

### NAND INTERFACE

### 256M-BIT MASK-PROGRAMMABLE ROM

#### Description

The  $\mu$ PD23C256112A is a 256 Mbit NAND interface programmable mask read-only memory that operates with a single power supply. The memory organization consists of (512 + 16 (Redundancy)) bytes x 32 pages x 2,048 blocks. The  $\mu$ PD23C256112A is a serial type mask ROM in which addresses and commands are input and data output serially via the I/O pins.

The  $\mu$ PD23C256112A is packed in 48-pin PLASTIC TSOP(I).

#### Features

- Word organization  
(33,554,432 + 1,048,576<sup>Note</sup>) words by 8 bits
- Page size  
(512 + 16<sup>Note</sup>) by 8 bits
- Block size  
(16,384 + 512<sup>Note</sup>) by 8 bits

**Note** Underlined parts are redundancy.

**Caution** Redundancy is not programmable parts and is fixed to all FFH.

- Operation mode  
READ mode (1), READ mode (2), READ mode (3), RESET, STATUS READ, ID READ
- Operating supply voltage :  $V_{CC} = 3.3 \pm 0.3$  V
- Access Time  
Memory cell array to starting address : 7  $\mu$ s (MAX.)
- ★ Read cycle time : 50 ns (MIN.)
- /RE access time : 35 ns (MAX.)
- Operating supply current  
During read : 30 mA (MAX.) (50 ns cycle operation)
- During standby (CMOS) : 100  $\mu$ A (MAX.)

#### Ordering Information

Part Number	Package
$\mu$ PD23C256112AGY-xxx-MJH	48-pin PLASTIC TSOP(I) (12x18) (Normal bent)
$\mu$ PD23C256112AGY-xxx-MKH	48-pin PLASTIC TSOP(I) (12x18) (Reverse bent)

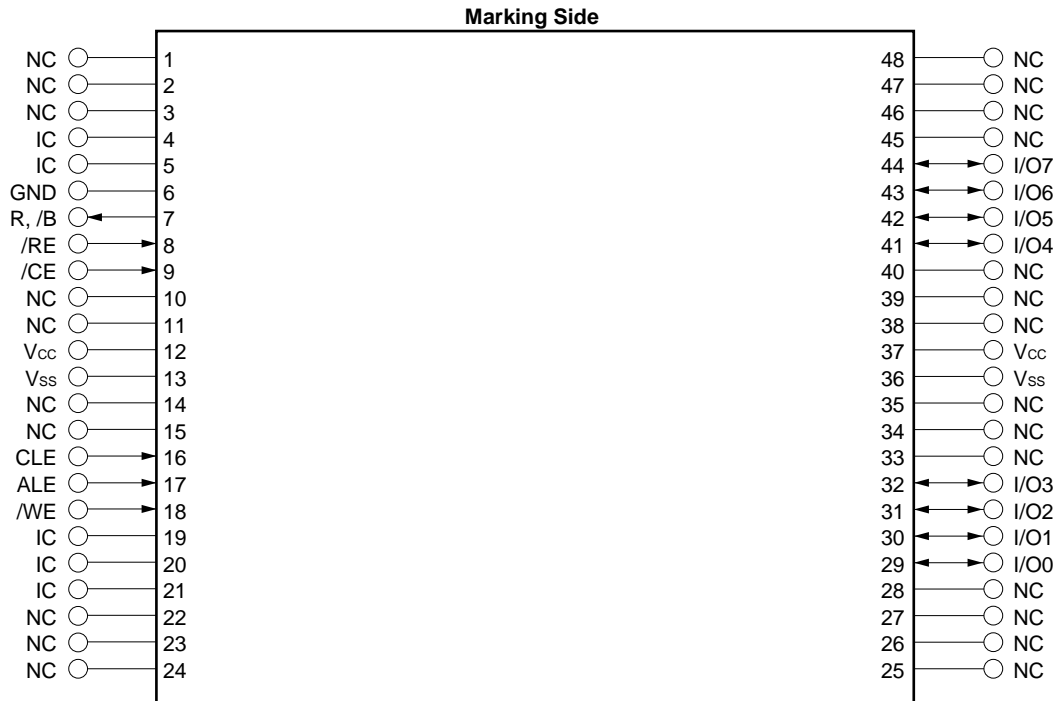
(xxx : ROM code suffix No.)

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Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

Pin Configurations

/xxx indicates active low signal.

48-pin PLASTIC TSOP(I) (12x18) (Normal bent)  
[ μPD23C256112AGY-xxx-MJH ]

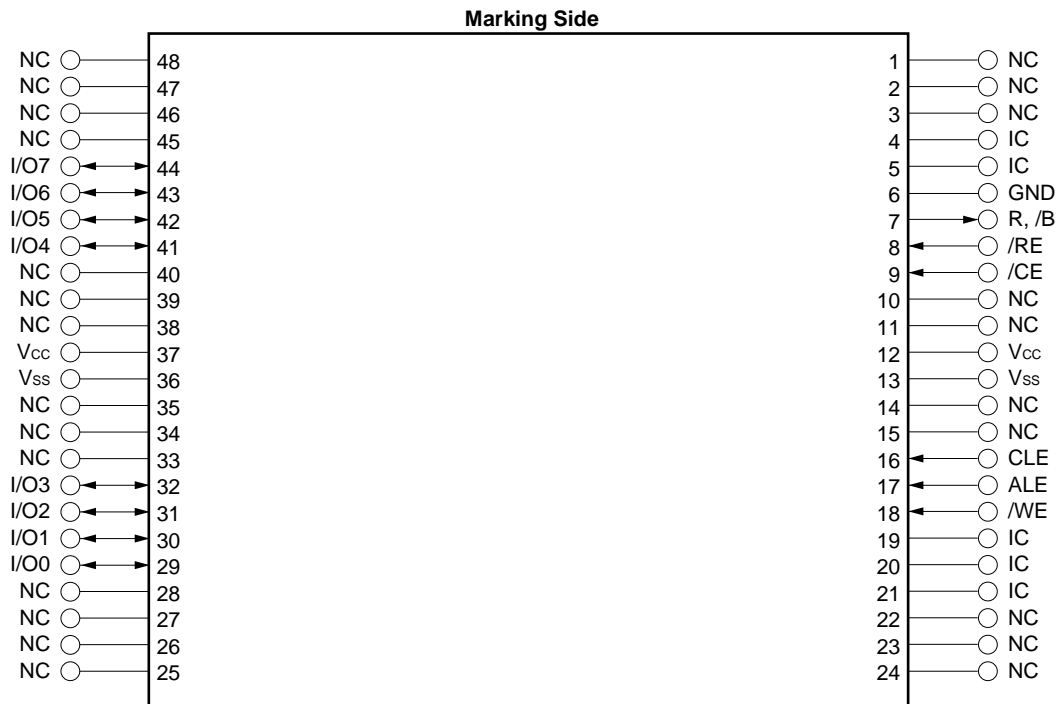


- |                        |  |
|------------------------|--|
| I/O0 to I/O7           | : Address Inputs / Command Inputs / Data Outputs |
| CLE                    | : Command Latch Enable Input                     |
| ALE                    | : Address Latch Enable Input                     |
| /WE                    | : Write Enable Input                             |
| /RE                    | : Read Enable Input                              |
| /CE                    | : Chip Enable Input                              |
| R, /B <sup>Note1</sup> | : READY, /BUSY Output                            |
| V <sub>cc</sub>        | : Supply voltage                                 |
| V <sub>ss</sub>        | : Ground   |
| NC <sup>Note2</sup>    | : No connection                                  |
| IC <sup>Note3</sup>    | : Internal connection                            |
| GND                    | : GND  |

- Notes**
1. This pin is an open-drain output pin. Therefore, a pull-up resistor is required when using this pin.
  2. Some signals can be applied because this pin is not connected to the inside of the chip.
  3. Leave this pin unconnected or connected to V<sub>ss</sub>.

**Remark** Refer to **Package Drawings** for the 1-pin index mark.

48-pin PLASTIC TSOP(I) (12x18) (Reverse bent)  
 [ μPD23C256112AGY-xxx-MKH ]



- I/O0 to I/O7 : Address Inputs / Command Inputs / Data Outputs
- CLE : Command Latch Enable Input
- ALE : Address Latch Enable Input
- /WE : Write Enable Input
- /RE : Read Enable Input
- /CE : Chip Enable Input
- R, /B<sup>Note1</sup> : READY, /BUSY Output
- Vcc : Supply voltage
- Vss : Ground
- NC<sup>Note2</sup> : No connection
- IC<sup>Note3</sup> : Internal connection
- GND : GND

