

## 3.0 Volt Multi-Chip Package (MCP) — 128 Mbit Simultaneous Operation Flash Memory and 32 Mbit Pseudo Static RAM

PRELIMINARY INFORMATION  
MARCH 2003

### MCP FEATURES

- Power supply voltage 2.7V to 3.3V
- High performance:  
Flash: 70ns maximum access time  
PSRAM: 65ns maximum access time
- Package: 107-ball BGA
- Operating Temperature: -30C to +85C

### FLASH FEATURES

- Power Dissipation:  
Read Current at 1 Mhz: 4 mA maximum  
Read Current at 5 Mhz: 18 mA maximum  
Sleep Mode: 5  $\mu$ A maximum
- User Configurable Banks  
Flash 1 (64 Mbit)  
Bank A1: 8Mbit (8KB x 8 and 64KB x 15)  
Bank B1: 24Mbit (64KB x 48)  
Bank C1: 24Mbit (64KB x 48)  
Bank D1: 8Mbit (8KB x 8 and 64KB x 15)  
  
Flash 2 (64 Mbit)  
Bank A2: 8Mbit (8KB x 8 and 64KB x 15)  
Bank B2: 24Mbit (64KB x 48)  
Bank C2: 24Mbit (64KB x 48)  
Bank D2: 8Mbit (8KB x 8 and 64KB x 15)  
User chooses two virtual banks from a  
combination of four physical banks
- Simultaneous R/W Operations (dual virtual bank):  
Zero latency between read and write operations; Data  
can be programmed or erased in one bank while data  
is simultaneously being read from the other bank
- Low-Power Mode:  
A period of no activity causes flash to enter a  
low-power state
- Erase Suspend/Resume:  
Suspends of erase activity to allow a read in the  
same bank
- Sector Erase Architecture:  
16 sectors of 4K words each and 126 sectors of 32K words  
each in Word mode. Any combination of sectors, or  
the entire flash can be simultaneously erased

- Erase Algorithms:  
Automatically preprograms/erases the flash memory  
entirely, or by sector
- Program Algorithms:  
Automatically writes and verifies data at specified  
address
- Hidden ROM Region:  
256 byte with a Factory-serialized secure electronic  
serial number (ESN), which is accessible through a  
command sequence
- Data Polling and Toggle Bit:  
Detects the completion of the program or erase cycle
- Ready-Busy Outputs (RY/ $\overline$ BY)  
Detection of program or erase cycle completion for  
each flash chip
- Over 100,000 write/erase cycles
- Low supply voltage ( $V_{ccf} \leq 2.5V$ ) inhibits writes
- $\overline$ WP/ACC input pin:  
If  $V_{IL}$ , allows partial protection of boot sectors  
If  $V_{IH}$ , allows removal of boot sector protection  
If  $V_{acc}$ , program time is improved

### PSRAM FEATURES (32 Mb density)

- Power Dissipation:  
Operating: 25 mA maximum  
Standby: 110  $\mu$ A maximum
- Chip Selects:  $\overline$ CE1r, CE2r
- Power down feature using CE2r  
Sleep Mode: 10  $\mu$ A maximum  
Nap: 65  $\mu$ A maximum  
8 mbit Partial: 80  $\mu$ A maximum
- Data retention supply voltage: 2.1 V to 3.3V
- Byte data control:  $\overline$ LB (DQ0–DQ7),  $\overline$ UB  
(DQ8–DQ15)

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## GENERAL DESCRIPTION

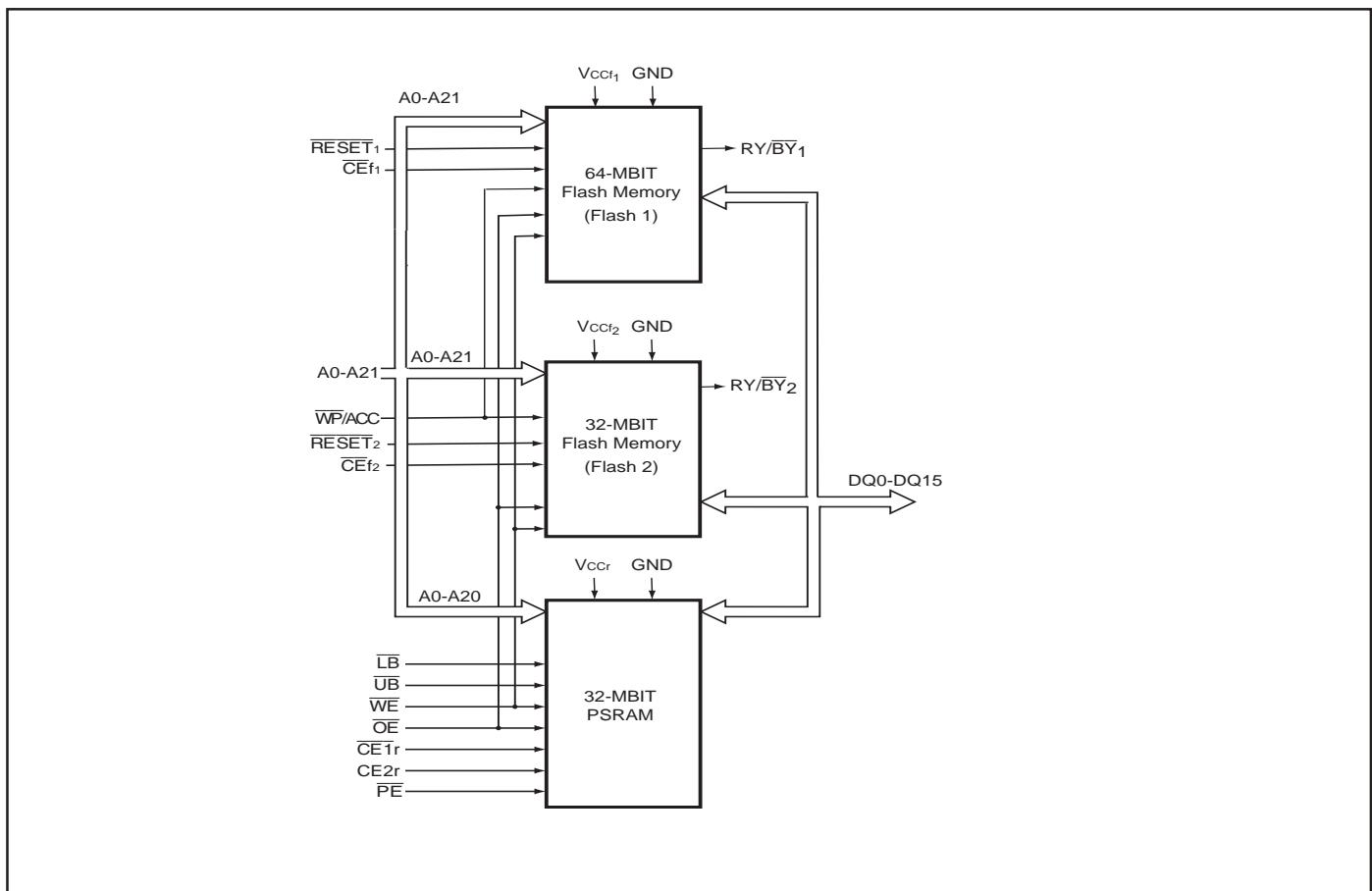
This 107-ball MCP is a space-saving combination of 3 memories: two 64Mbit Flash and one 32Mbit Pseudo SRAM. Each 64Mbit Flash (Flash1 and Flash 2) contains 4,194,304 words and the 32Mbit PSRAM contains 2,097,152 words. Each word is 16 bits wide. Data lines DQ0-DQ15 handle the access for all three memories. Write Enable, Output Enable, and A0-A20 are shared among the three memories. Single Byte data on the PSRAM can be accessed one at a time on DQ0-DQ7 or DQ8-DQ15 by using  $\overline{LB}$  or  $\overline{UB}$ , respectively.

The package uses a 3.0V power supply for all operations. No other source is required for program and erase operations. The flash can be programmed in system using this 3.0V supply, or can be programmed in a standard EPROM programmer.

The flash chips are compatible with the JEDEC Flash command set standard. The flash access time is 70ns and the PSRAM access time is 65ns.

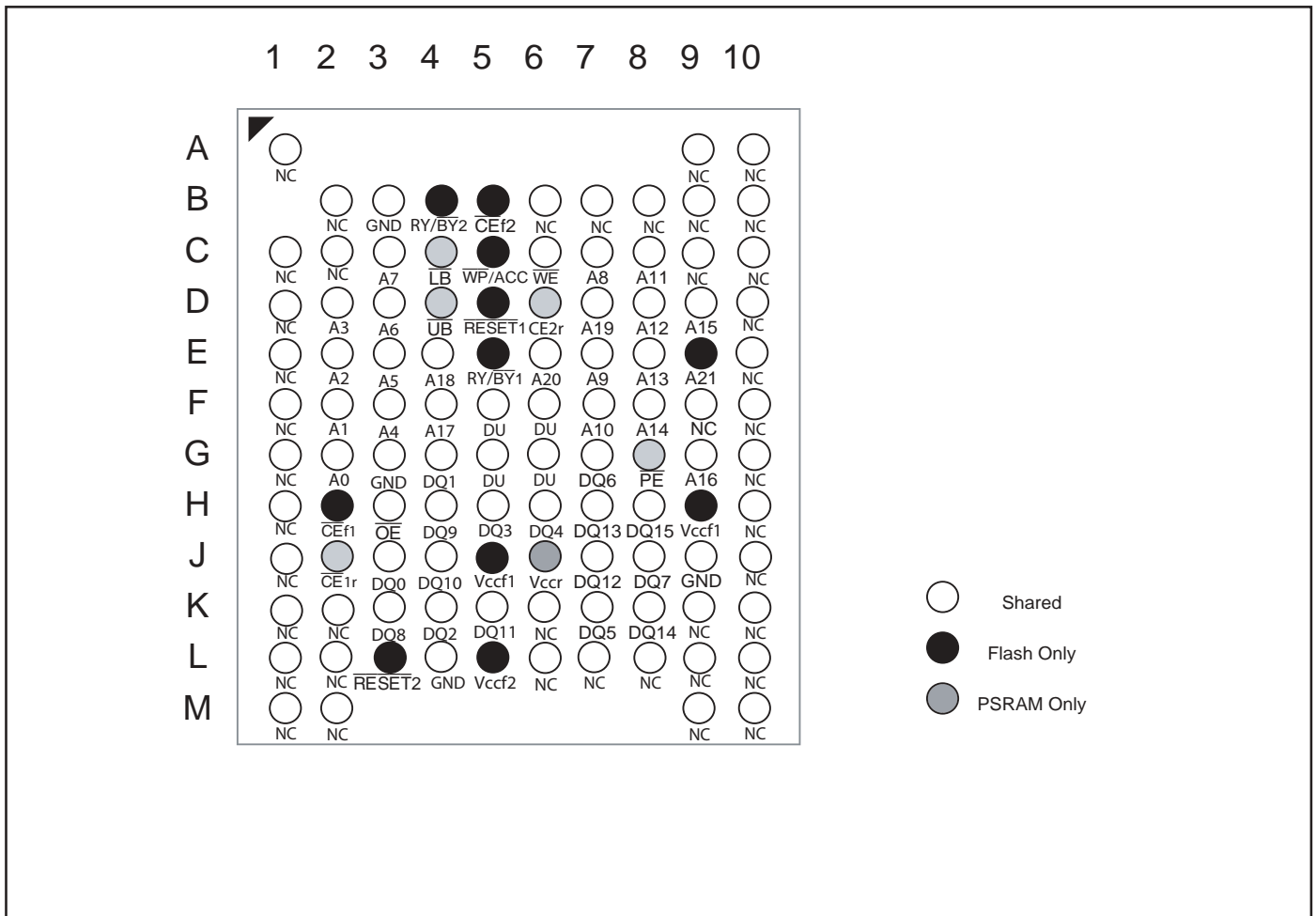
Each Flash memory implements an architecture composed of two virtual banks that allows simultaneous operation on each bank. Optimized performance can be achieved by first initializing a program or erase function in one bank, then immediately starting a read from the other bank. Both operations would then be operating simultaneously on the same chip, with zero latency.

## MCP BLOCK DIAGRAM



**PIN CONFIGURATION (128 Mb Flash and 32 Mb PSRAM)**

PACKAGE CODE: B 107 BALL FBGA (Top View) (9.00 mm x 10.00 mm Body, 0.8 mm Ball Pitch)

**PIN DESCRIPTIONS**

A0-A20	Address Inputs, Common	$\overline{\text{LB}}$	Lower-byte Control, PSRAM
A21	Address Input, Both Flash	$\overline{\text{UB}}$	Upper-byte Control, PSRAM
DQ0-DQ15	Data Inputs/Outputs, Common	$\overline{\text{WP/ACC}}$	Write Protect/Acceleration Pin, Both Flash
$\overline{\text{RESET1}}$	Reset, Flash1	$\text{RY}/\overline{\text{BY1}}$	Ready/Busy Output , Flash1
$\overline{\text{RESET2}}$	Reset, Flash2	$\text{RY}/\overline{\text{BY2}}$	Ready/Busy Output , Flash2
$\overline{\text{CE1r}}, \overline{\text{CE2r}}$	Chip Enable, PSRAM	NC	No Connection
$\overline{\text{CEf1}}$	Chip Enable, Flash1	DU	Do Not Use
$\overline{\text{CEf2}}$	Chip Enable, Flash2	Vccf1	Power, Flash1
$\overline{\text{OE}}$	Output Enable, Common	Vccf2	Power, Flash2
$\overline{\text{WE}}$	Write Enable, Common	Vccr	Power, PSRAM
$\overline{\text{PE}}$	Partial Enable, PSRAM	GND	Ground, Common

## DEVICE BUS OPERATION

OPERATION <sup>(1,2)</sup>	$\overline{CE}f1$	$\overline{CE}f2$	$\overline{CE}1r$	CE2r	$\overline{OE}$	$\overline{WE}$	$\overline{LB}s$	$\overline{UB}s$	$\overline{PE}$	A <sub>21</sub> -A <sub>0</sub>	DQ <sub>7</sub> -DQ <sub>0</sub>	DQ <sub>15</sub> -DQ <sub>8</sub>	$\overline{RESET}1$	$\overline{RESET}2$	$\overline{WP}/ACC^{(12)}$
Full Standby	H	H	H	H	X	X	X	X	H	X	High-Z	High-Z	H	H	X
Output Disable <sup>(3)</sup>	H	H	L	H	H	H	X	X	H	X <sup>(10)</sup>	High-Z	High-Z	H	H	X
	L	H	H	H	H	H	X	X	H	X	High-Z	High-Z	H	H	X
	H	L	H	H	H	H	X	X	H	X	High-Z	High-Z	H	H	X
Read from FLASH 1 <sup>(4)</sup> L	H	H	H	H	L	H	X	X	H	Valid	DOUT	DOUT	H	H	X
Read from FLASH 2 <sup>(4)</sup> H	L	H	H	H	L	H	X	X	H	Valid	DOUT	DOUT	H	H	X
Write to FLASH 1	L	H	H	H	H	L	X	X	H	Valid	DIN	DIN	H	H	X
Write to FLASH 2	H	L	H	H	H	L	X	X	H	Valid	DIN	DIN	H	H	X
Read from PSRAM <sup>(5)</sup>	H	H	L	H	L	H	L <sup>(9)</sup>	L <sup>(9)</sup>	H	Valid	DOUT	DOUT	H	H	X
Write to PSRAM	H	H	L	H	H	L	L	L	H	Valid	DIN	DIN	H	H	X
	H	H	L	H	H	L	H	L	H	Valid	High-Z	DIN	H	H	X
	H	H	L	H	H	L	L	H	H	Valid	DIN	High-Z	H	H	X
FLASH 1 Temporary Sector Group Unprotection <sup>(6)</sup>	X	X	X	X	X	X	X	X	X	X	X	X	V <sub>ID</sub>	X	X
FLASH 2 Temporary Sector Group Unprotection <sup>(6)</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	V <sub>ID</sub>	X
FLASH 1 Hardware Reset	X	X	H	H	X	X	X	X	X	X	High-Z	High-Z	L	X	X
FLASH 2 Hardware Reset	X	X	H	H	X	X	X	X	X	X	High-Z	High-Z	X	L	X
Boot Block Sector Write Protection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	L
PSRAM Power <sup>(7)</sup> Down Program	H	H	H	H	X	X	X	X	L	Valid	High-Z	High-Z	H	H	X
PSRAM No Read	H	H	L	H	L	H	H	H	H	Valid	High-Z	High-Z	H	H	X
PSRAM Power Down <sup>(8)</sup>	X	X	X	L	X	X	X	X	X	X	X	X	X	X	X

Legend : L = V<sub>IL</sub>, H = V<sub>IH</sub>, X = V<sub>IL</sub> or V<sub>IH</sub>. See "DC CHARACTERISTICS" for voltage levels.

## Notes:

- Other operations except for indicated this column are prohibited.
- Do not apply  $\overline{CE}f = V_{IL}$ ,  $\overline{CE}1r = V_{IL}$  and  $CE2r = V_{IH}$  all at once.
- PSRAM Output Disable condition should not be kept longer than 1ms.
- $\overline{WE}$  can be V<sub>IL</sub> if  $\overline{OE}$  is V<sub>IL</sub>,  $\overline{OE}$  at V<sub>IH</sub> initiates the write operations.
- PSRAM  $\overline{LB}$ ,  $\overline{UB}$  control at Read operation is not supported.
- It is also used for the extended sector group protections.
- The PSRAM Power Down Program can be performed one time after compliance of Power-UP timings and it should not be re-programmed after regular Read or Write.
- PSRAM Power Down mode can be entered from Standby state and all DQ pins are in High-Z state. IPD<sub>r</sub> current and data retention depends on the selection of Power Down Program.
- Either or both  $\overline{LB}$  and  $\overline{UB}$  must be Low for PSRAM Read Operation.
- Can be either V<sub>IL</sub> or V<sub>IH</sub> but must be valid before Read or Write.
- See "PSRAM Power Down Program Key Table" located in the next page.
- Protect "outer most" 2x8K bytes ( 4 words ) on both ends of the boot block sectors.

**ABSOLUTE MAXIMUM RATINGS<sup>(1,5)</sup>**

Symbol	Parameter	Rating		Unit
		Min.	Max.	
Tstg	Storage Temperature	-55	+125	°C
T <sub>A</sub>	Ambient Temperature with Power Applied	-30	+85	°C
V <sub>IN</sub> , V <sub>OUT</sub>	Voltage with Respect to Ground All Pins <sup>(2)</sup>	-0.3	V <sub>CC</sub> + 0.3 <sup>(6)</sup>	V
V <sub>ccf1</sub> , V <sub>ccf2</sub>	V <sub>ccf</sub> Supply <sup>(2)</sup>	-0.3	3.5	V
V <sub>ccr</sub>	V <sub>ccr</sub> Supply <sup>(2)</sup>	-0.3	3.5	V
V <sub>IN</sub>	$\overline{\text{RESET}}1$ , $\overline{\text{RESET}}2$ <sup>(3)</sup>	-0.5	+13.0	V
V <sub>ACC</sub>	$\overline{\text{WP}}/\text{ACC}$ <sup>(4)</sup>	-0.5	+10.5	V

**Notes:**

- Voltage is defined on the basis of GND = 0 V.
- Minimum DC voltage on input or I/O pins is -0.3 V. During voltage transitions, input or I/O pins may undershoot GND to -1.0 V for periods of up to 20 ns. Maximum DC voltage on input or I/O pins is V<sub>ccf1</sub>+ 0.3V , V<sub>ccf2</sub>+ 0.3V or V<sub>CCr</sub> + 0.3 V. During voltage transitions, input or I/O pins may overshoot to V<sub>ccf1</sub>+ 2.0V , V<sub>ccf2</sub>+ 2.0 V or V<sub>CCr</sub> + 1.0 V for periods of up to 20 ns.
- Minimum DC input voltage on  $\overline{\text{RESET}}1$  or  $\overline{\text{RESET}}2$  pin is -0.5 V. During voltage transitions,  $\overline{\text{RESET}}1$  or  $\overline{\text{RESET}}2$  pin may undershoot GND to -2.0 V for periods of up to 20 ns.  
The voltage difference between input and supply voltage (V<sub>IN</sub>-V<sub>ccf1</sub> or V<sub>ccf2</sub>) does not exceed 9.0 V.  
The maximum DC input voltage on the  $\overline{\text{RESET}}$  pin is +13.0 V that may overshoot to +14.0 V for periods of up to 20 ns.
- Minimum DC input voltage on  $\overline{\text{WP}}/\text{ACC}$  pin is -0.5 V. During voltage transitions,  $\overline{\text{WP}}/\text{ACC}$  pin may undershoot GND to -2.0 V for periods of up to 20 ns. Maximum DC input voltage on  $\overline{\text{WP}}/\text{ACC}$  pin is +10.5 V which may overshoot to +12.0 V for periods of up to 20 ns, when V<sub>ccf1</sub> or V<sub>ccf2</sub> is applied.
- Stress greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- This V<sub>cc</sub> refers to the minimum of V<sub>ccf1</sub>, V<sub>ccf2</sub>, or V<sub>ccr</sub> .

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Rating		Unit
		Min.	Max.	
T <sub>A</sub>	Ambient Temperature	-30	+85	°C
V <sub>ccf1</sub> , V <sub>ccf2</sub>	V <sub>ccf</sub> Supply Voltages	2.7	3.3	V
V <sub>ccr</sub>	V <sub>ccr</sub> Supply Voltages	2.7	3.3	V

**Note:**

Voltage is defined on the basis of GND = 0 V.

