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April 1st, 2010
Renesas Electronics Corporation

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RENESAS

MOS INTEGRATED CIRCUITS

μPD70F3102-33

V850E/MS1
32-BIT SINGLE-CHIP MICROCONTROLLER

DESCRIPTION

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 μPD70F3102A-33, is also available.

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

V850E/MS1 User's Manual Hardware: U12688E
V850E/MS1, V850E/MS2 User's Manual Architecture: U12197E

FEATURES

- Compatible with μPD703102-33
  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-33-8EU-A[Note]	144-pin plastic LQFP (fine pitch) (20 × 20)
μPD70F3102GJ-33-UEN[Note]	144-pin plastic LQFP (fine pitch) (20 × 20)

Note Under development

Remark Products with -A at the end of the part number are lead-free products.

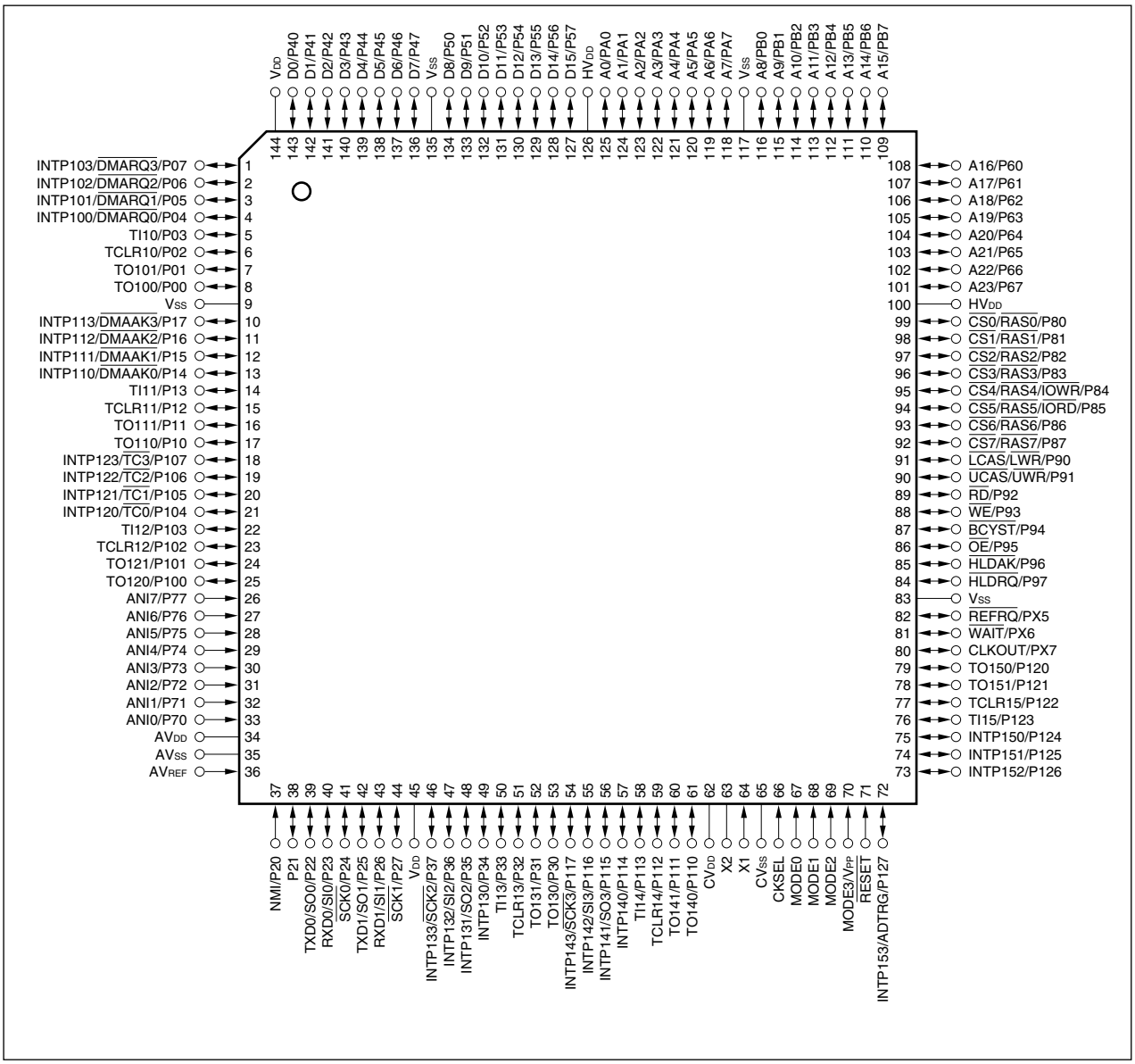
Document No. U13844EJ3V1DS00 (3rd edition)
Date Published August 2005 N CP(K)
Printed in Japan

The mark ★ shows major revised points.

PIN CONFIGURATION (TOP VIEW)

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

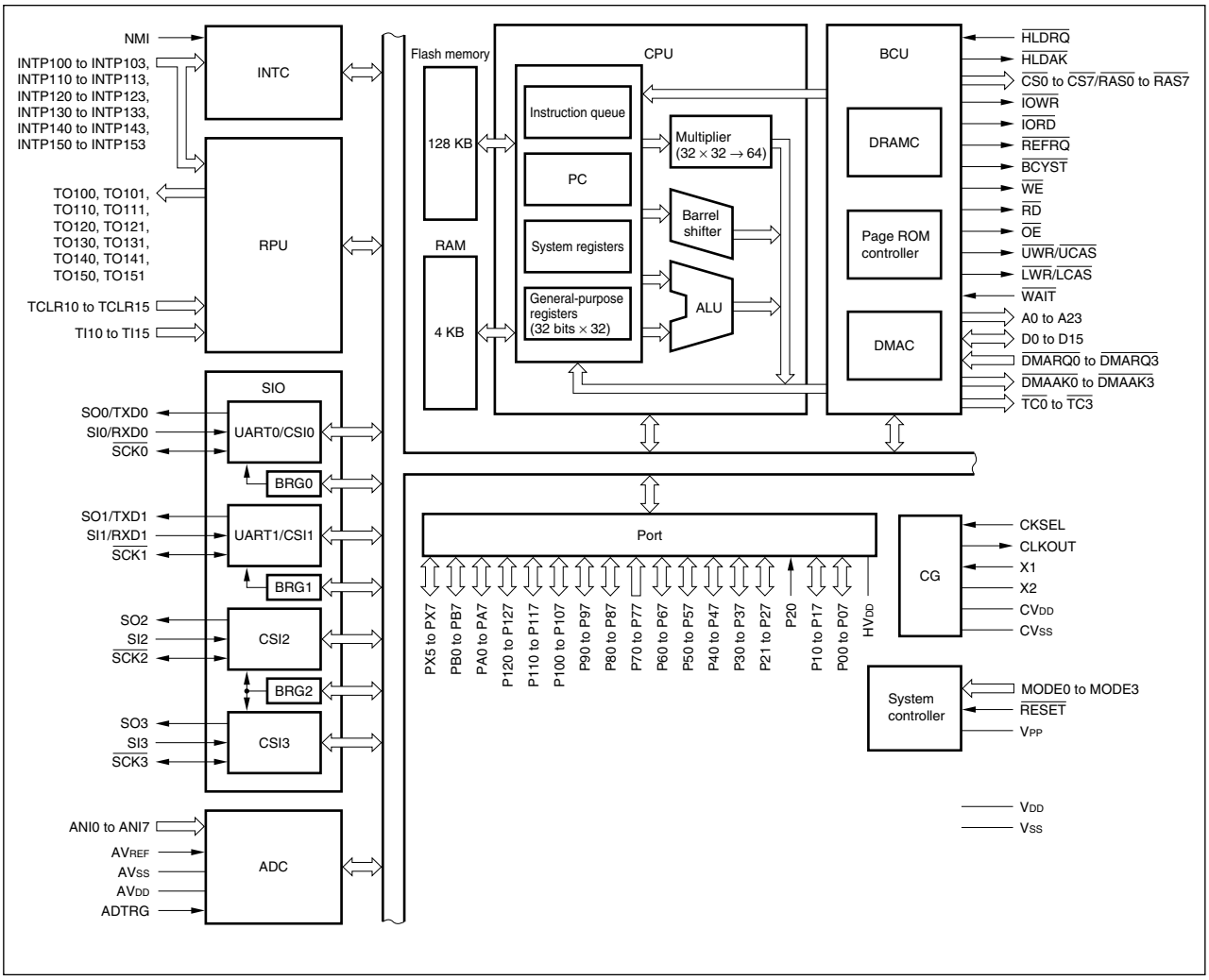
- **μPD70F3102GJ-33-8EU**
- ★ **μPD70F3102GJ-33-8EU-A**
- **μPD70F3102GJ-33-UEN**



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
$\overline{BCYST}$:	Bus cycle start timing	P110 to P117:	Port 11
CKSEL:	Clock generator operating mode select	P120 to P127:	Port 12
		PA0 to PA7:	Port A
CLKOUT:	Clock output	PB0 to PB7:	Port B
$\overline{CS0}$ to $\overline{CS7}$:	Chip select	PX5 to PX7:	Port X
CV_{DD}:	Clock generator power supply	$\overline{RAS0}$ to $\overline{RAS7}$:	Row address strobe
CV_{SS}:	Clock generator	$\overline{RD}$:	Read
D0 to D15:	Data bus	$\overline{REFRQ}$:	Refresh request
$\overline{DMAAK0}$ to $\overline{DMAAK3}$:	DMA acknowledge	$\overline{RESET}$:	Reset
$\overline{DMARQ0}$ to $\overline{DMARQ3}$:	DMA request	RXD0, RXD1:	Receive data
$\overline{HLDAK}$:	Hold acknowledge	$\overline{SCK0}$ to $\overline{SCK3}$:	Serial clock
$\overline{HLDRQ}$:	Hold request	SI0 to SI3:	Serial input
HV_{DD}:	Power supply for external pins	SO0 to SO3:	Serial output
INTP100 to INTP103,		$\overline{TC0}$ to $\overline{TC3}$:	Terminal count signal
INTP110 to INTP113,		TCLR10 to TCLR15:	Timer clear
INTP120 to INTP123,		TI10 to TI15:	Timer input
INTP130 to INTP133,		TO100, TO101,	
INTP140 to INTP143,		TO110, TO111,	
INTP150 to INTP153:	Interrupt request from peripherals	TO120, TO121,	
$\overline{IORD}$:	I/O read strobe	TO130, TO131,	
$\overline{IOWR}$:	I/O write strobe	TO140, TO141,	
$\overline{LCAS}$:	Lower column address strobe	TO150, TO151:	Timer output
$\overline{LWR}$:	Lower write strobe	TXD0, TXD1:	Transmit data
MODE0 to MODE3:	Mode	$\overline{UCAS}$:	Upper column address strobe
NMI:	Non-maskable interrupt request	$\overline{UWR}$:	Upper write strobe
$\overline{OE}$:	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	$\overline{WAIT}$:	Wait
P30 to P37:	Port 3	$\overline{WE}$:	Write enable
P40 to P47:	Port 4	X1, X2:	Crystal

INTERNAL BLOCK DIAGRAM



CONTENTS

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	Current consumption etc. differs (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	• 144-pin plastic LQFP (fine pitch) (20 × 20)	• 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/$\overline{\text{DMARQ0}}$
P05			INTP101/$\overline{\text{DMARQ1}}$
P06			INTP102/$\overline{\text{DMARQ2}}$
P07			INTP103/$\overline{\text{DMARQ3}}$
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/$\overline{\text{DMAAK0}}$
P15			INTP111/$\overline{\text{DMAAK1}}$
P16			INTP112/$\overline{\text{DMAAK2}}$
P17			INTP113/$\overline{\text{DMAAK3}}$
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			$\overline{\text{SCK0}}$
P25			TXD1/SO1
P26			RXD1/SI1
P27			$\overline{\text{SCK1}}$
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/$\overline{\text{SCK2}}$
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			$\overline{HLDAK}$
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			INTP120/$\overline{TC0}$
P105			INTP121/$\overline{TC1}$
P106			INTP122/$\overline{TC2}$
P107			INTP123/$\overline{TC3}$

(3/3)

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/$\overline{\text{SCK3}}$
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	External clear signal input of timers 10 to 15	P02
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/$\overline{\text{TC3}}$

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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/$\overline{SCK2}$
INTP140	Input	External maskable interrupt request input, or timer 14 external capture trigger input	P114
INTP141			P115/SO3
INTP142			P116/SI3
INTP143			P117/$\overline{SCK3}$
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
$\overline{SCK0}$	I/O	CSI0 to CSI3 serial clock input/output (3-wire)	P24
$\overline{SCK1}$			P27
$\overline{SCK2}$			P37/INTP133
$\overline{SCK3}$			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
$\overline{LWR}$	Output	External data bus lower byte write enable signal output	P90/$\overline{LCAS}$
$\overline{UWR}$	Output	External data bus upper byte write enable signal output	P91/$\overline{UCAS}$
$\overline{RD}$	Output	External data bus read strobe signal output	P92
$\overline{WE}$	Output	Write enable signal output for DRAM	P93
$\overline{OE}$	Output	Output enable signal output for DRAM	P95

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Pin Name	I/O	Function	Alternate Function
$\overline{LCAS}$	Output	Column address strobe signal output for lower data of DRAM	P90/$\overline{LWR}$
$\overline{UCAS}$	Output	Column address strobe signal output for higher data of DRAM	P91/$\overline{UWR}$
$\overline{RAS0}$ to $\overline{RAS3}$	Output	Row address strobe signal output for DRAM	P80/$\overline{CS0}$ to P83/$\overline{CS3}$
$\overline{RAS4}$			P84/$\overline{CS4}$/$\overline{IOWR}$
$\overline{RAS5}$			P85/$\overline{CS5}$/$\overline{IORD}$
$\overline{RAS6}$			P86/$\overline{CS6}$
$\overline{RAS7}$			P87/$\overline{CS7}$
$\overline{BCYST}$	Output	Strobe signal output indicating start of bus cycle	P94
$\overline{CS0}$ to $\overline{CS3}$	Output	Chip select signal output	P80/$\overline{RAS0}$ to P83/$\overline{RAS3}$
$\overline{CS4}$			P84/$\overline{RAS4}$/$\overline{IOWR}$
$\overline{CS5}$			P85/$\overline{RAS5}$/$\overline{IORD}$
$\overline{CS6}$			P86/$\overline{RAS6}$
$\overline{CS7}$			P87/$\overline{RAS7}$
$\overline{WAIT}$	Input	Control signal input that inserts a wait in the bus cycle	PX6
$\overline{REFRQ}$	Output	Refresh request signal output for DRAM	PX5
$\overline{IOWR}$	Output	DMA write strobe signal output	P84/$\overline{RAS4}$/$\overline{CS4}$
$\overline{IORD}$	Output	DMA read strobe signal output	P85/$\overline{RAS5}$/$\overline{CS5}$
$\overline{DMARQ0}$ to $\overline{DMARQ3}$	Input	DMA request signal input	P04/INTP100 to P07/INTP103
$\overline{DMAAK0}$ to $\overline{DMAAK3}$	Output	DMA acknowledge signal output	P14/INTP110 to P17/INTP113
$\overline{TC0}$ to $\overline{TC3}$	Output	DMA termination (terminal count) signal output	P104/INTP120 to P107/INTP123
$\overline{HLDAK}$	Output	Bus hold acknowledge output	P96
$\overline{HLDRQ}$	Input	Bus hold request input	P97
ANI0 to ANI7	Input	Analog input to A/D converter	P70 to P77
NMI	Input	Non-maskable interrupt request input	P20
CLKOUT	Output	System clock output	PX7
CKSEL	Input	Input that specifies the clock generator's operation mode	–
MODE0 to MODE2	Input	Operation mode specification	–
MODE3			V_{PP}
$\overline{RESET}$	Input	System reset input	–
X1	Input	Connecting system clock resonator. In the case of an external clock, it is input to X1.	–
X2	–		–
ADTRG	Input	A/D converter external trigger input	P127/INTP153
AV_{REF}	Input	Reference voltage applied to A/D converter	–
AV_{DD}	–	Positive power supply for A/D converter	–

(4/4)

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.

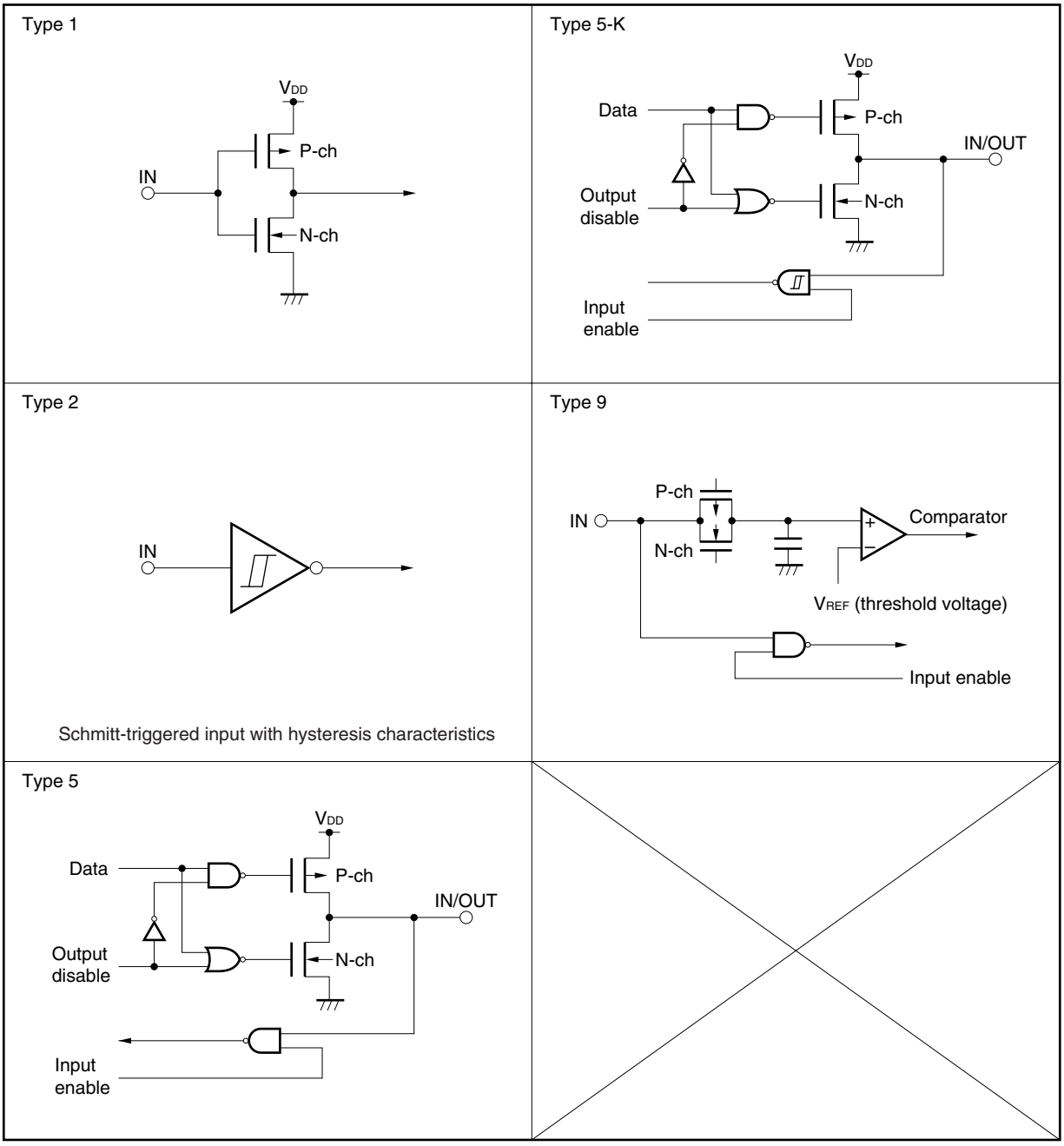
Table 2-1. Pin I/O Circuit Types and Recommended Connection of Unused Pins (1/2)

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/$\overline{\text{DMARQ0}}$ to P07/INTP103/$\overline{\text{DMARQ3}}$		
P10/TO110, P11/TO111	5	
P12/TCLR11, P13/TI11	5-K	
P14/INTP110/$\overline{\text{DMAAK0}}$ to P17/INTP113/$\overline{\text{DMAAK3}}$		
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/$\overline{\text{SCK0}}$		
P25/TXD1/SO1	5	
P26/RXD1/SI1	5-K	
P27/$\overline{\text{SCK1}}$		
P30/TO130, P31/TO131	5	
P32/TCLR13, P33/TI13	5-K	
P34/INTP130		
P35/INTP131/SO2		
P36/INTP132/SI2		
P37/INTP133/$\overline{\text{SCK2}}$		
P40/D0 to P47/D7	5	
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/$\overline{CS0}$/$\overline{RAS0}$ to P83/$\overline{CS3}$/$\overline{RAS3}$	5	Input: Independently connect to HV_{DD} or V_{SS} via a resistor. Output: Leave open.
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/$\overline{LCAS}$/$\overline{LWR}$		
P91/$\overline{UCAS}$/$\overline{UWR}$		
P92/$\overline{RD}$		
P93/$\overline{WE}$		
P94/$\overline{BCYST}$		
P95/$\overline{OE}$		
P96/$\overline{HLDAK}$		
P97/$\overline{HLDRQ}$		
P100/TO120, P101/TO121	5	Input: Independently connect to HV_{DD} or V_{SS} via a resistor. Output: Leave open.
P102/TCLR12, P103/TI12	5-K	
P104/INTP120/$\overline{TC0}$ to P107/INTP123/$\overline{TC3}$		
P110/TO140, P111/TO141	5	
P112/TCLR14, P113/TI14	5-K	
P114/INTP140		
P115/INTP141/SO3		
P116/INTP142/SI3		
P117/INTP143/$\overline{SCK3}$		
P120/TO150, P121/TO151	5	
P122/TCLR15, P123/TI15	5-K	
P124/INTP150 to P126/INTP152		
P127/INTP153/ADTRG		
PA0/A0 to PA7/A7	5	
PB0/A8 to PB7/A15		
PX5/$\overline{REFRQ}$		
PX6/$\overline{WAIT}$		
PX7/CLKOUT		
CKSEL	1	–
$\overline{RESET}$	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 I/O 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.

