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TOSHIBA

TENTATIVE   TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

32 GBIT (4G × 8 BIT) CMOS NAND E^{2}PROM
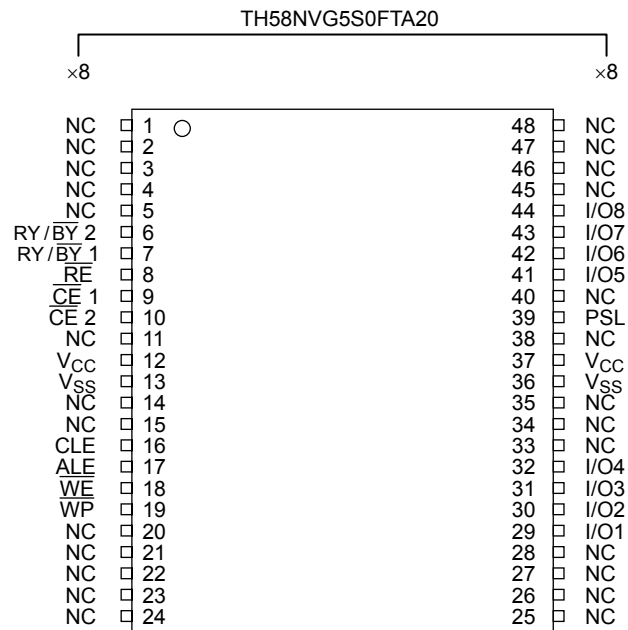
DESCRIPTION

The TH58NVG5S0F is a single 3.3V 32 Gbit (36,305,895,424 bits) NAND Electrically Erasable and Programmable Read-Only Memory (NAND E²PROM) organized as (4096 + 232) bytes × 64 pages × 16384 blocks. The device has two 4328-byte static registers which allow program and read data to be transferred between the register and the memory cell array in 4328-byte increments. The Erase operation is implemented in a single block unit (256 Kbytes + 14.5 Kbytes: 4328 bytes × 64 pages).

The TH58NVG5S0F is a serial-type memory device which utilizes the I/O pins for both address and data input/output as well as for command inputs. The Erase and Program operations are automatically executed making the device most suitable for applications such as solid-state file storage, voice recording, image file memory for still cameras and other systems which require high-density non-volatile memory data storage.

FEATURES

- Organization

	x8
Memory cell array	4328 × 256K × 8 × 4
Register	4328 × 8
Page size	4328 bytes
Block size	(256K + 14.5K) bytes

- Modes
  Read, Reset, Auto Page Program, Auto Block Erase, Status Read, Page Copy, Multi Page Program, Multi Block Erase, Multi Page Copy, Multi Page Read

- Mode control
  Serial input/output
  Command control

- Number of valid blocks
  Min 16064 blocks
  Max 16384 blocks

- Power supply
  V_{CC} = 2.7V to 3.6V

- Access time
  Cell array to register   30 μs max
  Serial Read Cycle   25 ns min (CL=100pF)

- Program/Erase time
  Auto Page Program   300 μs/page typ.
  Auto Block Erase   3 ms/block typ.

- Operating current
  Read (25 ns cycle)   30 mA max.
  Program (avg.)   30 mA max
  Erase (avg.)   30 mA max
  Standby   200 μA max

- Package
 TSOP I 48-P-1220-0.50C

- 4bit ECC for each 512Byte is required.

PIN ASSIGNMENT (TOP VIEW)

TH58NVG5S0FTA20

×8   ×8

Left	Pin		Pin	Right
NC	1 ○		48	NC
NC	2		47	NC
NC	3		46	NC
NC	4		45	NC
NC	5		44	I/O8
RY/$\overline{BY}$ 2	6		43	I/O7
RY/$\overline{BY}$ 1	7		42	I/O6
$\overline{RE}$	8		41	I/O5
$\overline{CE}$ 1	9		40	NC
$\overline{CE}$ 2	10		39	PSL
NC	11		38	NC
V_{CC}	12		37	V_{CC}
V_{SS}	13		36	V_{SS}
NC	14		35	NC
NC	15		34	NC
CLE	16		33	NC
ALE	17		32	I/O4
$\overline{WE}$	18		31	I/O3
$\overline{WP}$	19		30	I/O2
NC	20		29	I/O1
NC	21		28	NC
NC	22		27	NC
NC	23		26	NC
NC	24		25	NC

PINNAMES

I/O1 to I/O8	I/O port
$\overline{CE}$ 1	Chip enable (Chip A,B)
$\overline{CE}$ 2	Chip enable (Chip C,D)
$\overline{WE}$	Write enable
$\overline{RE}$	Read enable
CLE	Command latch enable
ALE	Address latch enable
PSL	Power on select
$\overline{WP}$	Write protect
RY/$\overline{BY}$ 1	Ready/Busy (Chip A,B)
RY/$\overline{BY}$ 2	Ready/Busy (Chip C,D)
V_{CC}	Power supply
V_{SS}	Ground

BLOCK DIAGRAM

TOSHIBA
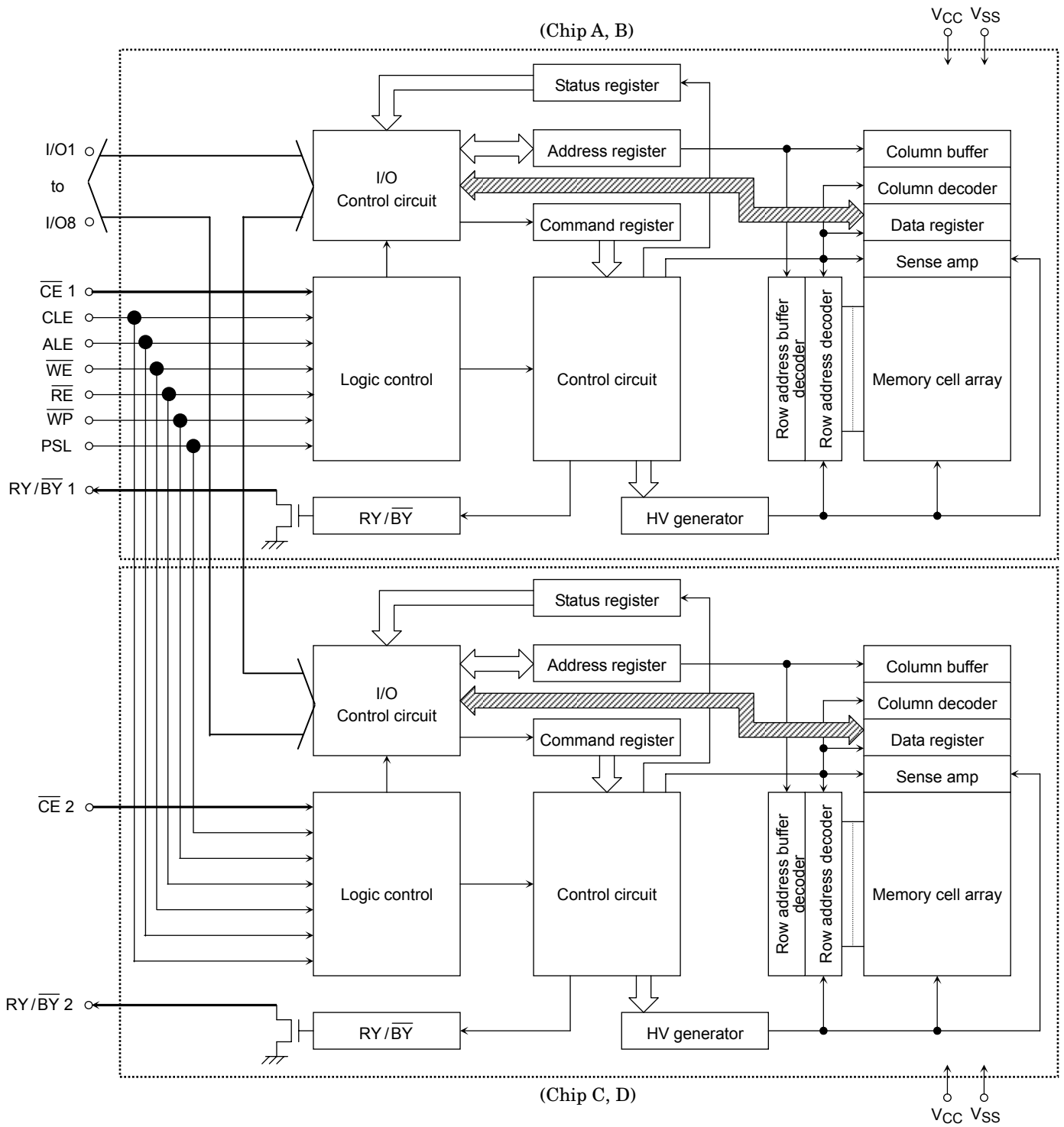
ABSOLUTE MAXIMUM RATINGS

SYMBOL	RATING	VALUE	UNIT
V_{CC}	Power Supply Voltage	−0.6 to 4.6	V
V_{IN}	Input Voltage	−0.6 to 4.6	V
$V_{I/O}$	Input /Output Voltage	−0.6 to V_{CC} + 0.3 ($\leq$ 4.6 V)	V
P_D	Power Dissipation	0.3	W
T_{SOLDER}	Soldering Temperature (10 s)	260	°C
T_{STG}	Storage Temperature	−55 to 150	°C
T_{OPR}	Operating Temperature	0 to 70	°C

CAPACITANCE ∗(Ta = 25°C, f = 1 MHz)

SYMB0L	PARAMETER	CONDITION	MIN	MAX	UNIT
C_{IN}	Input	V_{IN} = 0 V	—	40	pF
C_{OUT}	Output	V_{OUT} = 0 V	—	40	pF

∗   This parameter is periodically sampled and is not tested for every device.

VALID BLOCKS

SYMBOL	PARAMETER	MIN	TYP.	MAX	UNIT
N_{VB}	Number of Valid Blocks	16064	—	16384	Blocks

NOTE: The device occasionally contains unusable blocks. Refer to Application Note (13) toward the end of this document.

The first block (Block 0) is guaranteed to be a valid block at the time of shipment.

The specification for the minimum number of valid blocks is applicable over lifetime

The number of valid blocks is on the basis of single plane operations, and this may be decreased with two plane operations.

RECOMMENDED DC OPERATING CONDITIONS

SYMBOL	PARAMETER		MIN	TYP.	MAX	UNIT
V_{CC}	Power Supply Voltage		2.7	—	3.6	V
V_{IH}	High Level input Voltage	$2.7\ V \leq V_{CC} \leq 3.6\ V$	Vcc x 0.8	—	$V_{CC} + 0.3$	V
V_{IL}	Low Level Input Voltage	$2.7\ V \leq V_{CC} \leq 3.6\ V$	−0.3*	—	Vcc x 0.2	V

*   −2 V (pulse width lower than 20 ns)

DC CHARACTERISTICS (Ta = 0 to 70℃, V_{CC} = 2.7 to 3.6V)

SYMBOL	PARAMETER	CONDITION	MIN	TYP.	MAX	UNIT
I_{IL}	Input Leakage Current	$V_{IN} = 0\ V$ to V_{CC}	—	—	±10	μA
I_{LO}	Output Leakage Current	$V_{OUT} = 0\ V$ to V_{CC}	—	—	±10	μA
I_{CCO0} *1	Power On Reset Current	PSL = GND or NU	—	—	30	mA
		PSL = V_{CC}, FFh command input after Power On	—	—	30	
I_{CCO1} *2	Serial Read Current	$\overline{CE} = V_{IL}$, $I_{OUT} = 0\ mA$, tcycle = 25 ns	—	—	30	mA
I_{CCO2} *2	Programming Current	—	—	—	30	mA
I_{CCO3} *2	Erasing Current	—	—	—	30	mA
I_{CCS}	Standby Current	$\overline{CE} = V_{CC} − 0.2\ V$, $\overline{WP} = 0\ V/V_{CC}$, PSL = 0 V/$V_{CC}$/NU	—	—	200	μA
V_{OH}	High Level Output Voltage	$I_{OH} = −0.4\ mA$	2.4	—	—	V
V_{OL}	Low Level Output Voltage	$I_{OL} = 2.1\ mA$	—	—	0.4	V
I_{OL} ($RY/\overline{BY}$)	Output current of $RY/\overline{BY}$ pin	$V_{OL} = 0.4\ V$	—	8	—	mA

*1 Refer to application note (2) for detail

*2 Icco1/2/3 are the value of one chip, and an unselected chip is in Standby mode.

