ROM
μPD703014AGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	64 KB (Mask ROM)
μPD703014AF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	64 KB (Mask ROM)
μPD703014AYGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	64 KB (Mask ROM)
μPD703014AYF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	64 KB (Mask ROM)
μPD703015AGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	128 KB (Mask ROM)
μPD703015AF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	128 KB (Mask ROM)
μPD703015AYGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	128 KB (Mask ROM)
μPD703015AYF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	128 KB (Mask ROM)
μPD703017AGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	256 KB (Mask ROM)
μPD703017AF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	256 KB (Mask ROM)
μPD703017AYGC-xxx-8EU	100-pin plastic LQFP (fine-pitch) (14 × 14)	256 KB (Mask ROM)
μPD703017AYF1-xxx-EA6	121-pin plastic FBGA (12 × 12)	256 KB (Mask ROM)

**Remark**    xxx indicates ROM code suffix.

PIN CONFIGURATION

100-pin plastic LQFP (fine-pitch) (14 × 14)

- μPD703014AGC-xxx-8EU
- μPD703014AYGC-xxx-8EU
- μPD703015AGC-xxx-8EU
- μPD703015AYGC-xxx-8EU
- μPD703017AGC-xxx-8EU
- μPD703017AYGC-xxx-8EU



- Notes**
1. Connect the IC pin directly to Vss.
  2. Applies to the μPD703014AY, 703015AY, and 703017AY only.

★ 121-pin plastic FBGA (12 × 12)

μPD703014AF1-xxx-EA6

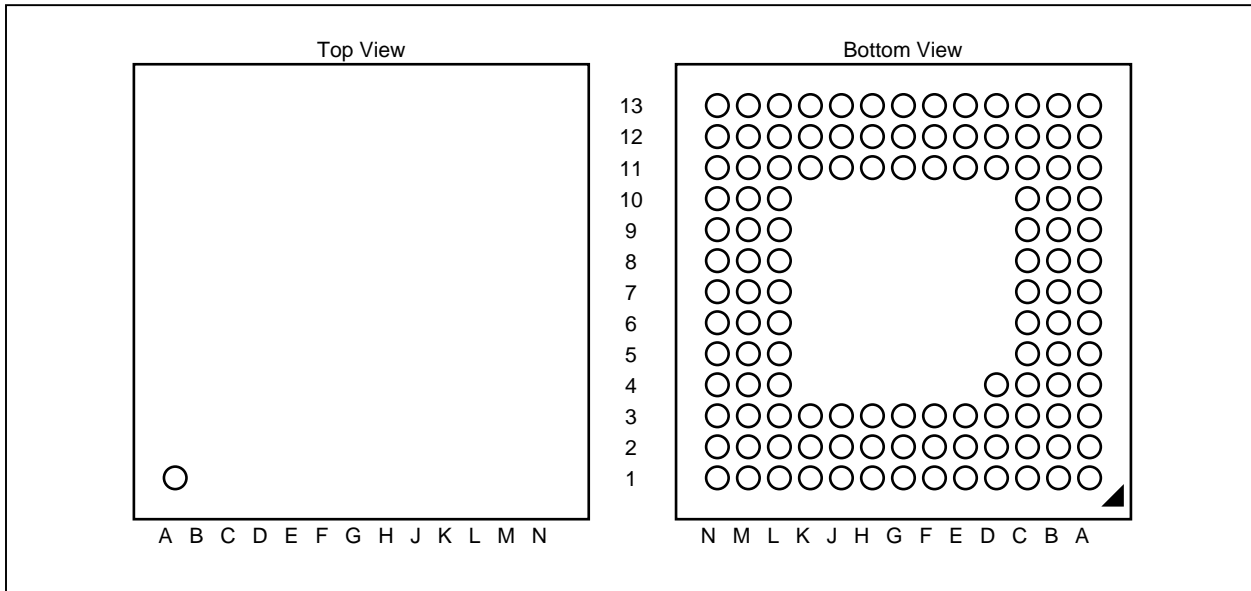
μPD703015AF1-xxx-EA6

μPD703017AF1-xxx-EA6

μPD703014AYF1-xxx-EA6

μPD703015AYF1-xxx-EA6

μPD703017AYF1-xxx-EA6



Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name
A1	P20	B8	P83	D2	V <sub>DD</sub>	G11	P60	K13	BV <sub>DD</sub>	M7	V <sub>SS</sub>
A2	P15	B9	P80	D3	V <sub>SS</sub>	G12	P56	L1	P104	M8	V <sub>SS</sub>
A3	V <sub>SS</sub>	B10	P75	D11	AV <sub>DD</sub>	G13	P57	L2	P105	M9	P92
A4	P13	B11	AV <sub>SS</sub>	D12	AV <sub>DD</sub>	H1	P34	L3	RESET	M10	P95
A5	P11	B12	AV <sub>SS</sub>	D13	AV <sub>DD</sub>	H2	P37	L4	V <sub>DD</sub>	M11	P41
A6	P06	B13	P71	E1	P25	H3	P35	L5	V <sub>SS</sub>	M12	P45
A7	P03	C1	P22	E2	V <sub>DD</sub>	H11	P55	L6	X2	M13	P44
A8	P00	C2	P23	E3	P30	H12	P53	L7	P90	N1	P107
A9	P81	C3	V <sub>SS</sub>	E11	AV <sub>DD</sub>	H13	P54	L8	P120	N2	P110
A10	P76	C4	P24	E12	P64	J1	IC <sup>Note</sup>	L9	P93	N3	P112
A11	P73	C5	P07	E13	P65	J2	IC <sup>Note</sup>	L10	P96	N4	V <sub>DD</sub>
A12	P72	C6	P04	F1	P26	J3	P100	L11	BV <sub>SS</sub>	N5	XT1
A13	AV <sub>SS</sub>	C7	P01	F2	P27	J11	P52	L12	BV <sub>SS</sub>	N6	V <sub>SS</sub>
B1	P21	C8	P82	F3	P33	J12	P50	L13	BV <sub>SS</sub>	N7	V <sub>SS</sub>
B2	P14	C9	P77	F11	P63	J13	P51	M1	P106	N8	CLKOUT
B3	V <sub>SS</sub>	C10	P74	F12	P61	K1	P101	M2	P111	N9	P91
B4	P12	C11	AV <sub>SS</sub>	F13	P62	K2	P102	M3	P113	N10	P94
B5	P10	C12	P70	G1	P31	K3	P103	M4	V <sub>DD</sub>	N11	P40
B6	P05	C13	AV <sub>REF</sub>	G2	P32	K11	P46	M5	XT2	N12	P42
B7	P02	D1	V <sub>DD</sub>	G3	P36	K12	P47	M6	X1	N13	P43

**Note** Connect the IC pin directly to V<sub>SS</sub>.

**Remarks 1.** Alternate function names are omitted. The alternate functions are identical to the 100-pin plastic LQFP.

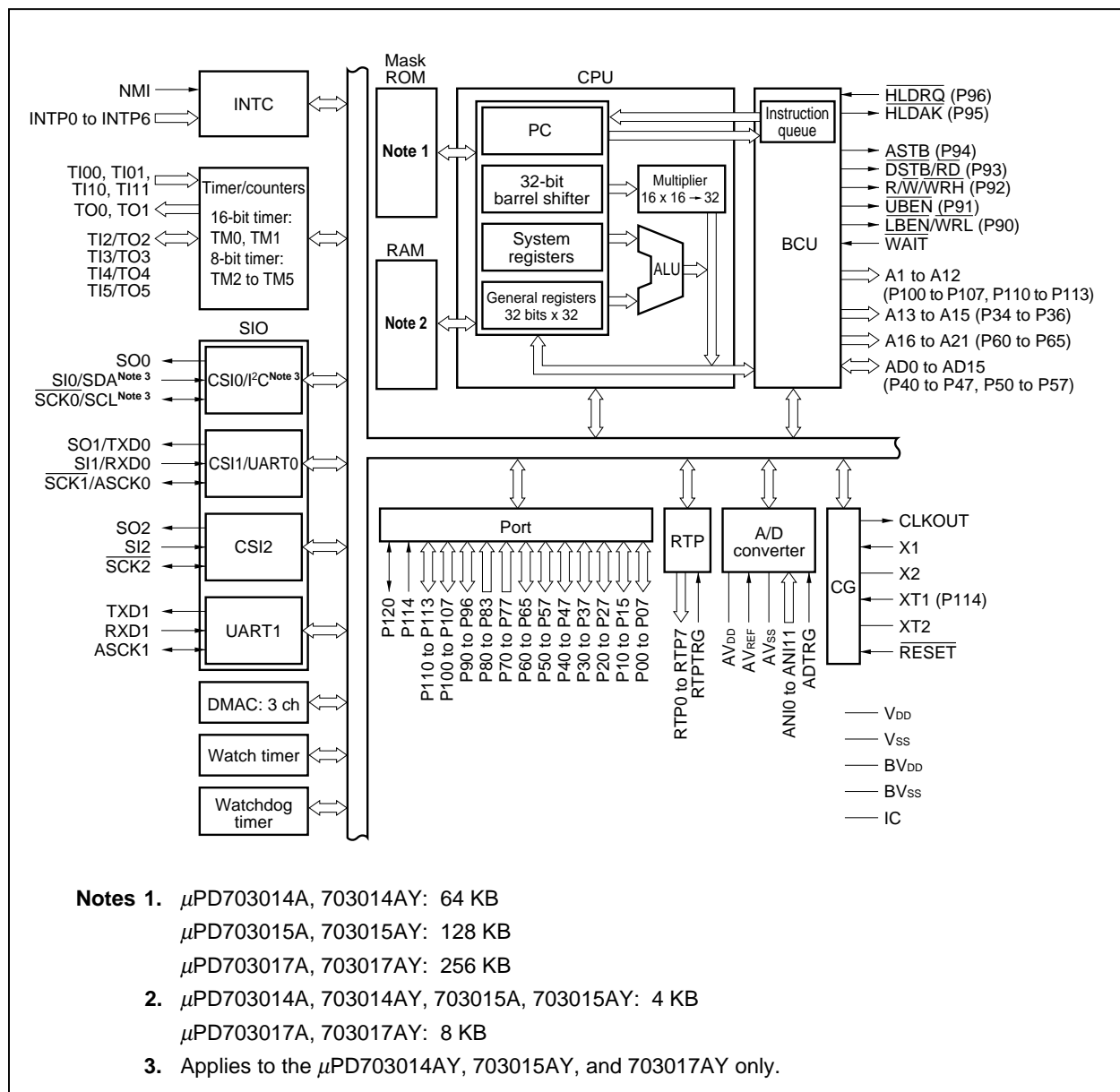
**2.** Connect the D4 pin directly to V<sub>SS</sub>.

**PIN IDENTIFICATION**

A1 to A21:	Address Bus	P90 to P96:	Port 9
AD0 to AD15:	Address/Data Bus	P100 to P107:	Port 10
ADTRG:	AD Trigger Input	P110 to P114:	Port 11
ANI0 to ANI11:	Analog Input	P120:	Port 12
ASCK0, ASCK1:	Asynchronous Serial Clock	$\overline{\text{RD}}$ :	Read
ASTB:	Address Strobe	RESET:	Reset
AV <sub>DD</sub> :	Analog V <sub>DD</sub>	RTP0 to RTP7:	Real-time Port
AV <sub>REF</sub> :	Analog Reference Voltage	RTPTRG:	RTP Trigger
AV <sub>SS</sub> :	Analog V <sub>SS</sub>	R $\overline{\text{W}}$ :	Read/Write Status
BV <sub>DD</sub> :	Power Supply for Bus Interface	RXD0, RXD1:	Receive Data
BV <sub>SS</sub> :	Ground for Bus Interface	$\overline{\text{SCK0}}$ to $\overline{\text{SCK2}}$ :	Serial Clock
CLKOUT:	Clock Output	SCL <sup>Note</sup> :	Serial Clock
$\overline{\text{DSTB}}$ :	Data Strobe	SDA <sup>Note</sup> :	Serial Data
$\overline{\text{HLDK}}$ :	Hold Acknowledge	SI0 to SI2:	Serial Input
$\overline{\text{HLDRQ}}$ :	Hold Request	SO0 to SO2:	Serial Output
IC:	Internally Connected	TI00, TI01, TI10, :	Timer Input
INTP0 to INTP6:	Interrupt Request From Peripherals	TI11, TI2 to TI5	
LBEN:	Lower Byte Enable	TO0 to TO5:	Timer Output
NMI:	Non-maskable Interrupt Request	TXD0, TXD1:	Transmit Data
P00 to P07:	Port 0	$\overline{\text{UBEN}}$ :	Upper Byte Enable
P10 to P15:	Port 1	V <sub>DD</sub> :	Power Supply
P20 to P27:	Port 2	V <sub>SS</sub> :	Ground
P30 to P37:	Port 3	$\overline{\text{WAIT}}$ :	Wait
P40 to P47:	Port 4	$\overline{\text{WRH}}$ :	Write Strobe High Level Data
P50 to P57:	Port 5	$\overline{\text{WRL}}$ :	Write Strobe Low Level Data
P60 to P65:	Port 6	X1, X2:	Crystal for Main Clock
P70 to P77:	Port 7	XT1, XT2:	Crystal for Sub-clock
P80 to P83:	Port 8		

**Note** Applies to the μPD703014AY, 703015AY, and 703017AY only.

INTERNAL BLOCK DIAGRAM



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1. PIN FUNCTIONS

1.1 Port Pins

(1/3)

Pin Name	I/O	PULL	Function	Alternate Function
P00	I/O	Yes	Port 0 8-bit I/O port Input/output can be specified in 1-bit units.	NMI
P01				INTP0
P02				INTP1
P03				INTP2
P04				INTP3
P05				INTP4/ADTRG
P06				INTP5/RTPTRG
P07				INTP6
P10	I/O	Yes	Port 1 6-bit I/O port Input/output can be specified in 1-bit units.	SI0/SDA <sup>Note</sup>
P11				SO0
P12				SCK0/SCL <sup>Note</sup>
P13				SI1/RXD0
P14				SO1/TXD0
P15				SCK1/ASCK0
P20	I/O	Yes	Port 2 8-bit I/O port Input/output can be specified in 1-bit units.	SI2
P21				SO2
P22				SCK2
P23				RXD1
P24				TXD1
P25				ASCK1
P26				TI2/TO2
P27				TI3/TO3
P30	I/O	Yes	Port 3 8-bit I/O port Input/output can be specified in 1-bit units.	TI00
P31				TI01
P32				TI10
P33				TI11
P34				TO0/A13
P35				TO1/A14
P36				TI4/TO4/A15
P37				TI5/TO5