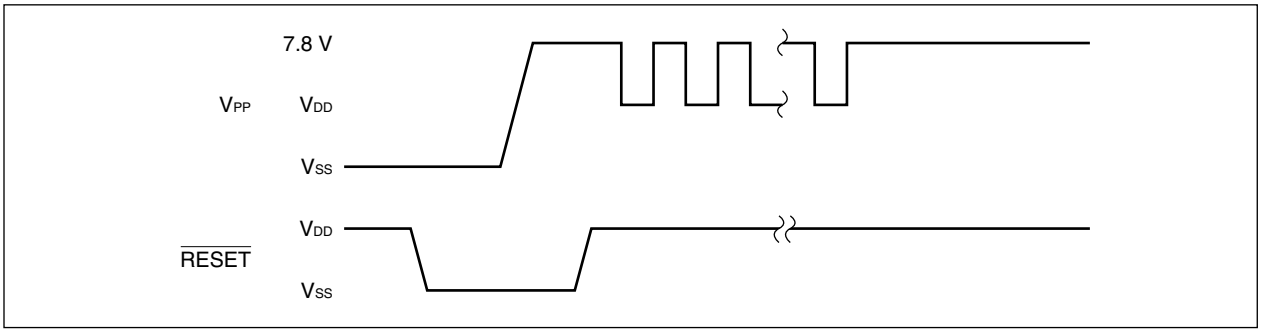
3.1 Selection of Communication Mode

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) $\overline{SCK0}$ (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

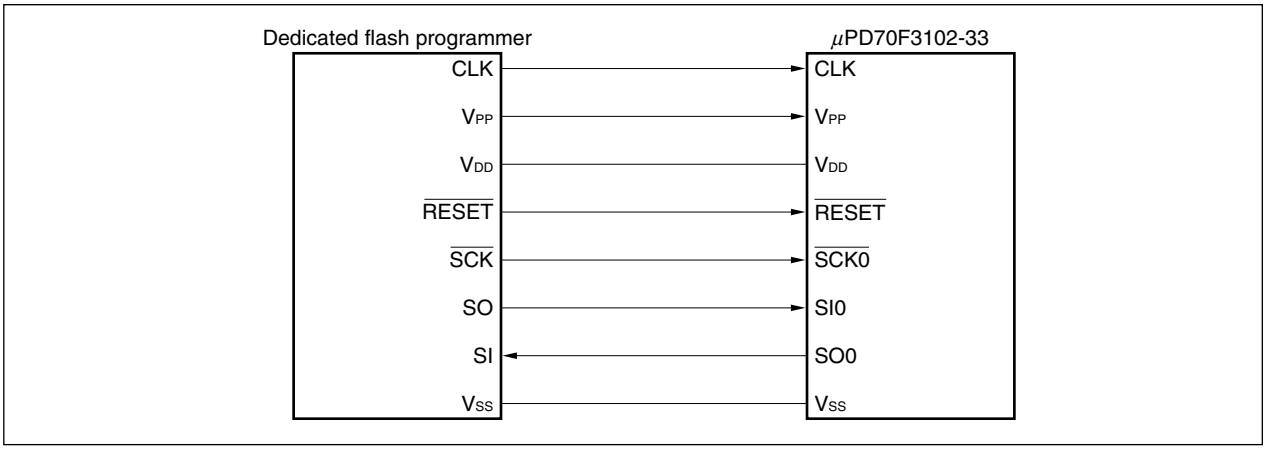
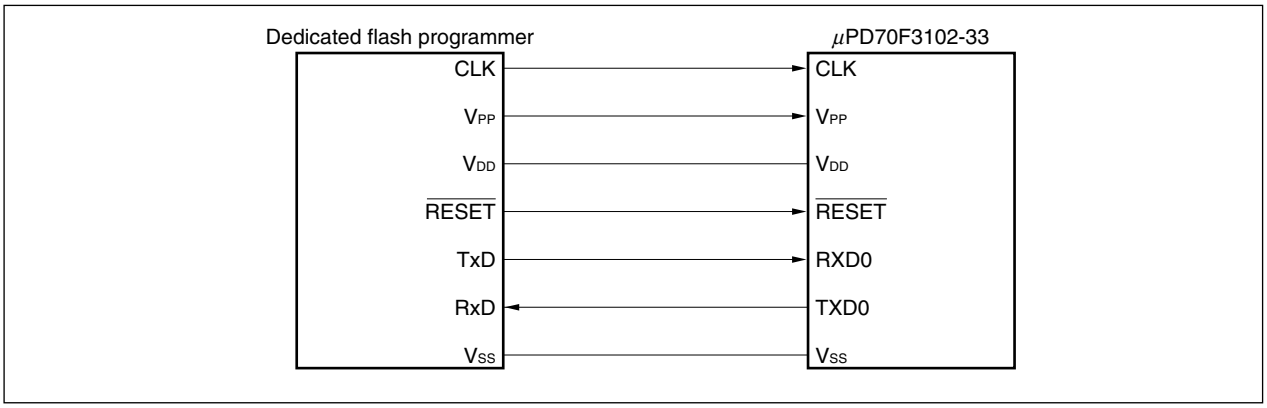


Figure 3-3. Connection of Dedicated Flash Programmer for UART0 Mode



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, $HV_{DD} \geq V_{DD}$		−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[Note]	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[Note]	V
		MODE3/V_{PP} pin		−0.5 to V_{DD} + 0.5[Note]	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[Note]	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[Note]	V
Analog input voltage	V_{IAN}	P70/ANI0 to P77/ANI7 pins	$AV_{DD} > HV_{DD}$	−0.5 to HV_{DD} + 0.5[Note]	V
			$HV_{DD} \geq AV_{DD}$	−0.5 to AV_{DD} + 0.5[Note]	V
A/D converter reference input voltage	AV_{REF}	$AV_{DD} > HV_{DD}$		−0.5 to HV_{DD} + 0.5[Note]	V
		$HV_{DD} \geq AV_{DD}$		−0.5 to AV_{DD} + 0.5[Note]	V
Operating ambient temperature	T_A			−40 to +85	°C
Storage temperature	T_{stg}			−65 to +125	°C

★ **Note** Use the product under conditions that ensure the absolute maximum ratings (MAX. values) of respective supply voltages are not exceeded.

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

2. Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

The ratings and conditions indicated for DC characteristics and AC characteristics represent the quality assurance range during normal operation.

Capacitance (T_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 (f_X)	Operating Ambient Temperature (T_A)	Supply Voltage (V_{DD}, HV_{DD})
★ Direct mode	2 to 33 MHz	−40 to +85°C	V_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%
PLL mode[Note 1]	20 to 33 MHz[Note 2]	−40 to +85°C	V_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%

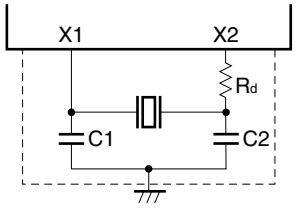
★ **Notes 1.** The internal operation clock frequency in PLL mode is the value during operation with a ×5 clock. When using a ×1 or ×1/2 clock by setting the CKDIVn (n = 0, 1) bit in the CKC register, operation is possible at a frequency of 20 MHz or lower.

2. 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)



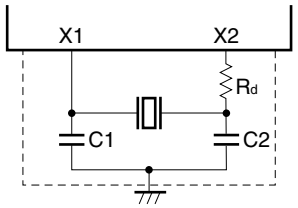
Type	Product Name	Oscillation Frequency f_{XX} (MHz)	Recommended Circuit Constant			Oscillation Voltage Range		Oscillation Stabilization Time (MAX.) T_{OST} (ms)
			C1 (pF)	C2 (pF)	R_d (kΩ)	MIN. (V)	MAX. (V)	
Surface mount	CSAC4.00MGC040	4.0	100	100	0	3.0	3.6	0.5
	CSTCC4.00MG0H6	4.0	On-chip	On-chip	0	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 close 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.

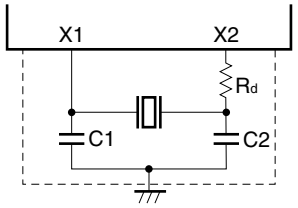
(ii) TDK Corporation (T_A = –40 to +85°C)



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 close 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.

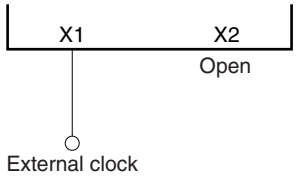
(iii) Kyocera Corporation (T_A = –20 to +80°C)



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 close 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°C)



Caution Input a CMOS level voltage to the X1 pin.

Cautions when turning on/off the power

The μPD70F3102-33 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 ±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) (1/2)

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/$\overline{\text{DMARQ0}}$ 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, $\overline{\text{RESET}}$

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) (2/2)

Parameter		Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply current	During normal	I_{DD1}	V_{DD} + CV_{DD}			2.0 × fx	4.5 × fx	mA
			HV_{DD}			1.8 × fx	3.0 × fx	mA
	During HALT	I_{DD2}	V_{DD} + CV_{DD}			1.4 × fx	3.0 × fx	mA
			HV_{DD}			0.8 × fx	1.5 × fx	mA
	During IDLE	I_{DD3}	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			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 = 2 to 33 MHz
PLL mode: fx = 20 to 33 MHz

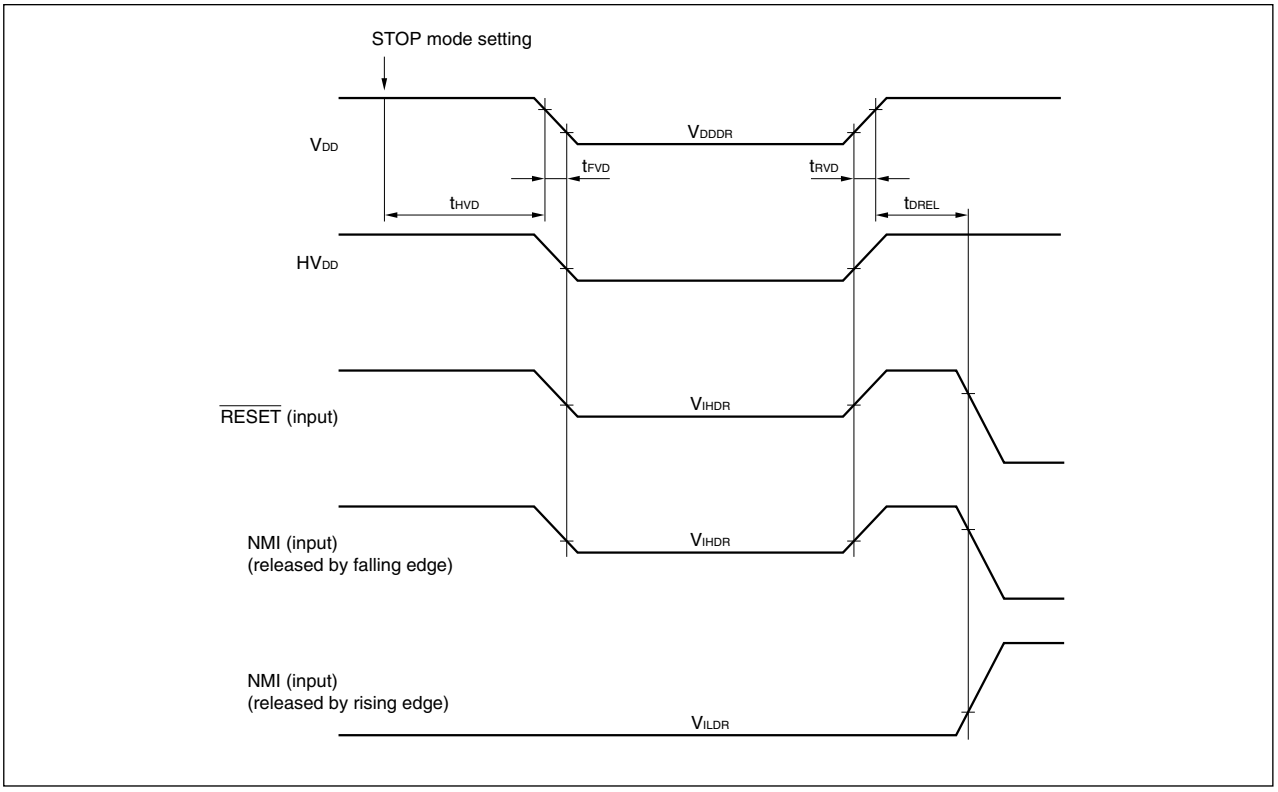
3. The fx unit is MHz.

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		20	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/$\overline{\text{DMARQ0}}$ 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, $\overline{\text{RESET}}$

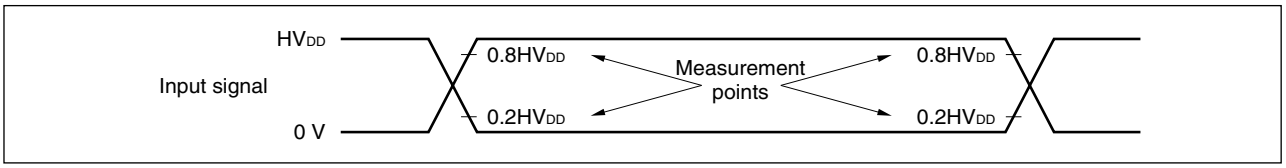
Remark TYP. values are reference values for when T_A = 25°C.



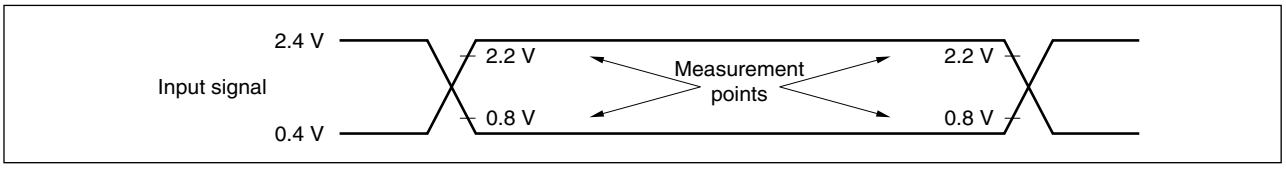
AC Characteristics (T_A = –40 to +85°C, V_{DD} = CV_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%, V_{SS} = 0 V, Output Pin Load Capacitance: C_L = 50 pF)

AC Test Input Measurement Points

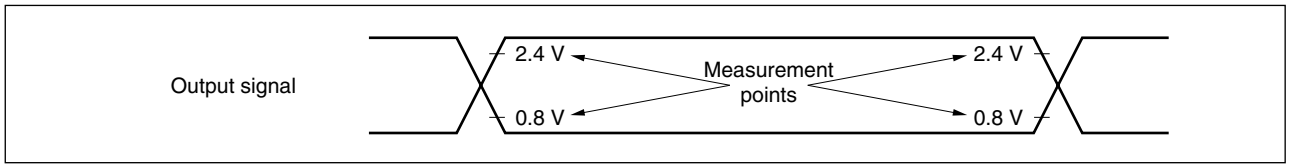
(a) P04/INTP100/$\overline{\text{DMARQ0}}$ to P07/INTP103/$\overline{\text{DMARQ3}}$, P14/INTP110/$\overline{\text{DMAAK0}}$ to P17/INTP113/$\overline{\text{DMAAK3}}$, P34/INTP130, P35/INTP131/SO2, P36/INTP132/SI2, P37/INTP133/$\overline{\text{SCK2}}$, P104/INTP120/$\overline{\text{TC0}}$ to P107/INTP123/$\overline{\text{TC3}}$, 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, $\overline{\text{RESET}}$



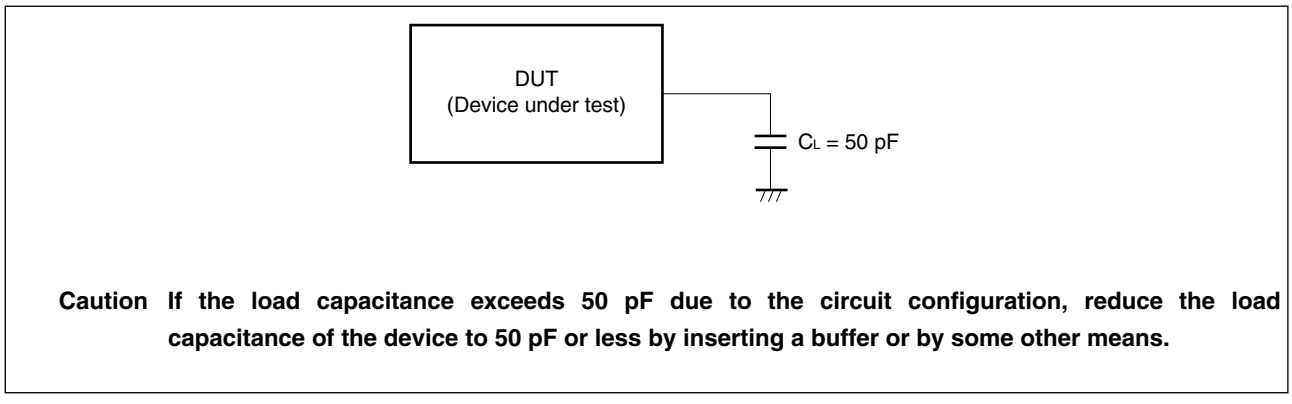
(b) Other than (a)



AC Test Output Measurement Points



Load Conditions

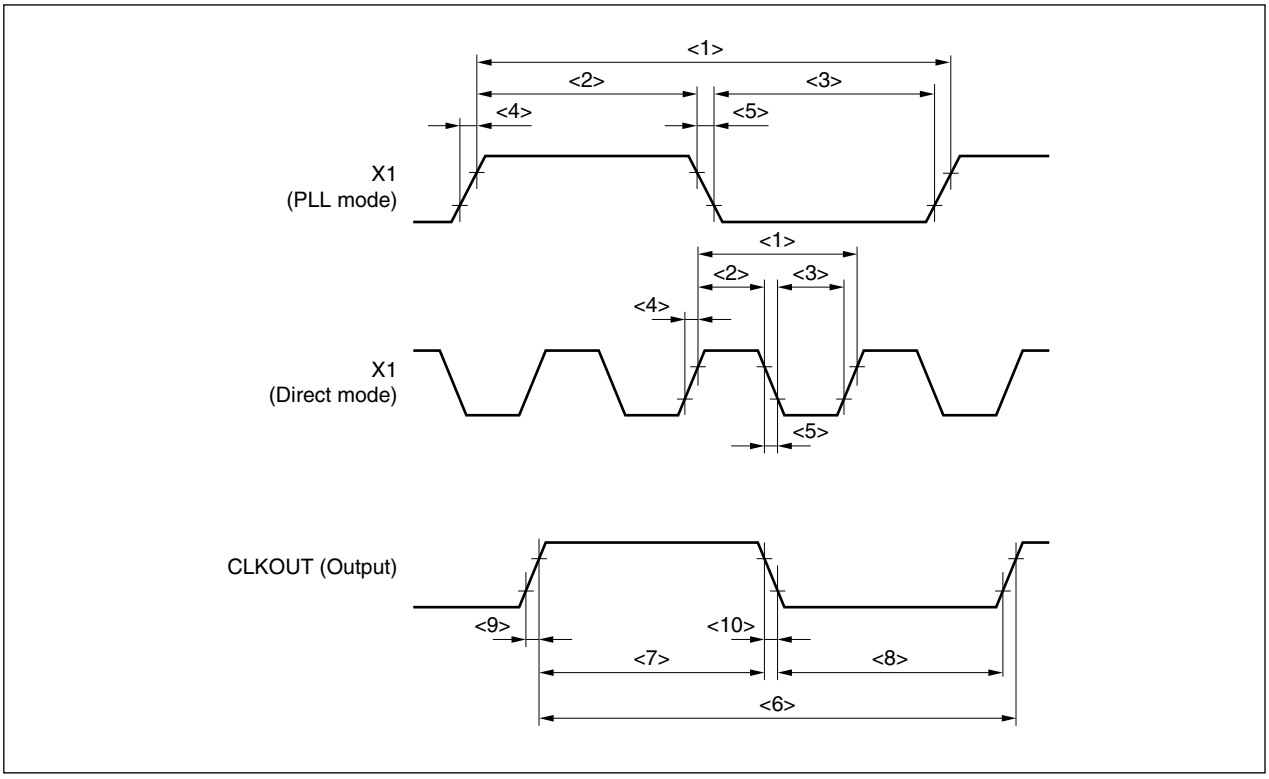


Caution If the load capacitance exceeds 50 pF due to the circuit configuration, reduce the load capacitance of the device to 50 pF or less by inserting a buffer or by some other means.

