

V850E/MS1™ 32-/16-BIT SINGLE-CHIP MICROCONTROLLER

The μPD70F3102-33 is a product that substitutes the internal mask ROM of the μPD703102-33 with flash memory. This enables users to perform on-board program writing and erasure, enabling effective evaluation during system development, small-lot production of multiple devices, and rapid production start, and quick development and time-to-market.

A version using a 3.3 V power supply for external pins, the μPD70F3102-A33, is also available.

For additional information, refer to the following user's manuals. Be sure to read them before starting design.

V850E/MS1 User's Manual Hardware: U12688E

V850E/MS1 User's Manual Architecture: U12197E

FEATURES

- μPD703102-33 compatible
Can be replaced by the μPD703102-33 with internal mask ROM for mass production
- Internal flash memory: 128 KB

ORDERING INFORMATION

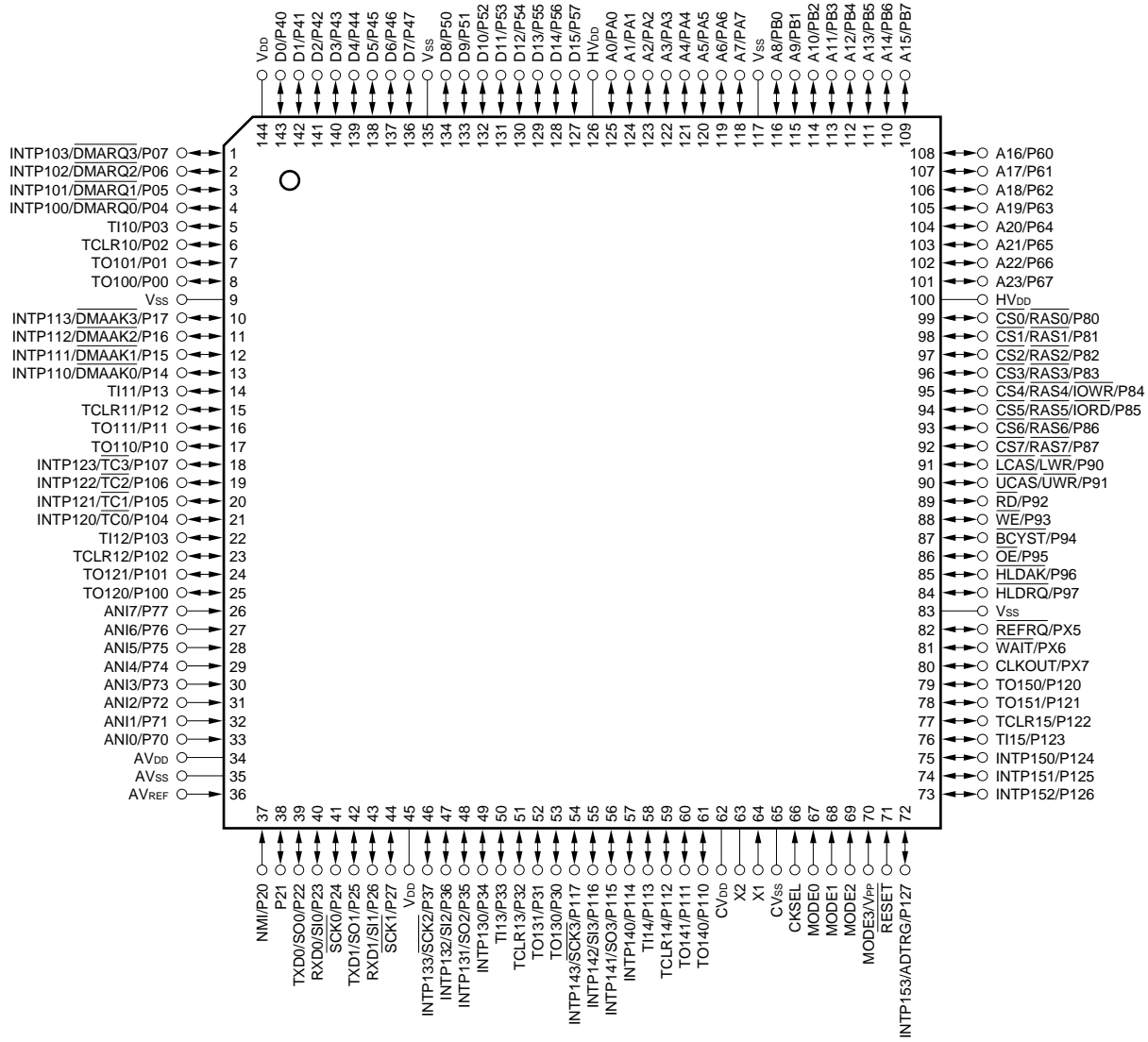
Part Number	Package
μPD70F3102GJ-33-8EU	144-pin plastic LQFP (fine pitch) (20 × 20)
★ μPD70F3102GJ-33-UEN	144-pin plastic LQFP (fine pitch) (20 × 20)

The information contained in this document is being issued in advance of the production cycle for the device. The parameters for the device may change before final production or NEC Corporation, at its own discretion, may withdraw the device prior to its production.
Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

PIN CONFIGURATION (Top View)

144-pin plastic LQFP (fine pitch) (20 × 20)

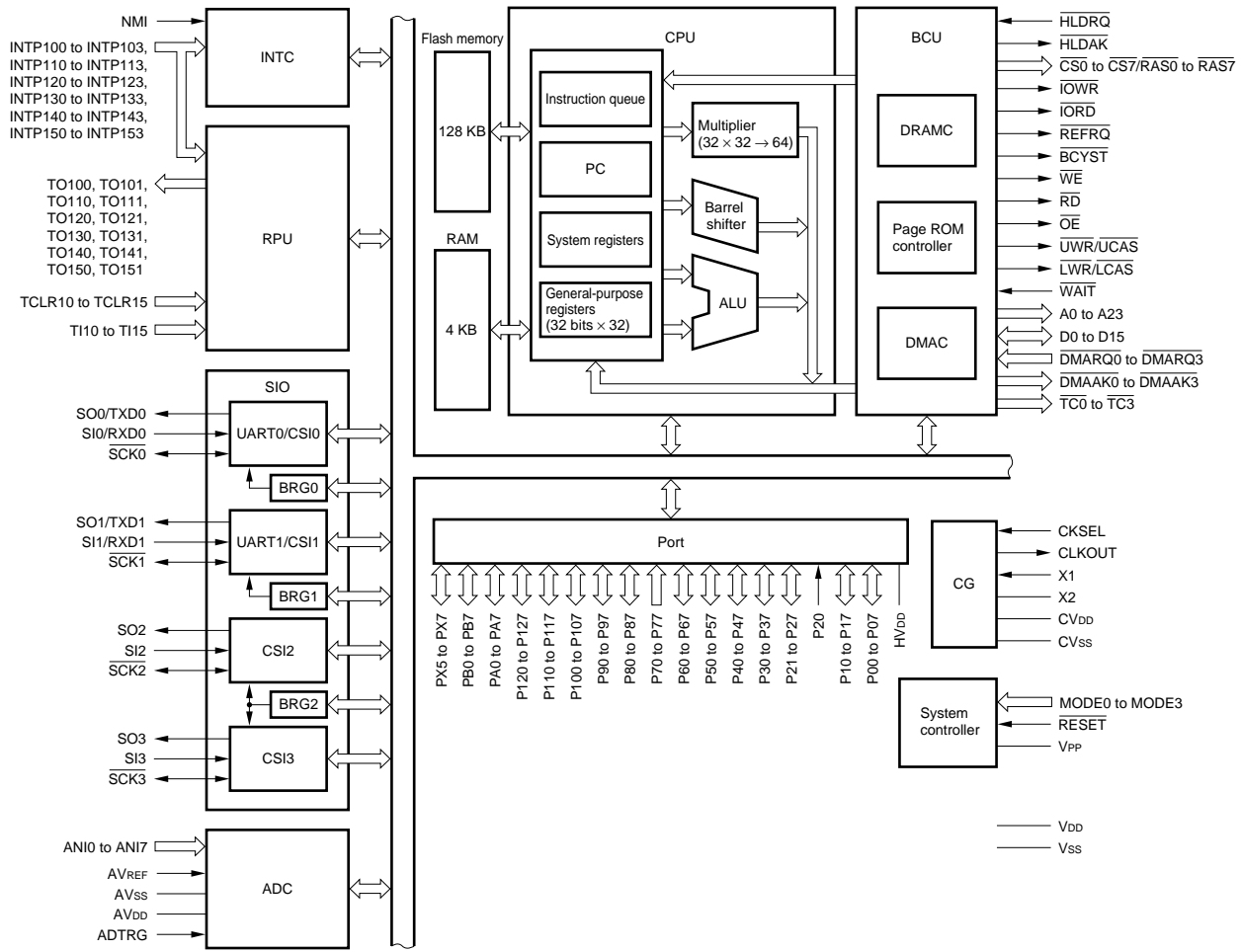
- μPD70F3102GJ-33-8EU
- ★ • μPD70F3102GJ-33-UEN



PIN IDENTIFICATION

A0 to A23:	Address Bus	P50 to P57:	Port 5
ADTRG:	AD Trigger Input	P60 to P67:	Port 6
ANI0 to ANI7:	Analog Input	P70 to P77:	Port 7
AV _{DD} :	Analog Power Supply	P80 to P87:	Port 8
AV _{REF} :	Analog Reference Voltage	P90 to P97:	Port 9
AV _{SS} :	Analog Ground	P100 to P107:	Port 10
$\overline{\text{BCYST}}$:	Bus Cycle Start Timing	P110 to P117:	Port 11
CKSEL:	Clock Generator Operating Mode	P120 to P127:	Port 12
	Select	PA0 to PA7:	Port A
CLKOUT:	Clock Output	PB0 to PB7:	Port B
$\overline{\text{CS0}}$ to $\overline{\text{CS7}}$:	Chip Select	PX5 to PX7:	Port X
CV _{DD} :	Clock Generator Power Supply	$\overline{\text{RAS0}}$ to $\overline{\text{RAS7}}$:	Row Address Strobe
CV _{SS} :	Clock Generator	$\overline{\text{RD}}$:	Read
D0 to D15:	Data Bus	$\overline{\text{REFRQ}}$:	Refresh Request
$\overline{\text{DMAAK0}}$ to $\overline{\text{DMAAK3}}$:	DMA Acknowledge	$\overline{\text{RESET}}$:	Reset
$\overline{\text{DMARQ0}}$ to $\overline{\text{DMARQ3}}$:	DMA Request	RXD0, RXD1:	Receive Data
$\overline{\text{HLDK}}$:	Hold Acknowledge	$\overline{\text{SCK0}}$ to $\overline{\text{SCK3}}$:	Serial Clock
$\overline{\text{HLDRQ}}$:	Hold Request	SI0 to SI3:	Serial Input
HV _{DD} :	Power Supply for External Pins	SO0 to SO3:	Serial Output
INTP100 to INTP103, INTP110 to INTP113, INTP120 to INTP123, INTP130 to INTP133, INTP140 to INTP143, INTP150 to INTP153:	Interrupt Request from Peripherals	$\overline{\text{TC0}}$ to $\overline{\text{TC3}}$:	Terminal Count Signal
$\overline{\text{IORD}}$:	I/O Read Strobe	TCLR10 to TCLR15:	Timer Clear
$\overline{\text{IOWR}}$:	I/O Write Strobe	TI10 to TI15:	Timer Input
$\overline{\text{LCAS}}$:	Lower Column Address Strobe	TO100, TO101, TO110, TO111, TO120, TO121, TO130, TO131, TO140, TO141, TO150, TO151:	Timer Output
$\overline{\text{LWR}}$:	Lower Write Strobe	TXD0, TXD1:	Transmit Data
MODE0 to MODE3:	Mode	$\overline{\text{UCAS}}$:	Upper Column Address Strobe
NMI:	Non-Maskable Interrupt Request	$\overline{\text{UWR}}$:	Upper Write Strobe
$\overline{\text{OE}}$:	Output Enable	V _{DD} :	Power Supply for Internal Unit
P00 to P07:	Port 0	V _{PP} :	Programming Power Supply
P10 to P17:	Port 1	V _{SS} :	Ground
P20 to P27:	Port 2	$\overline{\text{WAIT}}$:	Wait
P30 to P37:	Port 3	$\overline{\text{WE}}$:	Write Enable
P40 to P47:	Port 4	X1, X2:	Crystal

INTERNAL BLOCK DIAGRAM



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1. DIFFERENCES AMONG PRODUCTS

1.1 Differences Between μPD70F3102-33 and μPD703102-33

Item \ Product	μPD70F3102-33	μPD703102-33
Internal ROM	Flash memory	Mask ROM
Flash memory programming pin	Provided (V _{PP})	None
Flash memory programming mode	Provided (MODE0 = L, MODE1 = H, MODE2 = L, MODE3/V _{PP} = 7.8 V)	None
Electrical specifications	Consumption current etc. differ (see individual data sheets).	
Others	Circuit scale and master layout differ, thus noise immunity, noise radiation, etc. differ.	

- Cautions**
1. There are differences in noise immunity and noise radiation between the flash memory version and mask ROM version. When pre-producing an application set with the flash memory version and then mass-producing it with the mask ROM version, be sure to conduct sufficient evaluation for commercial samples (not engineering samples) of the mask ROM version.
 2. When switching from the flash memory version to the mask ROM version, write the same code to the free area of the internal ROM.

1.2 Differences Between μPD70F3102-33 and μPD70F3102A-33

Item \ Product	μPD70F3102-33	μPD70F3102A-33
HV _{DD}	4.5 to 5.5 V	3.0 to 3.6 V
Electrical specifications	See individual data sheets.	
Package	<ul style="list-style-type: none"> • 144-pin plastic LQFP (fine pitch) (20 × 20) 	<ul style="list-style-type: none"> • 157-pin plastic FBGA (14 × 14) • 144-pin plastic LQFP (fine pitch) (20 × 20)

2. PIN FUNCTIONS

2.1 Port Pins

(1/3)

Pin Name	I/O	Function	Alternate Function
P00	I/O	Port 0 8-bit I/O port Input/output can be specified in 1-bit units.	TO100
P01			TO101
P02			TCLR10
P03			TI10
P04			INTP100/DMARQ0
P05			INTP101/DMARQ1
P06			INTP102/DMARQ2
P07			INTP103/DMARQ3
P10	I/O	Port 1 8-bit I/O port Input/output can be specified in 1-bit units.	TO110
P11			TO111
P12			TCLR11
P13			TI11
P14			INTP110/DMAAK0
P15			INTP111/DMAAK1
P16			INTP112/DMAAK2
P17			INTP113/DMAAK3
P20	Input	Port 2 P20 is an input-only port. When a valid edge is input, it operates as an NMI input. The status of the NMI input is shown by bit 0 of register P2. P21 to P27 is a 7-bit I/O port. Input/output can be specified in 1-bit units.	NMI
P21	I/O		—
P22			TXD0/SO0
P23			RXD0/SI0
P24			SCK0
P25			TXD1/SO1
P26			RXD1/SI1
P27			SCK1
P30	I/O	Port 3 8-bit I/O port Input/output can be specified in 1-bit units.	TO130
P31			TO131
P32			TCLR13
P33			TI13
P34			INTP130
P35			INTP131/SO2
P36			INTP132/SI2
P37			INTP133/SCK2
P40 to P47	I/O	Port 4 8-bit I/O port Input/output can be specified in 1-bit units.	D0 to D7

(2/3)

Pin Name	I/O	Function	Alternate Function
P50 to P57	I/O	Port 5 8-bit I/O port Input/output can be specified in 1-bit units.	D8 to D15
P60 to P67	I/O	Port 6 8-bit I/O port Input/output can be specified in 1-bit units.	A16 to A23
P70 to P77	Input	Port 7 8-bit input-only port	ANI0 to ANI7
P80	I/O	Port 8 8-bit I/O port Input/output can be specified in 1-bit units.	$\overline{CS0}/\overline{RAS0}$
P81			$\overline{CS1}/\overline{RAS1}$
P82			$\overline{CS2}/\overline{RAS2}$
P83			$\overline{CS3}/\overline{RAS3}$
P84			$\overline{CS4}/\overline{RAS4}/\overline{IOWR}$
P85			$\overline{CS5}/\overline{RAS5}/\overline{IORD}$
P86			$\overline{CS6}/\overline{RAS6}$
P87			$\overline{CS7}/\overline{RAS7}$
P90	I/O	Port 9 8-bit I/O port Input/output can be specified in 1-bit units	$\overline{LCAS}/\overline{LWR}$
P91			$\overline{UCAS}/\overline{UWR}$
P92			\overline{RD}
P93			\overline{WE}
P94			\overline{BCYST}
P95			\overline{OE}
P96			\overline{HLDK}
P97			\overline{HLDRQ}
P100	I/O	Port 10 8-bit I/O port Input/output can be specified in 1-bit units.	TO120
P101			TO121
P102			TCLR12
P103			TI12
P104			$\overline{INTP120}/\overline{TC0}$
P105			$\overline{INTP121}/\overline{TC1}$
P106			$\overline{INTP122}/\overline{TC2}$
P107			$\overline{INTP123}/\overline{TC3}$

Pin Name	I/O	Function	Alternate Function
P110	I/O	Port 11 8-bit I/O port Input/output can be specified in 1-bit units.	TO140
P111			TO141
P112			TCLR14
P113			TI14
P114			INTP140
P115			INTP141/SO3
P116			INTP142/SI3
P117			INTP143/SCK3
P120	I/O	Port 12 8-bit I/O port Input/output can be specified in 1-bit units.	TO150
P121			TO151
P122			TCLR15
P123			TI15
P124			INTP150
P125			INTP151
P126			INTP152
P127			INTP153/ADTRG
PA0	I/O	Port A 8-bit I/O port Input/output can be specified in 1-bit units.	A0
PA1			A1
PA2			A2
PA3			A3
PA4			A4
PA5			A5
PA6			A6
PA7			A7
PB0	I/O	Port B 8-bit I/O port Input/output can be specified in 1-bit units.	A8
PB1			A9
PB2			A10
PB3			A11
PB4			A12
PB5			A13
PB6			A14
PB7			A15
PX5	I/O	Port X 3-bit I/O port Input/output can be specified in 1-bit units.	$\overline{\text{REFRQ}}$
PX6			$\overline{\text{WAIT}}$
PX7			CLKOUT

2.2 Non-Port Pins

(1/4)

Pin Name	I/O	Function	Alternate Function
TO100	Output	Pulse signal output of timers 10 to 15	P00
TO101			P01
TO110			P10
TO111			P11
TO120			P100
TO121			P101
TO130			P30
TO131			P31
TO140			P110
TO141			P111
TO150			P120
TO151			P121
TCLR10			Input
TCLR11	P12		
TCLR12	P102		
TCLR13	P32		
TCLR14	P112		
TCLR15	P122		
TI10	Input	External count clock input of timers 10 to 15	P03
TI11			P13
TI12			P103
TI13			P33
TI14			P113
TI15			P123
INTP100	Input	External maskable interrupt request input, or timer 10 external capture trigger input	P04/ $\overline{\text{DMARQ0}}$
INTP101			P05/ $\overline{\text{DMARQ1}}$
INTP102			P06/ $\overline{\text{DMARQ2}}$
INTP103			P07/ $\overline{\text{DMARQ3}}$
INTP110	Input	External maskable interrupt request input, or timer 11 external capture trigger input	P14/ $\overline{\text{DMAAK0}}$
INTP111			P15/ $\overline{\text{DMAAK1}}$
INTP112			P16/ $\overline{\text{DMAAK2}}$
INTP113			P17/ $\overline{\text{DMAAK3}}$
INTP120	Input	External maskable interrupt request input, or timer 12 external capture trigger input	P104/ $\overline{\text{TC0}}$
INTP121			P105/ $\overline{\text{TC1}}$
INTP122			P106/ $\overline{\text{TC2}}$
INTP123			P107/ $\overline{\text{TC3}}$

(2/4)

Pin Name	I/O	Function	Alternate Function
INTP130	Input	External maskable interrupt request input, or timer 13 external capture trigger input	P34
INTP131			P35/SO2
INTP132			P36/SI2
INTP133			P37/SCK2
INTP140	Input	External maskable interrupt request input, or timer 14 external capture trigger input	P114
INTP141			P115/SO3
INTP142			P116/SI3
INTP143			P117/SCK3
INTP150	Input	External maskable interrupt request input, or timer 15 external capture trigger input	P124
INTP151			P125
INTP152			P126
INTP153			P127/ADTRG
SO0	Output	CSI0 to CSI3 serial transmission data output (3-wire)	P22/TXD0
SO1			P25/TXD1
SO2			P35/INTP131
SO3			P115/INTP141
SI0	Input	CSI0 to CSI3 serial reception data input (3-wire)	P23/RXD0
SI1			P26/RXD1
SI2			P36/INTP132
SI3			P116/INTP142
SCK0	I/O	CSI0 to CSI3 serial clock input/output (3-wire)	P24
SCK1			P27
SCK2			P37/INTP133
SCK3			P117/INTP143
TXD0	Output	UART0 and UART1 serial transmission data output	P22/SO0
TXD1			P25/SO1
RXD0	Input	UART0 and UART1 serial reception data input	P23/SI0
RXD1			P26/SI1
D0 to D7	I/O	16-bit data bus for external memory	P40 to P47
D8 to D15			P50 to P57
A0 to A7	Output	24-bit address bus for external memory	PA0 to PA7
A8 to A15			PB0 to PB7
A16 to A23			P60 to P67
LWR	Output	External data bus lower byte write enable signal output	P90/LCAS
UWR	Output	External data bus upper byte write enable signal output	P91/UCAS
RD	Output	External data bus read strobe signal output	P92
WE	Output	Write enable signal output for DRAM	P93
OE	Output	Output enable signal output for DRAM	P95

(3/4)

Pin Name	I/O	Function	Alternate Function
$\overline{\text{LCAS}}$	Output	Column address strobe signal output for lower data of DRAM	P90/ $\overline{\text{LWR}}$
$\overline{\text{UCAS}}$	Output	Column address strobe signal output for higher data of DRAM	P91/ $\overline{\text{UWR}}$
$\overline{\text{RAS0}}$ to $\overline{\text{RAS3}}$	Output	Row address strobe signal output for DRAM	P80/ $\overline{\text{CS0}}$ to P83/ $\overline{\text{CS3}}$
$\overline{\text{RAS4}}$			P84/ $\overline{\text{CS4}}$ / $\overline{\text{IOWR}}$
$\overline{\text{RAS5}}$			P85/ $\overline{\text{CS5}}$ / $\overline{\text{IORD}}$
$\overline{\text{RAS6}}$			P86/ $\overline{\text{CS6}}$
$\overline{\text{RAS7}}$			P87/ $\overline{\text{CS7}}$
$\overline{\text{BCYST}}$			Output
$\overline{\text{CS0}}$ to $\overline{\text{CS3}}$	Output	Chip select signal output	P80/ $\overline{\text{RAS0}}$ to P83/ $\overline{\text{RAS3}}$
$\overline{\text{CS4}}$			P84/ $\overline{\text{RAS4}}$ / $\overline{\text{IOWR}}$
$\overline{\text{CS5}}$			P85/ $\overline{\text{RAS5}}$ / $\overline{\text{IORD}}$
$\overline{\text{CS6}}$			P86/ $\overline{\text{RAS6}}$
$\overline{\text{CS7}}$			P87/ $\overline{\text{RAS7}}$
$\overline{\text{WAIT}}$			Input
$\overline{\text{REFRQ}}$	Output	Refresh request signal output for DRAM	PX5
$\overline{\text{IOWR}}$	Output	DMA write strobe signal output	P84/ $\overline{\text{RAS4}}$ / $\overline{\text{CS4}}$
$\overline{\text{IORD}}$	Output	DMA read strobe signal output	P85/ $\overline{\text{RAS5}}$ / $\overline{\text{CS5}}$
$\overline{\text{DMARQ0}}$ to $\overline{\text{DMARQ3}}$	Input	DMA request signal input	P04/ $\overline{\text{INTP100}}$ to P07/ $\overline{\text{INTP103}}$
$\overline{\text{DMAAK0}}$ to $\overline{\text{DMAAK3}}$	Output	DMA acknowledge signal output	P14/ $\overline{\text{INTP110}}$ to P17/ $\overline{\text{INTP113}}$
$\overline{\text{TC0}}$ to $\overline{\text{TC3}}$	Output	DMA termination (terminal count) signal output	P104/ $\overline{\text{INTP120}}$ to P107/ $\overline{\text{INTP123}}$
$\overline{\text{HLDK}}$	Output	Bus hold acknowledge output	P96
$\overline{\text{HLDRQ}}$	Input	Bus hold request input	P97
$\overline{\text{ANI0}}$ to $\overline{\text{ANI7}}$	Input	Analog input to A/D converter	P70 to P77
$\overline{\text{NMI}}$	Input	Non-maskable interrupt request input	P20
$\overline{\text{CLKOUT}}$	Output	System clock output	PX7
$\overline{\text{CKSEL}}$	Input	Input that specifies the clock generator's operation mode	–
$\overline{\text{MODE0}}$ to $\overline{\text{MODE2}}$	Input	Operation mode specification	–
$\overline{\text{MODE3}}$			V _{PP}
$\overline{\text{RESET}}$	Input	System reset input	–
X1	Input	Connecting system clock resonator. In the case of an external clock, it is input to X1.	–
X2	–		–
$\overline{\text{ADTRG}}$	Input	A/D converter external trigger input	P127/ $\overline{\text{INTP153}}$
$\overline{\text{AVREF}}$	Input	Reference voltage applied to A/D converter	–
$\overline{\text{AVDD}}$	–	Positive power supply for A/D converter	–

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Pin Name	I/O	Function	Alternate Function
AV _{SS}	–	Ground potential for A/D converter	–
CV _{DD}	–	Positive power supply for the dedicated clock generator	–
CV _{SS}	–	Ground potential for dedicated clock generator	–
V _{DD}	–	Positive power supply (internal unit power supply)	–
HV _{DD}	–	Positive power supply (external pin power supply)	–
V _{SS}	–	Ground potential	–
V _{PP}	–	High-voltage application pin during program write/verify	MODE3

2.3 Pin I/O Circuit Types and Recommended Connection of Unused Pins

Table 2-1 shows the I/O circuit type of each pin and the recommended connection of unused pins, and Figure 2-1 shows the schematic circuit diagram for each I/O circuit type.