AC CHARACTERISTICS AND RECOMMENDED OPERATING CONDITIONS
(Ta = 0 to 70℃, V_{CC} = 2.7 to 3.6V)

SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{CLS}	CLE Setup Time	12	—	ns
t_{CLH}	CLE Hold Time	5	—	ns
t_{CS}	$\overline{CE}$ Setup Time	20	—	ns
t_{CH}	$\overline{CE}$ Hold Time	5	—	ns
t_{WP}	Write Pulse Width	12	—	ns
t_{ALS}	ALE Setup Time	12	—	ns
t_{ALH}	ALE Hold Time	5	—	ns
t_{DS}	Data Setup Time	12	—	ns
t_{DH}	Data Hold Time	5	—	ns
t_{WC}	Write Cycle Time	25	—	ns
t_{WH}	$\overline{WE}$ High Hold Time	10	—	ns
t_{WW}	$\overline{WP}$ High to $\overline{WE}$ Low	100	—	ns
t_{RR}	Ready to $\overline{RE}$ Falling Edge	20	—	ns
t_{RW}	Ready to $\overline{WE}$ Falling Edge	20	—	ns
t_{RP}	Read Pulse Width	12	—	ns
t_{RC}	Read Cycle Time	25	—	ns
t_{REA}	$\overline{RE}$ Access Time	—	20	ns
t_{CEA}	$\overline{CE}$ Access Time	—	25	ns
t_{CLR}	CLE Low to $\overline{RE}$ Low	10	—	ns
t_{AR}	ALE Low to $\overline{RE}$ Low	10	—	ns
t_{RHOH}	$\overline{RE}$ High to Output Hold Time	25	—	ns
t_{RLOH}	$\overline{RE}$ Low to Output Hold Time	5	—	ns
t_{RHZ}	$\overline{RE}$ High to Output High Impedance	—	60	ns
t_{CHZ}	$\overline{CE}$ High to Output High Impedance	—	20	ns
t_{CSD}	$\overline{CE}$ High to ALE or CLE Don't Care	0	—	ns
t_{REH}	$\overline{RE}$ High Hold Time	10	—	ns
t_{IR}	Output-High-impedance-to-$\overline{RE}$ Falling Edge	0	—	ns
t_{RHW}	$\overline{RE}$ High to $\overline{WE}$ Low	60	—	ns
t_{WHC}	$\overline{WE}$ High to $\overline{CE}$ Low	30	—	ns
t_{WHR}	$\overline{WE}$ High to $\overline{RE}$ Low	60	—	ns
t_{R}	Memory Cell Array to Starting Address	—	30	µs
$t_{DCBSYR1}$	Data Cache Busy in Read Cache (following 31h and 3Fh)	—	30	µs
$t_{DCBSYR2}$	Data Cache Busy in Page Copy (following 3Ah)	—	35	µs
t_{WB}	$\overline{WE}$ High to Busy	—	100	ns
t_{RST}	Device Reset Time (Ready/Read/Program/Erase)	—	10/10/30/500	µs

*1: tCLS and tALS can not be shorter than tWP

*2: tCS should be longer than tWP + 8ns.

AC TEST CONDITIONS

PARAMETER	CONDITION
	V$_{CC}$: 2.7 to 3.6V
Input level	0V to Vcc
Input pulse rise and fall time	3 ns
Input comparison level	Vcc / 2
Output data comparison level	Vcc / 2
Output load	C$_L$ (100 pF) + 1 TTL

Note: Busy to ready time depends on the pull-up resistor tied to the RY/$\overline{BY}$ pin.
(Refer to Application Note (9) toward the end of this document.)

PROGRAMMING AND ERASING CHARACTERISTICS
(Ta = 0 to 70℃, V$_{CC}$ = 2.7 to 3.6V)

SYMBOL	PARAMETER	MIN	TYP.	MAX	UNIT	NOTES
t$_{PROG}$	Average Programming Time	—	300	700	μs	
t$_{DCBSYW1}$	Data Cache Busy Time in Write Cache (following 11h)	—	0.5	1	μs	
t$_{DCBSYW2}$	Data Cache Busy Time in Write Cache (following 15h)	—	—	700	μs	(2)
N	Number of Partial Program Cycles in the Same Page	—	—	4		(1)
t$_{BERASE}$	Block Erasing Time	—	3	10	ms	

(1) Refer to Application Note (12) toward the end of this document.

(2) t$_{DCBSYW2}$ depends on the timing between internal programming time and data in time.

Data Output

When tREH is long, output buffers are disabled by /RE=High, and the hold time of data output depend on tRHOH (25ns MIN).   On this condition, waveforms look like normal serial read mode.
When tREH is short, output buffers are not disabled by /RE=High, and the hold time of data output depend on tRLOH (5ns MIN).   On this condition, output buffers are disabled by the rising edge of CLE,ALE,/CE or falling edge of /WE, and waveforms look like Extended Data Output Mode.

TIMING DIAGRAMS

Latch Timing Diagram for Command/Address/Data
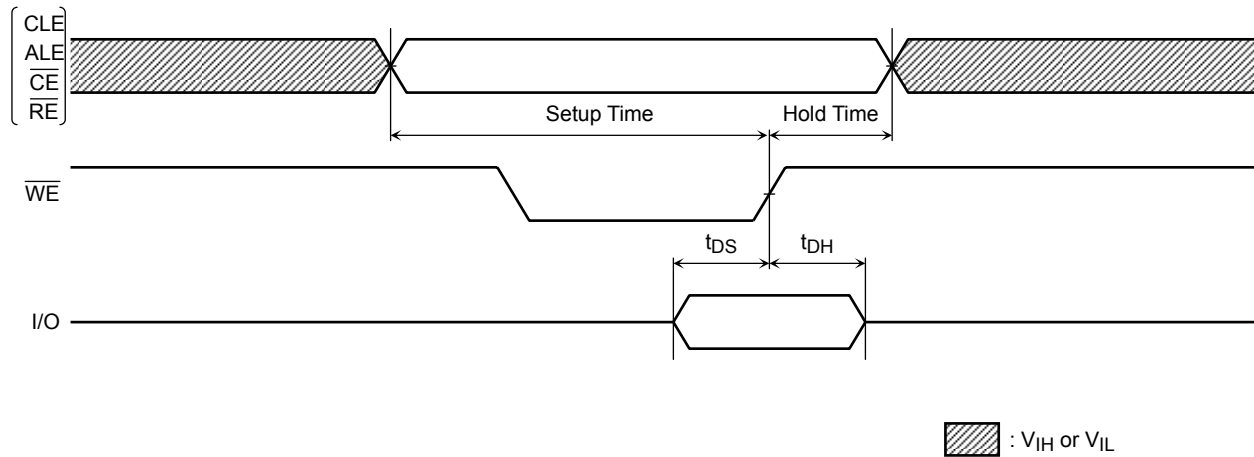
Command Input Cycle Timing Diagram
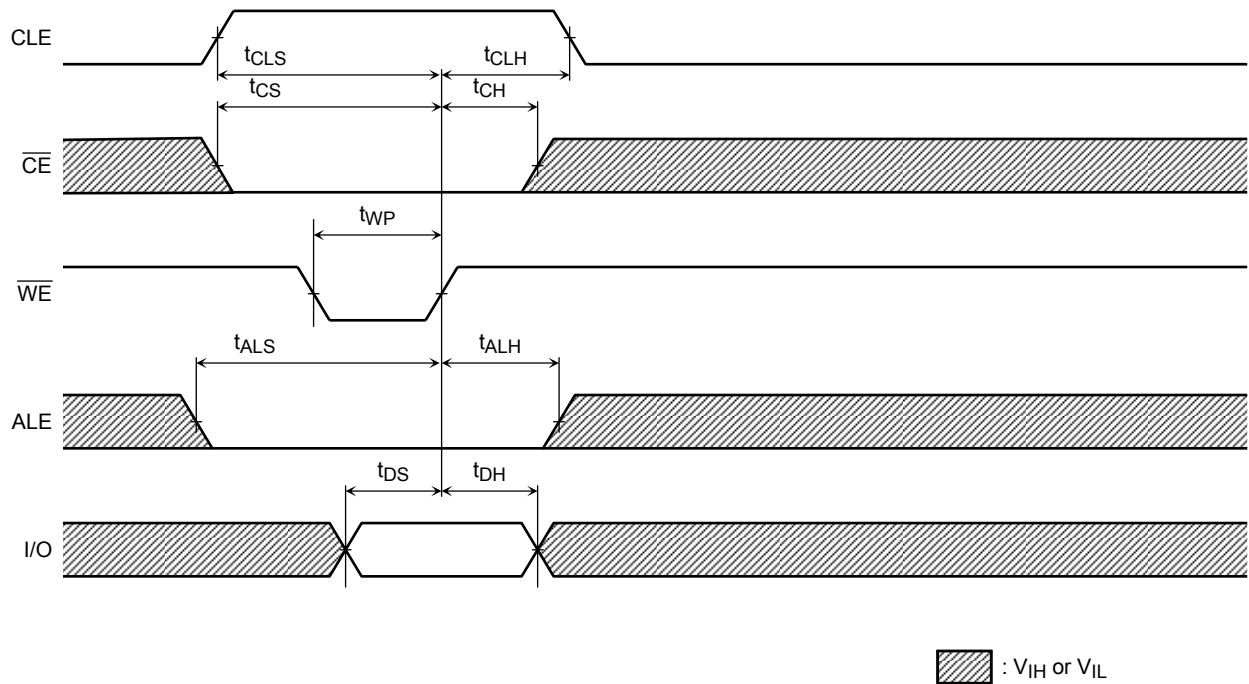
Address Input Cycle Timing Diagram