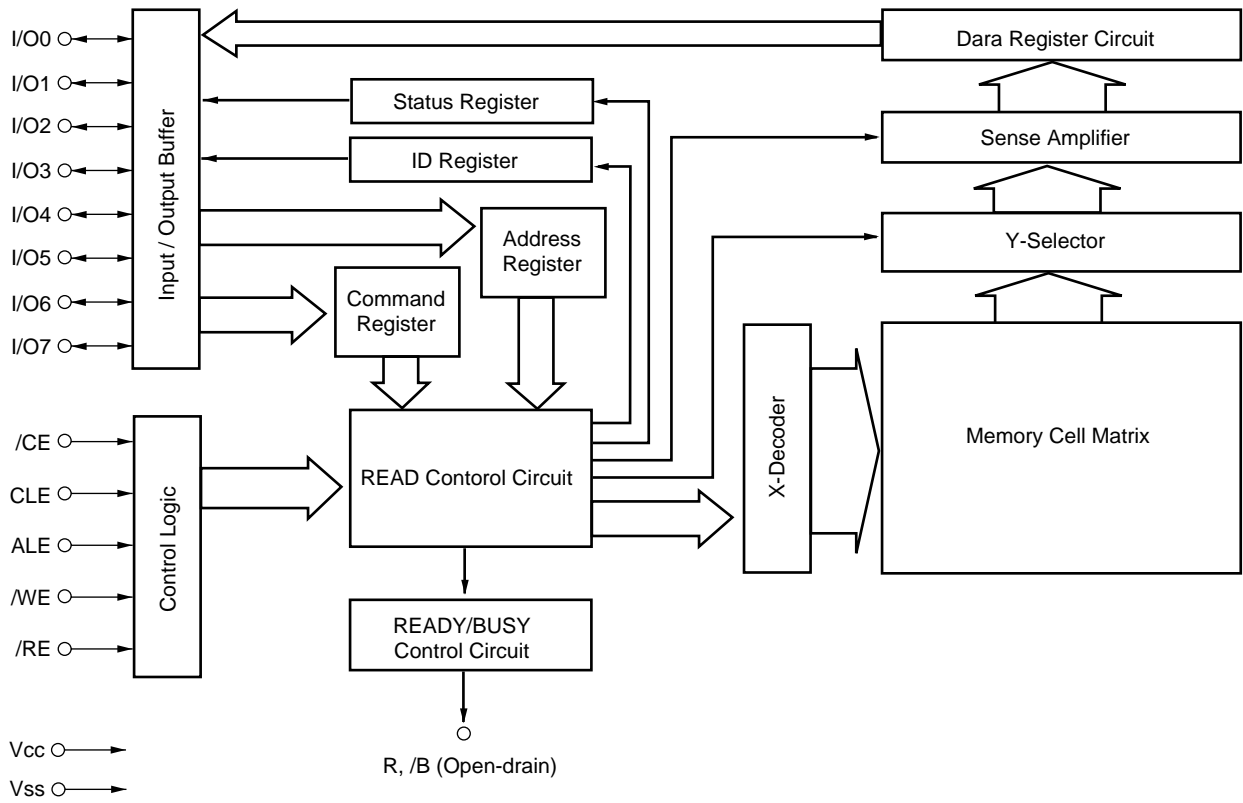
- Notes**
1. This pin is an open-drain output pin. Therefore, a pull-up resistor is required when using this pin.
  2. Some signals can be applied because this pin is not connected to the inside of the chip.
  3. Leave this pin unconnected or connected to Vss.

**Remark** Refer to **Package Drawings** for the 1-pin index mark.

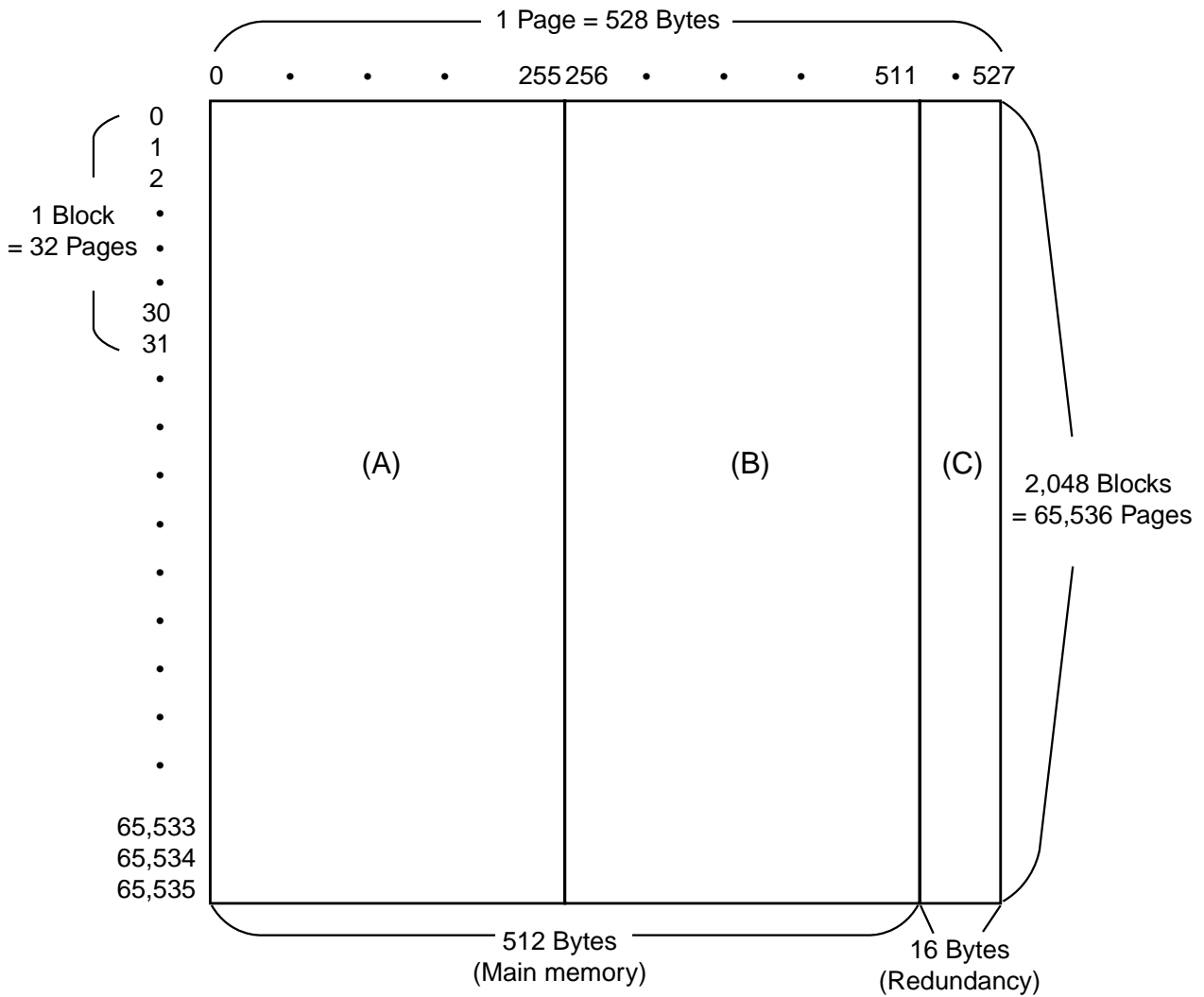
★ Input / Output Pin Functions

Pin name	Input / Output	Function
I/O0 to I/O7 (Address Inputs / Command Inputs / Data Outputs)	Input, Output	I/O port for address input, command input, and data output. I/O pins.
CLE (Command latch Enable Input)	Input	Input pin for signal for controlling loading of commands to command register in device. By making this signal high level at the rising edge or falling edge of the /WE signal, the data of the I/O0 to I/O7 pins is loaded to the command register as commands.
ALE (Address latch Enable Input)	Input	Input pin for signal for controlling loading of address data to the address register in the device. By making this signal high level at the rising edge or falling edge of the /WE signal, the data of the I/O0 to I/O7 pins is loaded as address.
/WE (Write Enable Input)	Input	Input pin for signal for loading the data from the I/O0 to I/O7 pins inside the device.
/RE (Read Enable Input)	Input	Input pin for signal for serially outputting data. The output data of I/O0 to I/O7 is determined after $t_{REA}$ from the falling edge of the /RE signal, and the internal address counter is incremented by +1 at the rising edge of the /RE signal.
/CE (Chip Enable Input)	Input	Input pin for device selection signal. During read, the standby mode is entered by making this signal high level.
R, /B (READY, /BUSY Output)	Output	Output pin for signal that notifies the internal operating status of the device to external. This is an open-drain output signal. During read, Busy is output during operation (R, /B = low level), and upon completion, Ready (R, /B = high level) is automatically output.