**Note** Applies to the μPD703014AY, 703015AY, and 703017AY only.

**Remark** PULL: On-chip pull-up resistor



(2/3)

Pin Name	I/O	PULL	Function	Alternate Function
P40	I/O	No	Port 4 8-bit I/O port Input/output can be specified in 1-bit units.	AD0
P41				AD1
P42				AD2
P43				AD3
P44				AD4
P45				AD5
P46				AD6
P47				AD7
P50	I/O	No	Port 5 8-bit I/O port Input/output can be specified in 1-bit units.	AD8
P51				AD9
P52				AD10
P53				AD11
P54				AD12
P55				AD13
P56				AD14
P57				AD15
P60	I/O	No	Port 6 6-bit I/O port Input/output can be specified in 1-bit units.	A16
P61				A17
P62				A18
P63				A19
P64				A20
P65				A21
P70	Input	No	Port 7 8-bit input port	ANI0
P71				ANI1
P72				ANI2
P73				ANI3
P74				ANI4
P75				ANI5
P76				ANI6
P77				ANI7
P80	Input	No	Port 8 4-bit input port	ANI8
P81				ANI9
P82				ANI10
P83				ANI11

**Remark** PULL: On-chip pull-up resistor

(3/3)

Pin Name	I/O	PULL	Function	Alternate Function
P90	I/O	No	Port 9 7-bit I/O port Input/output can be specified in 1-bit units.	$\overline{\text{LBEN}}/\overline{\text{WRL}}$
P91				$\overline{\text{UBEN}}$
P92				$\overline{\text{R/W}}/\overline{\text{WRH}}$
P93				$\overline{\text{DSTB}}/\overline{\text{RD}}$
P94				$\overline{\text{ASTB}}$
P95				$\overline{\text{HLDAK}}$
P96				$\overline{\text{HLDRQ}}$
P100	I/O	Yes	Port 10 8-bit I/O port Input/output can be specified in 1-bit units.	RTP0/A5
P101				RTP1/A6
P102				RTP2/A7
P103				RTP3/A8
P104				RTP4/A9
P105				RTP5/A10
P106				RTP6/A11
P107				RTP7/A12
P110	I/O	Yes	Port 11 5-bit I/O port Input/output can be specified in 1-bit units. P114 is fixed as input only.	A1
P111				A2
P112				A3
P113				A4
P114	Input	No		XT1
P120	I/O	No	Port 12 1-bit I/O port	$\overline{\text{WAIT}}$

**Remark** PULL: On-chip pull-up resistor

1.2 Non-Port Pins

(1/3)

Pin Name	I/O	PULL	Function	Alternate Function
A1 to A4	Output	Yes	Low-order address bus used for external memory expansion	P110 to P113
A5 to A12				P100/RTP0 to P107/RTP7
A13				P34/TO0
A14				P35/TI1
A15				P36/TI4/TO4
A16 to A21	Output	No	High-order address bus used for external memory expansion	P60 to P65
AD0 to AD7	I/O	No	16-bit multiplexed address/data bus used for external memory expansion	P40 to P47
AD8 to AD15				P50 to P57
ADTRG	Input	Yes	A/D converter external trigger input	P05/INTP4
ANI0 to ANI7	Input	No	Analog input to A/D converter	P70 to P77
ANI8 to ANI11	Input	No		P80 to P83
ASCK0	Input	Yes	Serial clock input for UART0 and UART1	P15/SCK1
ASCK1				P25
ASTB	Output	No	External address strobe signal output	P94
AV <sub>DD</sub>	–	–	Positive power supply for A/D converter	–
AV <sub>REF</sub>	Input	–	Reference voltage input for A/D converter	–
AV <sub>SS</sub>	–	–	Ground potential for A/D converter	–
BV <sub>DD</sub>	–	–	Positive power supply for bus interface	–
BV <sub>SS</sub>	–	–	Ground potential for bus interface	–
CLKOUT	Output	–	Internal system clock output	–
DSTB	Output	No	External data strobe signal output	P93/RD
HLD <sub>AK</sub>	Output	No	Bus hold acknowledge output	P95
HLD <sub>RQ</sub>	Input	No	Bus hold request input	P96
INTP0 to INTP3	Input	Yes	External interrupt request input (analog noise elimination)	P01 to P04
INTP4			External interrupt request input (digital noise elimination)	P05/ADTRG
INTP5				P06/RTPTRG
INTP6				P07
LBEN	Output	No	External data bus's low-order byte enable signal output	P90/WRL
NMI	Input	Yes	Non-maskable interrupt request input	P00
RD	Output	No	Read strobe signal output	P93/DSTB
RESET	Input	–	System reset input	–
RTP0 to RTP7	Output	Yes	Real-time output port	P100/A5 to P107/A12

**Remark** PULL: On-chip pull-up resistor

(2/3)

Pin Name	I/O	PULL	Function	Alternate Function	
RTPTRG	Input	Yes	RTP external trigger input	P06/INTP5	
R/W	Output	No	External read/write status output	P92/WRH	
RXD0	Input	Yes	Serial receive data input for UART0 and UART1	P13/SI1	
RXD1				P23	
SCK0	I/O	Yes	Serial clock I/O (3-wire type) for CSI0 to CSI2	P12	
SCK1				P15/ASCK0	
SCK2				P22	
SCL				I <sup>2</sup> C serial clock I/O <sup>Note</sup>	P12/SCK0
SDA				I <sup>2</sup> C serial transmit/receive data I/O <sup>Note</sup>	P10/SI0
SI0	Input	Yes	Serial receive data input (3-wire type) for CSI0 to CSI2	P10	
SI1				P13/RXD0	
SI2				P20	
SO0	Output	Yes	Serial transmit data output (3-wire type) for CSI0 to CSI2	P11	
SO1				P14/TXD0	
SO2				P21	
TI00	Input	Yes	External capture trigger input and external count clock input for TM0	P30	
TI01			External capture trigger input for TM0	P31	
TI10			External capture trigger input and external count clock input for TM1	P32	
TI11			External capture trigger input for TM1	P33	
TI2			External count clock input for TM2	P26/TO2	
TI3			External count clock input for TM3	P27/TO3	
TI4			External count clock input for TM4	P36/TO4/A15	
TI5			External count clock input for TM5	P37/TO5	
TO0, TO1			Output	Yes	Pulse signal output for TM0 and TM1
TO2	Pulse signal output for TM2	P26/TI2			
TO3	Pulse signal output for TM3	P27/TI3			
TO4	Pulse signal output for TM4	P36/TI4/A15			
TO5	Pulse signal output for TM5	P37/TI5			
TXD0	Output	Yes	Serial transmit data output for UART0 and UART1	P14/SO1	
TXD1				P24	
UBEN	Output	No	High-order byte enable signal output for external data bus	P91	
V <sub>DD</sub>	–	–	Positive power supply pin	–	
V <sub>SS</sub>	–	–	Ground potential	–	

**Note** Applies to the μPD703014AY, 703015AY, and 703017AY only.

**Remark** PULL: On-chip pull-up resistor

(3/3)

Pin Name	I/O	PULL	Function	Alternate Function
$\overline{\text{WAIT}}$	Input	No	Control signal input for inserting wait in bus cycle	P120
$\overline{\text{WRH}}$	Output	No	High-order byte write strobe signal output for external data bus	$\overline{\text{P92/R/W}}$
$\overline{\text{WRL}}$			Low-order byte write strobe signal output for external data bus	$\overline{\text{P90/LBEN}}$
X1	Input	No	Resonator connection for main clock	–
X2	–			–
XT1	Input	No	Resonator connection for subsystem clock	P114
XT2	–			–
IC	–	–	Internally connected (connect directly to V <sub>SS</sub> )	–

**Remark** PULL: On-chip pull-up resistor

**1.3 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 show in Table 1-1. For the input/output schematic circuit diagram of each type, refer to Figure 1-1.

**Table 1-1. Types of Pin I/O Circuits (1/2)**

Pin	Alternate Function	I/O Circuit Type	Recommended Connection of Unused Pins
P00	NMI	8-A	Input: Connect to V <sub>SS</sub> Output: Leave open
P01 to P04	INTP0 to INTP3		
P05	INTP4/ADTRG		
P06	INTP5/RTPTRG		
P07	INTP6		
P10	SI0/SDA <sup>Note</sup>	10-A	Input: Connect to V <sub>DD</sub> or V <sub>SS</sub> Output: Leave open
P11	SO0	26	
P12	SCK0/SCL <sup>Note</sup>	10-A	
P13	SI1/RXD0	8-A	
P14	SO1/TXD0	26	
P15	SCK1/ASCK0	10-A	
P20	SI2	8-A	
P21	SO2	26	
P22	SCK2	10-A	
P23	RXD1	8-A	
P24	TXD1	5-A	
P25	ASCK1	8-A	
P26, P27	TI2/TO2, TI3/TO3		
P30, P31	TI00, TI01		
P32, P33	TI10, TI11		
P34, P35	TO0/A13, TO1/A14	5-A	
P36	TI4/TO4/A15	8-A	
P37	TI5/TO5		
P40 to P47	AD0 to AD7	5	Input: Connect to BV <sub>DD</sub> or BV <sub>SS</sub> Output: Leave open
P50 to P57	AD8 to AD15		
P60 to P65	A16 to A21		
P70 to P77	ANI0 to ANI7	9	Connect to AV <sub>SS</sub> or AV <sub>DD</sub>
P80 to P83	ANI8 to ANI11		

**Note** Applies to the μPD703014AY, 703015AY, and 703017AY only.

Table 1-1. Types of Pin I/O Circuits (2/2)

Pin	Alternate Function	I/O Circuit Type	Recommended Connection of Unused Pins
P90	$\overline{\text{LBEN/WRL}}$	5	Input: Connect to $\text{BV}_{\text{DD}}$ or $\text{BV}_{\text{SS}}$ Output: Leave open
P91	$\overline{\text{UBEN}}$		
P92	$\overline{\text{R/W/WRH}}$		
P93	$\overline{\text{DSTB/RD}}$		
P94	ASTB		
P95	$\overline{\text{HLDAK}}$		
P96	$\overline{\text{HLDRQ}}$		
P100 to P107	RTP0/A5 to RTP7/A12	26	Input: Connect to $\text{V}_{\text{DD}}$ or $\text{V}_{\text{SS}}$ Output: Leave open
P110 to P113	A1 to A4	5-A	
P114	XT1	16	
P120	$\overline{\text{WAIT}}$	5	Input: Connect to $\text{BV}_{\text{DD}}$ or $\text{BV}_{\text{SS}}$ Output: Leave open
$\text{AV}_{\text{REF}}$	–	–	Connect to $\text{AV}_{\text{SS}}$
CLKOUT	–	4	Leave open
$\overline{\text{RESET}}$	–	2	–
X2	–	–	Leave open (when external clock is input to X1 pin)
XT2	–	16	Leave open
IC	–	–	Always connect directly to $\text{V}_{\text{SS}}$