: V_{IH} or V_{IL}
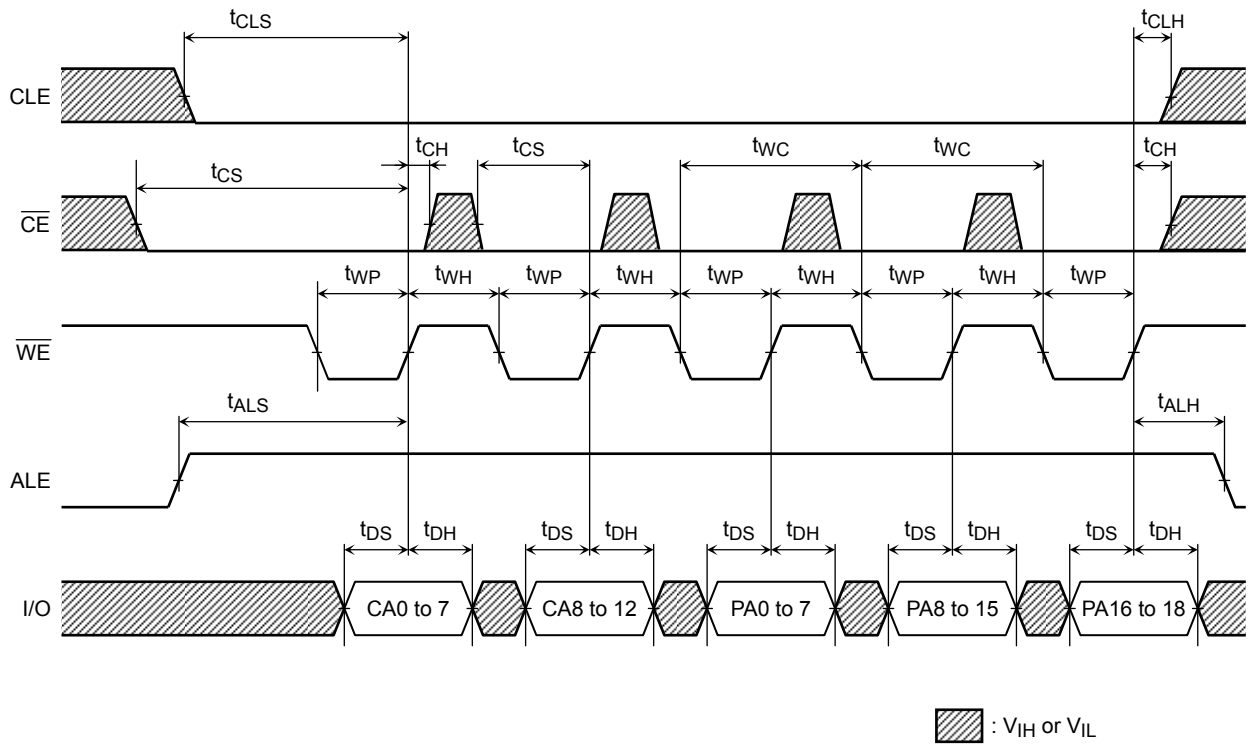
Data Input Cycle Timing Diagram
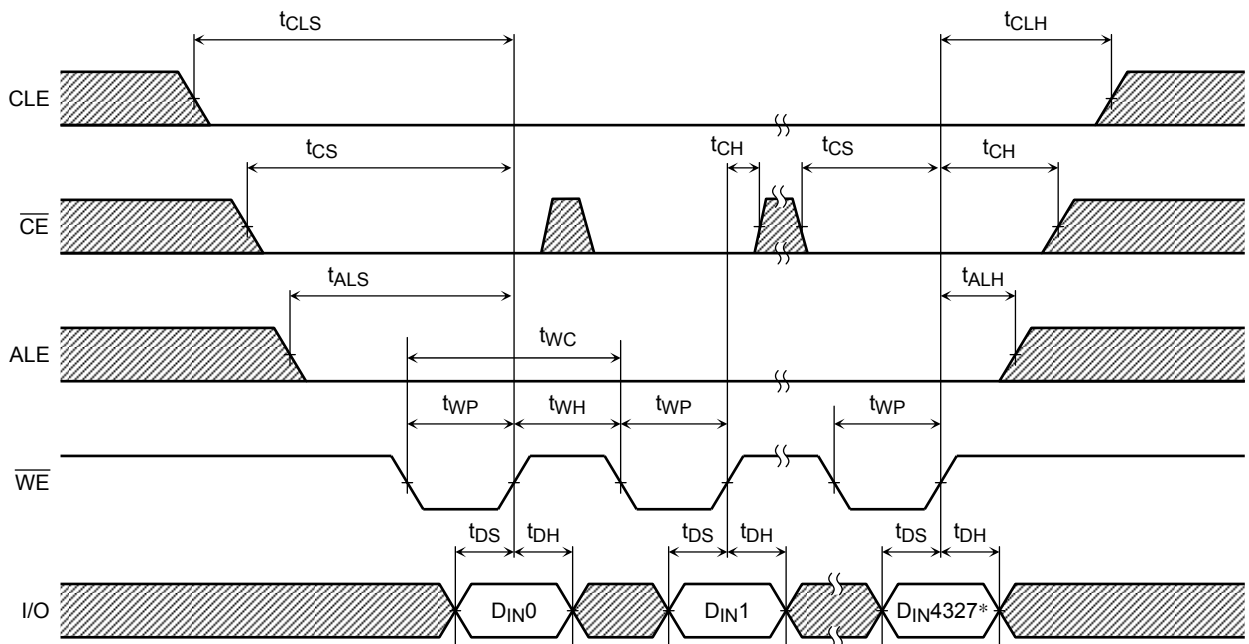
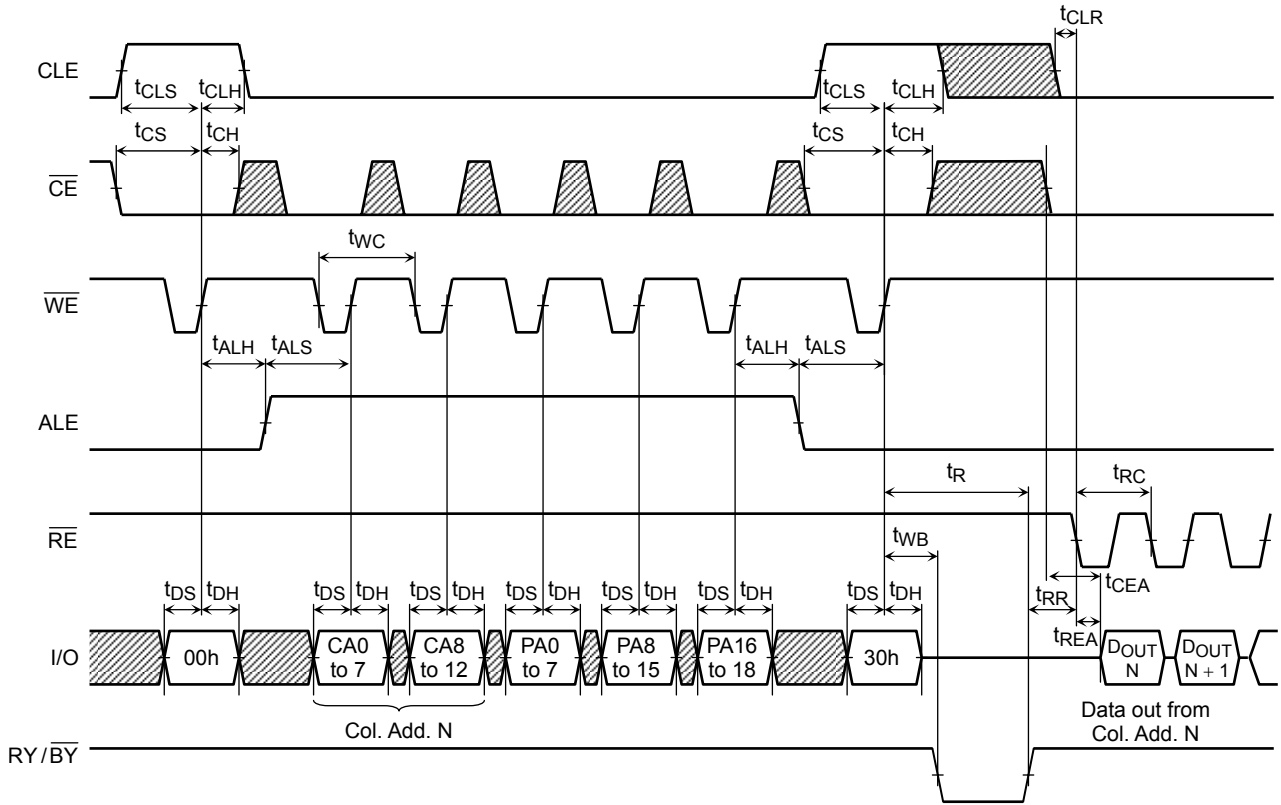Serial Read Cycle Timing Diagram
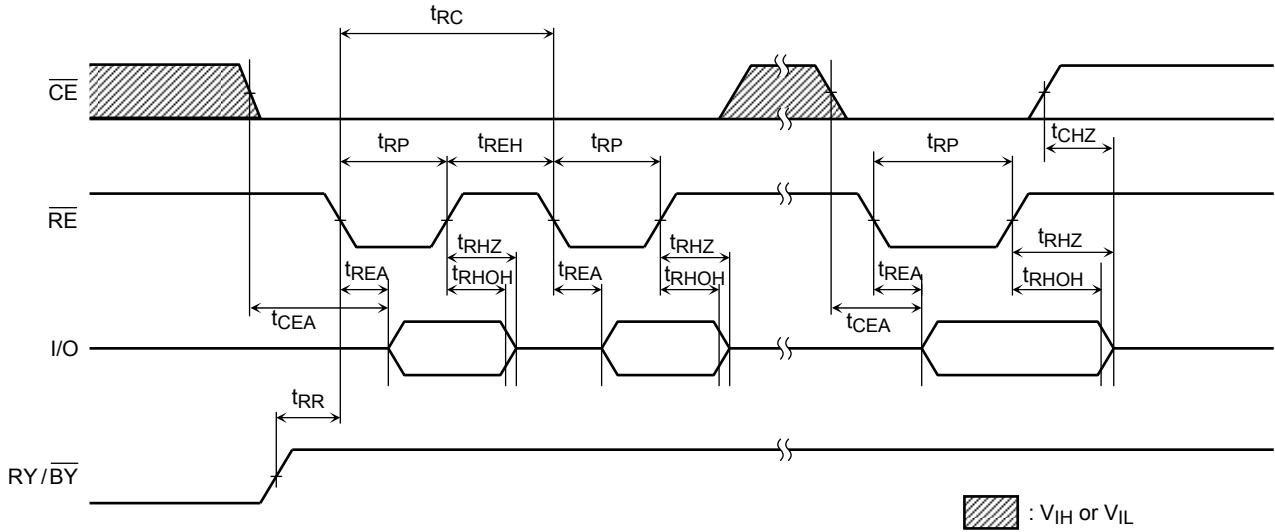
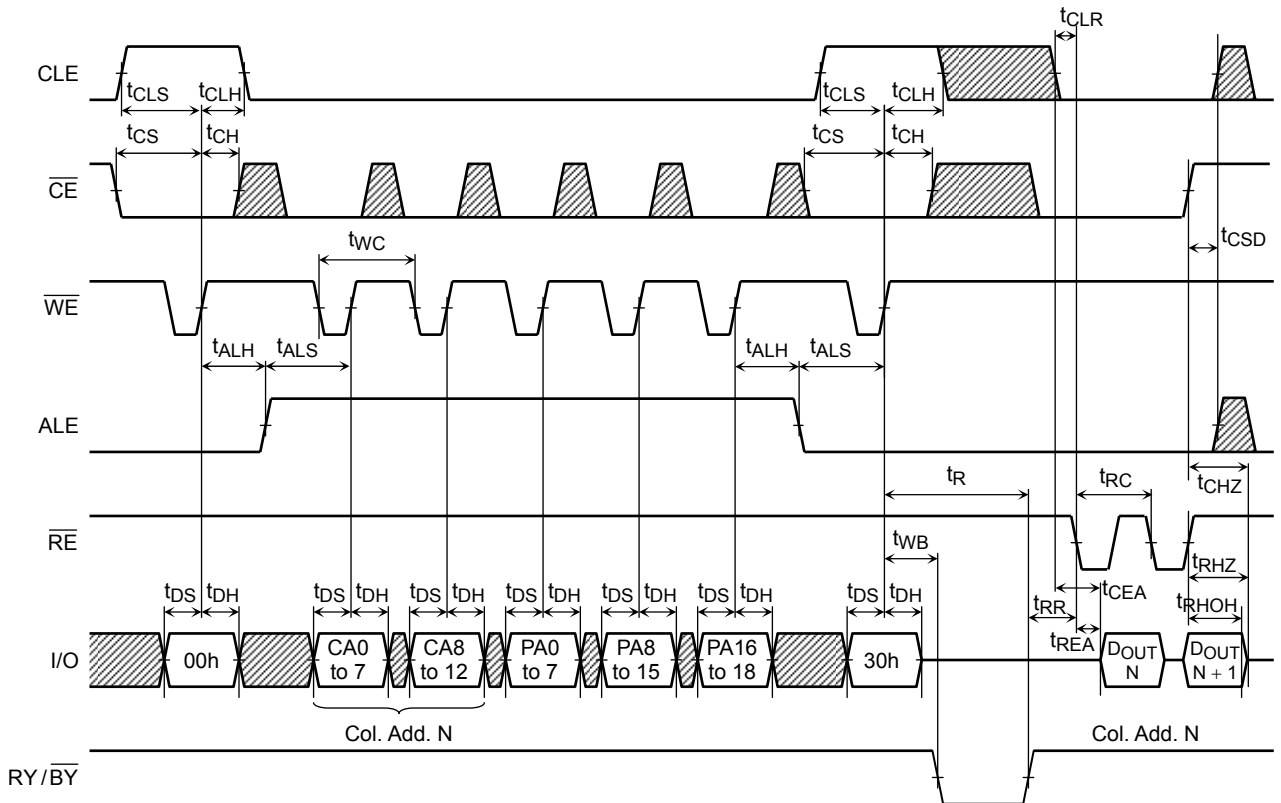Status Read Cycle Timing Diagram
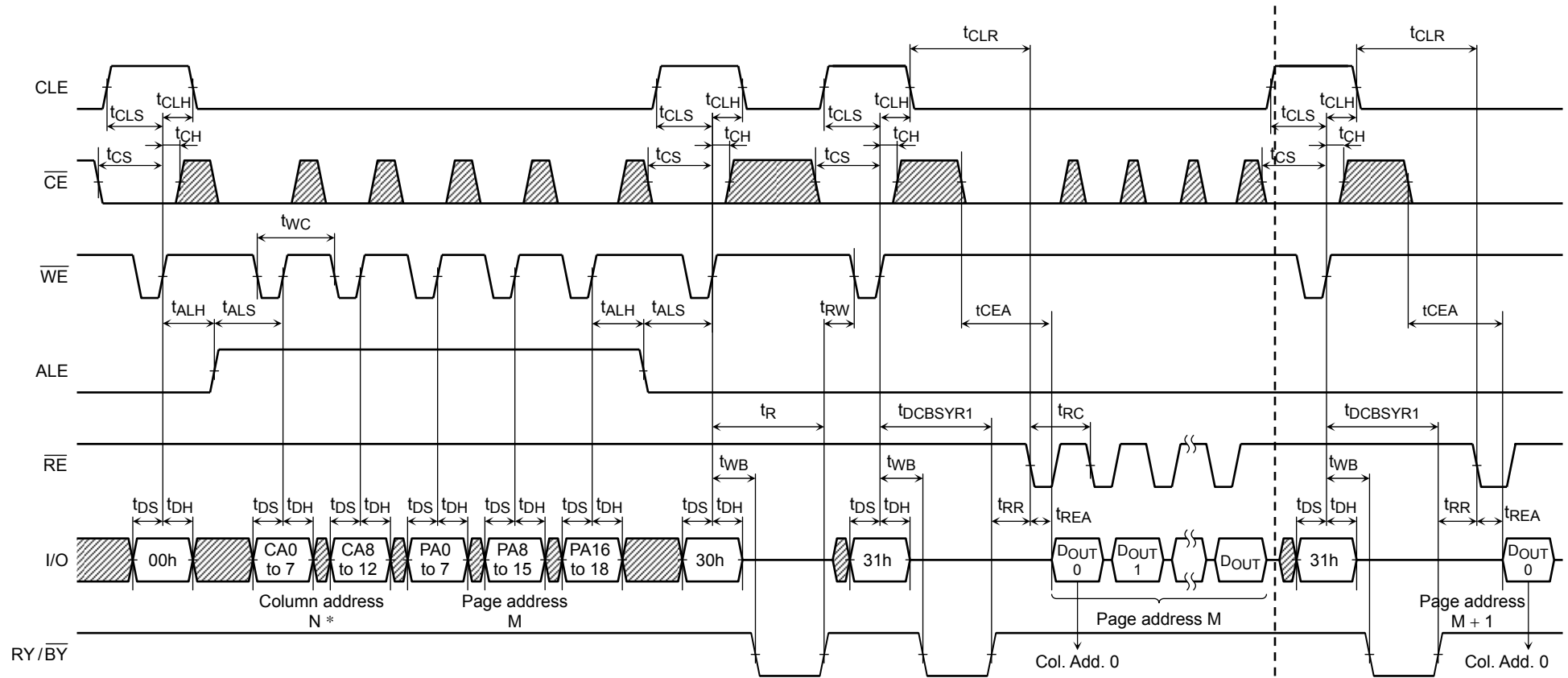