Block Diagram



Memory Area



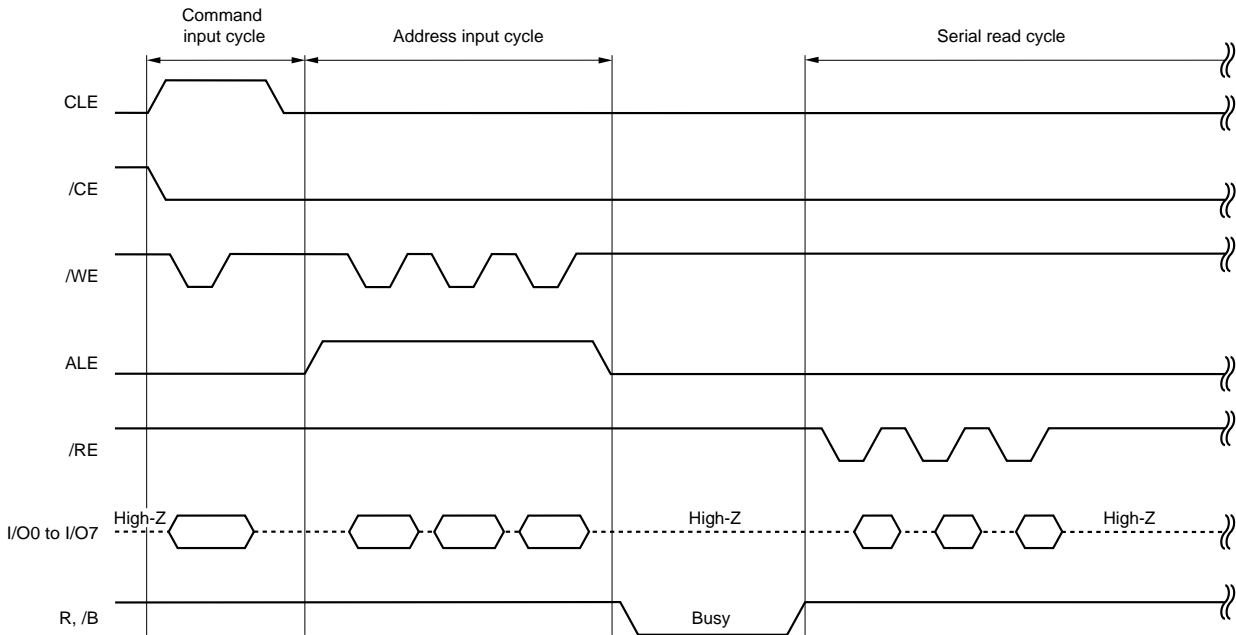
- The start address (SA) during read operation is specified divided into three areas using three types of read commands.
  - In read mode (1), start address (SA) is set in area (A).
  - In read mode (2), start address (SA) is set in area (B).
  - In read mode (3), start address (SA) is set in area (C).

One page consists of a total of 528 bytes broken down into 512 bytes (main memory) and 16 bytes (redundancy).  
 One block consists of 32 pages.

**Caution** The data of area (C) is redundancy. Redundancy is not programmable parts and is fixed to all FFH.

**Operation Modes**

Command input, address input, and serial read are all performed from I/O pins, and the respective statuses are controlled by the CLE, ALE, /WE, /RE, and /CE signals.



**Operation mode**

Mode	CLE	ALE	/CE	/WE	/RE
Command input cycle	H	L	L		H
Address input cycle	L	H	L		H
Serial read cycle	L	L	L	H	

**Operation mode during serial read**

Mode	CLE	ALE	/CE	/WE	/RE	I/O0 to I/O7
Data output	L	L	L	H	L	Data output
Output High-Z	L	L	L	H	H	High-Z
Standby	L	L	H	H	×	High-Z

**Remark** × : V<sub>IH</sub> or V<sub>IL</sub>

**Operation Commands**

The following six operation settings are possible by inputting commands from I/O pins.

Command	HEX	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0	Command receivable during Busy
Read mode(1)	00H	L	L	L	L	L	L	L	L	
Read mode(2)	01H	L	L	L	L	L	L	L	H	
Read mode(3) <sup>Note1</sup>	50H	L	H	L	H	L	L	L	L	
Reset <sup>Note2</sup>	FFH	H	H	H	H	H	H	H	H	○
Status read	70H	L	H	H	H	L	L	L	L	
ID read <sup>Note3</sup>	90H	H	L	L	H	L	L	L	L	

- Notes**
1. The data output in read mode (3) is all FFH.
  2. The only command that can be executed when the device is Busy is the reset command. Do not set any of the other commands while the device is Busy.
  3. For ID read, input "00H" during the first address cycle after setting a command.

**I/O Pin Correspondence Table during Address Input Cycle (Address Setting)**

(1) When 00H or 01H command is set [Read mode (1), Read mode (2)]

Command	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0
1st address cycle	A7	A6	A5	A4	A3	A2	A1	A0
2nd address cycle	A16	A15	A14	A13	A12	A11	A10	A9
3rd address cycle	A24	A23	A22	A21	A20	A19	A18	A17

(2) When 50H command is set [Read mode (3)]

Command	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0
1st address cycle	×	×	×	×	A3	A2	A1	A0
2nd address cycle	A16	A15	A14	A13	A12	A11	A10	A9
3rd address cycle	A24	A23	A22	A21	A20	A19	A18	A17

- Remarks**
1. A0 to A24 are internal addresses.
  2. Internal address A8 is set internally with command 00H or 01H.
  3. When 50H command is set [read mode (3)], the I/O4, I/O5, I/O6, and I/O7 inputs of the 1st address cycle are V<sub>IH</sub> or V<sub>IL</sub>.





**Usage Cautions**

(1) Rated operation

Operation using timing other than shown in the timing charts is not guaranteed.

(2) Commands that can be input

The only commands that can be input are 00H, 01H, 50H, 70H, 90H, and FFH. Do not input any other commands. If other commands are input, the subsequent operation is not guaranteed.

(3) Command limitations during Busy period

Do not input commands other than the reset command (FFH) during the Busy period. If a command is input during the Busy period, the subsequent operation is not guaranteed.

(4) Cautions regarding /RE clock

- Following the last /RE clock, do not input the /RE clock until the R, /B pin changes from Busy to Ready.
- Do not input the /RE clock other than during data output.

(5) Cautions upon power application

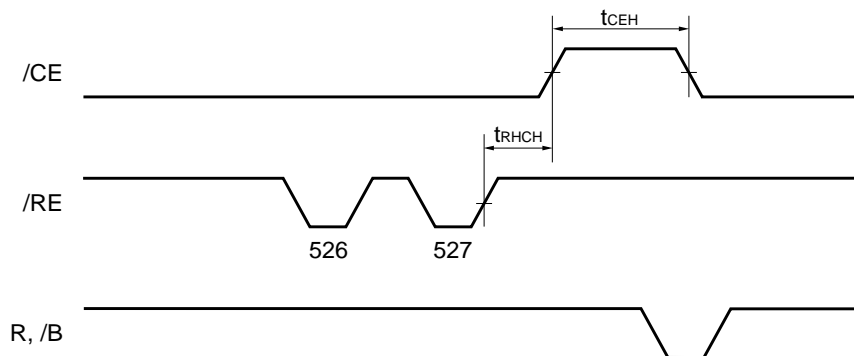
Since the state of the device is undetermined upon power on, input high level to the /CE pin and execute the reset command following power on.

(6) Cautions during read mode

- Perform address input immediately following command input. If address input is done without performing command input first, the correct data cannot be output because the operation mode is undetermined.
- To execute the read mode after the read mode has been stopped with the reset command (FFH) and /CE, input again a command and address.

(7) Busy output following access of last address in page in read mode

After the access to the last address in a page, if the delay ( $t_{RHCH}$ ) from /RE to /CE is 30 ns or less, the Ready status is maintained and Busy is not output by keeping /CE high level for a set period ( $t_{CEH}$ ).



**Electrical Specifications**

**Absolute Maximum Ratings**

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	V <sub>CC</sub>		-0.5 to +4.6	V
Input voltage	V <sub>I</sub>		-0.3 to V <sub>CC</sub> +0.3	V
Input / Output voltage	V <sub>I/O</sub>		-0.3 to V <sub>CC</sub> +0.3 ( ≤ 4.6)	V
Operating ambient temperature	T <sub>A</sub>		0 to 70	°C
Storage temperature	T <sub>stg</sub>		-65 to +150	°C

**Caution** Exposing the device to stress above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

**Capacitance (T<sub>A</sub> = 25°C)**

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C <sub>i</sub>	f = 1 MHz			10	pF
Output capacitance	C <sub>o</sub>				10	pF

**DC Characteristics (T<sub>A</sub> = 0 to 70°C, V<sub>CC</sub> = 3.3 ± 0.3 V)**

Parameter	Symbol	Test conditions	MIN.	TYP.	MAX.	Unit
High level input voltage	V <sub>IH</sub>		2.0		V <sub>CC</sub> + 0.3	V
Low level input voltage	V <sub>IL</sub>		-0.3		+0.8	V
High level output voltage	V <sub>OH</sub>	I <sub>OH</sub> = -400 μA	2.4			V
Low level output voltage	V <sub>OL</sub>	I <sub>OL</sub> = 2.1 mA			0.4	V
Input leakage current	I <sub>LI</sub>	V <sub>I</sub> = 0 V to V <sub>CC</sub>			±10	μA
Output leakage current	I <sub>LO</sub>	V <sub>O</sub> = 0 V to V <sub>CC</sub>			±10	μA
Power supply current in read	I <sub>CC01</sub>	/CE = V <sub>IL</sub> , I <sub>OUT</sub> = 0 mA, t <sub>CYCLE</sub> = 50 ns			30	mA
Power supply current in command input	I <sub>CC03</sub>	t <sub>CYCLE</sub> = 50 ns			30	mA
Power supply current in address input	I <sub>CC05</sub>	t <sub>CYCLE</sub> = 50 ns			30	mA
Standby current (TTL)	I <sub>CCS1</sub>	/CE = V <sub>IH</sub>			1	mA
Standby current (CMOS)	I <sub>CCS2</sub>	/CE = V <sub>CC</sub> - 0.2 V			100	μA
(R, /B) pin output current	I <sub>OL(R, /B)</sub>	V <sub>OL</sub> = 0.4 V		8		mA

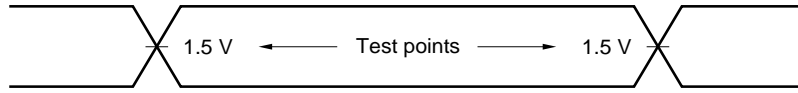
AC Characteristics (TA = 0 to 70°C, Vcc = 3.3 ± 0.3 V)