In the case of connection to V_{DD} or V_{SS} via a resistor, connection of a resistor of 1 to 10 kΩ is recommended.

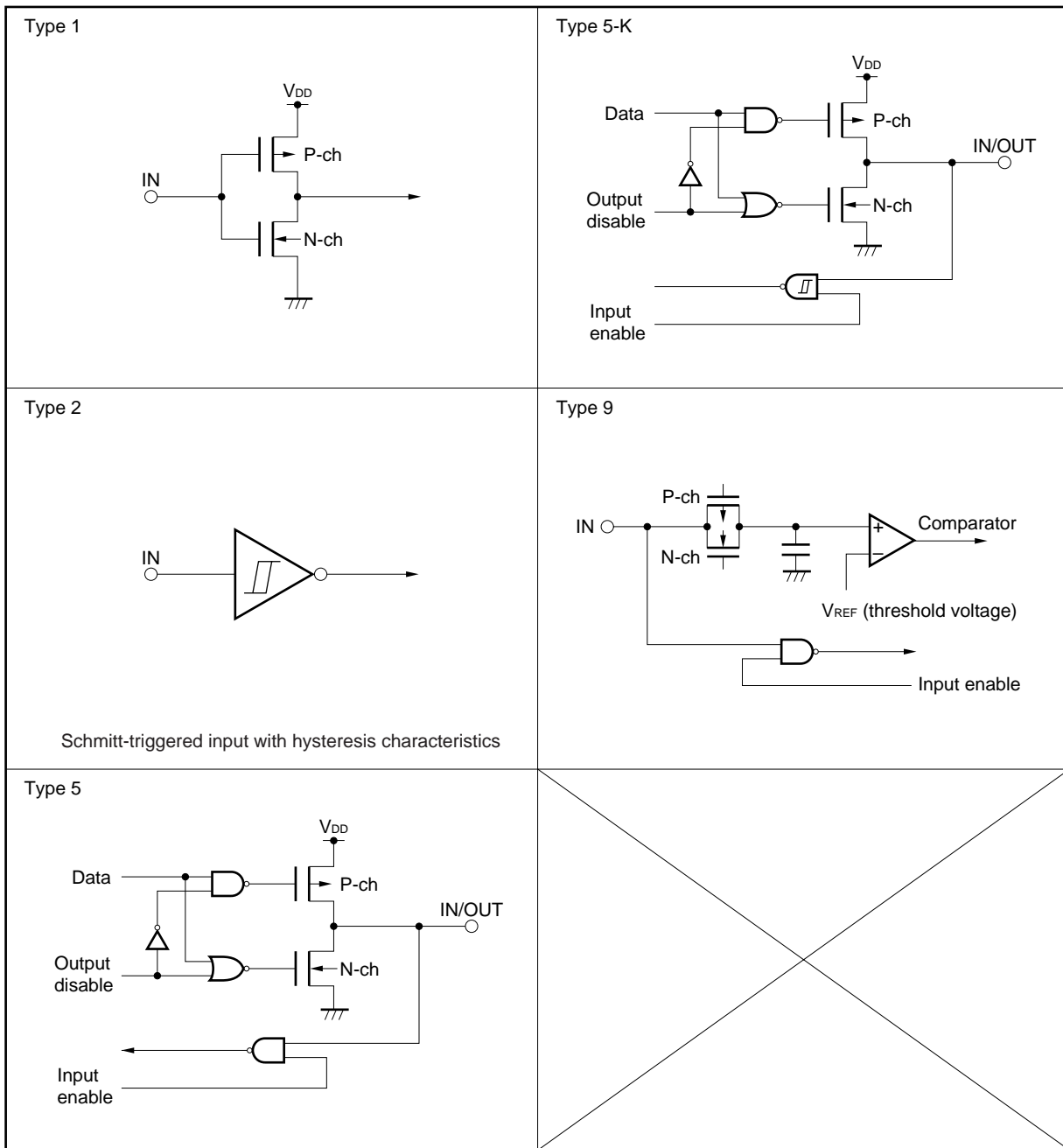
Table 2-1. Pin I/O Circuit Types and Recommended Connection of Unused Pins (1/2)

Pin	I/O Circuit Type	Recommended Connection of Unused Pins
P00/TO100, P01/TO101	5	Input: Independently connect to HV _{DD} or V _{SS} via a resistor. Output: Leave open.
P02/TCLR10, P03/TI10	5-K	
P04/INTP100/D _{MARQ0} to P07/INTP103/D _{MARQ3}		
P10/TO110, P11/TO111	5	
P12/TCLR11, P13/TI11	5-K	
P14/INTP110/D _{MAAK0} to P17/INTP113/D _{MAAK3}		
P20/NMI	2	Connect directly to V _{SS} .
P21	5	Input: Independently connect to HV _{DD} or V _{SS} via a resistor. Output: Leave open.
P22/TXD0/SO0		
P23/RXD0/SI0	5-K	
P24/SCK0		
P25/TXD1/SO1	5	
P26/RXD1/SI1	5-K	
P27/SCK1		
P30/TO130, P31/TO131	5	
P32/TCLR13, P33/TI13	5 - K	
P34/INTP130		
P35/INTP131/SO2		
P36/INTP132/SI2		
P37/INTP133/SCK2		
P40/D0 to P47/D7		
P50/D8 to P57/D15		
P60/A16 to P67/A23		
P70/ANI0 to P77/ANI7	9	Connect directly to V _{SS} .

Table 2-1. Pin I/O Circuit Types and Recommended Connection of Unused Pins (2/2)

Pin	I/O Circuit Type	Recommended Connection of Unused Pins
P80/ $\overline{\text{CS0}}$ / $\overline{\text{RAS0}}$ to P83/ $\overline{\text{CS3}}$ / $\overline{\text{RAS3}}$	5	Input: Independently connect to HV _{DD} or V _{SS} via a resistor. Output: Leave open.
P84/ $\overline{\text{CS4}}$ / $\overline{\text{RAS4}}$ / $\overline{\text{IOWR}}$, P85/ $\overline{\text{CS5}}$ / $\overline{\text{RAS5}}$ / $\overline{\text{IORD}}$		
P86/ $\overline{\text{CS6}}$ / $\overline{\text{RAS6}}$, P87/ $\overline{\text{CS7}}$ / $\overline{\text{RAS7}}$		
P90/ $\overline{\text{LCAS}}$ / $\overline{\text{LWR}}$		
P91/ $\overline{\text{UCAS}}$ / $\overline{\text{UWR}}$		
P92/ $\overline{\text{RD}}$		
P93/ $\overline{\text{WE}}$		
P94/ $\overline{\text{BCYST}}$		
P95/ $\overline{\text{OE}}$		
P96/ $\overline{\text{HLDK}}$		
P97/ $\overline{\text{HLDRQ}}$		
P100/ $\overline{\text{TO120}}$, P101/ $\overline{\text{TO121}}$	5	Input: Independently connect to HV _{DD} or V _{SS} via a resistor. Output: Leave open.
P102/ $\overline{\text{TCLR12}}$, P103/ $\overline{\text{TI12}}$	5-K	
P104/ $\overline{\text{INTP120}}$ / $\overline{\text{TC0}}$ to P107/ $\overline{\text{INTP123}}$ / $\overline{\text{TC3}}$		
P110/ $\overline{\text{TO140}}$, P111/ $\overline{\text{TO141}}$	5	
P112/ $\overline{\text{TCLR14}}$, P113/ $\overline{\text{TI14}}$	5-K	
P114/ $\overline{\text{INTP140}}$		
P115/ $\overline{\text{INTP141}}$ / $\overline{\text{SO3}}$		
P116/ $\overline{\text{INTP142}}$ / $\overline{\text{SI3}}$		
P117/ $\overline{\text{INTP143}}$ / $\overline{\text{SCK3}}$		
P120/ $\overline{\text{TO150}}$, P121/ $\overline{\text{TO151}}$	5	
P122/ $\overline{\text{TCLR15}}$, P123/ $\overline{\text{TI15}}$	5-K	
P124/ $\overline{\text{INTP150}}$ to P126/ $\overline{\text{INTP152}}$		
P127/ $\overline{\text{INTP153}}$ / $\overline{\text{ADTRG}}$		
PA0/ $\overline{\text{A0}}$ to PA7/ $\overline{\text{A7}}$	5	
PB0/ $\overline{\text{A8}}$ to PB7/ $\overline{\text{A15}}$		
PX5/ $\overline{\text{REFRQ}}$		
PX6/ $\overline{\text{WAIT}}$		
PX7/ $\overline{\text{CLKOUT}}$		
CKSEL	1	Connect directly to HV _{DD} .
RESET	2	–
MODE0 to MODE2		
MODE3/V _{PP}		Connect to V _{SS} via a resistor (R _{VPP}).
AV _{REF} , AV _{SS}	–	Connect directly to V _{SS} .
AV _{DD}	–	Connect directly to HV _{DD} .

Figure 2-1. Pin Input/Output Circuits



Caution Replace V_{DD} in the circuit diagrams with HV_{DD} .

3. FLASH MEMORY PROGRAMMING

The following two flash memory programming methods are available.

(1) On-board programming

The program is written to the flash memory using a dedicated flash programmer after the μPD70F3102-33 is mounted on the target board. Install the connectors, etc., required for communication with the dedicated flash programmer, on the target board.

(2) Off-board programming

The program is written to the flash memory using a dedicated adapter before the μPD70F3102-33 is mounted on the target board.

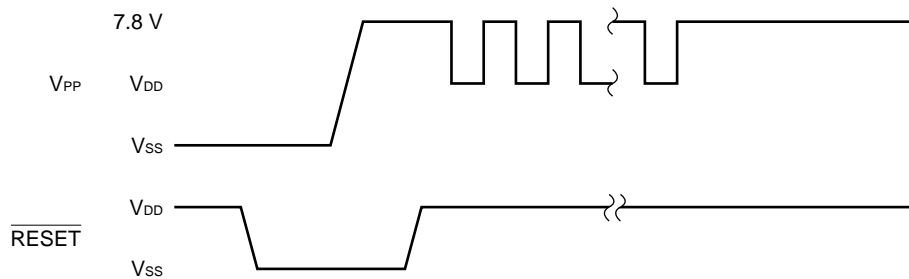
3.1 Selection of Communication System

Writing to the flash memory is done via serial communication using the dedicated flash programmer. Select one of the communication modes listed in Table 3-1. Base your selection of the communication mode on the selection format shown in Table 3-1. Refer to the number of V_{PP} pulses shown in Table 3-1 when selecting the communication mode.

Table 3-1. Communication Modes

Communication Mode	Pins Used	Number of V _{PP} Pulses
CSI0	SO0 (serial data output) SI0 (serial data input) SCK0 (serial clock input)	0
UART0	TXD0 (serial data output) RXD0 (serial data input)	8

Figure 3-1. Communication Mode Selection Format



3.2 Flash Memory Programming Functions

Flash memory programming is performed by sending and receiving commands and data according to the selected communication mode. Table 3-2 shows the main flash memory programming functions.

★ **Table 3-2. Main Flash Memory Programming Functions**

Function	Description
Batch erasure	Erases the contents of the entire memory.
Batch blank check	Checks whether the entire memory has been erased.
Data write	Writes data to flash memory based on the write start address and the number of bytes to be written.
Batch verify	Compares the contents of the entire memory with the input data.

3.3 Connecting the Dedicated Flash Programmer

The connection of the dedicated flash programmer to the μPD70F3102-33 differs depending on the communication mode. Figures 3-2 and 3-3 show the various connection types.

Figure 3-2. Connection of Dedicated Flash Programmer for CSI0 Mode

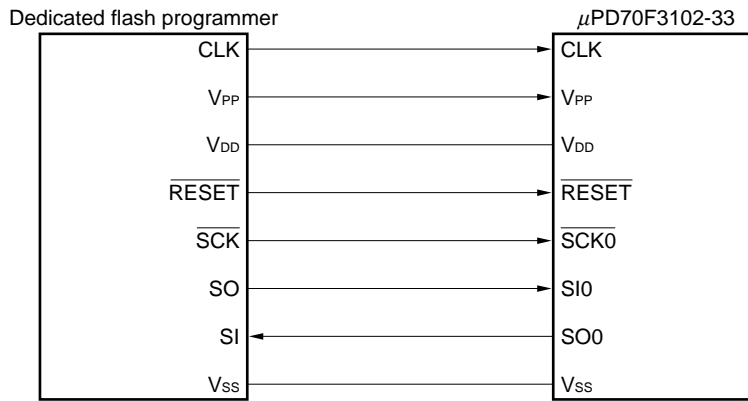
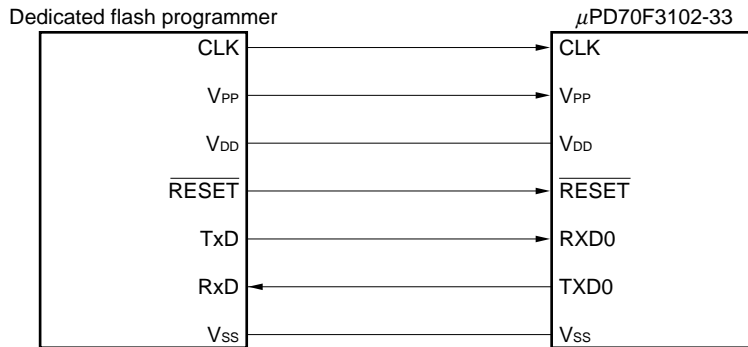


Figure 3-3. Connection of Dedicated Flash Programmer for UART0 Mode



4. ELECTRICAL SPECIFICATIONS

4.1 Normal Operation Mode

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Symbol	Conditions	Ratings	Unit	
Supply voltage	V _{DD}	V _{DD} pin	-0.5 to +4.6	V	
	HV _{DD}	HV _{DD} pin, HV _{DD} ≥ V _{DD}	-0.5 to +7.0	V	
	CV _{DD}	CV _{DD} pin	-0.5 to +4.6	V	
	CV _{SS}	CV _{SS} pin	-0.5 to +0.5	V	
	AV _{DD}	AV _{DD} pin	-0.5 to HV _{DD} + 0.5	V	
	AV _{SS}	AV _{SS} pin	-0.5 to +0.5	V	
Input voltage	V _I	Except X1 pin, MODE3/V _{PP} pin	-0.5 to HV _{DD} + 0.5	V	
		MODE3/V _{PP} pin	-0.5 to V _{DD} + 0.5	V	
		MODE3/V _{PP} pin in flash memory programming mode	-0.5 to +11.0	V	
Clock input voltage	V _K	X1, V _{DD} = 3.0 to 3.6 V	-0.5 to V _{DD} + 1.0	V	
Output current, low	I _{OL}	1 pin	4.0	mA	
		Total of all pins	100	mA	
Output current, high	I _{OH}	1 pin	-4.0	mA	
		Total of all pins	-100	mA	
Output voltage	V _O	HV _{DD} = 5.0 V ±10%	-0.5 to HV _{DD} + 0.5	V	
Analog input voltage	V _{IAN}	P70/ANI0 to P77/ANI7 pins	AV _{DD} > HV _{DD}	-0.5 to HV _{DD} + 0.5	V
			HV _{DD} ≥ AV _{DD}	-0.5 to AV _{DD} + 0.5	V
A/D converter reference input voltage	AV _{REF}	AV _{DD} > HV _{DD}	-0.5 to HV _{DD} + 0.5	V	
		HV _{DD} ≥ AV _{DD}	-0.5 to AV _{DD} + 0.5	V	
Operating ambient temperature	T _A		-40 to +85	°C	
Storage temperature	T _{stg}		-65 to +125	°C	

★

- Cautions**
1. Do not directly connect output pins (or I/O pins) of IC products, and do not connect them directly to V_{DD}, V_{CC}, or GND. However, open-drain pins and open-collector pins can be directly connected to each other. Moreover, external circuits that implement a timing that avoids conflict with the output of pins that go into high-impedance can be directly connected.
 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_A = 25°C, V_{DD} = HV_{DD} = CV_{DD} = V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input capacitance	C _i	f _c = 1 MHz Unmeasured pins returned to 0 V			15	pF
I/O capacitance	C _{io}				15	pF
Output capacitance	C _o				15	pF

Operating Conditions

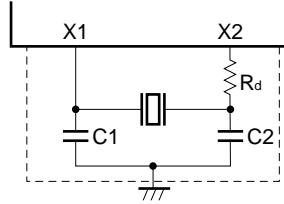
Operation Mode	Internal Operation Clock Frequency (ϕ)	Operating Ambient Temperature (T _A)	Supply Voltage (V _{DD} , HV _{DD})
★ Direct mode	10 to 33 MHz	-40 to +85°C	V _{DD} = 3.0 to 3.6 V, HV _{DD} = 5.0 V ±10%
PLL mode	20 to 33 MHz ^{Note}	-40 to +85°C	V _{DD} = 3.0 to 3.6 V, HV _{DD} = 5.0 V ±10%

★ **Note** Set the input clock frequency used in PLL mode to 4.0 to 6.6 MHz.

★ Recommended Oscillator

(a) Connection of ceramic resonator (T_A = -40 to +85°C)

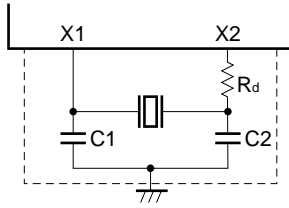
(i) Murata Mfg. Co., Ltd. (T_A = -40 to +85°C)



Type	Product Name	Oscillation Frequency f _{xx} (MHz)	Recommended Circuit Constant			Oscillation Voltage Range		Oscillation Stabilization Time (MAX.) T _{OST} (ms)
			C1 (pF)	C2 (pF)	R _d (kΩ)	MIN. (V)	MAX. (V)	
Surface mount	CSAC4.00MGC040	4.0	100	100	0	3.0	3.6	0.5
	CSTCC4.00MG0H6	4.0	On-chip	On-chip	0	3.0	3.6	0.3
	CSAC5.00MGC040	5.0	100	100	0	3.0	3.6	0.4
	CSTCC5.00MG0H6	5.0	On-chip	On-chip	0	3.0	3.6	0.2
	CSAC6.60MT	6.6	30	30	0	3.0	3.6	0.2
	CSTCC6.60MG0H6	6.6	On-chip	On-chip	0	3.0	3.6	0.1
	CSAC8.00MT	8.0	30	30	0	3.0	3.6	0.2
	CSTCC8.00MG0H6	8.0	On-chip	On-chip	0	3.0	3.6	0.3
Lead	CSA4.00MG040	4.0	100	100	0	3.0	3.6	0.5
	CST4.00MGW040	4.0	On-chip	On-chip	0	3.0	3.6	0.5
	CSA5.00MG040	5.0	100	100	0	3.0	3.6	0.5
	CST5.00MGW040	5.0	On-chip	On-chip	0	3.0	3.6	0.5
	CSA6.60MTZ	6.6	30	30	0	3.0	3.6	0.1
	CST6.60MTW	6.6	On-chip	On-chip	0	3.0	3.6	0.1
	CSA8.00MTZ	8.0	30	30	0	3.0	3.6	0.1
	CST8.00MTW	8.0	On-chip	On-chip	0	3.0	3.6	0.1

- Cautions**
1. Connect the oscillator as closely to the X1 and X2 pins as possible.
 2. Do not wire any other signal lines in the area indicated by the broken lines.
 3. Thoroughly evaluate the matching between the μPD70F3102-33 and the resonator.

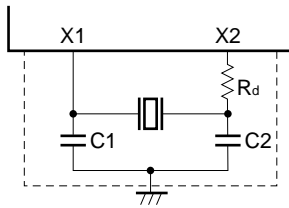
(ii) TDK Corporation (T_A = -40 to +85°C)



Manufacturer	Product Name	Oscillation Frequency f _{xx} (MHz)	Recommended Circuit Constant			Oscillation Voltage Range		Oscillation Stabilization Time (MAX.) T _{OST} (ms)
			C1 (pF)	C2 (pF)	R _d (kΩ)	MIN. (V)	MAX. (V)	
TDK	CCR4.0MC3	4.0	On-chip	On-chip	0	3.0	3.6	0.17
	CCR5.0MC3	5.0	On-chip	On-chip	0	3.0	3.6	0.15
	CCR8.0MC5	8.0	On-chip	On-chip	0	3.0	3.6	0.11

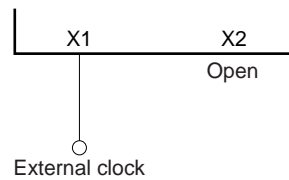
- Cautions**
1. Connect the oscillator as closely to the X1 and X2 pins as possible.
 2. Do not wire any other signal lines in the area indicated by the broken lines.
 3. Thoroughly evaluate the matching between the μPD70F3102-33 and the resonator.

(iii) Kyocera Corporation (T_A = -20 to +80°C)



Manufacturer	Product Name	Oscillation Frequency f _{xx} (MHz)	Recommended Circuit Constant			Oscillation Voltage Range		Oscillation Stabilization Time (MAX.) T _{OST} (ms)
			C1 (pF)	C2 (pF)	R _d (kΩ)	MIN. (V)	MAX. (V)	
Kyocera	PBRC5.00BR-A	5.0	On-chip	On-chip	0	3.0	3.6	0.06
	PBRC6.00BR-A	6.0	On-chip	On-chip	0	3.0	3.6	0.06
	PBRC6.60BR-A	6.6	On-chip	On-chip	0	3.0	3.6	0.06

- Cautions**
1. Connect the oscillator as closely to the X1 and X2 pins as possible.
 2. Do not wire any other signal lines in the area indicated by the broken lines.
 3. Thoroughly evaluate the matching between the μPD70F3102-33 and the resonator.

(b) External clock input ($T_A = -40$ to $+85^\circ\text{C}$)

Caution Input a CMOS level voltage to the X1 pin.

★ Cautions when turning on/off the power

The μ PD70F3102-33 is configured with power supply pins for the internal unit (V_{DD}) and for the external pins (HV_{DD}).

The operation guaranteed range is $V_{DD} = CV_{DD} = 3.0$ to 3.6 V, $HV_{DD} = 5.0$ V $\pm 10\%$. The input and output state of ports may be undefined when the voltage exceeds this range.