: V$_{IH}$ or V$_{IL}$
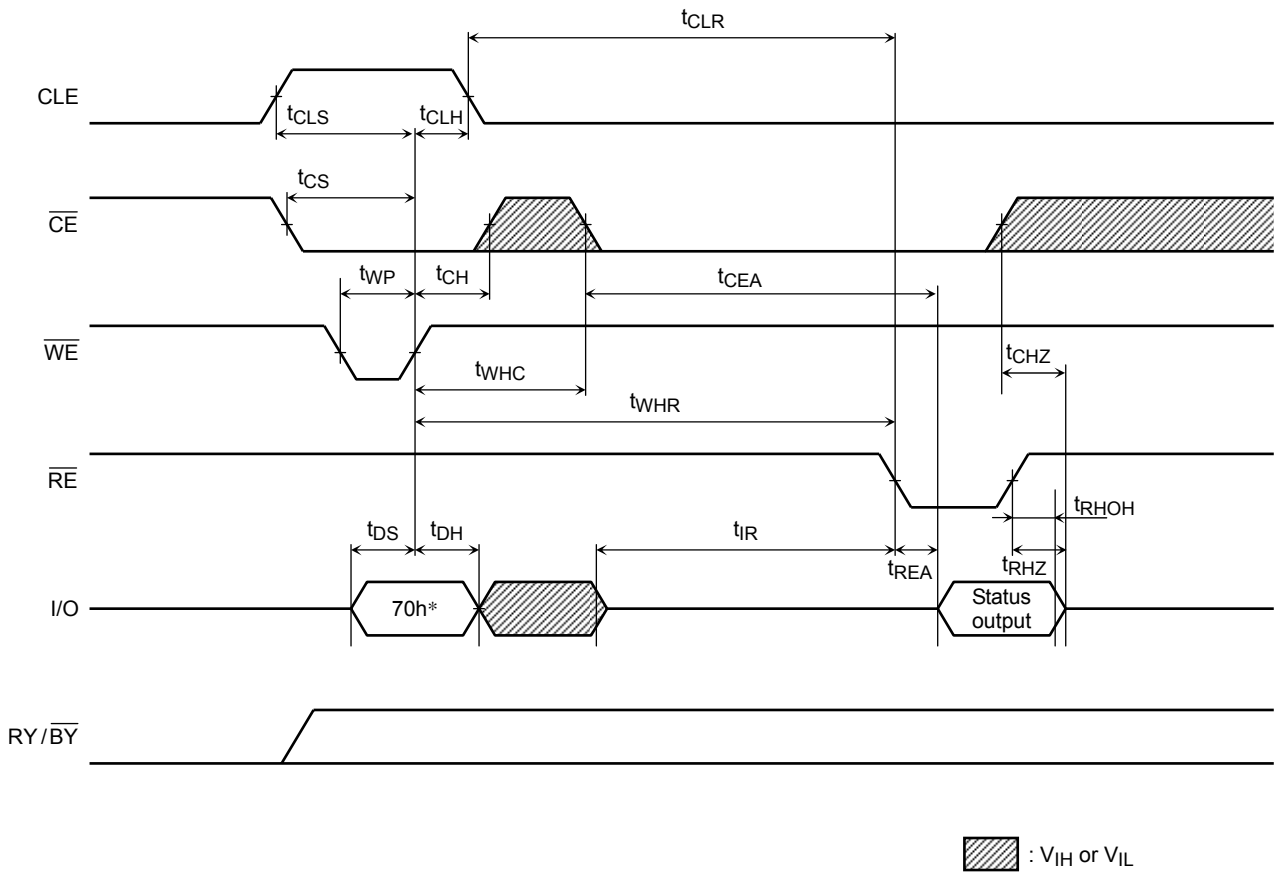
∗: 70h represents the hexadecimal number

Read Cycle Timing Diagram

Read Cycle Timing Diagram: When Interrupted by $\overline{CE}$
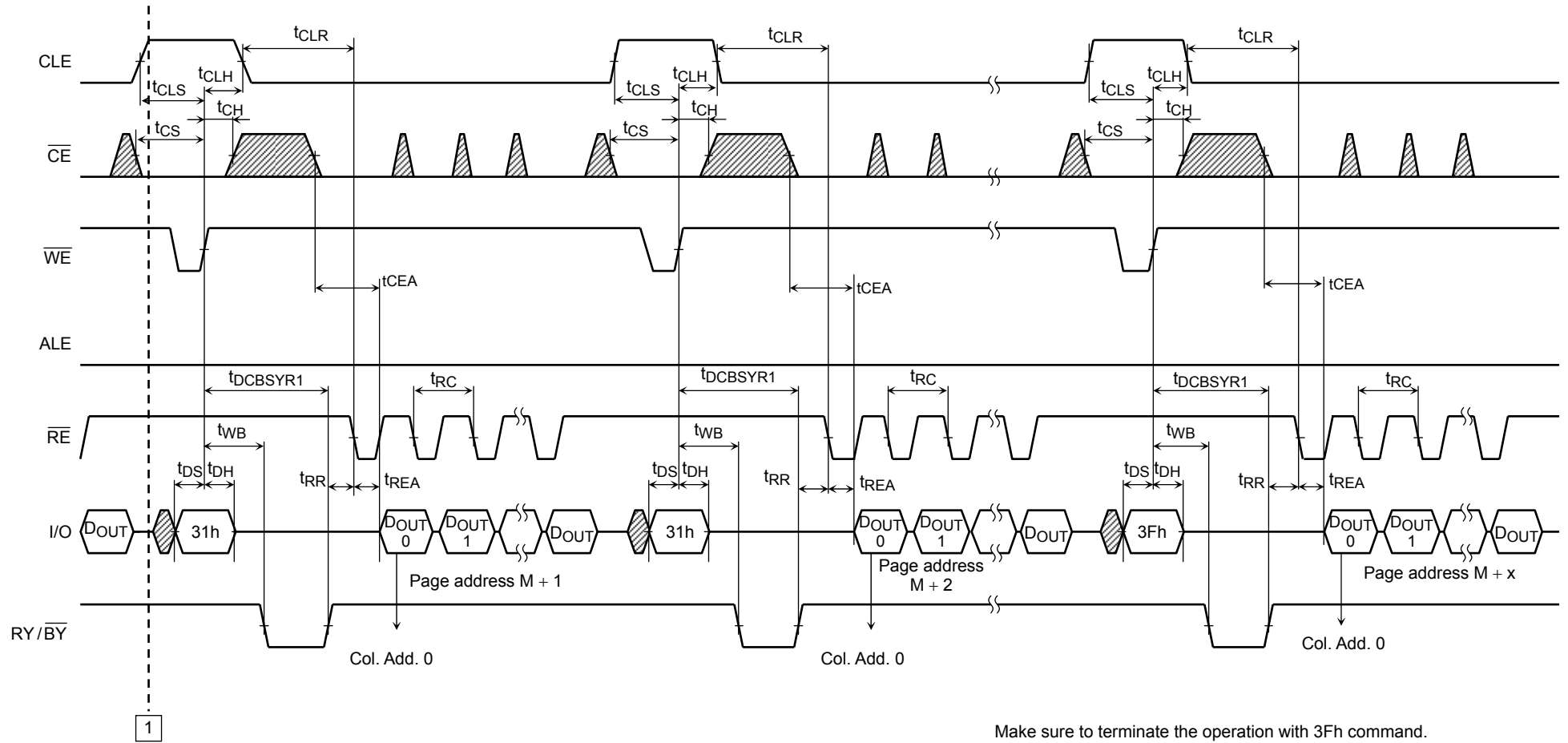
Read Cycle with Data Cache Timing Diagram (1/2)

* The column address will be reset to 0 by the 31h command input.