(1) Clock timing

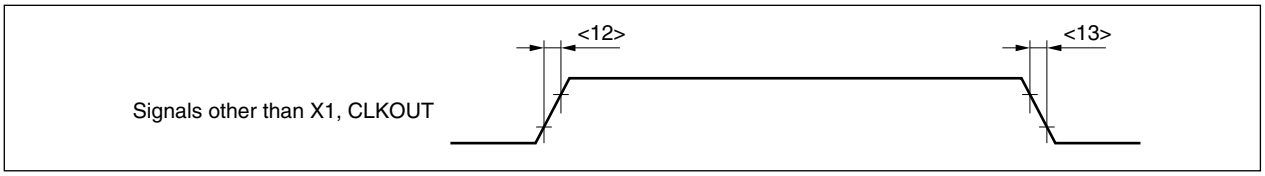
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
X1 input cycle	<1>	t_{CYX}	In direct mode	15	250	ns
			In PLL mode	150	250	ns
X1 input high-level width	<2>	t_{WXH}	In direct mode	5		ns
			In PLL mode	50		ns
X1 input low-level width	<3>	t_{WXL}	In direct mode	5		ns
			In PLL mode	50		ns
X1 input rise time	<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
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)

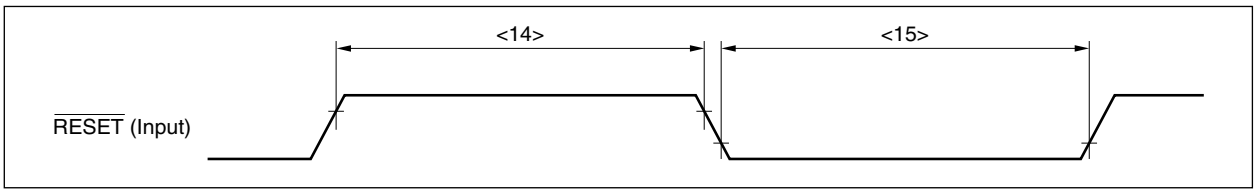
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
Output rise time	<12>	t_{OR}			10	ns
Output fall time	<13>	t_{OF}			10	ns



(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

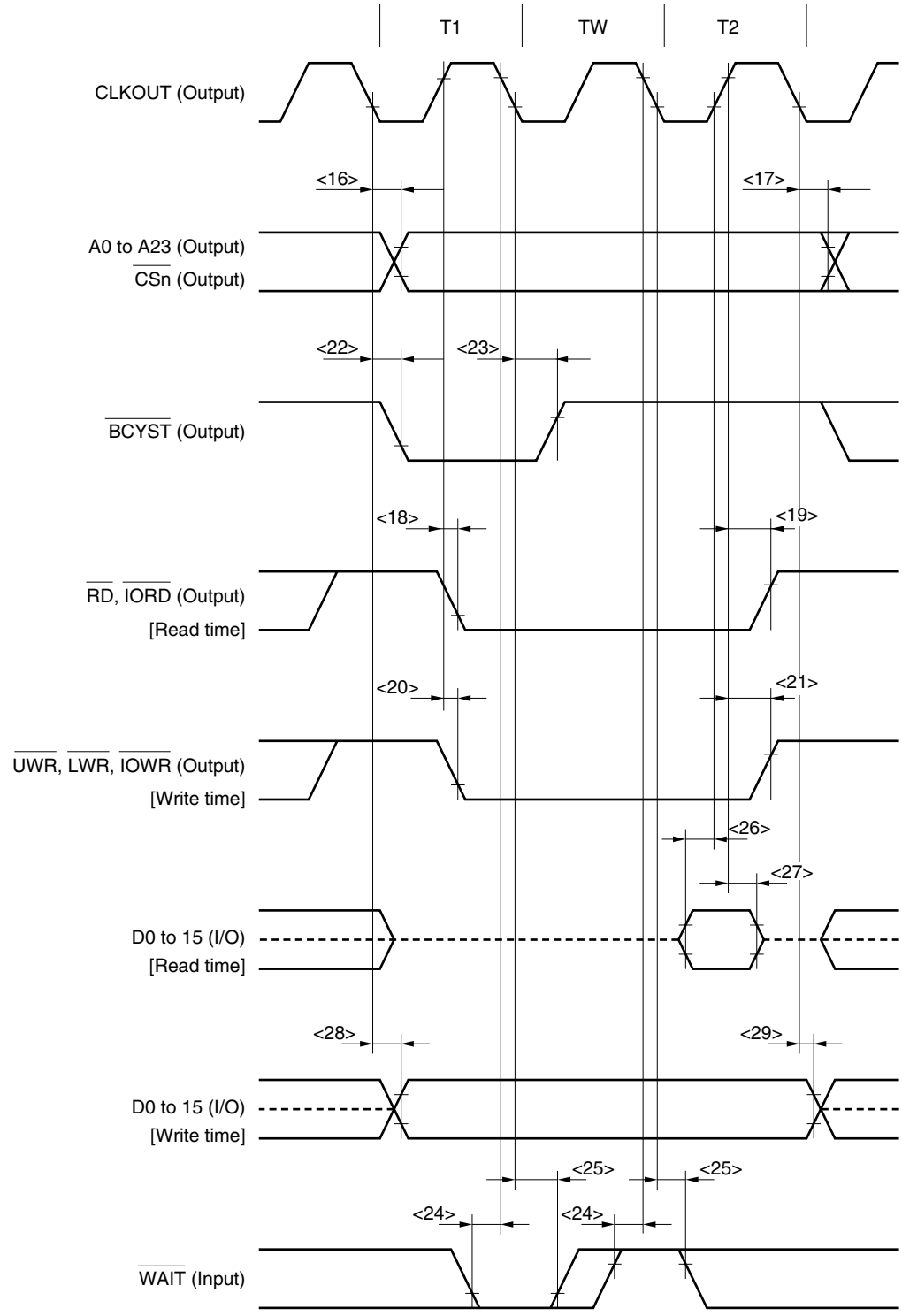
(a) Access timing (SRAM, external ROM, external I/O) (1/2)

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, $\overline{CSn}$ to $\overline{RD}$, $\overline{IORD}$↓	<34>	t_{DARD}		0.5T – 10		ns
Delay time from $\overline{RD}$, $\overline{IORD}$↑ to address	<35>	t_{DRDA}		(0.5 + i) T – 10		ns
Data input hold time (from $\overline{RD}$, $\overline{IORD}$↑)	<36>	t_{HRDID}		0		ns
Delay time from $\overline{RD}$, $\overline{IORD}$↑ 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 $\overline{BCYST}$↓)	<39>	t_{SBSW}	**Note**		T – 25	ns
$\overline{WAIT}$ hold time (from $\overline{BCYST}$↑)	<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 $\overline{WAIT}$

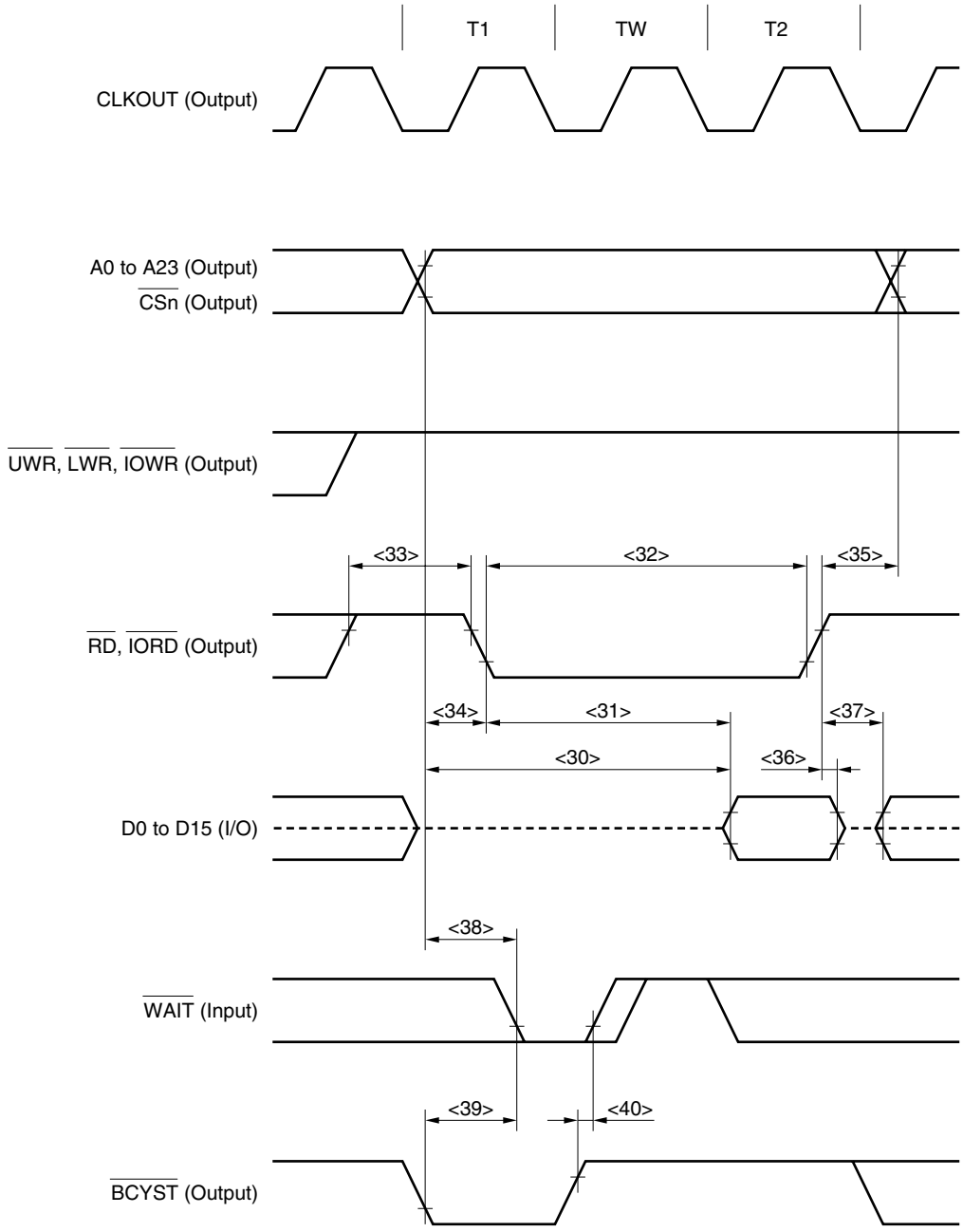
3. w_D: Number of waits specified by registers DWC1, DWC2

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
$\overline{WAIT}$ 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
Delay time from address, $\overline{CSn}$ to $\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}\downarrow$	<41>	t_{DAWR}		0.5T – 10		ns
Address setup time (to $\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}\uparrow$)	<42>	t_{SAWR}		(1.5 + w_D + w) T – 10		ns
Delay time from $\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}\uparrow$ to address	<43>	t_{DWRA}		0.5T – 10		ns
$\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}$ high-level width	<44>	t_{WWRH}		T – 10		ns
$\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}$ low-level width	<45>	t_{WWRL}		(1 + w_D + w) T – 10		ns
Data output setup time (to $\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}\uparrow$)	<46>	t_{SODWR}		(1.5 + w_D + w) T – 10		ns
Data output hold time (from $\overline{UWR}$, $\overline{LWR}$, $\overline{IOWR}\uparrow$)	<47>	t_{HWROD}		0.5T – 10		ns

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

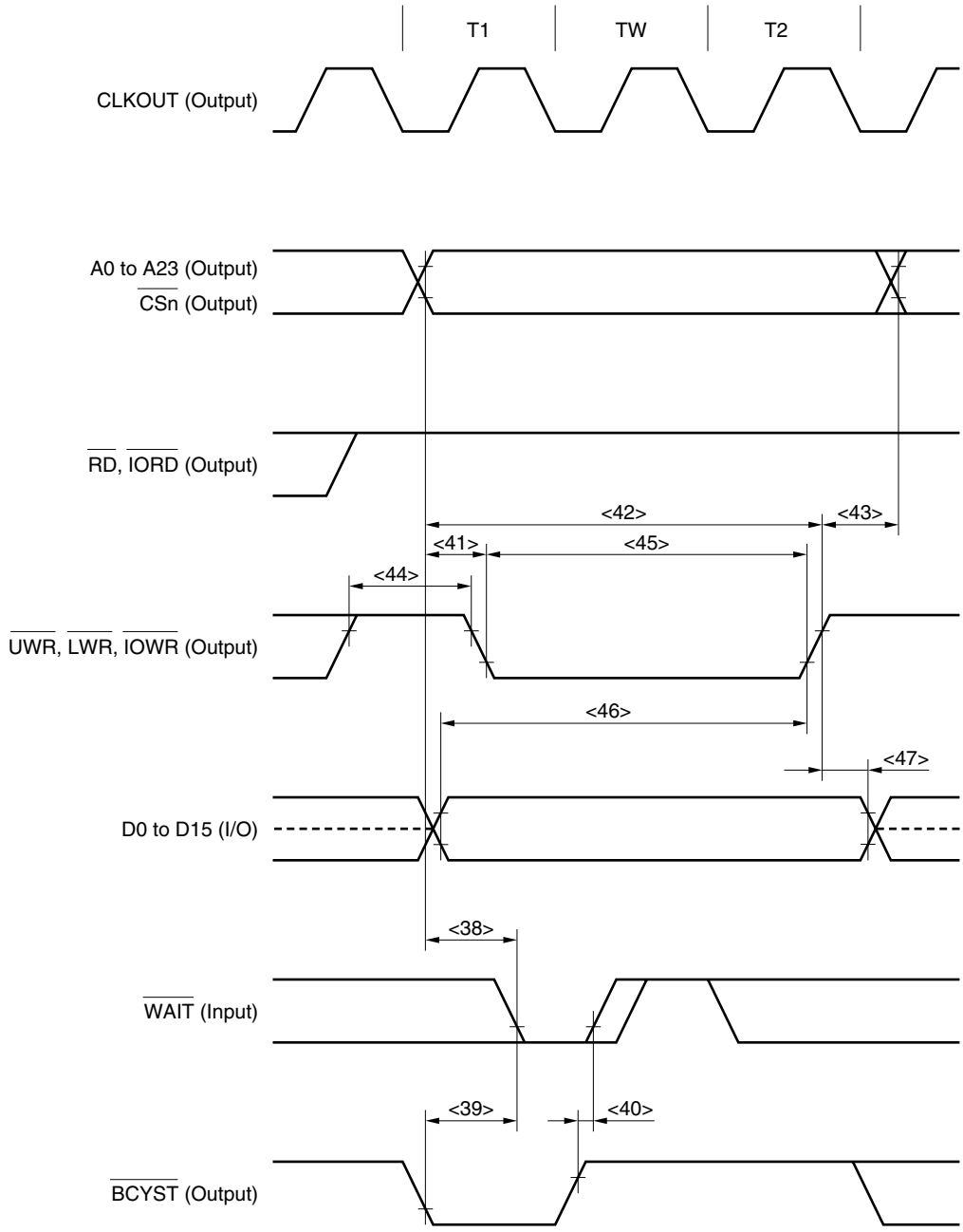
Remarks 1. T = t_{CYK}

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

3. w_D: Number of waits specified by registers DWC1 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
$\overline{WAIT}$ setup time (to CLKOUT↓)	<24>	t_{SWK}		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	<25>	t_{HKW}		2		ns
$\overline{RD}$ low-level width	<32>	t_{WRDL}		$(1 + w_D + w_F + w)$ T – 10		ns
$\overline{RD}$ high-level width	<33>	t_{WRDH}		T – 10		ns
Delay time from address, $\overline{CSn}$ to $\overline{RD}$↓	<34>	t_{DARD}		0.5T – 10		ns
Delay time from $\overline{RD}$↑ to address	<35>	t_{DRDA}		(0.5 + i) T – 10		ns
Delay time from $\overline{RD}$↑ 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 $\overline{BCYST}$↓)	<39>	t_{SBSW}	**Note**		T – 25	ns
$\overline{WAIT}$ hold time (from $\overline{BCYST}$↑)	<40>	t_{HBSW}	**Note**	0		ns
Delay time from address to $\overline{IOWR}$↓	<41>	t_{DAWR}		0.5T – 10		ns
Address setup time (to $\overline{IOWR}$↑)	<42>	t_{SAWR}		$(1.5 + w_D + w)$ T – 10		ns
Delay time from $\overline{IOWR}$↑ to address	<43>	t_{DWRA}		0.5T – 10		ns
$\overline{IOWR}$ high-level width	<44>	t_{WWRH}		T – 10		ns
$\overline{IOWR}$ low-level width	<45>	t_{WWRL}		$(1 + w_D + w)$ T – 10		ns
Delay time from $\overline{IOWR}$↑ to $\overline{RD}$↑	<48>	t_{DWRRD}	$w_F = 0$	0		ns
			$w_F = 1$	T – 10		ns
Delay time from $\overline{DMAAKm}$↓ to $\overline{IOWR}$↓	<49>	t_{DDAWR}		0.5T – 10		ns
Delay time from $\overline{IOWR}$↑ to $\overline{DMAAKm}$↑	<50>	t_{DWRDA}		$(0.5 + w_F)$ T – 10		ns

Note During the first $\overline{WAIT}$ 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 $\overline{WAIT}$