## DC CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	
I <sub>LI</sub>	Input Leakage	V <sub>IN</sub> =GND to V <sub>ccf</sub> , V <sub>ccr</sub>	-1.0	—	+1.0	μA	
I <sub>LO</sub>	Output Leakage	V <sub>OUT</sub> =GND to V <sub>ccf</sub> , V <sub>ccr</sub>	-1.0	—	+1.0	μA	
I <sub>LIT</sub>	RESET Inputs Leakage Current	V <sub>ccf</sub> =V <sub>ccf</sub> max., RESET = 12.5V	—	—	35	μA	
I <sub>cc1f</sub>	FLASH V <sub>cc</sub> <sup>(1)</sup> Active Current (Read)	CEf=V <sub>IL</sub> , OE=V <sub>IH</sub>	tCycle = 5Mhz	—	—	18	mA
			tCycle = 1Mhz	—	—	4	mA
I <sub>cc2f</sub>	FLASH V <sub>cc</sub> Active <sup>(2)</sup> Current(Program/Erase)	CEf=V <sub>IL</sub> , OE=V <sub>IH</sub>	—	—	35	mA	
I <sub>cc3f</sub>	FLASH V <sub>cc</sub> Active <sup>(5)</sup> Current (Read-While-Program)	CEf=V <sub>IL</sub> , OE=V <sub>IH</sub>	—	—	53	mA	
I <sub>cc4f</sub>	FLASH V <sub>cc</sub> Active <sup>(5)</sup> Current (Read-While-Erase)	CEf=V <sub>IL</sub> , OE=V <sub>IH</sub>	—	—	53	mA	
I <sub>cc5f</sub>	FLASH V <sub>cc</sub> Active Current (Erase-Suspend-Program)	CEf=V <sub>IL</sub> , OE=V <sub>IH</sub>	—	—	40	mA	
I <sub>ACC</sub>	WP/ACC Acceleration Program Current	V <sub>ccf</sub> = V <sub>cc</sub> max, WP/ACC = V <sub>ACC</sub> max	—	—	20	mA	
I <sub>cc1r</sub>	PSRAM V <sub>cc</sub> Active Current	V <sub>ccr</sub> = V <sub>ccr</sub> max, trc / twc = min	—	—	25	mA	
		CE1r=V <sub>IL</sub> , CE2r=V <sub>IH</sub> , V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub> , I <sub>OUT</sub> =0 mA	—	—	3	mA	
I <sub>SB1f</sub>	FLASH V <sub>cc</sub> Standby Current <sup>(7)</sup>	V <sub>ccf</sub> = V <sub>ccf</sub> max, CEf= V <sub>ccf</sub> ± 0.3V, RESET = V <sub>ccf</sub> ± 0.3V, WP/ACC = V <sub>ccf</sub> ± 0.3V	—	1	5	μA	
I <sub>SB2f</sub>	FLASH V <sub>cc</sub> <sup>(7)</sup> Standby Current (RESET)	V <sub>ccf</sub> = V <sub>ccf</sub> max, RESET= GND ± 0.3V, WP/ACC = V <sub>ccf</sub> ± 0.3V	—	1	5	μA	
I <sub>SB3f</sub>	FLASH V <sub>cc</sub> <sup>(3,7)</sup> Current (Automatic Sleep Mode)	V <sub>ccf</sub> = V <sub>ccf</sub> max, CEf = GND ± 0.3V, RESET = V <sub>ccf</sub> ± 0.3V, WP/ACC = V <sub>ccf</sub> ± 0.3V, V <sub>IN</sub> = V <sub>ccf</sub> ± 0.3V OR GND ± 0.3V	—	1	5	μA	
I <sub>SB1r</sub>	PSRAM V <sub>cc</sub> Standby <sup>(8)</sup> Current	V <sub>ccr</sub> = V <sub>ccr</sub> max, CE1r ≥ V <sub>ccr</sub> -0.2V, CE2r ≥ V <sub>ccr</sub> -0.2V, V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>ccr</sub> -0.2V	—	—	110	μA	
I <sub>PSDF</sub>	PSRAM V <sub>cc</sub> Power Down Current (Sleep Mode)	V <sub>ccr</sub> = V <sub>ccr</sub> max., CE1r ≥ V <sub>ccr</sub> - 0.2 V CE2r ≤ 0.2 V, V <sub>IN</sub> Cycle time = trc min	—	—	10	μA	
I <sub>PDNF</sub>	PSRAM V <sub>cc</sub> Power <sup>(8)</sup> Down Current (Nap Mode)	V <sub>ccr</sub> = V <sub>ccr</sub> max., CE1r ≥ V <sub>ccr</sub> - 0.2 V CE2r ≤ 0.2 V, V <sub>IN</sub> Cycle time = trc min	—	—	65	μA	

## DC CHARACTERISTICS (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I <sub>PD8r</sub>	PSRAM V <sub>CC</sub> Power Down Current (8M Partial) <sup>(8)</sup>	V <sub>CCR</sub> = V <sub>CCR</sub> max., CE1r ≥ V <sub>CCR</sub> - 0.2 V CE2r ≤ 0.2 V, V <sub>IN</sub> Cycle time = t <sub>RC</sub> min	—	—	80	μA
V <sub>IL</sub>	Input Low Level		-0.3	—	0.5	V
V <sub>IH</sub>	Input High Level (FLASH 1 or FLASH 2)		V <sub>CCf</sub> × 0.75	—	V <sub>CCf</sub> ± 0.3	V
V <sub>IH</sub>	Input High Level (PSRAM)		V <sub>CCR</sub> × 0.75	—	V <sub>CCR</sub> ± 0.3	V
V <sub>ID</sub>	Voltage for Sector Protection and Temp. Unprotection(RESET) <sup>(4)</sup>		11.5	—	12.5	V
V <sub>ACC</sub>	Voltage for WP/ACC Sector Protection/Unprotection and Program Acceleration <sup>(4)</sup>		8.5	9.0	9.5	V
V <sub>OL</sub>	Output Low Level (PSRAM)	V <sub>CCR</sub> = V <sub>CCR</sub> min., V <sub>CCS</sub> =V <sub>CCS</sub> min. I <sub>OL</sub> = 1.0 mA	—	—	0.4	V
V <sub>OH</sub>	Output High Level (PSRAM)	V <sub>CCR</sub> = V <sub>CCR</sub> min., V <sub>CCS</sub> =V <sub>CCS</sub> min. I <sub>OH</sub> = -0.5 mA	2.2	—	—	V
V <sub>OL</sub>	Output Low Level (Flash)	V <sub>CCf</sub> = V <sub>CCf</sub> min., V <sub>CCS</sub> =V <sub>CCS</sub> min. I <sub>OL</sub> = 4.0 mA	—	—	0.45	V
V <sub>OH</sub>	Output High Level (Flash)	V <sub>CCf</sub> = V <sub>CCf</sub> min., V <sub>CCS</sub> =V <sub>CCS</sub> min. I <sub>OH</sub> = -0.1 mA	V <sub>CCf</sub> - 0.4	—	—	V
V <sub>LKO</sub>	FLASH Low V <sub>CCf</sub> Lock-Out Voltage		2.3	2.4	2.5	V

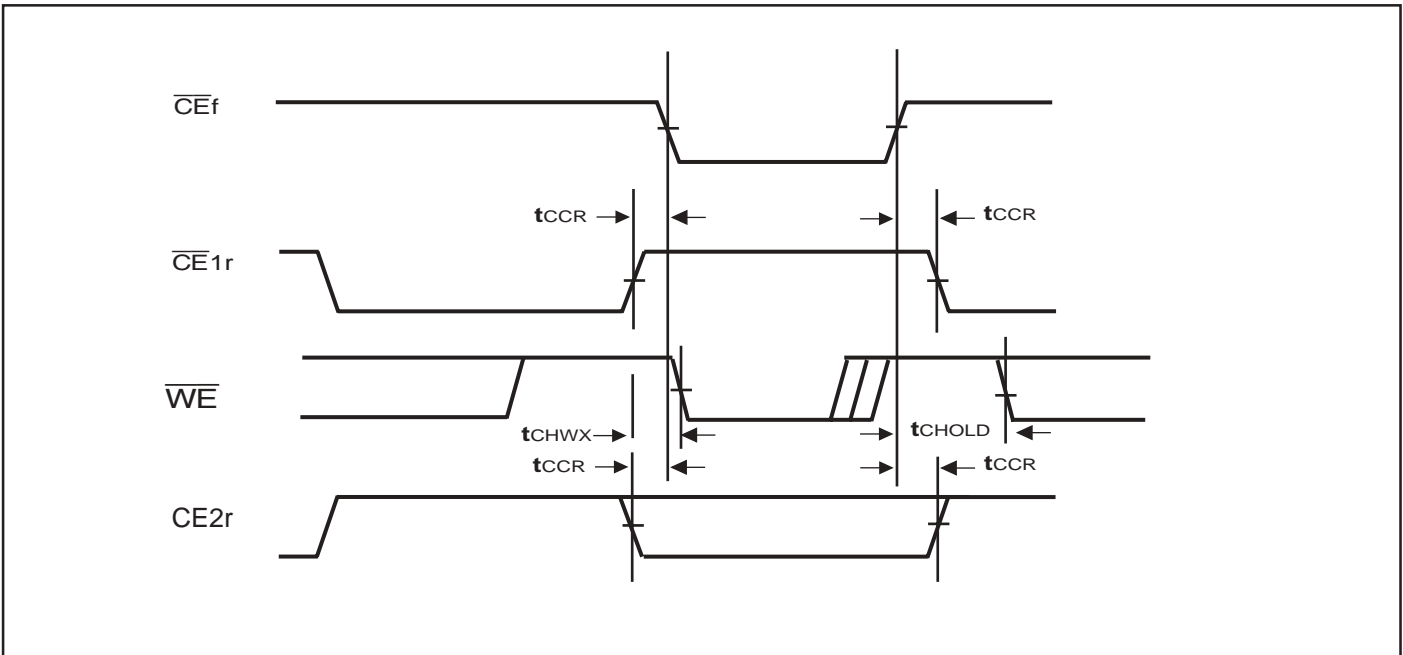
**Notes:**

1. ICC current listed includes both the DC operating current and the frequency dependent component.
2. ICC active while Embedded Algorithm (program or erase) is in progress.
3. Automatic sleep mode enables the low power mode when address remains stable for 150 ns.
4. Applicable for only V<sub>CCf</sub> applying.
5. Embedded Algorithm (program or erase) is in progress. (@5 MHz)
6. ISB2 r depends on V<sub>IN</sub> cycle time. Please refer to "APPENDIX A".
7. Standby current listed is for each FLASH chip.
8. Standby and Power down currents are reduced with V<sub>CCR</sub> ≤ 3.0 V .

AC CHARACTERISTICS -  $\overline{CE}$  TIMING

Parameter	Symbol	Condition	Min	Max	Unit
$\overline{CE}$ f Recover Time	$t_{CCR}$	—	0	—	ns
$\overline{CE}$ f Hold Time	$t_{CHOLD}$	—	3	—	ns
$\overline{CE}$ 1r High to $\overline{WE}$ Invalid time for Standby Entry	$t_{CHWX}$	—	10	—	ns

TIMING DIAGRAM FOR ALTERNATING PSRAM TO FLASH 1 OR FLASH 2





## FLEXIBLE SECTOR-ERASE ARCHITECTURE ON FLASH 1 or FLASH 2

Sector				Sector			
Bank	Address	K-Word	Address	Bank	Address	K-Word	Address
Bank A	SA0	4	000000h	Bank B	SA36	32	0E8000h
Bank A	SA1	4	001000h	Bank B	SA37	32	0F0000h
Bank A	SA2	4	002000h	Bank B	SA38	32	0F8000h
Bank A	SA3	4	003000h	Bank B	SA39	32	100000h
Bank A	SA4	4	004000h	Bank B	SA40	32	108000h
Bank A	SA5	4	005000h	Bank B	SA41	32	110000h
Bank A	SA6	4	006000h	Bank B	SA42	32	118000h
Bank A	SA7	4	007000h	Bank B	SA43	32	120000h
Bank A	SA8	32	008000h	Bank B	SA44	32	128000h
Bank A	SA9	32	010000h	Bank B	SA45	32	130000h
Bank A	SA10	32	018000h	Bank B	SA46	32	138000h
Bank A	SA11	32	020000h	Bank B	SA47	32	140000h
Bank A	SA12	32	028000h	Bank B	SA48	32	148000h
Bank A	SA13	32	030000h	Bank B	SA49	32	150000h
Bank A	SA14	32	038000h	Bank B	SA50	32	158000h
Bank A	SA15	32	040000h	Bank B	SA51	32	160000h
Bank A	SA16	32	048000h	Bank B	SA52	32	168000h
Bank A	SA17	32	050000h	Bank B	SA53	32	170000h
Bank A	SA18	32	058000h	Bank B	SA54	32	178000h
Bank A	SA19	32	060000h	Bank B	SA55	32	180000h
Bank A	SA20	32	068000h	Bank B	SA56	32	188000h
Bank A	SA21	32	070000h	Bank B	SA57	32	190000h
Bank A	SA22	32	078000h	Bank B	SA58	32	198000h
Bank B	SA23	32	080000h	Bank B	SA59	32	1A0000h
Bank B	SA24	32	088000h	Bank B	SA60	32	1A8000h
Bank B	SA25	32	090000h	Bank B	SA61	32	1B0000h
Bank B	SA26	32	098000h	Bank B	SA62	32	1B8000h
Bank B	SA27	32	0A0000h	Bank B	SA63	32	1C0000h
Bank B	SA28	32	0A8000h	Bank B	SA64	32	1C8000h
Bank B	SA29	32	0B0000h	Bank B	SA65	32	1D0000h
Bank B	SA30	32	0B8000h	Bank B	SA66	32	1D8000h
Bank B	SA31	32	0C0000h	Bank B	SA67	32	1E0000h
Bank B	SA32	32	0C8000h	Bank B	SA68	32	1E8000h
Bank B	SA33	32	0D0000h	Bank B	SA69	32	1F0000h
Bank B	SA34	32	0D8000h	Bank B	SA70	32	1F8000h
Bank B	SA35	32	0E0000h	Bank C	SA71	32	200000h

## FLEXIBLE SECTOR-ERASE ARCHITECTURE ON FLASH 1 or FLASH 2 (Continued)

Sector				Sector			
Bank	Address	K-Word	Address	Bank	Address	K-Word	Address
Bank C	SA72	32	208000h	Bank C	SA107	32	320000h
Bank C	SA73	32	210000h	Bank C	SA108	32	328000h
Bank C	SA74	32	218000h	Bank C	SA109	32	330000h
Bank C	SA75	32	220000h	Bank C	SA110	32	338000h
Bank C	SA76	32	228000h	Bank C	SA111	32	340000h
Bank C	SA77	32	230000h	Bank C	SA112	32	348000h
Bank C	SA78	32	238000h	Bank C	SA113	32	350000h
Bank C	SA79	32	240000h	Bank C	SA114	32	358000h
Bank C	SA80	32	248000h	Bank C	SA115	32	360000h
Bank C	SA81	32	250000h	Bank C	SA116	32	368000h
Bank C	SA82	32	258000h	Bank C	SA117	32	370000h
Bank C	SA83	32	260000h	Bank C	SA118	32	378000h
Bank C	SA84	32	268000h	Bank D	SA119	32	380000h
Bank C	SA85	32	270000h	Bank D	SA120	32	388000h
Bank C	SA86	32	278000h	Bank D	SA121	32	390000h
Bank C	SA87	32	280000h	Bank D	SA122	32	398000h
Bank C	SA89	32	290000h	Bank D	SA124	32	3A8000h
Bank C	SA90	32	298000h	Bank D	SA125	32	3B0000h
Bank C	SA91	32	2A0000h	Bank D	SA126	32	3B8000h
Bank C	SA92	32	2A8000h	Bank D	SA127	32	3C0000h
Bank C	SA93	32	2B0000h	Bank D	SA128	32	3C8000h
Bank C	SA94	32	2B8000h	Bank D	SA129	32	3D0000h
Bank C	SA95	32	2C0000h	Bank D	SA130	32	3D8000h
Bank C	SA96	32	2C8000h	Bank D	SA131	32	3E0000h
Bank C	SA97	32	2D0000h	Bank D	SA132	32	3E8000h
Bank C	SA98	32	2D8000h	Bank D	SA133	32	3F0000h
Bank C	SA99	32	2E0000h	Bank D	SA134	4	3F8000h
Bank C	SA100	32	2E8000h	Bank D	SA135	4	3F9000h
Bank C	SA101	32	2F0000h	Bank D	SA136	4	3FA000h
Bank C	SA102	32	2F8000h	Bank D	SA137	4	3FB000h
Bank C	SA103	32	300000h	Bank D	SA138	4	3FC000h
Bank C	SA104	32	308000h	Bank D	SA139	4	3FD000h
Bank C	SA105	32	310000h	Bank D	SA140	4	3FE000h
Bank C	SA106	32	318000h	Bank D	SA141	4	3FF000h

## USER CONFIGURABLE BANK ARCHITECTURE TABLE - FLASH 1 or FLASH 2

Virtual Bank 1			Virtual Bank 2	
Bank Split	Volume	Combination	Volume	Combination
Choice 1	8 Mbit	Bank A	56 Mbit	Bank B, C, D
Choice 2	24 Mbit	Bank B	40 Mbit	Bank A, C, D
Choice 3	24 Mbit	Bank C	40 Mbit	Bank A, B, D
Choice 4	8 Mbit	Bank D	56 Mbit	Bank A, B, C

## EXAMPLE OF VIRTUAL BANKS COMBINATION TABLE - FLASH 1 or FLASH 2

Virtual Bank 1				Virtual Bank 2		
Bank Split	Volume	Combination	Sector Size	Volume	Combination	Sector Size
Choice 1	8 Mbit	Bank A	8x4 Kword	56 Mbit	Bank B, C, D	8x4 Kword
			15x32 Kword			111x32 Kword
Choice 2	16 Mbit	Bank A,D	16x4 Kword	48 Mbit	Bank B,C	96x32 Kword
			30x32 Kword			
Choice 3	24 Mbit	Bank B	48x32 Kword	40 Mbit	Bank A, C, D	16x4 Kword
						78x32 Kword
Choice 4	32 Mbit	Bank A,B	8x4 Kword	32 Mbit	Bank C,D	8x4 Kword
			63x32 Kword			63x32 Kword

**Notes:**

- 1) When multiple sector erase over several banks is operated, the system cannot read out of the bank to which a sector being erased belongs. For example, if erasing is taking place at both Bank A and Bank B, neither Bank A nor Bank B is read out. They would output the sequence flag once they were selected. Meanwhile the system would get to read from either Bank C or Bank D.
- 2) Each word is made-up of 2 bytes: one upper byte and one lower byte. A KWord is 2<sup>10</sup> words.

**SIMULTANEOUS OPERATION TABLE - FLASH 1 or FLASH 2**

Case	Virtual Bank 1 Status	Virtual Bank 2 Status
1	Read Mode	Read Mode
2	Read Mode	Autoselect Mode
3	Read Mode	Program Mode
4	Read Mode	Erase Mode <sup>(1)</sup>
5	Autoselect Mode	Read Mode
6	Program Mode	Read Mode
7	Erase Mode <sup>(1)</sup>	Read Mode

**Note:**

- 1) By writing erase suspend command on the bank address of sector being erased, the erase operation gets suspended so that it enables reading from or programming the remaining sectors.
- 2) Bank 1 and Bank 2 are divided for the sake of convenience at Simultaneous Operation. Actually, the Bank consists of 4 banks, Bank A, Bank B, Bank C, and Bank D. Bank Address (BA) means to specify each of the Banks.

## SECTOR ADDRESS TABLE - FLASH 1 or FLASH 2

Bank	Sector	Bank Address			Sector Address							Address Range
		A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Word Mode
Bank A	SA0	0	0	0	0	0	0	0	0	0	0	000000h to 000FFFh
Bank A	SA1	0	0	0	0	0	0	0	0	0	1	001000h to 001FFFh
Bank A	SA2	0	0	0	0	0	0	0	0	1	0	002000h to 002FFFh
Bank A	SA3	0	0	0	0	0	0	0	0	1	1	003000h to 003FFFh
Bank A	SA4	0	0	0	0	0	0	0	1	0	0	004000h to 004FFFh
Bank A	SA5	0	0	0	0	0	0	0	1	0	1	005000h to 005FFFh
Bank A	SA6	0	0	0	0	0	0	0	1	1	0	006000h to 006FFFh
Bank A	SA7	0	0	0	0	0	0	0	1	1	1	007000h to 007FFFh
Bank A	SA8	0	0	0	0	0	0	1	X	X	X	008000h to 00FFFFh
Bank A	SA9	0	0	0	0	0	1	0	X	X	X	010000h to 017FFFh
Bank A	SA10	0	0	0	0	0	1	1	X	X	X	018000h to 01FFFFh
Bank A	SA11	0	0	0	0	1	0	0	X	X	X	020000h to 027FFFh
Bank A	SA12	0	0	0	0	1	0	1	X	X	X	028000h to 02FFFFh
Bank A	SA13	0	0	0	0	1	1	0	X	X	X	030000h to 037FFFh
Bank A	SA14	0	0	0	0	1	1	1	X	X	X	038000h to 03FFFFh
Bank A	SA15	0	0	0	1	0	0	0	X	X	X	040000h to 047FFFh
Bank A	SA16	0	0	0	1	0	0	1	X	X	X	048000h to 04FFFFh
Bank A	SA17	0	0	0	1	0	1	0	X	X	X	050000h to 057FFFh
Bank A	SA18	0	0	0	1	0	1	1	X	X	X	058000h to 05FFFFh
Bank A	SA19	0	0	0	1	1	0	0	X	X	X	060000h to 067FFFh
Bank A	SA20	0	0	0	1	1	0	1	X	X	X	068000h to 06FFFFh
Bank A	SA21	0	0	0	1	1	1	0	X	X	X	070000h to 077FFFh
Bank A	SA22	0	0	0	1	1	1	1	X	X	X	078000h to 07FFFFh
Bank B	SA23	0	0	1	0	0	0	0	X	X	X	080000h to 087FFFh
Bank B	SA24	0	0	1	0	0	0	1	X	X	X	088000h to 08FFFFh
Bank B	SA25	0	0	1	0	0	1	0	X	X	X	090000h to 097FFFh
Bank B	SA26	0	0	1	0	0	1	1	X	X	X	098000h to 09FFFFh
Bank B	SA27	0	0	1	0	1	0	0	X	X	X	0A0000h to 0A7FFFh
Bank B	SA28	0	0	1	0	1	0	1	X	X	X	0A8000h to 0AFFFFh
Bank B	SA29	0	0	1	0	1	1	0	X	X	X	0B0000h to 0B7FFFh
Bank B	SA30	0	0	1	0	1	1	1	X	X	X	0B8000h to 0BFFFFh
Bank B	SA31	0	0	1	1	0	0	0	X	X	X	0C0000h to 0C7FFFh
Bank B	SA32	0	0	1	1	0	0	1	X	X	X	0C8000h to 0CFFFFh

## SECTOR ADDRESS TABLE - FLASH 1 or FLASH 2 (Continued)

Bank	Sector	Bank Address			Sector Address							Address Range
		A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Word Mode
Bank B	SA33	0	0	1	1	0	1	0	X	X	X	0D0000h to 0D7FFFh
Bank B	SA34	0	0	1	1	0	1	1	X	X	X	0D8000h to 0DFFFFh
Bank B	SA35	0	0	1	1	1	0	0	X	X	X	0E0000h to 0E7FFFh
Bank B	SA36	0	0	1	1	1	0	1	X	X	X	0E8000h to 0EFFFFh
Bank B	SA37	0	0	1	1	1	1	0	X	X	X	0F0000h to 0F7FFFh
Bank B	SA38	0	0	1	1	1	1	1	X	X	X	0F8000h to 0FFFFFFh
Bank B	SA39	0	1	0	0	0	0	0	X	X	X	100000h to 107FFFh
Bank B	SA40	0	1	0	0	0	0	1	X	X	X	108000h to 10FFFFh
Bank B	SA41	0	1	0	0	0	1	0	X	X	X	110000h to 117FFFh
Bank B	SA42	0	1	0	0	0	1	1	X	X	X	118000h to 11FFFFh
Bank B	SA43	0	1	0	0	1	0	0	X	X	X	120000h to 127FFFh
Bank B	SA44	0	1	0	0	1	0	1	X	X	X	128000h to 12FFFFh
Bank B	SA45	0	1	0	0	1	1	0	X	X	X	130000h to 137FFFh
Bank B	SA46	0	1	0	0	1	1	1	X	X	X	138000h to 13FFFFh
Bank B	SA47	0	1	0	1	0	0	0	X	X	X	140000h to 147FFFh
Bank B	SA48	0	1	0	1	0	0	1	X	X	X	148000h to 14FFFFh
Bank B	SA49	0	1	0	1	0	1	0	X	X	X	150000h to 157FFFh
Bank B	SA50	0	1	0	1	0	1	1	X	X	X	158000h to 15FFFFh
Bank B	SA51	0	1	0	1	1	0	0	X	X	X	160000h to 167FFFh
Bank B	SA52	0	1	0	1	1	0	1	X	X	X	168000h to 16FFFFh
Bank B	SA53	0	1	0	1	1	1	0	X	X	X	170000h to 177FFFh
Bank B	SA54	0	1	0	1	1	1	1	X	X	X	178000h to 17FFFFh
Bank B	SA55	0	1	1	0	0	0	0	X	X	X	180000h to 187FFFh
Bank B	SA56	0	1	1	0	0	0	1	X	X	X	188000h to 18FFFFh
Bank B	SA57	0	1	1	0	0	1	0	X	X	X	190000h to 197FFFh
Bank B	SA58	0	1	1	0	0	1	1	X	X	X	198000h to 19FFFFh
Bank B	SA59	0	1	1	0	1	0	0	X	X	X	1A0000h to 1A7FFFh
Bank B	SA60	0	1	1	0	1	0	1	X	X	X	1A8000h to 1AFFFFh
Bank B	SA61	0	1	1	0	1	1	0	X	X	X	1B0000h to 1B7FFFh
Bank B	SA62	0	1	1	0	1	1	1	X	X	X	1B8000h to 1BFFFFh
Bank B	SA63	0	1	1	1	0	0	0	X	X	X	1C0000h to 1C7FFFh
Bank B	SA64	0	1	1	1	0	0	1	X	X	X	1C8000h to 1CFFFFh
Bank B	SA65	0	1	1	1	0	1	0	X	X	X	1D0000h to 1D7FFFh