Parameter	Symbol	MIN	TYP.	MAX.	Unit
CLE setup time	tCLS	0			ns
CLE hold time	tCLH	10			ns
/CE setup time	tCS	0			ns
/CE hold time	tCH	10			ns
Write pulse width	tWP	25			ns
ALE setup time	tALS	0			ns
ALE hold time	tALH	10			ns
Data setup time	tDS	20			ns
Data hold time	tDH	10			ns
Write cycle time	tWC	50			ns
/WE high hold time	tWH	15			ns
Ready to /RE falling edge	tRR	20			ns
Read pulse width	tRP	35			ns
Read cycle time	tRC	50			ns
/RE access time (serial data access)	tREA			35	ns
/CE high hold time for last address in serial read cycle	tCEH	100			ns
/RE access time (ID read )	tREID			35	ns
/RE high to output High-Z	tRHZ	10		30	ns
/CE high to output High-Z	tCHZ			20	ns
/RE high hold time	tREH	15			ns
Output High-Z to /RE falling edge	tIR	0			ns
/RE access time (status read)	tRSTO			35	ns
/CE access time (status read)	tCSTO			45	ns
/WE high to /CE low	tWHC	30			ns
/WE high to /RE low	tWHR	30			ns
ALE low to /RE low (ID read)	tAR1	100			ns
/CE low to /RE low (ID read)	tCR	100			ns
Memory cell array to starting address	tR			7	μs
/WE high to Busy	tWB			200	ns
ALE low to /RE low (read cycle)	tAR2	50			ns
/RE last clock rising edge to Busy (in sequential read)	tRB			200	ns
/CE high to Ready (when interrupted by /CE in read mode)	tCRY <sup>Note</sup>			1	μs
Device reset time	tRST			6	μs

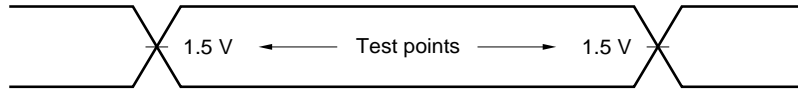
**Note** tCRY (time from /CE high to Ready) depends on the pull-up resistor of the R, /B output pin.

AC Test Conditions

Input waveform (Rise / Fall Time  $\leq 5$  ns)



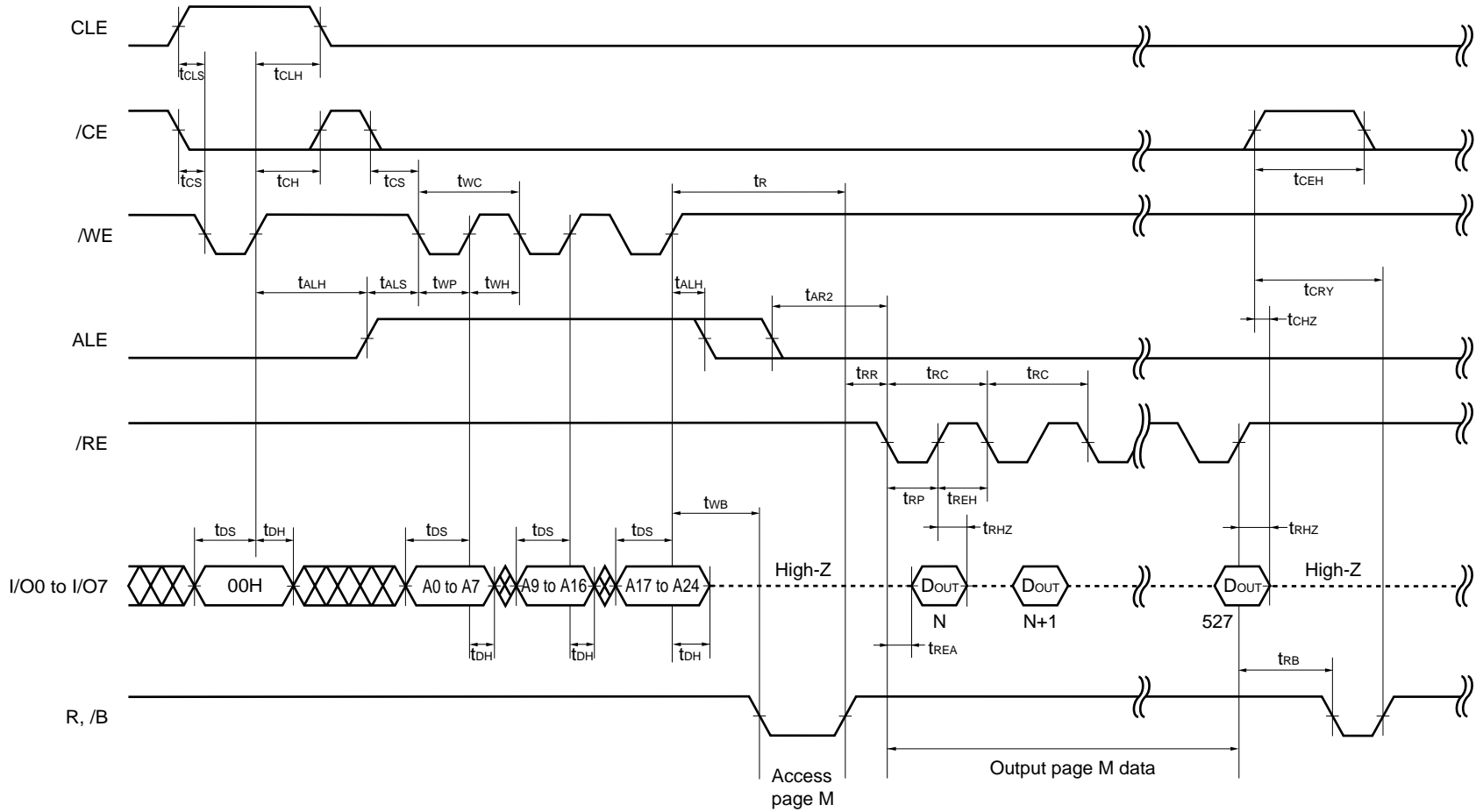
Output waveform



Output load

1 TTL + 100 pF

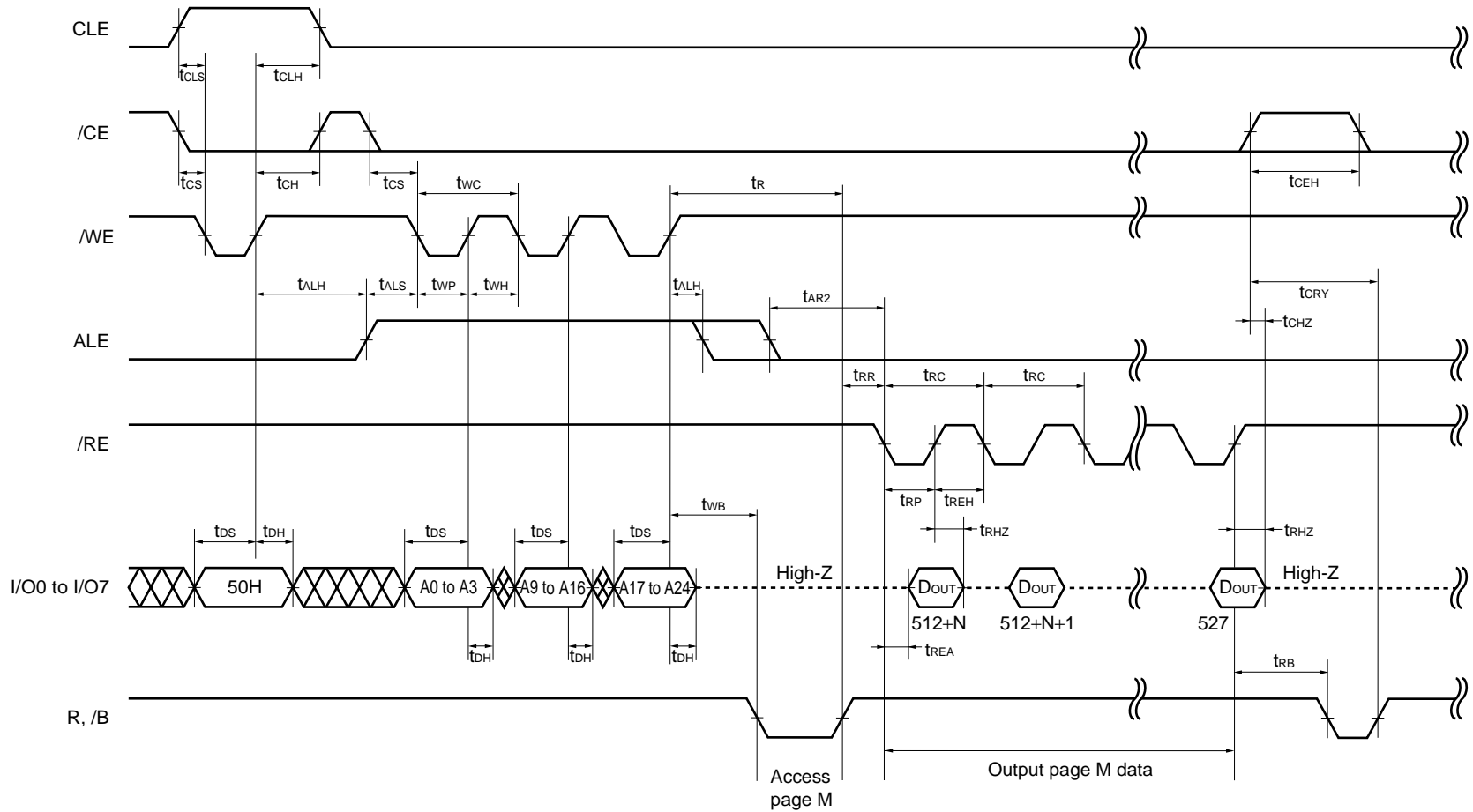
**Read Cycle Timing Chart (1)**  
**(In case of read mode (1))**



- Remarks**
1. Start address (SA) specification when read is performed with command 00H. N: 0 to 255
  2. Then time ( $t_{CRY}$ ) from /CE high to Ready is cancelled depends on the pull-up register of the R,/B output pin.