DC Characteristics (T_A = -40 to 85°C, V_{DD} = CV_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%, V_{SS} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit	
Input voltage, high	V _{IH}	Except Note 1	2.2		HV _{DD} + 0.3	V	
		Note 1	0.8HV _{DD}		HV _{DD} + 0.3	V	
Input voltage, low	V _{IL}	Except Notes 1 and 2	-0.5		+0.8	V	
		Note 1	-0.5		0.2HV _{DD}	V	
Clock input voltage, high	V _{XH}	X1 pin	Direct mode	0.8V _{DD}		V _{DD} + 0.3	V
			PLL mode	0.8V _{DD}		V _{DD} + 0.3	V
Clock input voltage, low	V _{XL}	X1 pin	Direct mode	-0.3		0.15V _{DD}	V
			PLL mode	-0.3		0.15V _{DD}	V
Schmitt-triggered input threshold voltage	HV _T ⁺	Note 1 , rising edge			3.0	V	
	HV _T ⁻	Note 1 , falling edge			2.0	V	
Schmitt-triggered input hysteresis width	HV _T ⁺ -HV _T ⁻	Note 1		0.5		V	
Output voltage, high	V _{OH}	I _{OH} = -2.5 mA	0.7HV _{DD}			V	
		I _{OH} = -100 μA	HV _{DD} - 0.4			V	
Output voltage, low,	V _{OL}	I _{OL} = 2.5 mA			0.45	V	
Input leakage current, high	I _{LIH}	V _I = HV _{DD} , except Note 2			10	μA	
Input leakage current, low	I _{LIL}	V _I = 0 V, except Note 2			-10	μA	
Output leakage current, high	I _{LOH}	V _O = HV _{DD}			10	μA	
Output leakage current, low	I _{LOL}	V _O = 0 V			-10	μA	

Notes 1. P04/INTP100/D_{MARQ0} to P07/INTP103/D_{MARQ3}, P14/INTP110/D_{MAAK0} to P17/INTP113/D_{MAAK3}, P34/INTP130, P35/INTP131/SO2, P36/INTP132/SI2, P37/INTP133/S_{CK2}, P104/INTP120/T_{C0} to P107/INTP123/T_{C3}, P114/INTP140, P115/INTP141/SO3, P116/INTP142/SI3, P117/INTP143/S_{CK3}, P124/INTP150 to P126/INTP152, P127/INTP153/ADTRG, P02/TCLR10, P12/TCLR11, P32/TCLR13, P102/TCLR12, P112/TCLR14, P122/TCLR15, P03/TI10, P13/TI11, P33/TI13, P103/TI12, P113/TI14, P123/TI15, P20/NMI, P23/RXD0/SI0, P24/S_{CK0}, P26/RXD1/SI1, P27/S_{CK1}, MODE0 to MODE2, R_{ESET}

2. When using the P70/AN10 to P77/ANI7 pins as analog inputs.

Remark TYP. values are reference values for when T_A = 25°C, V_{DD} = CV_{DD} = 3.3 V, HV_{DD} = 5.0 V.

DC Characteristics (T_A = -40 to 85°C, V_{DD} = CV_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%, V_{SS} = 0 V)

★

Parameter		Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply current	During normal	I _{DD1}	Direct mode	V _{DD} + CV _{DD}		2.0 × fx	4.5 × fx	mA
				HV _{DD}		1.8 × fx	3.0 × fx	mA
			PLL mode	V _{DD} + CV _{DD}		2.7 × fx - 17.0	4.5 × fx	mA
				HV _{DD}		1.3 × fx - 3.6	3.0 × fx	mA
	During HALT	I _{DD2}	Direct mode	V _{DD} + CV _{DD}		1.4 × fx	3.0 × fx	mA
				HV _{DD}		0.8 × fx	1.5 × fx	mA
			PLL mode	V _{DD} + CV _{DD}		1.8 × fx - 10.0	3.0 × fx	mA
				HV _{DD}		0.8 × fx - 1.0	1.5 × fx	mA
	During IDLE	I _{DD3}	Direct mode	V _{DD} + CV _{DD}		3.0	10	mA
				HV _{DD}		0.5	1.0	mA
			PLL mode	V _{DD} + CV _{DD}		3.0	10	mA
				HV _{DD}		0.5	1.0	mA
During STOP	I _{DD4}	V _{DD} + CV _{DD}	-40°C ≤ T _A ≤ +40°C		20	50	μA	
			+40°C < T _A ≤ +85°C		20	600	μA	
		HV _{DD}			10	20	μA	

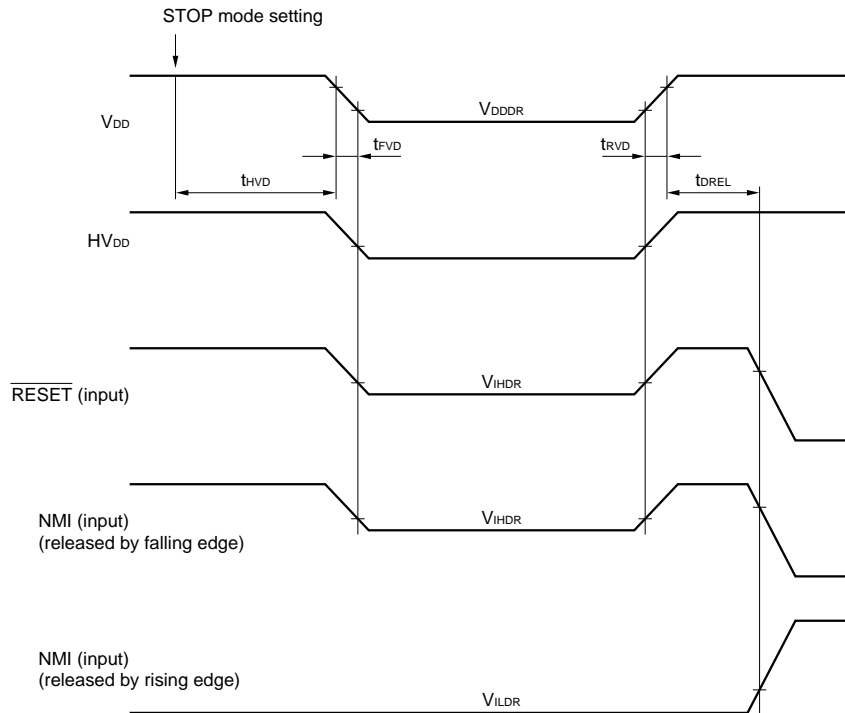
- Remarks**
1. TYP. values are reference values for when T_A = 25°C, V_{DD} = CV_{DD} = 3.3 V, HV_{DD} = 5.0 V.
 2. Direct mode: fx = 10 to 33 MHz
PLL mode: fx = 20 to 33 MHz
 3. The fx unit is MHz.

Data Retention Characteristics (T_A = -40 to +85°C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Data retention voltage	V _{DDDR}	STOP mode, V _{DD} = V _{DDDR}	1.5		3.6	V
	HV _{DDDR}	STOP mode, HV _{DD} = HV _{DDDR}	V _{DDDR}		5.5	V
★ Data retention current	I _{DDDR}	V _{DD} = V _{DDDR}	-40°C ≤ T _A ≤ +40°C		50	μA
			+40°C < T _A ≤ +85°C		600	μA
Supply voltage rise time	t _{rVD}		200			μs
Supply voltage fall time	t _{fVD}		200			μs
Supply voltage hold time (from STOP mode setting)	t _{hVD}		0			ms
STOP release signal input time	t _{dREL}		0			ns
Data retention high-level input voltage	V _{IHDR}	Note	0.8HV _{DDDR}		HV _{DDDR}	V
Data retention low-level input voltage	V _{ILDR}	Note	0		0.2HV _{DDDR}	V

Note P04/INTP100/DMARQ0 to P07/INTP103/DMARQ3, P14/INTP110/DMAAK0 to P17/INTP113/DMAAK3, P34/INTP130, P35/INTP131/SO2, P36/INTP132/SI2, P37/INTP133/SCK2, P104/INTP120/TC0 to P107/INTP123/TC3, P114/INTP140, P115/INTP141/SO3, P116/INTP142/SI3, P117/INTP143/SCK3, P124/INTP150 to P126/INTP152, P127/INTP153/ADTRG, P02/TCLR10, P12/TCLR11, P32/TCLR13, P102/TCLR12, P112/TCLR14, P122/TCLR15, P03/TI10, P13/TI11, P33/TI13, P103/TI12, P113/TI14, P123/TI15, P20/NMI, P23/RXD0/SI0, P24/SCK0, P26/RXD1/SI1, P27/SCK1, MODE0 to MODE2, RESET

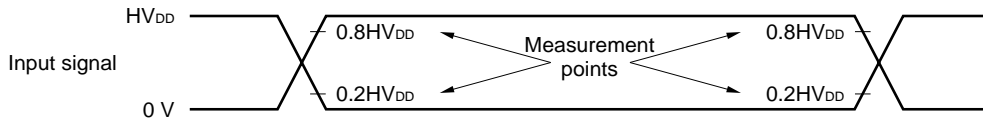
Remark TYP. values are reference values for when T_A = 25°C.



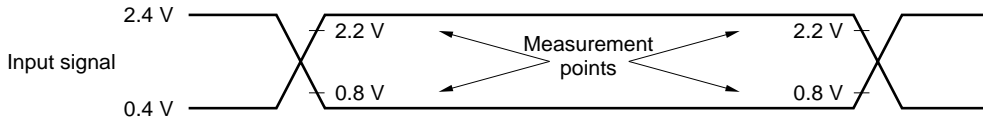
AC Characteristics ($T_A = -40$ to $+85^\circ\text{C}$, $V_{DD} = CV_{DD} = 3.0$ to 3.6 V, $HV_{DD} = 5.0$ V $\pm 10\%$, $V_{SS} = 0$ V, Output Pin Load Capacitance: $C_L = 50$ pF)

AC Test Input Waveforms

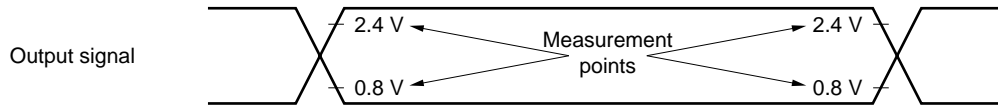
- (a) P04/INTP100/ $\overline{\text{DMARQ0}}$ to P07/INTP103/ $\overline{\text{DMARQ3}}$, P14/INTP110/ $\overline{\text{DMAAK0}}$ to P17/INTP113/ $\overline{\text{DMAAK3}}$, P34/INTP130, P35/INTP131/SO2, P36/INTP132/SI2, P37/INTP133/ $\overline{\text{SCK2}}$, P104/INTP120/ $\overline{\text{TC0}}$ to P107/INTP123/ $\overline{\text{TC3}}$, P114/INTP140, P115/INTP141/SO3, P116/INTP142/SI3, P117/INTP143/ $\overline{\text{SCK3}}$, P124/INTP150 to P126/INTP152, P127/INTP153/ADTRG, P02/TCLR10, P12/TCLR11, P32/TCLR13, P102/TCLR12, P112/TCLR14, P122/TCLR15, P03/TI10, P13/TI11, P33/TI13, P103/TI12, P113/TI14, P123/TI15, P20/NMI, P23/RXD0/SI0, P24/ $\overline{\text{SCK0}}$, P26/RXD1/SI1, P27/ $\overline{\text{SCK1}}$, MODE0 to MODE2, $\overline{\text{RESET}}$



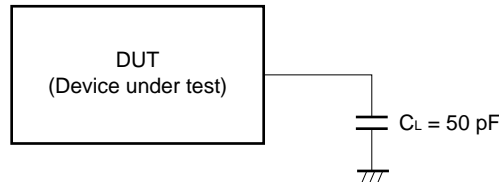
- (b) Other than (a)



AC Test Output Measurement Points



Load Conditions

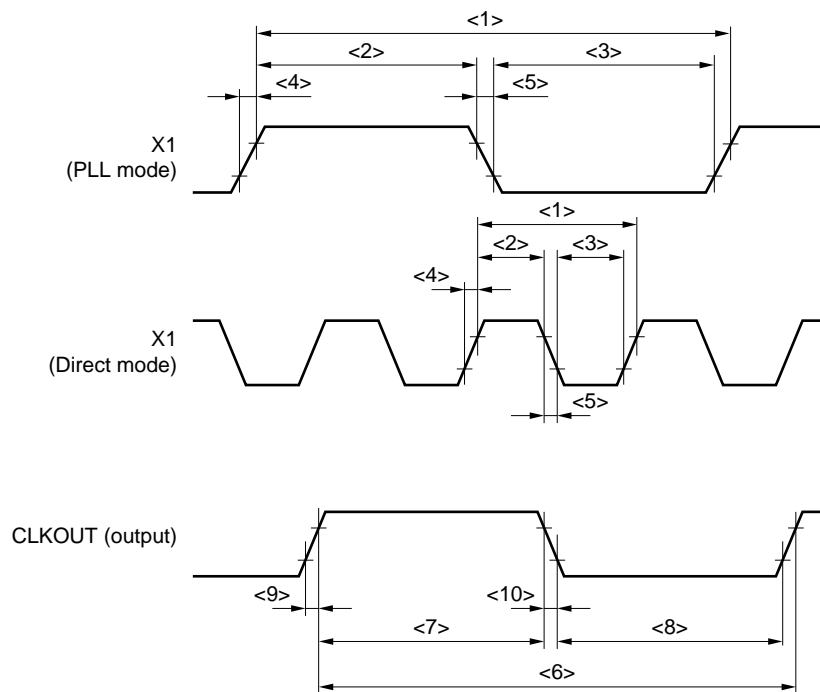


Caution If the load capacitance exceeds 50 pF due to the circuit configuration, reduce the load capacitance of the device to 50 pF or less by inserting a buffer or by some other means.

(1) Clock timing

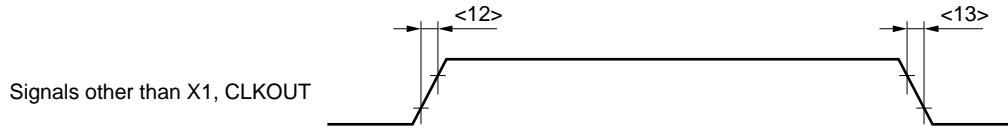
Parameter	Symbol	Conditions	MIN.	MAX.	Unit	
X1 input cycle	<1>	t _{CYX}	In direct mode	15	250	ns
			In PLL mode	150	250	ns
X1 input high-level width	<2>	t _{WXH}	In direct mode	5		ns
			In PLL mode	50		ns
X1 input low-level width	<3>	t _{WXL}	In direct mode	5		ns
			In PLL mode	50		ns
X1 input rise time	<4>	t _{XR}	In direct mode		4	ns
			In PLL mode		10	ns
X1 input fall time	<5>	t _{XF}	In direct mode		4	ns
			In PLL mode		10	ns
★ CPU operating frequency	–	φ	10	33	MHz	
★ CLKOUT output cycle	<6>	t _{CYK}	30	100	ns	
CLKOUT high-level width	<7>	t _{WKH}	0.5T – 7		ns	
CLKOUT low-level width	<8>	t _{WKL}	0.5T – 4		ns	
CLKOUT rise time	<9>	t _{KR}		5	ns	
CLKOUT fall time	<10>	t _{KF}		5	ns	

Remark T = t_{CYK}



(2) Output waveform (other than X1, CLKOUT)

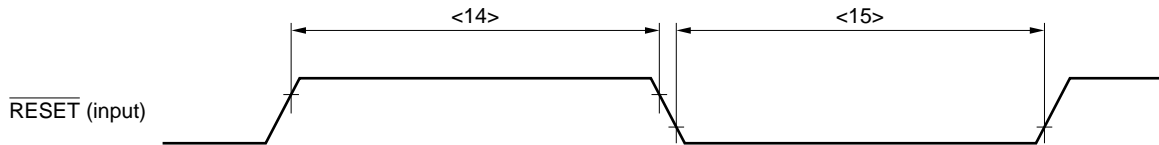
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
Output rise time	<12>	t _{OR}			10	ns
Output fall time	<13>	t _{OF}			10	ns



(3) Reset timing

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
$\overline{\text{RESET}}$ pin high-level width	<14>	t _{WRSH}		500		ns
$\overline{\text{RESET}}$ pin low-level width	<15>	t _{WRSL}	At power ON, STOP mode release	500 + T _{OS}		ns
			Except at power ON, STOP mode release	500		ns

Remark T_{OS}: Oscillation stabilization time



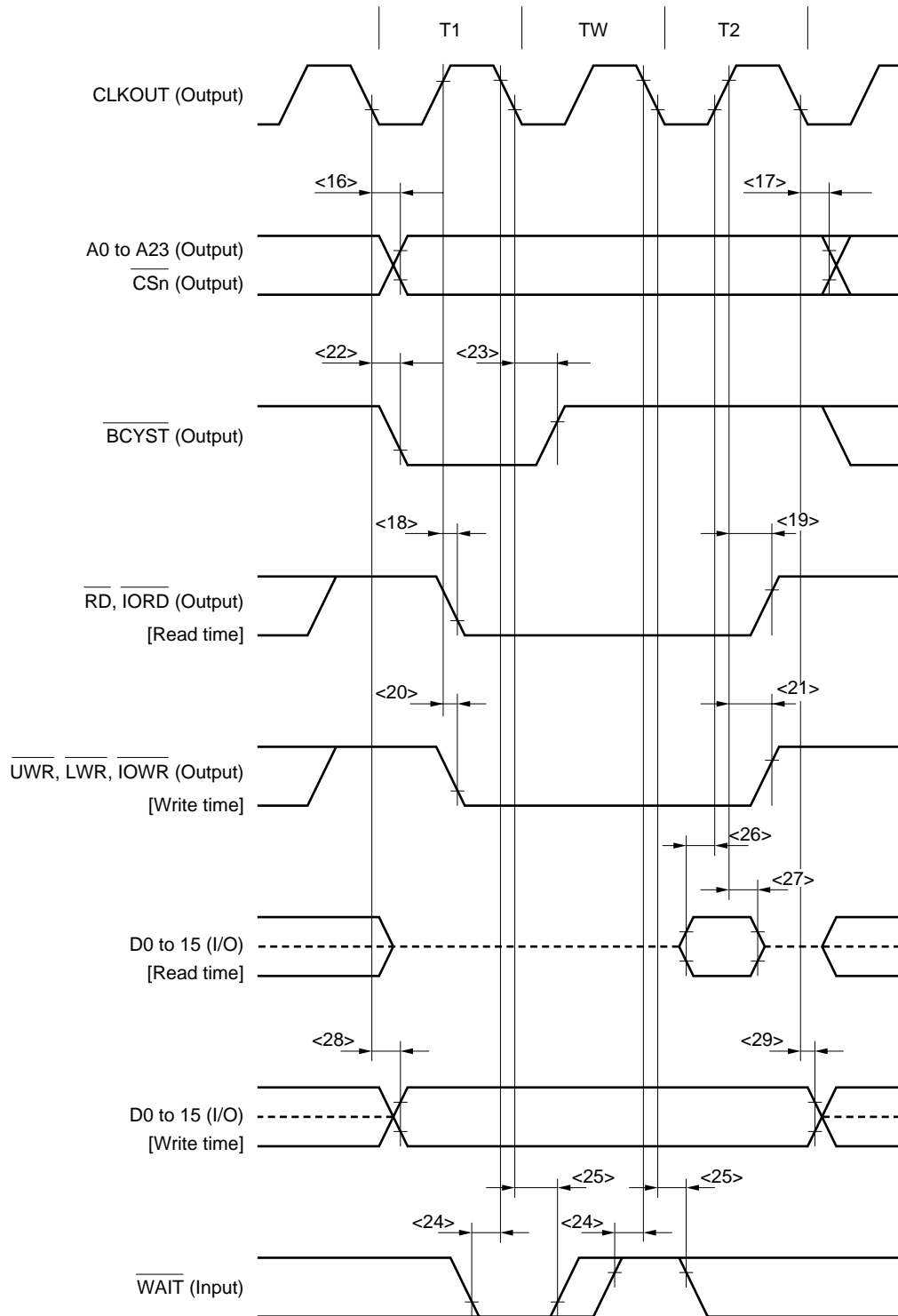
(4) SRAM, external ROM, external I/O access timing

(a) Access timing (SRAM, external ROM, external I/O) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Address, \overline{CSn} output delay time (from CLKOUT↓)	<16> t_{DKA}		2	10	ns
Address, \overline{CSn} output hold time (from CLKOUT↓)	<17> t_{HKA}		2	10	ns
\overline{RD} , \overline{IORD} ↓ delay time (from CLKOUT↑)	<18> t_{DKRDL}		2	14	ns
\overline{RD} , \overline{IORD} ↑ delay time (from CLKOUT↑)	<19> t_{HKRDH}		2	14	ns
\overline{UWR} , \overline{LWR} , \overline{IOWR} ↓ delay time (from CLKOUT↑)	<20> t_{DKWRL}		2	10	ns
\overline{UWR} , \overline{LWR} , \overline{IOWR} ↑ delay time (from CLKOUT↑)	<21> t_{HKWRH}		2	10	ns
\overline{BCYST} ↓ delay time (from CLKOUT↓)	<22> t_{DKBSL}		2	10	ns
\overline{BCYST} ↑ delay time (from CLKOUT↓)	<23> t_{HKBSH}		2	10	ns
\overline{WAIT} setup time (to CLKOUT↓)	<24> t_{SWK}		15		ns
\overline{WAIT} hold time (from CLKOUT↓)	<25> t_{HKW}		2		ns
Data input setup time (to CLKOUT↑)	<26> t_{SKID}		18		ns
Data input hold time (from CLKOUT↑)	<27> t_{HKID}		2		ns
Data output delay time (from CLKOUT↓)	<28> t_{DKOD}		2	10	ns
Data output hold time (from CLKOUT↓)	<29> t_{HKOD}		2	10	ns

- Remarks**
1. Observe at least one of the data input hold times, t_{HKID} or t_{HRDID} .
 2. $n = 0$ to 7

(a) Access timing (SRAM, external ROM, external I/O) (2/2)



- Remarks**
1. Timing when number of waits specified by registers DWC1 and DWC2 is 0.
 2. Broken lines indicate high impedance.
 3. $n = 0$ to 7

(b) Read timing (SRAM, external ROM, external I/O) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Data input setup time (to address)	<30>	t _{SAID}		$(1.5 + w_D + w) T - 28$	ns
Data input setup time (to \overline{RD})	<31>	t _{SRDID}		$(1 + w_D + w) T - 32$	ns
\overline{RD} , \overline{IORD} low-level width	<32>	t _{WRDL}	$(1 + w_D + w) T - 10$		ns
\overline{RD} , \overline{IORD} high-level width	<33>	t _{WRDH}	$T - 10$		ns
Delay time from address, \overline{CS}_n to \overline{RD} , $\overline{IORD}\downarrow$	<34>	t _{DARD}	$0.5T - 10$		ns
Delay time from \overline{RD} , $\overline{IORD}\uparrow$ to address	<35>	t _{DRDA}	$(0.5 + i) T - 10$		ns
Data input hold time (from \overline{RD} , $\overline{IORD}\uparrow$)	<36>	t _{HRDID}	0		ns
Delay time from \overline{RD} , $\overline{IORD}\uparrow$ to data output	<37>	t _{DRDOD}	$(0.5 + i) T - 10$		ns
\overline{WAIT} setup time (to address)	<38>	t _{SAW}	Note	$T - 25$	ns
\overline{WAIT} setup time (to $\overline{BCYST}\downarrow$)	<39>	t _{SBSW}	Note	$T - 25$	ns
\overline{WAIT} hold time (from $\overline{BCYST}\uparrow$)	<40>	t _{HBSW}	Note	0	ns

Note During the first \overline{WAIT} sampling, when the number of waits specified by registers DWC1 and DWC2 is 0.

Remarks 1. $T = t_{CYK}$

2. w : Number of waits due to \overline{WAIT}

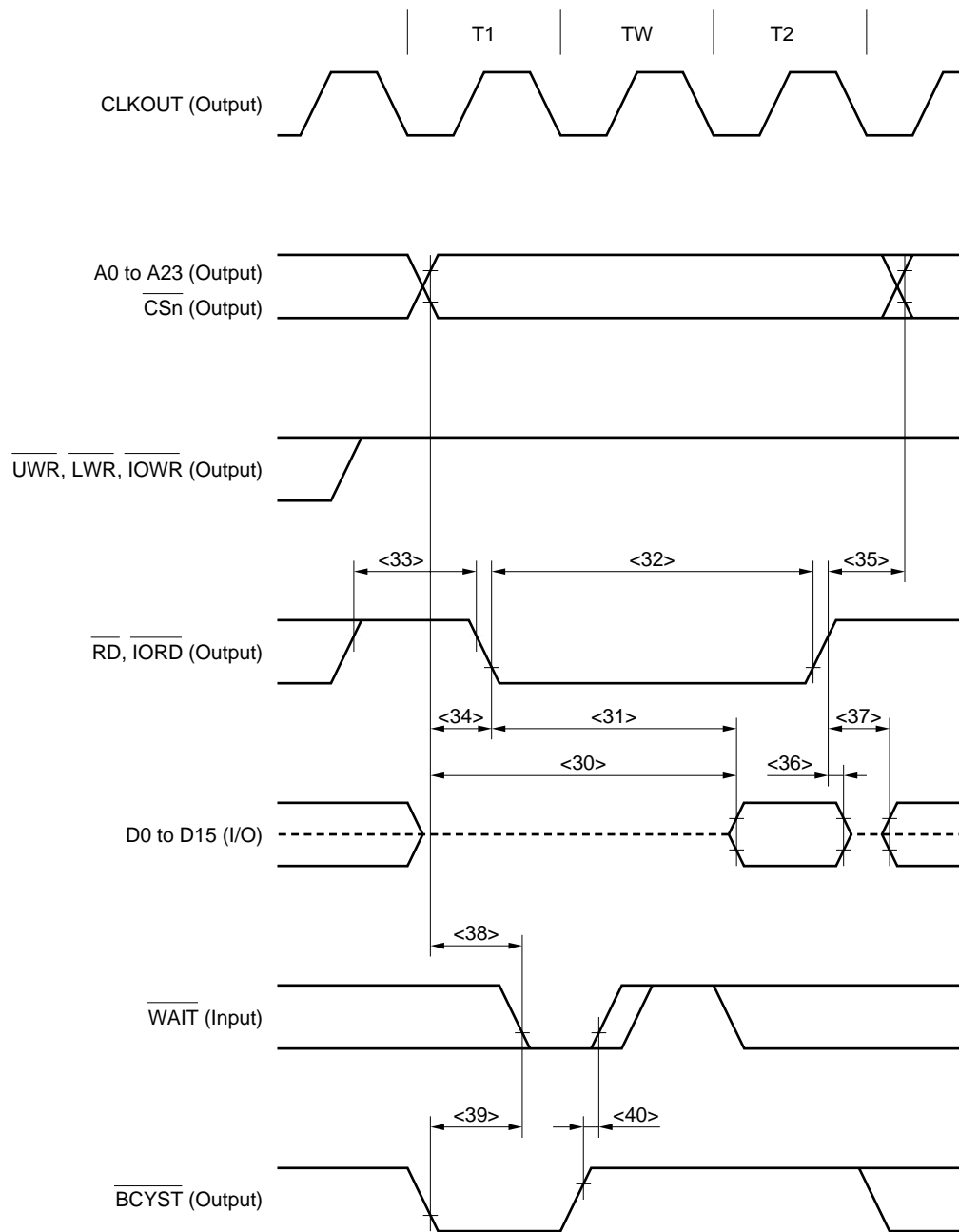
3. w_D : Number of waits specified by registers DWC1, DWC2

4. i : Number of idle states inserted when a write cycle follows the read cycle.