## SECTOR ADDRESS TABLE - FLASH 1 or FLASH 2 (Continued)

Bank	Sector	Bank Address			Sector Address							Address Range	
		A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Word Mode	
Bank B	SA66	0	1	1	1	0	1	1	X	X	X	1D8000h to 1DFFFFh	
Bank B	SA67	0	1	1	1	1	0	0	X	X	X	1E0000h to 1E7FFFh	
Bank B	SA68	0	1	1	1	1	0	1	X	X	X	1E8000h to 1EFFFFh	
Bank B	SA69	0	1	1	1	1	1	0	X	X	X	1F0000h to 1F7FFFh	
Bank B	SA70	0	1	1	1	1	1	1	X	X	X	1F8000h to 1FFFFFh	
Bank C	SA71	1	0	0	0	0	0	0	X	X	X	200000h to 207FFFh	
Bank C	SA72	1	0	0	0	0	0	1	X	X	X	208000h to 20FFFFh	
Bank C	SA73	1	0	0	0	0	1	0	X	X	X	210000h to 217FFFh	
Bank C	SA74	1	0	0	0	0	1	1	X	X	X	218000h to 21FFFFh	
Bank C	SA75	1	0	0	0	1	0	0	X	X	X	220000h to 227FFFh	
Bank C	SA76	1	0	0	0	1	0	1	X	X	X	228000h to 22FFFFh	
Bank C	SA77	1	0	0	0	1	1	0	X	X	X	230000h to 237FFFh	
Bank C	SA78	1	0	0	0	1	1	1	X	X	X	238000h to 23FFFFh	
Bank C	SA79	1	0	0	1	0	0	0	X	X	X	240000h to 247FFFh	
Bank C	SA80	1	0	0	1	0	0	1	X	X	X	248000h to 24FFFFh	
Bank C	SA81	1	0	0	1	0	1	0	X	X	X	250000h to 257FFFh	
Bank C	SA82	1	0	0	1	0	1	1	X	X	X	258000h to 25FFFFh	
Bank C	SA83	1	0	0	1	1	0	0	X	X	X	260000h to 267FFFh	
Bank C	SA84	1	0	0	1	1	0	1	X	X	X	268000h to 26FFFFh	
Bank C	SA85	1	0	0	1	1	1	0	X	X	X	270000h to 277FFFh	
Bank C	SA86	1	0	0	1	1	1	1	X	X	X	278000h to 27FFFFh	
Bank C	SA87	1	0	1	0	0	0	0	X	X	X	280000h to 287FFFh	
Bank C	SA88	1	0	1	0	0	0	1	X	X	X	288000h to 28FFFFh	
Bank C	SA89	1	0	1	0	0	1	0	X	X	X	290000h to 297FFFh	
Bank C	SA90	1	0	1	0	0	1	1	X	X	X	298000h to 29FFFFh	
Bank C	SA91	1	0	1	0	1	0	0	X	X	X	2A0000h to 2A7FFFh	
Bank C	SA92	1	0	1	0	1	0	1	X	X	X	2A8000h to 2AFFFFh	
Bank C	SA93	1	0	1	0	1	1	0	X	X	X	2B0000h to 2B7FFFh	
Bank C	SA94	1	0	1	0	1	1	1	X	X	X	2B8000h to 2BFFFFh	
Bank C	SA95	1	0	1	1	0	0	0	X	X	X	2C0000h to 2C7FFFh	
Bank C	SA96	1	0	1	1	0	0	1	X	X	X	2C8000h to 2CFFFFh	
Bank C	SA97	1	0	1	1	0	1	0	X	X	X	2D0000h to 2D7FFFh	
Bank C	SA98	1	0	1	1	0	1	1	X	X	X	2D8000h to 2DFFFFh	
Bank C	SA99	1	0	1	1	1	0	0	X	X	X	2E0000h to 2E7FFFh	

## SECTOR ADDRESS TABLE - FLASH 1 or FLASH 2 (Continued)

Bank	Sector	Bank Address			Sector Address							Address Range	
		A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Word Mode	
Bank C	SA100	1	0	1	1	1	0	1	X	X	X	2E8000h to 2EFFFFh	
Bank C	SA101	1	0	1	1	1	1	0	X	X	X	2F0000h to 2F7FFFh	
Bank C	SA102	1	0	1	1	1	1	1	X	X	X	2F8000h to 2FFFFFFh	
Bank C	SA103	1	1	0	0	0	0	0	X	X	X	300000h to 307FFFh	
Bank C	SA104	1	1	0	0	0	0	1	X	X	X	308000h to 30FFFFh	
Bank C	SA105	1	1	0	0	0	1	0	X	X	X	310000h to 317FFFh	
Bank C	SA106	1	1	0	0	0	1	1	X	X	X	318000h to 31FFFFh	
Bank C	SA107	1	1	0	0	1	0	0	X	X	X	320000h to 327FFFh	
Bank C	SA108	1	1	0	0	1	0	1	X	X	X	328000h to 32FFFFh	
Bank C	SA109	1	1	0	0	1	1	0	X	X	X	330000h to 337FFFh	
Bank C	SA110	1	1	0	0	1	1	1	X	X	X	338000h to 33FFFFh	
Bank C	SA111	1	1	0	1	0	0	0	X	X	X	340000h to 347FFFh	
Bank C	SA112	1	1	0	1	0	0	1	X	X	X	348000h to 34FFFFh	
Bank C	SA113	1	1	0	1	0	1	0	X	X	X	350000h to 357FFFh	
Bank C	SA114	1	1	0	1	0	1	1	X	X	X	358000h to 35FFFFh	
Bank C	SA115	1	1	0	1	1	0	0	X	X	X	360000h to 367FFFh	
Bank C	SA116	1	1	0	1	1	0	1	X	X	X	368000h to 36FFFFh	
Bank C	SA117	1	1	0	1	1	1	0	X	X	X	370000h to 377FFFh	
Bank C	SA118	1	1	0	1	1	1	1	X	X	X	378000h to 37FFFFh	
Bank D	SA119	1	1	1	0	0	0	0	X	X	X	380000h to 387FFFh	
Bank D	SA120	1	1	1	0	0	0	1	X	X	X	388000h to 38FFFFh	
Bank D	SA121	1	1	1	0	0	1	0	X	X	X	390000h to 397FFFh	
Bank D	SA122	1	1	1	0	0	1	1	X	X	X	398000h to 39FFFFh	
Bank D	SA123	1	1	1	0	1	0	0	X	X	X	3A0000h to 3A7FFFh	
Bank D	SA124	1	1	1	0	1	0	1	X	X	X	3A8000h to 3AFFFFh	
Bank D	SA125	1	1	1	0	1	1	0	X	X	X	3B0000h to 3B7FFFh	
Bank D	SA126	1	1	1	0	1	1	1	X	X	X	3B8000h to 3BFFFFh	
Bank D	SA127	1	1	1	1	0	0	0	X	X	X	3C0000h to 3C7FFFh	
Bank D	SA128	1	1	1	1	0	0	1	X	X	X	3C8000h to 3CFFFFh	
Bank D	SA129	1	1	1	1	0	1	0	X	X	X	3D0000h to 3D7FFFh	
Bank D	SA130	1	1	1	1	0	1	1	X	X	X	3D8000h to 3DFFFFh	
Bank D	SA131	1	1	1	1	1	0	0	X	X	X	3E0000h to 3E7FFFh	
Bank D	SA132	1	1	1	1	1	0	1	X	X	X	3E8000h to 3EFFFFh	
Bank D	SA133	1	1	1	1	1	1	0	X	X	X	3F0000h to 3F7FFFh	
Bank D	SA134	1	1	1	1	1	1	1	0	0	0	3F8000h to 3F8FFFh	
Bank D	SA135	1	1	1	1	1	1	1	0	0	1	3F9000h to 3F9FFFh	
Bank D	SA136	1	1	1	1	1	1	1	0	1	0	3FA000h to 3FAFFFh	
Bank D	SA137	1	1	1	1	1	1	1	0	1	1	3FB000h to 3FBFFFh	
Bank D	SA138	1	1	1	1	1	1	1	1	0	0	3FC000h to 3FCFFFh	
Bank D	SA139	1	1	1	1	1	1	1	1	0	1	3FD000h to 3FDFFFh	
Bank D	SA140	1	1	1	1	1	1	1	1	1	0	3FE000h to 3FEFFFh	
Bank D	SA141	1	1	1	1	1	1	1	1	1	1	3FF000h to 3FFFFFFh	



## SECTOR ADDRESS GROUP TABLE - FLASH 1 or FLASH 2

Sector	A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Sectors
SGA0	0	0	0	0	0	0	0	0	0	0	SA0
SGA1	0	0	0	0	0	0	0	0	0	1	SA1
SGA2	0	0	0	0	0	0	0	0	1	0	SA2
SGA3	0	0	0	0	0	0	0	0	1	1	SA3
SGA4	0	0	0	0	0	0	0	1	0	0	SA4
SGA5	0	0	0	0	0	0	0	1	0	1	SA5
SGA6	0	0	0	0	0	0	0	1	1	0	SA6
SGA7	0	0	0	0	0	0	0	1	1	1	SA7
SGA8	0	0	0	0	0	0	1	0	X	X	SA8 to SA10
						1	1				
SGA9	0	0	0	0	1	X	X	X	X	X	SA11 to SA14
SGA10	0	0	0	1	0	X	X	X	X	X	SA15 to SA18
SGA11	0	0	0	1	1	X	X	X	X	X	SA19 to SA22
SGA12	0	0	1	0	0	X	X	X	X	X	SA23 to SA26
SGA13	0	0	1	0	1	X	X	X	X	X	SA27 to SA30
SGA14	0	0	1	1	0	X	X	X	X	X	SA31 to SA34
SGA15	0	0	1	1	1	X	X	X	X	X	SA35 to SA38
SGA16	0	1	0	0	0	X	X	X	X	X	SA39 to SA42
SGA17	0	1	0	0	1	X	X	X	X	X	SA43 to SA46
SGA18	0	1	0	1	0	X	X	X	X	X	SA47 to SA50
SGA19	0	1	0	1	1	X	X	X	X	X	SA51 to SA54
SGA20	0	1	1	0	0	X	X	X	X	X	SA55 to SA58
SGA21	0	1	1	0	1	X	X	X	X	X	SA59 to SA62
SGA22	0	1	1	1	0	X	X	X	X	X	SA63 to SA66
SGA23	0	1	1	1	1	X	X	X	X	X	SA67 to SA70
SGA24	1	0	0	0	0	X	X	X	X	X	SA71 to SA74
SGA25	1	0	0	0	1	X	X	X	X	X	SA75 to SA78
SGA26	1	0	0	1	0	X	X	X	X	X	SA79 to SA82
SGA27	1	0	0	1	1	X	X	X	X	X	SA83 to SA86
SGA28	1	0	1	0	0	X	X	X	X	X	SA87 to SA90
SGA29	1	0	1	0	1	X	X	X	X	X	SA91 to SA94
SGA30	1	0	1	1	0	X	X	X	X	X	SA95 to SA98
SGA31	1	0	1	1	1	X	X	X	X	X	SA99 to SA102
SGA32	1	1	0	0	0	X	X	X	X	X	SA103 to SA106

## SECTOR ADDRESS GROUP TABLE - FLASH 1 or FLASH 2 (Continued)

Sector	A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	Sectors
SGA33	1	1	0	0	1	X	X	X	X	X	SA107 to SA110
SGA34	1	1	0	1	0	X	X	X	X	X	SA111 to SA114
SGA35	1	1	0	1	1	X	X	X	X	X	SA115 to SA118
SGA36	1	1	1	0	0	X	X	X	X	X	SA119 to SA122
SGA37	1	1	1	0	1	X	X	X	X	X	SA123 to SA126
SGA38	1	1	1	1	0	X	X	X	X	X	SA127 to SA130
						0	0				
SGA39	1	1	1	1	1	0	1	X	X	X	SA131 to SA133
						1	0				
SGA40	1	1	1	1	1	1	1	0	0	0	SA134
SGA41	1	1	1	1	1	1	1	0	0	1	SA135
SGA42	1	1	1	1	1	1	1	0	1	0	SA136
SGA43	1	1	1	1	1	1	1	0	1	1	SA137
SGA44	1	1	1	1	1	1	1	1	0	0	SA138
SGA45	1	1	1	1	1	1	1	1	0	1	SA139
SGA46	1	1	1	1	1	1	1	1	1	0	SA140
SGA47	1	1	1	1	1	1	1	1	1	1	SA141

## FLASH MEMORY AUTOSELECT CODES TABLE - FLASH 1 or FLASH 2

Type	A21 to A12	A6	A3	A2	A1	A0	Code (HEX)
Manufacturer's Code	BA	L	L	L	L	L	04h
Device Code	BA	L	L	L	L	H	227Eh
Extended Device Code <sup>(2)</sup>	BA	L	H	H	H	H	2201h
Sector Group Protection	Sector Group Address	L	L	L	H	L	01h <sup>(1)</sup>

Legend: L = VIL, H = VIH. See "DC CHARACTERISTICS" for voltage levels.

**Notes:**

1. Outputs 01h at protected sector group addresses and outputs 00h at unprotected sector group addresses.
2. A read cycle at address (BA) 01h outputs device code. When 227Eh was output, this indicates that there will require two additional codes, called Extended Device Codes. Therefore the system may continue reading out these Extended Device Codes at the address of (BA) 0Eh, as well as at (BA) 0Fh.

## FLASH MEMORY COMMAND DEFINITIONS - FLASH 1 or FLASH 2

Command Sequence	Bus Write Cycle Req'd	First Bus Cycle		Second Bus Write Cycle		Third Bus Write Cycle		Fourth Bus Read/Write		Fifth Bus Cycle		Sixth Bus Cycle	
		Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data	Addr.	Data
Read / Reset (1)	1	XXXh	F0h	—	—	—	—	—	—	—	—	—	—
Read / Reset (1)	3	555h	AAh	2AAh	55h	555h	F0h	RA	RD	—	—	—	—
Autoselect	3	555h	AAh	2AAh	55h	(BA) 555h	90h	—	—	—	—	—	—
Program	4	555h	AAh	2AAh	55h	555h	A0h	PA	PD	—	—	—	—
Program Suspend	1	BA	B0h	—	—	—	—	—	—	—	—	—	—
Program Resume	1	BA	30h	—	—	—	—	—	—	—	—	—	—
Chip Erase	6	555h	AAh	2AAh	55h	555h	80h	555h	AAh	2AAh	55h	555h	10h
Sector Erase	6	555h	AAh	2AAh	55h	555h	80h	555h	AAh	2AAh	55h	SA	30h
Erase Suspend	1	BA	B0h	—	—	—	—	—	—	—	—	—	—
Erase Resume	1	BA	30h	—	—	—	—	—	—	—	—	—	—
Extended Sector Group Protection (3)	4	XXXh	60h	SGA	60h	SGA	40h	SGA	SD	—	—	—	—
Set to Fast Mode (2)	3	555h	AAh	2AAh	55h	555h	20h	—	—	—	—	—	—
Fast Program (2)	2	XXXh	A0h	PA	PD	—	—	—	—	—	—	—	—
Reset from Fast Mode (2)	2	BA	90h	XXXh	(6) F0h	—	—	—	—	—	—	—	—
Query (4)	1	(BA) 55h	98h	—	—	—	—	—	—	—	—	—	—
Hi-ROM Entry	3	555h	AAh	2AAh	55h	555h	88h	—	—	—	—	—	—
Hi-ROM Program (5)	4	555h	AAh	2AAh	55h	555h	A0h	(HRA) PA	PD	—	—	—	—
Hi-ROM Exit (5)	4	555h	AAh	2AAh	55h	(HRBA) 555h	90h	XXXh	00h	—	—	—	—

**Notes:**

- Both Read/Reset commands are functionally equivalent, resetting the device to the read mode.
- This command is valid during Fast Mode.
- This command is valid while  $\overline{\text{RESET}} = \text{V}_{\text{ID}}$
- The valid address is A6 to A0.
- This command is valid during Hi-ROM mode.
- The data "00h" is also acceptable.

**FLASH MEMORY COMMAND DEFINITIONS - FLASH 1 or FLASH 2 (Continued)****Notes:**

- Address bits A21 to A11 = X = "H" or "L" for all address commands except Program Address (PA), Sector Address (SA), and Bank Address (BA), and Sector Group Address (SPA).
- Bus operations are defined in "DEVICE BUS OPERATIONS".
- RA = Address of the memory location to be read  
PA = Address of the memory location to be programmed. Addresses are latched on the falling edge of the write pulse.
- SA = Address of the sector to be erased. The combination of A21, A20, A19, A18, A17, A16, A15, A14, A13, and A12 will uniquely select any sector. BA = Bank Address (A21, A20, A19)
- RD = Data read from location RA during read operation.  
PD = Data to be programmed at location PA. Data is latched on the rising edge of the write pulse.
- SPA = Sector group address to be protected. Set sector group address and (A6, A3, A2, A1, A0) = (0, 0, 0, 1, 0).  
SD = Sector group protection verify data. Output 01h at protected sector group addresses and output 00h at unprotected sector group addresses.
- HRA = Address of the Hi-ROM area : 000000h to 00007Fh  
HRBA = Bank Address of the Hi-ROM area (A21 = A20 = A19 = VIL)
- The system should generate the following address patterns : 555h or 2AAh to addresses A10 to A0
- Both Read/Reset commands are functionally equivalent, resetting the device to the read mode.
- Command combinations not described in *FLASH Memory Command Definitions* are illegal.

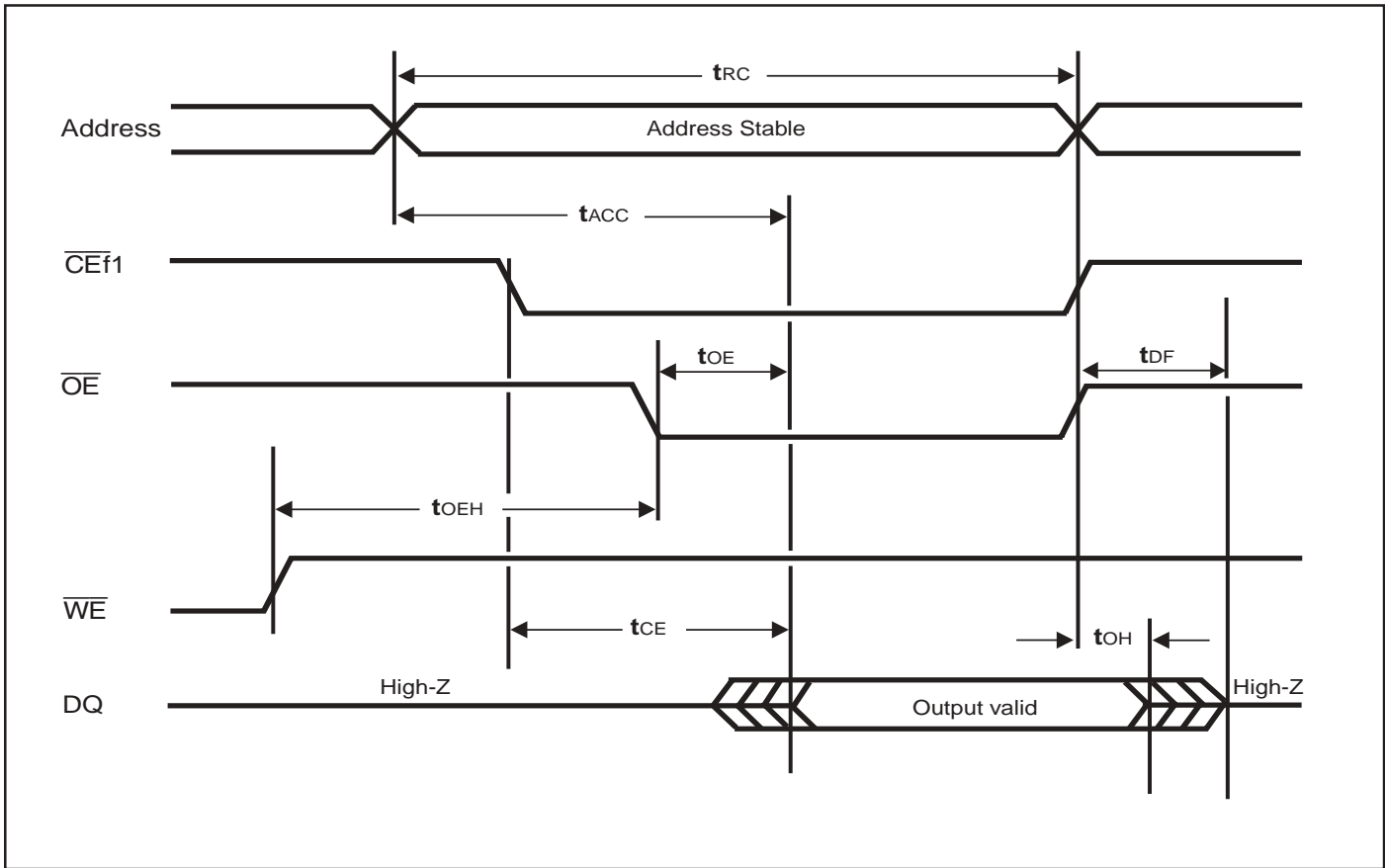
**FLASH READ ONLY OPERATIONS CHARACTERISTICS - FLASH 1 or FLASH 2**

Parameter	JEDEC Symbol	Standard Symbol	Condition	Min	Max	Unit
Read Cycle Time	t <sub>AVAV</sub>	t <sub>RC</sub>		70	—	ns
Address to Output Delay	t <sub>AVQV</sub>	t <sub>ACC</sub>	$\overline{CE}f = V_{IL}, \overline{OE} = V_{IL}$	—	70	ns
Chip Enable to Output Delay	t <sub>ELQV</sub>	t <sub>CE</sub>	$\overline{OE} = V_{IL}$	—	70	ns
Output Enable to Output Delay	t <sub>GLQV</sub>	t <sub>OE</sub>		—	30	ns
Chip Enable to Output High-Z	t <sub>EHQZ</sub>	t <sub>DF</sub>		—	25	ns
Output Enable to Output High-Z	t <sub>GHQZ</sub>	t <sub>DF</sub>		—	25	ns
Output Hold Time From Addresses, $\overline{CE}f$ or $\overline{OE}$ , Whichever Occurs First	t <sub>AXQX</sub>	t <sub>OH</sub>		0	—	ns
$\overline{RESET}$ Pin Low to Read Mode	—	t <sub>READY</sub>		—	20	μs