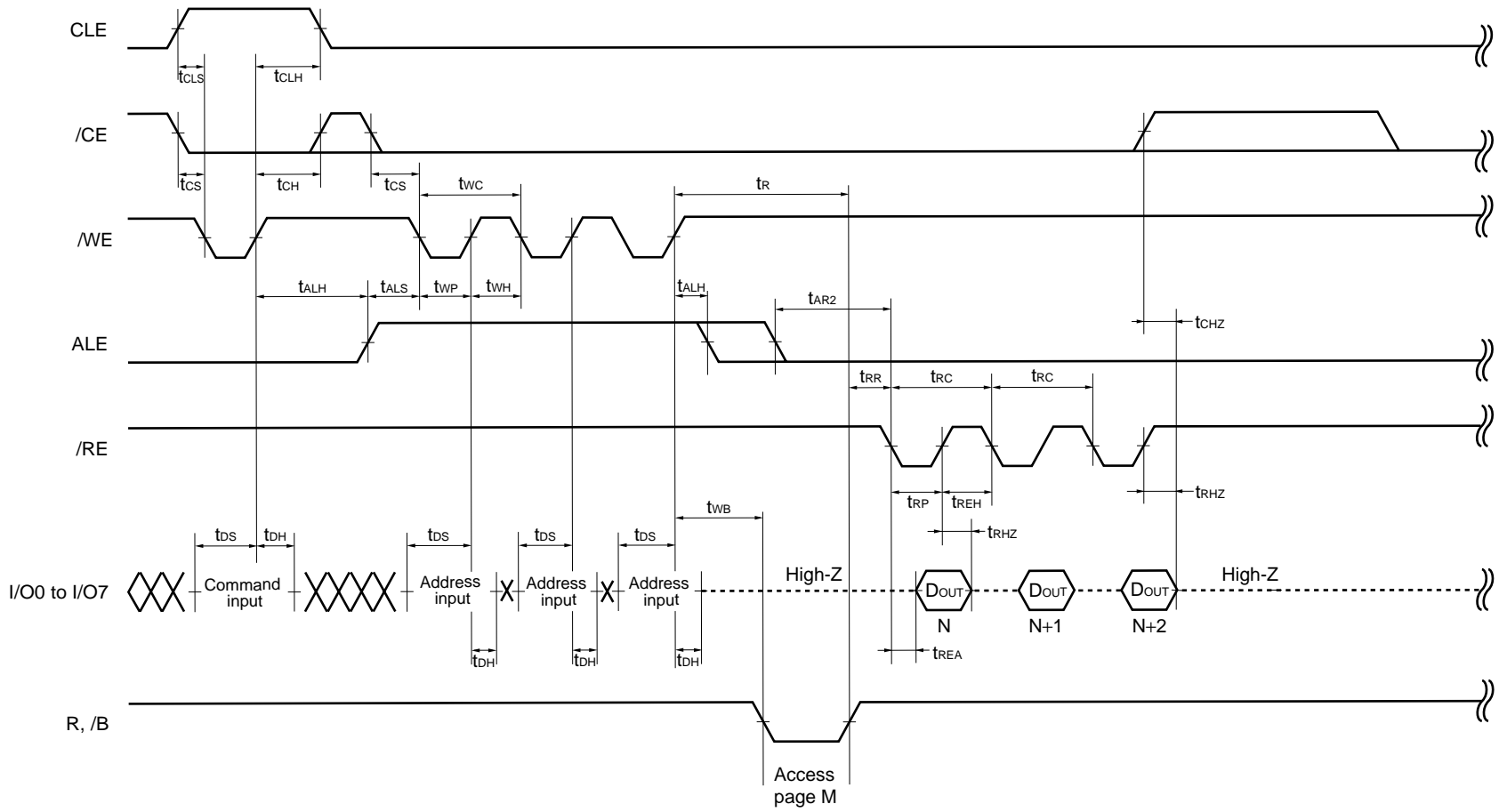


**Read Cycle Timing Chart (3)**  
(In case of read mode (3))



- Remarks**
1. Start address (SA) specification when read is performed with command 50H. N: 0 to 15
  2. The start address of area C (redundancy data) is specified with A0 to A3 during the 1st address cycle. At this time, A4 to A7 are Don't Care.
  3. The time ( $t_{CRY}$ ) from /CE high to Ready is cancelled depends on the pull-up register of the R, /B output pin.
  4. The data that is output is FFH.

**Read Cycle Timing Chart (4)**  
 (When /CE is made high level in the read mode)

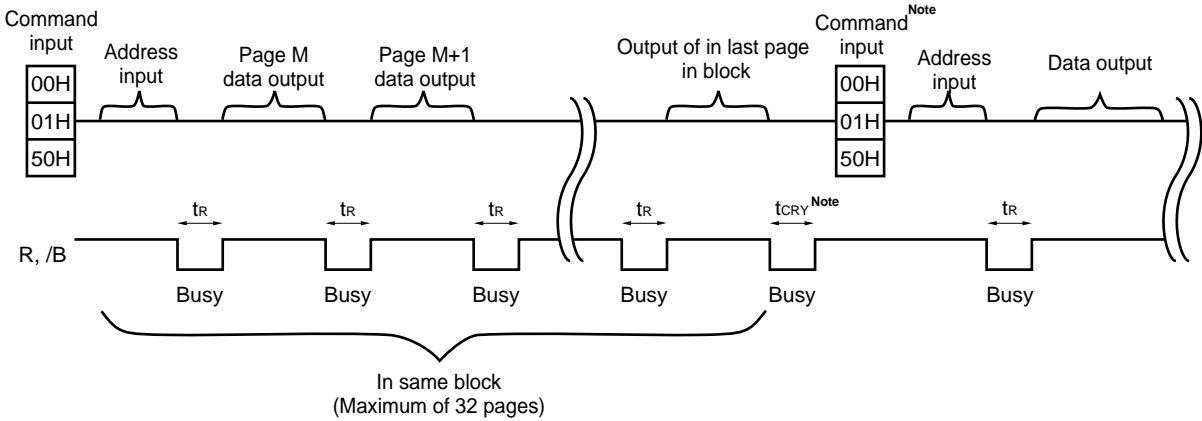


**Remark** If /CE is made high level during the read cycle, the read operation until that time is cancelled. Therefore, to perform read again, execute a new command and new address input.



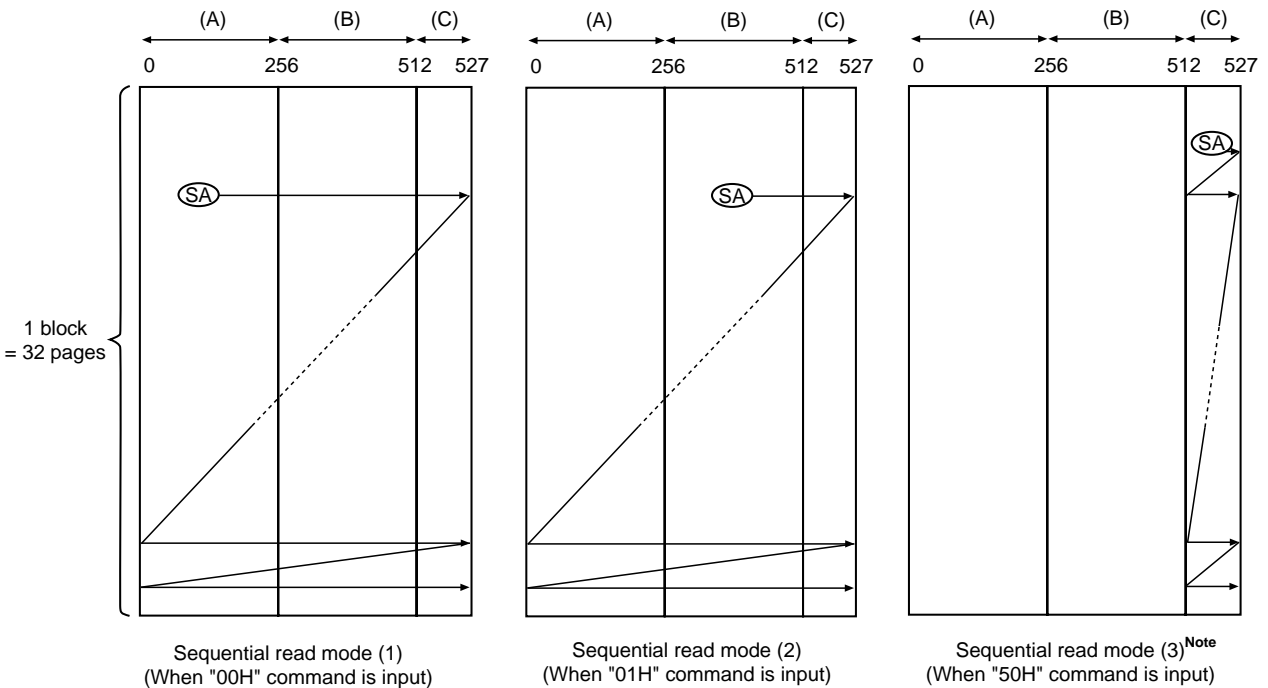
**Sequential Read**

In read modes (1), (2), and (3), when a command (00H, 01H, 50H) is input and an address specified, if it is in the block that includes the address that was specified first, the address is automatically incremented and the read operation is continuously performed until the last address in the same block, by inputting the /RE clock. At this time, a Busy period ( $t_R$ ) occurs after the last address is accessed in a page.