5. Observe at least one of the data input hold times, t_{HKID} or t_{HRDID}.

6. $n = 0$ to 7

(b) Read timing (SRAM, external ROM, external I/O) (2/2)



- Remarks**
1. Timing when the number of waits specified by registers DWC1 and DWC2 is 0.
 2. Broken lines indicate high impedance.
 3. $n = 0$ to 7

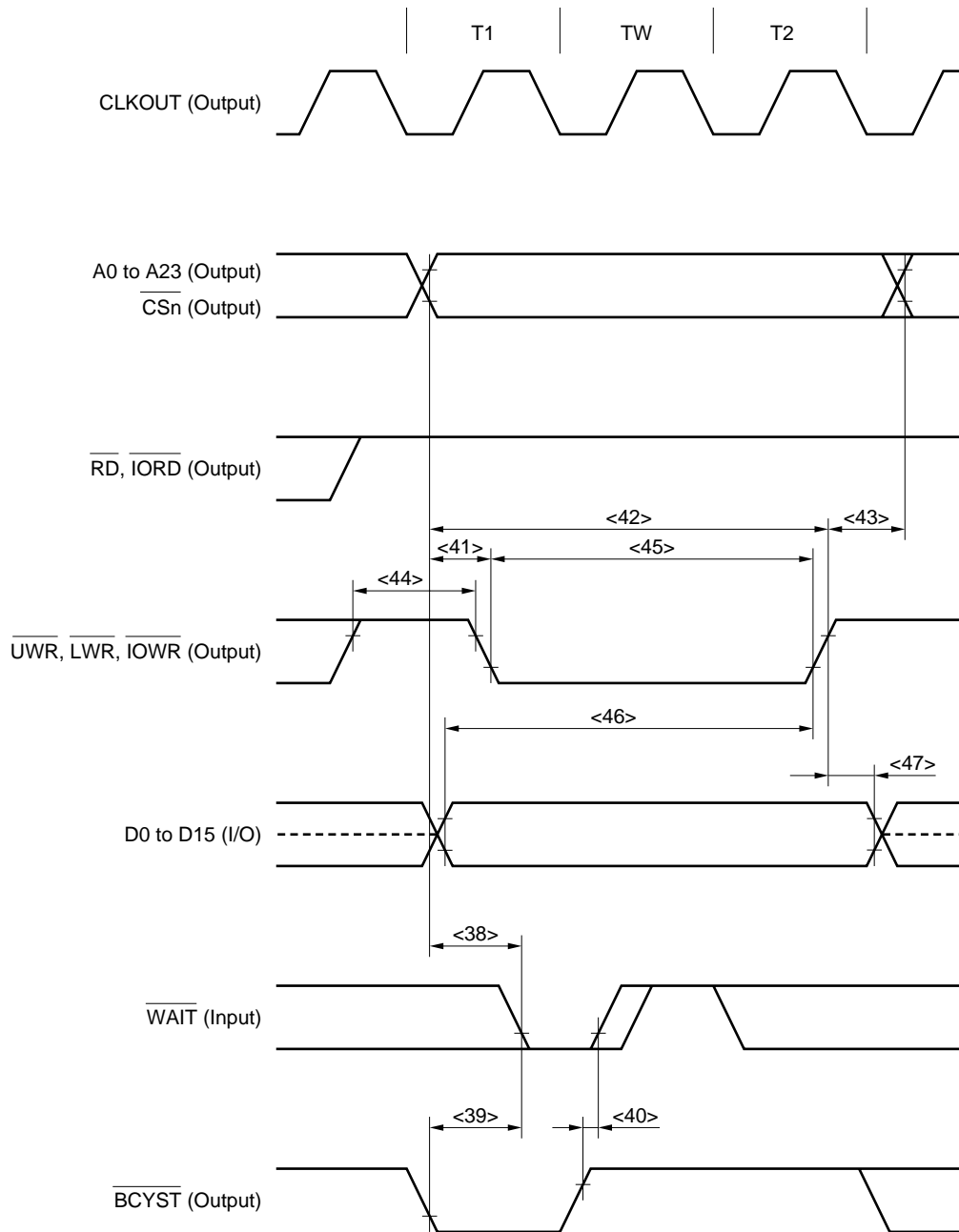
(c) Write timing (SRAM, external ROM, external I/O) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to address)	<38> t_{SAW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ setup time (to $\overline{\text{BCYST}}\downarrow$)	<39> t_{BSW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ hold time (from $\overline{\text{BCYST}}\uparrow$)	<40> t_{HBSW}	Note	0		ns
Delay time from address, $\overline{\text{CS}}_n$ to $\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}\downarrow$	<41> t_{DAWR}		$0.5T - 10$		ns
Address setup time (to $\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}\uparrow$)	<42> t_{SAWR}		$(1.5 + w_D + w) T - 10$		ns
Delay time from $\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}\uparrow$ to address	<43> t_{DWRA}		$0.5T - 10$		ns
$\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}$ high-level width	<44> t_{WWRH}		$T - 10$		ns
$\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}$ low-level width	<45> t_{WURL}		$(1 + w_D + w) T - 10$		ns
Data output setup time (to $\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}\uparrow$)	<46> t_{SODWR}		$(1.5 + w_D + w) T - 10$		ns
Data output hold time (from $\overline{\text{UWR}}$, $\overline{\text{LWR}}$, $\overline{\text{IOWR}}\uparrow$)	<47> t_{HWROD}		$0.5T - 10$		ns

Note During the first $\overline{\text{WAIT}}$ sampling, when the number of waits specified by registers DWC1 and DWC2 is 0.

- Remarks**
1. $T = t_{\text{CYK}}$
 2. w : Number of waits due to $\overline{\text{WAIT}}$
 3. w_D : Number of waits specified by registers DWC1 and DWC2
 4. $n = 0$ to 7

(c) Write timing (SRAM, external ROM, external I/O) (2/2)



- Remarks**
1. Timing when the number of waits specified by registers DWC1 and DWC2 is 0.
 2. Broken lines indicate high impedance.
 3. n = 0 to 7

(d) DMA flyby transfer timing (SRAM → external I/O transfer) (1/2)

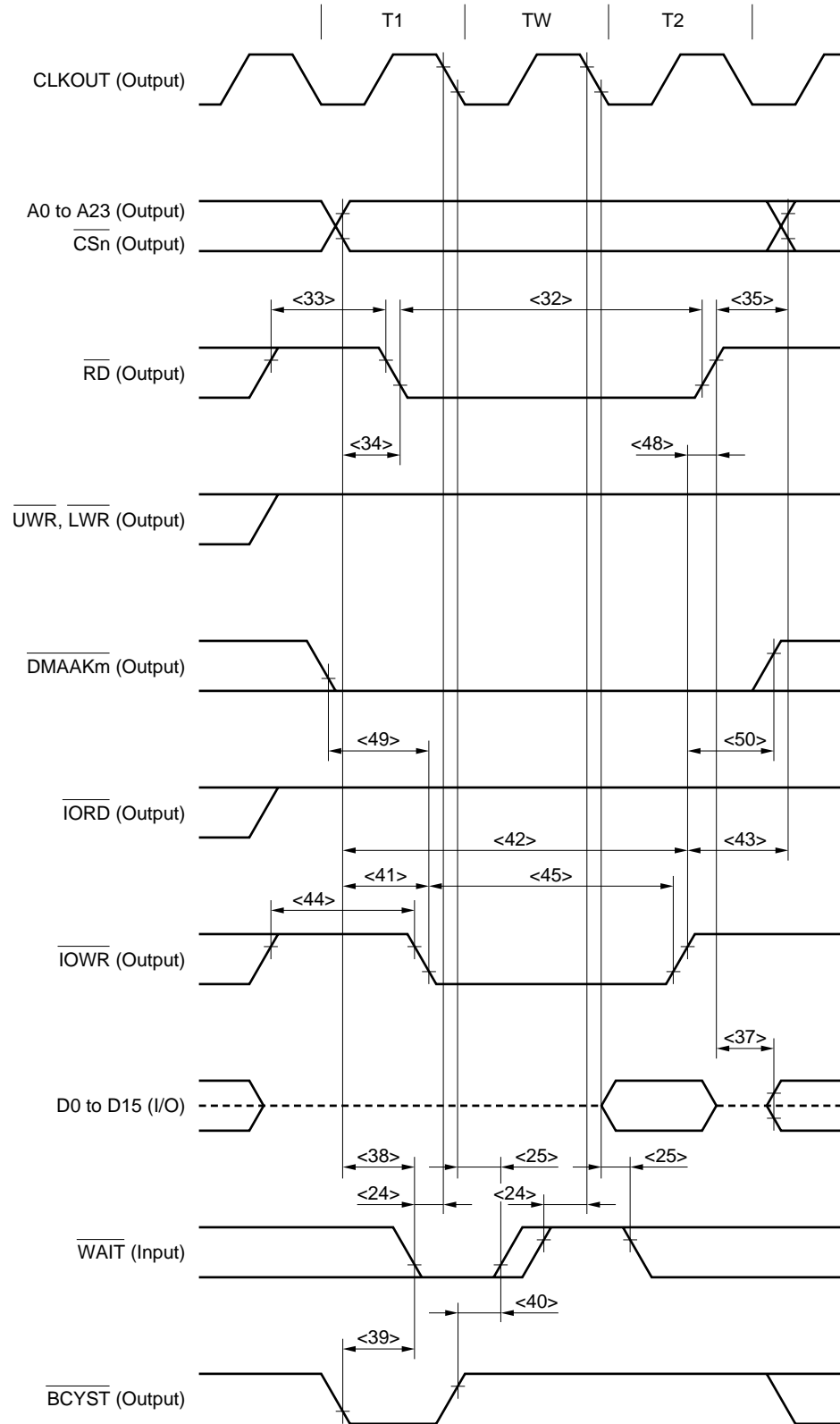
Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24> t _{SWK}		15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25> t _{HKW}		2		ns
$\overline{\text{RD}}$ low-level width	<32> t _{WRDL}		$(1 + w_D + w_F + w) T - 10$		ns
$\overline{\text{RD}}$ high-level width	<33> t _{WRDH}		$T - 10$		ns
Delay time from address, $\overline{\text{CS}}_n$ to RD↓	<34> t _{DARD}		$0.5T - 10$		ns
Delay time from $\overline{\text{RD}}\uparrow$ to address	<35> t _{DRDA}		$(0.5 + i) T - 10$		ns
Delay time from $\overline{\text{RD}}\uparrow$ to data output	<37> t _{DRDOD}		$(0.5 + i) T - 10$		ns
$\overline{\text{WAIT}}$ setup time (to address)	<38> t _{SAW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ setup time (to BCYST↓)	<39> t _{SBSW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ hold time (from BCYST↑)	<40> t _{HBSW}	Note	0		ns
Delay time from address to IOWR↓	<41> t _{DAWR}		$0.5T - 10$		ns
Address setup time (to IOWR↑)	<42> t _{SAWR}		$(1.5 + w_D + w) T - 10$		ns
Delay time from IOWR↑ to address	<43> t _{DWRA}		$0.5T - 10$		ns
IOWR high-level width	<44> t _{WWRH}		$T - 10$		ns
IOWR low-level width	<45> t _{WWRL}		$(1 + w_D + w) T - 10$		ns
Delay time from IOWR↑ to $\overline{\text{RD}}\uparrow$	<48> t _{DWRRD}	WF = 0	0		ns
		WF = 1	$T - 10$		ns
Delay time from $\overline{\text{DMAAK}}_m\downarrow$ to IOWR↓	<49> t _{DDAWR}		$0.5T - 10$		ns
Delay time from IOWR↑ to $\overline{\text{DMAAK}}_m\uparrow$	<50> t _{DWRDA}		$(0.5 + w_F) T - 10$		ns

Note During the first $\overline{\text{WAIT}}$ sampling, when number of waits specified by registers DWC1 and DWC2 is 0.

Remarks 1. T = t_{cyk}

2. w: Number of waits due to $\overline{\text{WAIT}}$
3. w_D: Number of waits specified by registers DWC1, DWC2
4. w_F: Number of waits inserted to source-side access during DMA flyby transfer
5. i: Number of idle states inserted when a write cycle follows the read cycle
6. n = 0 to 7, m = 0 to 3

(d) DMA flyby transfer timing (SRAM → external I/O transfer) (2/2)



- Remarks**
1. Timing when the number of waits specified by registers DWC1 and DWC2 is 0.
 2. Broken lines indicate high impedance.
 3. n = 0 to 7, m = 0 to 3

(e) DMA flyby transfer timing (external I/O → SRAM transfer) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24> t _{SWK}		15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25> t _{HKW}		2		ns
$\overline{\text{IORD}}$ low-level width	<32> t _{WRDL}		$(1 + w_D + w_F + w) T - 10$		ns
$\overline{\text{IORD}}$ high-level width	<33> t _{WRDH}		$T - 10$		ns
Delay time from address, $\overline{\text{CSn}}$ to $\overline{\text{IORD}}\downarrow$	<34> t _{DARD}		$0.5T - 10$		ns
Delay time from $\overline{\text{IORD}}\uparrow$ to address	<35> t _{DRDA}		$(0.5 + i) T - 10$		ns
Delay time from $\overline{\text{IORD}}\uparrow$ to data output	<37> t _{DRDOD}		$(0.5 + i) T - 10$		ns
$\overline{\text{WAIT}}$ setup time (to address)	<38> t _{SAW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ setup time (to BCYST↓)	<39> t _{SBSW}	Note		$T - 25$	ns
$\overline{\text{WAIT}}$ hold time (from BCYST↑)	<40> t _{HBSW}	Note	0		ns
Delay time from address to $\overline{\text{UWR}}$, $\overline{\text{LWR}}\downarrow$	<41> t _{DAWR}		$0.5T - 10$		ns
Address setup time (to $\overline{\text{UWR}}$, $\overline{\text{LWR}}\uparrow$)	<42> t _{SAWR}		$(1.5 + w_D + w) T - 10$		ns
Delay time from $\overline{\text{UWR}}$, $\overline{\text{LWR}}$ to address	<43> t _{DWRA}		$0.5T - 10$		ns
$\overline{\text{UWR}}$, $\overline{\text{LWR}}$ high-level width	<44> t _{WWRH}		$T - 10$		ns
$\overline{\text{UWR}}$, $\overline{\text{LWR}}$ low-level width	<45> t _{WWRL}		$(1 + w_D + w) T - 10$		ns
Delay time from $\overline{\text{UWR}}$, $\overline{\text{LWR}}\uparrow$ to $\overline{\text{IORD}}\uparrow$	<48> t _{DWRRD}	WF = 0	0		ns
		WF = 1	$T - 10$		ns
Delay time from $\overline{\text{DMAAKm}}\downarrow$ to $\overline{\text{IORD}}\downarrow$	<51> t _{DDARD}		$0.5T - 10$		ns
Delay time from $\overline{\text{IORD}}\uparrow$ to $\overline{\text{DMAAKm}}\uparrow$	<52> t _{DRDDA}		$0.5T - 10$		ns

Note During the first $\overline{\text{WAIT}}$ sampling, when the number of waits specified by registers DWC1 and DWC2 is 0.

Remarks 1. $T = t_{\text{CYK}}$

2. w: Number of waits due to $\overline{\text{WAIT}}$

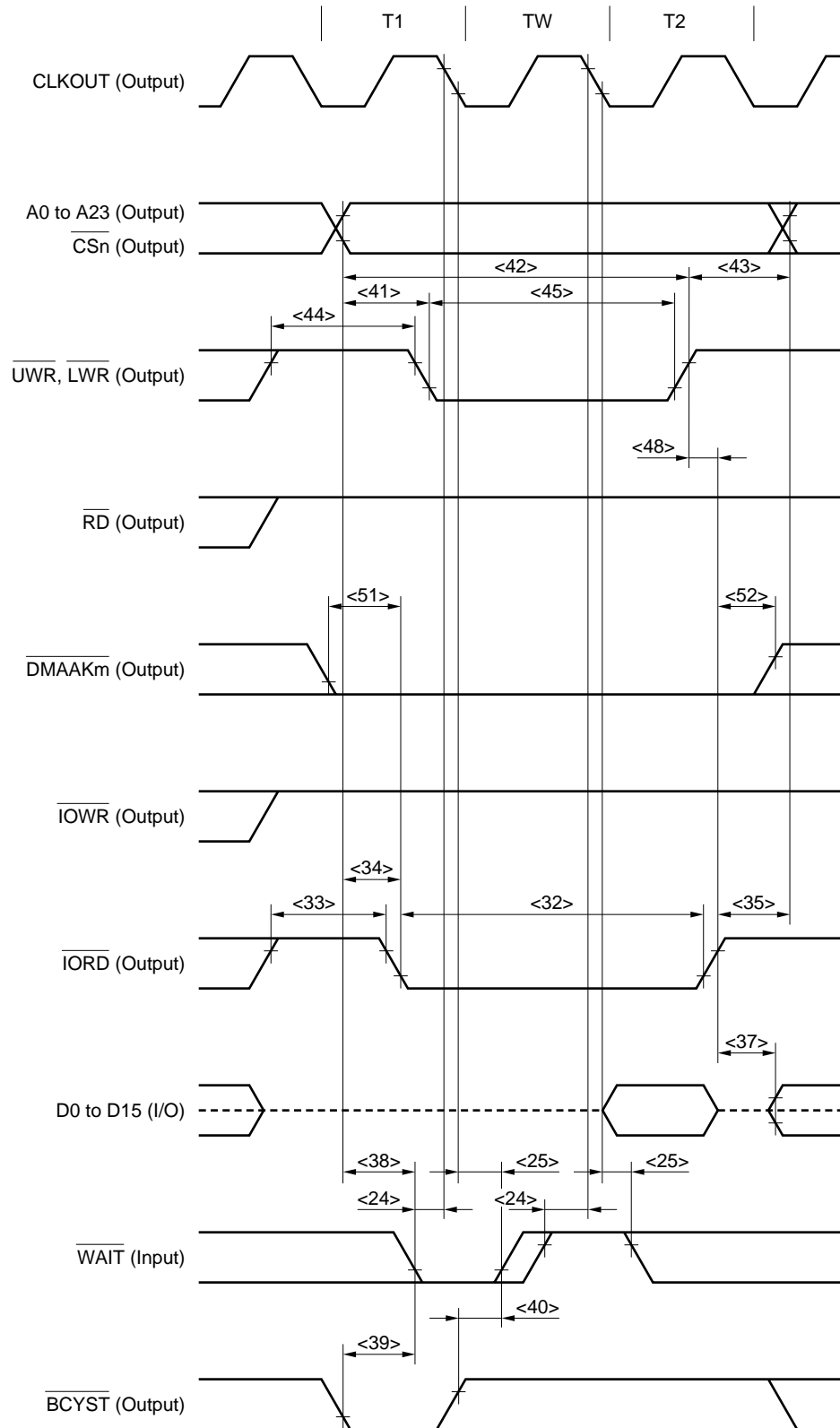
3. w_D: Number of waits specified by registers DWC1 and DWC2.

4. w_F: Number of waits inserted to source-side access during DMA flyby transfer.

5. i: Number of idle states inserted when a write cycle follows the read cycle.

6. n = 0 to 7, m = 0 to 3

(e) DMA flyby transfer timing (external I/O → SRAM transfer) (2/2)



- Remarks**
1. Timing when the number of waits specified by registers DWC1 and DWC2 is 0 and $w_F = 0$.
 2. Broken lines indicate high impedance.
 3. $n = 0$ to 7, $m = 0$ to 3

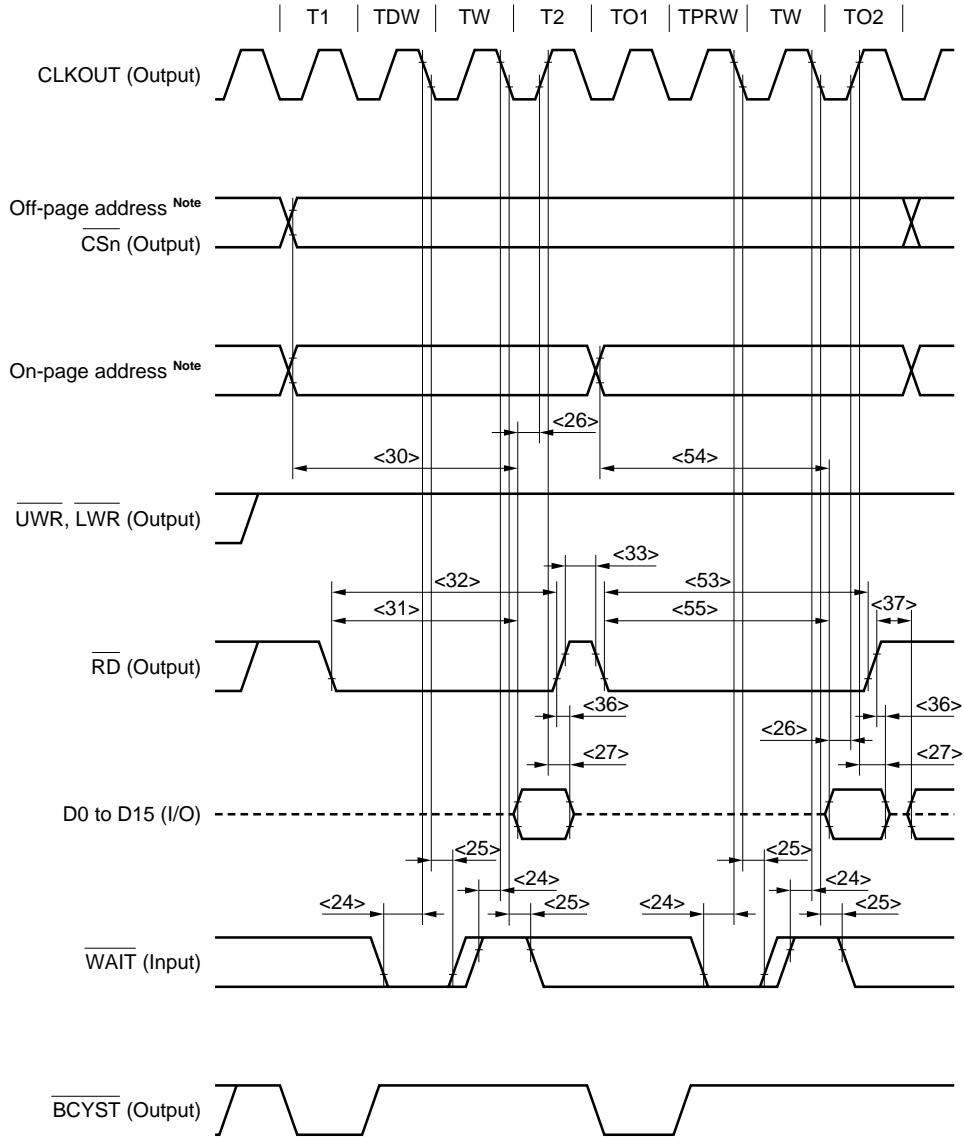
(5) Page ROM access timing (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24> t _{SWK}		15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25> t _{HKW}		2		ns
Data input setup time (to CLKOUT↑)	<26> t _{SKID}		18		ns
Data input hold time (from CLKOUT↑)	<27> t _{HKID}		2		ns
Off-page data input setup time (to address)	<30> t _{SAID}			(1.5 + w _D + w) T - 28	ns
Off-page data input setup time (to $\overline{\text{RD}}$)	<31> t _{SRDID}			(1 + w _D + w) T - 32	ns
Off-page $\overline{\text{RD}}$ low-level width	<32> t _{WRDL}		(1 + w _D + w) T - 10		ns
$\overline{\text{RD}}$ high-level width	<33> t _{WRDH}		0.5T - 10		ns
Data input hold time (from $\overline{\text{RD}}$)	<36> t _{HRDID}		0		ns
Delay time from $\overline{\text{RD}}$ ↑ to data output	<37> t _{DRDOD}		(0.5 + i) T - 10		ns
On-page $\overline{\text{RD}}$ low-level width	<53> t _{WORDL}		(1.5 + w _{PR} + w) T - 10		ns
On-page data input setup time (to address)	<54> t _{SOAID}			(1.5 + w _{PR} + w) T - 28	ns
On-page data input setup time (to $\overline{\text{RD}}$)	<55> t _{SORDID}			(1.5 + w _{PR} + w) T - 32	ns

Remarks 1. T = t_{cyk}

2. w: Number of waits due to $\overline{\text{WAIT}}$
3. w_D: Number of waits specified by registers DWC1 and DWC2.
4. w_{PR}: Number of waits specified by register PRC.
5. i: Number of idle states inserted when a write cycle follows the read cycle.
6. Observe at least one of the data input hold times, t_{HKID} or t_{HRDID}.