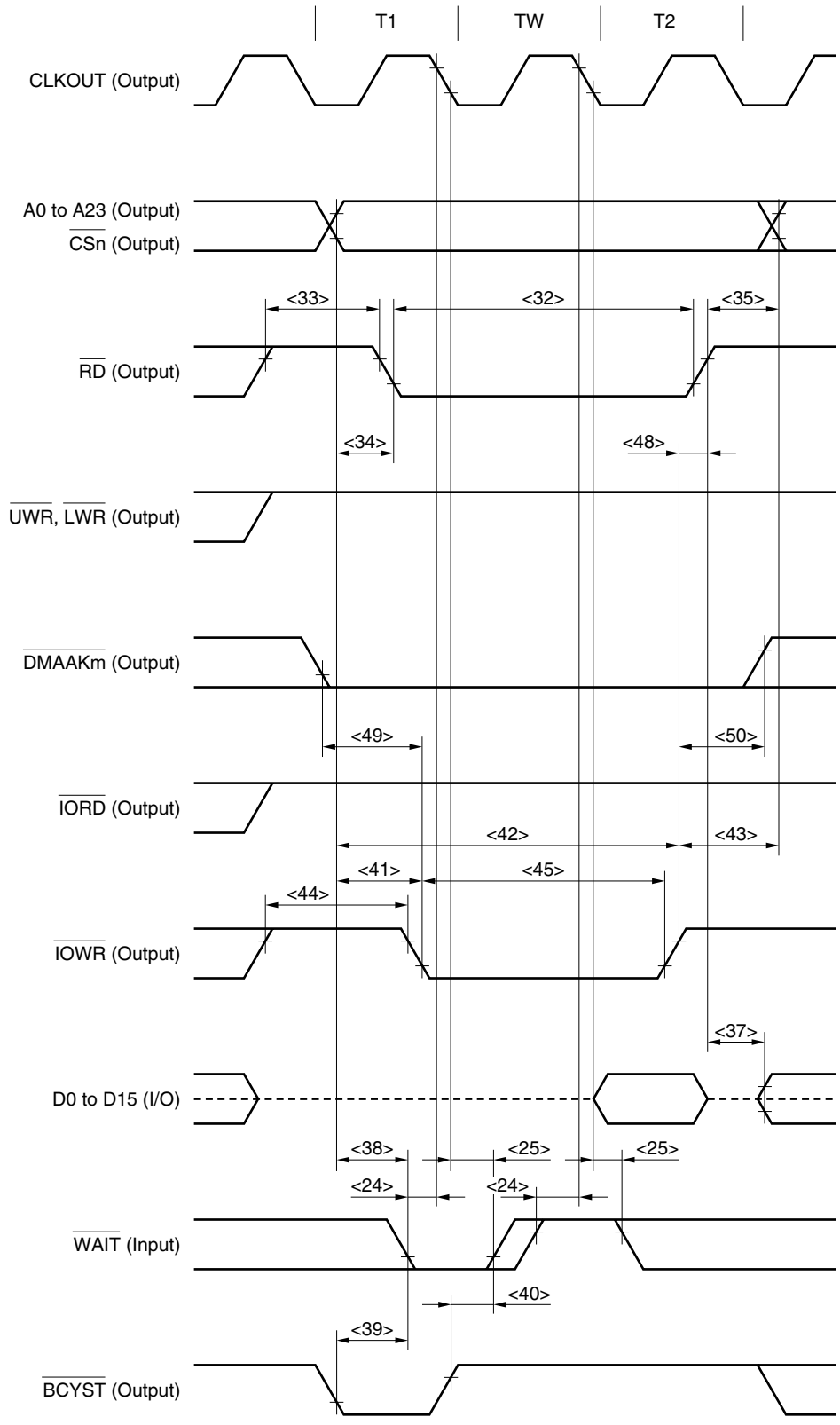
3. w_D: Number of waits specified by registers DWC1, DWC2

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
$\overline{WAIT}$ setup time (to CLKOUT↓)	<24>	t_{SWK}		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	<25>	t_{HKW}		2		ns
$\overline{IORD}$ low-level width	<32>	t_{WRDL}		$(1 + w_D + w_F + w)$ T – 10		ns
$\overline{IORD}$ high-level width	<33>	t_{WRDH}		T – 10		ns
Delay time from address, $\overline{CSn}$ to $\overline{IORD}$↓	<34>	t_{DARD}		0.5T – 10		ns
Delay time from $\overline{IORD}$↑ to address	<35>	t_{DRDA}		(0.5 + i) T – 10		ns
Delay time from $\overline{IORD}$↑ 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 $\overline{BCYST}$↓)	<39>	t_{SBSW}	**Note**		T – 25	ns
$\overline{WAIT}$ hold time (from $\overline{BCYST}$↑)	<40>	t_{HBSW}	**Note**	0		ns
Delay time from address to $\overline{UWR}$, $\overline{LWR}$↓	<41>	t_{DAWR}		0.5T – 10		ns
Address setup time (to $\overline{UWR}$, $\overline{LWR}$↑)	<42>	t_{SAWR}		$(1.5 + w_D + w)$ T – 10		ns
Delay time from $\overline{UWR}$, $\overline{LWR}$↑ to address	<43>	t_{DWRA}		0.5T – 10		ns
$\overline{UWR}$, $\overline{LWR}$ high-level width	<44>	t_{WWRH}		T – 10		ns
$\overline{UWR}$, $\overline{LWR}$ low-level width	<45>	t_{WWRL}		$(1 + w_D + w)$ T – 10		ns
Delay time from $\overline{UWR}$, $\overline{LWR}$↑ to $\overline{IORD}$↑	<48>	t_{DWRRD}	$w_F = 0$	0		ns
			$w_F = 1$	T – 10		ns
Delay time from $\overline{DMAAKm}$↓ to $\overline{IORD}$↓	<51>	t_{DDARD}		0.5T – 10		ns
Delay time from $\overline{IORD}$↑ to $\overline{DMAAKm}$↑	<52>	t_{DRDDA}		0.5T – 10		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 $\overline{WAIT}$

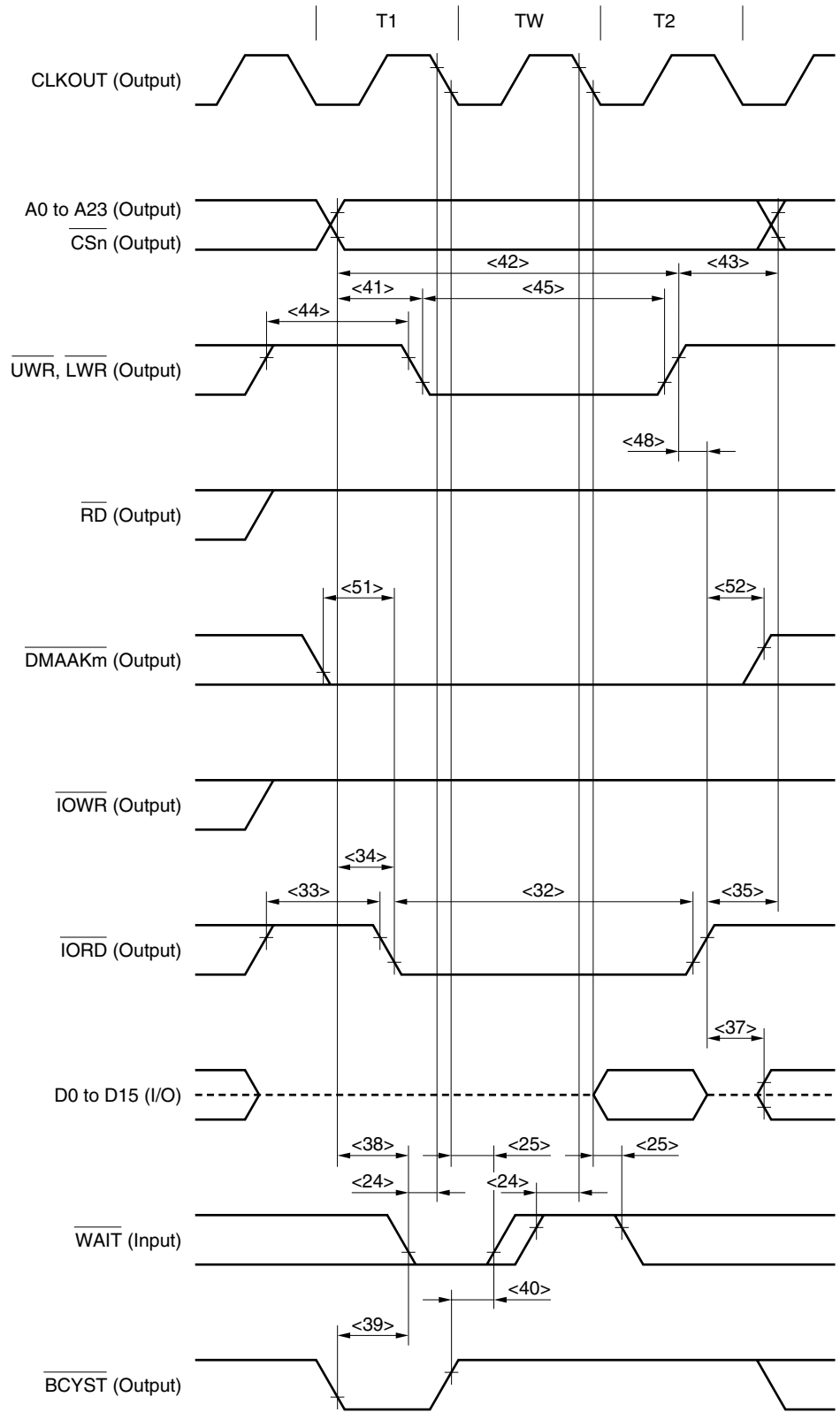
3. w_D: Number of waits specified by registers DWC1 and DWC2.

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
$\overline{WAIT}$ 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
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 $\overline{RD}$)	<31>	t_{SRDID}			(1 + w_D + w) T – 32	ns
Off-page $\overline{RD}$ low-level width	<32>	t_{WRDL}		(1 + w_D + w) T – 10		ns
$\overline{RD}$ high-level width	<33>	t_{WRDH}		0.5T – 10		ns
Data input hold time (from $\overline{RD}$)	<36>	t_{HRDID}		0		ns
Delay time from $\overline{RD}$↑ to data output	<37>	t_{DRDOD}		(0.5 + i) T – 10		ns
On-page $\overline{RD}$ 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 $\overline{RD}$)	<55>	t_{SORDID}			(1.5 + w_{PR} + w) T – 32	ns

Remarks 1. T = t_{CYK}

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

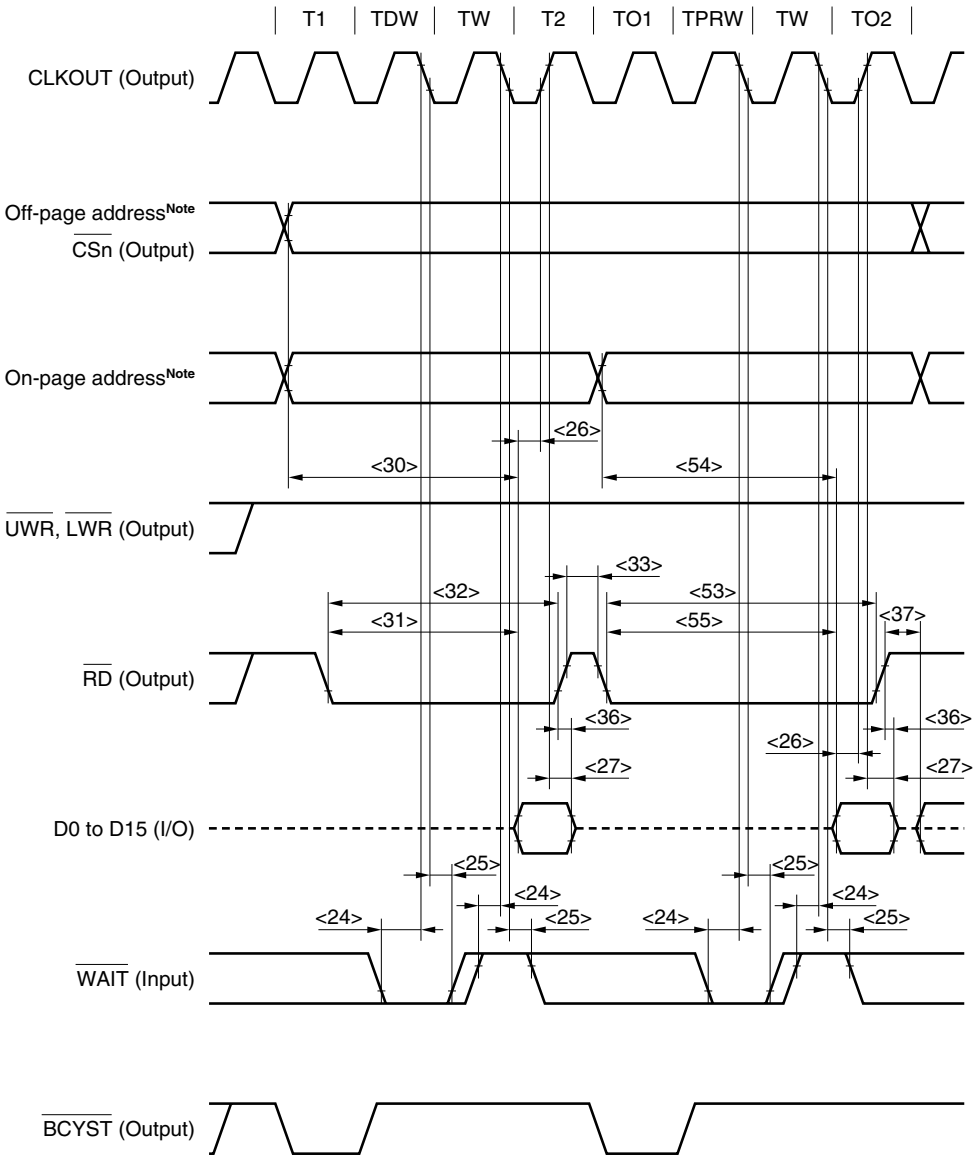
3. w_D: Number of waits specified by registers DWC1 and DWC2.

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
$\overline{WAIT}$ 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
Delay time from $\overline{OE}$↑ to data output	<37>	t_{DRDOD}		(0.5 + i) T – 10		ns
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}		(1.5 + w_{DA} + w) T – 10		ns
Read/write cycle time	<60>	t_{RC}		(3 + w_{RP} + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{RAS}$ recharge time	<61>	t_{RP}		(0.5 + w_{RP}) T – 10		ns
$\overline{RAS}$ pulse time	<62>	t_{RAS}		(2.5 + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{RAS}$ hold time	<63>	t_{RSH}		(1.5 + w_{DA} + w) T – 10		ns
Column address read time for $\overline{RAS}$	<64>	t_{RAL}		(2 + w_{DA} + w) T – 10		ns
$\overline{CAS}$ pulse width	<65>	t_{CAS}		(1 + w_{DA} + w) T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time	<66>	t_{CRP}		(1 + w_{RP}) T – 10		ns
$\overline{CAS}$ hold time	<67>	t_{CSH}		(2 + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{WE}$ setup time	<68>	t_{RCS}		(2 + w_{RP} + w_{RH}) T – 10		ns
$\overline{WE}$ hold time (from $\overline{RAS}$↑)	<69>	t_{RRH}		0.5T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↑)	<70>	t_{RCH}		T – 10		ns
$\overline{CAS}$ precharge time	<71>	t_{CPN}		(2 + w_{RP} + w_{RH}) T – 10		ns
Output enable access time	<72>	t_{OEA}			(2 + w_{RP} + w_{RH} + w_{DA} + w) T – 28	ns
$\overline{RAS}$ access time	<73>	t_{RAC}			(2 + w_{RH} + w_{DA} + w) T – 28	ns
Access time from column address	<74>	t_{AA}			(1.5 + w_{DA} + w) T – 28	ns
$\overline{CAS}$ access time	<75>	t_{CAC}			(1 + w_{DA} + w) T – 28	ns

Remarks 1. T = t_{CYK}

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

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

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

5. w_{DA}: 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.

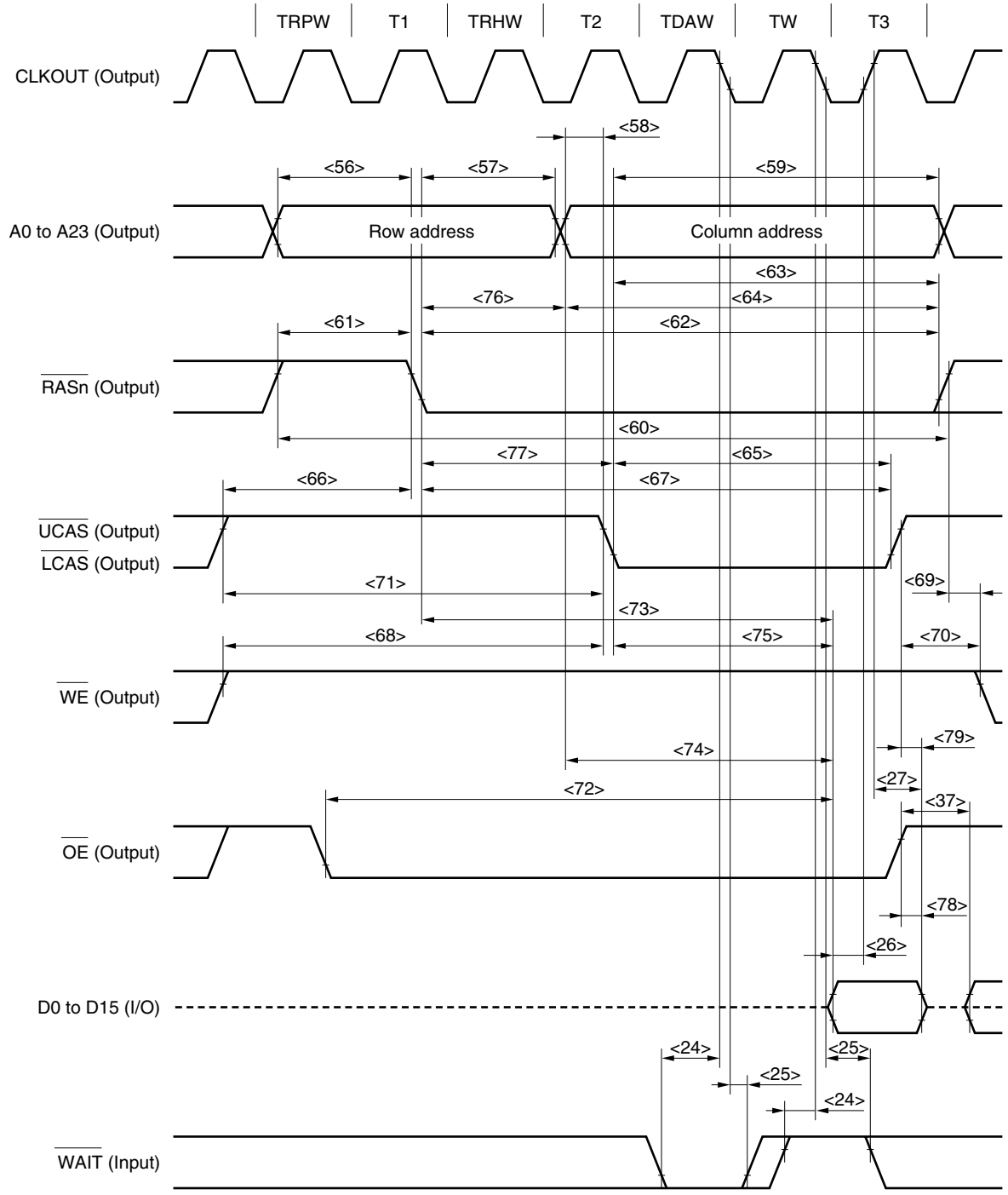
(a) Read timing (high-speed page DRAM access, normal access: off-page) (2/3)

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

Remarks 1. T = t_{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 $\overline{OE}$↑ 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 $\overline{CAS}$↓)	<68>	t_{RCS}		(1 + w_{CP}) T – 10		ns
$\overline{WE}$ hold time (from $\overline{RAS}$↑)	<69>	t_{RRH}		0.5 T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↑)	<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 $\overline{OE}$↑)	<78>	t_{OEZ}		0		ns
Output buffer turn-off delay time (from $\overline{CAS}$↑)	<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