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

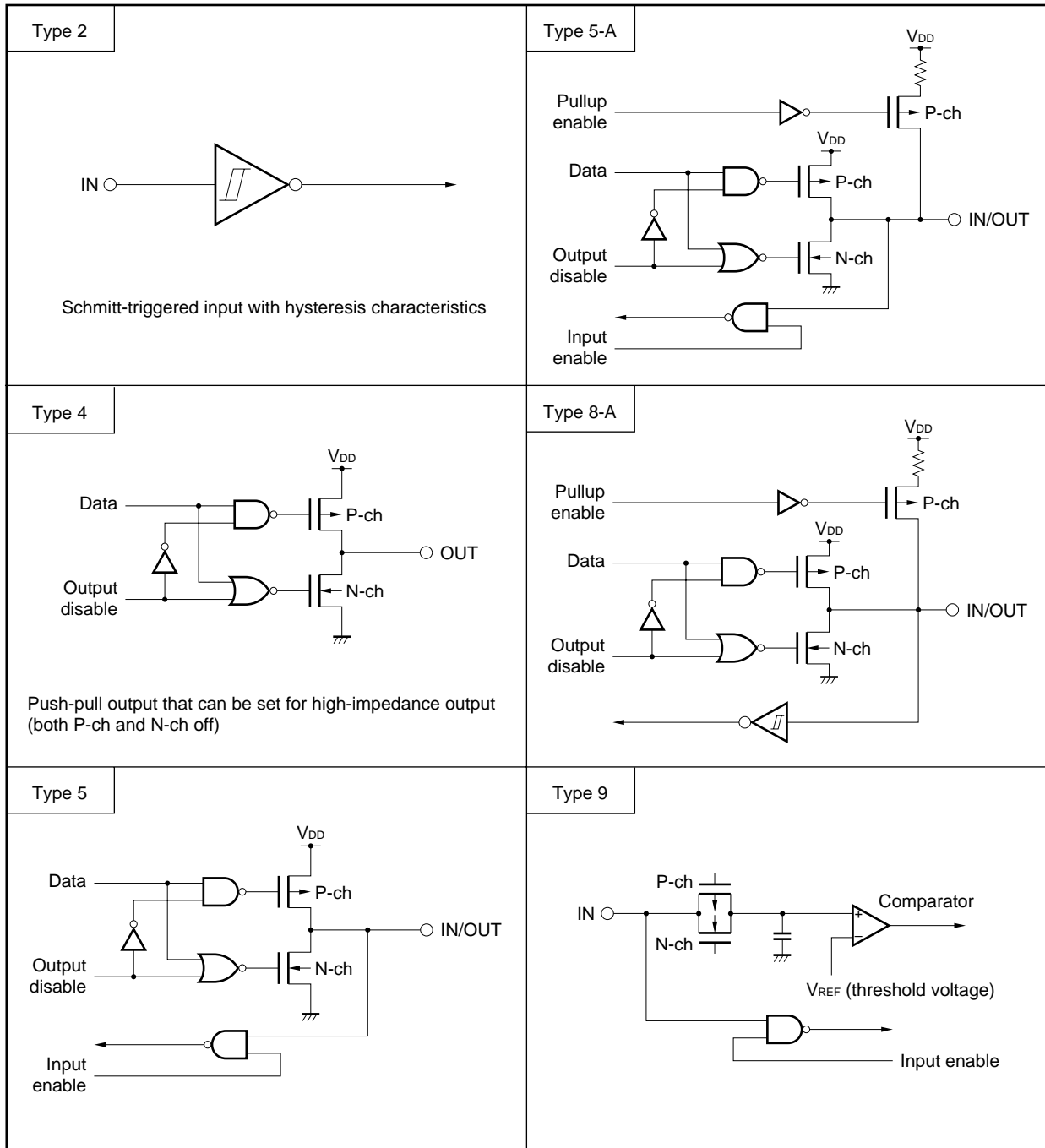
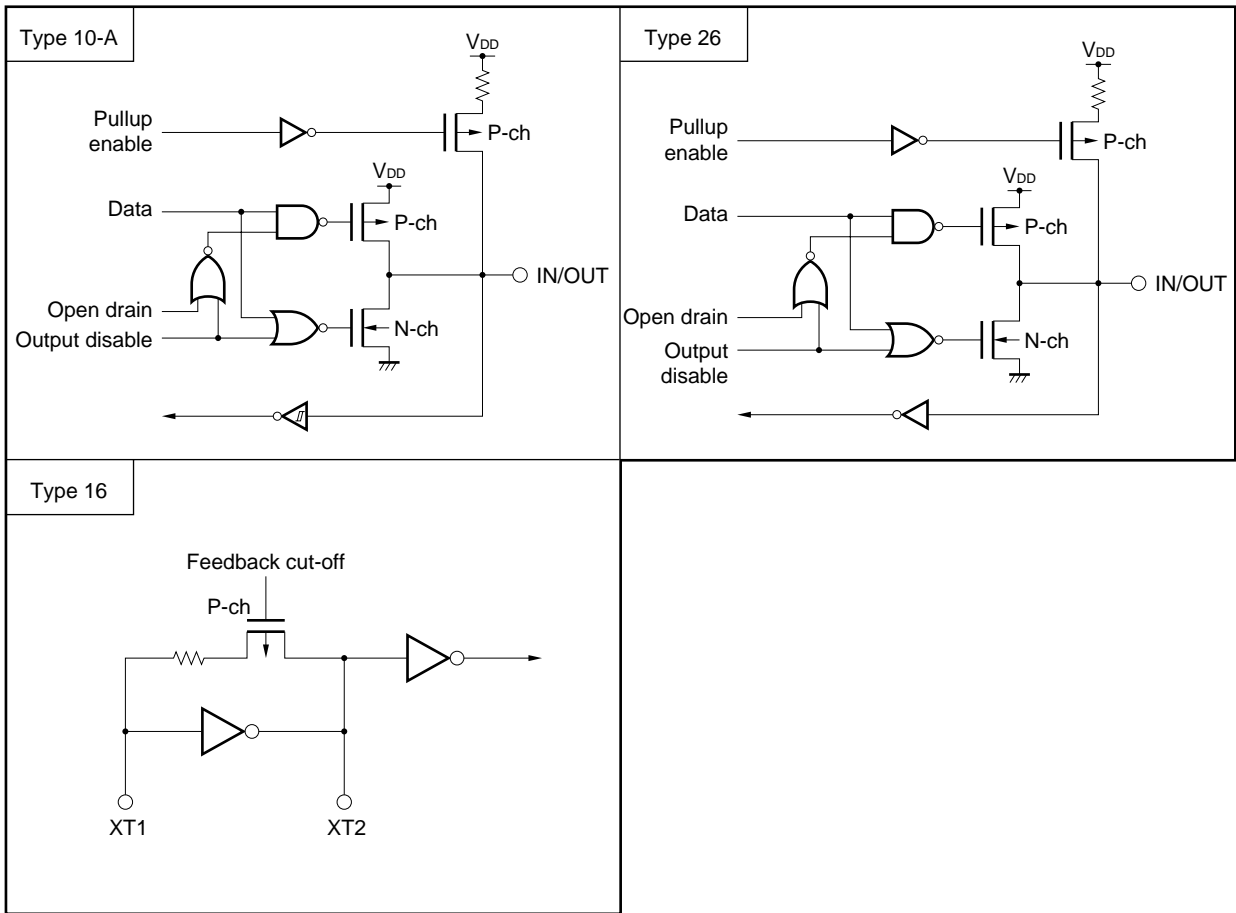




Figure 1-1. Pin Input/Output Circuits (2/2)



## 2. ELECTRICAL SPECIFICATIONS

### Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ , $V_{SS} = 0\text{ V}$ )

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{DD}$		-0.5 to +4.6	V
	$AV_{DD}$		-0.5 to +4.6	V
	$BV_{DD}$		-0.5 to +4.6	V
	$AV_{SS}$		-0.5 to +0.5	V
	$BV_{SS}$		-0.5 to +0.5	V
Input voltage	$V_{I1}$	<b>Note 1</b>	-0.5 to $V_{DD} + 0.5^{\text{Note 4}}$	V
	$V_{I2}$	<b>Note 2</b>	-0.5 to $BV_{DD} + 0.5^{\text{Note 4}}$	V
Clock input voltage	$V_K$	X1, XT1, $V_{DD} = 2.7$ to $3.6\text{ V}$	-0.5 to $V_{DD} + 1.0^{\text{Note 4}}$	V
Analog input voltage	$V_{IAN}$	<b>Note 3</b> ( $AV_{DD}$ )	-0.5 to $AV_{DD} + 0.5^{\text{Note 4}}$	V
Analog reference input voltage	$AV_{REF}$	$AV_{REF}$	-0.5 to $AV_{DD} + 0.5^{\text{Note 4}}$	V
Output current, low	$I_{OL}$	Per pin	4.0	mA
		Total for P00 to P07, P10 to P15, P20 to P25	25	mA
		Total for P26, P27, P30 to P37, P100 to P107, P110 to P113	25	mA
		Total for P40 to P47, P90 to P96, P120, CLKOUT	25	mA
		Total for P50 to P57, P60 to P65	25	mA
Output current, high	$I_{OH}$	Per pin	-4.0	mA
		Total for P00 to P07, P10 to P15, P20 to P25	-25	mA
		Total for P26, P27, P30 to P37, P100 to P107, P110 to P113	-25	mA
		Total for P40 to P47, P90 to P96, P120, CLKOUT	-25	mA
		Total for P50 to P57, P60 to P65	-25	mA
Output voltage	$V_{O1}$	<b>Note 1</b> , $V_{DD} = 2.7$ to $3.6\text{ V}$	-0.5 to $V_{DD} + 0.5^{\text{Note 4}}$	V
	$V_{O2}$	<b>Note 2</b> , $BV_{DD} = 2.7$ to $3.6\text{ V}$	-0.5 to $BV_{DD} + 0.5^{\text{Note 4}}$	V
Operating ambient temperature	$T_A$		-40 to +85	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-65 to +150	$^\circ\text{C}$

- Notes**
1. Ports 0, 1, 2, 3, 10, 11, 12,  $\overline{\text{RESET}}$ , and their alternate-function pins.
  2. Ports 4, 5, 6, 9, CLKOUT, and their alternate-function pins.
  3. Ports 7, 8, and their alternate-function pins.
  4. Be sure not to exceed the absolute maximum ratings (MAX. value) of each supply voltage.

**Cautions**

1. Do not directly connect the output (or I/O) pins of IC products to each other, or to  $V_{DD}$ ,  $V_{CC}$ , and GND. Open-drain pins or open-collector pins, however, can be directly connected to each other. Direct connection of the output pins between an IC product and an external circuit is possible, if the output pins can be set to the high-impedance state and the output timing of the external circuit is designed to avoid output conflict.

2. Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.  
 The ratings and conditions indicated for DC characteristics and AC characteristics represent the quality assurance range during normal operation.

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

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input capacitance	C <sub>i</sub>	f <sub>c</sub> = 1 MHz Unmeasured pins returned to 0 V			15	pF
I/O capacitance	C <sub>io</sub>				15	pF
Output capacitance	C <sub>o</sub>				15	pF

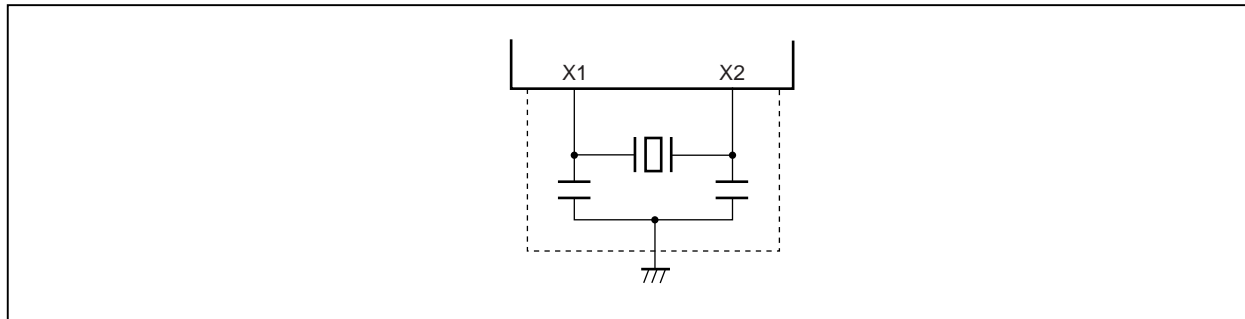
**Operating Conditions**

Internal Operation Clock Frequency	Supply Voltage (V <sub>DD</sub> )	Operating Ambient Temperature (T <sub>A</sub> )
2 MHz ≤ f <sub>xx</sub> ≤ 17 MHz	2.7 to 3.6 V	-40 to +85°C
2 MHz ≤ f <sub>xx</sub> ≤ 20 MHz	3.0 to 3.6 V	-40 to +85°C
f <sub>XT</sub> = 32.768 kHz	2.7 to 3.6 V	-40 to +85°C

Recommended Oscillator

(1) Main system clock oscillator (T<sub>A</sub> = -40 to +85°C)

(a) Connection of ceramic resonator or crystal resonator



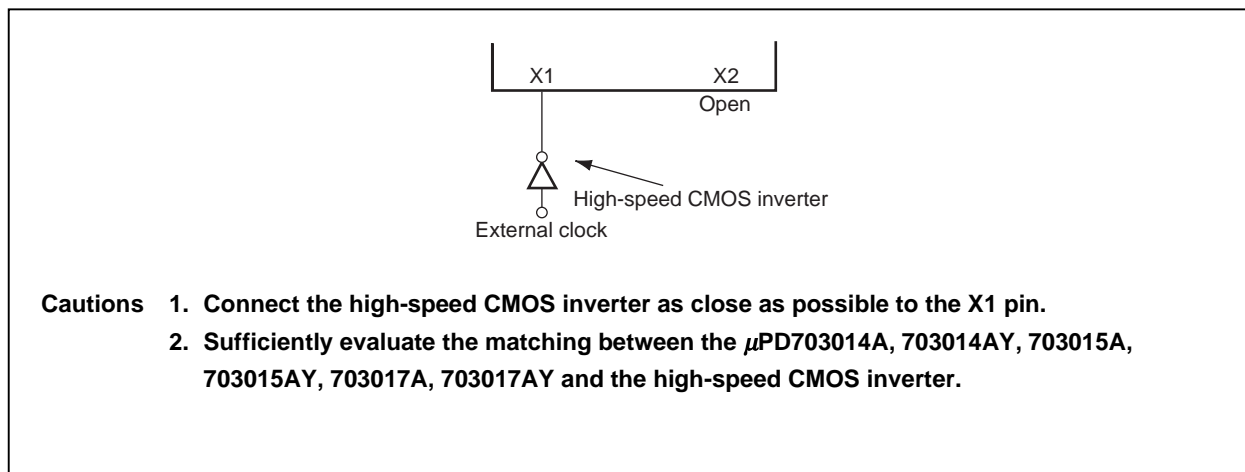
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
★ Oscillation frequency	f <sub>xx</sub>	V <sub>DD</sub> = 2.7 to 3.6 V	2		17	MHz
		V <sub>DD</sub> = 3.0 to 3.6 V	2		20	MHz
Oscillation stabilization time		Upon reset release		2 <sup>19</sup> /f <sub>xx</sub>		s
		Upon STOP mode release		<b>Note</b>		s

**Note** The TYP value differs depending on the setting of the oscillation stabilization time select register (OSTS).

**Caution** Ensure that the duty of oscillation waveform is between 45% and 55%.

- Remarks**
1. Connect the oscillator as close as possible to the X1 and X2 pins.
  2. Do not route the wiring near broken lines.
  3. Sufficiently evaluate the matching between the oscillator and resonator.

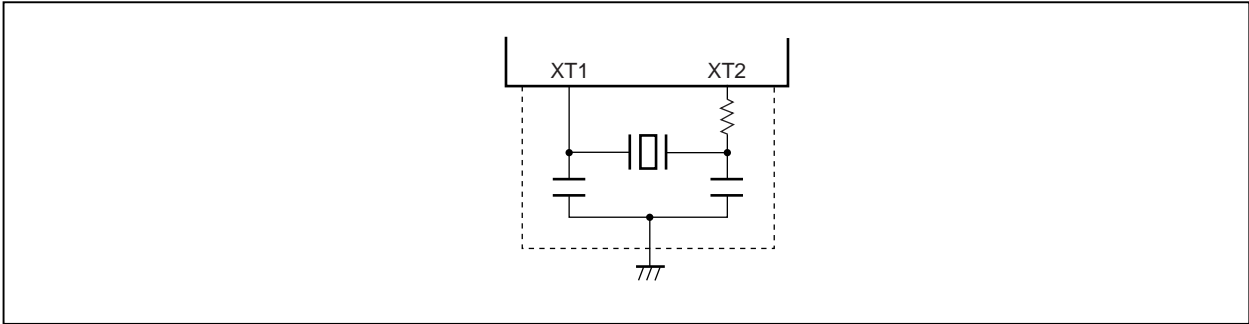
(b) External clock input



- Cautions**
1. Connect the high-speed CMOS inverter as close as possible to the X1 pin.
  2. Sufficiently evaluate the matching between the μPD703014A, 703014AY, 703015A, 703015AY, 703017A, 703017AY and the high-speed CMOS inverter.