1

Continues to 1 of next page

Read Cycle with Data Cache Timing Diagram (2/2)

Make sure to terminate the operation with 3Fh command.

1

Continues from 1 of last page

Column Address Change in Read Cycle Timing Diagram (1/2)
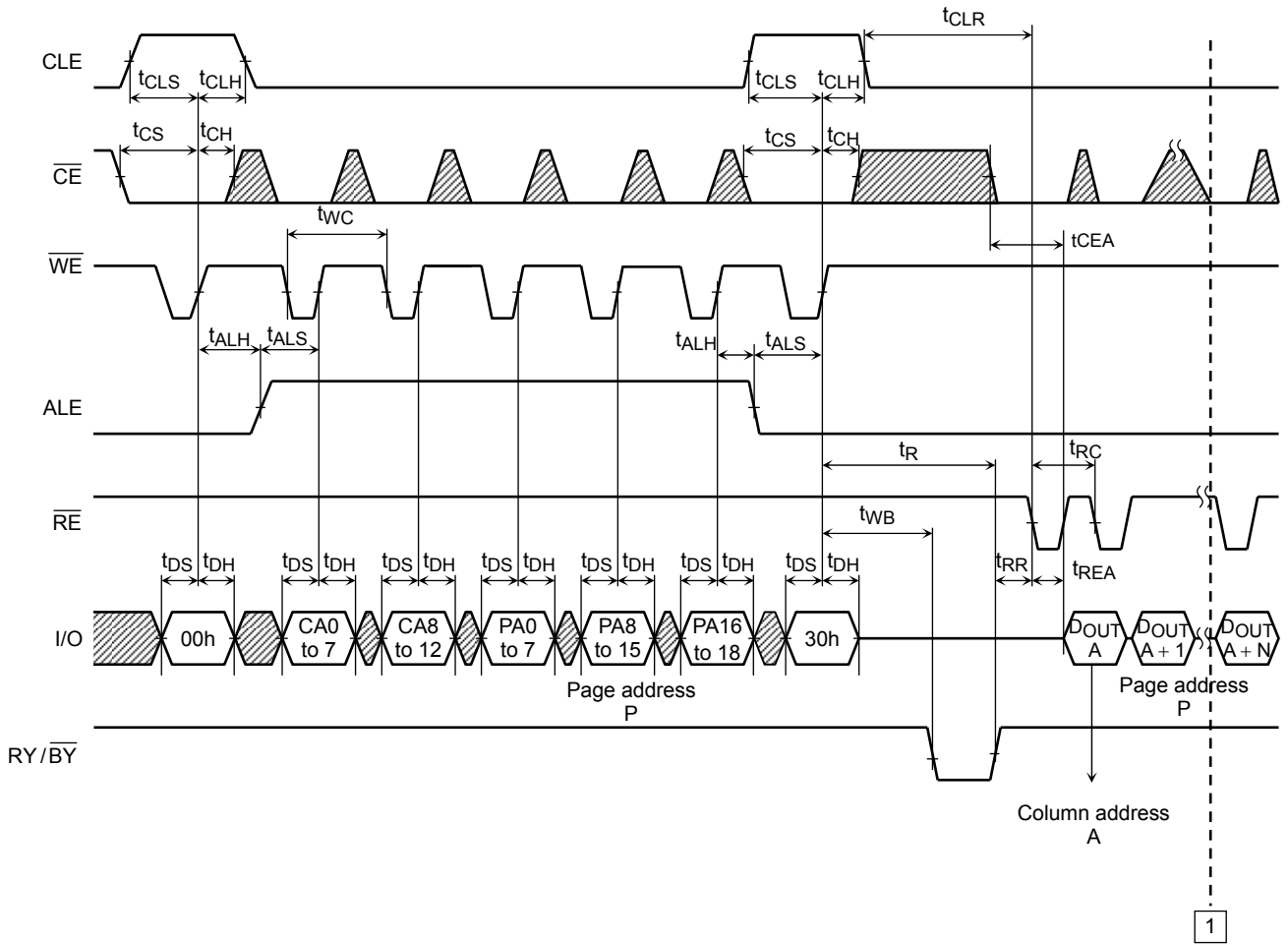
Continues from ⬛1⬛ of next page

Column Address Change in Read Cycle Timing Diagram (2/2)
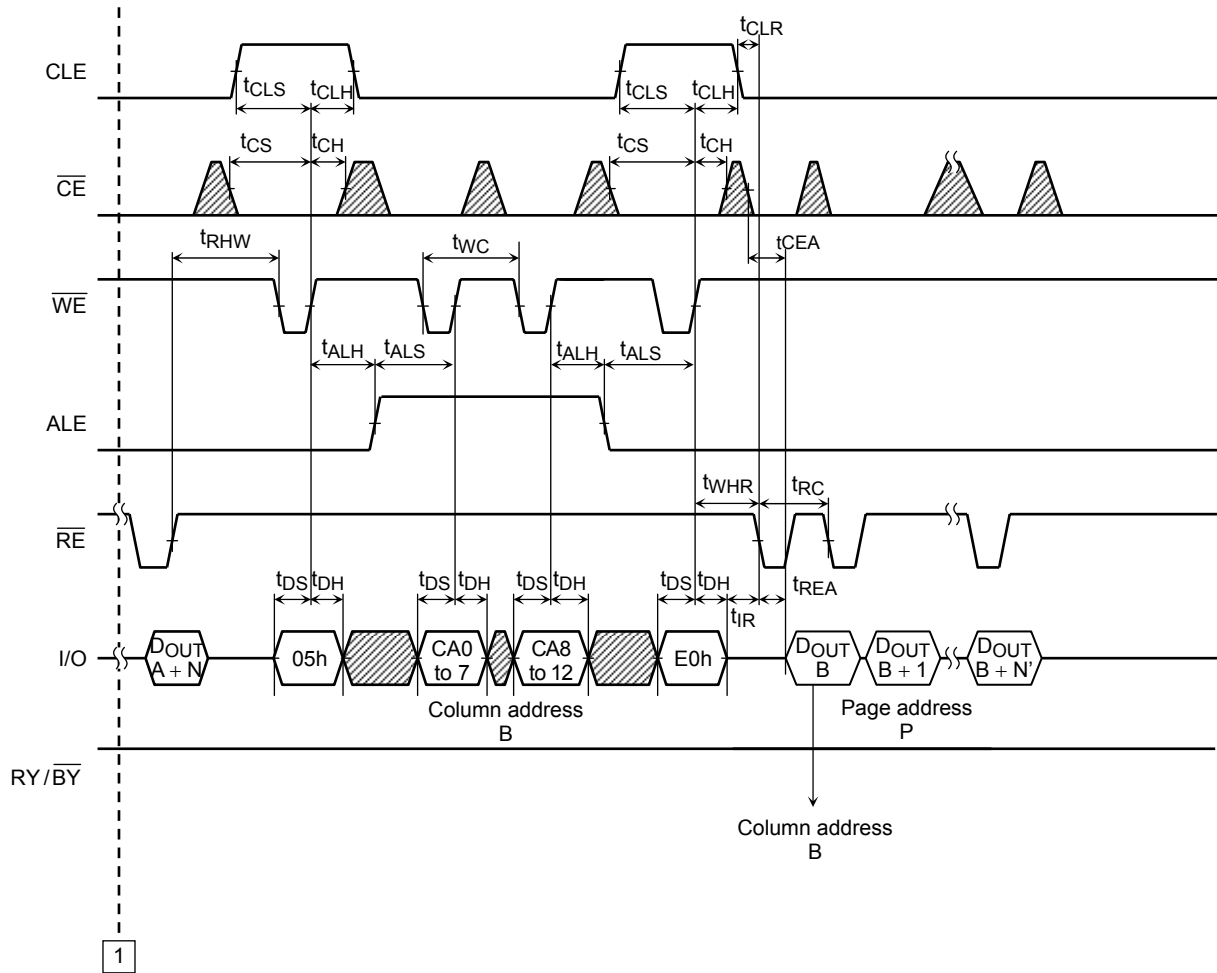
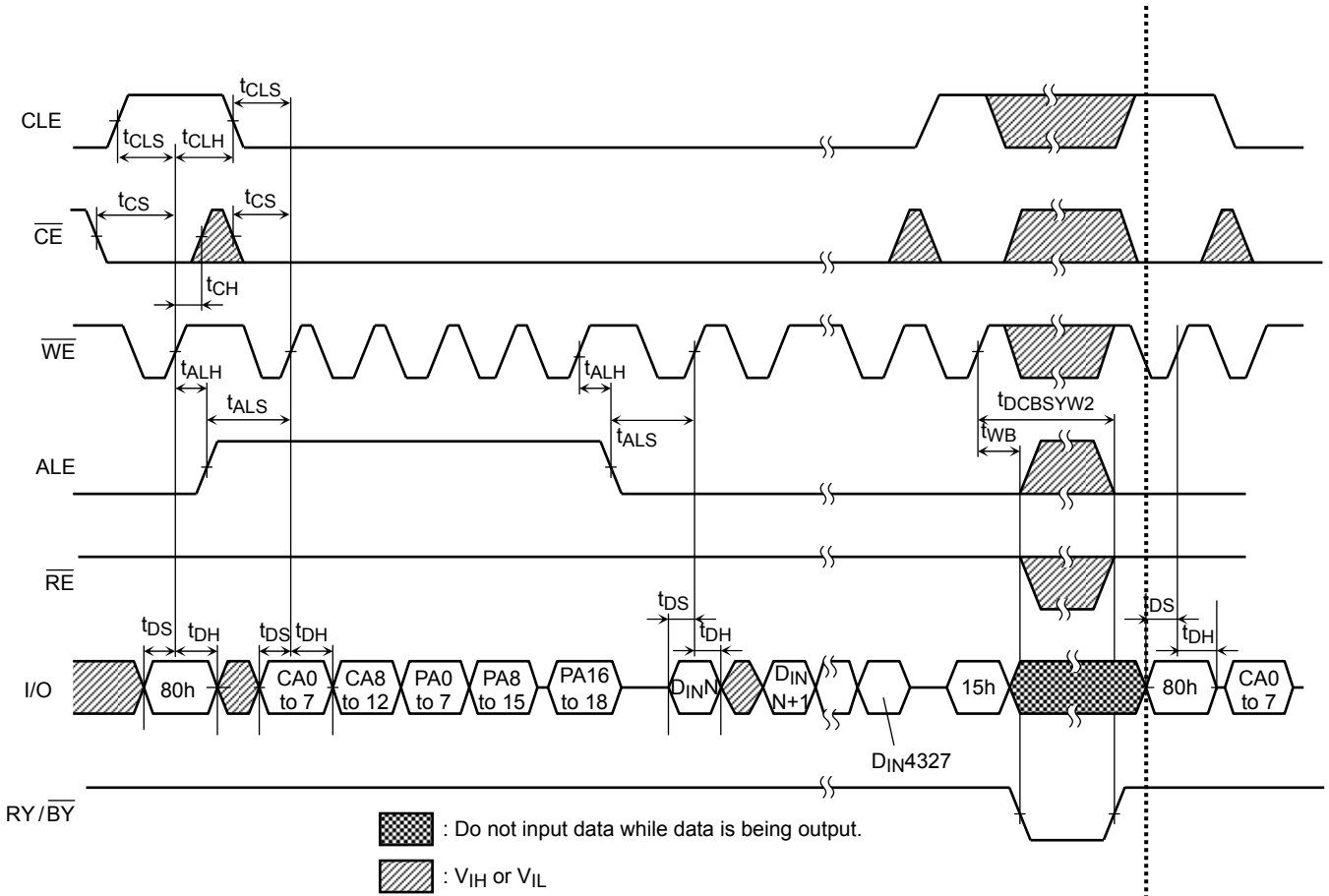Continues from ⊡1⊡ of last page