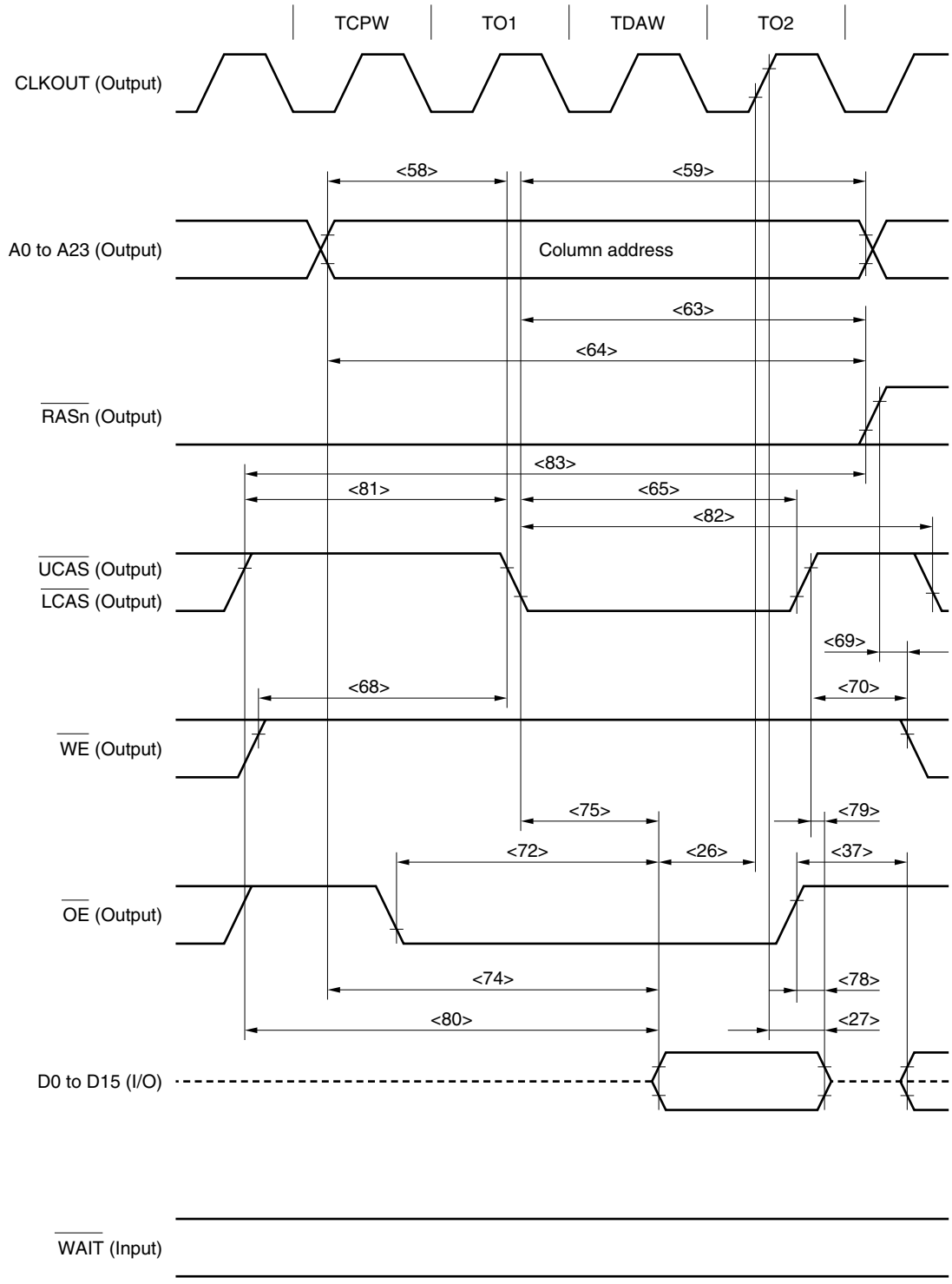
Remarks 1. T = t_{CYK}

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
$\overline{WAIT}$ setup time (to CLKOUT↓)	<24>	t_{SWK}		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	<25>	t_{HKW}		2		ns
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}		(1.5 + w_{DA} + w) T – 10		ns
Read/write cycle time	<60>	t_{RC}		(3 + w_{RP} + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{RAS}$ precharge time	<61>	t_{RP}		(0.5 + w_{RP}) T – 10		ns
$\overline{RAS}$ pulse time	<62>	t_{RAS}		(2.5 + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{RAS}$ hold time	<63>	t_{RSH}		(1.5 + w_{DA} + w) T – 10		ns
Column address read time (from $\overline{RAS}$↑)	<64>	t_{RAL}		(2 + w_{DA} + w) T – 10		ns
$\overline{CAS}$ pulse width	<65>	t_{CAS}		(1 + w_{DA} + w) T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time	<66>	t_{CRP}		(1 + w_{RH}) T – 10		ns
$\overline{CAS}$ hold time	<67>	t_{CSH}		(2 + w_{RH} + w_{DA} + w) T – 10		ns
$\overline{CAS}$ precharge time	<71>	t_{CPN}		(2 + w_{RP} + w_{RH}) T – 10		ns
$\overline{RAS}$ column address delay time	<76>	t_{RAD}		(0.5+ w_{RH}) T – 10		ns
$\overline{RAS}$ to $\overline{CAS}$ delay time	<77>	t_{RCD}		(1 + w_{RH}) T – 10		ns
$\overline{WE}$ setup time (to $\overline{CAS}$↓)	<84>	t_{WCS}		(1 + w_{RP} + w_{RH}) T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↓)	<85>	t_{WCH}		(1 + w_{DA} + w) T – 10		ns
Data setup time (to $\overline{CAS}$↓)	<86>	t_{DS}		(1.5 + w_{RP} + w_{RH}) T – 10		ns
Data hold time (from $\overline{CAS}$↓)	<87>	t_{DH}		(1.5 + w_{DA} + w) T – 10		ns

Remarks 1. T = t_{CYK}

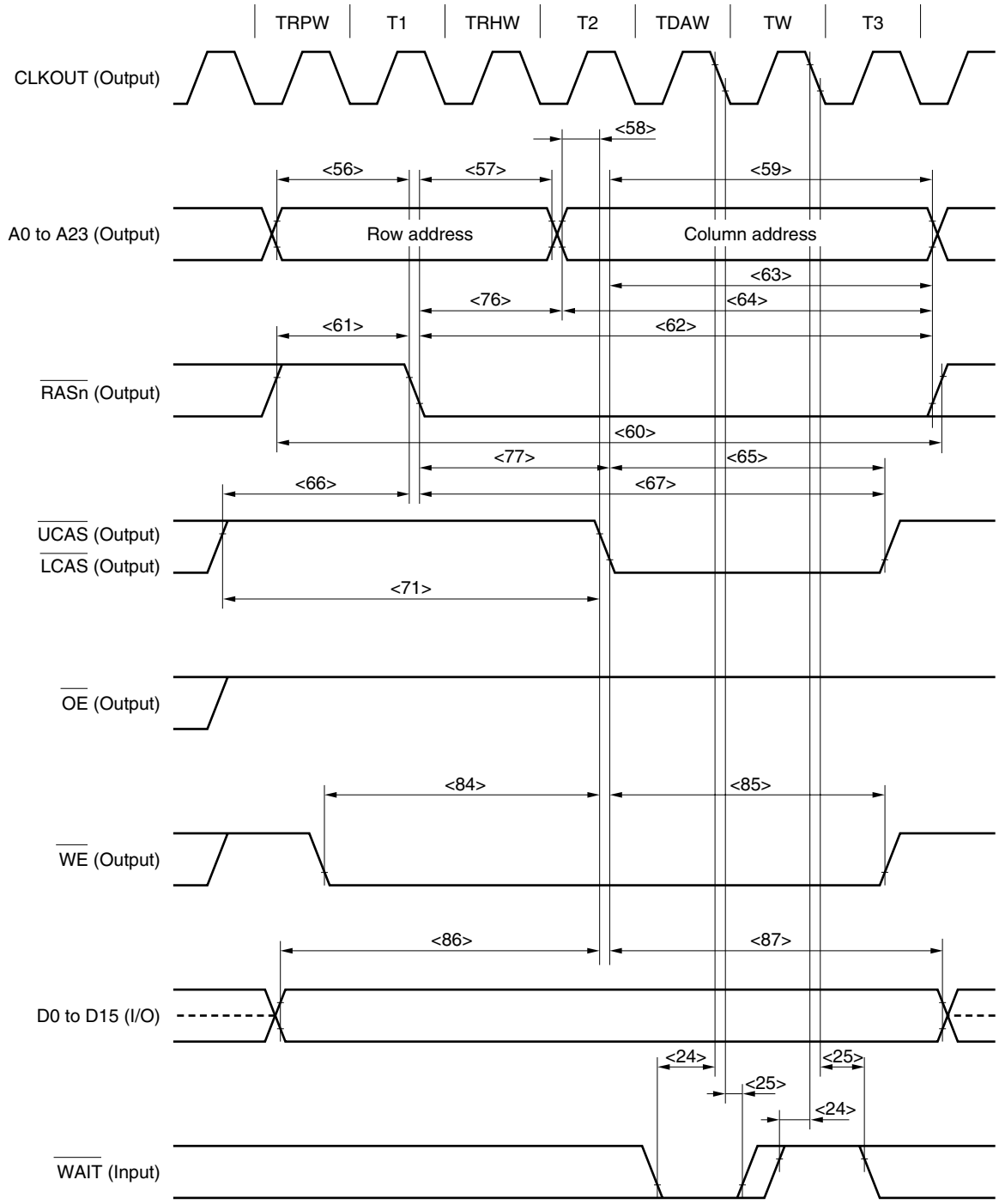
2. w: Number of waits due to $\overline{WAIT}$

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

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

5. w_{DA}: 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)

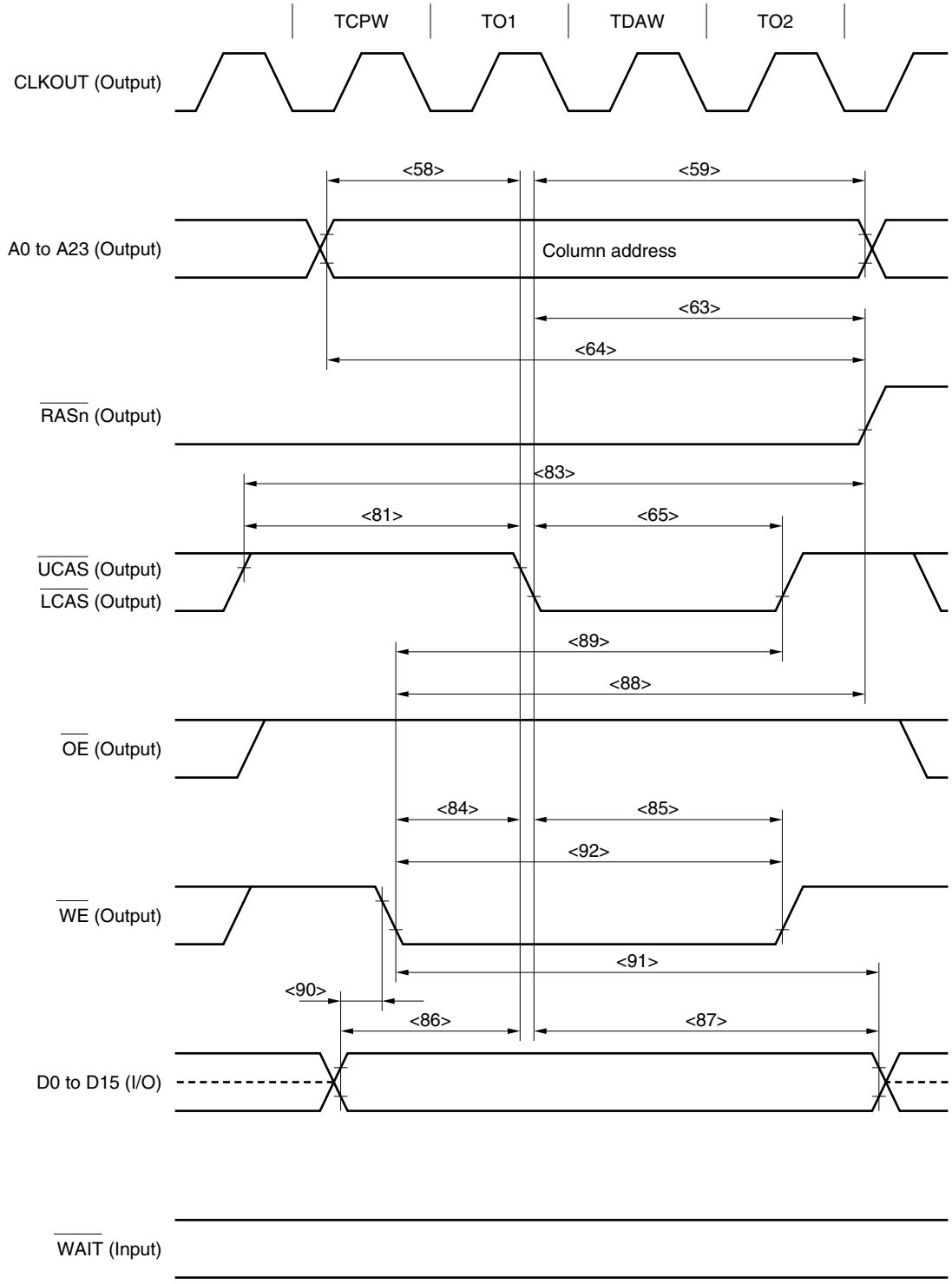
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
Column address setup time	<58>	t_{ASC}		$(0.5 + w_{CP})$ T – 10		ns
Column address hold time	<59>	t_{CAH}		$(1.5 + w_{DA})$ T – 10		ns
$\overline{RAS}$ hold time	<63>	t_{RSH}		$(1.5 + w_{DA})$ T – 10		ns
Column address read time (from $\overline{RAS}\uparrow$)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

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

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 $\overline{OE}$↑ to data output		<37>	t_{DRDOD}		(0.5 + i) T – 10		ns
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
$\overline{RAS}$ precharge time		<61>	t_{RP}		(0.5 + w_{RP}) T – 10		ns
Column address read time (to $\overline{RAS}$↑)		<64>	t_{RAL}		(2 + w_{CP} + w_{DA}) T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time		<66>	t_{CRP}		(1 + w_{RP}) T – 10		ns
$\overline{CAS}$ hold time		<67>	t_{CSH}		(1.5 + w_{RH} + w_{DA}) T – 10		ns
$\overline{WE}$ setup time (to $\overline{CAS}$↓)		<68>	t_{RCS}		(2 + w_{RP} +w_{RH}) T – 10		ns
$\overline{WE}$ hold time (from $\overline{RAS}$↑)		<69>	t_{RRH}		0.5T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↑)		<70>	t_{RCH}		1.5T – 10		ns
$\overline{RAS}$ access time		<73>	t_{RAC}			(2 + w_{RH} + w_{DA}) T – 28	ns
Access time from column address		<74>	t_{AA}			(1.5 + w_{DA}) T – 28	ns
$\overline{CAS}$ access time		<75>	t_{CAC}			(1 + w_{DA}) T – 28	ns
Delay time from $\overline{RAS}$ to column address		<76>	t_{RAD}		(0.5 + w_{RH}) T – 10		ns
$\overline{RAS}$ to $\overline{CAS}$ delay time		<77>	t_{RCD}		(1 + w_{RH}) T – 10		ns
Output buffer turn-off delay time (from $\overline{OE}$)		<78>	t_{OEZ}		0		ns
Access time from $\overline{CAS}$ precharge		<80>	t_{ACP}			(1.5 + w_{CP} + w_{DA}) T – 28	ns
$\overline{CAS}$ precharge time		<81>	t_{CP}		(0.5 + w_{CP}) T – 10		ns
$\overline{RAS}$ hold time for $\overline{CAS}$ precharge		<83>	t_{RHCP}		(2 + w_{CP} + w_{DA}) T – 10		ns
Read cycle time		<93>	t_{HPC}		(1 + w_{DA} + w_{CP}) T – 10		ns
$\overline{RAS}$ pulse width		<94>	t_{RASP}		(2.5 + w_{RH} + w_{DA}) T – 10		ns
$\overline{CAS}$ pulse width		<95>	t_{HCAS}		(0.5 + w_{DA}) T – 10		ns
Hold time from $\overline{OE}$ to $\overline{CAS}$	Off-page	<96>	t_{OCH1}		(2 + w_{RH} + w_{DA}) T – 10		ns
	On-page	<97>	t_{OCH2}		(0.5 + w_{DA}) T – 10		ns
Data input hold time (from $\overline{CAS}$↓)		<98>	t_{DHC}		0		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)

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_{OEA1}			$(2 + w_{RP} + w_{RH} + w_{DA})$ T – 28	ns
	On-page	<100>	t_{OEA2}			$(1 + w_{CP} + w_{DA})$ T – 28	ns

Remarks 1. T = t_{CYK}

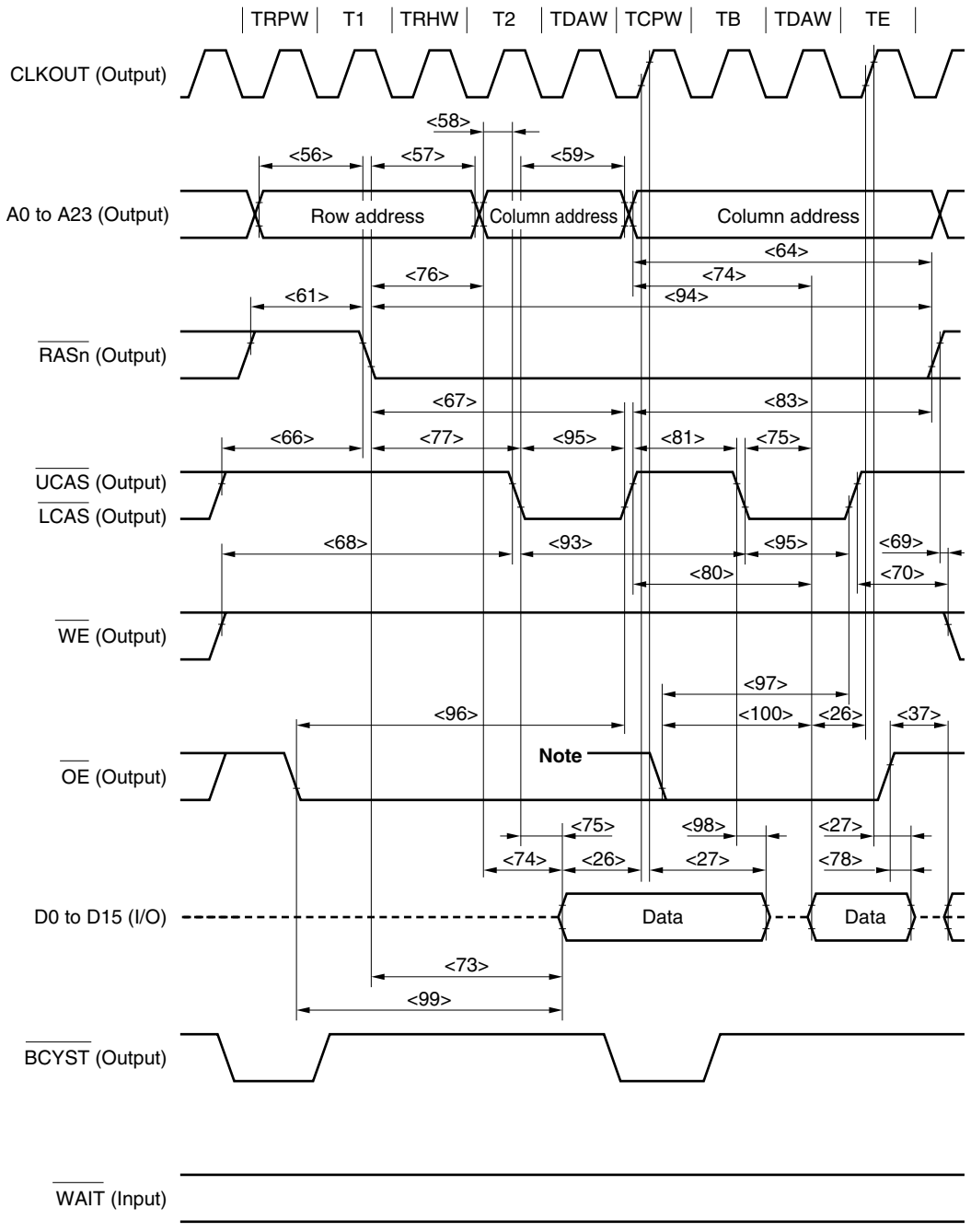
2. w_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