(5) Page ROM access timing (2/2)



Note On-page addresses and off-page addresses are as follows.

PRC Register			On-Page Addresses	Off-Page Addresses
MA5	MA4	MA3		
0	0	0	A0, A1	A2 to A23
0	0	1	A0 to A2	A3 to A23
0	1	1	A0 to A3	A4 to A23
1	1	1	A0 to A4	A5 to A23

Remarks 1. These timings are for the following cases:

Number of waits (TDW) specified by registers DWC1 and DWC2: 1

Number of waits (TPRW) specified by register PRC: 1

2. Broken lines indicate high impedance.

3. n = 0 to 7

(6) DRAM access timing

(a) Read timing (high-speed page DRAM access, normal access: off-page) (1/3)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24> t _{SWK}		15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25> t _{HKW}		2		ns
Data input setup time (to CLKOUT↑)	<26> t _{SKID}		18		ns
Data input hold time (from CLKOUT↑)	<27> t _{HKID}		2		ns
Delay time from $\overline{\text{OE}}\uparrow$ to data output	<37> t _{DRDOD}		$(0.5 + i) T - 10$		ns
Row address setup time	<56> t _{ASR}		$(0.5 + \text{WRP}) T - 10$		ns
Row address hold time	<57> t _{RAH}		$(0.5 + \text{WRH}) T - 10$		ns
Column address setup time	<58> t _{ASC}		$0.5T - 10$		ns
Column address hold time	<59> t _{CAH}		$(1.5 + \text{WDA} + w) T - 10$		ns
Read/write cycle time	<60> t _{RC}		$(3 + \text{WRP} + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{RAS}}$ recharge time	<61> t _{RP}		$(0.5 + \text{WRP}) T - 10$		ns
$\overline{\text{RAS}}$ pulse time	<62> t _{RAS}		$(2.5 + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{RAS}}$ hold time	<63> t _{RSH}		$(1.5 + \text{WDA} + w) T - 10$		ns
Column address read time for $\overline{\text{RAS}}$	<64> t _{RAL}		$(2 + \text{WDA} + w) T - 10$		ns
$\overline{\text{CAS}}$ pulse width	<65> t _{CAS}		$(1 + \text{WDA} + w) T - 10$		ns
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	<66> t _{CRP}		$(1 + \text{WRP}) T - 10$		ns
$\overline{\text{CAS}}$ hold time	<67> t _{CSH}		$(2 + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{WE}}$ setup time	<68> t _{RCS}		$(2 + \text{WRP} + \text{WRH}) T - 10$		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{RAS}}\uparrow$)	<69> t _{RRH}		$0.5T - 10$		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\uparrow$)	<70> t _{RCH}		$T - 10$		ns
$\overline{\text{CAS}}$ precharge time	<71> t _{CPN}		$(2 + \text{WRP} + \text{WRH}) T - 10$		ns
Output enable access time	<72> t _{OEA}			$(2 + \text{WRP} + \text{WRH} + \text{WDA} + w) T - 28$	ns
$\overline{\text{RAS}}$ access time	<73> t _{RAC}			$(2 + \text{WRH} + \text{WDA} + w) T - 28$	ns
Access time from column address	<74> t _{AA}			$(1.5 + \text{WDA} + w) T - 28$	ns
$\overline{\text{CAS}}$ access time	<75> t _{CAC}			$(1 + \text{WDA} + w) T - 28$	ns

Remarks 1. T = t_{cyk}

2. w: Number of waits due to $\overline{\text{WAIT}}$
3. WRP: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. WRH: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. WDA: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
6. i: Number of idle states inserted when a write cycle follows the read cycle.

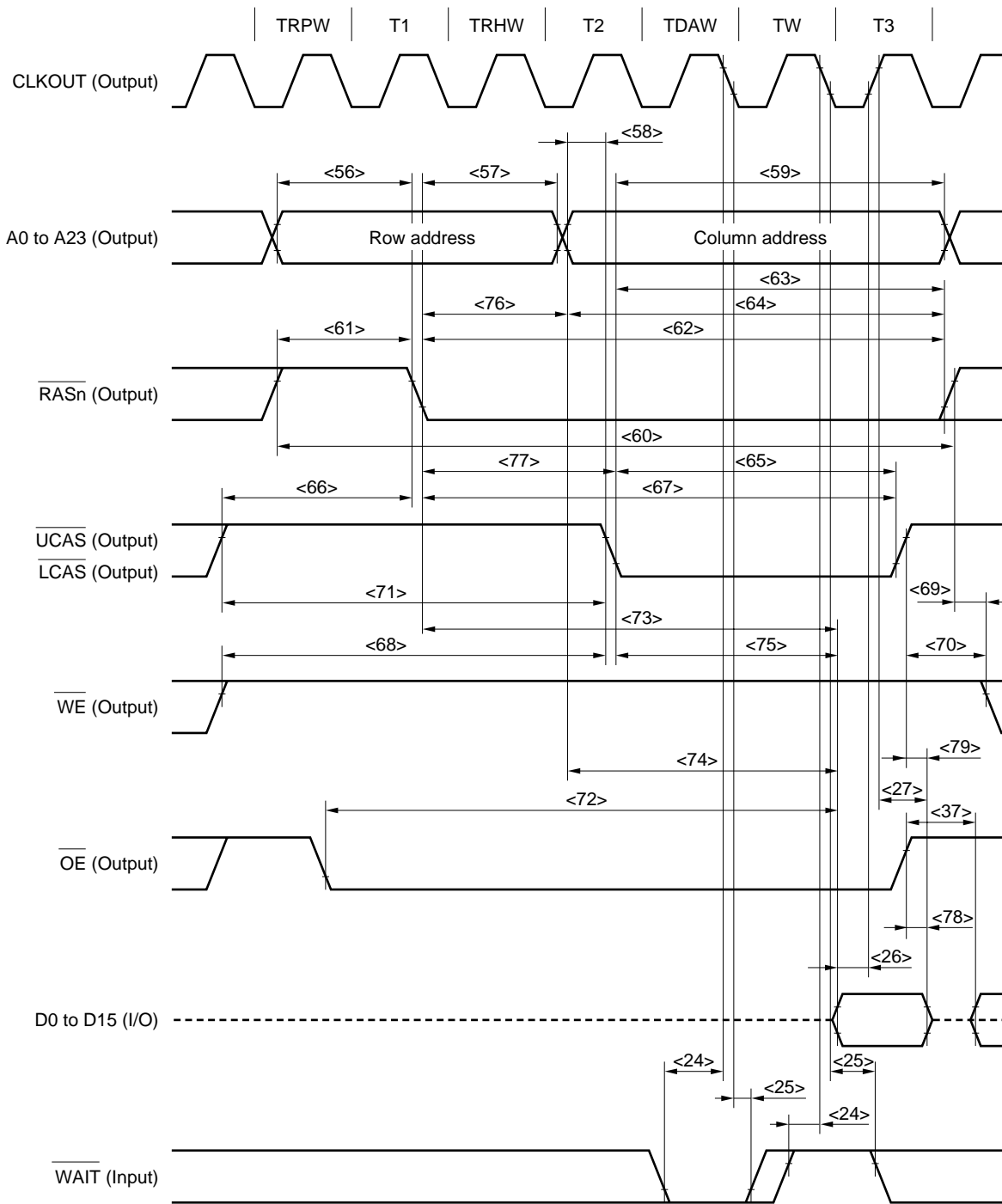
(a) Read timing (high-speed page DRAM access, normal access: off-page) (2/3)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{RAS}}$ column address delay time	<76> t_{RAD}		$(0.5 + w_{\text{RH}}) T - 10$		ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	<77> t_{RCD}		$(1 + w_{\text{RH}}) T - 10$		ns
Output buffer turn off delay time (from $\overline{\text{OE}}\uparrow$)	<78> t_{OEZ}		0		ns
Output buffer turn off delay time (from $\overline{\text{CAS}}\uparrow$)	<79> t_{OFF}		0		ns

Remarks 1. $T = t_{\text{CYK}}$

2. w_{RH} : Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

(a) Read timing (high-speed page DRAM access, normal access: off-page) (3/3)



- Remarks**
1. These timings are for the following cases (n = 0 to 3, xx = 00 to 03, 10 to 13):
 - Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
 - Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
 - Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
 2. Broken lines indicate high impedance.
 3. n = 0 to 7

[MEMO]

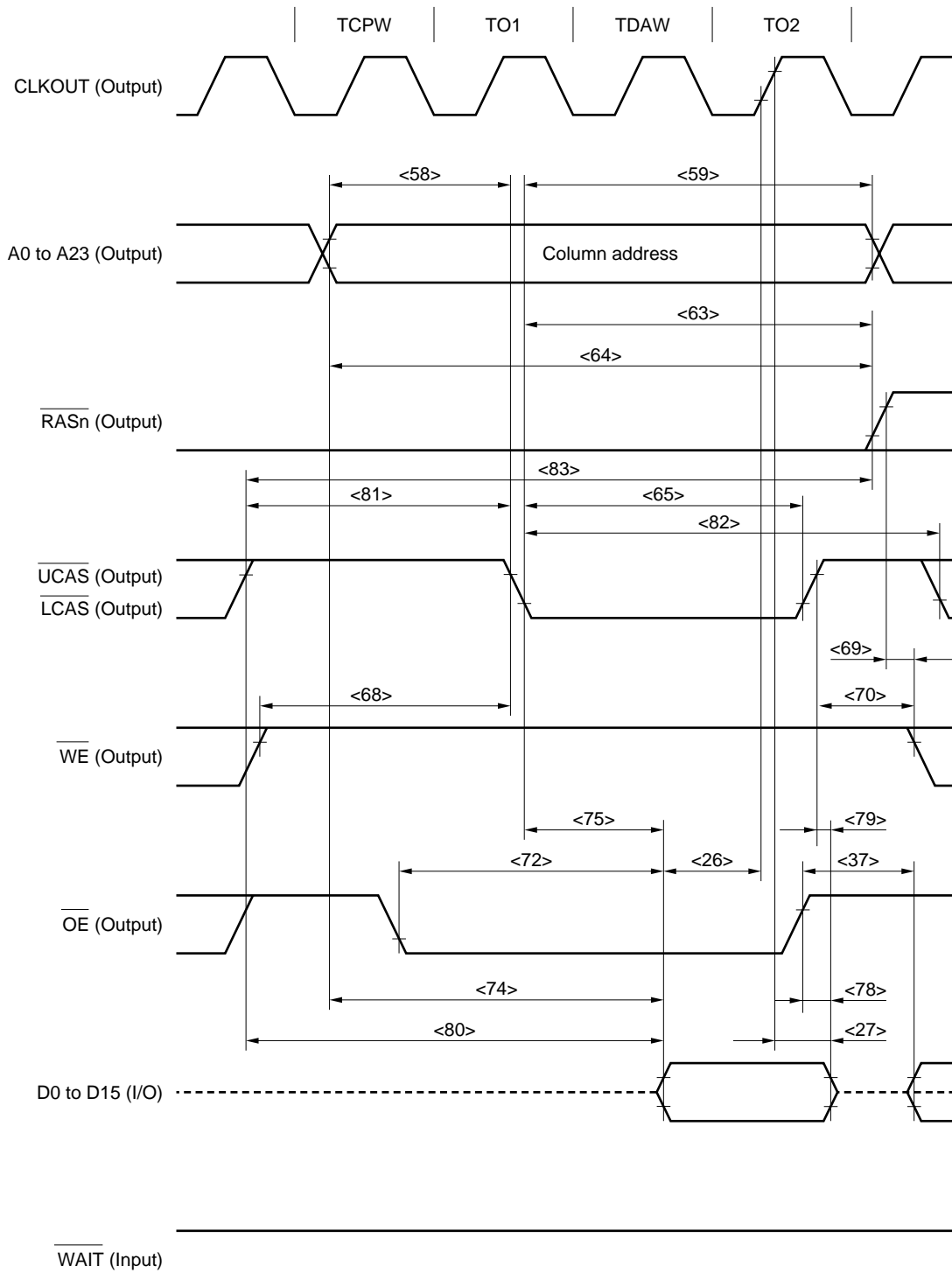
(b) Read timing (high-speed DRAM access: on-page) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Data input setup time (to CLKOUT↑)	<26> t _{SKID}		18		ns
Data input hold time (from CLKOUT↑)	<27> t _{HKID}		2		ns
Delay time from $\overline{OE}\uparrow$ to data output	<37> t _{DRDOD}		$(0.5 + i) T - 10$		ns
Column address setup time	<58> t _{ASC}		$(0.5 + W_{CP}) T - 10$		ns
Column address hold time	<59> t _{CAH}		$(1.5 + W_{DA}) T - 10$		ns
\overline{RAS} hold time	<63> t _{RSH}		$(1.5 + W_{DA}) T - 10$		ns
Column address read time for \overline{RAS}	<64> t _{RAL}		$(2 + W_{CP} + W_{DA}) T - 10$		ns
\overline{CAS} pulse width	<65> t _{CAS}		$(1 + W_{DA}) T - 10$		ns
\overline{WE} setup time (to $\overline{CAS}\downarrow$)	<68> t _{RCS}		$(1 + W_{CP}) T - 10$		ns
\overline{WE} hold time (from $\overline{RAS}\uparrow$)	<69> t _{RRH}		$0.5 T - 10$		ns
\overline{WE} hold time (from $\overline{CAS}\uparrow$)	<70> t _{RCH}		$T - 10$		ns
Output enable access time	<72> t _{OEA}			$(1 + W_{CP} + W_{DA}) T - 28$	ns
Access time from column address	<74> t _{AA}			$(1.5 + W_{CP} + W_{DA}) T - 28$	ns
\overline{CAS} access time	<75> t _{CAC}			$(1 + W_{DA}) T - 28$	ns
Output buffer turn-off delay time (from $\overline{OE}\uparrow$)	<78> t _{OEZ}		0		ns
Output buffer turn-off delay time (from $\overline{CAS}\uparrow$)	<79> t _{OFF}		0		ns
Access time from \overline{CAS} precharge	<80> t _{ACP}			$(2 + W_{CP} + W_{DA}) T - 28$	ns
\overline{CAS} precharge time	<81> t _{CP}		$(1 + W_{CP}) T - 10$		ns
High-speed page mode cycle time	<82> t _{PC}		$(2 + W_{CP} + W_{DA}) T - 10$		ns
\overline{RAS} hold time from \overline{CAS} precharge	<83> t _{RHCP}		$(2.5 + W_{CP} + W_{DA}) T - 10$		ns

Remarks 1. T = t_{cyk}

2. w_{CP}: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
3. w_{DA}: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. i: Number of idle states inserted when a write cycle follows the read cycle.

(b) Read timing (high-speed DRAM access: on-page) (2/2)



- Remarks**
1. These timings are for the following cases ($n = 0$ to 3 , $xx = 00$ to 03 , 10 to 13):
 - Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1
 - Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
 2. Broken lines indicate high impedance.
 3. $n = 0$ to 7

(c) Write timing (high-speed page DRAM access, normal access: off-page) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24>	t _{SWK}	15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25>	t _{HKW}	2		ns
Row address setup time	<56>	t _{ASR}	$(0.5 + \text{WRP}) T - 10$		ns
Row address hold time	<57>	t _{RAH}	$(0.5 + \text{WRH}) T - 10$		ns
Column address setup time	<58>	t _{ASC}	$0.5T - 10$		ns
Column address hold time	<59>	t _{CAH}	$(1.5 + \text{WDA} + w) T - 10$		ns
Read/write cycle time	<60>	t _{RC}	$(3 + \text{WRP} + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{RAS}}$ precharge time	<61>	t _{RP}	$(0.5 + \text{WRP}) T - 10$		ns
$\overline{\text{RAS}}$ pulse time	<62>	t _{RAS}	$(2.5 + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{RAS}}$ hold time	<63>	t _{RSH}	$(1.5 + \text{WDA} + w) T - 10$		ns
Column address read time (from $\overline{\text{RAS}}\uparrow$)	<64>	t _{RAL}	$(2 + \text{WDA} + w) T - 10$		ns
$\overline{\text{CAS}}$ pulse width	<65>	t _{CAS}	$(1 + \text{WDA} + w) T - 10$		ns
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	<66>	t _{CRP}	$(1 + \text{WRH}) T - 10$		ns
$\overline{\text{CAS}}$ hold time	<67>	t _{CSH}	$(2 + \text{WRH} + \text{WDA} + w) T - 10$		ns
$\overline{\text{CAS}}$ precharge time	<71>	t _{CPN}	$(2 + \text{WRP} + \text{WRH}) T - 10$		ns
$\overline{\text{RAS}}$ column address delay time	<76>	t _{RAD}	$(0.5 + \text{WRH}) T - 10$		ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	<77>	t _{RCD}	$(1 + \text{WRH}) T - 10$		ns
$\overline{\text{WE}}$ setup time (to $\overline{\text{CAS}}\downarrow$)	<84>	t _{WCS}	$(1 + \text{WRP} + \text{WRH}) T - 10$		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\downarrow$)	<85>	t _{WCH}	$(1 + \text{WDA} + w) T - 10$		ns
Data setup time (to $\overline{\text{CAS}}\downarrow$)	<86>	t _{DS}	$(1.5 + \text{WRP} + \text{WRH}) T - 10$		ns
Data hold time (from $\overline{\text{CAS}}\downarrow$)	<87>	t _{DH}	$(1.5 + \text{WDA} + w) T - 10$		ns

Remarks 1. T = t_{CYK}

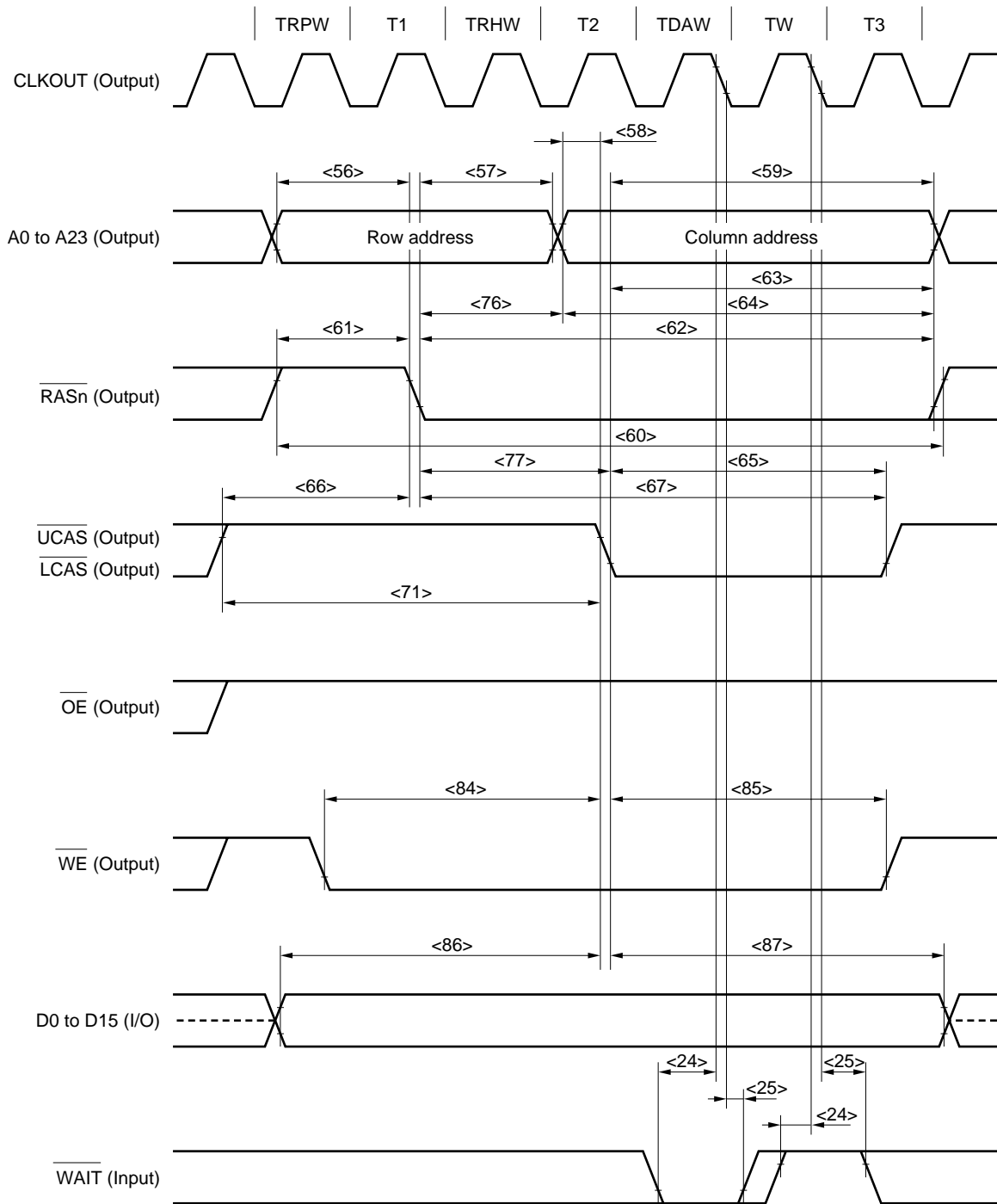
2. w: Number of waits due to $\overline{\text{WAIT}}$

3. WRP: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

4. WRH: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

5. WDA: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

(c) Write timing (high-speed page DRAM access, normal access: off-page) (2/2)



Remarks 1. These timings are for the following cases ($n = 0$ to 3 , $xx = 00$ to 03 , 10 to 13):

- Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
- Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
- Number of waits (TDAW) specified by DACxx bit of register DRCn: 1