Data Output Timing Diagram
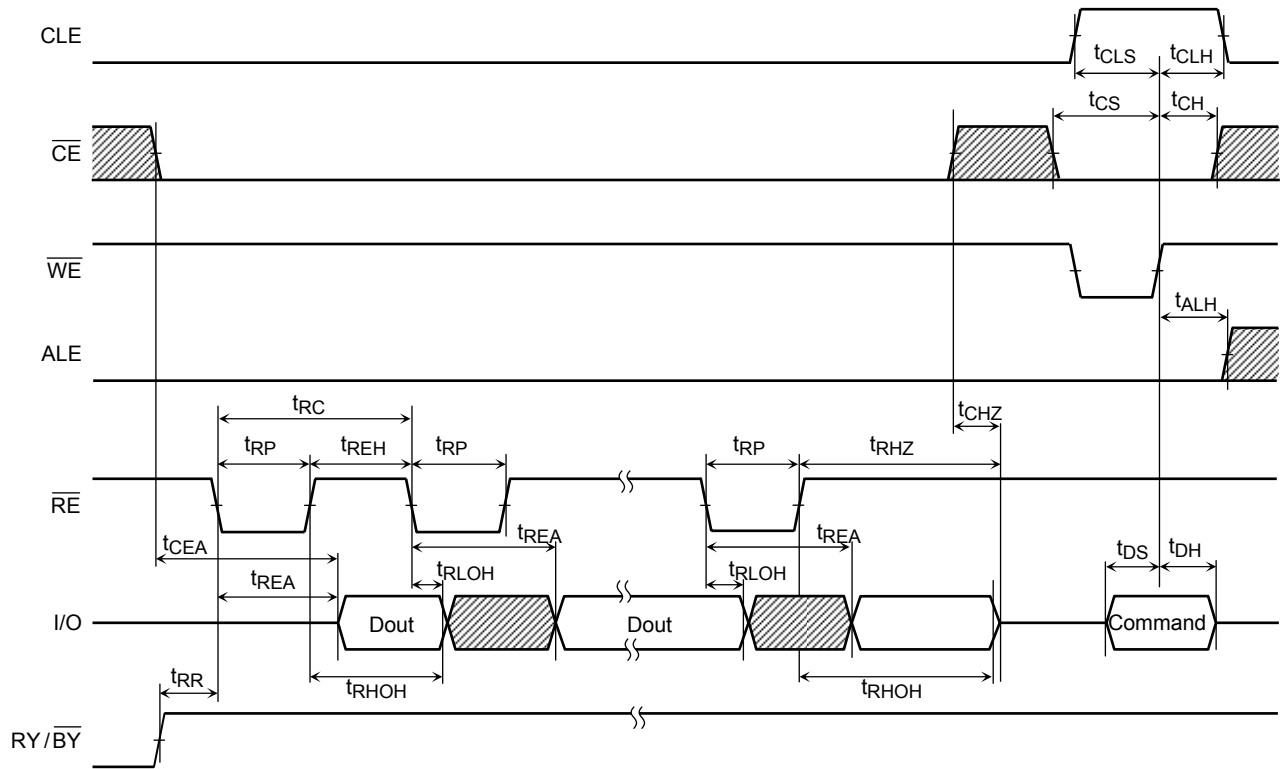
Auto-Program Operation Timing Diagram
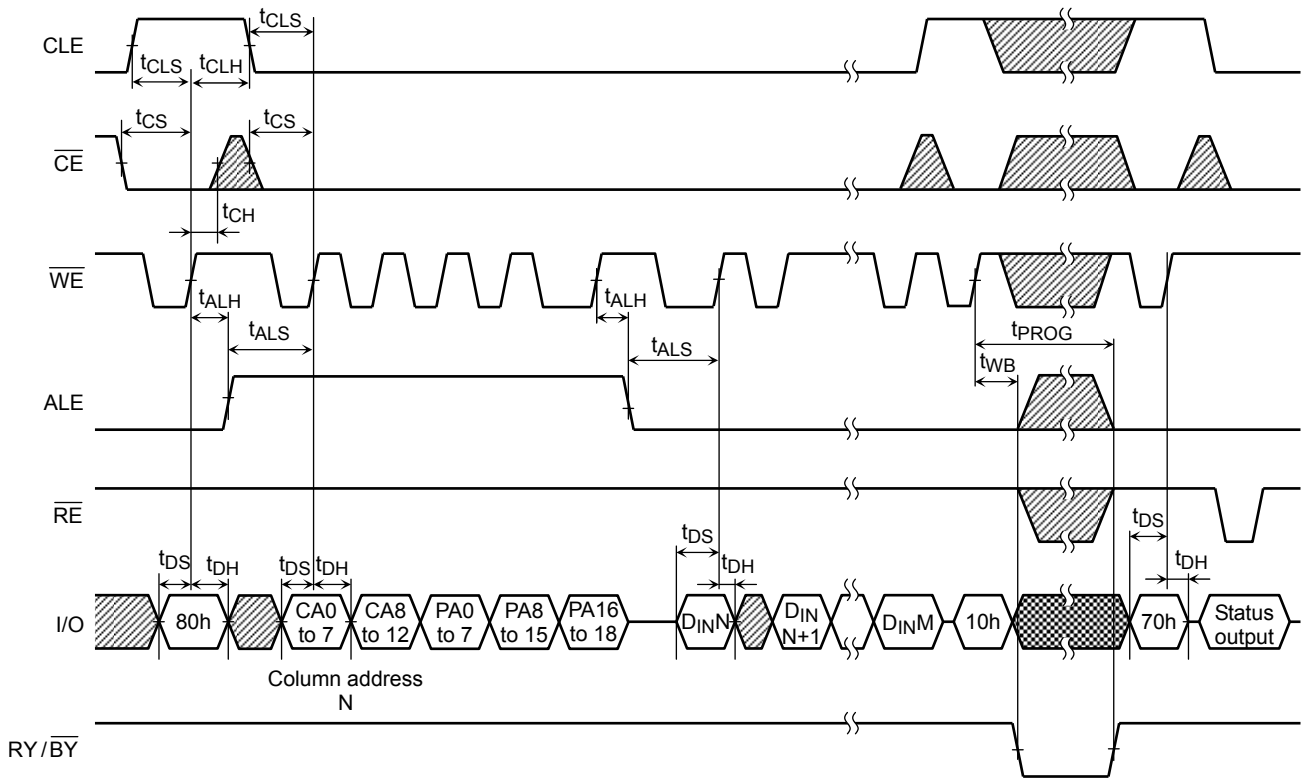
: Do not input data while data is being output.

: V_{IH} or V_{IL}

*) M: up to 4327 (byte input data for ×8 device).

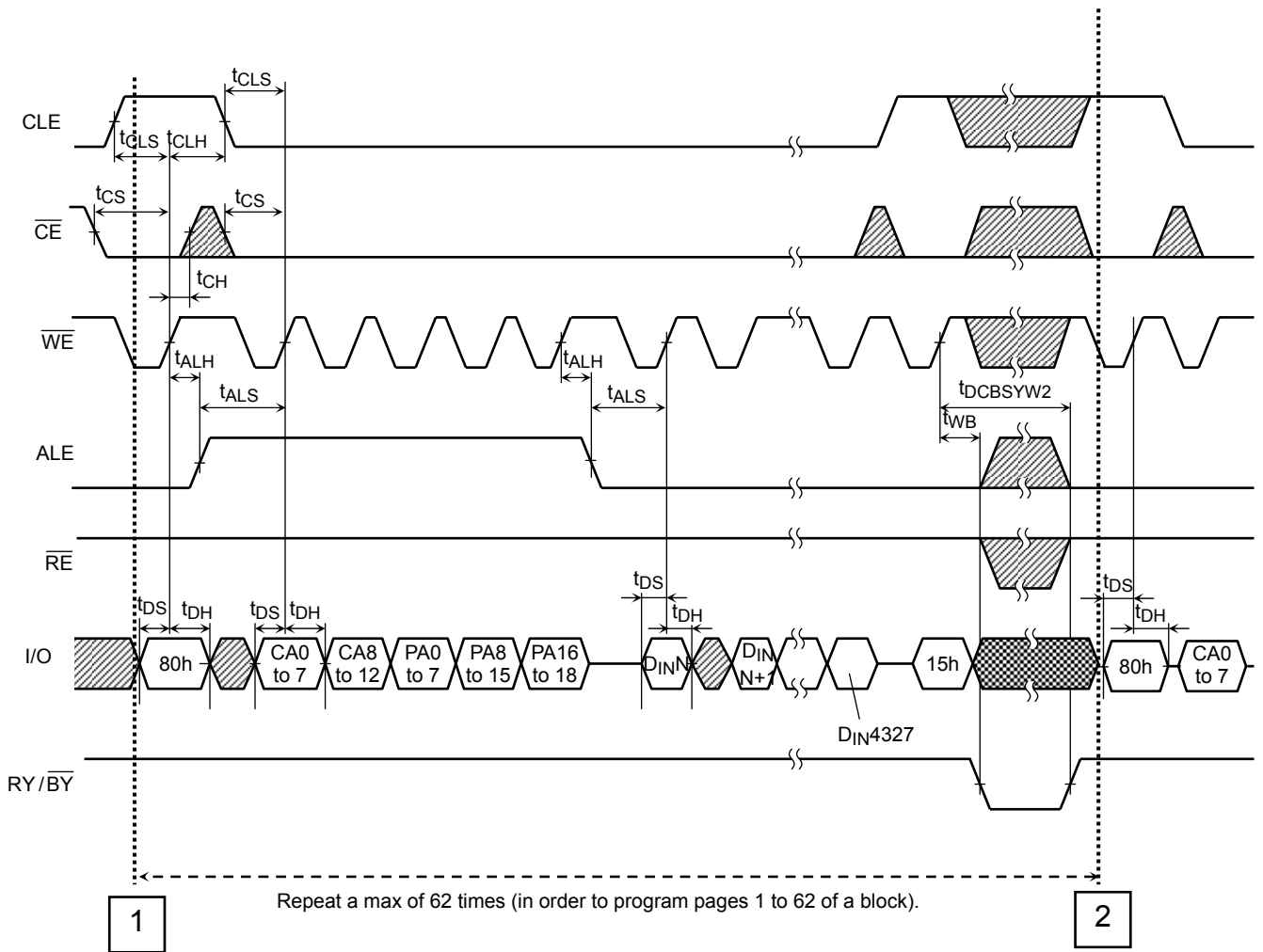Auto-Program Operation with Data Cache Timing Diagram (1/3)

▨ : Do not input data while data is being output.