(2) Subsystem clock oscillator ( $T_A = -40$  to  $+85^\circ\text{C}$ )

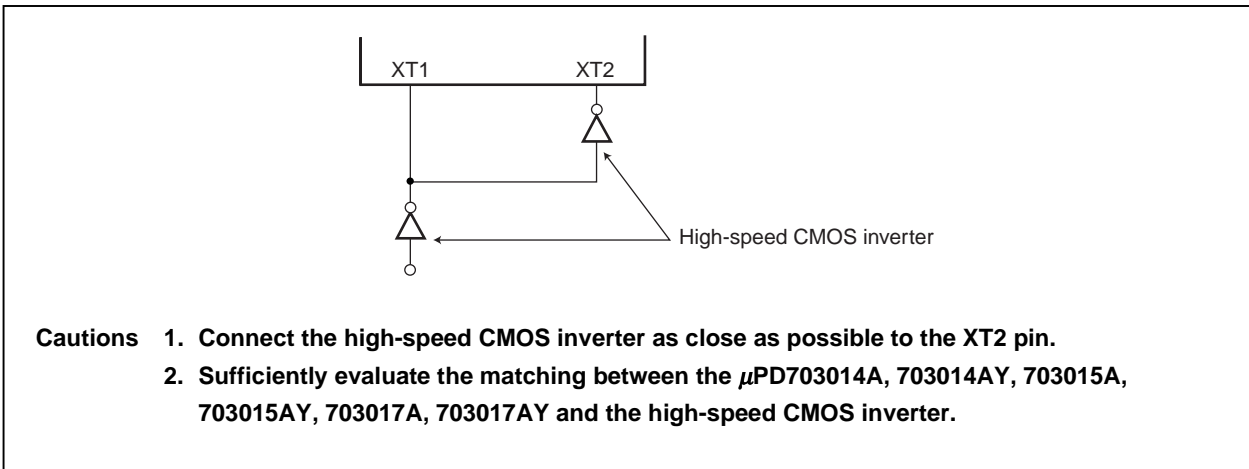
(a) Connection of crystal resonator



Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Oscillation frequency	$f_{XT}$		32	32.768	35	kHz
Oscillation stabilization time				10		s

- Remarks**
1. Connect the oscillator as close as possible to the XT1 and XT2 pins.
  2. Do not route the wiring near broken lines.
  3. Sufficiently evaluate the matching between the oscillator and resonator.

(b) External clock input



- Cautions**
1. Connect the high-speed CMOS inverter as close as possible to the XT2 pin.
  2. Sufficiently evaluate the matching between the  $\mu$ PD703014A, 703014AY, 703015A, 703015AY, 703017A, 703017AY and the high-speed CMOS inverter.

DC Characteristics

(1) Operating conditions (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = AV<sub>DD</sub> = BV<sub>DD</sub> = 2.7 to 3.6 V, V<sub>SS</sub> = AV<sub>SS</sub> = BV<sub>SS</sub> = 0 V) (1/2)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage, high	V <sub>IH1</sub>	Pins other than below		0.7V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH2</sub>	<b>Note 1</b>		0.7AV <sub>DD</sub>		AV <sub>DD</sub>	V
	V <sub>IH3</sub>	<b>Note 2</b>		0.75V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH4</sub>	X1, XT1 (P114), XT2		0.8V <sub>DD</sub>		V <sub>DD</sub>	V
Input voltage, low	V <sub>IL1</sub>	Pins other than below		V <sub>SS</sub>		0.3V <sub>DD</sub>	V
	V <sub>IL2</sub>	<b>Note 1</b>		AV <sub>SS</sub>		0.3AV <sub>DD</sub>	V
	V <sub>IL3</sub>	<b>Note 2</b>		V <sub>SS</sub>		0.2V <sub>DD</sub>	V
	V <sub>IL4</sub>	X1, XT1 (P114), XT2		V <sub>SS</sub>		0.2V <sub>DD</sub>	V
Output voltage, high	V <sub>OH1</sub>	<b>Note 3</b>	I <sub>OH</sub> = -3 mA	0.8V <sub>DD</sub>			V
	V <sub>OH2</sub>	<b>Note 4</b>	I <sub>OH</sub> = -1 mA	0.8V <sub>DD</sub>			V
Output voltage, low	V <sub>OL1</sub>	<b>Note 3</b>	I <sub>OL</sub> = 1.6 mA			0.4	V
	V <sub>OL2</sub>	<b>Note 4</b> (Except pins P10 and P12)	I <sub>OL</sub> = 1.6 mA			0.4	V
	V <sub>OL3</sub>	P10, P12	I <sub>OL</sub> = 3 mA			0.4	V
Input leakage current, high	I <sub>LIH</sub>	V <sub>I</sub> = V <sub>DD</sub> = AV <sub>DD</sub> = BV <sub>DD</sub>	Pins other than below			5	μA
			X1, XT1, XT2			20	μA
Input leakage current, low	I <sub>LIL</sub>	V <sub>I</sub> = 0 V	Pins other than below			-5	μA
			X1, XT1, XT2			-20	μA
Output leakage current, high	I <sub>LOH</sub>	V <sub>O</sub> = V <sub>DD</sub> = AV <sub>DD</sub> = BV <sub>DD</sub>				5	μA
Output leakage current, low	I <sub>LOL</sub>	V <sub>O</sub> = 0 V				-5	μA
Supply current <sup>Note 5</sup>	I <sub>DD1</sub>	Normal operation	f <sub>xx</sub> = 17 MHz All peripheral functions operating		17	30	mA
	I <sub>DD2</sub>	HALT mode	f <sub>xx</sub> = 17 MHz All peripheral functions operating		8	20	mA
	I <sub>DD3</sub>	IDLE mode	f <sub>xx</sub> = 17 MHz Watch timer operating		1	4	mA
	I <sub>DD4</sub>	STOP mode (subsystem oscillator, watch timer operating)			8	60	μA
		STOP mode (subsystem oscillator stopped (XT1 = V <sub>SS</sub> ))			1	60	μA

(1) Operating conditions (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = AV<sub>DD</sub> = BV<sub>DD</sub> = 2.7 to 3.6 V, V<sub>SS</sub> = AV<sub>SS</sub> = BV<sub>SS</sub> = 0 V) (2/2)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply current <sup>Note 5</sup>	I <sub>DD5</sub>	Subsystem clock normal operation mode f <sub>XT</sub> = 32.768 kHz (main system clock stopped)		40	140	μA
	I <sub>DD6</sub>	Subsystem clock IDLE mode f <sub>XT</sub> = 32.768 kHz (main system clock stopped, watch timer operating)		8	60	μA
Pull-up resistance	R <sub>L</sub>	V <sub>IN</sub> = 0 V	10	30	100	kΩ

- Notes**
1. P70 to P77, P80 to P83, and their alternate-function pins.
  2. P00 to P07, P10, P12, P13, P15, P20, P22, P23, P25 to P27, P30 to P33, P36, P37,  $\overline{\text{RESET}}$ , and their alternate-function pins.
  3. CLKOUT, P40 to P47, P50 to P57, P60 to P65, P90 to P96, P120, and their alternate-function pins.
  4. P00 to P07, P10 to P15, P20 to P27, P30 to P37, P100 to P107, P110 to P113, and their alternate-function pins.
  5. The TYP. value of V<sub>DD</sub> is 3.3 V. The current consumed by the output buffer is not included.

(2) Operating conditions (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = AV<sub>DD</sub> = BV<sub>DD</sub> = 3.0 to 3.6 V, V<sub>SS</sub> = AV<sub>SS</sub> = BV<sub>SS</sub> = 0 V) (1/2)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage, high	V <sub>IH1</sub>	Pins other than below		0.7V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH2</sub>	<b>Note 1</b>		0.7AV <sub>DD</sub>		AV <sub>DD</sub>	V
	V <sub>IH3</sub>	<b>Note 2</b>		0.75V <sub>DD</sub>		V <sub>DD</sub>	V
	V <sub>IH4</sub>	X1, XT1 (P114), XT2		0.8V <sub>DD</sub>		V <sub>DD</sub>	V
Input voltage, low	V <sub>IL1</sub>	Pins other than below		V <sub>SS</sub>		0.3V <sub>DD</sub>	V
	V <sub>IL2</sub>	<b>Note 1</b>		AV <sub>SS</sub>		0.3AV <sub>DD</sub>	V
	V <sub>IL3</sub>	<b>Note 2</b>		V <sub>SS</sub>		0.2V <sub>DD</sub>	V
	V <sub>IL4</sub>	X1, X2, XT1 (P114), XT2		V <sub>SS</sub>		0.2V <sub>DD</sub>	V
Output voltage, high	V <sub>OH1</sub>	<b>Note 3</b>	I <sub>OH</sub> = -3 mA	0.8V <sub>DD</sub>			V
	V <sub>OH2</sub>	<b>Note 4</b>	I <sub>OH</sub> = -1 mA	0.8V <sub>DD</sub>			V
Output voltage, low	V <sub>OL1</sub>	<b>Note 3</b>	I <sub>OL</sub> = 1.6 mA			0.4	V
	V <sub>OL2</sub>	<b>Note 4</b> (Except pins P10 and P12)	I <sub>OL</sub> = 1.6 mA			0.4	V
	V <sub>OL3</sub>	P10, P12	I <sub>OL</sub> = 3 mA			0.4	V
Input leakage current, high	I <sub>LIH</sub>	V <sub>I</sub> = V <sub>DD</sub> = AV <sub>DD</sub> = BV <sub>DD</sub>	Pins other than below			5	μA
			X1, XT1, XT2			20	μA
Input leakage current, low	I <sub>LIL</sub>	V <sub>I</sub> = 0 V	Pins other than below			-5	μA
			X1, XT1, XT2			-20	μA
Output leakage current, high	I <sub>LOH</sub>	V <sub>O</sub> = V <sub>DD</sub>				5	μA
Output leakage current, low	I <sub>LOL</sub>	V <sub>O</sub> = 0 V				-5	μA
Supply current <sup>Note 5</sup>	I <sub>DD1</sub>	Normal operation	f <sub>xx</sub> = 20 MHz All peripheral functions operating		20	35	mA
	I <sub>DD2</sub>	HALT mode	f <sub>xx</sub> = 20 MHz All peripheral functions operating		9	22	mA
	I <sub>DD3</sub>	IDLE mode	f <sub>xx</sub> = 20 MHz Watch timer operating		1.2	4.5	mA
	I <sub>DD4</sub>	STOP mode (subsystem oscillator, watch timer operating)			8	60	μA
STOP mode (subsystem oscillator stopped (XT1 = V <sub>SS</sub> ))			1	60	μA		



(2) Operating conditions ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = AV_{DD} = BV_{DD} = 3.0$  to  $3.6$  V,  $V_{SS} = AV_{SS} = BV_{SS} = 0$  V) (2/2)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply current <sup>Note 5</sup>	I <sub>DD5</sub>	Subsystem clock normal operation mode f <sub>XT</sub> = 32.768 kHz (main system clock stopped)		40	140	μA
	I <sub>DD6</sub>	Subsystem clock IDLE mode f <sub>XT</sub> = 32.768 kHz (main system clock stopped, watch timer operating)		8	60	μA
Pull-up resistance	R <sub>L</sub>	V <sub>IN</sub> = 0 V	10	30	100	kΩ

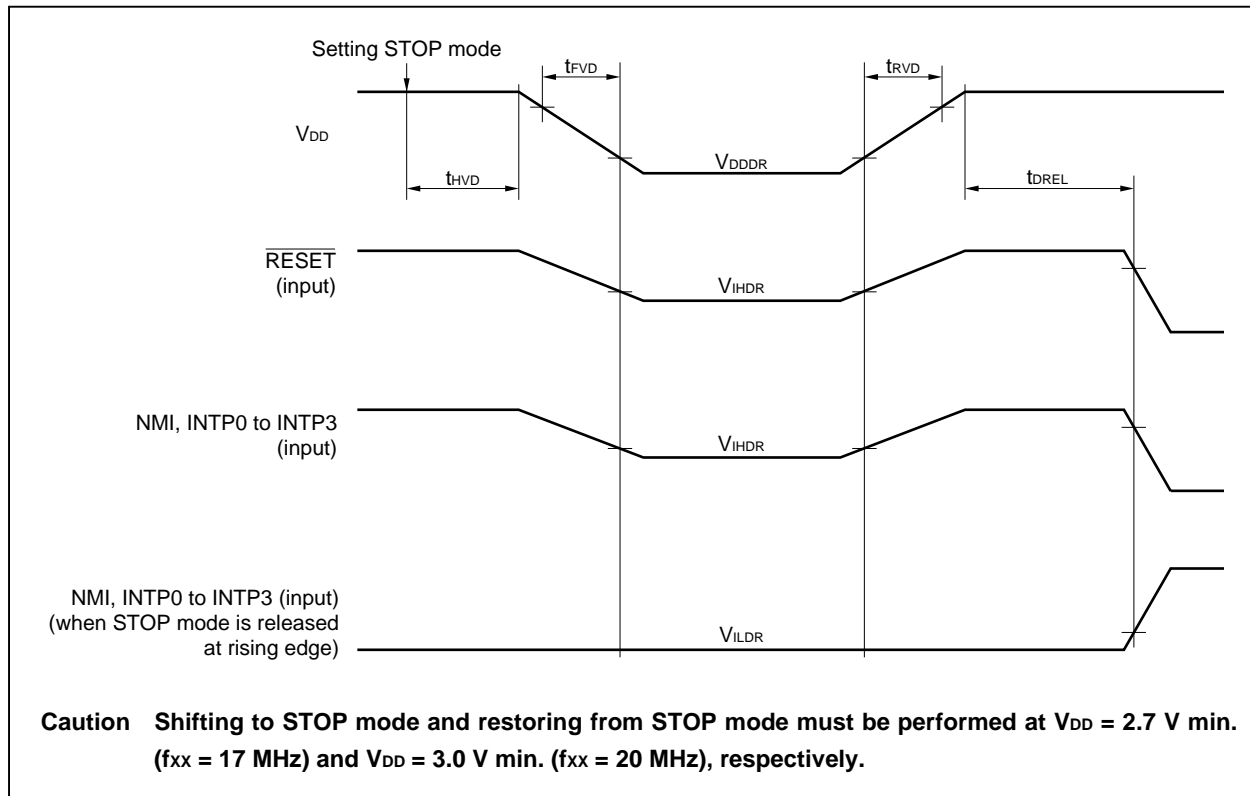
- Notes**
1. P70 to P77, P80 to P83, and their alternate-function pins.
  2. P00 to P07, P10, P12, P13, P15, P20, P22, P23, P25 to P27, P30 to P33, P36, P37,  $\overline{\text{RESET}}$  and their alternate-function pins.
  3. CLKOUT, P40 to P47, P50 to P57, P60 to P65, P90 to P96, P120, and their alternate-function pins.
  4. P00 to P07, P10 to P15, P20 to P27, P30 to P37, P100 to P107, P110 to P113, and their alternate-function pins.
  5. The TYP. value of V<sub>DD</sub> is 3.3 V. The current consumed by the output buffer is not included.