2. Broken lines indicate high impedance.

3. $n = 0$ to 7

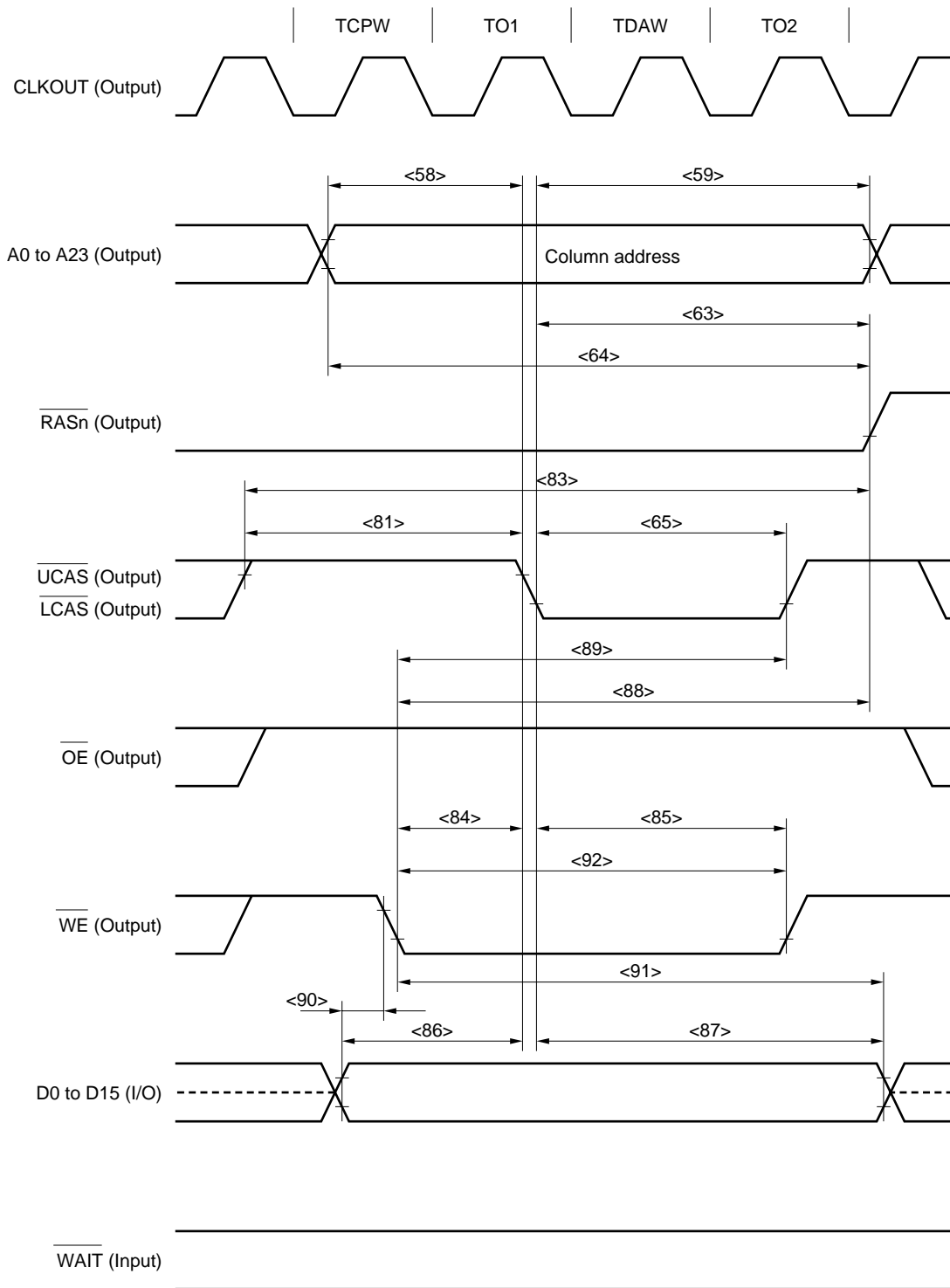
(d) Write timing (high-speed page DRAM access: on-page) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Column address setup time	<58> t _{ASC}		(0.5 + W _{CP}) T - 10		ns
Column address hold time	<59> t _{CAH}		(1.5 + W _{DA}) T - 10		ns
$\overline{\text{RAS}}$ hold time	<63> t _{RSH}		(1.5 + W _{DA}) T - 10		ns
Column address read time (from $\overline{\text{RAS}}\uparrow$)	<64> t _{RAL}		(2 + W _{CP} + W _{DA}) T - 10		ns
$\overline{\text{CAS}}$ pulse width	<65> t _{CAS}		(1 + W _{DA}) T - 10		ns
$\overline{\text{CAS}}$ precharge time	<81> t _{CP}		(1 + W _{CP}) T - 10		ns
$\overline{\text{RAS}}$ hold time for $\overline{\text{CAS}}$ precharge	<83> t _{RHCP}		(2.5 + W _{CP} + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ setup time (to $\overline{\text{CAS}}\downarrow$)	<84> t _{WCS}	W _{CP} ≥ 1	W _{CP} T - 10		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\downarrow$)	<85> t _{WCH}		(1 + W _{DA}) T - 10		ns
Data setup time (to $\overline{\text{CAS}}\downarrow$)	<86> t _{DS}		(0.5 + W _{CP}) T - 10		ns
Data hold time (from $\overline{\text{CAS}}\downarrow$)	<87> t _{DH}		(1.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ read time (from $\overline{\text{RAS}}\uparrow$)	<88> t _{RWL}	W _{CP} = 0	(1.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ read time (from $\overline{\text{CAS}}\uparrow$)	<89> t _{CWL}	W _{CP} = 0	(1 + W _{DA}) T - 10		ns
Data setup time (to $\overline{\text{WE}}\downarrow$)	<90> t _{DSWE}	W _{CP} = 0	0.5T - 10		ns
Data hold time (from $\overline{\text{WE}}\downarrow$)	<91> t _{DHWE}	W _{CP} = 0	(1.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ pulse width	<92> t _{WP}	W _{CP} = 0	(1 + W _{DA}) T - 10		ns

Remarks 1. T = t_{cyk}

- 2. W_{CP}: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
- 3. W_{DA}: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

(d) Write timing (high-speed page DRAM access: on-page) (2/2)



- Remarks**
- These timings are for the following cases ($n = 0$ to 3 , $xx = 00$ to 03 , 10 to 13):
 - Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1
 - Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
 - Broken lines indicate high impedance.
 - $n = 0$ to 7

(e) Read timing (EDO DRAM) (1/3)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Data input setup time (to CLKOUT↑)	<26> tSKID		18		ns
Data input hold time (from CLKOUT↑)	<27> tHKID		2		ns
Delay time from OE↑ to data output	<37> tDRDOD		$(0.5 + i) T - 10$		ns
Row address setup time	<56> tASR		$(0.5 + WRP) T - 10$		ns
Row address hold time	<57> tRAH		$(0.5 + WRH) T - 10$		ns
Column address setup time	<58> tASC		$0.5T - 10$		ns
Column address hold time	<59> tCAH		$(0.5 + WDA) T - 10$		ns
RAS precharge time	<61> tRP		$(0.5 + WRP) T - 10$		ns
Column address read time (to RAS↑)	<64> tRAL		$(2 + WCP + WDA) T - 10$		ns
CAS to RAS precharge time	<66> tCRP		$(1 + WRP) T - 10$		ns
CAS hold time	<67> tCSH		$(1.5 + WRH + WDA) T - 10$		ns
WE setup time (to CAS↓)	<68> tRCS		$(2 + WRP + WRH) T - 10$		ns
WE hold time (from RAS↑)	<69> tRRH		$0.5T - 10$		ns
WE hold time (from CAS↑)	<70> tRCH		$1.5T - 10$		ns
RAS access time	<73> tRAC			$(2 + WRH + WDA) T - 28$	ns
Access time from column address	<74> tAA			$(1.5 + WDA) T - 28$	ns
CAS access time	<75> tCAC			$(1 + WDA) T - 28$	ns
Delay time from RAS to column address	<76> tRAD		$(0.5 + WRH) T - 10$		ns
RAS to CAS delay time	<77> tRCD		$(1 + WRH) T - 10$		ns
Output buffer turn-off delay time (from OE)	<78> tOEZ		0		ns
Access time from CAS precharge	<80> tACP			$(1.5 + WCP + WDA) T - 28$	ns
CAS precharge time	<81> tCP		$(0.5 + WCP) T - 10$		ns
RAS hold time for CAS precharge	<83> tRHCP		$(2 + WCP + WDA) T - 10$		ns
Read cycle time	<93> tHPC		$(1 + WDA + WCP) T - 10$		ns
RAS pulse width	<94> tRASP		$(2.5 + WRH + WDA) T - 10$		ns
CAS pulse width	<95> tHCAS		$(0.5 + WDA) T - 10$		ns
Hold time from OE to CAS	Off-page	<96> tOCH1	$(2 + WRH + WDA) T - 10$		ns
	On-page	<97> tOCH2	$(0.5 + WDA) T - 10$		ns
Data input hold time (from CAS↓)	<98> tDHC		0		ns

Remarks 1. T = tCYK

2. WRP: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
3. WRH: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. WDA: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. WCP: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
6. i: Number of idle states inserted when a write cycle follows the read cycle.

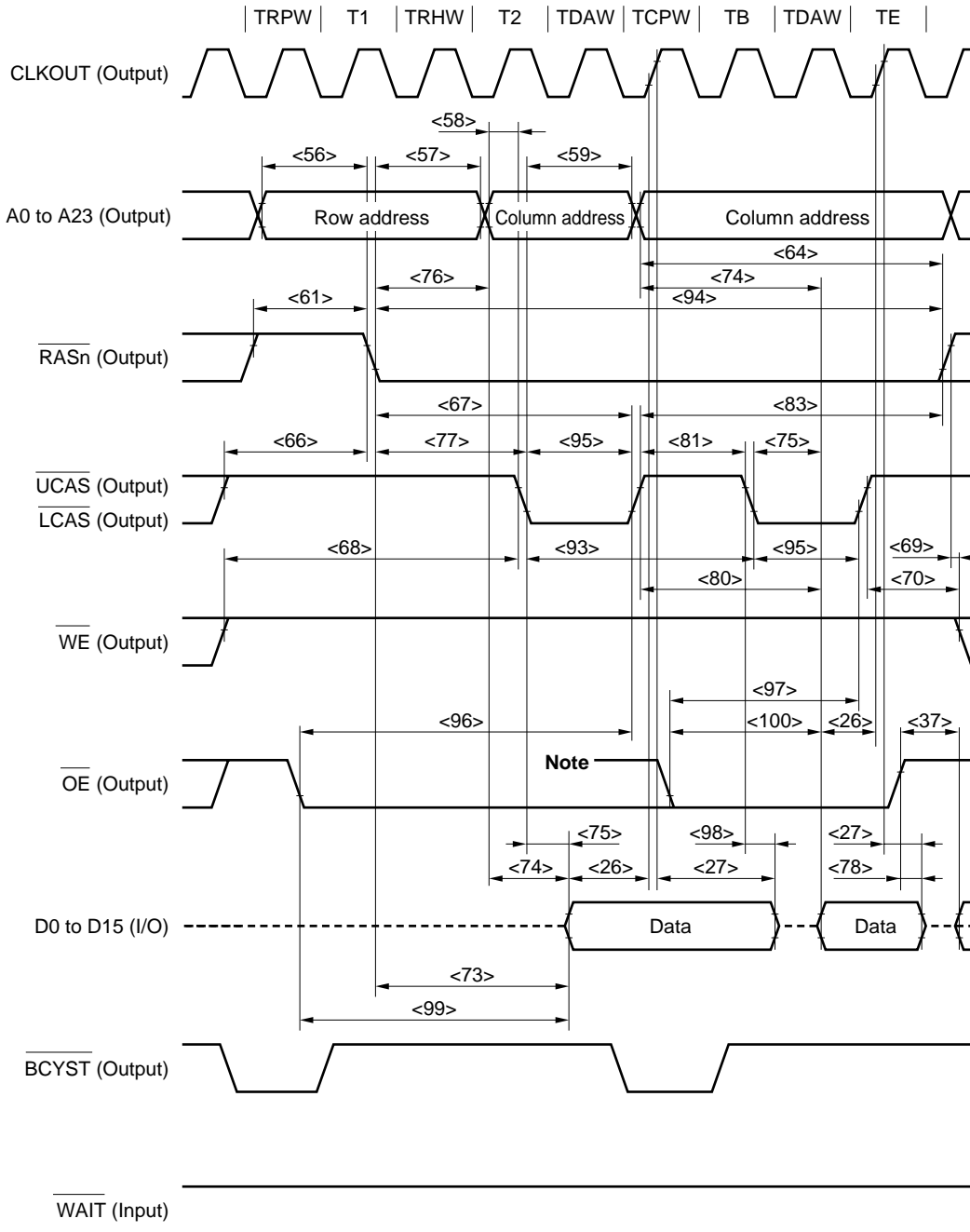
(e) Read timing (EDO DRAM) (2/3)

Parameter		Symbol		Conditions	MIN.	MAX.	Unit
Output enable access time	Off-page	<99>	t _{OE1}			(2 + W _{RP} + W _{RH} + W _{DA}) T - 28	ns
	On-page	<100>	t _{OE2}			(1 + W _{CP} + W _{DA}) T - 28	ns

Remarks 1. T = t_{CYK}

2. W_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
3. W_{RH}: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. W_{DA}: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. W_{CP}: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

(e) Read timing (EDO DRAM) (3/3)



Note In case of on-page access from another cycle, while $\overline{\text{RASn}}$ is low level.

Remarks 1. These timings are for the following cases ($n = 0$ to 3 , $xx = 00$ to 03 , 10 to 13):

- Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
- Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
- Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
- Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1

2. Broken lines indicate high impedance.

3. $n = 0$ to 7

[MEMO]

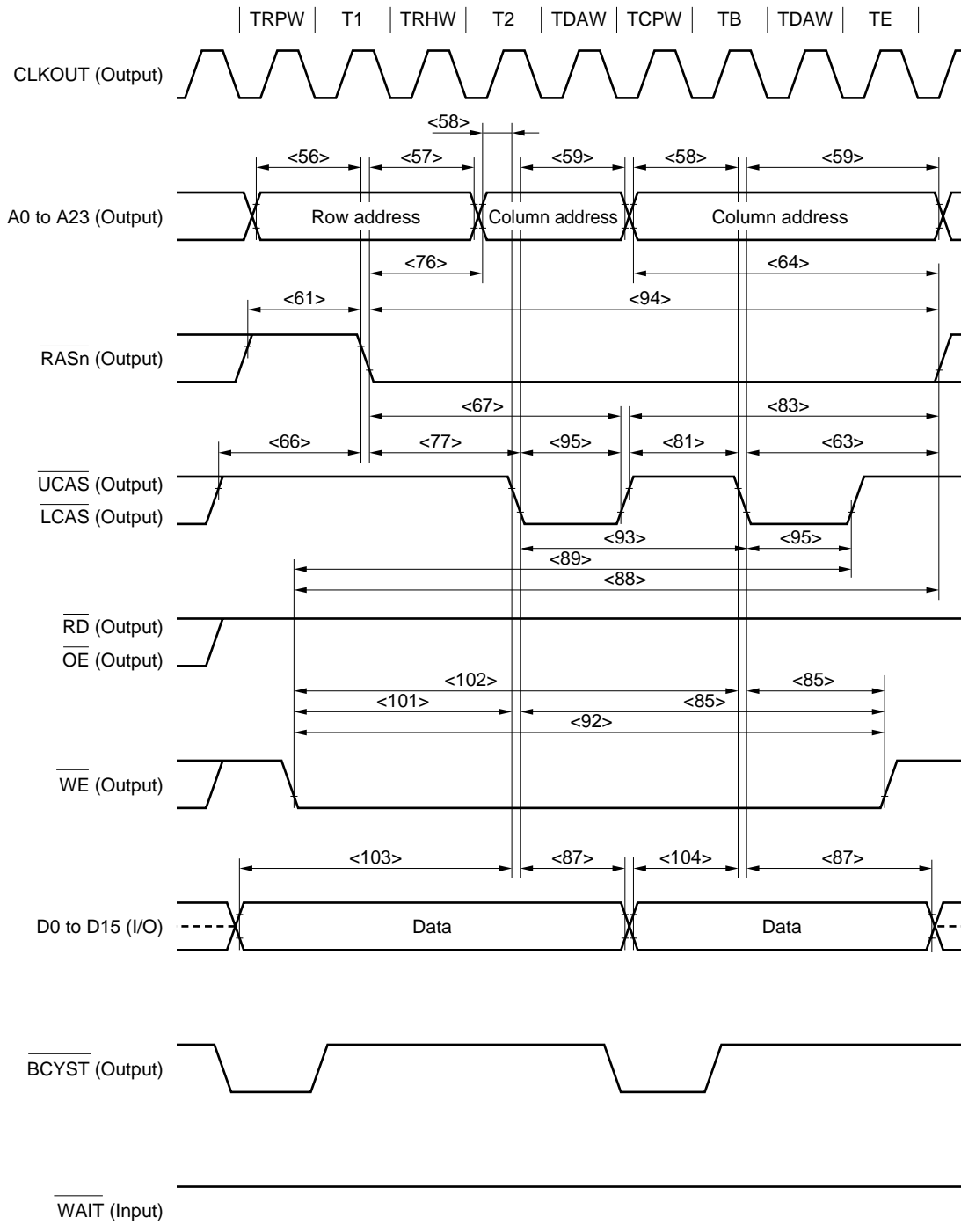
(f) Write timing (EDO DRAM) (1/2)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Row address setup time	<56> t _{ASR}		(0.5 + W _{RP}) T - 10		ns
Row address hold time	<57> t _{RAH}		(0.5 + W _{RH}) T - 10		ns
Column address setup time	<58> t _{ASC}		0.5T - 10		ns
Column address hold time	<59> t _{CAH}		(0.5 + W _{DA}) T - 10		ns
$\overline{\text{RAS}}$ precharge time	<61> t _{RP}		(0.5 + W _{RP}) T - 10		ns
$\overline{\text{RAS}}$ hold time	<63> t _{RSH}		(1.5 + W _{DA}) T - 10		ns
Column address read time (to $\overline{\text{RAS}}\uparrow$)	<64> t _{RAL}		(2 + W _{CP} + W _{DA}) T - 10		ns
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	<66> t _{CRP}		(1 + W _{RP}) T - 10		ns
$\overline{\text{CAS}}$ hold time	<67> t _{CSH}		(1.5 + W _{RH} + W _{DA}) T - 10		ns
Delay time from $\overline{\text{RAS}}$ to column address	<76> t _{RAD}		(0.5 + W _{RH}) T - 10		ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	<77> t _{RCD}		(1 + W _{RH}) T - 10		ns
$\overline{\text{CAS}}$ precharge time	<81> t _{CP}		(0.5 + W _{CP}) T - 10		ns
$\overline{\text{RAS}}$ hold time for $\overline{\text{CAS}}$ precharge	<83> t _{RHCP}		(2 + W _{CP} + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\downarrow$)	<85> t _{WCH}		(1 + W _{DA}) T - 10		ns
Data hold time (from $\overline{\text{CAS}}\downarrow$)	<87> t _{DH}		(0.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ read time (to $\overline{\text{RAS}}\uparrow$)	On-page <88> t _{RWL}	W _{CP} = 0	(1.5 + t _{WDA}) T - 10		ns
$\overline{\text{WE}}$ read time (to $\overline{\text{CAS}}\uparrow$)	On-page <89> t _{CWL}	W _{CP} = 0	(0.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ pulse width	On-page <92> t _{WP}	W _{CP} = 0	(1 + W _{DA}) T - 10		ns
Write cycle time	<93> t _{HPC}		(1 + W _{DA} + W _{CP}) T - 10		ns
$\overline{\text{RAS}}$ pulse width	<94> t _{RASP}		(2.5 + W _{RH} + W _{DA}) T - 10		ns
$\overline{\text{CAS}}$ pulse width	<95> t _{HCAS}		(0.5 + W _{DA}) T - 10		ns
$\overline{\text{WE}}$ setup time (to $\overline{\text{CAS}}\downarrow$)	Off-page <101> t _{WCS1}		(1 + W _{RP} + W _{RH}) T - 10		ns
	On-page <102> t _{WCS2}	W _{CP} ≥ 1	W _{CP} T - 10		ns
Data setup time (to $\overline{\text{CAS}}\downarrow$)	Off-page <103> t _{DS1}		(1.5 + W _{RP} + W _{RH}) T - 10		ns
	On-page <104> t _{DS2}		(0.5 + W _{CP}) T - 10		ns

Remarks 1. T = t_{cyk}

2. W_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
3. W_{RH}: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. W_{DA}: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. W_{CP}: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

(f) Write timing (EDO DRAM) (2/2)



Remarks 1. These timings are for the following cases (n = 0 to 3, xx = 00 to 03, 10 to 13):

- Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
- Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
- Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
- Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1

2. Broken lines indicate high impedance.

3. n = 0 to 7

(g) DMA flyby transfer timing (DRAM (EDO, high-speed page) → external I/O transfer) (1/3)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24>	t _{SWK}	15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25>	t _{HKW}	2		ns
Delay time from $\overline{\text{OE}}\uparrow$ to data output	<37>	t _{DRDOD}	(0.5 + i) T – 10		ns
Delay time from address to $\overline{\text{TOWR}}\downarrow$	<41>	t _{DAWR}	(0.5 + WRP) T – 10		ns
Address setup time (to $\overline{\text{IOWR}}\uparrow$)	<42>	t _{SAWR}	(2 + WRP + WRH + WDA + w) T – 10		ns
Delay time from $\overline{\text{IOWR}}\uparrow$ to address	<43>	t _{DWRA}	0.5T – 10		ns
Delay time from $\overline{\text{IOWR}}\uparrow$ to $\overline{\text{RD}}\uparrow$	<48>	t _{DWRRD}	WF = 0	0	ns
			WF = 1	T – 10	ns
$\overline{\text{IOWR}}$ low-level width	<50>	t _{WWRL}	(2 + WRH + WDA + w) T – 10		ns
Row address setup time	<56>	t _{ASR}	(0.5 + WRP) T – 10		ns
Row address hold time	<57>	t _{RAH}	(0.5 + WRH) T – 10		ns
Column address setup time	<58>	t _{ASC}	0.5T – 10		ns
Column address hold time	<59>	t _{CAH}	(1.5 + WDA + WF + w) T – 10		ns
Read/write cycle time	<60>	t _{RC}	(3 + WRP + WRH + WDA + WF + w) T – 10		ns
$\overline{\text{RAS}}$ precharge time	<61>	t _{RP}	(0.5 + WRP) T – 10		ns
$\overline{\text{RAS}}$ hold time	<63>	t _{RSH}	(1.5 + WDA + WF + w) T – 10		ns
Column address read time for $\overline{\text{RAS}}$	<64>	t _{RAL}	(2 + WCP + WDA + WF + w) T – 10		ns
$\overline{\text{CAS}}$ pulse width	<65>	t _{CAS}	(1 + WDA + WF + w) T – 10		ns
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	<66>	t _{CRP}	(1 + WRP) T – 10		ns
$\overline{\text{CAS}}$ hold time	<67>	t _{CSH}	(2 + WRH + WDA + WF + w) T – 10		ns
$\overline{\text{WE}}$ setup time (to $\overline{\text{CAS}}\downarrow$)	<68>	t _{RCS}	(2 + WRP + WRH) T – 10		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{RAS}}\uparrow$)	<69>	t _{RRH}	0.5T – 10		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\uparrow$)	<70>	t _{RCH}	1.5T – 10		ns
$\overline{\text{CAS}}$ precharge time	<71>	t _{CPN}	(2 + WRP + WRH) T – 10		ns
$\overline{\text{RAS}}$ column address delay time	<76>	t _{RAD}	(0.5 + WRH) T – 10		ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	<77>	t _{RCD}	(1 + WRH) T – 10		ns

Remarks 1. T = t_{cyk}

2. w: Number of waits due to $\overline{\text{WAIT}}$
3. WRP: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. WRH: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. WDA: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
6. WCP: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
7. WF: Number of waits inserted to source-side access during DMA flyby transfer
8. i: Number of idle states inserted when a write cycle follows the read cycle.