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
$\overline{RAS}$ precharge time		<61>	t_{RP}		(0.5 + w_{RP}) T – 10		ns
$\overline{RAS}$ hold time		<63>	t_{RSH}		(1.5 + w_{DA}) T – 10		ns
Column address read time (to $\overline{RAS}\uparrow$)		<64>	t_{RAL}		(2 + w_{CP} + w_{DA}) T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time		<66>	t_{CRP}		(1 + w_{RP}) T – 10		ns
$\overline{CAS}$ hold time		<67>	t_{CSH}		(1.5 + w_{RH} + w_{DA}) T – 10		ns
Delay time from $\overline{RAS}$ to column address		<76>	t_{RAD}		(0.5 + w_{RH}) T – 10		ns
$\overline{RAS}$ to $\overline{CAS}$ delay time		<77>	t_{RCD}		(1 + w_{RH}) T – 10		ns
$\overline{CAS}$ precharge time		<81>	t_{CP}		(0.5 + w_{CP}) T – 10		ns
$\overline{RAS}$ hold time for $\overline{CAS}$ precharge		<83>	t_{RHCP}		(2 + w_{CP} + w_{DA}) T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}\downarrow$)		<85>	t_{WCH}		(1 + w_{DA}) T – 10		ns
Data hold time (from $\overline{CAS}\downarrow$)		<87>	t_{DH}		(0.5 + w_{DA}) T – 10		ns
$\overline{WE}$ read time (to $\overline{RAS}\uparrow$)	On-page	<88>	t_{RWL}	w_{CP} = 0	(1.5 + tw_{DA}) T – 10		ns
$\overline{WE}$ read time (to $\overline{CAS}\uparrow$)	On-page	<89>	t_{CWL}	w_{CP} = 0	(0.5 + w_{DA}) T – 10		ns
$\overline{WE}$ 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
$\overline{RAS}$ pulse width		<94>	t_{RASP}		(2.5 + w_{RH} + w_{DA}) T – 10		ns
$\overline{CAS}$ pulse width		<95>	t_{HCAS}		(0.5 + w_{DA}) T – 10		ns
$\overline{WE}$ setup time (to $\overline{CAS}\downarrow$)	Off-page	<101>	t_{WCS1}		(1 + w_{RP} + w_{RH}) T – 10		ns
	On-page	<102>	t_{WCS2}	$w_{CP} \geq 1$	w_{CP}T – 10		ns
Data setup time (to $\overline{CAS}\downarrow$)	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}

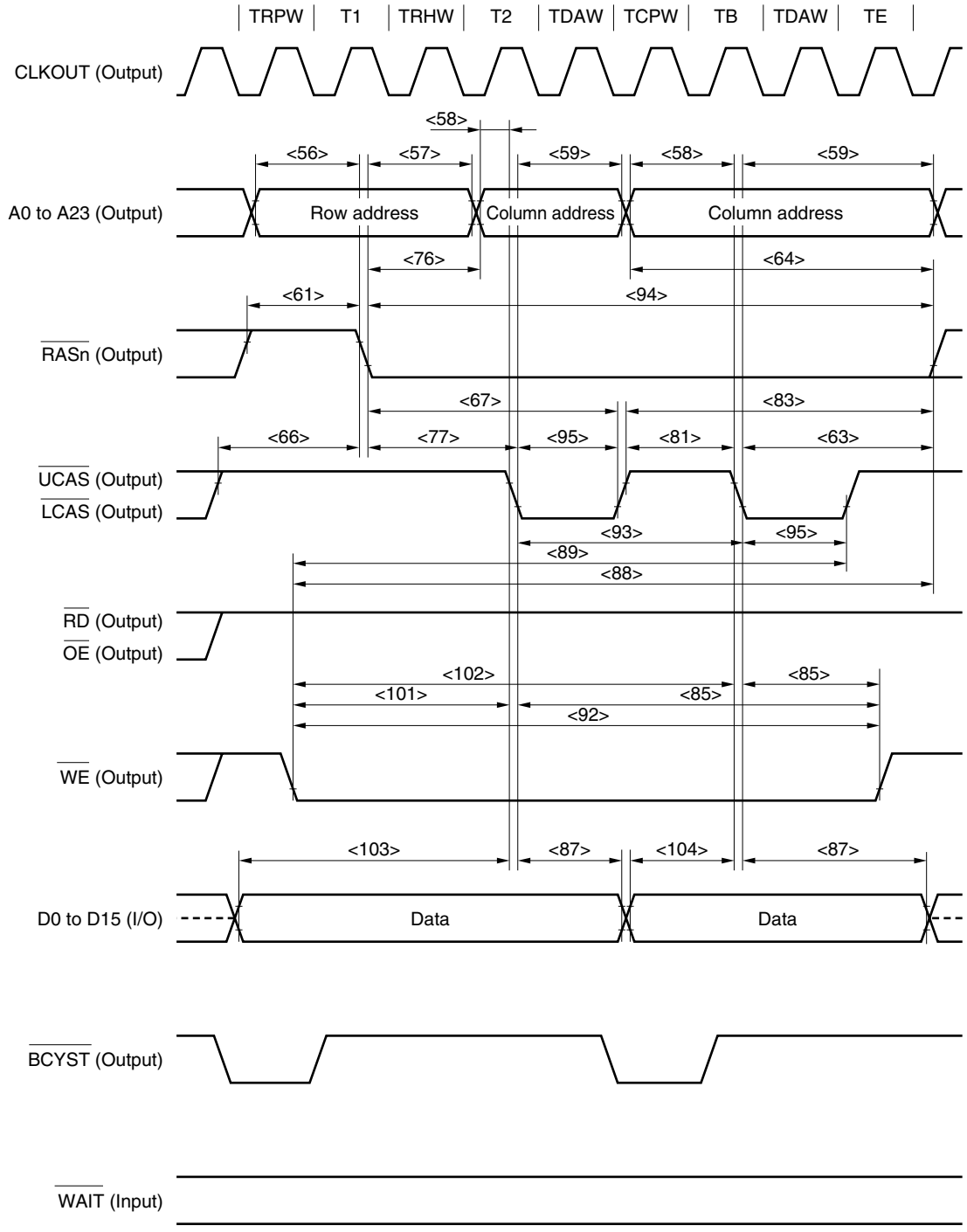
2. w_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

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
$\overline{WAIT}$ setup time (to CLKOUT↓)	<24>	t_{SWK}		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	<25>	t_{HKW}		2		ns
Delay time from $\overline{OE}$↑ to data output	<37>	t_{DRDOD}		(0.5 + i) T – 10		ns
Delay time from address to $\overline{IOWR}$↓	<41>	t_{DAWR}		($0.5 + w_{RP}$) T – 10		ns
Address setup time (to $\overline{IOWR}$↑)	<42>	t_{SAWR}		($2 + w_{RP} + w_{RH} + w_{DA} + w$) T –10		ns
Delay time from $\overline{IOWR}$↑ to address	<43>	t_{DWRA}		0.5T – 10		ns
Delay time from $\overline{IOWR}$↑ to $\overline{RD}$↑	<48>	t_{DWRRD}	w_F = 0	0		ns
			w_F = 1	T – 10		ns
$\overline{IOWR}$ low-level width	<50>	t_{WWRL}		($2 + w_{RH} + w_{DA} + w$) T – 10		ns
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}		($1.5 + w_{DA} + w_F + w$) T – 10		ns
Read/write cycle time	<60>	t_{RC}		($3 + w_{RP} + w_{RH} + w_{DA} + w_F + w$) T – 10		ns
$\overline{RAS}$ precharge time	<61>	t_{RP}		($0.5 + w_{RP}$) T – 10		ns
$\overline{RAS}$ hold time	<63>	t_{RSH}		($1.5 + w_{DA} + w_F + w$) T – 10		ns
Column address read time for $\overline{RAS}$	<64>	t_{RAL}		($2 + w_{CP} + w_{DA} + w_F + w$) T – 10		ns
$\overline{CAS}$ pulse width	<65>	t_{CAS}		($1 + w_{DA} + w_F + w$) T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time	<66>	t_{CRP}		($1 + w_{RP}$) T –10		ns
$\overline{CAS}$ hold time	<67>	t_{CSH}		($2 + w_{RH} + w_{DA} + w_F + w$) T – 10		ns
$\overline{WE}$ setup time (to $\overline{CAS}$↓)	<68>	t_{RCS}		($2 + w_{RP} + w_{RH}$) T – 10		ns
$\overline{WE}$ hold time (from $\overline{RAS}$↑)	<69>	t_{RRH}		0.5T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↑)	<70>	t_{RCH}		1.5T – 10		ns
$\overline{CAS}$ precharge time	<71>	t_{CPN}		($2 + w_{RP} + w_{RH}$) T – 10		ns
Delay time from $\overline{RAS}$ to column address	<76>	t_{RAD}		($0.5 + w_{RH}$) T – 10		ns
$\overline{RAS}$ to $\overline{CAS}$ delay time	<77>	t_{RCD}		($1 + w_{RH}$) T – 10		ns

Remarks 1. T = t_{CYK}

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

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

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

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

6. w_{CP}: Number of waits specified by CPCxx 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. 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>	t_{OEZ}		0		ns
Output buffer turn-off delay time (from $\overline{CAS}\uparrow$)		<79>	t_{OFF}		0		ns
$\overline{CAS}$ precharge time		<81>	t_{CP}		$(0.5 + w_{CP})$ T – 10		ns
High-speed mode cycle time		<82>	t_{PC}		$(2 + w_{CP} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{RAS}$ hold time for $\overline{CAS}$ precharge		<83>	t_{RHCP}		$(2.5 + w_{CP} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{RAS}$ pulse width		<94>	t_{RASP}		$(2.5 + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns
Hold time from $\overline{OE}$ to $\overline{CAS}$ (from $\overline{CAS}\uparrow$)	Off-page	<96>	t_{OCH1}		$(2.5 + w_{RP} + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns
	On-page	<97>	t_{OCH2}		$(1.5 + w_{CP} + w_{DA} + w_F + w)$ T – 10		ns
Delay time from $\overline{DMAAKm}\downarrow$ to $\overline{CAS}\downarrow$		<105>	t_{DDACS}		$(1.5 + w_{RH})$ T – 10		ns
Delay time from $\overline{IOWR}\downarrow$ to $\overline{CAS}\downarrow$		<106>	t_{DRDCS}		$(1 + w_{RH})$ 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)

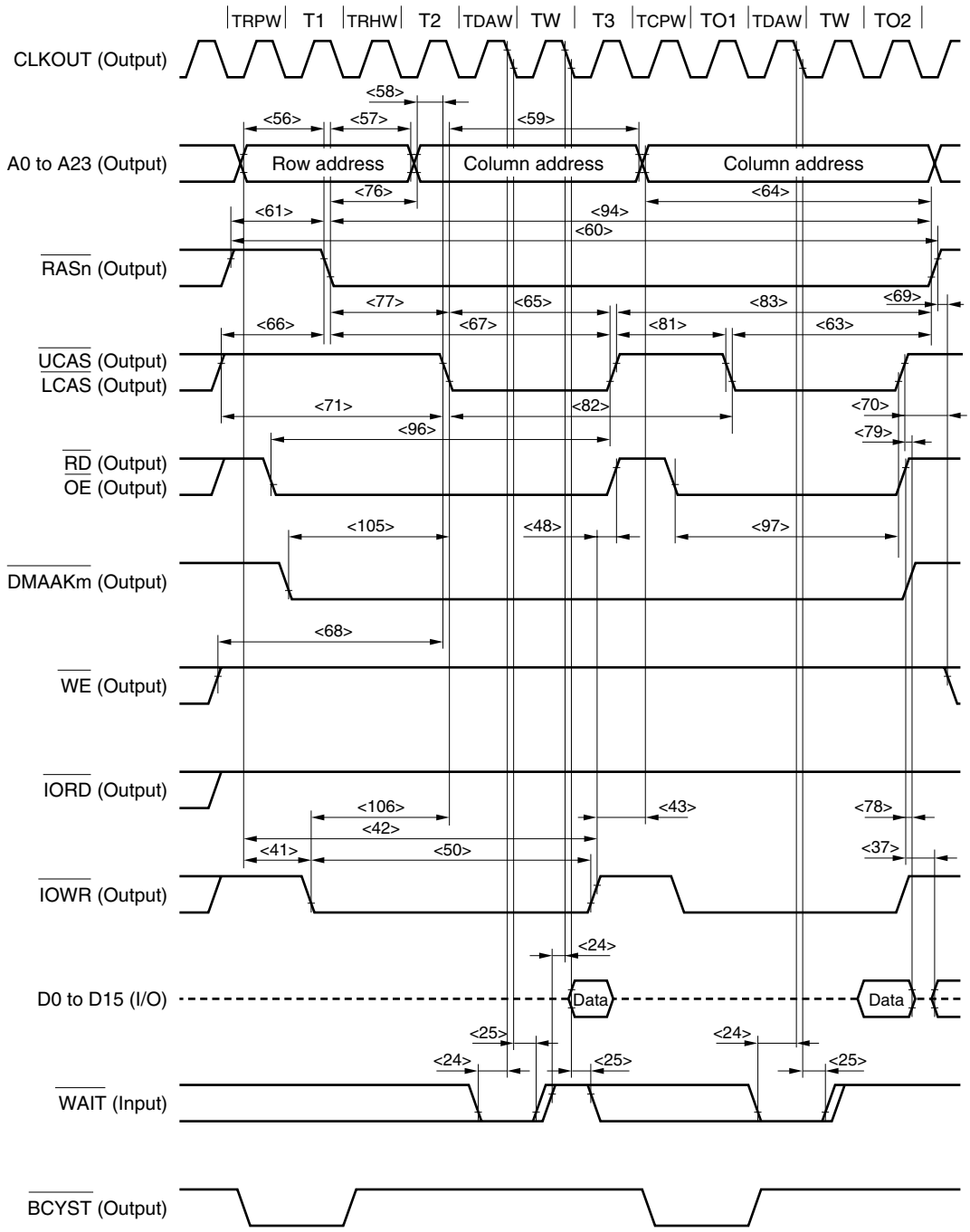
5. w_{RH}: Number of waits specified by RHCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

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
$\overline{WAIT}$ setup time (to CLKOUT↓)	<24>	t_{SWK}		15		ns
$\overline{WAIT}$ hold time (from CLKOUT↓)	<25>	t_{HKW}		2		ns
$\overline{IORD}$ low-level width	<32>	t_{WRDL}		$(2 + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{IORD}$ high-level width	<33>	t_{WRDH}		T – 10		ns
Delay time from address to $\overline{IORD}$↑	<34>	t_{DARD}		0.5T – 10		ns
Delay time from $\overline{IORD}$↑ to address	<35>	t_{DRDA}		(0.5 + i) T – 10		ns
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}		$(1.5 + w_{DA} + w_F)$ T – 10		ns
Read/write cycle time	<60>	t_{RC}		$(3 + w_{RP} + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{RAS}$ precharge time	<61>	t_{RP}		$(0.5 + w_{RP})$ T – 10		ns
$\overline{RAS}$ hold time	<63>	t_{RSH}		$(1.5 + w_{DA} + w_F)$ T – 10		ns
Column address read time for $\overline{RAS}$	<64>	t_{RAL}		$(2 + w_{CP} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{CAS}$ pulse width	<65>	t_{CAS}		$(1 + w_{DA} + w_F)$ T – 10		ns
$\overline{CAS}$ to $\overline{RAS}$ precharge time	<66>	t_{CRP}		$(1 + w_{RP})$ T – 10		ns
$\overline{CAS}$ hold time	<67>	t_{CSH}		$(2 + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{CAS}$ precharge time	<71>	t_{CPN}		$(2 + w_{RP} + w_{RH} + w)$ T – 10		ns
Delay time from $\overline{RAS}$ to column address	<76>	t_{RAD}		$(0.5 + w_{RH})$ T – 10		ns
$\overline{RAS}$ to $\overline{CAS}$ delay time	<77>	t_{RCD}		$(1 + w_{RH} + w)$ T – 10		ns
$\overline{CAS}$ precharge time	<81>	t_{CP}		$(0.5 + w_{CP} + w)$ T – 10		ns
High-speed page mode cycle time	<82>	t_{PC}		$(2 + w_{CP} + w_{DA} + w_F + w)$ T – 10		ns
$\overline{RAS}$ hold time for $\overline{CAS}$ precharge	<83>	t_{RHCP}		$(2.5 + w_{CP} + w_{DA} + w)$ T – 10		ns
$\overline{WE}$ hold time (from $\overline{CAS}$↓)	<85>	t_{WCH}		$(1 + w_{DA})$ T – 10		ns
$\overline{WE}$ read time (to $\overline{RAS}$↑)	<88>	t_{RWL}	$w_{CP} = 0$	$(1.5 + w_{DA} + w)$ T – 10		ns
$\overline{WE}$ read time (to $\overline{CAS}$↑)	<89>	t_{CWL}	$w_{CP} = 0$	$(1 + w_{DA} + w)$ T – 10		ns
$\overline{WE}$ pulse width	<92>	t_{WP}	$w_{CP} = 0$	$(1 + w_{DA} + w)$ T – 10		ns
$\overline{RAS}$ pulse width	<94>	t_{RASP}		$(2.5 + w_{RH} + w_{DA} + w_F + w)$ T – 10		ns

Remarks 1. T = t_{CYK}

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

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

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

6. w_{CP}: Number of waits specified by CPCxx 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. i: Number of idle states inserted when a write cycle follows the read cycle.