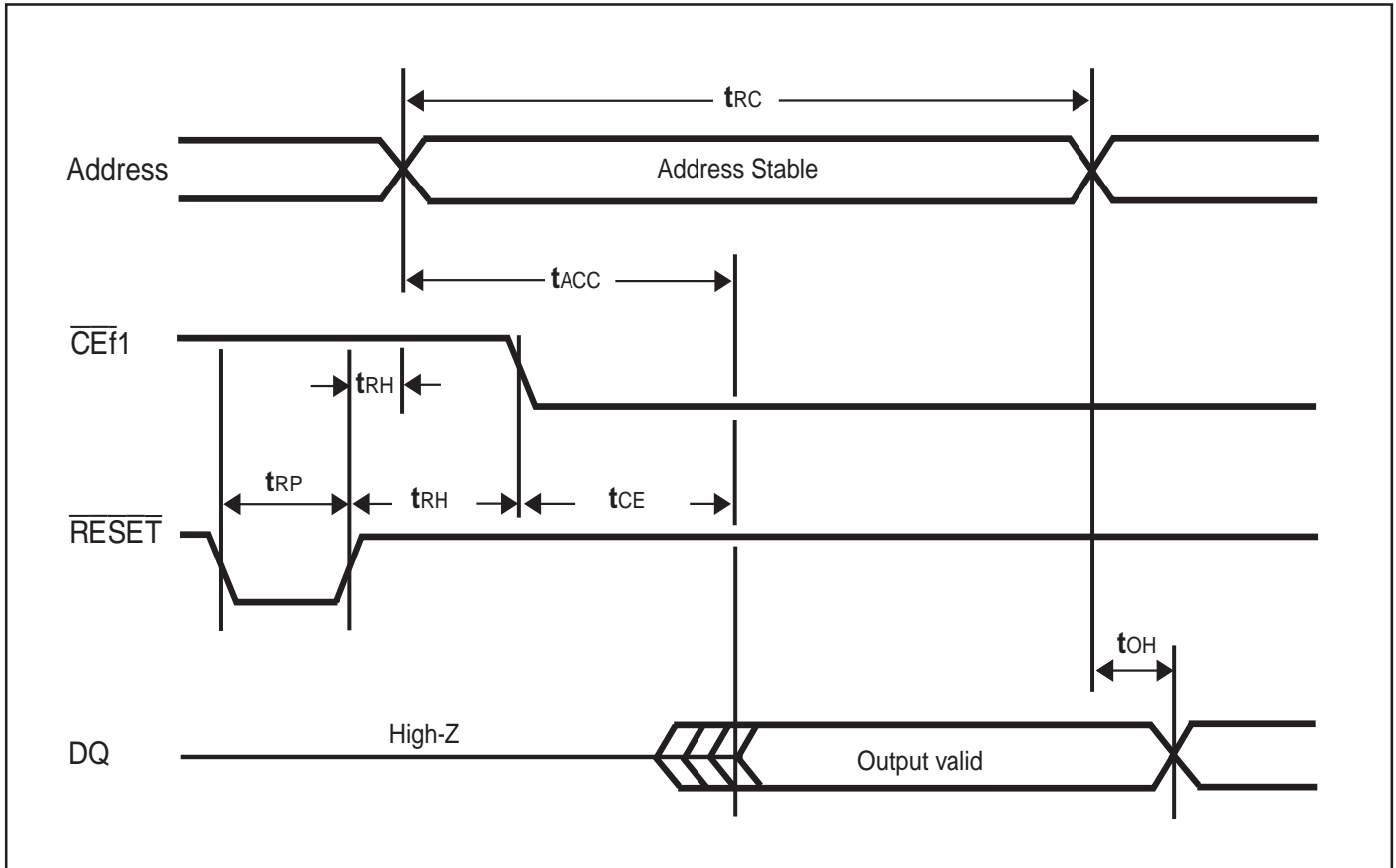
**Test Conditions:**

Output Load : 1 TTL gate and 30 pF  
 Input rise and fall times : 5 ns  
 Input pulse levels : 0.0 V or VCCf  
 Timing measurement reference level  
 Input : VCCf/2  
 Output : VCCf/2

FLASH READ CYCLE - FLASH 1 or FLASH 2



FLASH HARDWARE  $\overline{\text{RESET}}$  / READ OPERATION TIMING DIAGRAM - FLASH 1 or FLASH 2



## FLASH WRITE/ERASE/PROGRAM OPERATIONS - FLASH 1 or FLASH 2

Parameter	JEDEC Symbol	Standard Symbol	Min	Typ	Max	Unit
Write Cycle Time	tAVAV	tWC	70	—	—	ns
Address Setup Time	tAVWL	tAS	0	—	—	ns
Address Setup Time to $\overline{OE}$ Low During Toggle Bit Polling	—	tASO	12	—	—	ns
Address Hold Time	tWLAX	tAH	45	—	—	ns
Address Hold Time from $\overline{CEf}$ or $\overline{OE}$ High During Toggle Bit Polling	—	tAHT	0	—	—	ns
Data Setup Time	tDVWH	tDS	30	—	—	ns
Data Hold Time	tWHDX	tDH	0	—	—	ns
Output Enable Hold Time Read	—	tOEH	0	—	—	ns
Output Enable Hold Time Toggle and $\overline{Data}$ Polling	—	tOEH	10	—	—	ns
$\overline{CEf}$ High During Toggle Bit Polling	—	tCEPH	20	—	—	ns
$\overline{OE}$ High During Toggle Bit Polling	—	tOEPH	20	—	—	ns
Read Recover Time Before Write ( $\overline{OE}$ to $\overline{CEf}$ )	tGHWL	tGHWL	0	—	—	ns
Read Recover Time Before Write ( $\overline{OE}$ to $\overline{WE}$ )	tGHEL	tGHEL	0	—	—	ns
$\overline{WE}$ Setup Time ( $\overline{CEf}$ to $\overline{WE}$ )	tWLEL	tWS	0	—	—	ns
$\overline{CEf}$ Setup Time ( $\overline{WE}$ to $\overline{CEf}$ )	tELWL	tCS	0	—	—	ns
$\overline{WE}$ Hold Time ( $\overline{CEf}$ to $\overline{WE}$ )	tEWHW	tWH	0	—	—	ns
$\overline{CEf}$ Hold Time ( $\overline{WE}$ to $\overline{CEf}$ )	tWHEH	tCH	0	—	—	ns
Write Pulse Width	tWHWL	tWP	35	—	—	ns
$\overline{CEf}$ Pulse Width	tELEH	tCP	35	—	—	ns
Write Pulse Width High	tWHWL	tWP	25	—	—	ns
$\overline{CEf}$ Pulse Width High	tEHEL	tCPH	25	—	—	ns
Word Programming Operation <sup>(1)</sup>	tWHWH1	tWHWH1	—	6	100	$\mu$ s
Sector Erase Operation <sup>(1)</sup>	tWHWH2	tWHWH2	—	0.5	2.0	s
Vcc Setup Time	—	tVCS	50	—	—	$\mu$ s
Rise Time to V <sub>ID</sub> <sup>(2)</sup>	—	tVIDR	500	—	—	ns
Rise Time to V <sub>ACC</sub> <sup>(3)</sup>	—	tVACCR	500	—	—	ns
Voltage Transition Time <sup>(2)</sup>	—	tVLHT	4	—	—	$\mu$ s
Write Pulse Width <sup>(2)</sup>	—	tWPP	100	—	—	$\mu$ s



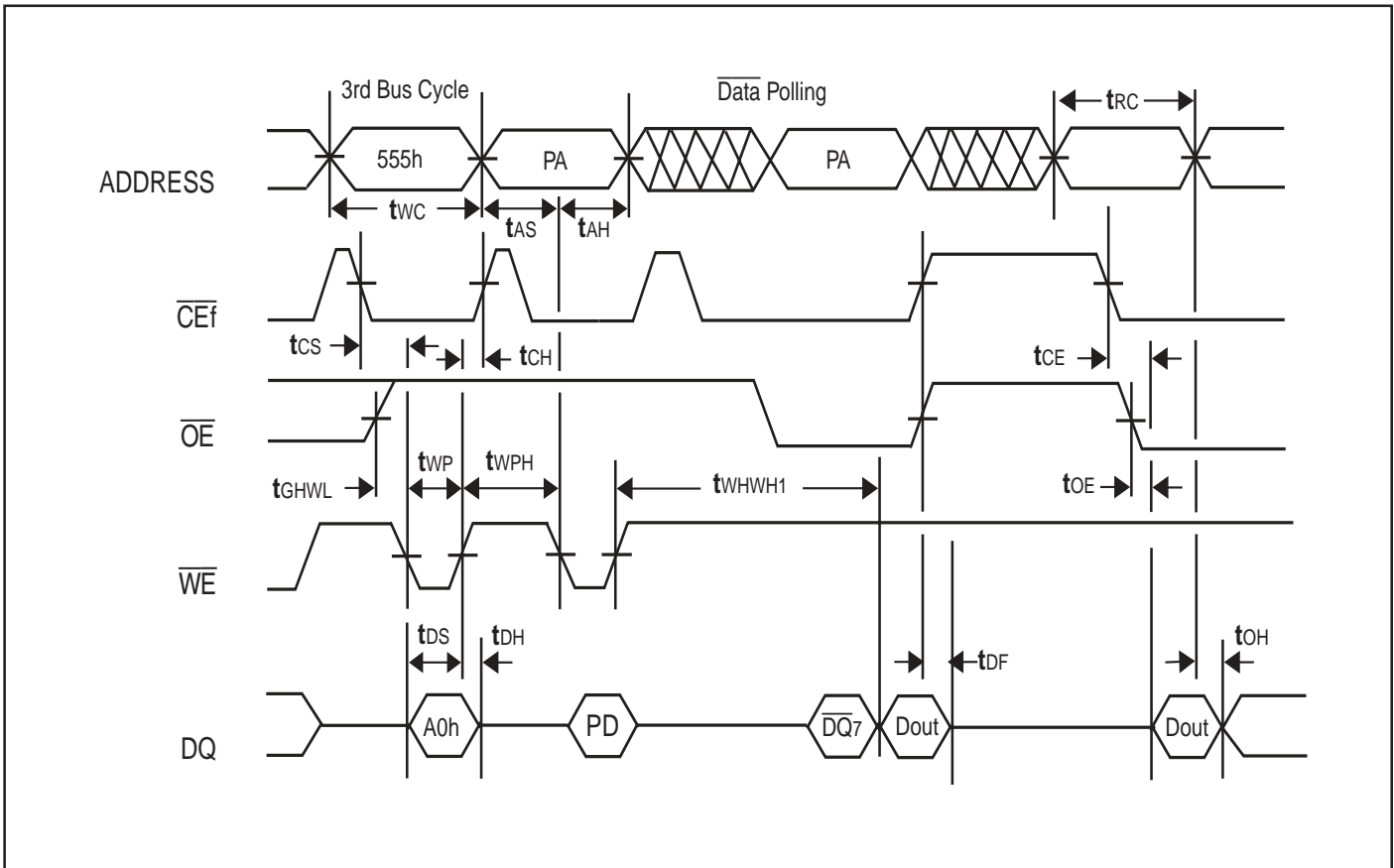
## FLASH WRITE/ERASE/PROGRAM OPERATIONS - FLASH 1 or FLASH 2 (Continued)

Parameter	JEDEC Symbol	Standard Symbol	Min	Typ	Max	Unit
$\overline{OE}$ Setup Time to $\overline{WE}$ Active <sup>(2)</sup>	—	tOESP	4	—	—	μs
$\overline{CEf}$ Setup Time to $\overline{WE}$ Active <sup>(2)</sup>	—	tCSP	4	—	—	μs
Recover Time from RY/ $\overline{BY}$	—	tRB	0	—	—	ns
$\overline{RESET}$ Pulse Width	—	tRP	500	—	—	ns
$\overline{RESET}$ High Level Period Before Read	—	tRH	200	—	—	ns
Program/Erase Valid to RY/ $\overline{BY}$ Delay	—	tBUSY	—	—	90	ns
Delay Time from Embedded Output Enable	—	tEOE	—	—	70	ns
Erase Time-Out Time	—	tTOW	50	—	—	μs
Erase Suspend Transition Time	—	tSPD	—	—	20	μs

**Notes:**

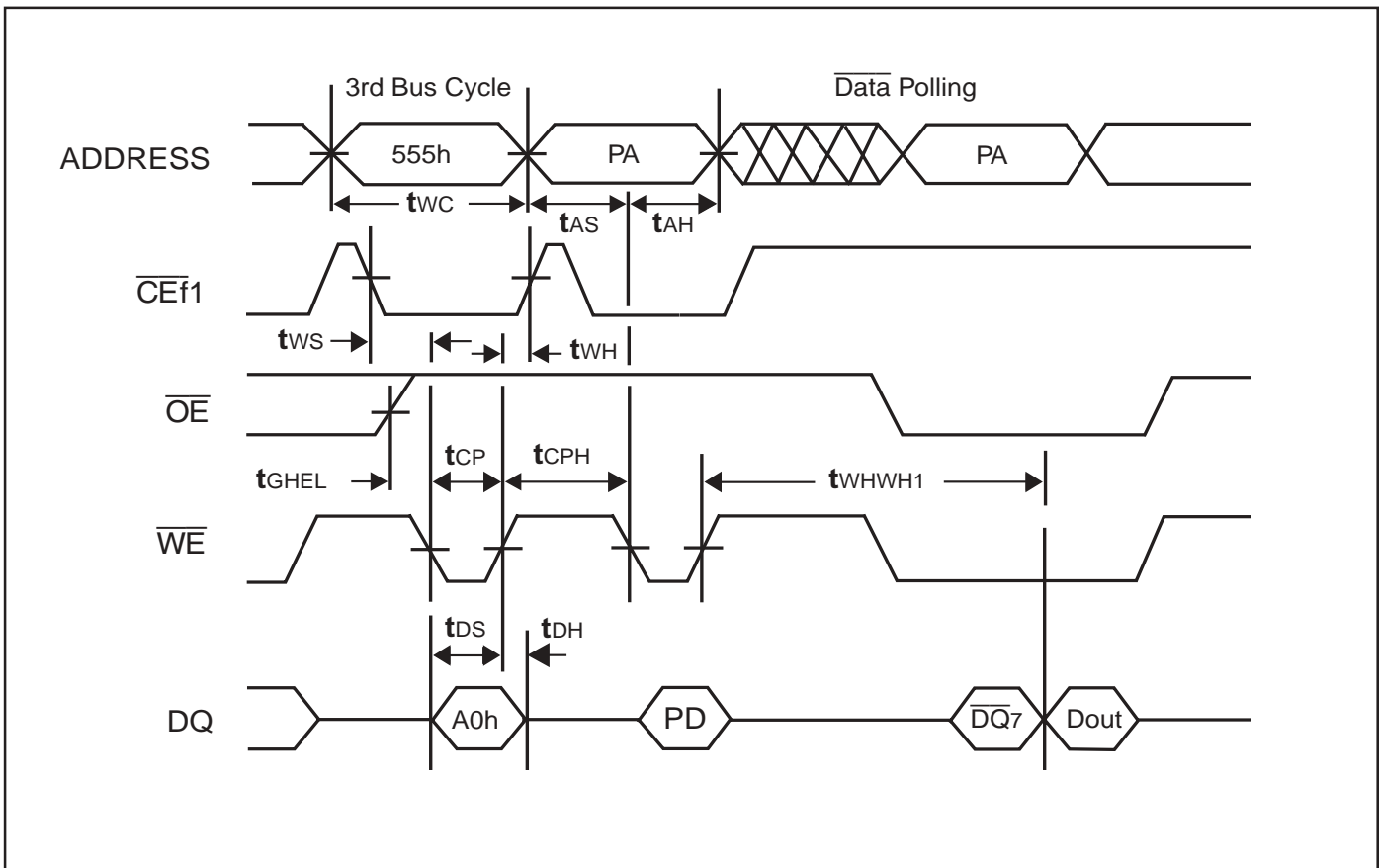
1. Does not include preprogramming time.
2. For Sector Group Protection operation.
3. For Accelerated Program operation.

## FLASH WRITE CYCLE - FLASH 1 or FLASH 2

( $\overline{WE}$  CONTROL)**Notes:**

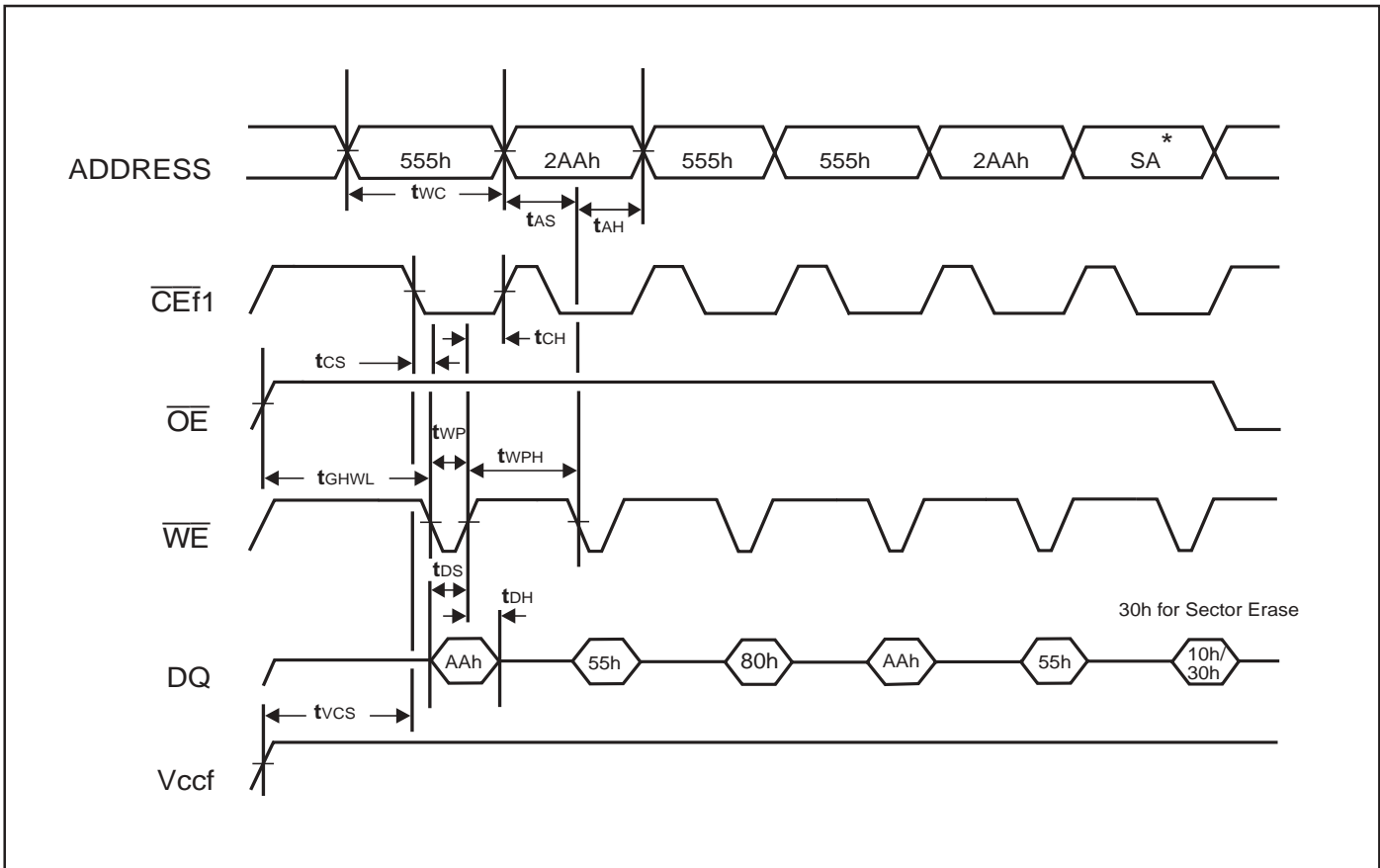
1. PA is address of the memory location to be programmed.
2. PD is data to be programmed at byte address.
3.  $\overline{DQ7}$  is the output of the complement of the data written to the device.
4. DOUT is the output of the data written to the device.
5. Figure indicates last two bus cycles out of four bus cycle sequence.

## FLASH WRITE CYCLE - FLASH 1 or FLASH 2

( $\overline{\text{CEf1}}$  CONTROL)**Notes:**

1. PA is address of the memory location to be programmed.
2. PD is data to be programmed at byte address.
3.  $\overline{\text{DQ7}}$  is the output of the complement of the data written to the device.
4. DOUT is the output of the data written to the device.
5. Figure indicates last two bus cycles out of four bus cycle sequence.

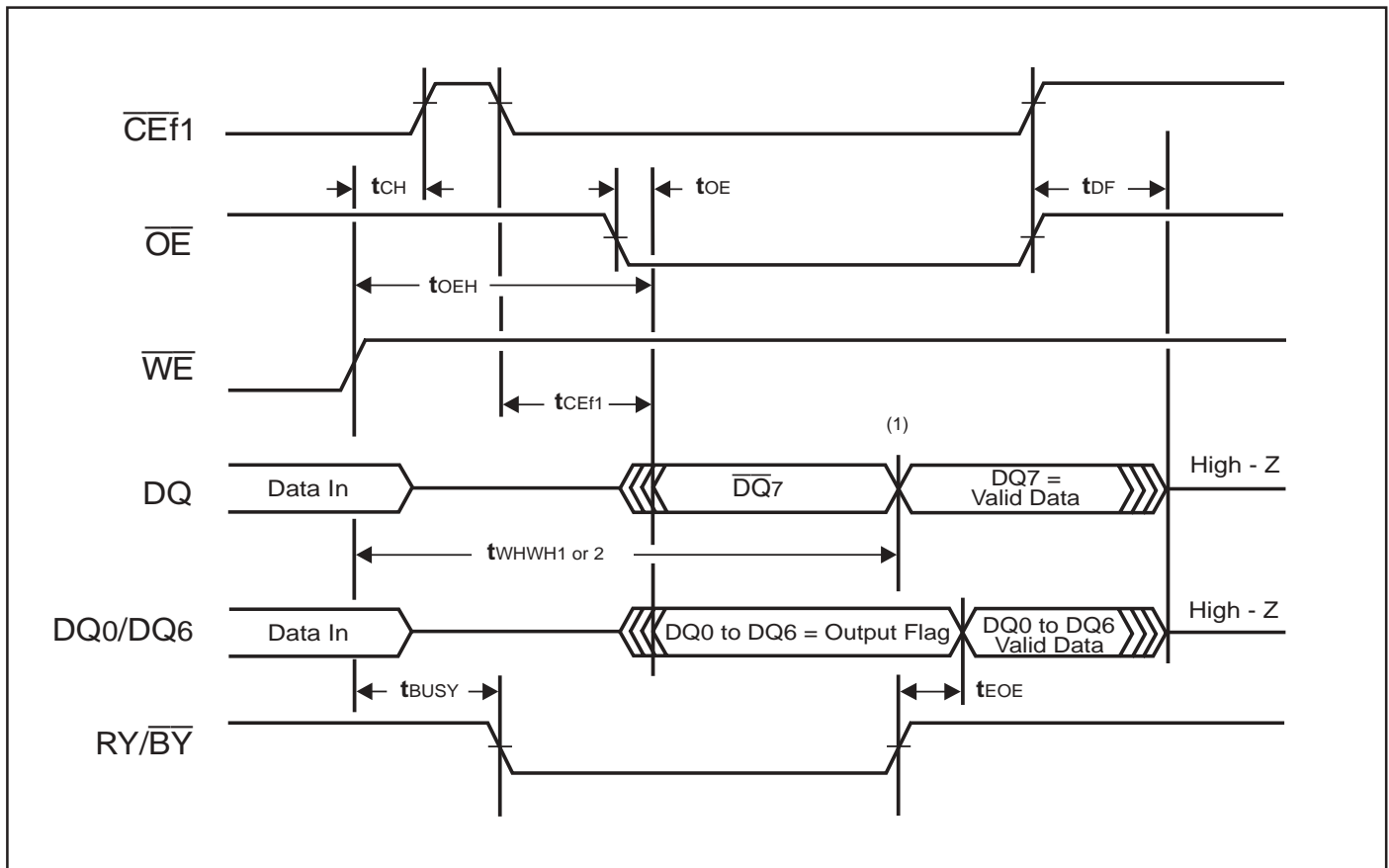
FLASH AC WAVEFORMS CHIP/SECTOR ERASE OPERATIONS - FLASH 1 or FLASH 2



Notes:

1. SA is the sector address for Sector Erase. Address = 555h for Chip Erase.

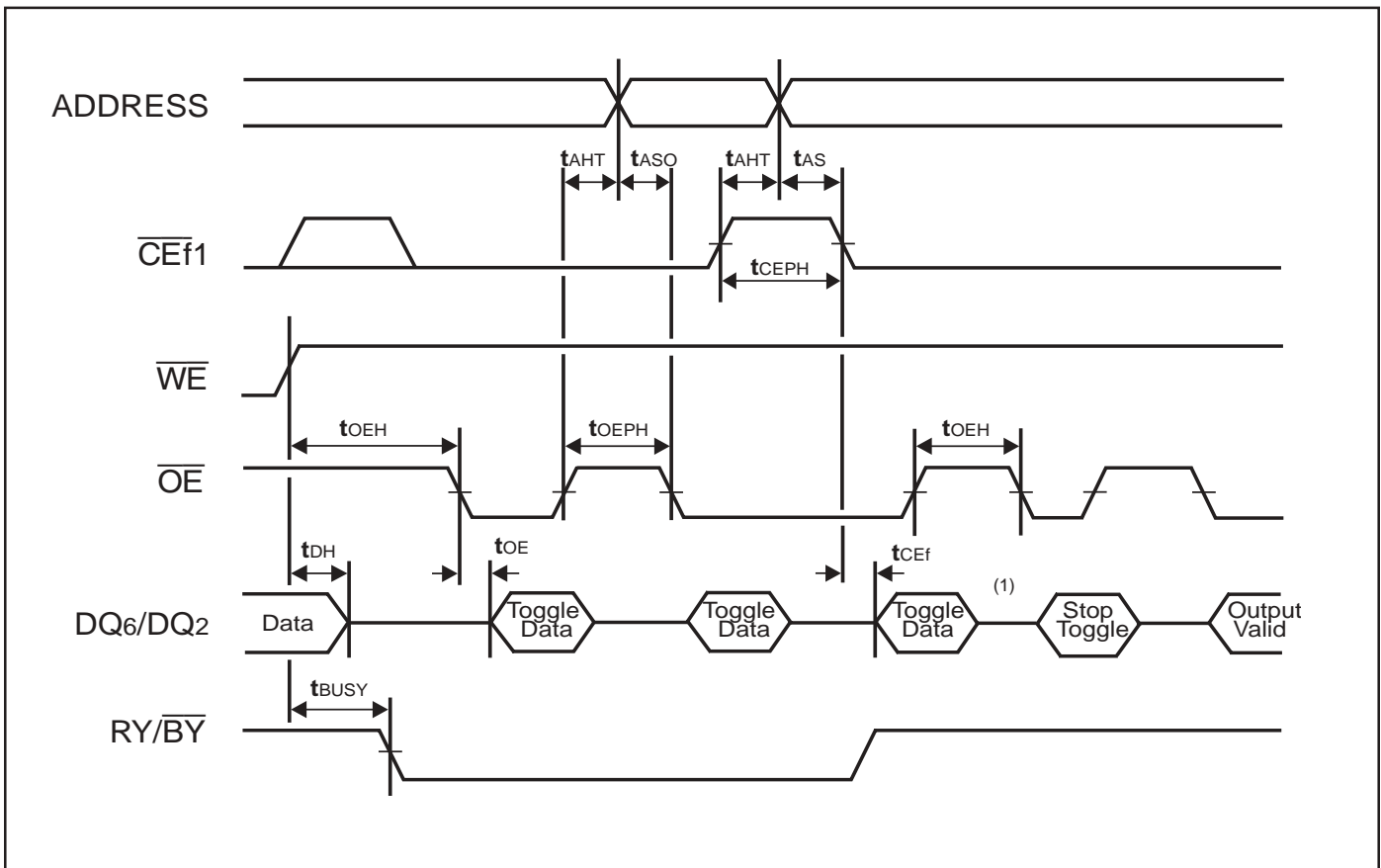
### FLASH AC WAVEFORMS FOR $\overline{\text{DATA}}$ POLLING DURING EMBEDDED ALGORITHM OPERATIONS - FLASH 1 or FLASH 2



#### Notes:

1.  $\overline{\text{DQ7}}$  = Valid Data (the device has completed the Embedded operation.)