▨ : V_{IH} or V_{IL}

CA0 to CA12 is 0 in this diagram.

1

Auto-Program Operation with Data Cache Timing Diagram (2/3)

Repeat a max of 62 times (in order to program pages 1 to 62 of a block).

1

2

Continued from 1 of last page

▓▓ : Do not input data while data is being output.

▨▨ : V_{IH} or V_{IL}

Auto-Program Operation with Data Cache Timing Diagram (3/3)

CLE

CE

WE

ALE

RE

I/O: 80h, CA0 to 7, CA8 to 12, PA0 to 7, PA8 to 15, PA16 to 18, D$_{IN}$N, D$_{IN}$N+1, D$_{IN}$4327, 10h, 70h, Status

RY/BY

t_{CLS}, t_{CLH}, t_{CS}, t_{CH}, t_{ALH}, t_{ALS}, t_{DS}, t_{DH}, t_{PROG} (*1), t_{WB}

▨ : Do not input data while data is being output.

▨ : V$_{IH}$ or V$_{IL}$
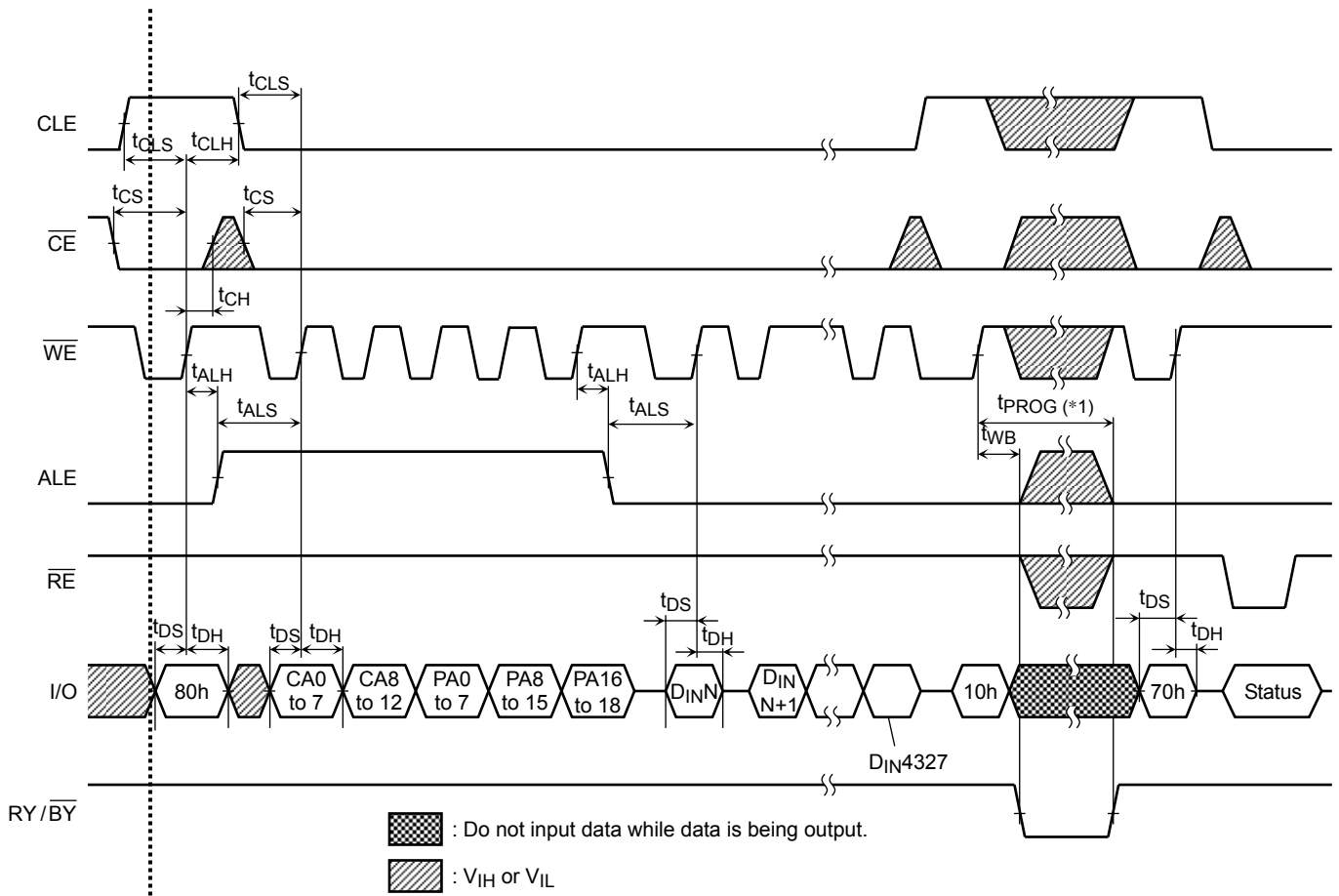
2

Continued from 2 of last page

(*1) t_{PROG}: Since the last page programming by 10h command is initiated after the previous cache program, the t_{PROG} during cache programming is given by the following equation.
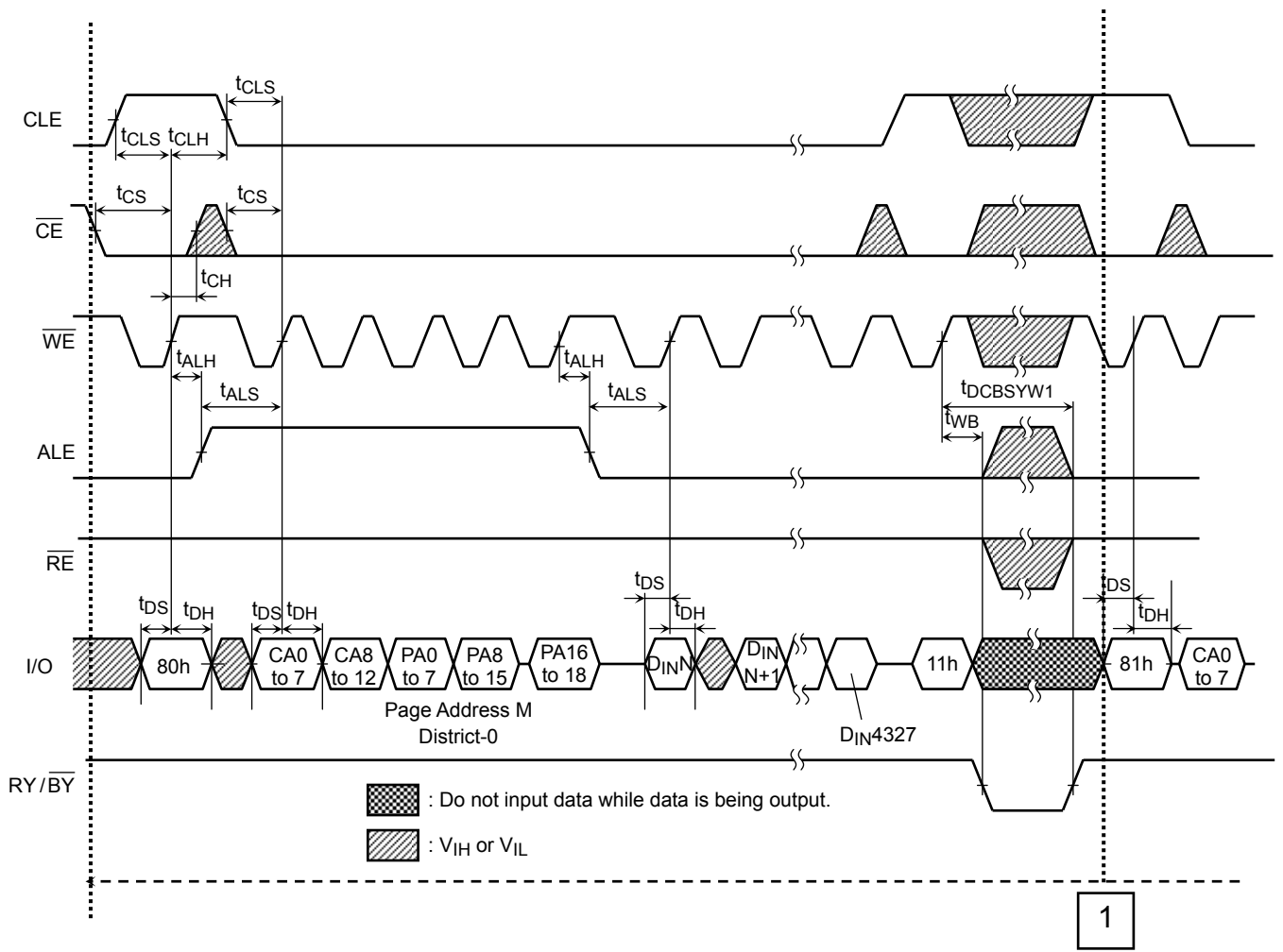
t_{PROG} = t_{PROG} of the last page + t_{PROG} of the previous page − A
A = (command input cycle + address input cycle + data input cycle time of the last page)

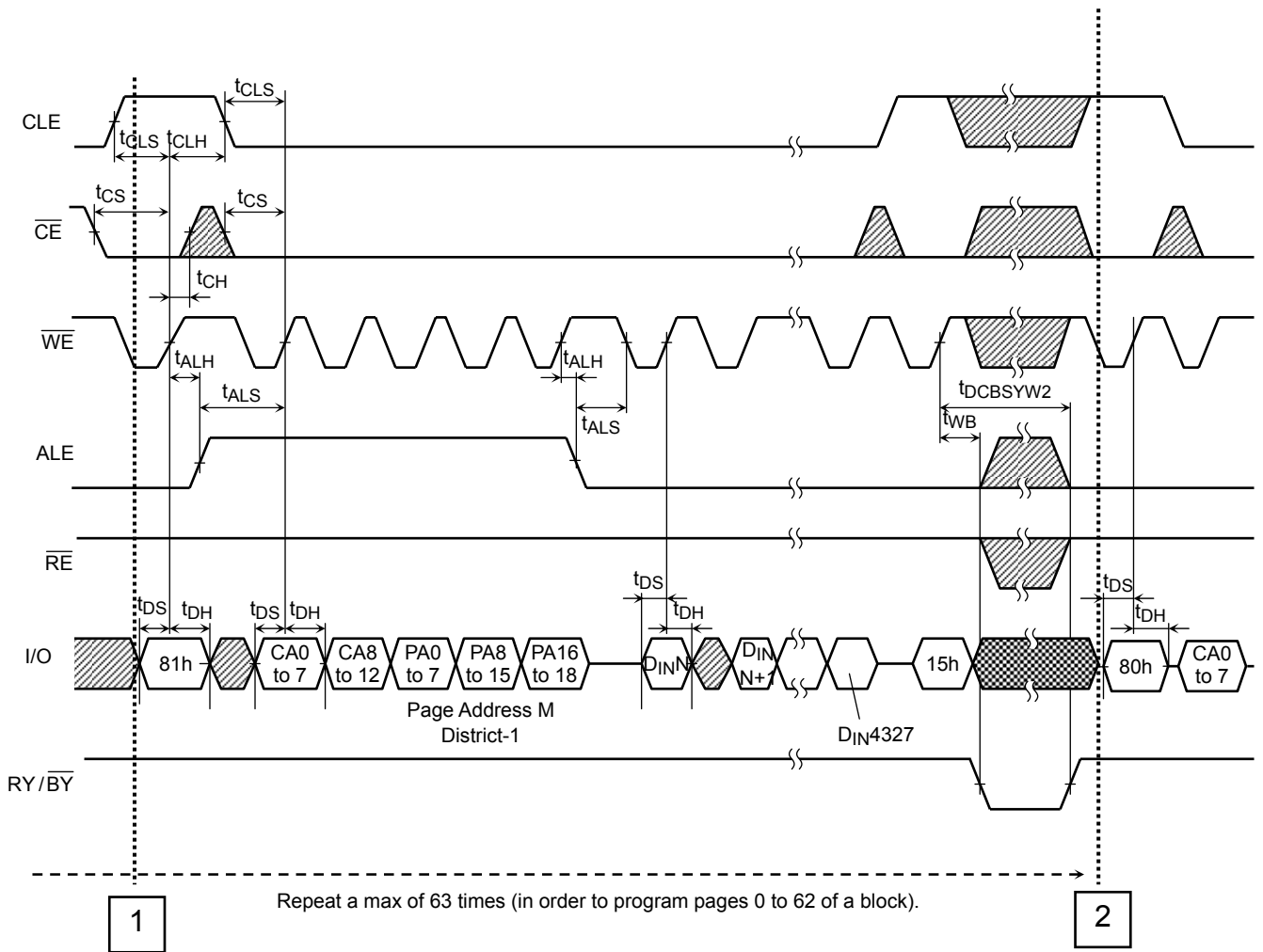If "A" exceeds the t_{PROG} of previous page, t_{PROG} of the last page is t_{PROG} max.