Data Retention Characteristics (T<sub>A</sub> = -40 to +85°C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Data retention voltage	V <sub>DDDR</sub>	STOP mode	1.8		3.6	V
Data retention current	I <sub>DDDR</sub>	V <sub>DDDR</sub> [V]		1	60	μA
Supply voltage rise time	t <sub>rVD</sub>		200			μs
Supply voltage fall time	t <sub>fVD</sub>		200			μs
Supply voltage hold time (from STOP mode setting)	t <sub>HVD</sub>		0			ms
STOP release signal input time	t <sub>DREL</sub>		0			ms
Data retention high-level input voltage	V <sub>IHDR</sub>	All input ports	V <sub>IHn</sub>		V <sub>DDDR</sub>	V
Data retention low-level input voltage	V <sub>ILDR</sub>	All input ports	0		V <sub>ILn</sub>	V

Remarks 1. TYP. values are reference values for when T<sub>A</sub> = 25°C.

2. n = 1 to 4

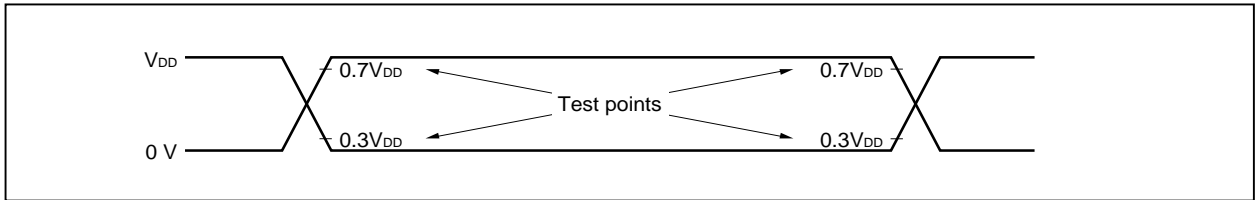


**Caution** Shifting to STOP mode and restoring from STOP mode must be performed at V<sub>DD</sub> = 2.7 V min. (f<sub>xx</sub> = 17 MHz) and V<sub>DD</sub> = 3.0 V min. (f<sub>xx</sub> = 20 MHz), respectively.

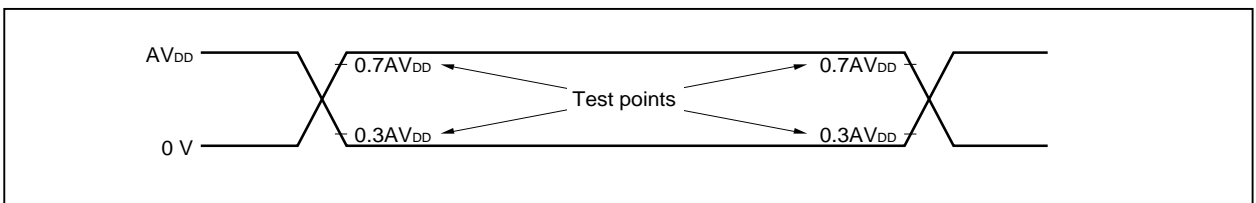
AC Characteristics

AC Test Input Waveforms

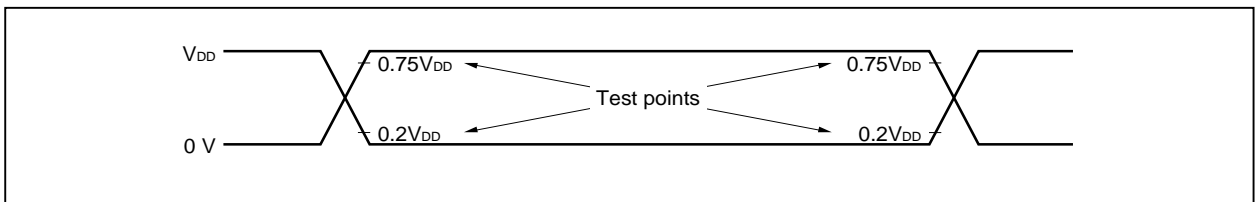
- (1) P11, P14, P21, P24, P34, P35, P100 to P107, P110 to P113, and their alternate-function pins



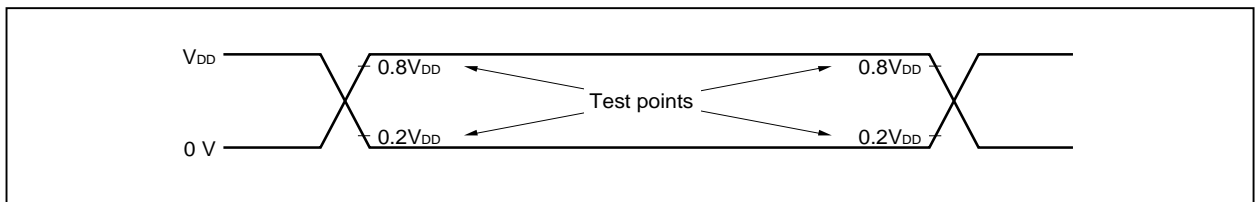
- (2) P70 to P77, P80 to P83, and their alternate-function pins



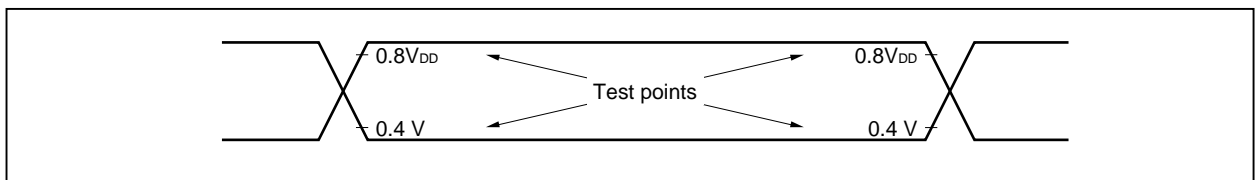
- (3) P00 to P07, P10, P12, P13, P15, P20, P22, P23, P25 to P27, P30 to P33, P36, P37,  $\overline{\text{RESET}}$ , and their alternate-function pins



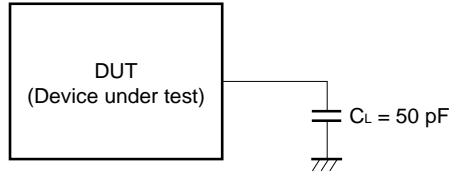
- (4) X1, XT1 (P114), XT2



AC Test Output Test Points



## Load conditions



**Caution** If the load capacitance exceeds 50 pF due to the circuit configuration, bring the load capacitance of the device to 50 pF or less by inserting a buffer or by some other means.

**Clock Timing**

**(1) Operating conditions (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = BV<sub>DD</sub> = 2.7 to 3.6 V, V<sub>SS</sub> = BV<sub>SS</sub> = 0 V, Output pin load capacitance: C<sub>L</sub> = 50 pF)**

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
X1 input cycle	t <sub>CYX</sub>	<1>		58.8		ns
XT1 input cycle				28.5		μs
X1 input high-level width	t <sub>WXH</sub>	<2>		26.4		ns
XT1 input high-level width				12.8		μs
X1 input low-level width	t <sub>WXL</sub>	<3>		26.4		ns
XT1 input low-level width				12.8		μs
X1 input rise time	t <sub>XR</sub>	<4>			0.5 (t <sub>CYX</sub> - t <sub>WXH</sub> - t <sub>WXL</sub> )	ns
X1 input fall time	t <sub>XF</sub>	<5>			0.5 (t <sub>CYX</sub> - t <sub>WXH</sub> - t <sub>WXL</sub> )	ns
CLKOUT output cycle	t <sub>CYK</sub>	<6>		58.8 ns	31.2 μs	
CLKOUT high-level width	t <sub>WKH</sub>	<7>		0.4t <sub>CYK</sub> - 10		ns
CLKOUT low-level width	t <sub>WKL</sub>	<8>		0.4t <sub>CYK</sub> - 10		ns
CLKOUT rise time	t <sub>KR</sub>	<9>			10	ns
CLKOUT fall time	t <sub>KF</sub>	<10>			10	ns

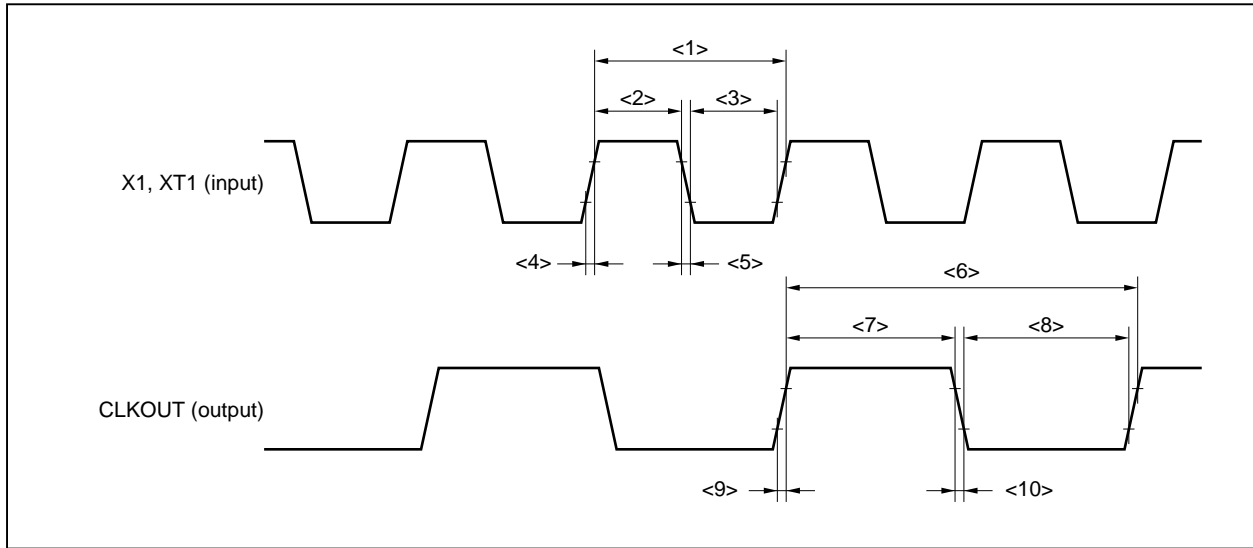
- Remarks**
1. T = t<sub>CYK</sub>
  2. Ensure that the duty is between 45% and 55%.

**(2) Operating conditions (T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = BV<sub>DD</sub> = 3.0 to 3.6 V, V<sub>SS</sub> = BV<sub>SS</sub> = 0 V, Output pin load capacitance: C<sub>L</sub> = 50 pF)**

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
X1 input cycle	t <sub>CYX</sub>	<1>		50.0		ns
XT1 input cycle				28.5		μs
X1 input high-level width	t <sub>WXH</sub>	<2>		22.5		ns
XT1 input high-level width				12.8		μs
X1 input low-level width	t <sub>WXL</sub>	<3>		22.5		ns
XT1 input low-level width				12.8		μs
X1 input rise time	t <sub>XR</sub>	<4>			0.5 (t <sub>CYX</sub> - t <sub>WXH</sub> - t <sub>WXL</sub> )	ns
X1 input fall time	t <sub>XF</sub>	<5>			0.5 (t <sub>CYX</sub> - t <sub>WXH</sub> - t <sub>WXL</sub> )	ns
CLKOUT output cycle	t <sub>CYK</sub>	<6>		50.0 ns	31.2 μs	
CLKOUT high-level width	t <sub>WKH</sub>	<7>		0.4t <sub>CYK</sub> - 10		ns
CLKOUT low-level width	t <sub>WKL</sub>	<8>		0.4t <sub>CYK</sub> - 10		ns
CLKOUT rise time	t <sub>KR</sub>	<9>			10	ns
CLKOUT fall time	t <sub>KF</sub>	<10>			10	ns

- Remarks**
1. T = t<sub>CYK</sub>
  2. Ensure that the duty is between 45% and 55%.