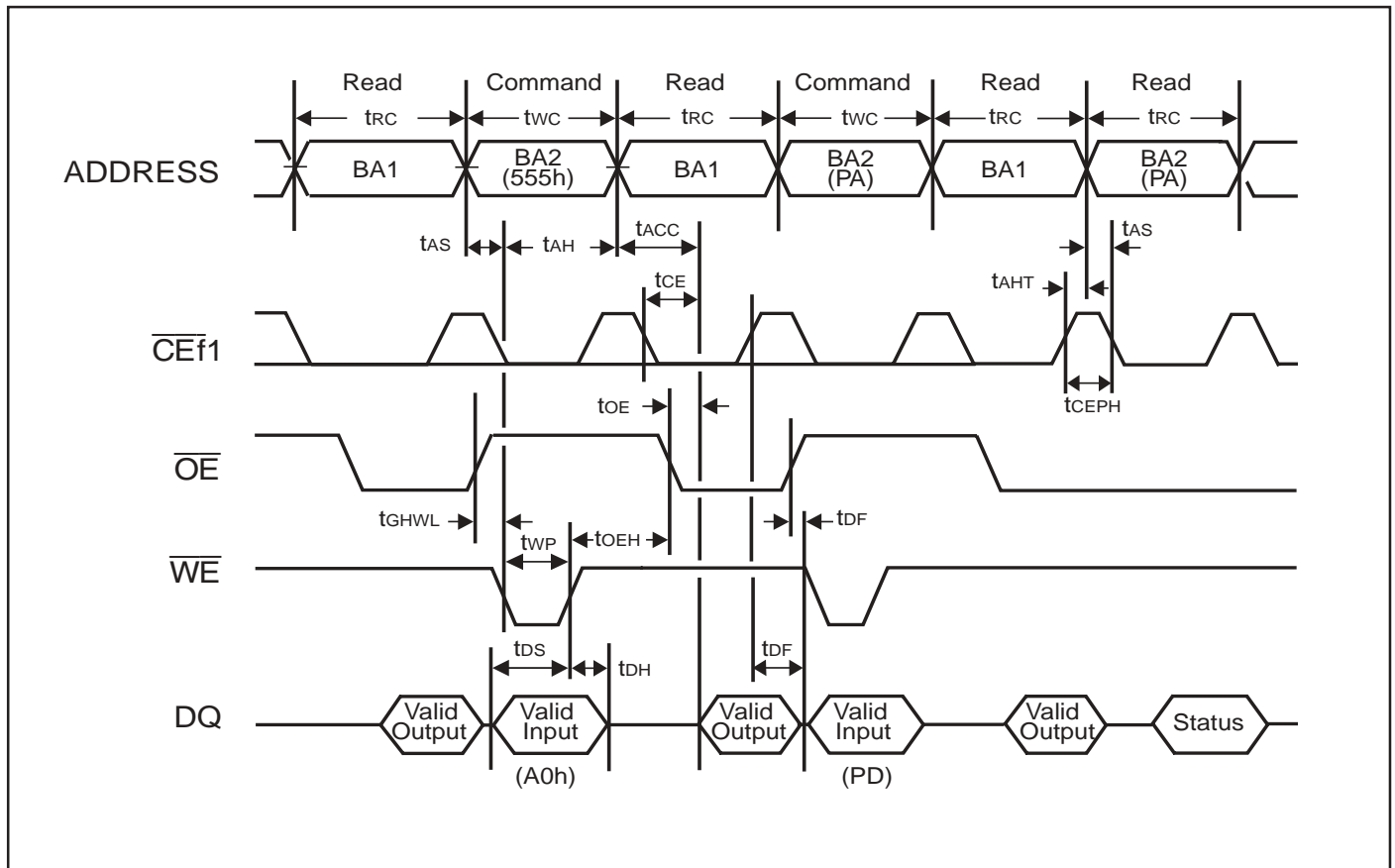
**FLASH AC WAVEFORMS  
FOR TOGGLE BIT DURING EMBEDDED ALGORITHM OPERATIONS - FLASH 1 or FLASH 2**



**Notes:**

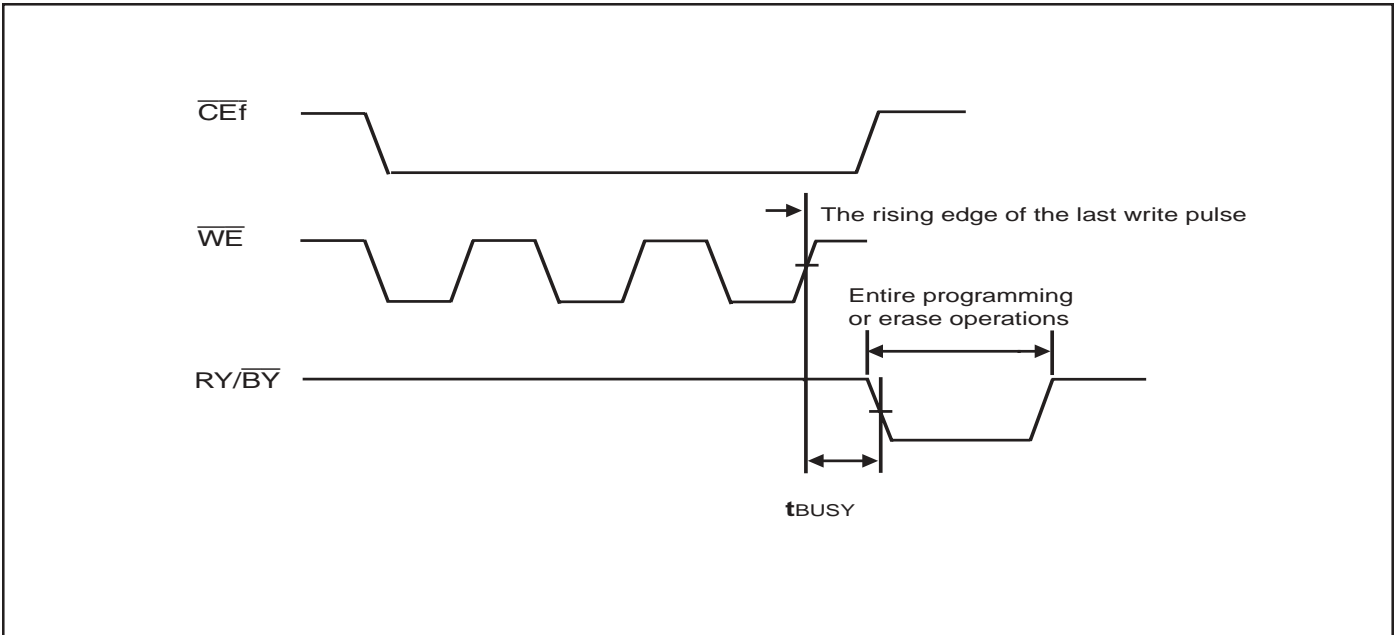
1. DQ6 stops toggling (the device has completed the Embedded operation).

## FLASH BACK-to-BACK READ/WRITE TIMING DIAGRAM - FLASH 1 or FLASH 2

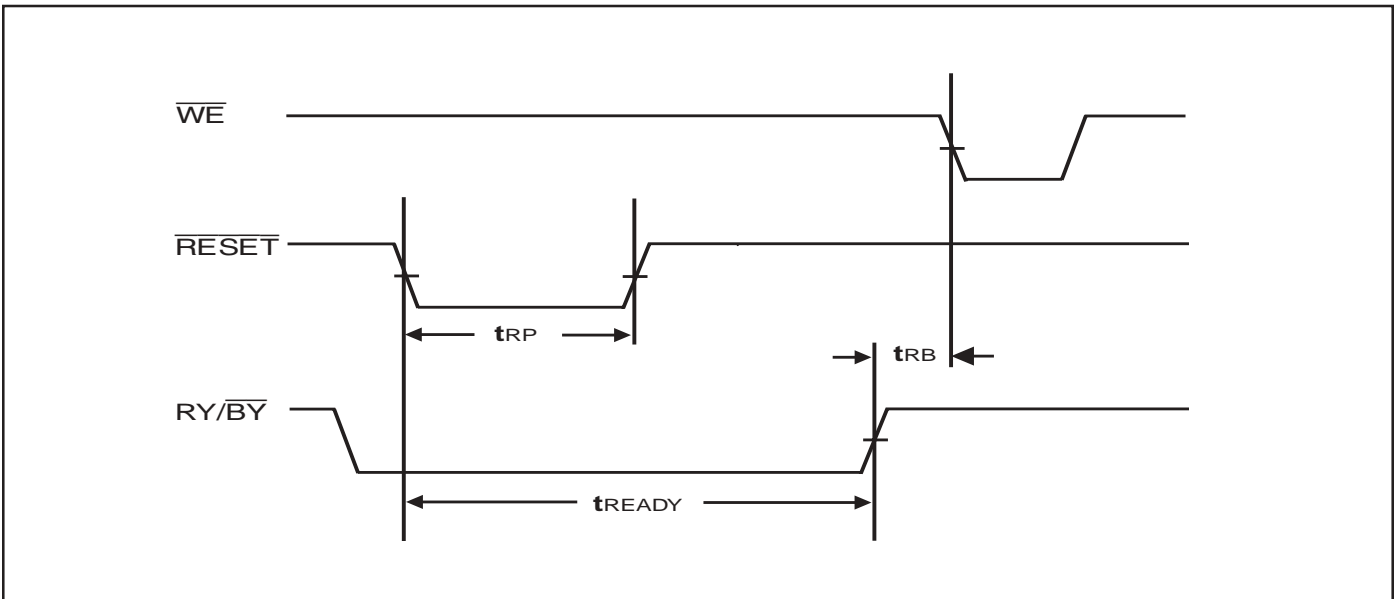
**Note:**

1. This is example of Read for Bank 1 and Embedded Algorithm (program) for Bank 2.  
 BA1: Address of Virtual Bank 1.  
 BA2: Address of Virtual Bank 2.

**FLASH RY/ $\overline{\text{BY}}$  TIMING DIAGRAM  
DURING WRITE/ERASE OPERATIONS - FLASH 1 or FLASH 2**

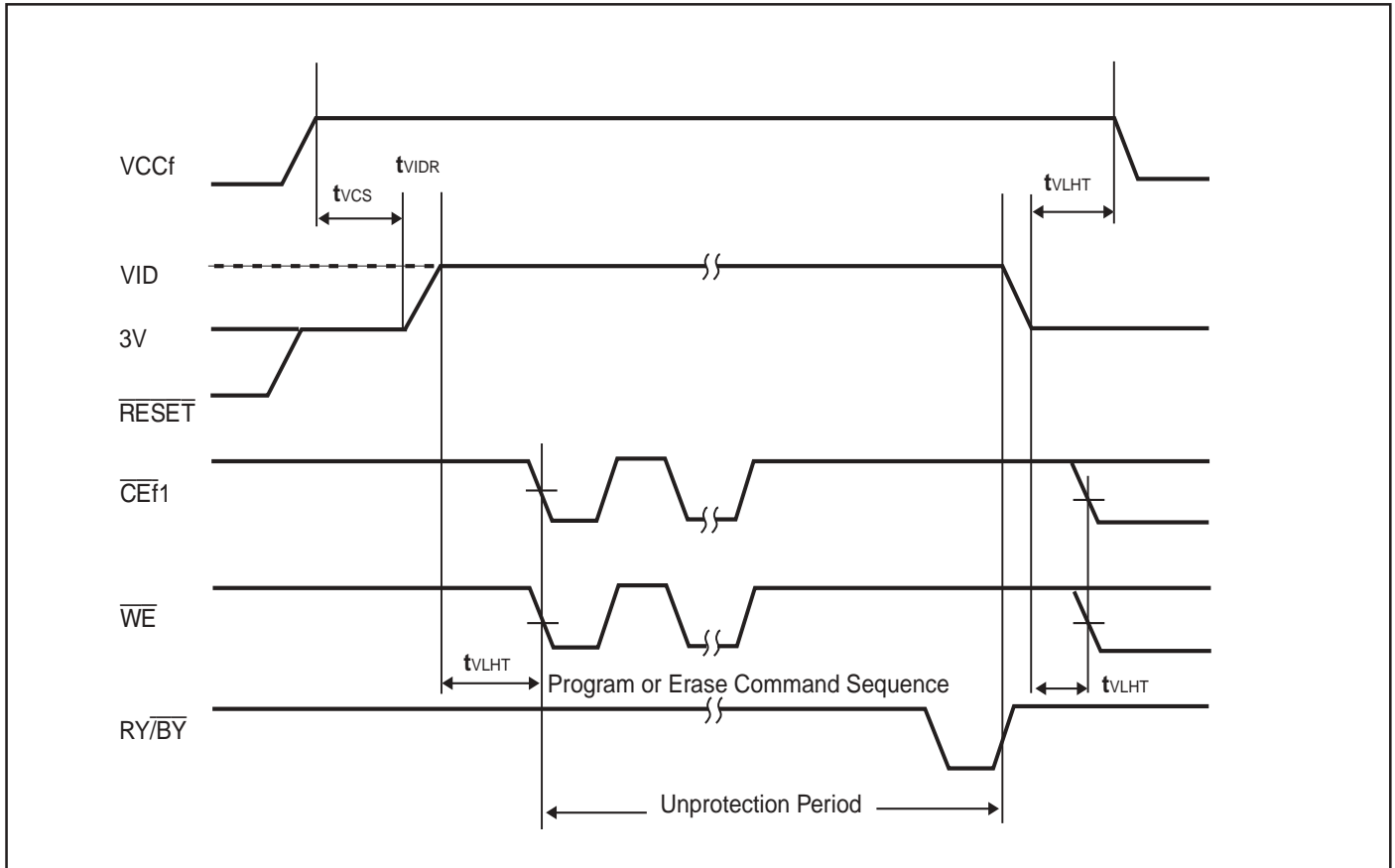


**FLASH  $\overline{\text{RESET}}$ ,  $\text{RY}/\overline{\text{BY}}$  TIMING DIAGRAM - FLASH 1 or FLASH 2**

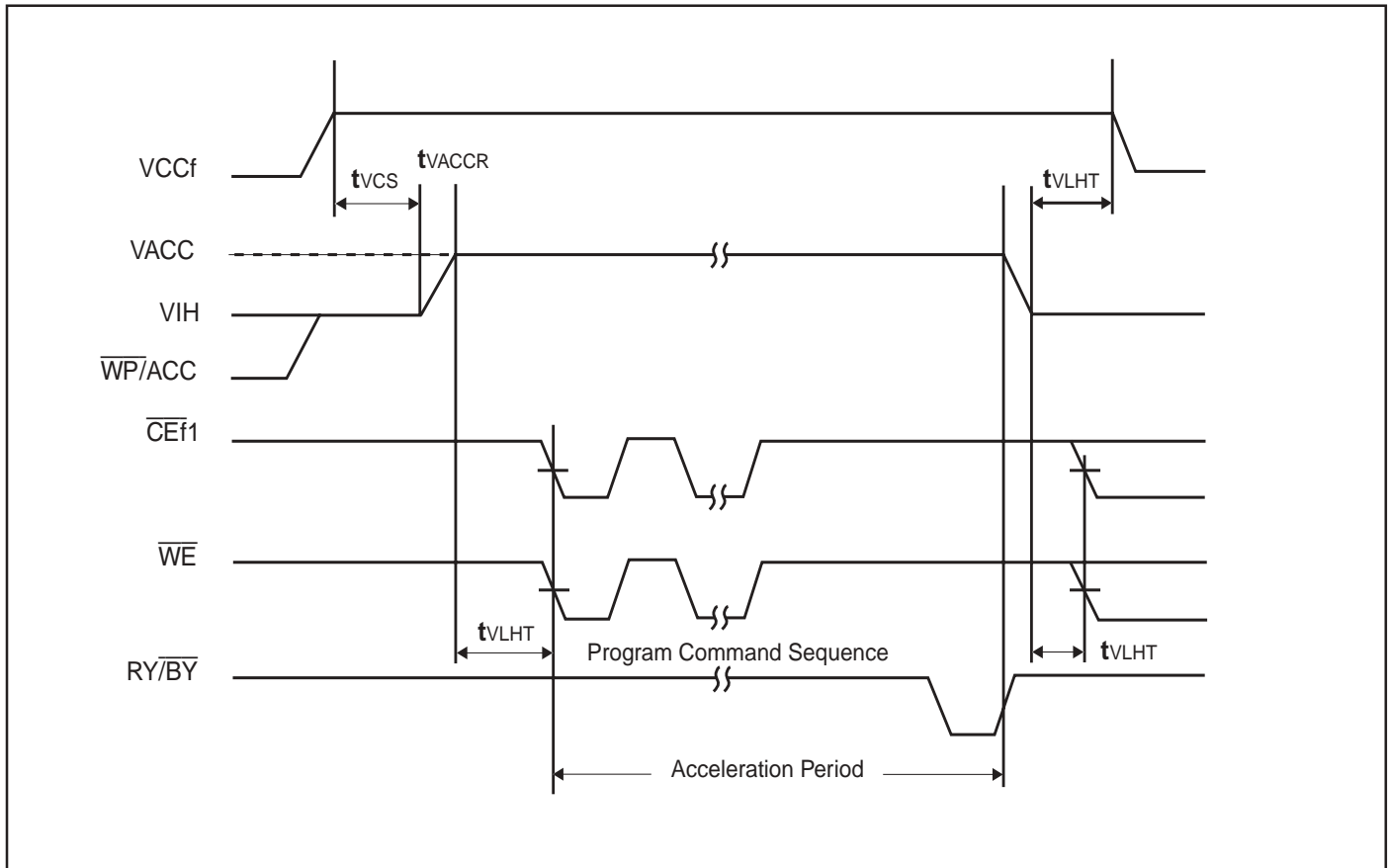




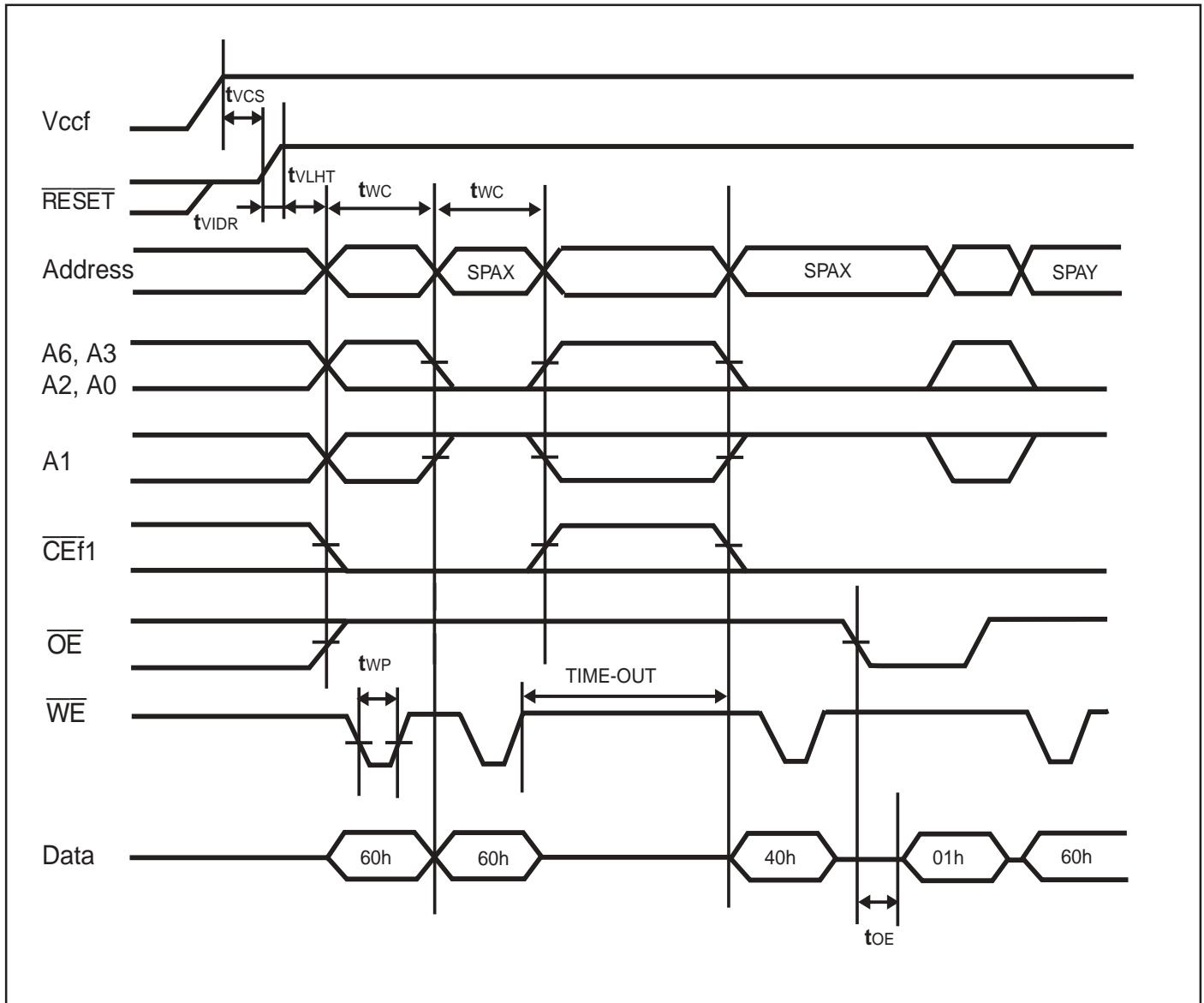
FLASH TEMPORARY SECTOR GROUP UNPROTECTION - FLASH 1 or FLASH 2



FLASH ACCELERATED PROGRAM - FLASH 1 or FLASH 2



FLASH EXTENDED SECTOR GROUP PROTECTION- FLASH 1 or FLASH 2



Notes:

1. SPAX : Sector Group Address to be protected, SPAY : Next Group Sector Address to be protected, TIME-OUT: Time-Out window = 250  $\mu s$  (Min)

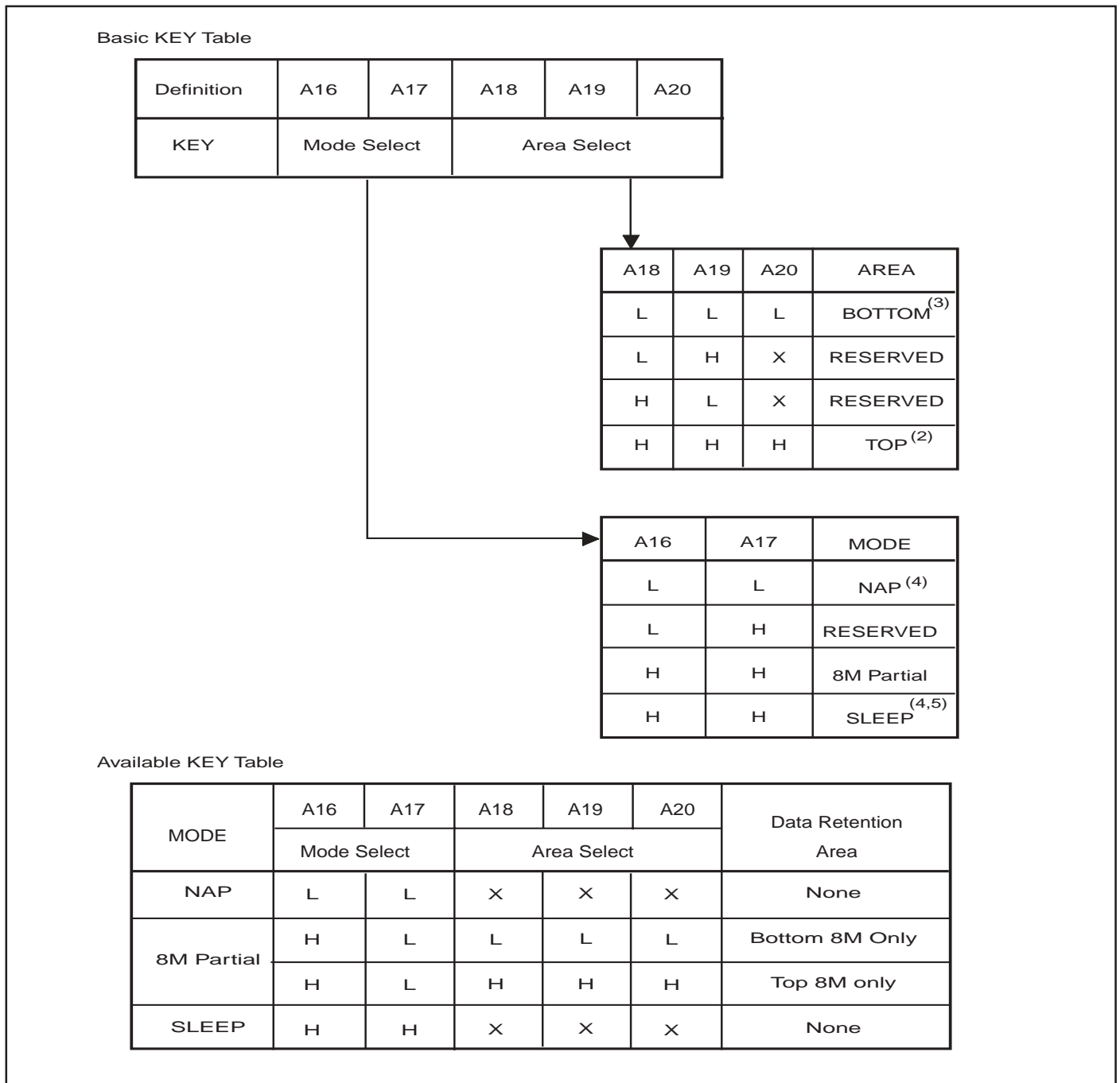
**FLASH ERASE AND PROGRAMMING PERFORMANCE - FLASH 1 or FLASH 2**

Parameter	Min.	Typ. <sup>(1)</sup>	Max.	Unit	Remarks
Sector Erase Time	—	0.5	2.0	s	Excludes programming time prior to erasure
Word Programming Time	—	6.0	100	μs	Excludes system-level overhead
Chip Programming Time	—	—	200	s	Excludes system-level overhead
Erase/Program Cycle	100,000	—	—	cycle	

**Note:**

1. Typical Erase conditions TA = 25°C, VCCf\_1 & VCCf\_2 = 2.9V. Typical Program conditions TA = 25°C, VCCf\_1 & VCCf\_2 = 2.9V. Data= Checker

## PSRAM POWER DOWN PROGRAM KEY TABLE



## Notes:

- 1: The Power Down Program can be performed one time after compliance of Power-up timings and it should not be re-programmed after regular Read or Write. Unspecified addresses, A0 to A15, can be either High or Low during the programming. The RESERVED key should not be used.
- 2: TOP area is from the lowest address location. (i.e., A[20:0] = H)
- 3: BOTTOM area is from the highest address location. (i.e., A[20:0] = L)
- 4: NAP and SLEEP do not retain the data and Area Select is ignored.
- 5: Default state. Power Down Program to this SLEEP mode can be omitted.

## PSRAM READ OPERATIONS

Parameter	Symbol	Min	Max.	Unit
Read Cycle Time	t <sub>RC</sub>	70	—	ns
Chip Enable Access Time <sup>(1,3)</sup>	t <sub>CE</sub>	—	65	ns
Output Enable Access Time <sup>(1)</sup>	t <sub>OE</sub>	—	40	ns
Address Access Time <sup>(1,4)</sup>	t <sub>AA</sub>	—	65	ns
Output Data Hold Time <sup>(1)</sup>	t <sub>OH</sub>	5	—	ns
$\overline{\text{CE}}1\text{r Low to Output Low-Z}^{(2)}$	t <sub>CLZ</sub>	5	—	ns
$\overline{\text{OE}} \text{ Low to Output Low-Z}^{(2)}$	t <sub>OLZ</sub>	0	—	ns
$\overline{\text{CE}}1\text{r High to Output High-Z}^{(2)}$	t <sub>CHZ</sub>	—	20	ns
$\overline{\text{OE}} \text{ High to Output High-Z}^{(2)}$	t <sub>OHZ</sub>	—	20	ns
Address Setup Time to $\overline{\text{CE}}1\text{r Low}^{(5)}$	t <sub>ASC</sub>	-5	—	ns
Address Setup Time to $\overline{\text{OE}}^{(3,6)}$	t <sub>ASO</sub>	25	—	ns
Address Setup Time to $\overline{\text{OE}}^{(7)}$	t <sub>ASO(ABS)</sub>	10	—	ns
$\overline{\text{LB}}/\overline{\text{UB}}$ Set up Time to $\overline{\text{CE}}1\text{r Low}^{(5)}$	t <sub>BSC</sub>	-5	—	ns
$\overline{\text{LB}}/\overline{\text{UB}}$ Set up Time to $\overline{\text{OE}} \text{ Low}$	t <sub>BSO</sub>	-10	—	ns
Address Invalid Time <sup>(4)</sup>	t <sub>AX</sub>	—	5	ns
Address Hold Time from $\overline{\text{CE}}1\text{r Low}^{(4)}$	t <sub>CLAH</sub>	70	—	ns
Address Hold Time from $\overline{\text{OE}} \text{ Low}^{(4,8)}$	t <sub>OLAH</sub>	45	—	ns
Address Hold Time from $\overline{\text{CE}}1\text{r High}$	t <sub>CHAH</sub>	-5	—	ns
Address Hold Time from $\overline{\text{OE}} \text{ High}$	t <sub>OHAH</sub>	-5	—	ns
$\overline{\text{LB}}/\overline{\text{UB}}$ Hold Time to $\overline{\text{CE}}1\text{r Low}$	t <sub>CHBH</sub>	-5	—	ns
$\overline{\text{LB}}/\overline{\text{UB}}$ Hold Time to $\overline{\text{OE}} \text{ Low}$	t <sub>OHBH</sub>	-5	—	ns
$\overline{\text{CE}}1\text{r Low to } \overline{\text{OE}} \text{ Low Delay Time}^{(3,6,8,9)}$	t <sub>CLOL</sub>	25	1000	ns
$\overline{\text{OE}} \text{ Low to } \overline{\text{CE}}1\text{r High Delay Time}^{(8)}$	t <sub>OLCH</sub>	45	—	ns
$\overline{\text{CE}}1\text{r High Pulse Width}$	t <sub>CP</sub>	12	—	ns
$\overline{\text{OE}} \text{ High Pulse Width}^{(6,8,9)}$	t <sub>OP</sub>	25	1000	ns
$\overline{\text{OE}} \text{ High Pulse Width}^{(7)}$	t <sub>OP(ABS)</sub>	12	—	ns

**Notes:**

- The output load is 30 pF.
- The output load is 5 pF.
- The t<sub>CE</sub> is applicable if  $\overline{\text{OE}}$  is brought to Low before  $\overline{\text{CE}}1\text{r}$  goes Low and is also applicable if actual value of both or either t<sub>ASO</sub> or t<sub>CLOL</sub> is shorter than specified value.
- Applicable only to A0 and A1 when both  $\overline{\text{CE}}1\text{r}$  and  $\overline{\text{OE}}$  are kept at Low for the address access.
- Applicable if  $\overline{\text{OE}}$  is brought to Low before  $\overline{\text{CE}}1\text{r}$  goes Low.
- The t<sub>ASO</sub>, t<sub>CLOL</sub> (Min) and t<sub>OP</sub> (Min) are reference values when the access time is determined by t<sub>OE</sub>.  
If the actual value of each parameter is shorter than the specified minimum value, t<sub>OE</sub> becomes longer by the amount of subtracting actual value from specified minimum value.  
For example, if actual t<sub>ASO</sub>, t<sub>ASO</sub> (actual), is shorter than specified minimum value, t<sub>ASO</sub> (Min), during  $\overline{\text{OE}}$  control access (i.e.,  $\overline{\text{CE}}1\text{r}$  stays Low), the t<sub>OE</sub> becomes t<sub>OE</sub> (Max) + t<sub>ASO</sub> (Min) - t<sub>ASO</sub> (actual).
- The t<sub>ASO[ABS]</sub> and t<sub>OP[ABS]</sub> are the absolute minimum values during  $\overline{\text{OE}}$  control access.
- If actual value of either t<sub>CLOL</sub> or t<sub>OP</sub> is shorter than specified minimum value, both t<sub>OLAH</sub> and t<sub>OLCH</sub> become t<sub>RC</sub> (Min) - t<sub>CLOL</sub> (actual) or t<sub>RC</sub> (Min) - t<sub>OP</sub> (actual).
- Maximum value is applicable if  $\overline{\text{CE}}1\text{r}$  is kept at Low.

## PSRAM WRITE OPERATIONS

Parameter	Symbol	Value		Unit
		Min.	Max.	
Write Cycle Time <sup>(1)</sup>	t <sub>WC</sub>	70	—	ns
Address Setup Time <sup>(2)</sup>	t <sub>AS</sub>	0	—	ns
Address Hold Time <sup>(2)</sup>	t <sub>AH</sub>	35	—	ns
$\overline{\text{CE}}1\text{r}$ Write Setup Time	t <sub>CS</sub>	0	1000	ns
$\overline{\text{CE}}1\text{r}$ Write Hold Time	t <sub>CH</sub>	0	1000	ns
$\overline{\text{WE}}$ Setup Time	t <sub>WS</sub>	0	—	ns
$\overline{\text{WE}}$ Hold Time	t <sub>WH</sub>	0	—	ns
$\overline{\text{LB}}$ and $\overline{\text{UB}}$ Setup Time	t <sub>BS</sub>	-5	—	ns
$\overline{\text{LB}}$ and $\overline{\text{UB}}$ Hold Time	t <sub>BH</sub>	-5	—	ns
$\overline{\text{OE}}$ Setup Time <sup>(3)</sup>	t <sub>OES</sub>	0	1000	ns
$\overline{\text{OE}}$ Hold Time <sup>(3,4)</sup>	t <sub>OEH</sub>	25	1000	ns
$\overline{\text{OE}}$ Hold Time <sup>(5)</sup>	t <sub>OEH</sub> (ABS)	12	—	ns
$\overline{\text{OE}}$ High to $\overline{\text{CE}}1\text{r}$ Low Setup Time <sup>(6)</sup>	t <sub>OHCL</sub>	-5	—	ns
$\overline{\text{OE}}$ High to Address Hold Time <sup>(7)</sup>	t <sub>OH AH</sub>	-5	—	ns
$\overline{\text{CE}}1\text{r}$ Write Pulse Width <sup>(1,8)</sup>	t <sub>CW</sub>	45	—	ns
$\overline{\text{WE}}$ Write Pulse Width <sup>(1,8)</sup>	t <sub>WP</sub>	45	—	ns
$\overline{\text{CE}}1\text{r}$ Write Recovery Time <sup>(1,9)</sup>	t <sub>WRC</sub>	10	—	ns
$\overline{\text{WE}}$ Write Recovery Time <sup>(1,3,9)</sup>	t <sub>WR</sub>	10	1000	ns
Data Setup Time	t <sub>DS</sub>	15	—	ns
Data Hold Time	t <sub>DH</sub>	0	—	ns
$\overline{\text{CE}}1\text{r}$ High Pulse Width <sup>(9)</sup>	t <sub>CP</sub>	12	—	ns

**Notes:**

- Minimum value must be equal or greater than the sum of actual t<sub>CW</sub> (or t<sub>WP</sub>) and t<sub>WRC</sub> (or t<sub>WR</sub>).
- New write address is valid from either  $\overline{\text{CE}}1\text{r}$  or  $\overline{\text{WE}}$  that is brought to High.
- Maximum value is applicable if  $\overline{\text{CE}}1\text{r}$  is kept at Low and both  $\overline{\text{WE}}$  and  $\overline{\text{OE}}$  are kept at High.
- The t<sub>OEH</sub> is specified from end of t<sub>WC</sub> (Min), and is a reference value when access time is determined by t<sub>OE</sub>. If actual value is shorter than specified minimum value, t<sub>OE</sub> becomes longer by the amount of subtracting actual value from specified minimum value.
- The t<sub>OEH</sub>[ABS] is the absolute minimum value if write cycle is terminated by  $\overline{\text{WE}}$  and  $\overline{\text{CE}}1\text{r}$  stay Low.
- t<sub>OHCL</sub> (Min) must be satisfied if read operation is not performed prior to write operation. In case  $\overline{\text{OE}}$  is disabled after t<sub>OHCL</sub> (Min),  $\overline{\text{WE}}$  Low must be asserted after t<sub>RC</sub> (Min) from  $\overline{\text{CE}}1\text{r}$  Low. In other words, read operation is initiated if t<sub>OHCL</sub> (Min) is not satisfied.
- Applicable if  $\overline{\text{CE}}1\text{r}$  stays Low after read operation.
- t<sub>CW</sub> and t<sub>WP</sub> are applicable if write operation is initiated by  $\overline{\text{CE}}1\text{r}$  and  $\overline{\text{WE}}$ , respectively.
- t<sub>WRC</sub> and t<sub>WR</sub> are applicable if write operation is terminated by  $\overline{\text{CE}}1\text{r}$  and  $\overline{\text{WE}}$ , respectively. The t<sub>WR</sub> (Min) can be ignored if  $\overline{\text{CE}}1\text{r}$  is brought to High together or after  $\overline{\text{WE}}$  is brought to High. In such a case, the t<sub>CP</sub> (Min) must be satisfied.

## PSRAM POWER DOWN PARAMETERS

Parameter	Symbol	Value		Unit
		Min.	Max.	
CE2r Low Setup Time for Power down Entry	tCSP	10	—	ns
CE2r Low Hold Time after Power down Entry	tC2LP	70	—	ns
$\overline{CE}1r$ High Hold Time Following CE2r High after Power down Exit SLEEP Mode only	tCHH	350	—	$\mu$ s
$\overline{CE}1r$ High Setup Time following CE2r High after Power down Exit (Except for SLEEP Mode)	tCHHN	1	—	$\mu$ s
$\overline{CE}1r$ High Setup Time following CE2r High after Power down Exit	tCHS	10	—	ns
$\overline{CE}1r$ High to $\overline{PE}$ Low Setup Time <sup>(1)</sup>	tEPS	70	—	ns
$\overline{PE}$ Power Down Program Pulse Width <sup>(1)</sup>	tEP	70	—	ns
$\overline{PE}$ High to $\overline{CE}1r$ Low Hold Time <sup>(1)</sup>	tEPH	70	—	ns
Address Setup Time to $\overline{PE}$ High <sup>(1)</sup>	tEAS	15	—	ns
Address Setup Time from $\overline{PE}$ High <sup>(1)</sup>	tEAH	0	—	ns

**Note:**

1. Applies to Power Down Program.

## PSRAM OTHER TIMING PARAMETERS

Parameter	Symbol	Value		Unit
		Min.	Max.	
$\overline{CE}1r$ High to $\overline{OE}$ Invalid for Standby Entry	tCHOX	10	—	ns
$\overline{CE}1r$ High to $\overline{WE}$ Invalid for Standby Entry <sup>(1)</sup>	tCHWX	10	—	ns
CE2r Low Hold Time after Power-up <sup>(2)</sup>	tC2LH	50	—	$\mu$ s
CE2r High Hold Time after Power-up <sup>(3)</sup>	tC2HL	50	—	$\mu$ s
$\overline{CE}1r$ High Hold Time Following CE2r High after Power-up <sup>(2)</sup>	tCHH	350	—	$\mu$ s
Input Transition Time <sup>(4)</sup>	t <sub>T</sub>	1	25	ns

**Notes:**

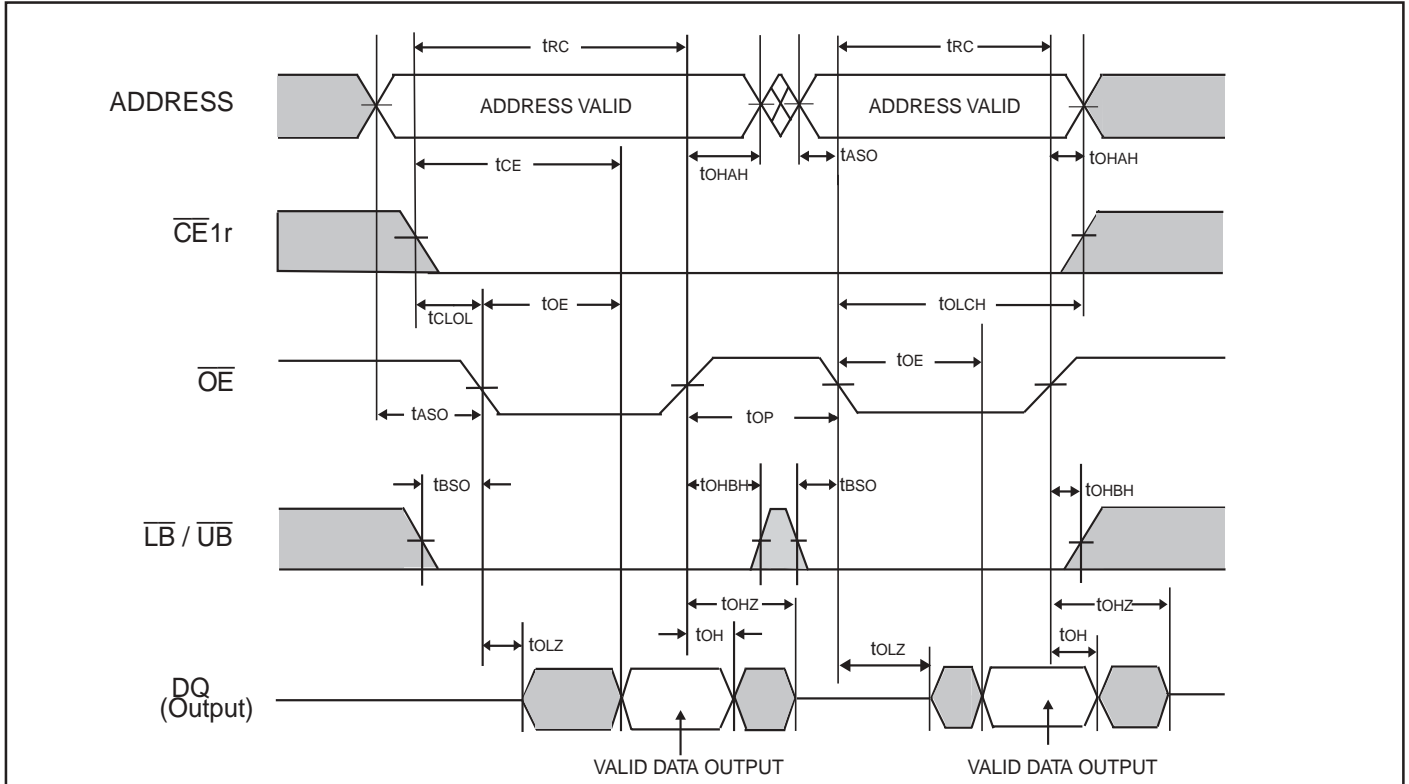
- Unintended data may be written into any address location if t<sub>CHWX</sub> is not satisfied.
- Must satisfy t<sub>CHH</sub> (Min) after t<sub>C2LH</sub> (Min) .
- Requires Power Down mode entry and exit after t<sub>C2HL</sub>.
- Input Transition Time (t<sub>T</sub>) at AC testing is 5 ns as shown below. If actual t<sub>T</sub> is longer than 5 ns, it may violate some timing parameters.