**Note** To perform read again after reading the 527th byte of data of the last page of block, stop the read operation once, and then restart the read operation by inputting again the read command and an address.

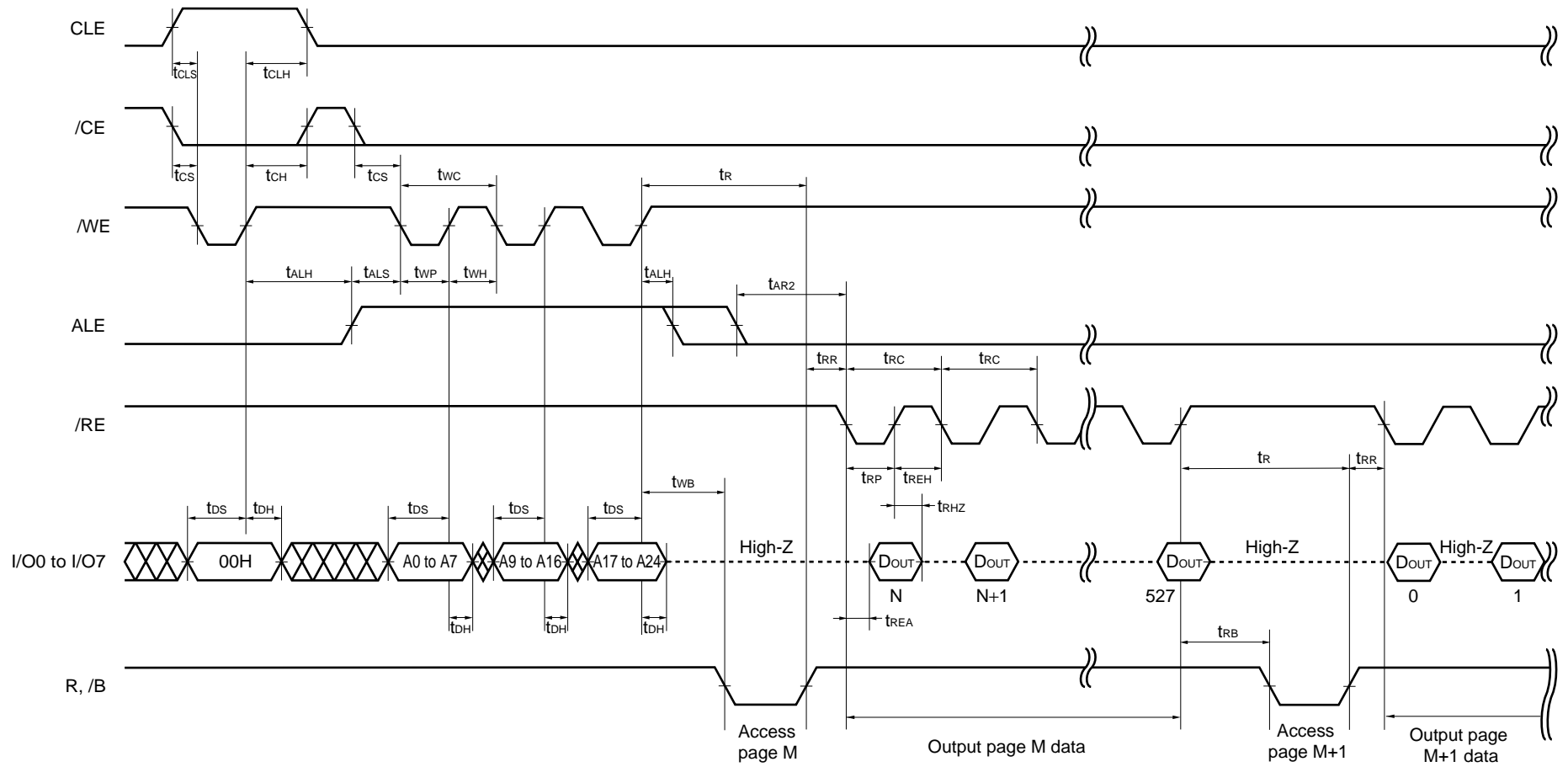
**Relationship Between Command and Start Address (SA) during Sequential Read**



**Note** When the "50H" command is set, only the (C) area (redundancy data part) is continuously read.

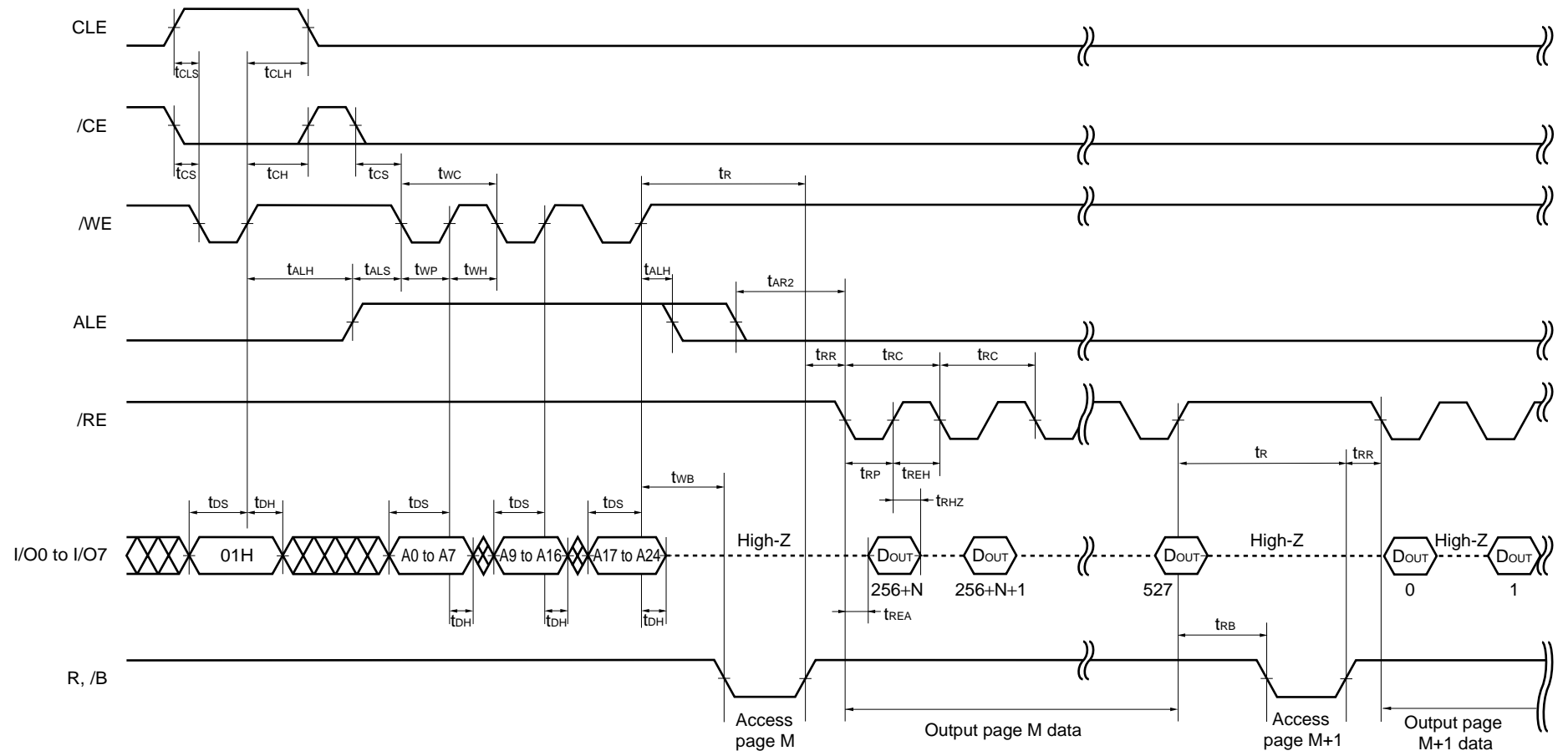
- When the "00H" command is set, the start address (SA) is set to area (A).
- When the "01H" command is set, the start address (SA) is set to area (B).
- When the "50H" command is set, the start address (SA) is set to area (C).