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

Parameter		Symbol		Conditions	MIN.	MAX.	Unit
$\overline{WE}$ setup time (to $\overline{CAS}\downarrow$)	Off-page	<101>	t_{WCS1}	$w_{CP} = 0$	$(1 + w_{RH} + w_{RP} + w) T - 10$		ns
	On-page	<102>	t_{WCS2}	$w_{CP} \geq 1$	$w_{CP}T - 10$		ns
Delay time from $\overline{DMAAKm}\downarrow$ to $\overline{CAS}\downarrow$		<105>	t_{DDACS}		$(1.5 + w_{RH} + w) T - 10$		ns
Delay time from $\overline{IORD}\downarrow$ to $\overline{CAS}\downarrow$		<106>	t_{DRDCS}		$(1 + w_{RH} + w) T - 10$		ns
Delay time from $\overline{WE}\uparrow$ to $\overline{IORD}\uparrow$		<107>	t_{DWERD}	$w_F = 0$	0		ns
				$w_F = 1$	$T - 10$		ns

Remarks 1. $T = t_{CYK}$

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

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

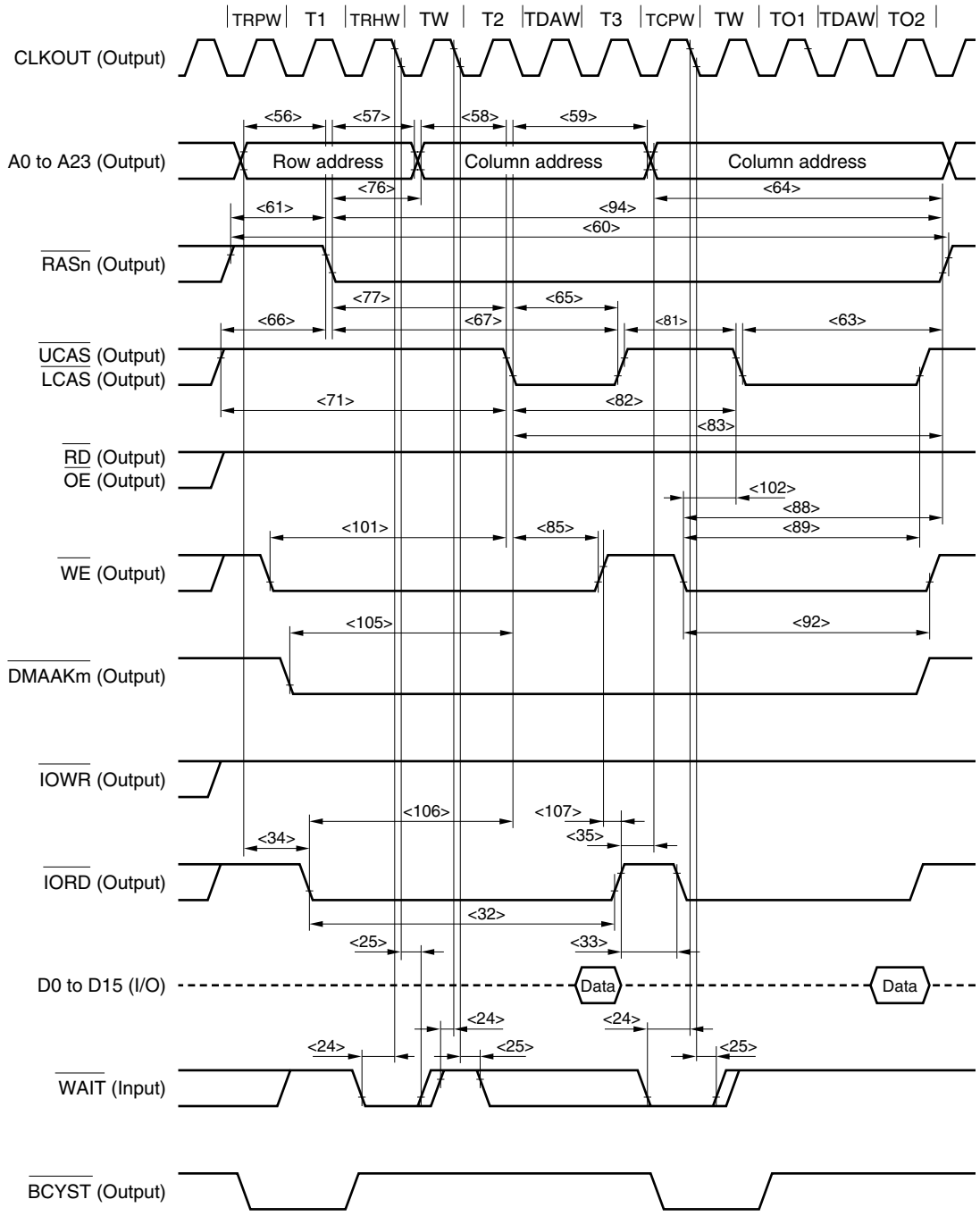
4. w_{RP}: Number of waits specified by RPCxx bit of register DRCn (n = 0 to 3, xx = 00 to 03, 10 to 13)

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

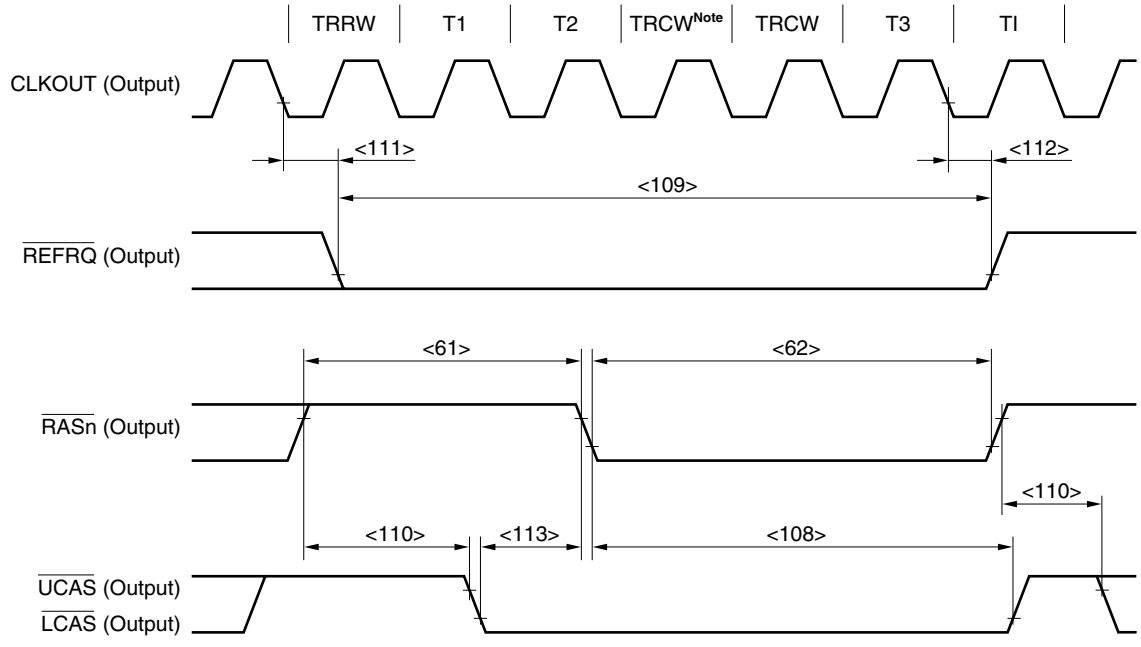
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
$\overline{RAS}$ precharge time	<61>	t_{RP}		(1.5 + w_{RRW}) T – 10		ns
$\overline{RAS}$ pulse width	<62>	t_{RAS}		(1.5 + w_{RCW}[Note]) T – 10		ns
$\overline{CAS}$ hold time	<108>	t_{CHR}		(1.5 + w_{RCW}[Note]) T – 10		ns
$\overline{REFRQ}$ pulse width	<109>	t_{WRFL}		(3 + w_{RRW} + w_{RCW}[Note]) T – 10		ns
$\overline{RAS}$ precharge $\overline{CAS}$ hold time	<110>	t_{RPC}		(0.5 + w_{RRW}) T – 10		ns
$\overline{REFRQ}$ active delay time (from CLKOUT↓)	<111>	t_{DKRF}		2	10	ns
$\overline{REFRQ}$ inactive delay time (from CLKOUT↓)	<112>	t_{HKRF}		2	10	ns
$\overline{CAS}$ 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

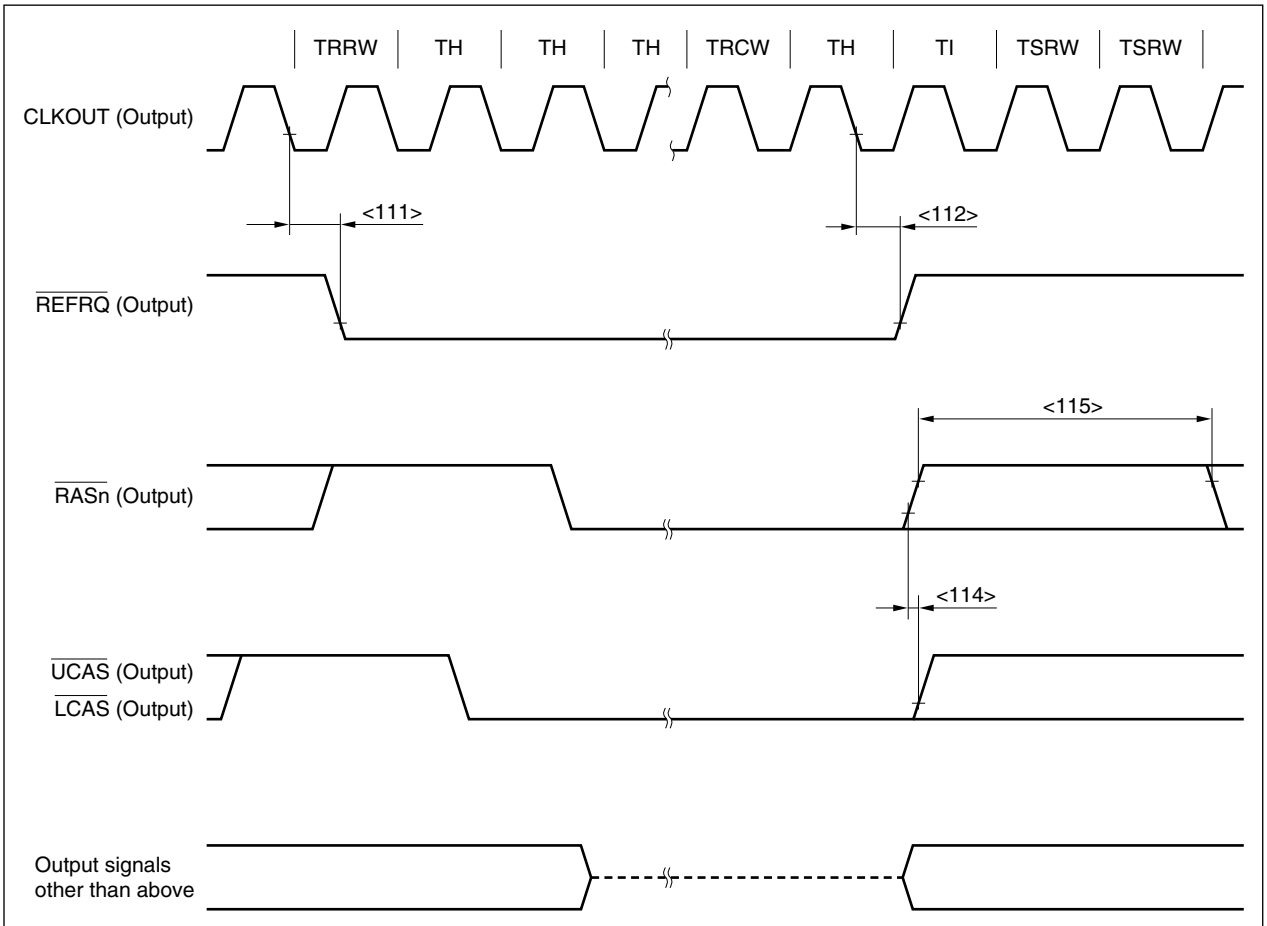
2. n = 0 to 7

(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_{SRW}) T – 10		ns

Remarks 1. T = t_{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

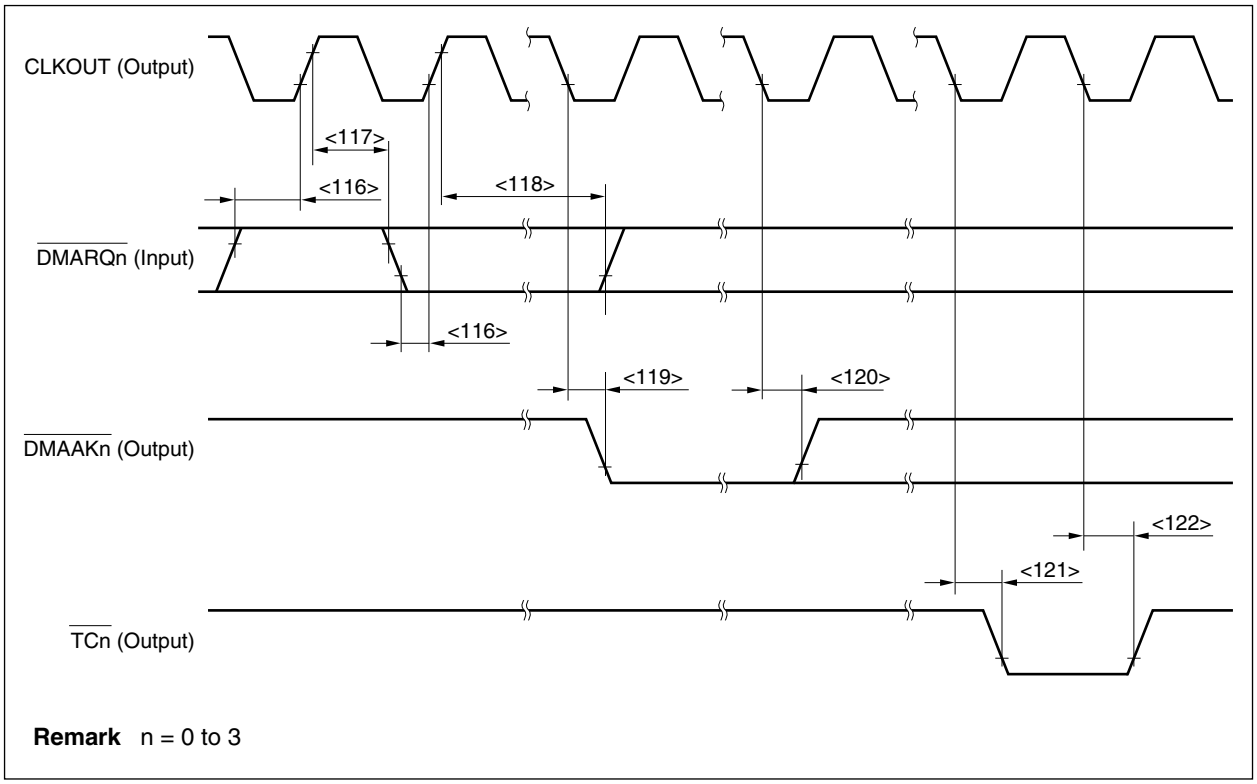
2. Broken lines indicate high impedance.

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 $\overline{\text{DMAAKn}}$↓		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

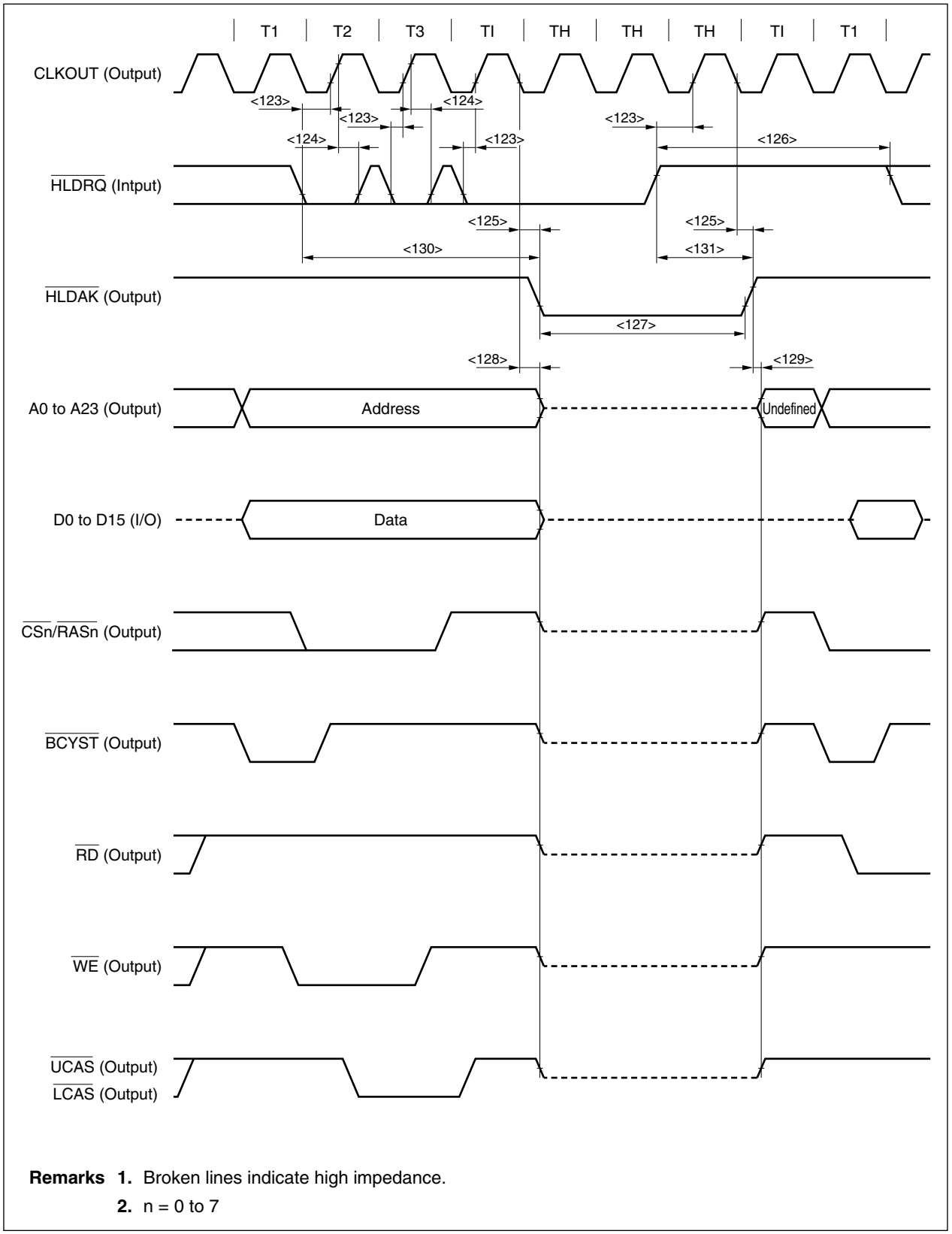
[MEMO]

(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}

(8) Bus hold timing (2/2)



Remarks 1. Broken lines indicate high impedance.