(Note) Make sure to terminate the operation with 80h-10h- command sequence.
If the operation is terminated by 80h-15h command sequence, monitor I/O 6 (Ready / Busy) by issuing Status Read command (70h) and make sure the previous page program operation is completed. If the page program operation is completed issue FFh reset before next operation.

Multi-Page Program Operation with Data Cache Timing Diagram (1/4)

Page Address M
District-0

$D_{IN}4327$

▨ : Do not input data while data is being output.

▨ : V_{IH} or V_{IL}

Multi-Page Program Operation with Data Cache Timing Diagram (2/4)

Repeat a max of 63 times (in order to program pages 0 to 62 of a block).
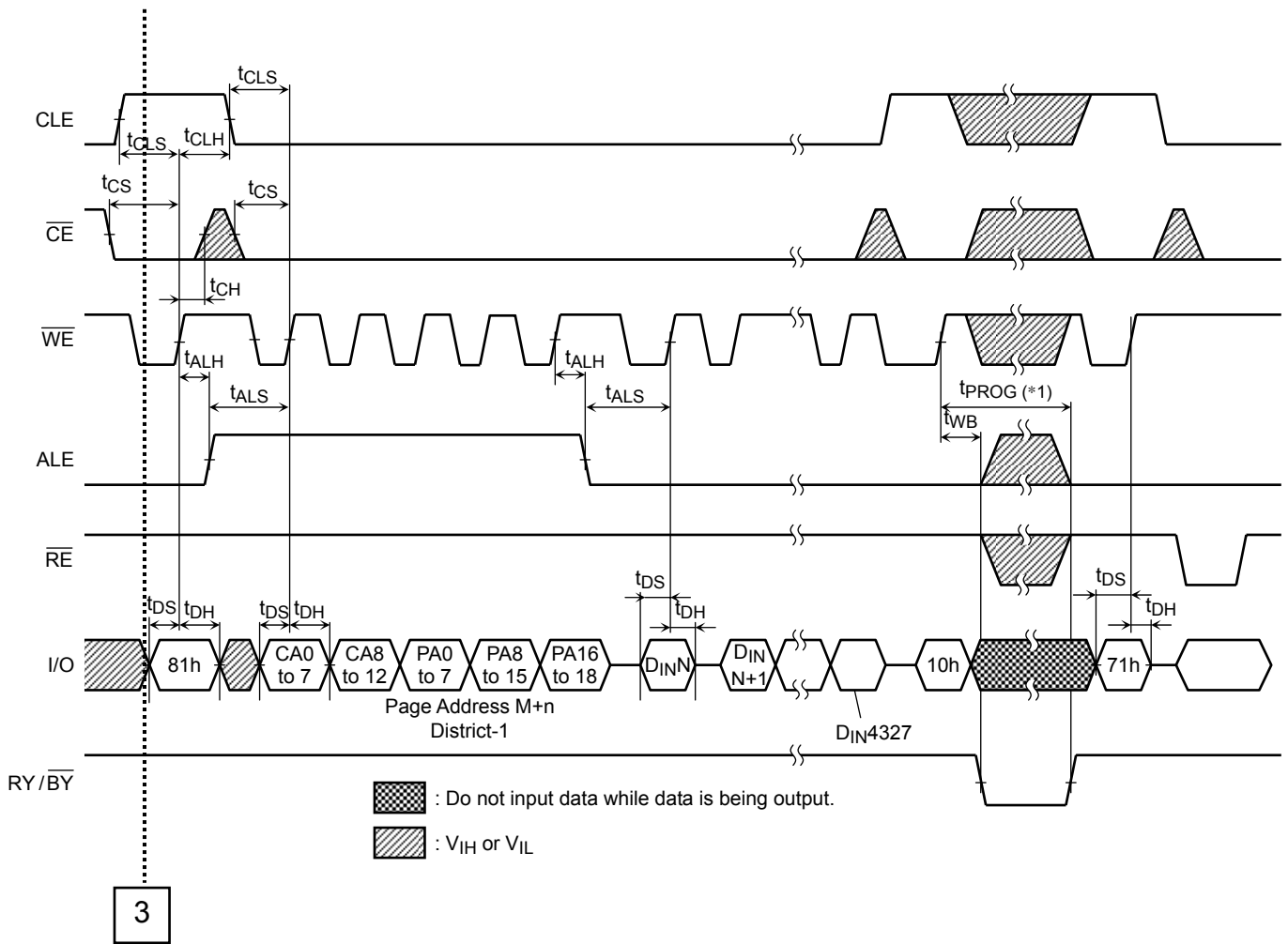
Continued from 1 of last page

▦ : Do not input data while data is being output.

▨ : V$_{IH}$ or V$_{IL}$

TOSHIBA

Multi-Page Program Operation with Data Cache Timing Diagram (3/4)

Page Address M+n
District-0

D_{IN}4327

: Do not input data while data is being output.

: V_{IH} or V_{IL}

2

3
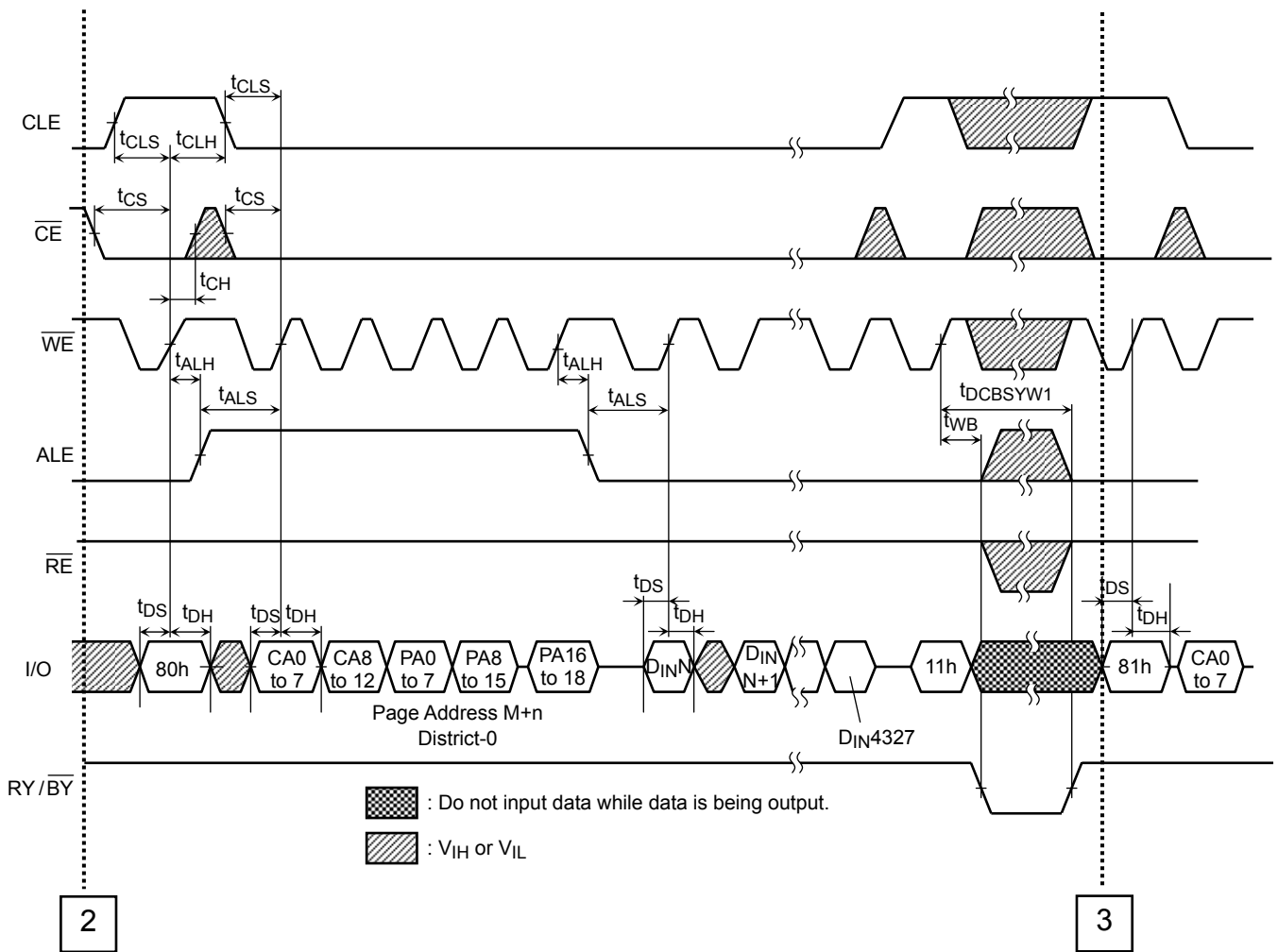
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Multi-Page Program Operation with Data Cache Timing Diagram (4/4)

: Do not input data while data is being output.

: V_{IH} or V_{IL}

3

Continued from 3 of last page

(*1) t_{PROG}: Since the last page programming by 10h command is initiated after the previous cache program, the t_{PROG} during cache programming is given by the following equation.

$t_{PROG} = t_{PROG}$ of the last page $+ t_{PROG}$ of the previous page $- A$
$A = $ (command input cycle $+$ address input cycle $+$ data input cycle time of the last page)

If "A" exceeds the t_{PROG} of previous page, t_{PROG} of the last page is t_{PROG} max.

(Note)   Make sure to terminate the operation with 80h-10h- command sequence.
If the operation is terminated by 81h-15h command sequence, monitor I/O 6 (Ready / Busy) by issuing Status Read command (70h) and make sure the previous page program operation is completed. If the page program operation is completed issue FFh reset before next operation.

Auto Block Erase Timing Diagram

: V_{IH} or V_{IL} : Do not input data while data is being output.