**Sequential Read Cycle Timing Chart (1)**  
(In case of read mode (1))



**Remark** Start address (SA) specification when read is performed with command 00H. N: 0 to 255

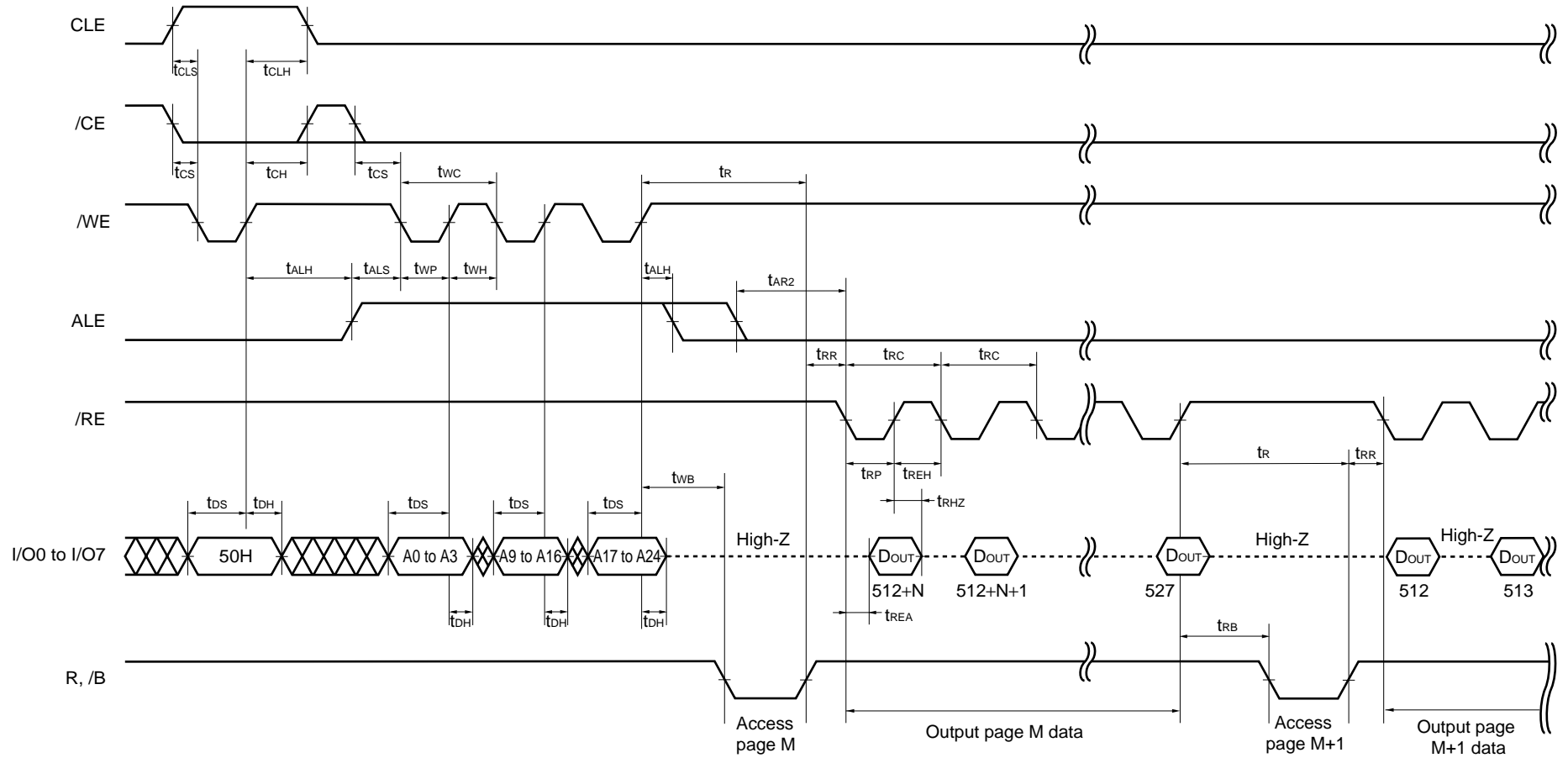
**Sequential Read Cycle Timing Chart (2)**  
**(In case of read mode (2))**



**Remark** Start address (SA) specification when read is performed with command 01H. N: 0 to 255

Data Sheet M15902EJ2V0DS

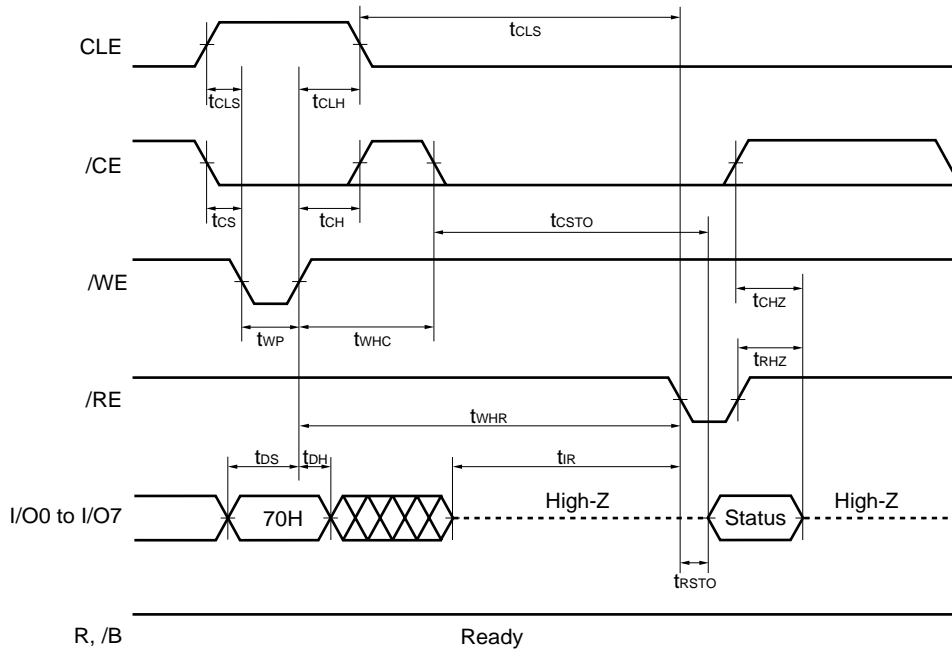
**Sequential Read Cycle Timing Chart (3)**  
**(In case of read mode (3))**



**Remark** Start address (SA) specification when read is performed with command 50H. N: 0 to 15

Status Read

Status information can be output from the I/O pins with the /RE clock following input of the 70H command. Status read is a function to recognize the status of the device from external.

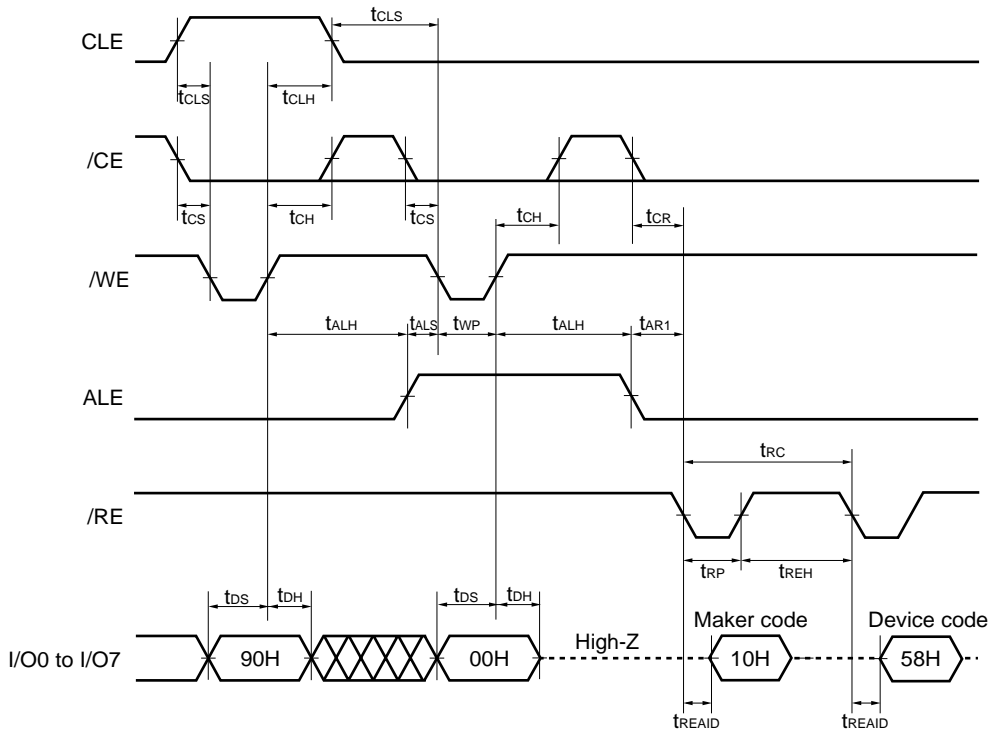


	Status	Status output data <sup>Note</sup>
I/O0	Ready / Busy	0 / 1
I/O1	Not used	0
I/O2	Not used	0
I/O3	Not used	0
I/O4	Not used	0
I/O5	Not used	0
I/O6	Ready / Busy	1 / 0
I/O7	Write protect	0