**Clock Timing**



**(1) Timing of pins other than CLKOUT, ports 4, 5, 6, and 9**

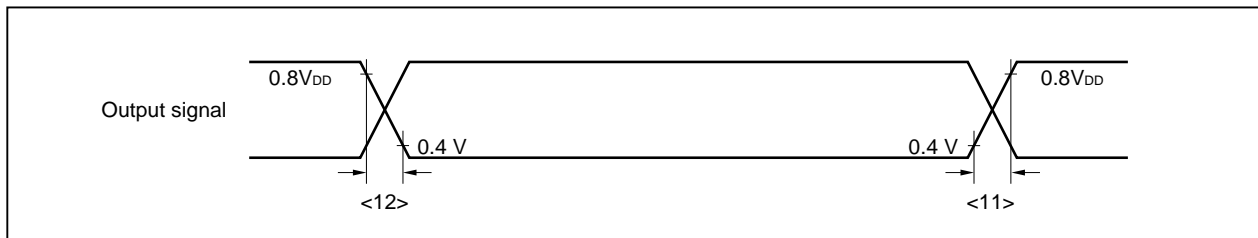
( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Output rise time	$t_{oR}$ <11>			20	ns
Output fall time	$t_{oF}$ <12>			20	ns

**(2) Timing of pins other than CLKOUT, ports 4, 5, 6, and 9**

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 3.0$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Output rise time	$t_{oR}$ <11>			20	ns
Output fall time	$t_{oF}$ <12>			20	ns



**Bus Timing (CLKOUT Asynchronous)**

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Address setup time (to $\overline{\text{ASTB}}\downarrow$ )	$t_{\text{SAST}}$ <13>		$0.5T - 15$		ns
Address hold time (from $\overline{\text{ASTB}}\downarrow$ )	$t_{\text{HSTA}}$ <14>		$0.5T - 15$		ns
Address float from $\overline{\text{DSTB}}\downarrow$	$t_{\text{FDA}}$ <15>			2	ns
Data input setup time from address	$t_{\text{SAID}}$ <16>			$(2 + n)T - 25$	ns
Data input setup time from $\overline{\text{DSTB}}\downarrow$	$t_{\text{SDID}}$ <17>			$(1 + n)T - 25$	ns
Delay time from $\overline{\text{ASTB}}\downarrow$ to $\overline{\text{DSTB}}\downarrow$	$t_{\text{DSTD}}$ <18>		$0.5T - 15$		ns
Data input hold time (from $\overline{\text{DSTB}}\uparrow$ )	$t_{\text{HDID}}$ <19>		0		ns
Address output time from $\overline{\text{DSTB}}\uparrow$	$t_{\text{DDA}}$ <20>		$(1 + i)T - 15$		ns
Delay time from $\overline{\text{DSTB}}\uparrow$ to $\overline{\text{ASTB}}\uparrow$	$t_{\text{DDST1}}$ <21>		$0.5T - 15$		ns
Delay time from $\overline{\text{DSTB}}\uparrow$ to $\overline{\text{ASTB}}\downarrow$	$t_{\text{DDST2}}$ <22>		$(1.5 + i)T - 15$		ns
$\overline{\text{DSTB}}$ low-level width	$t_{\text{WDL}}$ <23>		$(1 + n)T - 15$		ns
$\overline{\text{ASTB}}$ high-level width	$t_{\text{WSTH}}$ <24>		$T - 15$		ns
Data output time from $\overline{\text{DSTB}}\downarrow$	$t_{\text{DOD}}$ <25>			15	ns
Data output setup time (to $\overline{\text{DSTB}}\uparrow$ )	$t_{\text{SODD}}$ <26>		$(1 + n)T - 20$		ns
Data output hold time (from $\overline{\text{DSTB}}\uparrow$ )	$t_{\text{HDOD}}$ <27>		$T - 15$		ns
$\overline{\text{WAIT}}$ setup time (to address)	$t_{\text{SAWT1}}$ <28>	$n \geq 1$		$1.5T - 25$	ns
	$t_{\text{SAWT2}}$ <29>	$n \geq 1$		$(1.5 + n)T - 25$	ns
$\overline{\text{WAIT}}$ hold time (from address)	$t_{\text{HAWT1}}$ <30>	$n \geq 1$	$(0.5 + n)T$		ns
	$t_{\text{HAWT2}}$ <31>	$n \geq 1$	$(1.5 + n)T$		ns
$\overline{\text{WAIT}}$ setup time (to $\overline{\text{ASTB}}\downarrow$ )	$t_{\text{SSTWT1}}$ <32>	$n \geq 1$		$T - 25$	ns
	$t_{\text{SSTWT2}}$ <33>	$n \geq 1$		$(1 + n)T - 25$	ns
$\overline{\text{WAIT}}$ hold time (from $\overline{\text{ASTB}}\downarrow$ )	$t_{\text{HSTWT1}}$ <34>	$n \geq 1$	$nT$		ns
	$t_{\text{HSTWT2}}$ <35>	$n \geq 1$	$(1 + n)T$		ns
$\overline{\text{HLDRQ}}$ high-level width	$t_{\text{WHQH}}$ <36>		$T + 10$		ns
$\overline{\text{HLDAK}}$ low-level width	$t_{\text{WHAL}}$ <37>		$T - 15$		ns
Bus output delay time from $\overline{\text{HLDAK}}\uparrow$	$t_{\text{DHAC}}$ <38>		0		ns
Delay time from $\overline{\text{HLDRQ}}\downarrow$ to $\overline{\text{HLDAK}}\downarrow$	$t_{\text{DHQHA1}}$ <39>			$(2n + 7.5)T + 25$	ns
Delay time from $\overline{\text{HLDRQ}}\uparrow$ to $\overline{\text{HLDAK}}\uparrow$	$t_{\text{DHQHA2}}$ <40>		$0.5T$	$1.5T + 25$	ns

- Remarks**
1.  $T = 1/f_{\text{CPU}}$  ( $f_{\text{CPU}}$ : CPU operation clock frequency)
  2.  $n$ : Number of wait clocks inserted in the bus cycle.  
The sampling timing changes when a programmable wait is inserted.
  3.  $i$ : Number of idle states inserted after the read cycle (0 or 1).
  4. The values in the above specifications are values for when clocks with a 5:5 duty ratio are input from X1.

**Bus Timing (CLKOUT Synchronous)**

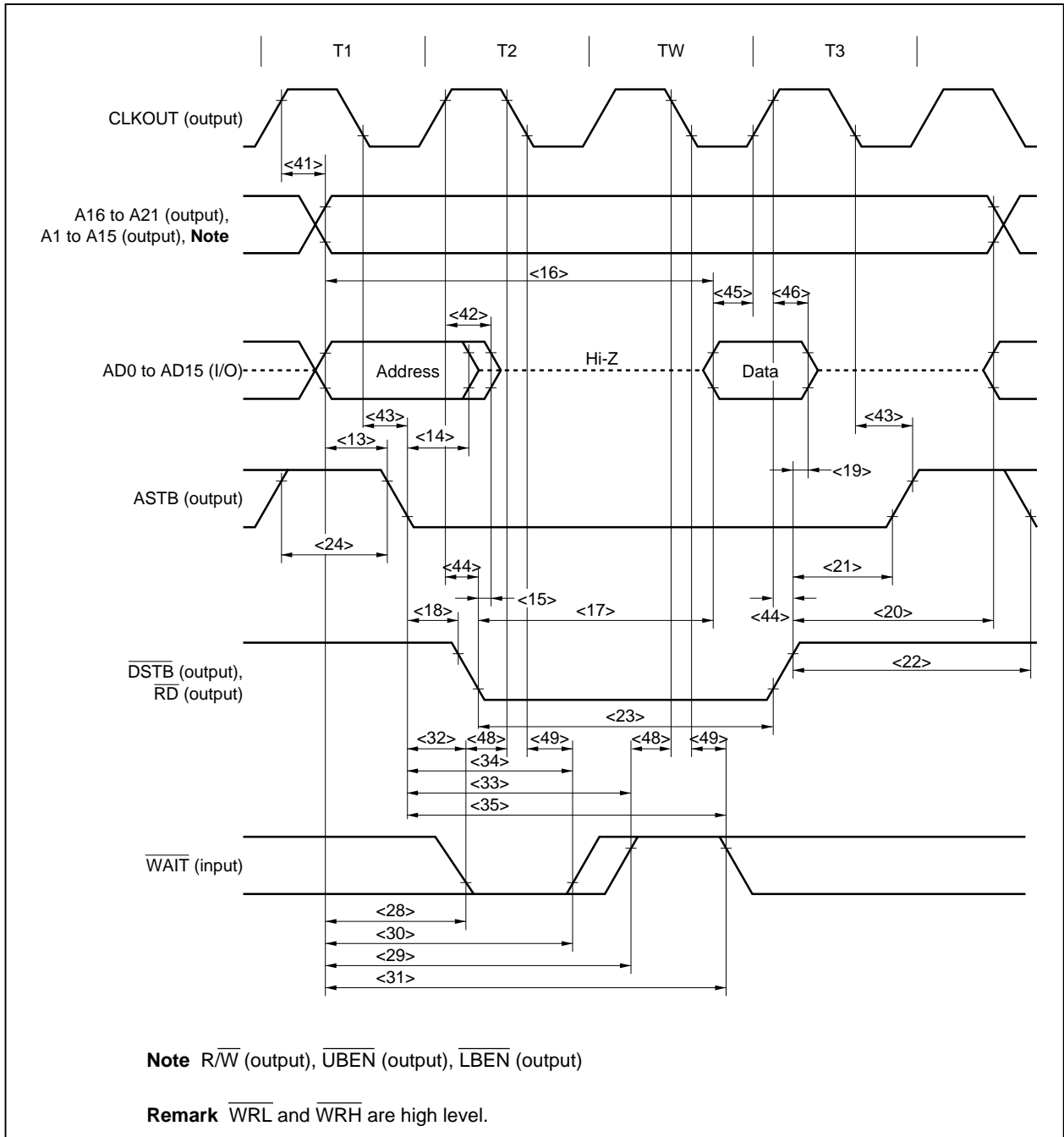
( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
Delay time from CLKOUT↑ to address	$t_{DKA}$	<41>		0	19	ns
Delay time from CLKOUT↑ to address float	$t_{FKA}$	<42>		-12	7	ns
Delay time from CLKOUT↓ to ASTB	$t_{DKST}$	<43>		-12	7	ns
Delay time from CLKOUT↑ to $\overline{DSTB}$	$t_{DKD}$	<44>		-5	14	ns
Data input setup time (to CLKOUT↑)	$t_{SIDK}$	<45>		15		ns
Data input hold time (from CLKOUT↑)	$t_{HKID}$	<46>		5		ns
Data output delay time from CLKOUT↑	$t_{DKOD}$	<47>			19	ns
$\overline{WAIT}$ setup time (to CLKOUT↓)	$t_{SWTK}$	<48>		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	$t_{HKWT}$	<49>		5		ns
$\overline{HLDRQ}$ setup time (to CLKOUT↓)	$t_{SHQK}$	<50>		15		ns
$\overline{HLDRQ}$ hold time (from CLKOUT↓)	$t_{HKHQ}$	<51>		5		ns
Delay time from CLKOUT↑ to bus float	$t_{DKF}$	<52>			19	ns
Delay time from CLKOUT↑ to $\overline{HLDK}$	$t_{DKHA}$	<53>			19	ns

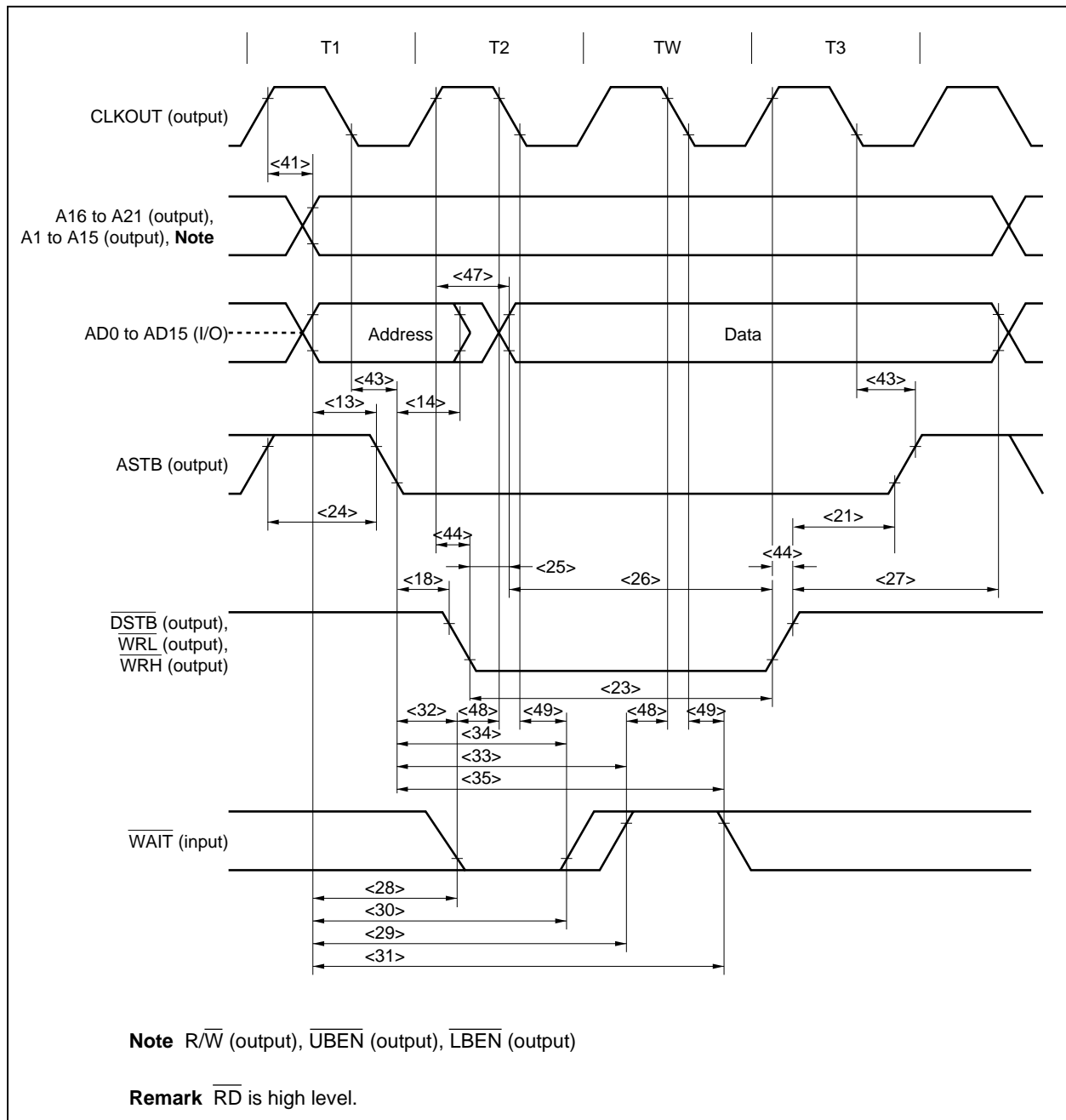
**Remark** The values in the above specifications are values for when clocks with a 5:5 duty ratio are input from X1.