## PSRAM AC TEST CONDITIONS

Parameter	Symbol	Condition	Value	Unit
Input High Level	V <sub>IH</sub>	V <sub>CC</sub> = 2.7V to 3.3V	2.3	V
Input Low Level	V <sub>IL</sub>	V <sub>CC</sub> = 2.7V to 3.3V	0.4	V
Input Timing Measurement Level	V <sub>REF</sub>	V <sub>CC</sub> = 2.7V to 3.3V	1.3	V
Input Transition Time	t <sub>T</sub>	Between V <sub>IL</sub> and V <sub>IH</sub>	5	ns

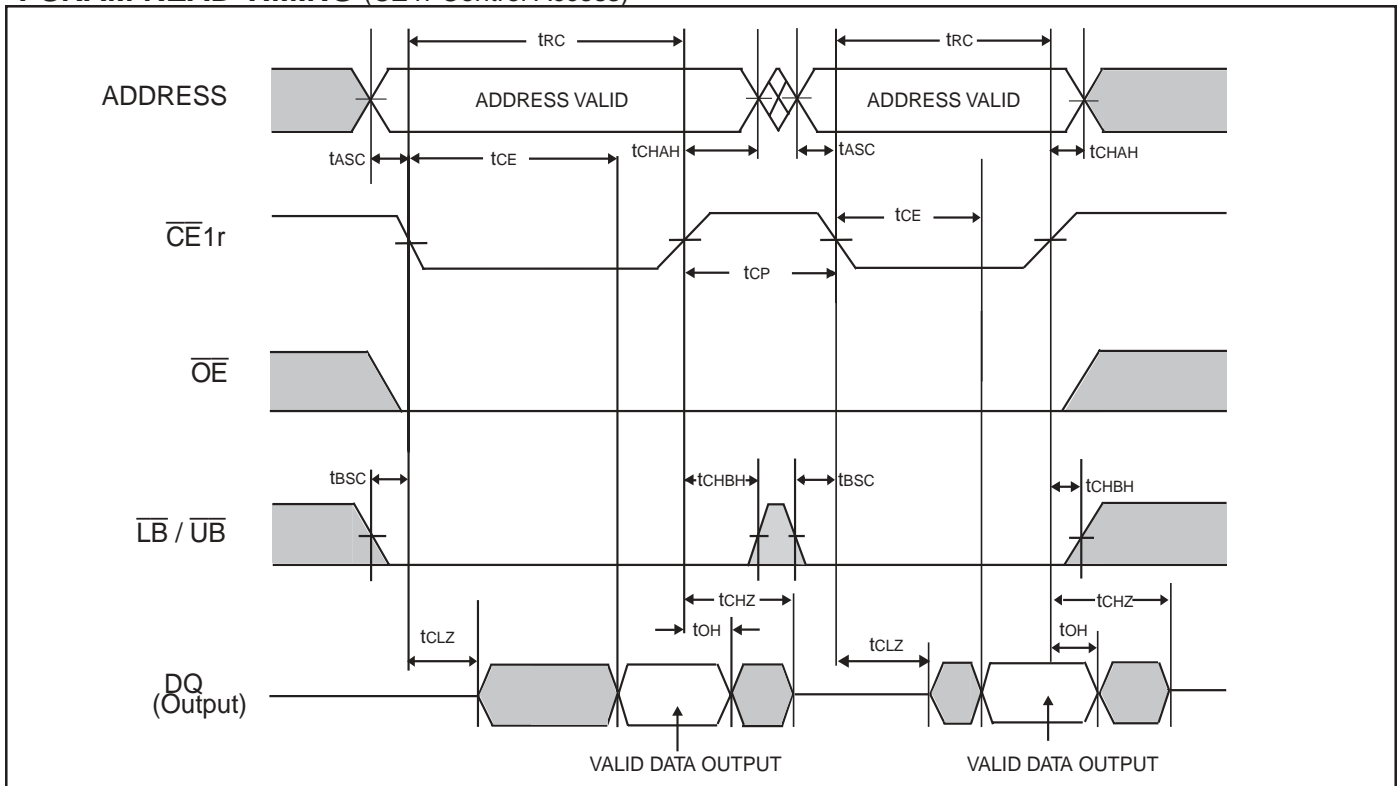


**PSRAM READ TIMING ( $\overline{OE}$  Control Access)**



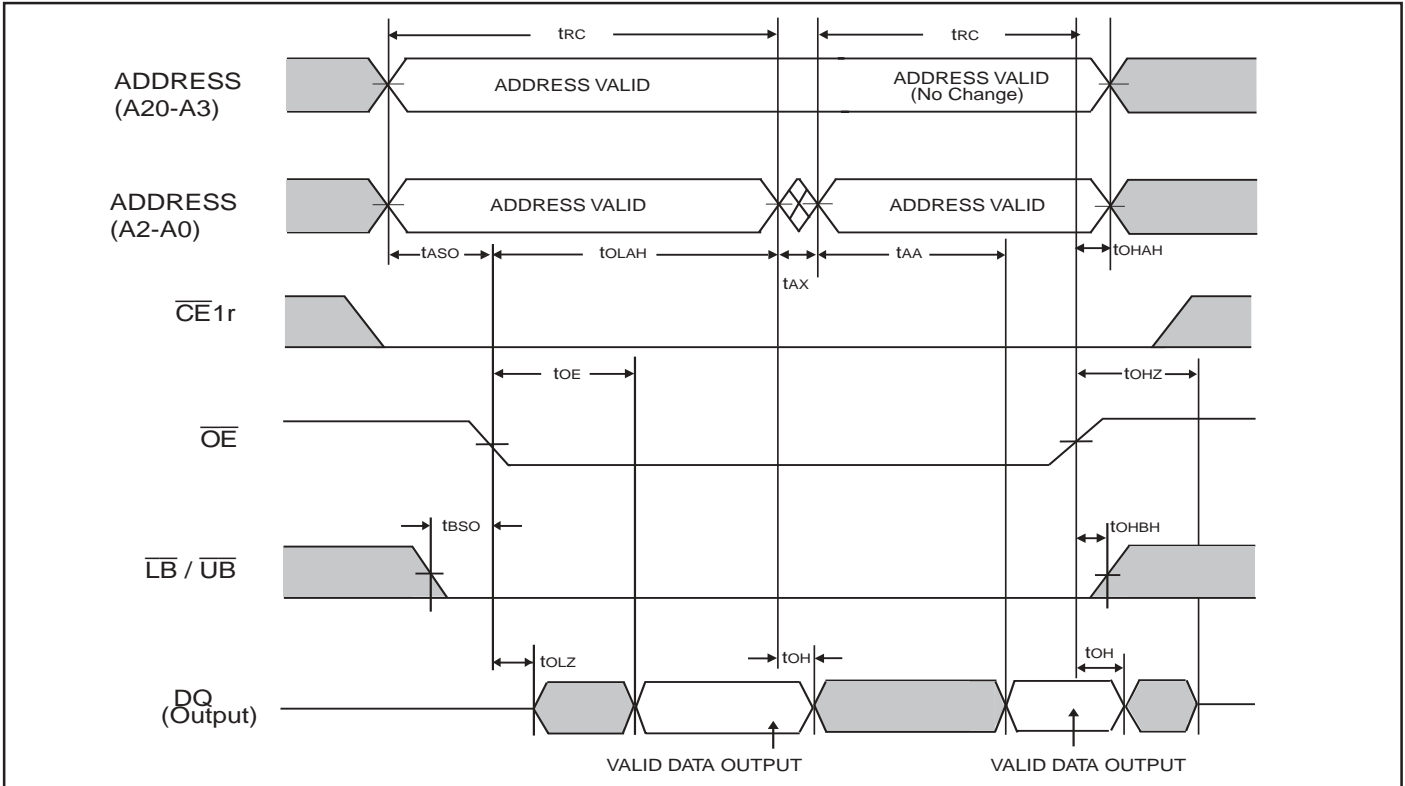
Note: CE2r,  $\overline{PE}$  and  $\overline{WE}$  must be High during read cycle. Either or both  $\overline{LB}$  and  $\overline{UB}$  must be Low when both  $\overline{CE1r}$  and  $\overline{OE}$  are Low.

**PSRAM READ TIMING ( $\overline{CE1r}$  Control Access)**



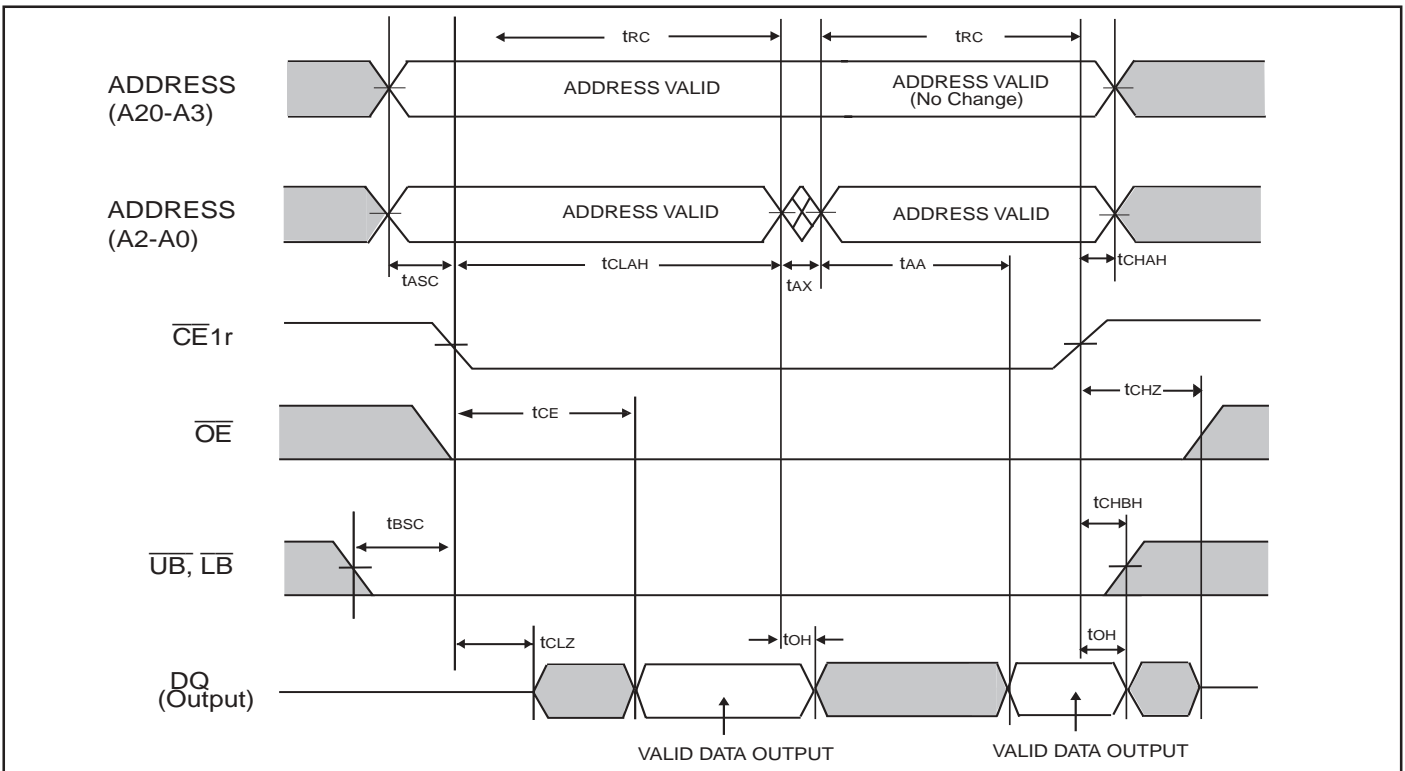
Note: CE2r,  $\overline{PE}$  and  $\overline{WE}$  must be High during read cycle. Either or both  $\overline{LB}$  and  $\overline{UB}$  must be Low when both  $\overline{CE1r}$  and  $\overline{OE}$  are Low.

**PSRAM READ TIMING** (Address Access after  $\overline{OE}$  Control Access)



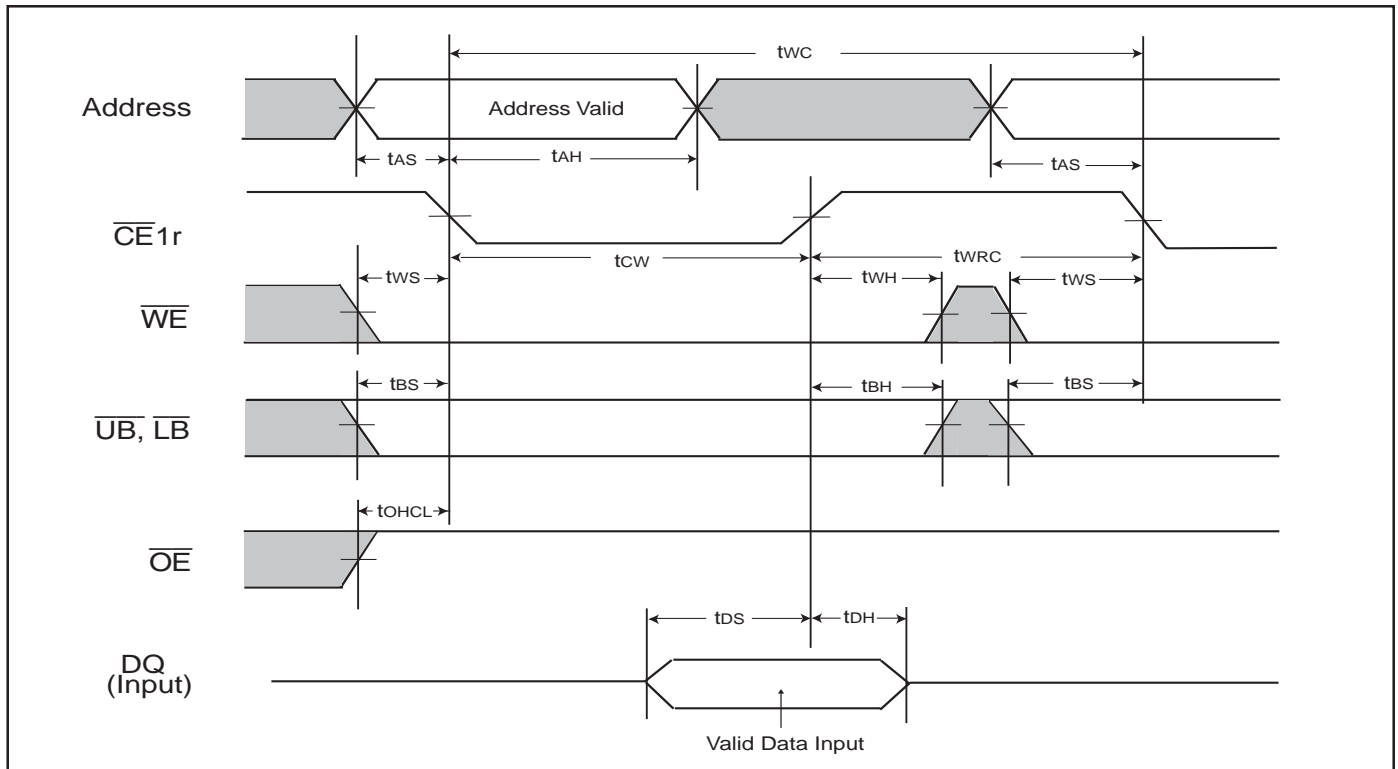
Note:  $\overline{CE2r}$ ,  $\overline{PE}$  and  $\overline{WE}$  must be High during read cycle. Either or both  $\overline{LB}$  and  $\overline{UB}$  must be Low when both  $\overline{CE1r}$  and  $\overline{OE}$  are Low.

**PSRAM READ TIMING** (Address Access after  $\overline{CE1r}$  Control Access)



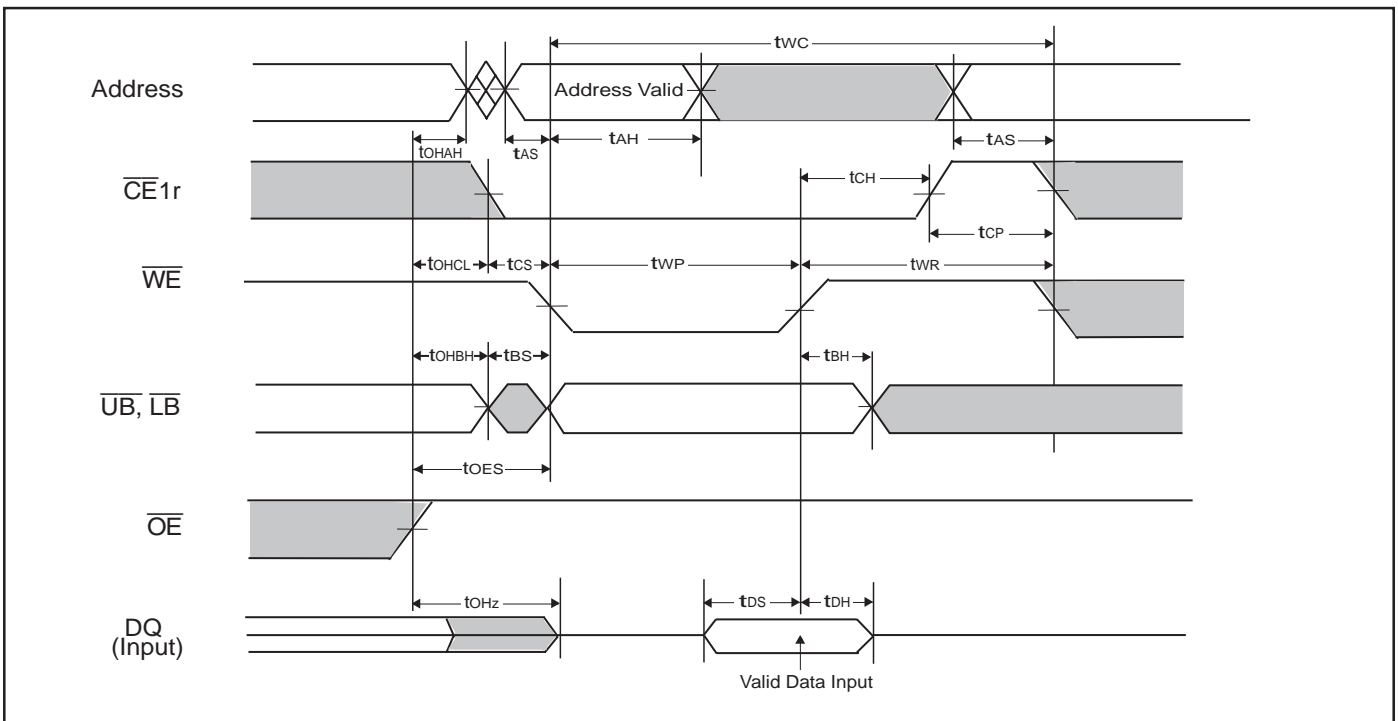
Note:  $\overline{CE2r}$ ,  $\overline{PE}$  and  $\overline{WE}$  must be High during read cycle. Either or both  $\overline{LB}$  and  $\overline{UB}$  must be Low when both  $\overline{CE1r}$  and  $\overline{OE}$  are Low.

**PSRAM WRITE TIMING ( $\overline{CE}1r$  Control)**



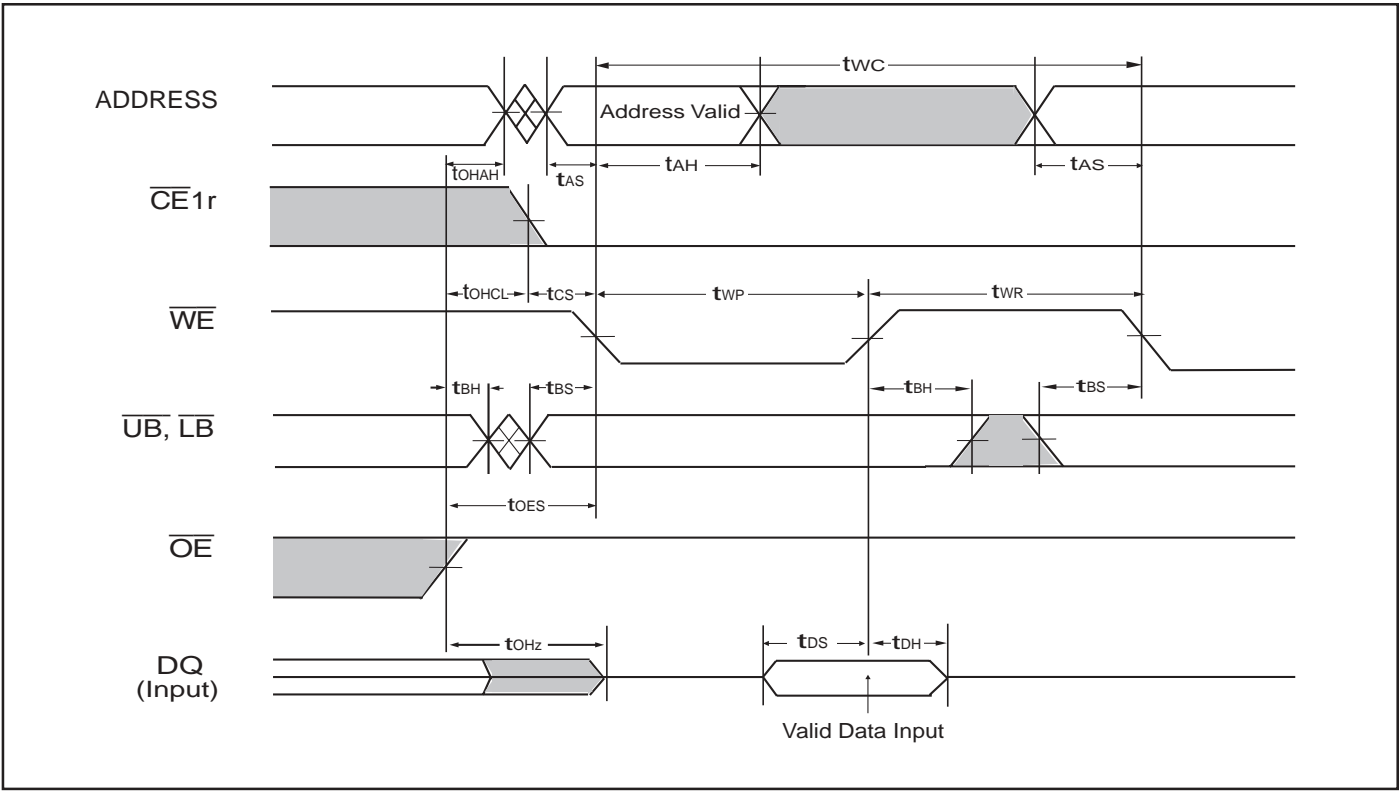
Note:  $\overline{CE}2r$  and  $\overline{PE}$  must be High during write cycle.

**PSRAM WRITE TIMING ( $\overline{WE}$  Control, Single Write Operation)**



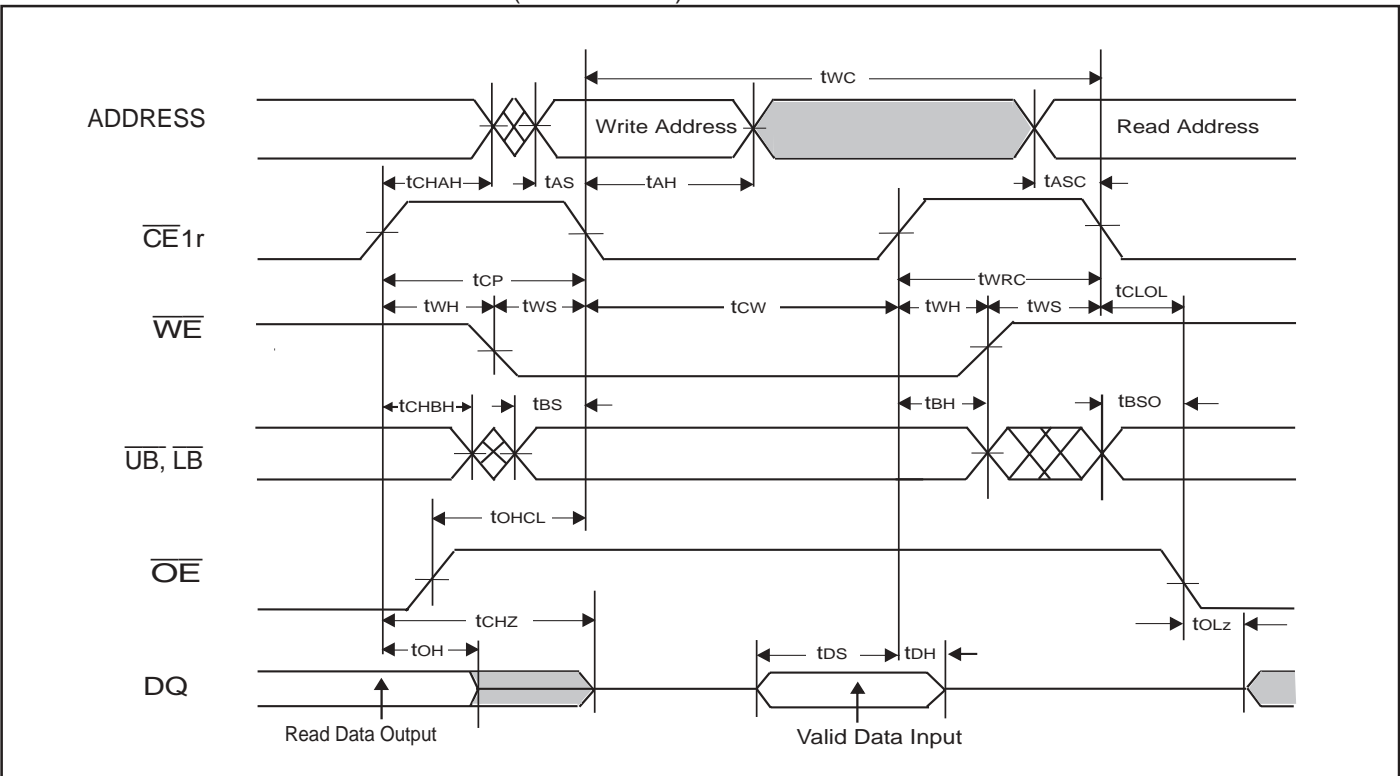
Note:  $\overline{CE}2r$  and  $\overline{PE}$  must be High during write cycle.