**Note** Use the status read command only during Ready.

**ID Read**

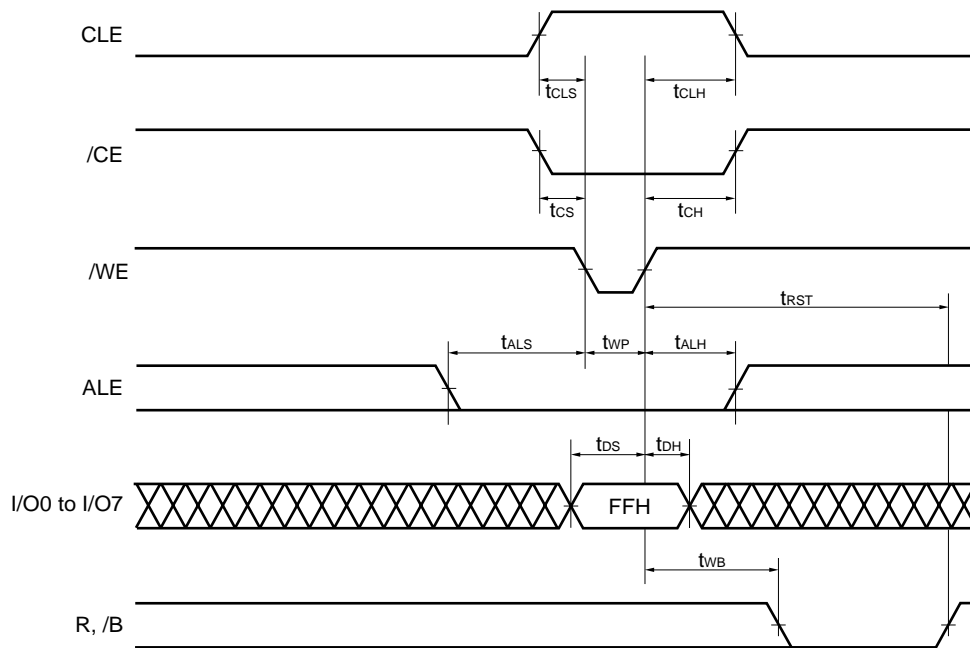
To recognize the ID code (maker code / device code) of this device in a system, execute the ID read command. The ID code can be read with the following timing.



	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0	HEX
Maker code	L	L	L	H	L	L	L	L	10H
Device code	L	H	L	H	H	L	L	L	58H

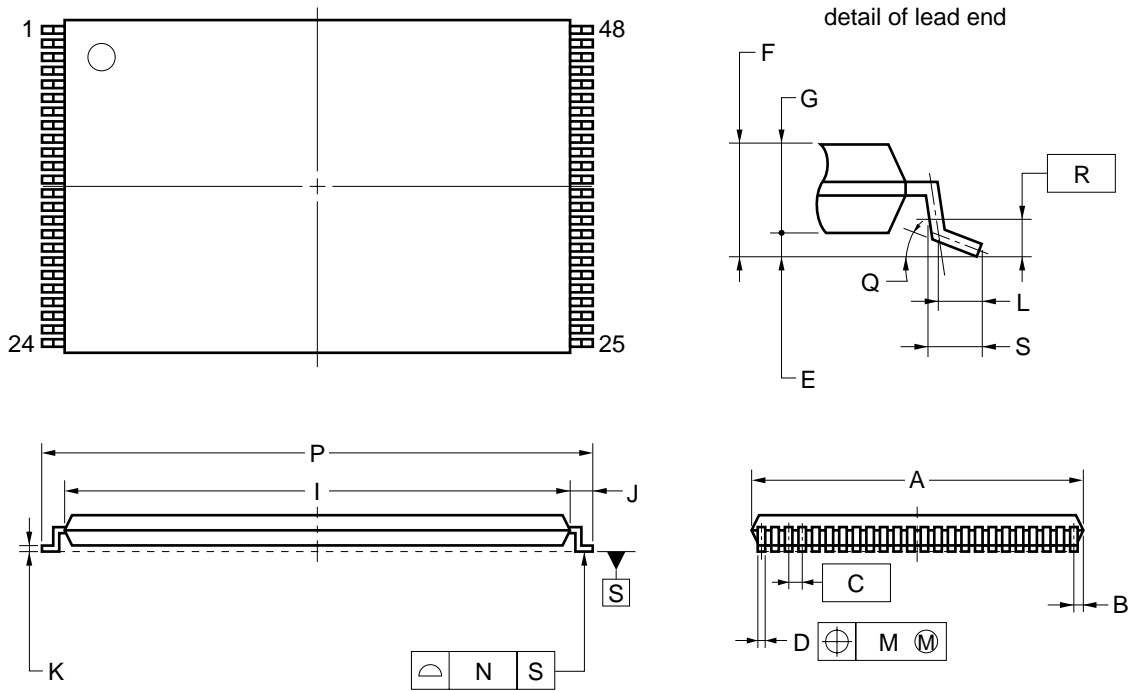
- Cautions 1.** If the /RE clock is input after the maker code and device code are output, the output data is not guaranteed. Therefore, do not input the /RE clock following device code output.
- 2.** Do not input an address other than 00H after setting the ID read command (90H). If an address other than 00H is input, the data following /RE clock input is not guaranteed.

Reset Cycle Timing Chart



Package Drawings

48-PIN PLASTIC TSOP(I) (12x18)



NOTES

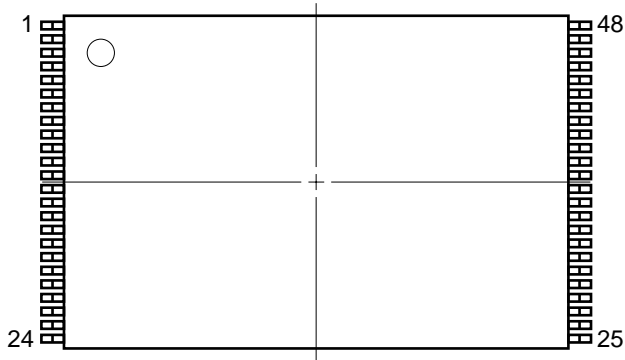
1. Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.
2. "A" excludes mold flash. (Includes mold flash : 12.4 mm MAX.)

ITEM	MILLIMETERS
A	12.0±0.1
B	0.45 MAX.
C	0.5 (T.P.)
D	0.22±0.05
E	0.1±0.05
F	1.2 MAX.
G	1.0±0.05
I	16.4±0.1
J	0.8±0.2
K	0.145±0.05
L	0.5
M	0.10
N	0.10
P	18.0±0.2
Q	3° <sup>+5°</sup> <sub>-3°</sub>
R	0.25
S	0.60±0.15

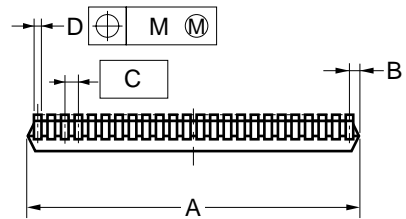
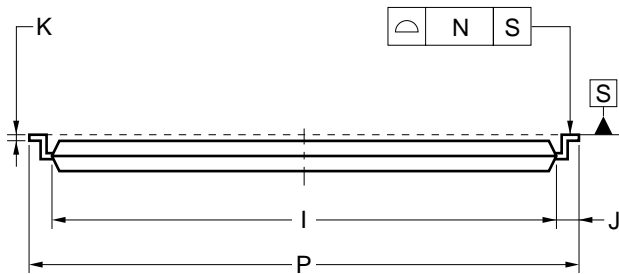
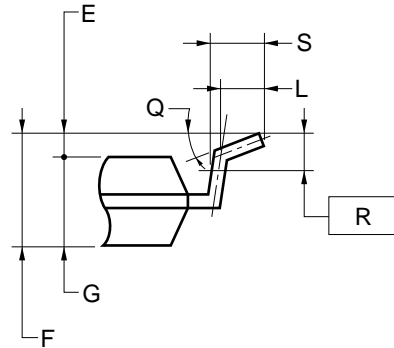
S48GY-50-MJH1-1



48-PIN PLASTIC TSOP(I) (12x18)



detail of lead end



NOTES

1. Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.
2. "A" excludes mold flash. (Includes mold flash : 12.4 mm MAX.)

ITEM	MILLIMETERS
A	12.0±0.1
B	0.45 MAX.
C	0.5 (T.P.)
D	0.22±0.05
E	0.1±0.05
F	1.2 MAX.
G	1.0±0.05
I	16.4±0.1
J	0.8±0.2
K	0.145±0.05
L	0.5
M	0.10
N	0.10
P	18.0±0.2
Q	3°+5° -3°
R	0.25
S	0.60±0.15

S48GY-50-MKH1-1

**Recommended Soldering Conditions**

Please consult with our sales offices for soldering conditions of the  $\mu$ PD23C256112A.

**Types of Surface Mount Device**

$\mu$ PD23C256112AGY-MJH : 48-pin PLASTIC TSOP(I) (12x18) (Normal bent)

$\mu$ PD23C256112AGY-MKH : 48-pin PLASTIC TSOP(I) (12x18) (Reverse bent)

**Revision History**

Edition/ Date	Page		Type of revision	Location	Description (Previous edition → This edition)
	This edition	Previous edition			
2nd edition/ Sep. 2002	p.1	p.1	Modification	Features	Read cycle time: 50ns(MAX.) → 50ns(MIN.)
	p.4	p.4	Modification	Input/Output Pin Functions	Signal Descriptions→Input/Output Pin Functions
	p.9	p.23	Modification	Usage Cautions	Moved in front of Electrical Specifications page

[ MEMO ]

[ MEMO ]

[ MEMO ]

**NOTES FOR CMOS DEVICES****① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS**

Note:

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

**② HANDLING OF UNUSED INPUT PINS FOR CMOS**

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to  $V_{DD}$  or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

**③ STATUS BEFORE INITIALIZATION OF MOS DEVICES**

Note:

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

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"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

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