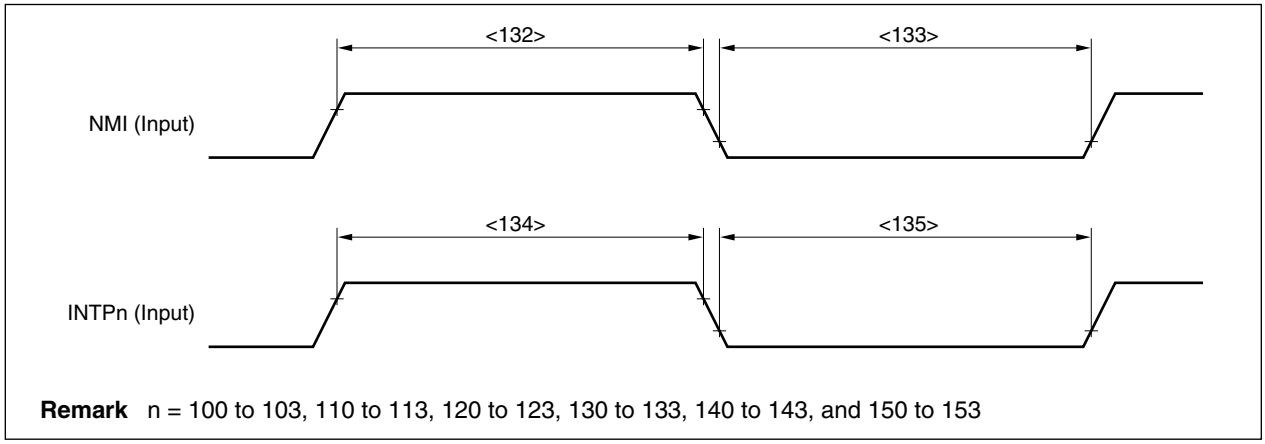
2. n = 0 to 7

(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_{WITL}		4T + 10		ns

Remarks 1. n = 100 to 103, 110 to 113, 120 to 123, 130 to 133, 140 to 143, and 150 to 153

2. T = t_{CYK}



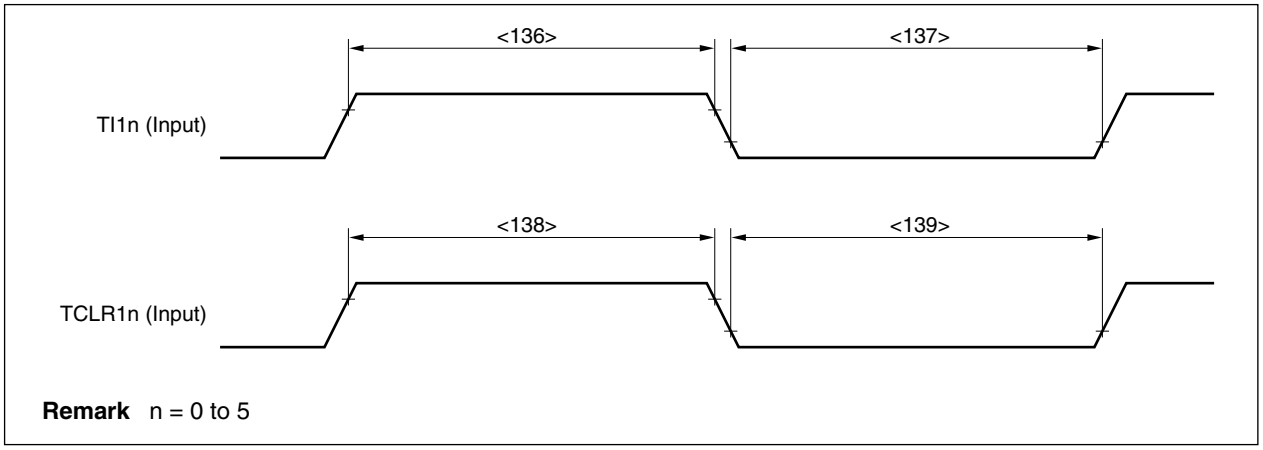
Remark n = 100 to 103, 110 to 113, 120 to 123, 130 to 133, 140 to 143, and 150 to 153

(10) RPU timing

Parameter	Symbol		Conditions	MIN.	MAX.	Unit
TI1n high-level width	<136>	t_{WTIH}		3T + 18		ns
TI1n 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 1. n = 0 to 5

2. T = t_{CYK}

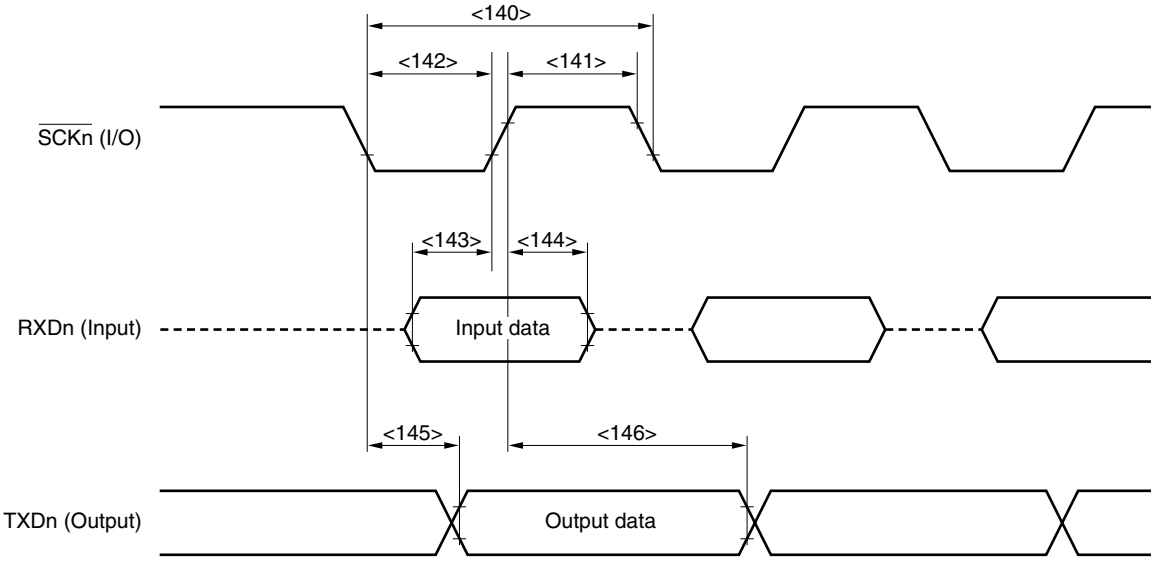


Remark n = 0 to 5

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

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

Remark n = 0, 1



Remarks 1. Broken lines indicate high impedance.

2. n = 0, 1

(12) CSI0 to CSI3 timing

(a) Master mode

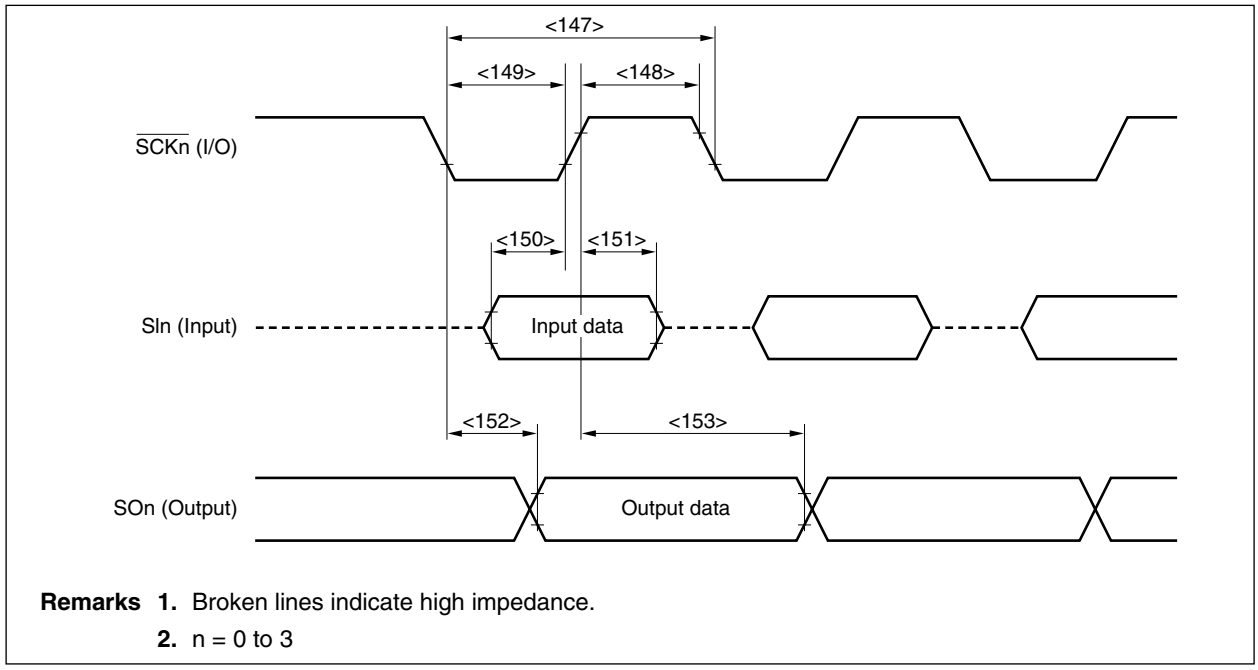
Parameter	Symbol		Conditions	MIN.	MAX.	Unit
$\overline{SCKn}$ cycle	<147>	t_{CYSK1}	Output	100		ns
$\overline{SCKn}$ high-level width	<148>	t_{WSK1H}	Output	$0.5t_{CYSK1} - 20$		ns
$\overline{SCKn}$ low-level width	<149>	t_{WSK1L}	Output	$0.5t_{CYSK1} - 20$		ns
SIn setup time (to $\overline{SCKn}\uparrow$)	<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°C, V_{DD} = CV_{DD} = 3.0 to 3.6 V, HV_{DD} = 5.0 V ±10%, V_{SS} = 0 V, HV_{DD} – 0.5 V ≤ AV_{DD} ≤ HV_{DD})

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution	–		10			bit
Overall error	–				±4	LSB
Quantization error	–				±1/2	LSB
Conversion time	t_{CONV}		5		10	μs
★ Sampling time	t_{SAMP}		Conversion clock[Note]/6			ns
Zero scale error	–				±4	LSB
Scale error	–				±4	LSB
Linearity error	–				±3	LSB
Analog input voltage	V_{IAN}		–0.3		AV_{REF} + 0.3	V
Analog input resistance	R_{AN}			2		MΩ
AV_{REF} input voltage	AV_{REF}	AV_{REF} = AV_{DD}	4.5		5.5	V
AV_{REF} input current	AI_{REF}				2.0	mA
AV_{DD} current	AI_{DD}				6	mA

★ **Note** The conversion clock is the clock value set by the ADM1 register.

4.2 Flash Memory Programming Mode

★ **Basic Characteristics (T_A = –40 to +85°C (Other Than When Rewriting), HV_{DD} = AV_{DD} = 4.5 to 5.5 V, V_{DD} = 3.0 to 3.6 V, V_{SS} = AV_{SS} = 0 V) (1/2)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating frequency	f_X		20		33	MHz
V_{PP} supply voltage	V_{PP1}	During flash memory programming	7.5	7.8	8.1	V
	V_{PPL}	V_{PP} low-level detection	$0.8V_{DD}$		$1.2V_{DD}$	V
	V_{PPM}	V_{PP} and V_{DD} level detection	$0.65V_{DD}$	V_{DD}	V_{DD} + 0.3	V
	V_{PPH}	V_{PP} high-voltage level detection	7.5	7.8	8.1	V
HV_{DD} supply current	I_{DD}	V_{PP} = V_{PP1}			50	mA
V_{PP} supply current	I_{PP}	V_{PP} = 8.1 V			150	mA
Step erase time	t_{ER}	K, P category[Note 1] (Recommendation: Step erase = 5 s)		5		s
		Other than K, P category[Note 1] (Recommendation: Step erase = 0.2 s)		0.2		s
Total erase time	t_{ERA}	K, P category[Note 1] When step erase time = 5 s **Note 2**			60	s
		Other than K, P category[Note 1] When step erase time = 0.2 s **Note 2**			20	s
Write-back time	t_{WB}	**Note 3**	0.99	1	1.01	ms

Notes 1. The category is indicated by the fifth letter from the left of the lot number.

2. The prewrite time prior to erasure and the erase verify time (write-back time) are not included.

3. The recommended set value of the write-back time is 1 ms.

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

Remark When PG-FP3 is used, the time parameters required for write/erase are automatically set by downloading parameter files. Do not change the set values unless otherwise specified.

★ **Basic Characteristics (T_A = –40 to +85°C (Other Than When Rewriting), HV_{DD} = AV_{DD} = 4.5 to 5.5 V, V_{DD} = 3.0 to 3.6 V, V_{SS} = AV_{SS} = 0 V) (2/2)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Number of write-backs per write-back command	C_{WB}	When write-back time = 1 ms **Note 1**			300	Times/write-back command
Number of erase/write-backs	C_{ERWB}				16	Times
Step write time	t_{WT}	**Note 2**	18	20	22	μs
Total write time per word	t_{WTW}	Setting: Step write time = 20 μs (1 word = 4 bytes) **Note 3**	20		200	μs/word
Number of rewrites	C_{ERWR}	K category[Note 4]	5			Tiimes
		P category[Note 4]	10			Times
		Other than K, P category[Note 4] One erase + one write after erase = one rewrite **Note 5**	20			Times
Temperature during write	T_{PRG}	K, P category[Note 4]	10		40	°C
		Other than K, P category[Note 4]	10		85	°C

Notes 1. When the write-back command is issued, write-back is performed once. Therefore, the retry count must be the maximum value minus the number of commands issued.

2. The recommended set value of the step write time is 20 μs.

3. The actual write time per word is the sum of this value plus 100 μs. The internal verify time during and after write is not included.

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

5. When writing initially to shipped products, “erase to write” and “write only” are both counted as one rewrite.

Example (P: Write E: Erase)

Product ⟶ P → E → P → E → P: Three rewrites

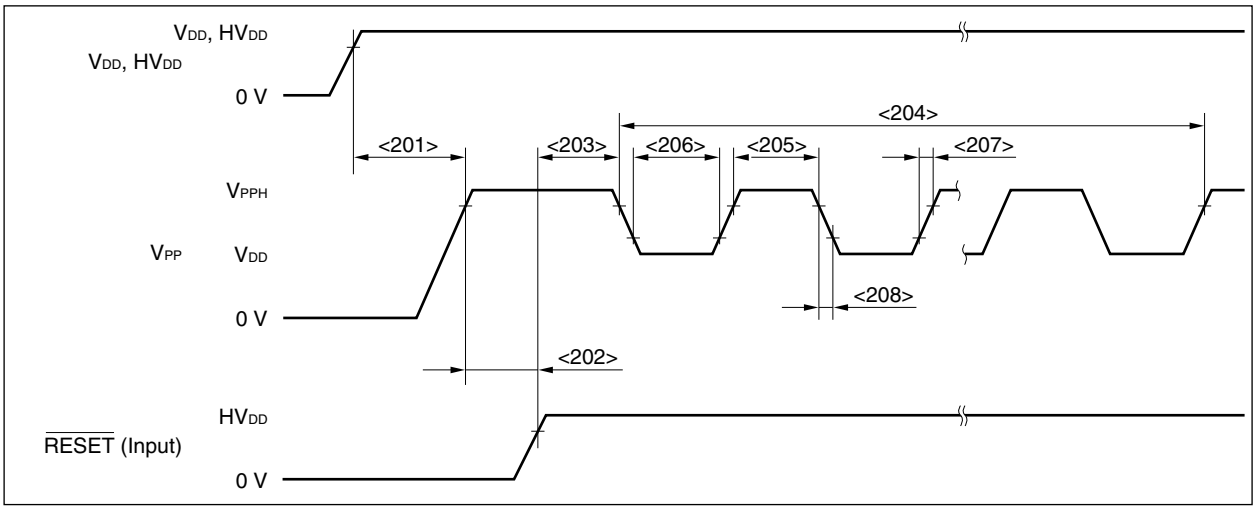
Product → E → P → E → P → E → P: Three rewrites

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

Remark When PG-FP3 is used, the time parameters required for write/erase are automatically set by downloading parameter files. Do not change the set values unless otherwise specified.

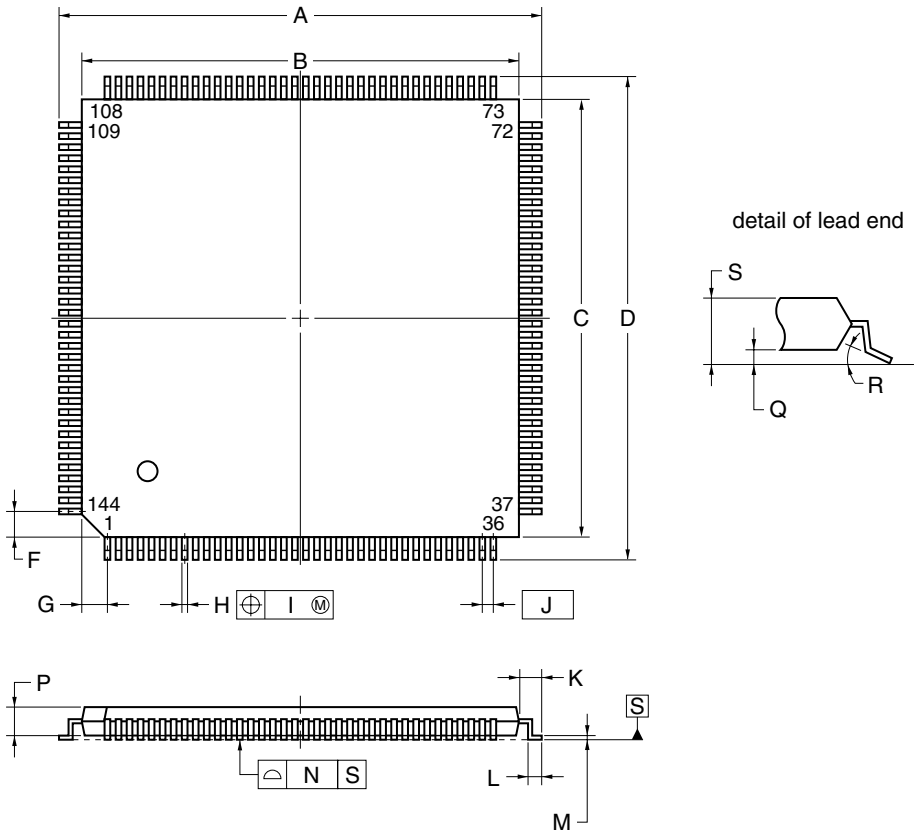
Serial Write Operation Characteristics

Parameter	Symbol		Conditions	MIN.	TYP.	MAX.	Unit
V_{DD}↑ to V_{PP}↑ set time	<201>	t_{DRPSR}		200			ns
V_{PP}↑ to $\overline{RESET}$↑ set time	<202>	t_{PSRRF}		1			μs
$\overline{RESET}$↑ 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)



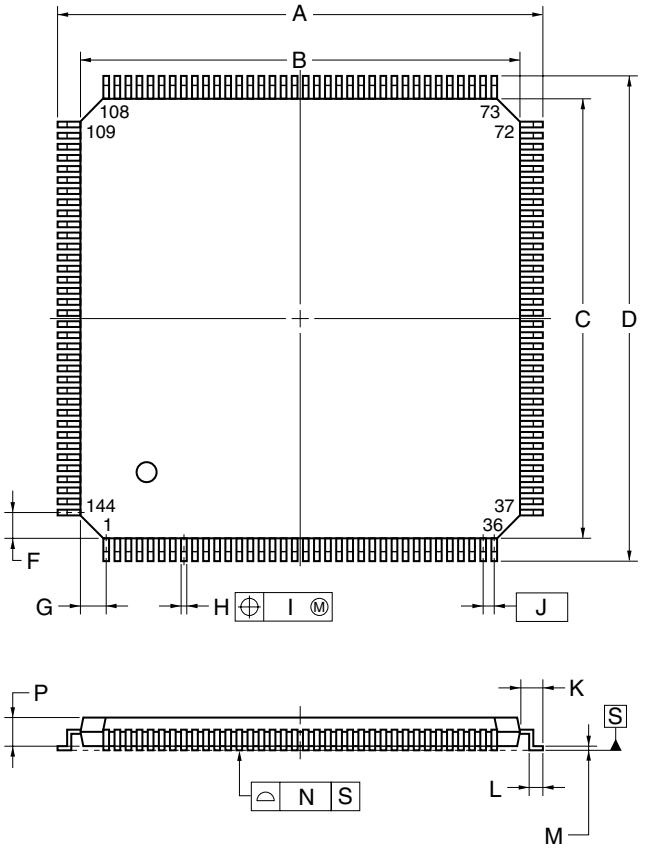
NOTE

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

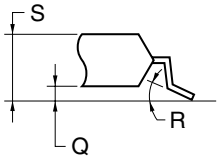
ITEM	MILLIMETERS
A	22.0±0.2
B	20.0±0.2
C	20.0±0.2
D	22.0±0.2
F	1.25
G	1.25
H	$0.22^{+0.05}_{-0.04}$
I	0.10
J	0.5 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	$0.145^{+0.055}_{-0.045}$
N	0.10
P	1.4±0.1
Q	0.125±0.075
R	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$
S	1.7 MAX.

S144GJ-50-8EU-3

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



detail of lead end



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	$3^{\circ}{}^{+4^{\circ}}_{-3^{\circ}}$
S	1.5±0.1

S144GJ-50-UEN

6. RECOMMENDED SOLDERING CONDITIONS

The μPD70F3102-33 should be soldered and mounted under the following recommended conditions.
For technical information, see the following website.

Semiconductor Device Mount Manual (http://www.necel.com/pkg/en/mount/index.html)

Table 6-1. Surface Mounting Type Soldering Conditions

μPD70F3102GJ-33-8EU: 144-pin plastic LQFP (fine pitch) (20 × 20)

★ **μPD70F3102GJ-33-UEN: 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
★ VPS	Package peak temperature: 215°C, Time: 25 to 40 seconds max. (at 200°C or higher), Count: Twice or less, Exposure limit: 3 days[Note] (after that, prebake at 125°C for 10 hours)	VP15-103-2
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 Do not use different soldering methods together (except for partial heating).**

★ **Remarks 1.** For soldering methods and conditions other than those recommended above, consult an NEC Electronics sales representative.

★ **2.** The soldering conditions for the μPD70F3102GJ-33-8EU-A have not been determined.

★ **3.** Products with -A at the end of the part number are lead-free products.

NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (MAX) and V_{IH} (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (MAX) and V_{IH} (MIN).

② HANDLING OF UNUSED INPUT PINS

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD

A 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 when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up 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 benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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 (U15170J[Note])

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- Availability of related technical literature
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