(g) DMA flyby transfer timing (DRAM (EDO, high-speed page) → external I/O transfer) (2/3)

Parameter		Symbol	Conditions	MIN.	MAX.	Unit
Output buffer turn-off delay time (from $\overline{OE}\uparrow$)		<78>	toEZ	0		ns
Output buffer turn-off delay time (from $\overline{CAS}\uparrow$)		<79>	toFF	0		ns
\overline{CAS} precharge time		<81>	tCP	$(0.5 + w_{CP}) T - 10$		ns
High-speed mode cycle time		<82>	tPC	$(2 + w_{CP} + w_{DA} + w_F + w) T - 10$		ns
\overline{RAS} hold time for \overline{CAS} precharge		<83>	trHCP	$(2.5 + w_{CP} + w_{DA} + w_F + w) T - 10$		ns
\overline{RAS} pulse width		<94>	trASP	$(2.5 + w_{RH} + w_{DA} + w_F + w) T - 10$		ns
Hold time from \overline{OE} to \overline{CAS} (from $\overline{CAS}\uparrow$)	Off-page	<96>	toCH1	$(2.5 + w_{RP} + w_{RH} + w_{DA} + w_F + w) T - 10$		ns
	On-page	<97>	toCH2	$(1.5 + w_{CP} + w_{DA} + w_F + w) T - 10$		ns
Delay time from $\overline{DMAAKm}\downarrow$ to $\overline{CAS}\downarrow$		<105>	tdDACS	$(1.5 + w_{RH}) T - 10$		ns
Delay time from $\overline{IOWR}\downarrow$ to $\overline{CAS}\downarrow$		<106>	tdRDCS	$(1 + w_{RH}) T - 10$		ns

Remarks 1. $T = t_{CYK}$

2. w : Number of waits due to \overline{WAIT}

3. w_{CP} : Number of waits specified by CPCxx bit of register DRCn ($n = 0$ to 3, $xx = 00$ to 03, 10 to 13)

4. w_{DA} : Number of waits specified by DACxx bit of register DRCn ($n = 0$ to 3, $xx = 00$ to 03, 10 to 13)

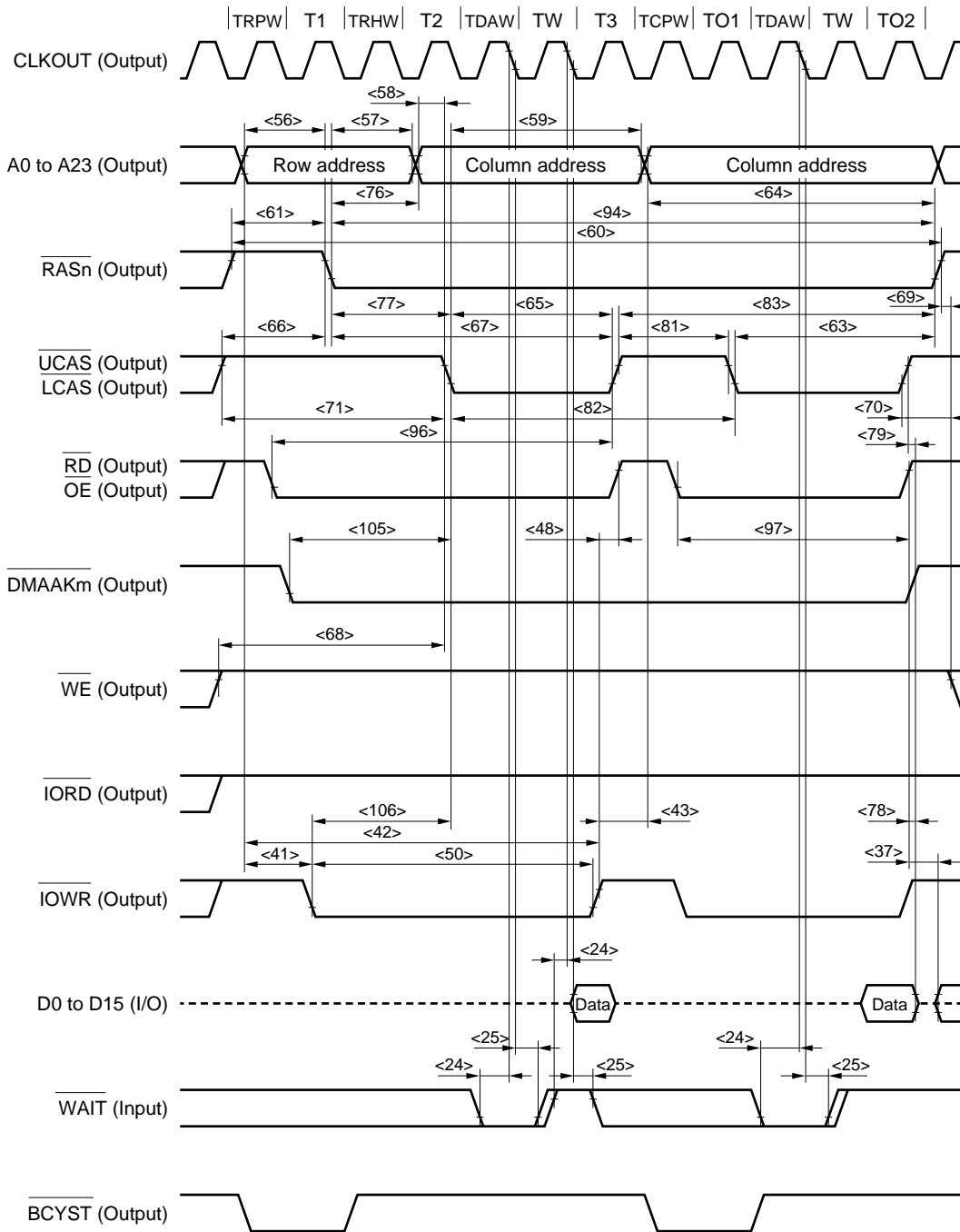
5. w_{RH} : Number of waits specified by RHCxx bit of register DRCn ($n = 0$ to 3, $xx = 00$ to 03, 10 to 13)

6. w_{RP} : Number of waits specified by RPCxx bit of register DRCn ($n = 0$ to 3, $xx = 00$ to 03, 10 to 13)

7. w_F : Number of waits inserted to source-side access during DMA flyby transfer

8. $m = 0$ to 3

(g) DMA flyby transfer timing (DRAM (EDO, high-speed page) → external I/O transfer) (3/3)



Remarks 1. These timings are for the following cases (n = 0 to 3, xx = 00 to 03, 10 to 13):

- Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
- Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
- Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
- Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1
- Number of waits inserted to source-side access during DMA flyby transfer: 0

2. Broken lines indicate high impedance.

3. n = 0 to 7, m = 0 to 3

(h) DMA flyby transfer timing (external I/O → DRAM (EDO, high-speed page) transfer) (1/3)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{WAIT}}$ setup time (to CLKOUT↓)	<24>	t _{SWK}	15		ns
$\overline{\text{WAIT}}$ hold time (from CLKOUT↓)	<25>	t _{HKW}	2		ns
$\overline{\text{IORD}}$ low-level width	<32>	t _{WRDL}	$(2 + \text{WRH} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns
$\overline{\text{IORD}}$ high-level width	<33>	t _{WRDH}	$T - 10$		ns
Delay time from address to $\overline{\text{IORD}}\uparrow$	<34>	t _{DARD}	$0.5T - 10$		ns
Delay time from $\overline{\text{IORD}}\uparrow$ to address	<35>	t _{DRDA}	$(0.5 + i) T - 10$		ns
Row address setup time	<56>	t _{ASR}	$(0.5 + \text{WRP}) T - 10$		ns
Row address hold time	<57>	t _{RAH}	$(0.5 + \text{WRH}) T - 10$		ns
Column address setup time	<58>	t _{ASC}	$0.5T - 10$		ns
Column address hold time	<59>	t _{CAH}	$(1.5 + \text{WDA} + \text{WF}) T - 10$		ns
Read/write cycle time	<60>	t _{RC}	$(3 + \text{WRP} + \text{WRH} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns
$\overline{\text{RAS}}$ precharge time	<61>	t _{RP}	$(0.5 + \text{WRP}) T - 10$		ns
$\overline{\text{RAS}}$ hold time	<63>	t _{RSH}	$(1.5 + \text{WDA} + \text{WF}) T - 10$		ns
Column address read time for $\overline{\text{RAS}}$	<64>	t _{RAL}	$(2 + \text{WCP} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns
$\overline{\text{CAS}}$ pulse width	<65>	t _{CAS}	$(1 + \text{WDA} + \text{WF}) T - 10$		ns
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	<66>	t _{CRP}	$(1 + \text{WRP}) T - 10$		ns
$\overline{\text{CAS}}$ hold time	<67>	t _{CSH}	$(2 + \text{WRH} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns
$\overline{\text{CAS}}$ precharge time	<71>	t _{CPN}	$(2 + \text{WRP} + \text{WRH} + \text{w}) T - 10$		ns
$\overline{\text{RAS}}$ column address delay time	<76>	t _{RAD}	$(0.5 + \text{WRH}) T - 10$		ns
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	<77>	t _{RCD}	$(1 + \text{WRH} + \text{w}) T - 10$		ns
$\overline{\text{CAS}}$ precharge time	<81>	t _{CP}	$(0.5 + \text{WCP} + \text{w}) T - 10$		ns
High-speed page mode cycle time	<82>	t _{PC}	$(2 + \text{WCP} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns
$\overline{\text{RAS}}$ hold time for $\overline{\text{CAS}}$ precharge	<83>	t _{RHCP}	$(2.5 + \text{WCP} + \text{WDA} + \text{w}) T - 10$		ns
$\overline{\text{WE}}$ hold time (from $\overline{\text{CAS}}\downarrow$)	<85>	t _{WCH}	$(1 + \text{WDA}) T - 10$		ns
$\overline{\text{WE}}$ read time (to $\overline{\text{RAS}}\uparrow$)	<88>	t _{RWL}	$\text{WCP} = 0$ $(1.5 + \text{WDA} + \text{w}) T - 10$		ns
$\overline{\text{WE}}$ read time (to $\overline{\text{CAS}}\uparrow$)	<89>	t _{CWL}	$\text{WCP} = 0$ $(1 + \text{WDA} + \text{w}) T - 10$		ns
$\overline{\text{WE}}$ pulse width	<92>	t _{WP}	$\text{WCP} = 0$ $(1 + \text{WDA} + \text{w}) T - 10$		ns
$\overline{\text{RAS}}$ pulse width	<94>	t _{RASP}	$(2.5 + \text{WRH} + \text{WDA} + \text{WF} + \text{w}) T - 10$		ns

Remarks 1. T = t_{CYK}

2. w: Number of waits due to $\overline{\text{WAIT}}$

3. WRH: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

4. WDA: Number of waits specified by DACxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

5. WRP: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

6. WCP: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

7. WF: Number of waits inserted to source-side access during DMA flyby transfer.

8. i: Number of idle states inserted when a write cycle follows the read cycle.

9. n = 0 to 7

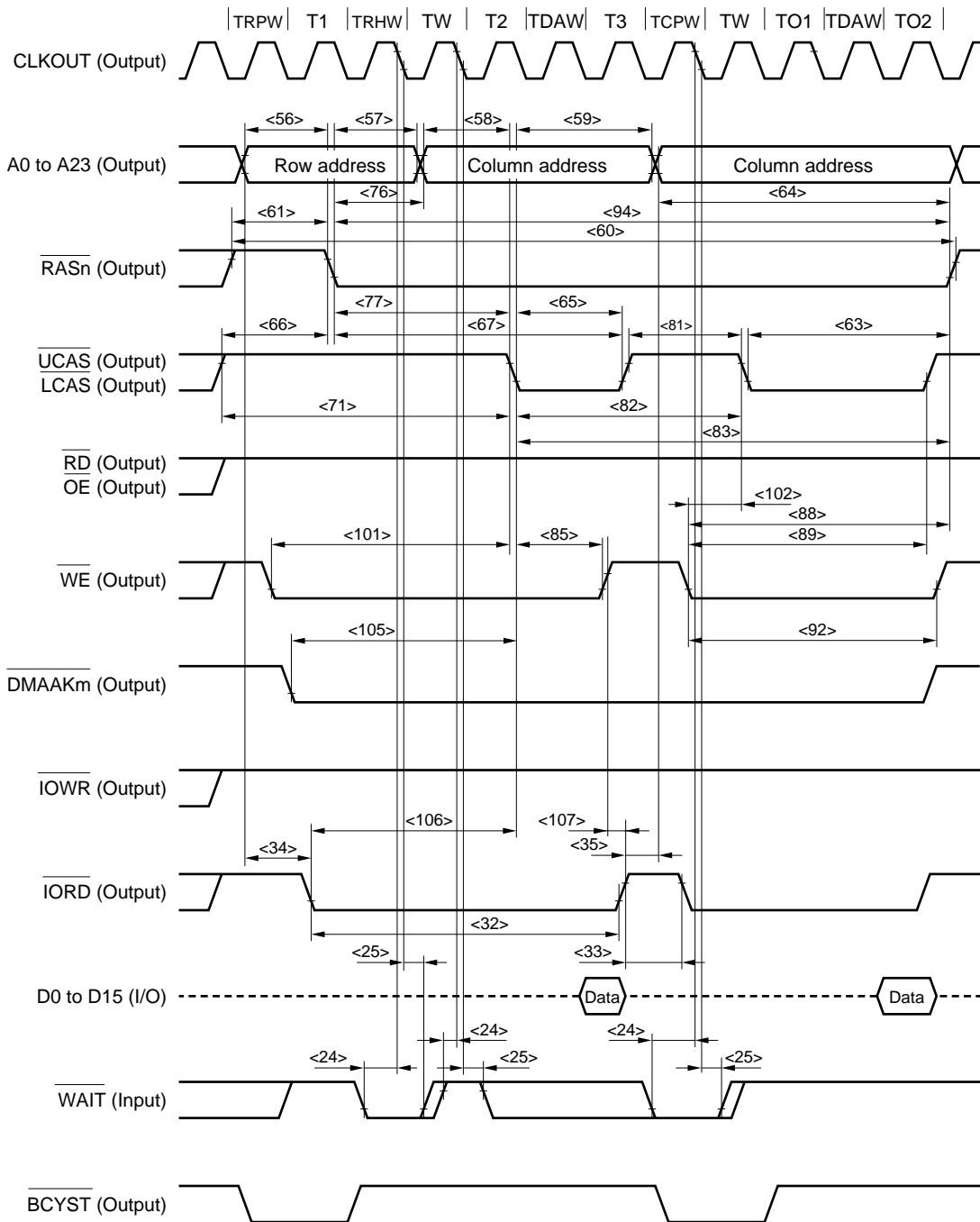
(h) DMA flyby transfer timing (external I/O → DRAM (EDO, high-speed page) transfer) (2/3)

Parameter		Symbol		Conditions	MIN.	MAX.	Unit
WE setup time (to CAS↓)	Off-page	<101>	tWCS1	WCP = 0	$(1 + W_{RH} + W_{RP} + w) T - 10$		ns
	On-page	<102>	tWCS2	WCP ≥ 1	$W_{CP}T - 10$		ns
Delay time from DMAAKm↓ to CAS↓		<105>	tDACS		$(1.5 + W_{RH} + w) T - 10$		ns
Delay time from IORD↓ to CAS↓		<106>	tDRDCS		$(1 + W_{RH} + w) T - 10$		ns
Delay time from WE↑ to IORD↑		<107>	tDWERD	WF = 0	0		ns
				WF = 1	$T - 10$		ns

Remarks 1. T = t_{cyk}

2. w: Number of waits due to WAIT
3. w_{RH}: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
4. w_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
5. w_{CP}: Number of waits specified by CPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)
6. w_F: Number of waits inserted to source-side access during DMA flyby transfer
7. m = 0 to 3

(h) DMA flyby transfer timing (external I/O → DRAM (EDO, high-speed page) transfer) (3/3)



- Remarks 1.** These timings are for the following cases ($n = 0$ to 3 , $xx = 00$ to 03 , 10 to 13):
- Number of waits (TRPW) specified by RPCxx bit of register DRCn: 1
 - Number of waits (TRHW) specified by RHCxx bit of register DRCn: 1
 - Number of waits (TDAW) specified by DACxx bit of register DRCn: 1
 - Number of waits (TCPW) specified by CPCxx bit of register DRCn: 1
 - Number of waits inserted to source-side access during DMA flyby transfer: 0
- 2.** Broken lines indicate high impedance.
- 3.** $n = 0$ to 7 , $m = 0$ to 3

(i) CBR refresh timing

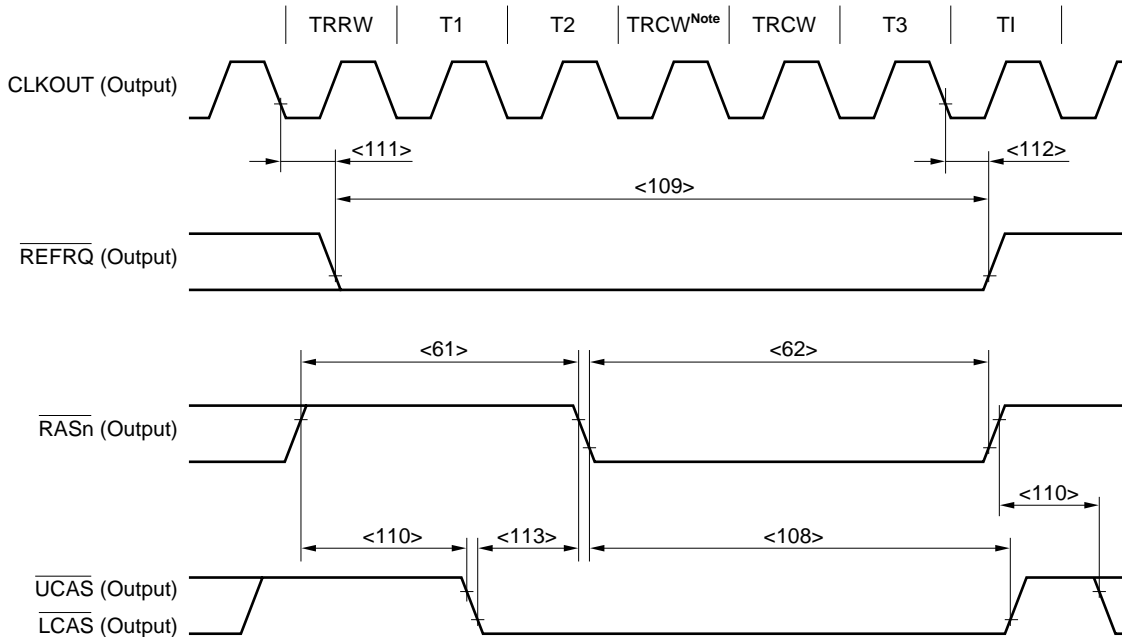
Parameter	Symbol	Conditions	MIN.	MAX.	Unit
RAS precharge time	<61> t _{RP}		$(1.5 + W_{RRW}) T - 10$		ns
RAS pulse width	<62> t _{RAS}		$(1.5 + W_{RCW}^{Note}) T - 10$		ns
CAS hold time	<108> t _{CHR}		$(1.5 + W_{RCW}^{Note}) T - 10$		ns
REFRQ pulse width	<109> t _{WRFL}		$(3 + W_{RRW} + W_{RCW}^{Note}) T - 10$		ns
RAS precharge CAS hold time	<110> t _{RPC}		$(0.5 + W_{RRW}) T - 10$		ns
REFRQ active delay time (from CLKOUT↓)	<111> t _{DKRF}		2	10	ns
REFRQ inactive delay time (from CLKOUT↓)	<112> t _{HKRF}		2	10	ns
CAS setup time	<113> t _{CSR}		$T - 10$		ns

Note W_{RCW} is inserted for at least 1 clock, regardless of the setting of bits RCW0 to RCW2 of register RWC.

Remarks 1. T = t_{CYK}

2. W_{RRW}: Number of waits specified by bits RRW0 and RRW1 of register RWC

3. W_{RCW}: Number of waits specified by bits RCW0 to RCW2 of register RWC.



Note This TRCW is always inserted, regardless of the setting of bits RCW0 to RCW2 of register RWC.

Remarks 1. These timings are for the following cases:

Number of waits (TRRW) specified by bits RRW0 and RRW1 of register RWC: 1

Number of waits (TRCW) specified by bits RCW0 to RCW2 of register RWC: 2

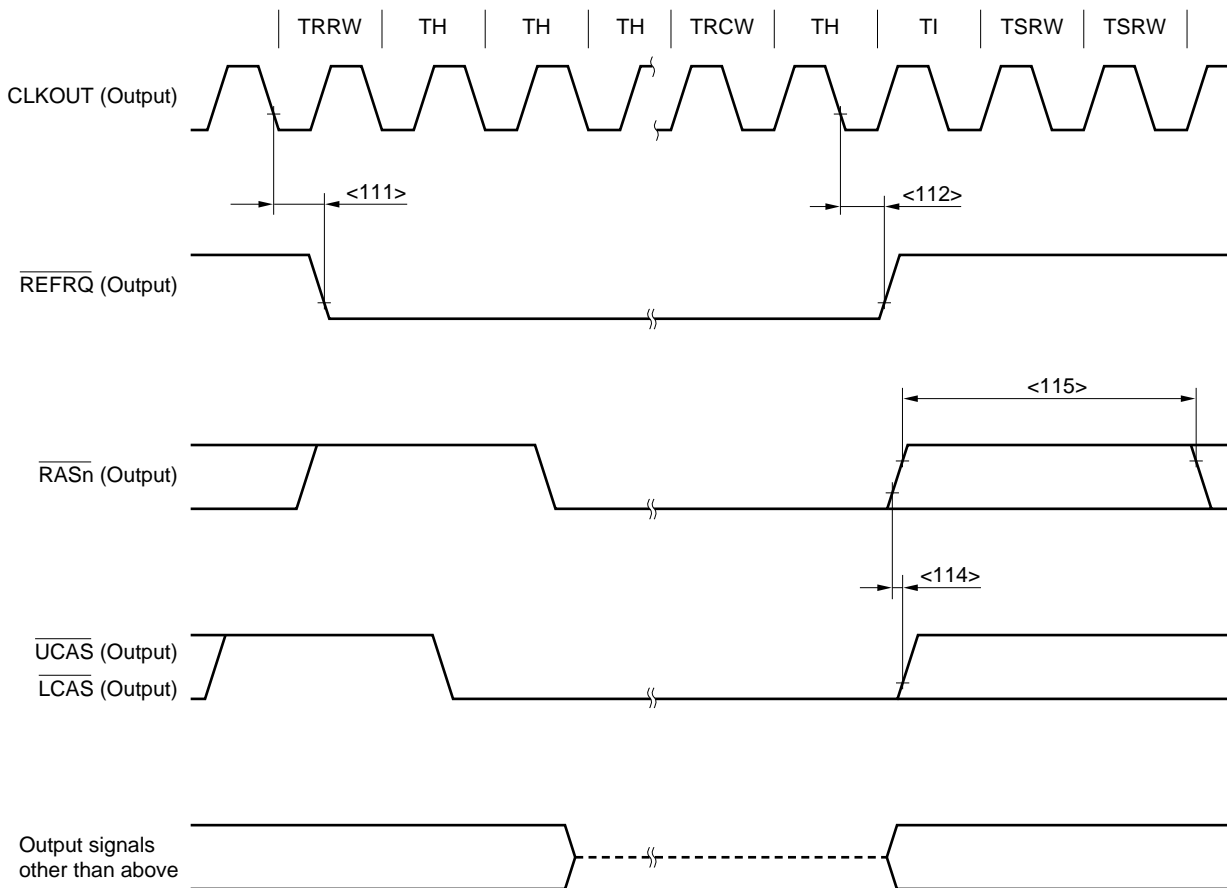
2. n = 0 to 7

(j) CBR self refresh timing

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{REFRQ}}$ active delay time (from CLKOUT↓)	<111> t_{DKRF}		2	10	ns
$\overline{\text{REFRQ}}$ inactive delay time (from CLKOUT↓)	<112> t_{HKRF}		2	10	ns
$\overline{\text{CAS}}$ hold time	<114> t_{CHS}		-5		ns
$\overline{\text{RAS}}$ precharge time	<115> t_{RPS}		$(1 + 2W_{\text{SRW}}) T - 10$		ns

Remarks 1. $T = t_{\text{CYK}}$

2. W_{SRW} : Number of waits specified by bits SRW0 to SRW2 of register RWC.



Remarks 1. These timings are for the following cases:

Number of waits (TRRW) specified by bits RRW0 and RRW1 of register RWC: 1

Number of waits (TRCW) specified by bits RCW0 to RCW2 of register RWC: 1

Number of waits (TSRW) specified by bits SRW0 to SRW2 of register RWC: 2

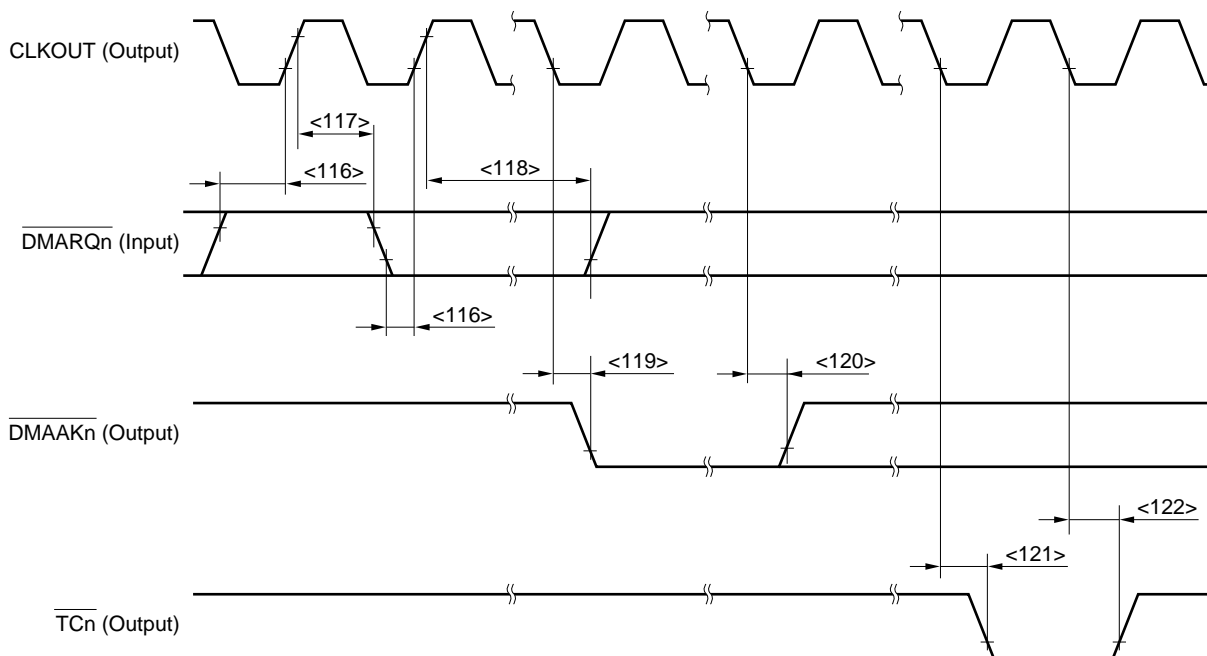
2. Broken lines indicate high impedance.