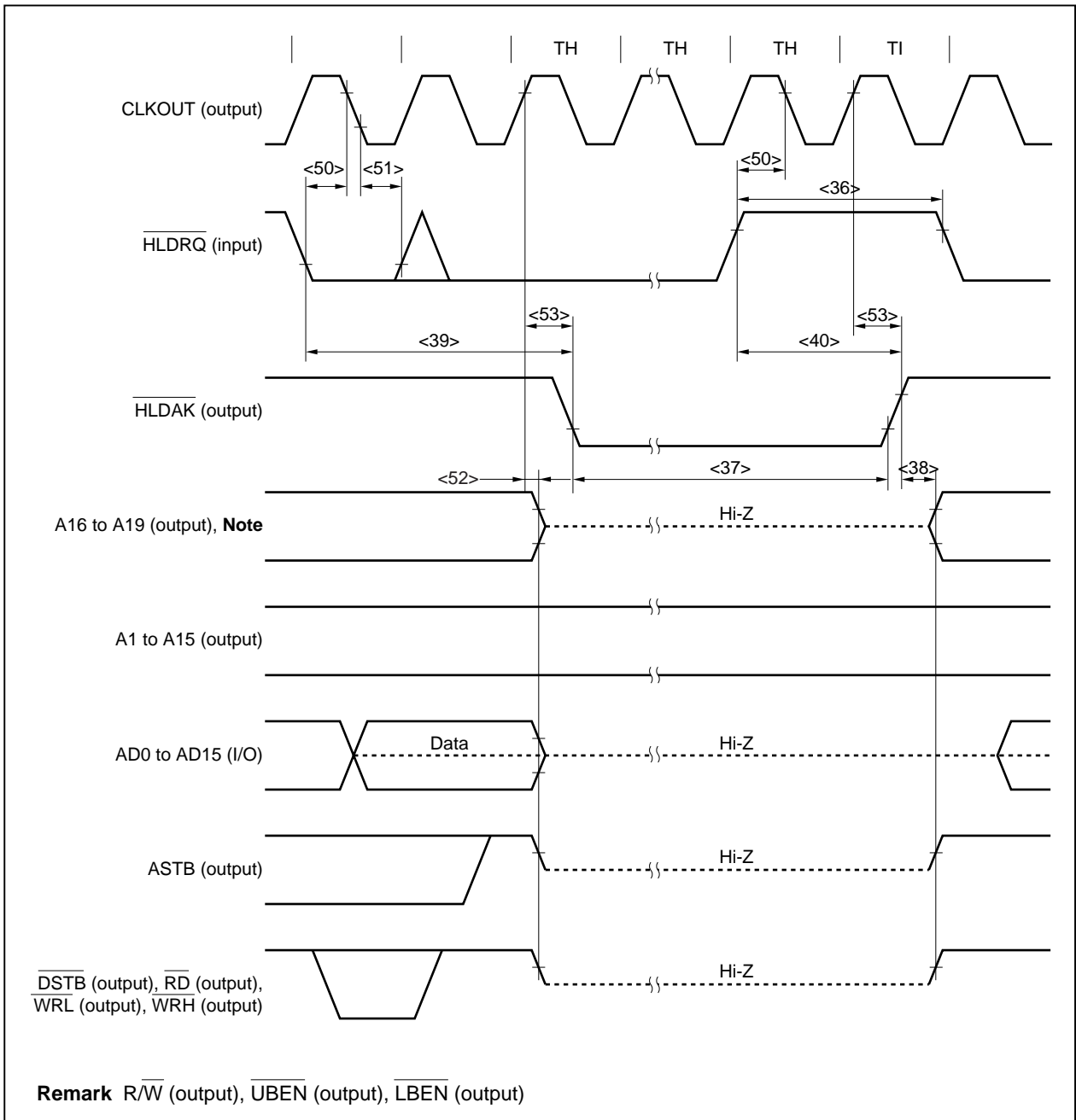
Read Cycle (CLKOUT Synchronous/Asynchronous, 1 Wait)



Write Cycle (CLKOUT Synchronous/Asynchronous, 1 Wait)



Bus Hold



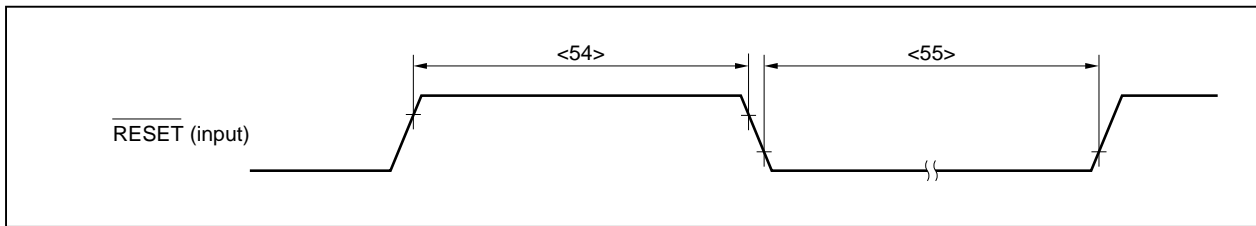
**Reset/Interrupt Timing**

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

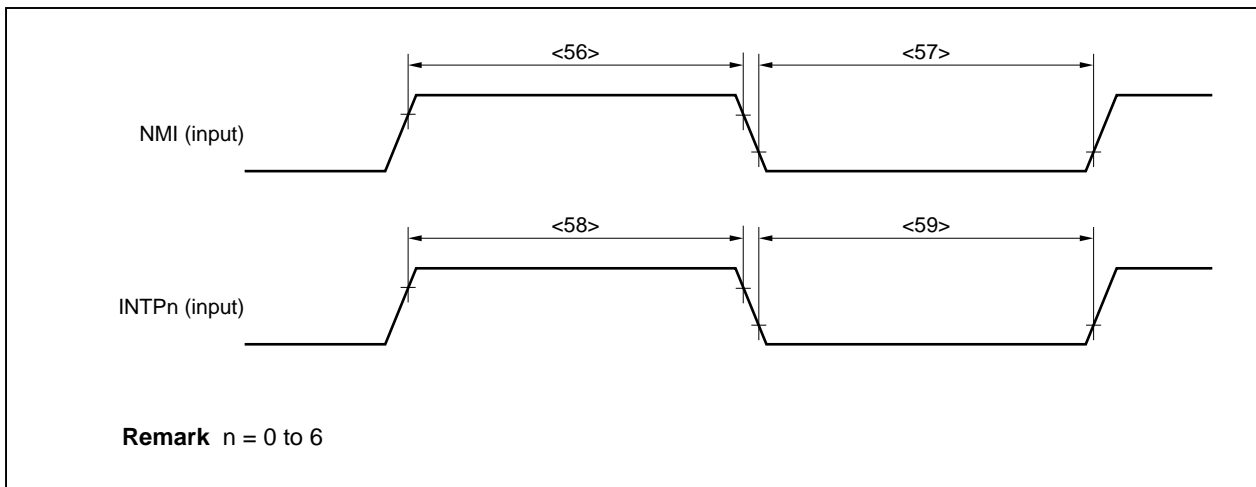
Parameter	Symbol	Conditions	MIN.	MAX.	Unit
RESET high-level width	$t_{WRSH}$ <54>		500		ns
RESET low-level width	$t_{WRSL}$ <55>		500		ns
NMI high-level width	$t_{WNIH}$ <56>		500		ns
NMI low-level width	$t_{WNIL}$ <57>		500		ns
INTPn high-level width	$t_{WITH}$ <58>	n = 0 to 3 (analog noise elimination)	500		ns
		n = 4 to 6 (digital noise elimination)	$3T + 20$		ns
INTPn low-level width	$t_{WITL}$ <59>	n = 0 to 3 (analog noise elimination)	500		ns
		n = 4 to 6 (digital noise elimination)	$3T + 20$		ns

**Remark**  $T = 1/f_{xx}$

**Reset**



**Interrupt**



**Remark** n = 0 to 6

**TIn Input Timing**

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
TIn0, TIn1 high-level width	$t_{TInH}$	<60>	$n = 0, 1$	$2T_{sam} + 20^{Note}$	ns
TIn high-level width			$n = 2$ to $5$	$3T + 20$	ns
TIn0, TIn1 low-level width	$t_{TInL}$	<61>	$n = 0, 1$	$2T_{sam} + 20^{Note}$	ns
TIn low-level width			$n = 2$ to $5$	$3T + 20$	ns

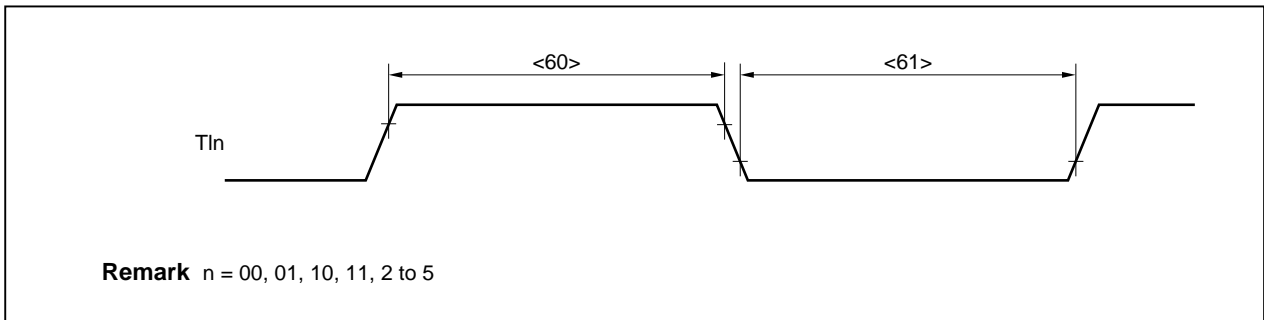
**Note**  $T_{sam}$  (count clock cycle) can be selected from the following by setting the PRMn2 to PRMn0 bits of prescaler mode register n, n1 (PRMn, PRMn1).

For  $n = 0$  (TM0):  $T_{sam} = 2T, 4T, 16T, 64T, 256T$ , or  $1/INTWTI$  cycle

For  $n = 1$  (TM1):  $T_{sam} = 2T, 4T, 16T, 32T, 128T$ , or  $256T$  cycle

★ However, when the TIn0 valid edge is selected as the count clock cycle,  $T_{sam} = 2T$ .

**Remark**  $T = 1/f_{xx}$



CSI Timing

(1) Master mode ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

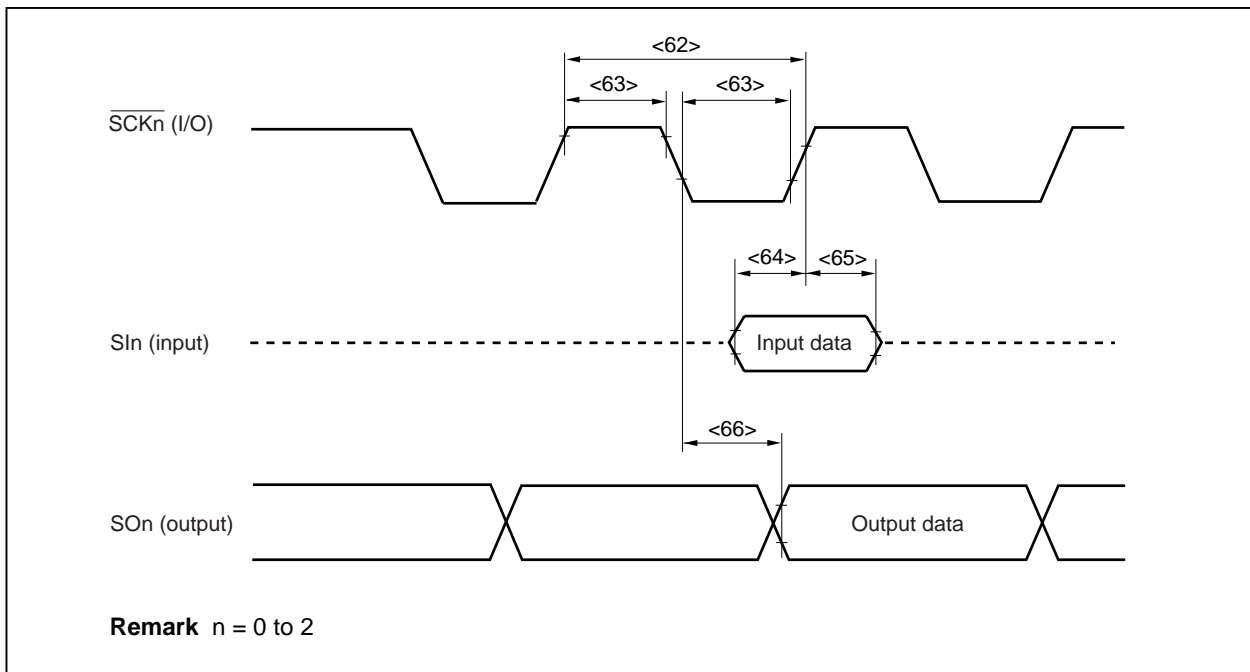
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
$\overline{\text{SCKn}}$ cycle time	$t_{\text{CY1}}$	<62>		400		ns
$\overline{\text{SCKn}}$ high-/low-level width	$t_{\text{KH1}}, t_{\text{KL1}}$	<63>		140		ns
SIn setup time (to $\overline{\text{SCKn}}\uparrow$ )	$t_{\text{SIK1}}$	<64>		50		ns
SIn hold time (from $\overline{\text{SCKn}}\uparrow$ )	$t_{\text{KSH1}}$	<65>		50		ns
Delay time from $\overline{\text{SCKn}}\downarrow$ to SOn output	$t_{\text{KSO1}}$	<66>			60	ns

Remark n = 0 to 2

(2) Slave mode ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
$\overline{\text{SCKn}}$ cycle time	$t_{\text{CY2}}$	<62>		400		ns
$\overline{\text{SCKn}}$ high-/low-level width	$t_{\text{KH2}}, t_{\text{KL2}}$	<63>		140		ns
SIn setup time (to $\overline{\text{SCKn}}\uparrow$ )	$t_{\text{SIK2}}$	<64>		50		ns
SIn hold time (from $\overline{\text{SCKn}}\uparrow$ )	$t_{\text{KSI2}}$	<65>		50		ns
Delay time from $\overline{\text{SCKn}}\downarrow$ to SOn output	$t_{\text{KSO2}}$	<66>			60	ns

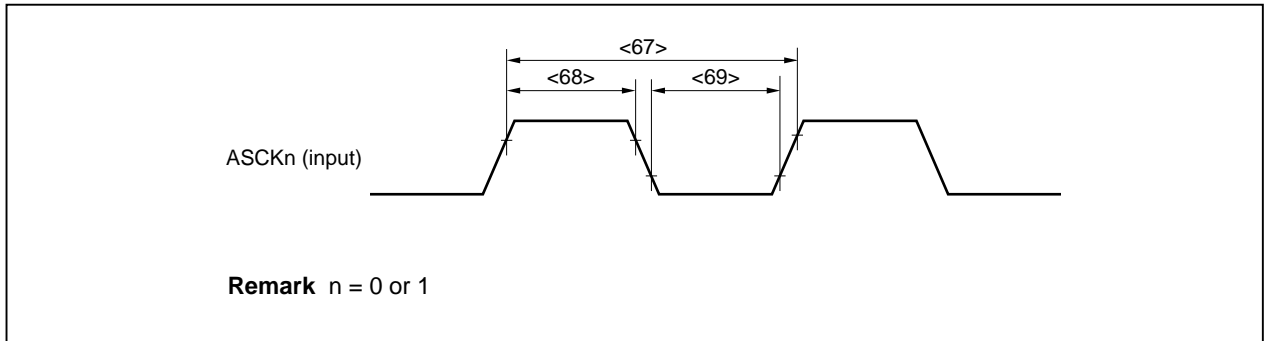
Remark n = 0 to 2



UART Timing ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = BV_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = BV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
ASCKn cycle time	$t_{KY13}$	<67>	200		ns
ASCKn high-level width	$t_{KH13}$	<68>	80		ns
ASCKn low-level width	$t_{KL13}$	<69>	80		ns