3. $n = 0$ to 7

(7) DMAC timing

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{DMARQn}}$ setup time (to CLKOUT↑)	<116> t_{SDRK}		15		ns
$\overline{\text{DMARQn}}$ hold time (from CLKOUT↑)	<117> t_{HKDR1}		2		ns
	<118> t_{HKDR2}	Until $\overline{\text{DMAAKn}}\downarrow$			ns
$\overline{\text{DMAAKn}}$ output delay time (from CLKOUT↓)	<119> t_{DKDA}		2	10	ns
$\overline{\text{DMAAKn}}$ output hold time (from CLKOUT↓)	<120> t_{HKDA}		2	10	ns
$\overline{\text{TCn}}$ output delay time (from CLKOUT↓)	<121> t_{DKTC}		2	10	ns
$\overline{\text{TCn}}$ output hold time (from CLKOUT↓)	<122> t_{HKTC}		2	10	ns

Remark n = 0 to 3



Remark n = 0 to 3

[MEMO]

(8) Bus hold timing (1/2)

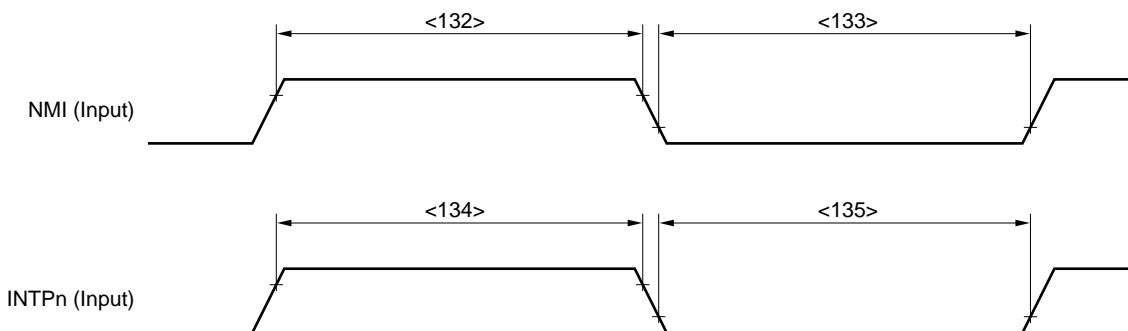
Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{HLDRQ}}$ setup time (to CLKOUT↑)	<123> t _{SHRK}		15		ns
$\overline{\text{HLDRQ}}$ hold time (from CLKOUT↑)	<124> t _{HKHR}		2		ns
Delay time from CLKOUT↓ to $\overline{\text{HLDAK}}$	<125> t _{DKHA}		2	10	ns
$\overline{\text{HLDRQ}}$ high-level width	<126> t _{WHQH}		T + 17		ns
$\overline{\text{HLDAK}}$ low-level width	<127> t _{WHAL}		T - 8		ns
Delay time from CLKOUT↓ to bus float	<128> t _{DKCF}			10	ns
Delay time from $\overline{\text{HLDAK}}$ ↑ to bus output	<129> t _{DHAC}		0		ns
Delay time from $\overline{\text{HLDRQ}}$ ↓ to $\overline{\text{HLDAK}}$ ↓	<130> t _{DHQHA1}		2.5T		ns
Delay time from $\overline{\text{HLDRQ}}$ ↑ to $\overline{\text{HLDAK}}$ ↑	<131> t _{DHQHA2}		0.5T	1.5T	ns

Remark T = t_{cyk}

(9) Interrupt timing

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
NMI high-level width	<132> t_{WNIH}		500		ns
NMI low-level width	<133> t_{WNIL}		500		ns
INTPn high-level width	<134> t_{WITH}		$4T + 10$		ns
INTPn low-level width	<135> t_{WTIL}		$4T + 10$		ns

- Remarks**
- n = 100 to 103, 110 to 113, 120 to 123, 130 to 133, 140 to 143, and 150 to 153
 - T = t_{CYK}

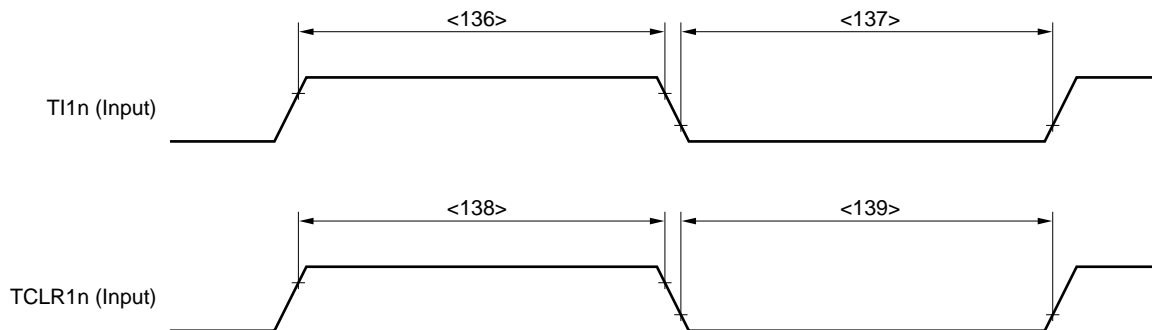


Remark n = 100 to 103, 110 to 113, 120 to 123, 130 to 133, 140 to 143, and 150 to 153

(10) RPU timing

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
T11n high-level width	<136> t_{WTIH}		$3T + 18$		ns
T11n low-level width	<137> t_{WTIL}		$3T + 18$		ns
TCLR1n high-level width	<138> t_{WTCH}		$3T + 18$		ns
TCLR1n low-level width	<139> t_{WTCL}		$3T + 18$		ns

- Remarks**
- n = 0 to 5
 - T = t_{CYK}

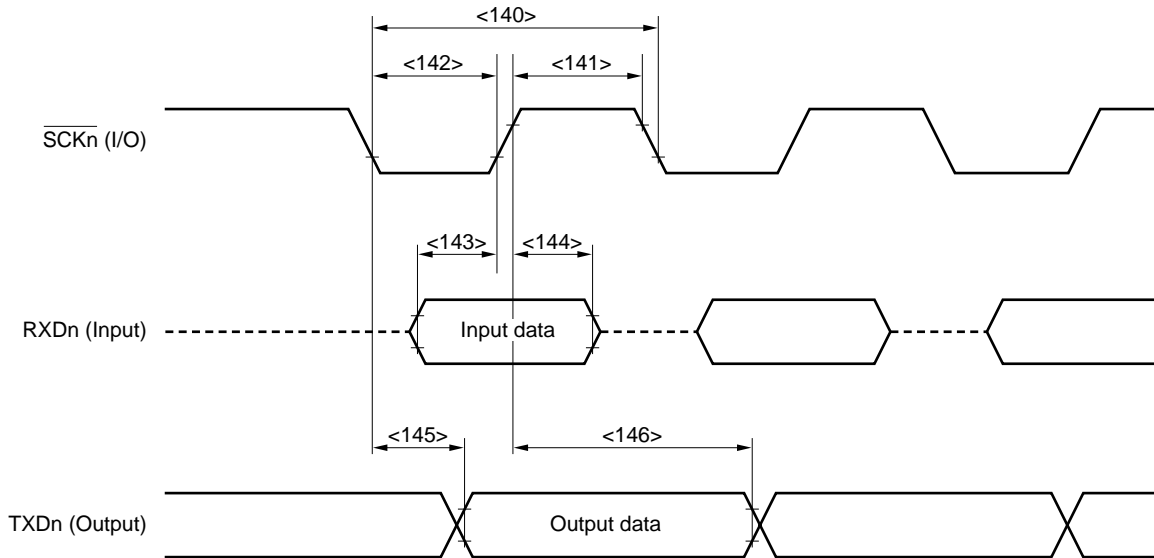


Remark n = 0 to 5

(11) UART0, UART1 timing (synchronized with clock, master mode only)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
$\overline{\text{SCKn}}$ cycle	<140> t_{CYSK0}	Output	250		ns
$\overline{\text{SCKn}}$ high-level width	<141> t_{WSK0H}	Output	$0.5t_{\text{CYSK0}} - 20$		ns
$\overline{\text{SCKn}}$ low-level width	<142> t_{WSK0L}	Output	$0.5t_{\text{CYSK0}} - 20$		ns
RxDn setup time (to $\overline{\text{SCKn}}\uparrow$)	<143> t_{SRXSK}		30		ns
RxDn hold time (from $\overline{\text{SCKn}}\uparrow$)	<144> t_{HSKRX}		0		ns
TxDn output delay time (from $\overline{\text{SCKn}}\downarrow$)	<145> t_{DSKTX}			20	ns
TxDn output hold time (from $\overline{\text{SCKn}}\uparrow$)	<146> t_{HSTX}		$0.5t_{\text{CYSK0}} - 5$		ns

Remark n = 0, 1



- Remarks
1. Broken lines indicate high impedance.
 2. n = 0, 1

(12) CSI0 to CSI3 timing

(a) Master mode

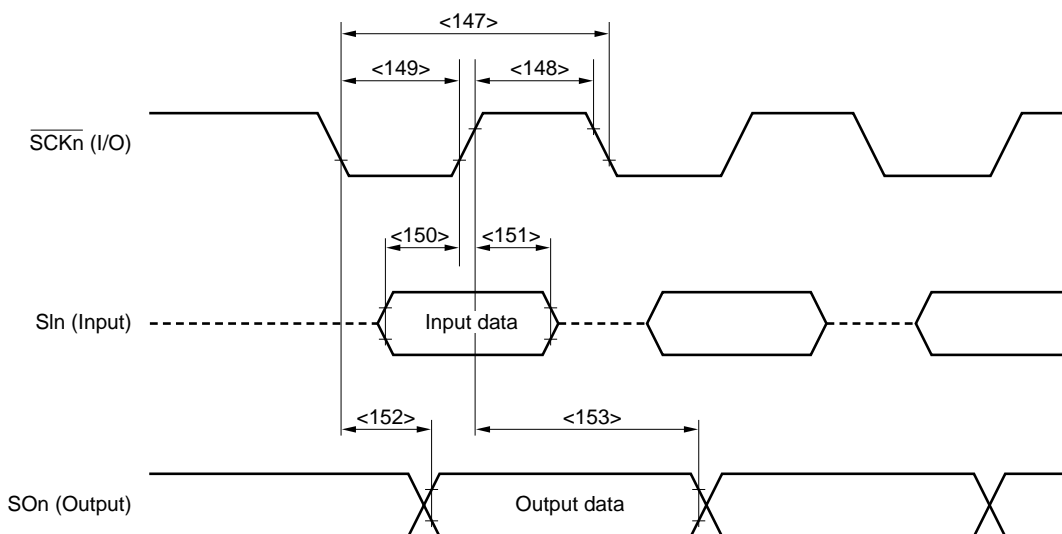
Parameter	Symbol	Conditions	MIN.	MAX.	Unit
\overline{SCKn} cycle	<147> t_{CYSK1}	Output	100		ns
\overline{SCKn} high-level width	<148> t_{WSK1H}	Output	$0.5t_{CYSK1} - 20$		ns
\overline{SCKn} low-level width	<149> t_{WSK1L}	Output	$0.5t_{CYSK1} - 20$		ns
SIn setup time (to $\overline{SCKn}\uparrow$)	<150> t_{SSISK}		30		ns
SIn hold time (from $\overline{SCKn}\uparrow$)	<151> t_{HSKSI}		0		ns
SOn output delay time (from $\overline{SCKn}\downarrow$)	<152> t_{DSKSO}			20	ns
SOn output hold time (from $\overline{SCKn}\uparrow$)	<153> t_{HSKSO}		$0.5t_{CYSK1} - 5$		ns

Remark n = 0 to 3

(b) Slave mode

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
\overline{SCKn} cycle	<147> t_{CYSK1}	Input	100		ns
\overline{SCKn} high-level width	<148> t_{WSK1H}	Input	30		ns
\overline{SCKn} low-level width	<149> t_{WSK1L}	Input	30		ns
SIn setup time (to $\overline{SCKn}\uparrow$)	<150> t_{SSISK}		10		ns
SIn hold time (from $\overline{SCKn}\uparrow$)	<151> t_{HSKSI}		10		ns
SOn output delay time (from $\overline{SCKn}\downarrow$)	<152> t_{DSKSO}			30	ns
SOn output hold time (from $\overline{SCKn}\uparrow$)	<153> t_{HSKSO}		t_{WSK1H}		ns

Remark n = 0 to 3



Remarks 1. Broken lines indicate high impedance.

2. n = 0 to 3

A/D Converter Characteristics ($T_A = -40$ to $+85^\circ\text{C}$, $V_{DD} = CV_{DD} = 3.0$ to 3.6 V, $HV_{DD} = 5.0$ V $\pm 10\%$,
 $V_{SS} = 0$ V, $HV_{DD} - 0.5$ V $\leq AV_{DD} \leq HV_{DD}$, Output Pin Load Capacitance: $C_L = 50$ pF)

★

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution	–		10			bit
Overall error	–				± 4	LSB
Quantization error	–				$\pm 1/2$	LSB
Conversion time	t_{CONV}		5		10	μs
Sampling time	t_{SAMP}		833			ns
Zero scale error	–				± 2	LSB
Scale error	–				± 2	LSB
Linearity error	–				± 1	LSB
Analog input voltage	V_{IAN}		-0.3		$AV_{REF} + 0.3$	V
Analog input resistance	R_{AN}			2		$M\Omega$
AV_{REF} input voltage	AV_{REF}	$AV_{REF} = AV_{DD}$	4.5		5.5	V
AV_{REF} input current	AI_{REF}				1.6	mA
AV_{DD} current	AI_{DD}				6	mA

4.2 Flash Memory Programming Mode

★ Basic Characteristics (T_A = 10 to 40°C (When Rewriting), T_A = -40 to +85°C (Other Than When Rewriting))

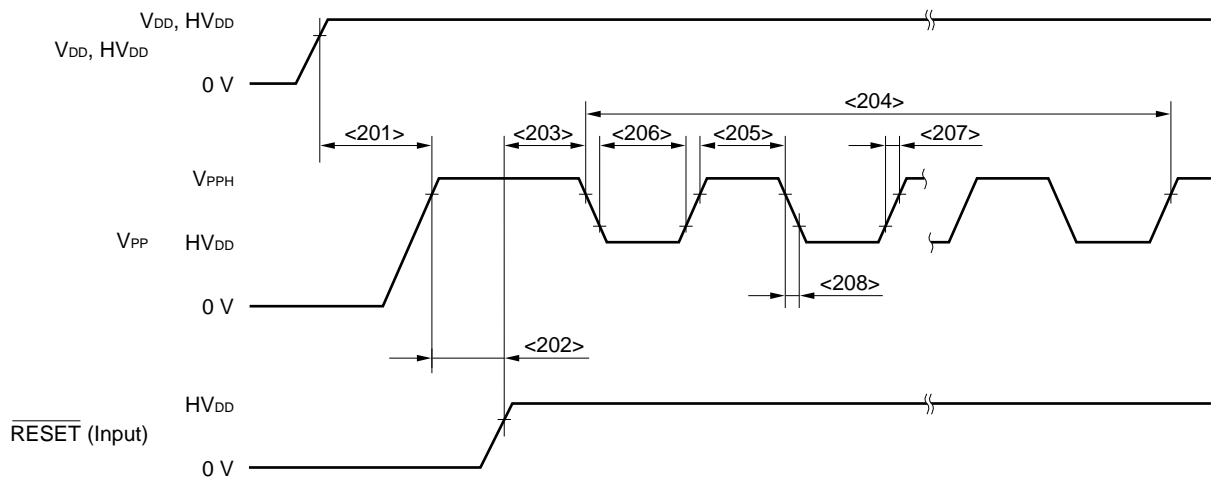
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating frequency	f _X		20		33	MHz
Power supply voltage	V _{DD}				3.6	V
	HV _{DD}				5.5	V
	V _{PP}	V _{DD} high-level detection	0.8V _{DD}	V _{DD}	1.2V _{DD}	V
	V _{PPH}	V _{PP} high-voltage detection	7.5	7.8	8.1	V
HV _{DD} supply current	I _{DD}				50	mA
V _{PP} supply current	I _{PP}	V _{PP} = 8.1 V			150	mA
Number of writes	C _{WRT}	K category ^{Note}	5			Times
		P category ^{Note}	10			Times
		Other than K, P category ^{Note}	20			Times
Write time	t _{WRT}	Per 1 byte	20		200	μs
Erase time	t _{ERASE}	K, P category ^{Note} (Recommendation: Step erase = 5 s)			60	s
		Other than K, P category ^{Note} (Recommendation: Step erase = 0.2 s)			20	s
Temperature during write	T _{PRG}	K, P category ^{Note}	10		40	°C
		Other than K, P category ^{Note}	10		85	°C

Note The category is indicated by the fifth letter from the left of the lot number.

Caution The I category is applied to engineering samples only. The number of rewrites is not guaranteed for the I category products.

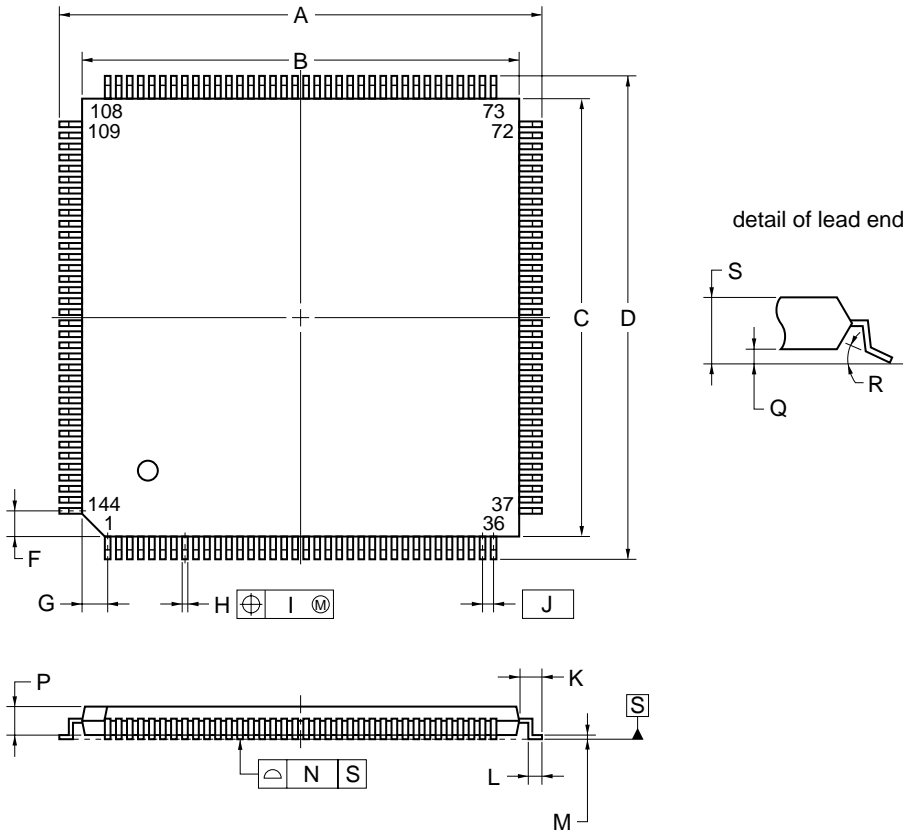
Serial Write Operation Characteristics

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
V _{DD} ↑ to V _{PP} ↑ set time	<201>	t _{DRPSR}	200			ns
V _{PP} ↑ to $\overline{\text{RESET}}\uparrow$ set time	<202>	t _{PSRRF}	1			μs
$\overline{\text{RESET}}\uparrow$ to V _{PP} count start time	<203>	t _{RFOF}	V _{PP} = 7.8 V	5T + 500		μs
Count execution time	<204>	t _{COUNT}			10	ms
V _{PP} counter high-level width	<205>	t _{CH}	1			μs
V _{PP} counter low-level width	<206>	t _{CL}	1			μs
V _{PP} counter rise time	<207>	t _R			3	μs
V _{PP} counter fall time	<208>	t _F			3	μs



5. PACKAGE DRAWINGS

144-PIN PLASTIC LQFP (FINE PITCH) (20x20)



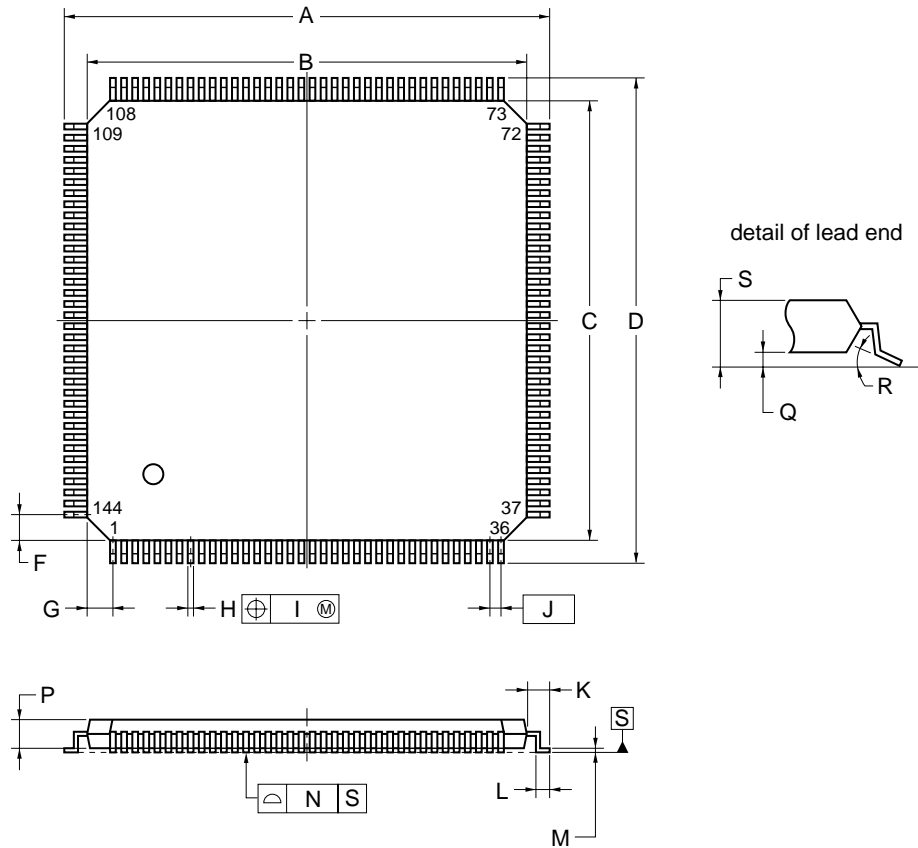
NOTE

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

ITEM	MILLIMETERS
A	22.0±0.2
B	20.0±0.2
C	20.0±0.2
D	22.0±0.2
F	1.25
G	1.25
H	0.22 ^{+0.05} _{-0.04}
I	0.10
J	0.5 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	0.145 ^{+0.055} _{-0.045}
N	0.10
P	1.4±0.1
Q	0.125±0.075
R	3 ^{+7°} _{-3°}
S	1.7 MAX.

S144GJ-50-8EU-3

★ 144-PIN PLASTIC LQFP (FINE PITCH) (20x20)



NOTE

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

ITEM	MILLIMETERS
A	22.0±0.2
B	20.0±0.2
C	20.0±0.2
D	22.0±0.2
F	1.25
G	1.25
H	0.22±0.05
I	0.08
J	0.5 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	0.17 ^{+0.03} _{-0.07}
N	0.08
P	1.4
Q	0.10±0.05
R	3° ^{+4°} _{-3°}
S	1.5±0.1

S144GJ-50-UEN

6. RECOMMENDED SOLDERING CONDITIONS

These products 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 6-1. Surface Mounting Type Soldering Conditions

μPD70F3102GJ-33-8EU: 144-pin plastic LQFP (Fine Pitch) (20 × 20)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Twice or less, Exposure limit: 3 days ^{Note} (after that, prebake at 125°C for 10 hours)	IR35-103-2
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** The recommended soldering conditions of the μPD70F3102GJ-33-UEN are yet to be determined.

[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.

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: 408-588-6000
800-366-9782
Fax: 408-588-6130
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
Tel: 02-66 75 41
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.

Velizy-Villacoublay, France
Tel: 01-30-67 58 00
Fax: 01-30-67 58 99

NEC Electronics (France) S.A.

Spain Office
Madrid, Spain
Tel: 91-504-2787
Fax: 91-504-2860

NEC Electronics (Germany) GmbH

Scandinavia Office
Taeby, 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.

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

NEC Electronics Singapore Pte. Ltd.

United Square, Singapore 1130
Tel: 65-253-8311
Fax: 65-250-3583

NEC Electronics Taiwan Ltd.

Taipei, Taiwan
Tel: 02-2719-2377
Fax: 02-2719-5951

NEC do Brasil S.A.

Electron Devices Division
Rodovia Presidente Dutra, Km 214
07210-902-Guarulhos-SP Brasil
Tel: 55-11-6465-6810
Fax: 55-11-6465-6829

Related Documents μPD70F3102A-33 Data Sheet (U13845E)
μPD703100-33, 703100-40, 703101-33, 703102-33 Data Sheet (U13995E)
μPD703100A-33, 703100A-40, 703101A-33, 703102A-33 Data Sheet (U14168E)

Reference Materials Electrical Characteristics for Microcomputer (IEI-601)^{Note}

Note This document number is that of Japanese version.

The related documents in this publication may include preliminary versions. However, preliminary versions are not marked as such.

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