Remark n = 0, 1



I<sup>2</sup>C Bus Mode (μPD703014AY, 703015AY, 703017AY only)

(T<sub>A</sub> = -40 to +85°C, V<sub>DD</sub> = 2.7 to 3.6 V, V<sub>SS</sub> = 0 V)

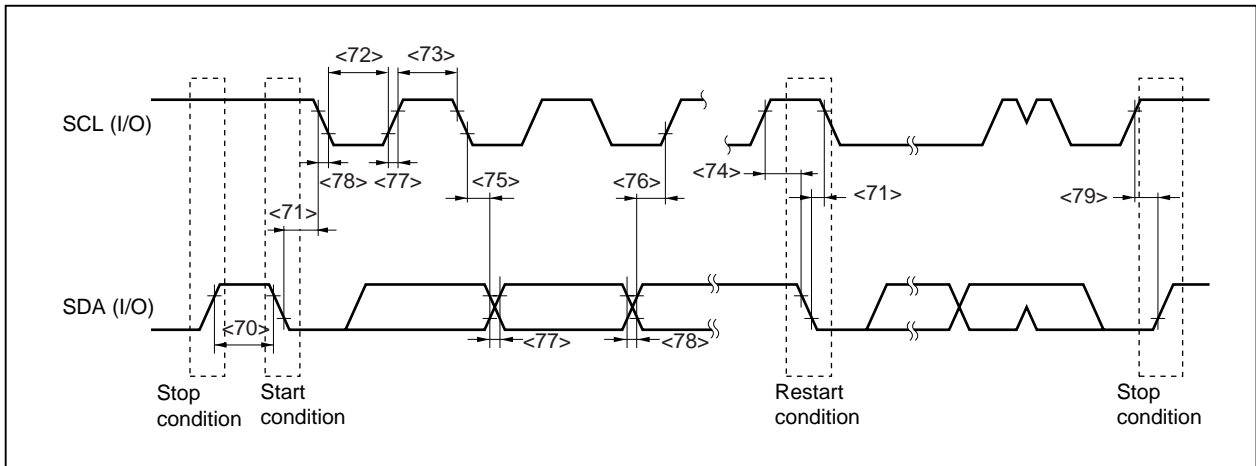
Parameter		Symbol		Normal Mode		High-Speed Mode		Unit
				MIN.	MAX.	MIN.	MAX.	
SCL clock frequency		f <sub>CLK</sub>		0	100	0	400	kHz
Bus-free time (between stop/start conditions)		t <sub>BUF</sub>	<70>	4.7	–	1.3	–	μs
Hold time <sup>Note 1</sup>		t <sub>HD:STA</sub>	<71>	4.0	–	0.6	–	μs
SCL clock low-level width		t <sub>LOW</sub>	<72>	4.7	–	1.3	–	μs
SCL clock high-level width		t <sub>HIGH</sub>	<73>	4.0	–	0.6	–	μs
Setup time for start/restart conditions		t <sub>SU:STA</sub>	<74>	4.7	–	0.6	–	μs
Data hold time	CBUS compatible master	t <sub>HD:DAT</sub>	<75>	5.0	–	–	–	μs
	I <sup>2</sup> C mode			0 <sup>Note 2</sup>	–	0 <sup>Note 2</sup>	0.9 <sup>Note 3</sup>	μs
Data setup time		t <sub>SU:DAT</sub>	<76>	250	–	100 <sup>Note 4</sup>	–	ns
SDA and SCL signal rise time		t <sub>R</sub>	<77>	–	1000	20 + 0.1Cb <sup>Note 5</sup>	300	ns
SDA and SCL signal fall time		t <sub>F</sub>	<78>	–	300	20 + 0.1Cb <sup>Note 5</sup>	300	ns
Stop condition setup time		t <sub>SU:STO</sub>	<79>	4.0	–	0.6	–	μs
Capacitance load of each bus line		Cb		–	400	–	400	pF

- Notes**
- At the start condition, the first clock pulse is generated after the hold time.
  - The system requires a minimum of 300 ns hold time internally for the SDA signal (at V<sub>IHmin.</sub> of SCL signal) in order to occupy the undefined area at the falling edge of SCL.
  - If the system does not extend the SCL signal low hold time (t<sub>LOW</sub>), only the maximum data hold time (t<sub>HD:DAT</sub>) needs to be satisfied.
  - The high-speed mode I<sup>2</sup>C bus can be used in the normal-mode I<sup>2</sup>C bus system. In this case, set the high-speed mode I<sup>2</sup>C bus so that it meets the following conditions.
    - If the system does not extend the SCL signal's low state hold time:  
t<sub>SU:DAT</sub> ≥ 250 ns
    - If the system extends the SCL signal's low state hold time:  
Transmit the following data bit to the SDA line prior to the SCL line release (t<sub>Rmax.</sub> + t<sub>SU:DAT</sub> = 1000 + 250 = 1250 ns: Normal mode I<sup>2</sup>C bus specification).
  - Cb: Total capacitance of one bus line (unit: pF)

**Remark** The maximum operating frequency of the μPD703014AY, 703015AY, and 703017AY is 17 MHz.



I<sup>2</sup>C Bus Mode ( $\mu$ PD703014AY, 703015AY, 703017AY only)



A/D Converter ( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{DD} = AV_{DD} = AV_{REF} = 2.7$  to  $3.6$  V,  $V_{SS} = AV_{SS} = 0$  V, Output pin load capacitance:  $C_L = 50$  pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution			10	10	10	bit
Overall error <sup>Note 1</sup>					$\pm 0.8$	%FSR
Conversion time	$t_{CONV}$		5		100	$\mu\text{s}$
Zero-scale error <sup>Note 1</sup>					$\pm 0.4$	%FSR
Full-scale error <sup>Note 1</sup>					$\pm 0.4$	%FSR
Integral linearity error <sup>Note 2</sup>					$\pm 4$	LSB
Differential linearity error <sup>Note 2</sup>					$\pm 4$	LSB
Analog reference voltage	$AV_{REF}$	$AV_{REF} = AV_{DD}$	2.7		3.6	V
Analog input voltage	$V_{IAN}$		$AV_{SS}$		$AV_{REF}$	V
$AV_{REF}$ current	$AI_{REF}$			360	500	$\mu\text{A}$
Power supply current	$AI_{DD}$			1	3	mA

**Notes 1.** Excluding quantization error ( $\pm 0.05$  %FSR)

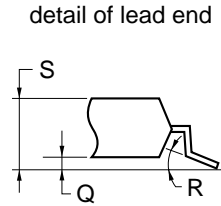
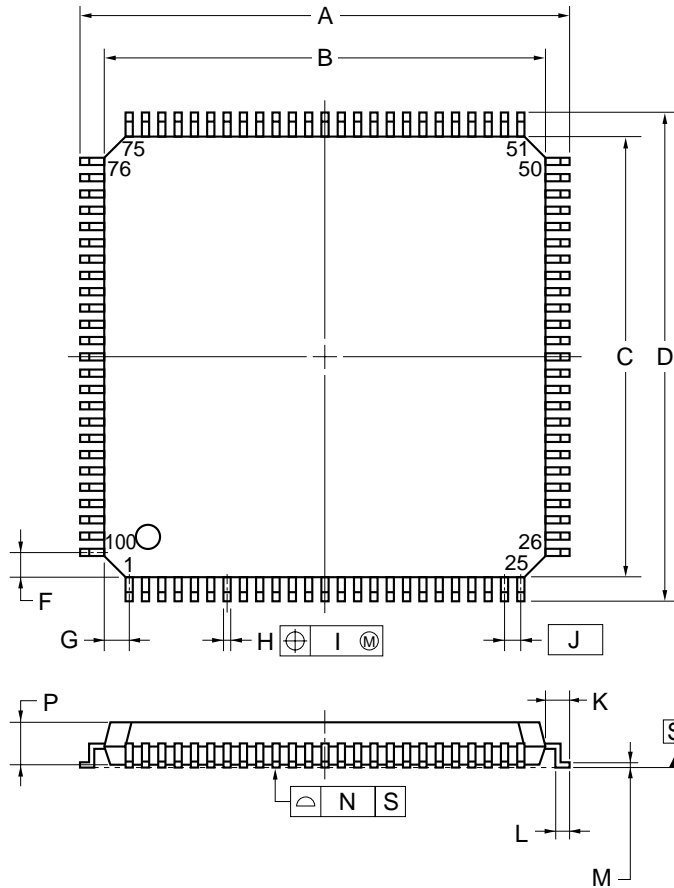
**2.** Excluding quantization error ( $\pm 0.5$  LSB)

**Remark** LSB: Least Significant Bit

FSR: Full Scale Range

★3. PACKAGE DRAWINGS

100-PIN PLASTIC LQFP (FINE PITCH) (14x14)



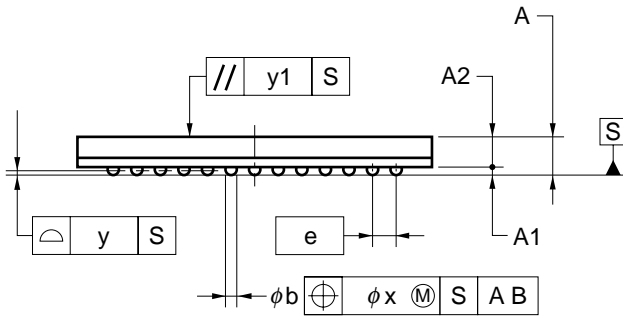
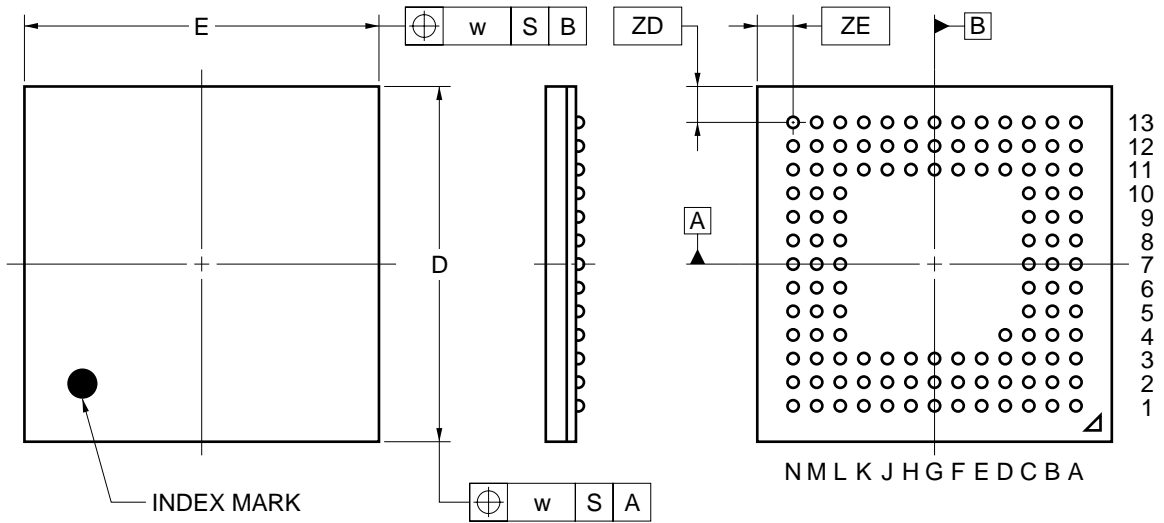
NOTE

Each lead centerline is located within 0.08 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	16.00±0.20
B	14.00±0.20
C	14.00±0.20
D	16.00±0.20
F	1.00
G	1.00
H	0.22 <sup>+0.05</sup> <sub>-0.04</sub>
I	0.08
J	0.50 (T.P.)
K	1.00±0.20
L	0.50±0.20
M	0.17 <sup>+0.03</sup> <sub>-0.07</sub>
N	0.08
P	1.40±0.05
Q	0.10±0.05
R	3° <sup>+7°</sup> <sub>-3°</sub>
S	1.60 MAX.

S100GC-50-8EU, 8EA-2

121-PIN PLASTIC FBGA (12x12)



ITEM	MILLIMETERS
D	12.00±0.10
E	12.00±0.10
w	0.20
A	1.48±0.10
A1	0.35±0.06
A2	1.13
e	0.80
b	0.50 <sup>+0.05</sup> <sub>-0.10</sub>
x	0.08
y	0.10
y1	0.20
ZD	1.20
ZE	1.20

P121F1-80-EA6

4. RECOMMENDED SOLDERING CONDITIONS

The μPD703014A, 703014AY, 703015A, 703015AY, 703017A, and 703017AY should be soldered and mounted under the following recommended conditions.

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

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

Table 4-1. Surface Mounting Type Soldering Conditions

- (1) μPD703014AGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)
- μPD703014AYGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)
- μPD703015AGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)
- μPD703015AYGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)
- μPD703017AGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)
- μPD703017AYGC-xxx-8EU: 100-pin plastic LQFP (fine-pitch) (14 × 14)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Two times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR35-107-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Two times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	VP15-107-2
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	—

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

**Caution** Do not use different soldering methods together (except for partial heating).

- ★ (2) μPD703014AF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)
- μPD703014AYF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)
- μPD703015AF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)
- μPD703015AYF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)
- μPD703017AF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)
- μPD703017AYF1-xxx-EA6: 121-pin plastic FBGA (12 × 12)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Two times or less Exposure limit: 7 days <sup>Note</sup> (after that, prebake at 125°C for 10 hours)	IR35-107-2
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	—

**Note** After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

[MEMO]

## NOTES FOR CMOS DEVICES

## ① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

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

## ② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS 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.

**Caution** Purchase of NEC I<sup>2</sup>C components conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C Standard Specification as defined by Philips.

**Reference document** Electrical Characteristics for Microcomputer (IEI-601)<sup>Note</sup>

**Note** This document number is that of the Japanese version.

**Related document**  $\mu$ PD70F3017A, 70F3017AY Data Sheet (U14527E)

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- Availability of related technical literature
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- Network requirements

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