**PSRAM WRITE TIMING** ( $\overline{WE}$  Control, Continuous Write Operation)



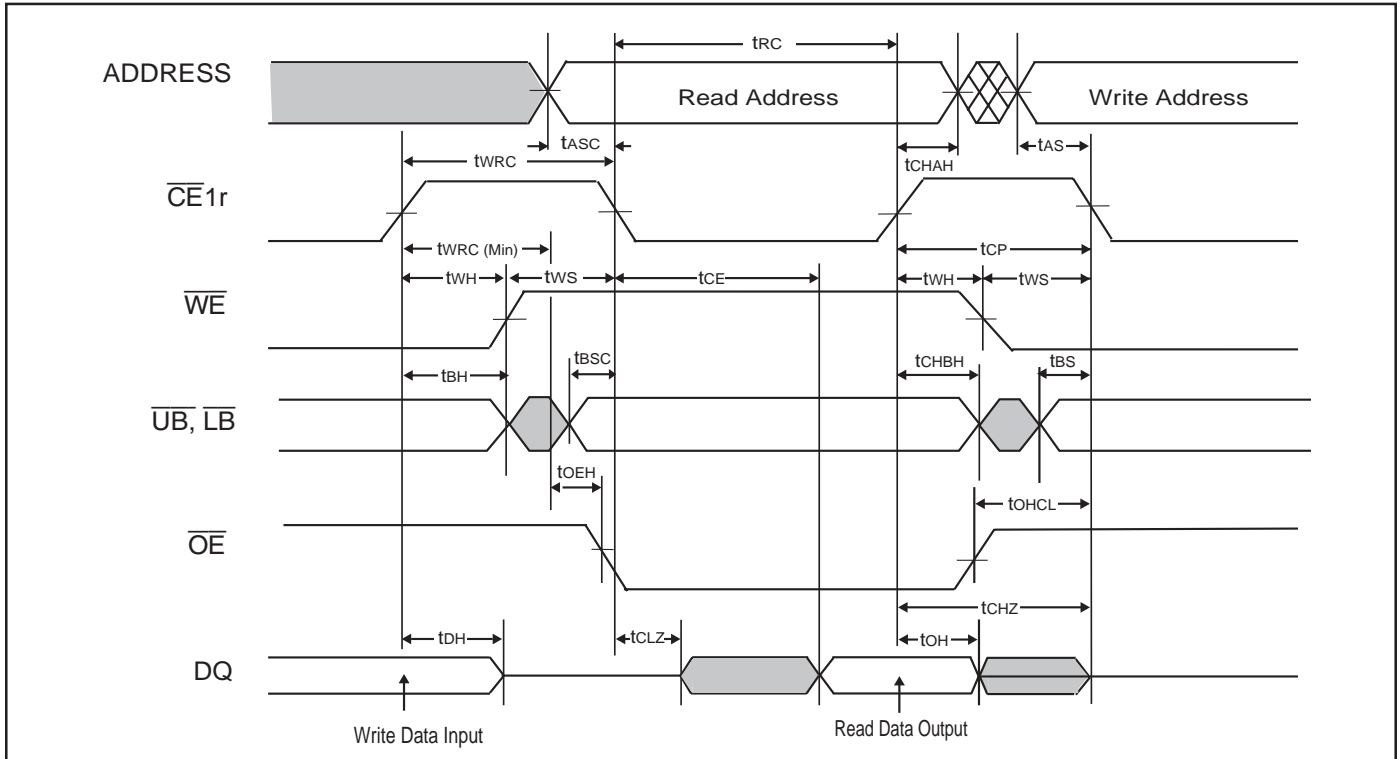
Note:  $\overline{CE2r}$  and  $\overline{PE}$  must be High during write cycle.

**PSRAM READ / WRITE TIMING** ( $\overline{CE1r}$  Control)



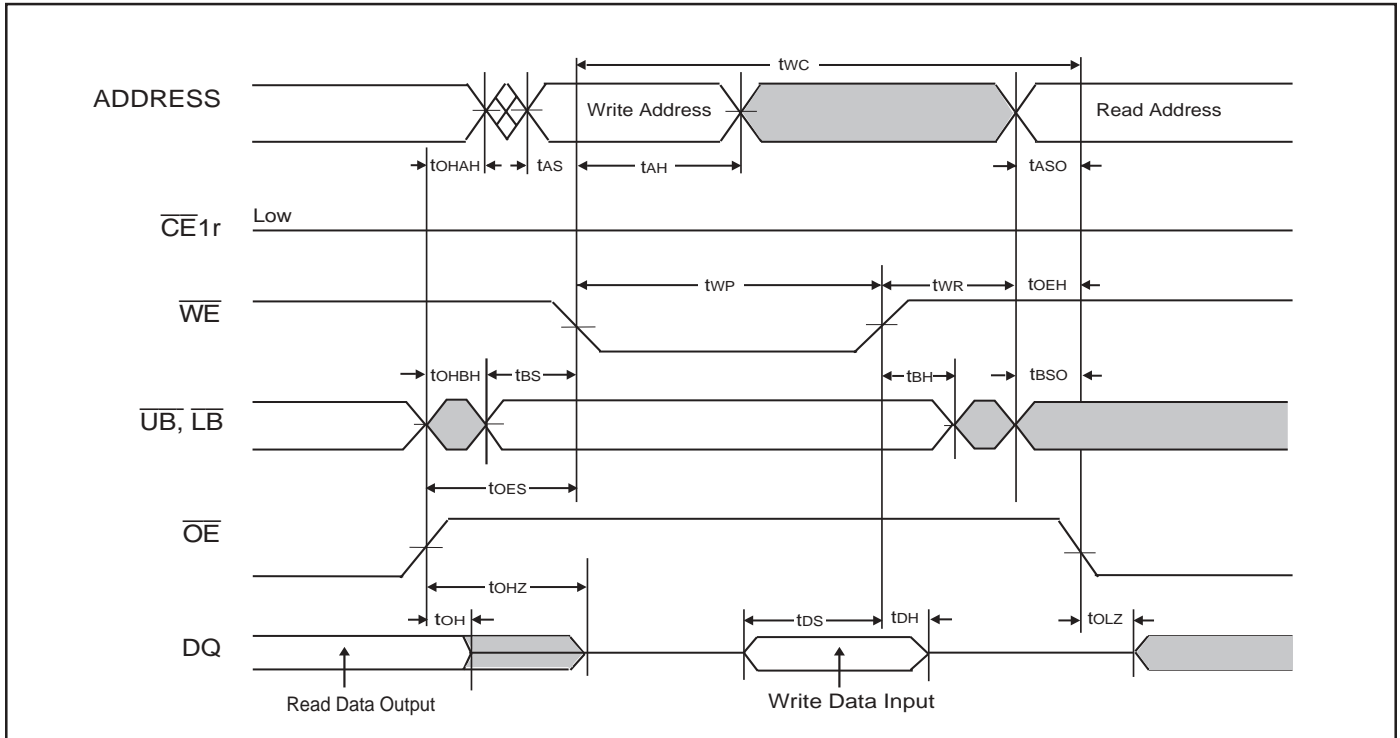
Note: Write address is valid from either  $\overline{CE1r}$  or  $\overline{WE}$  of last falling edge.

**PSRAM READ / WRITE TIMING ( $\overline{CE}1r$  Control)**



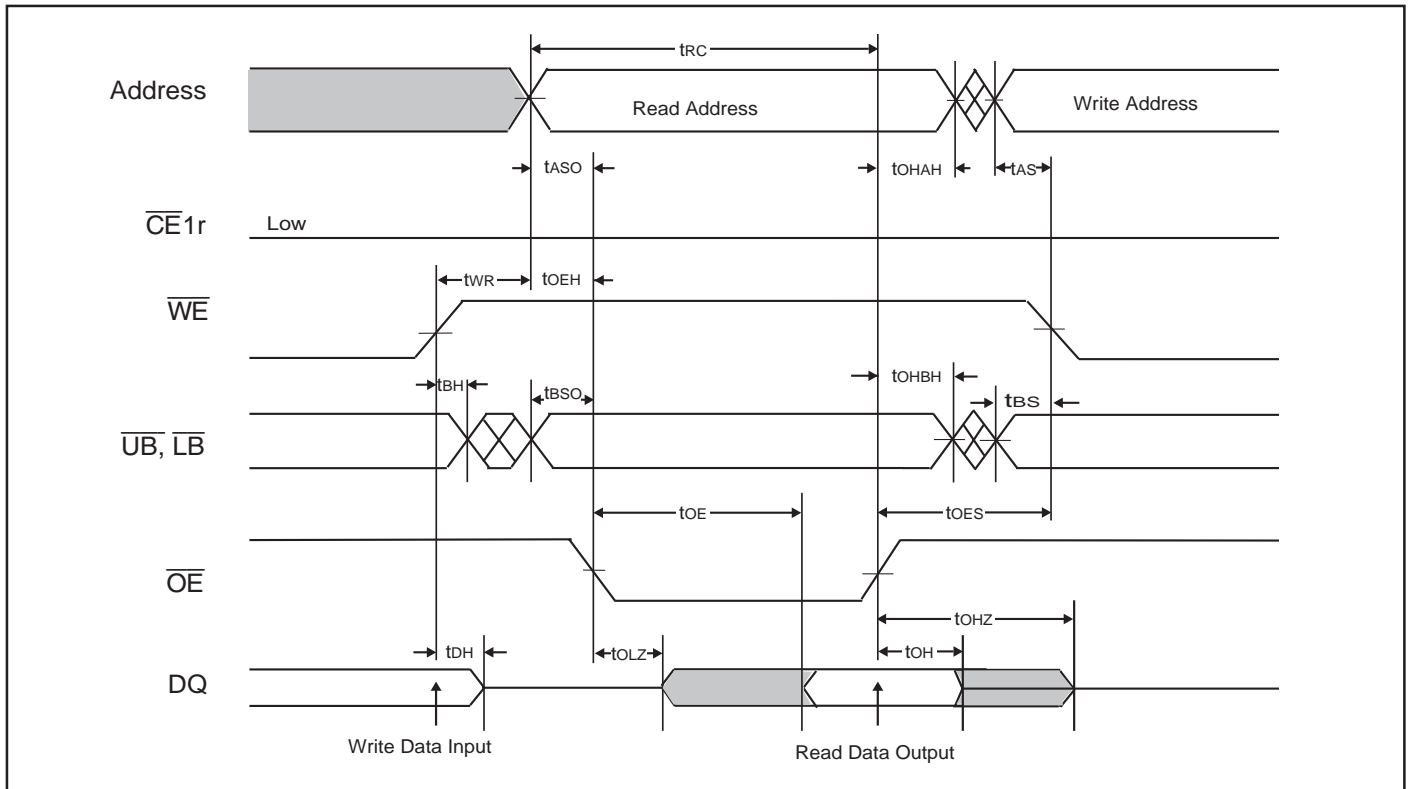
Note: The  $t_{OEHL}$  is specified from the time satisfied oth  $t_{WRC}$  and  $t_{WR(min)}$ .

**PSRAM READ / WRITE TIMING (READ =  $\overline{OE}$  Control, WRITE =  $\overline{WE}$  Control)**



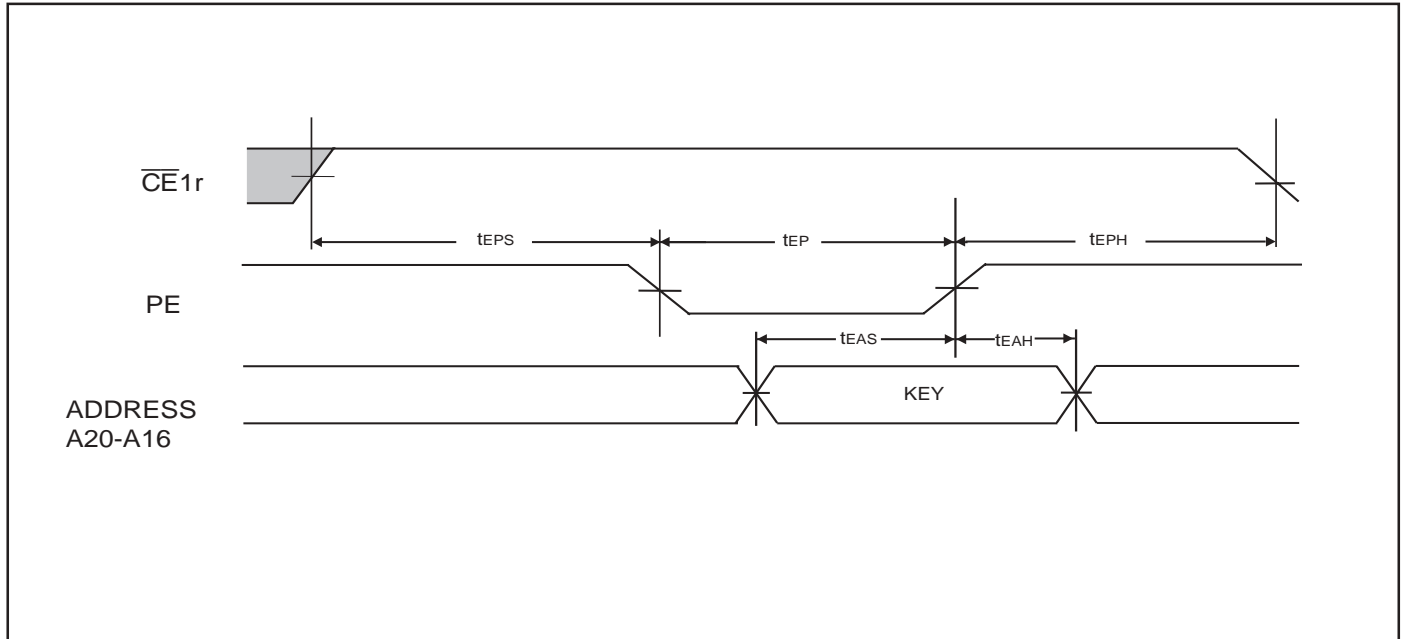
Note:  $\overline{CE}1r$  can be tied to Low for  $\overline{WE}$  and  $\overline{OE}$  controlled operation. When  $\overline{CE}1r$  is tied to Low, output is exclusively controlled by  $\overline{OE}$ .

**PSRAM READ / WRITE TIMING** (READ =  $\overline{OE}$  Control, WRITE =  $\overline{WE}$  Control)



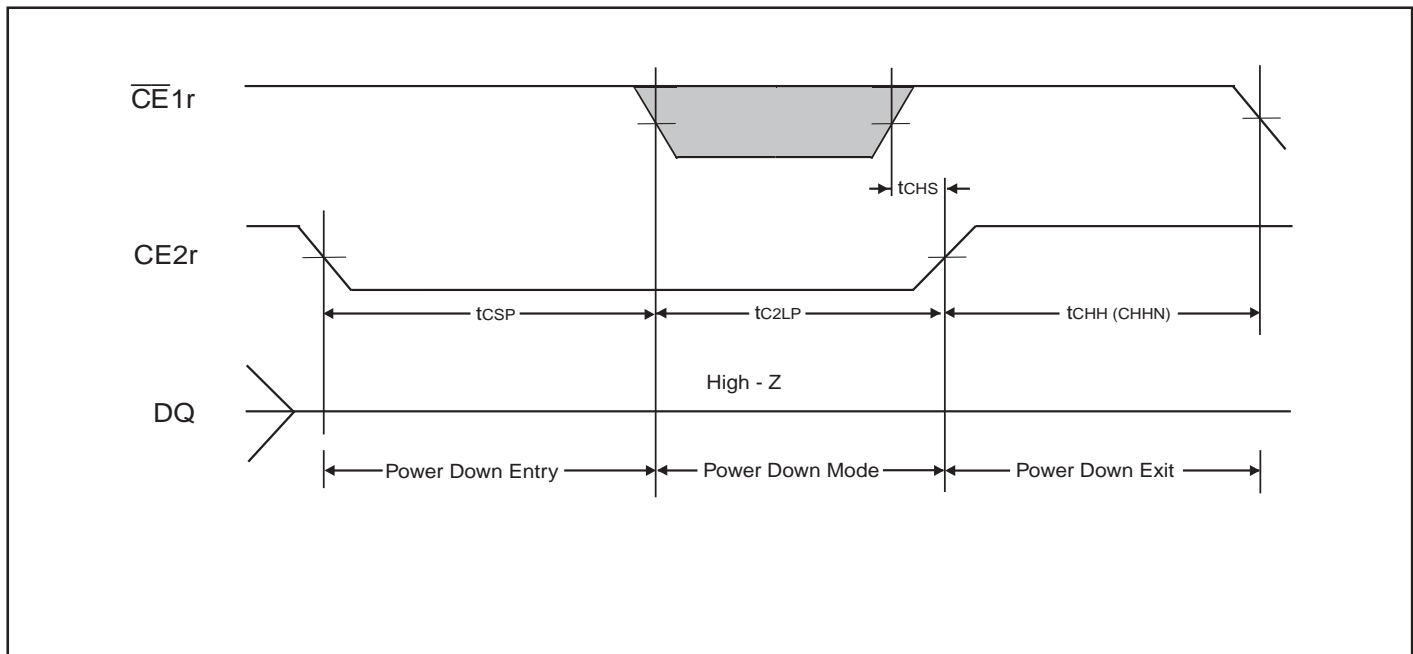
Note:  $\overline{CE1r}$  can be tied to Low for  $\overline{WE}$  and  $\overline{OE}$  controlled operation. When  $\overline{CE1r}$  is tied to Low, output is exclusively controlled  $\overline{OE}$ .

**PSRAM POWER DOWN TIMING**



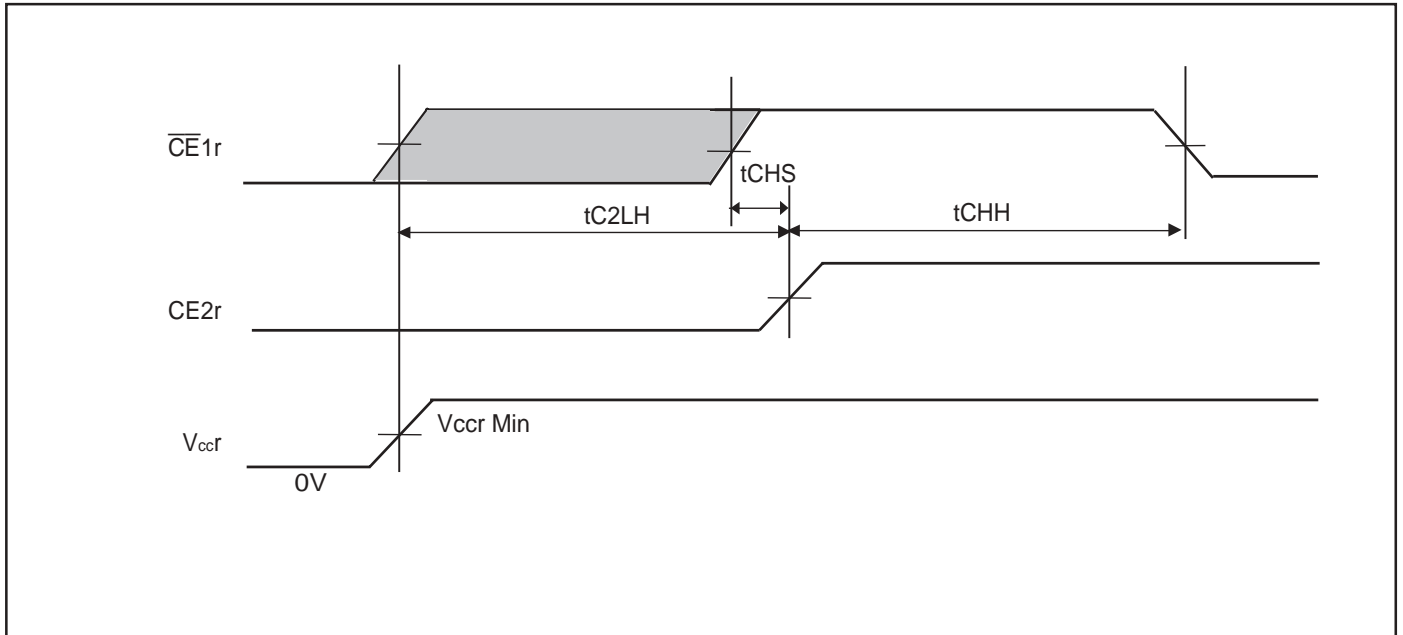
Note:  $CE2r$  must be High for Power Down Programming. Any other inputs not specified above can be either High or Low.

**PSRAM STANDBY ENTRY and EXIT TIMING**



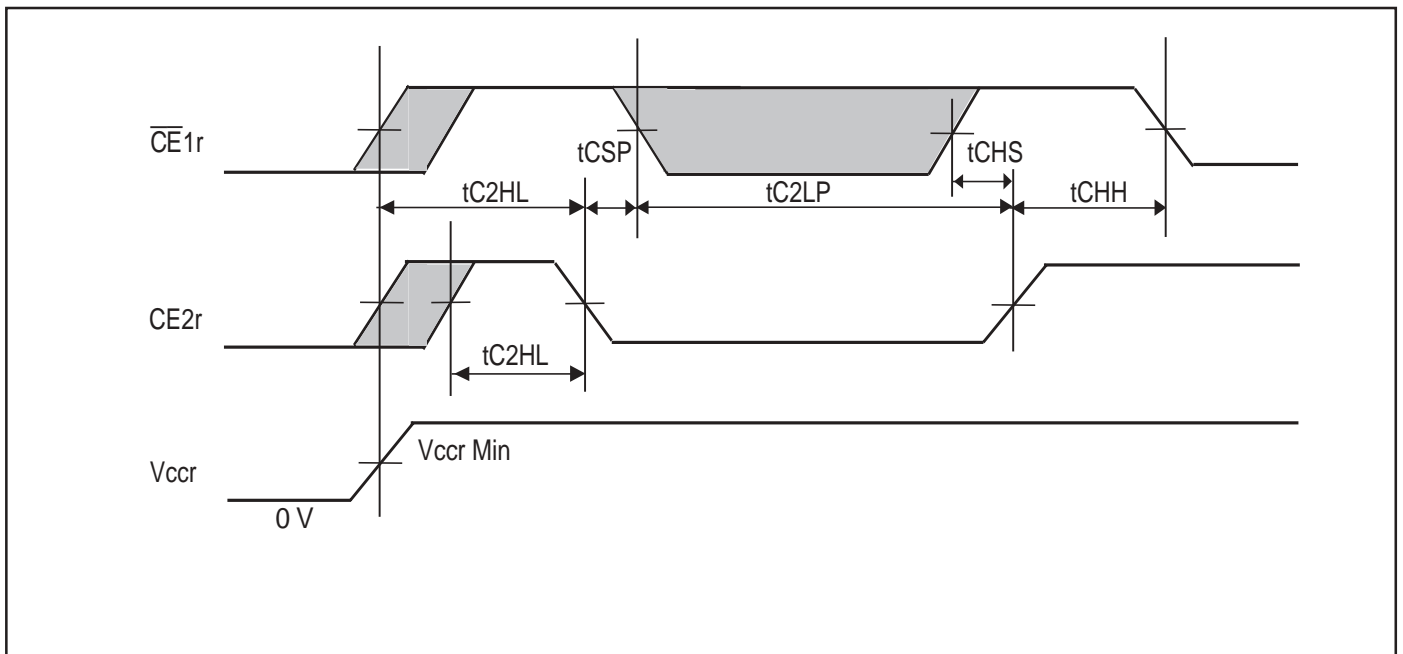
Note: This Power Down mode can be also used for Power-up Timing #2 except that  $t_{CHHN}$  can not be used at Power-up Timing.

## PSRAM POWER UP TIMING 1



Note: The  $t_{C2LH}$  specifies after  $V_{ccr}$  reaches specified minimum level.

## PSRAM POWER UP TIMING 2



Note: The  $t_{C2HL}$  specifies from  $CE2r$  Low to High transition after  $V_{ccr}$  reaches specified minimum level.  $\overline{CE1r}$  must be brought to High prior to or together with  $CE2r$  Low to High transition.



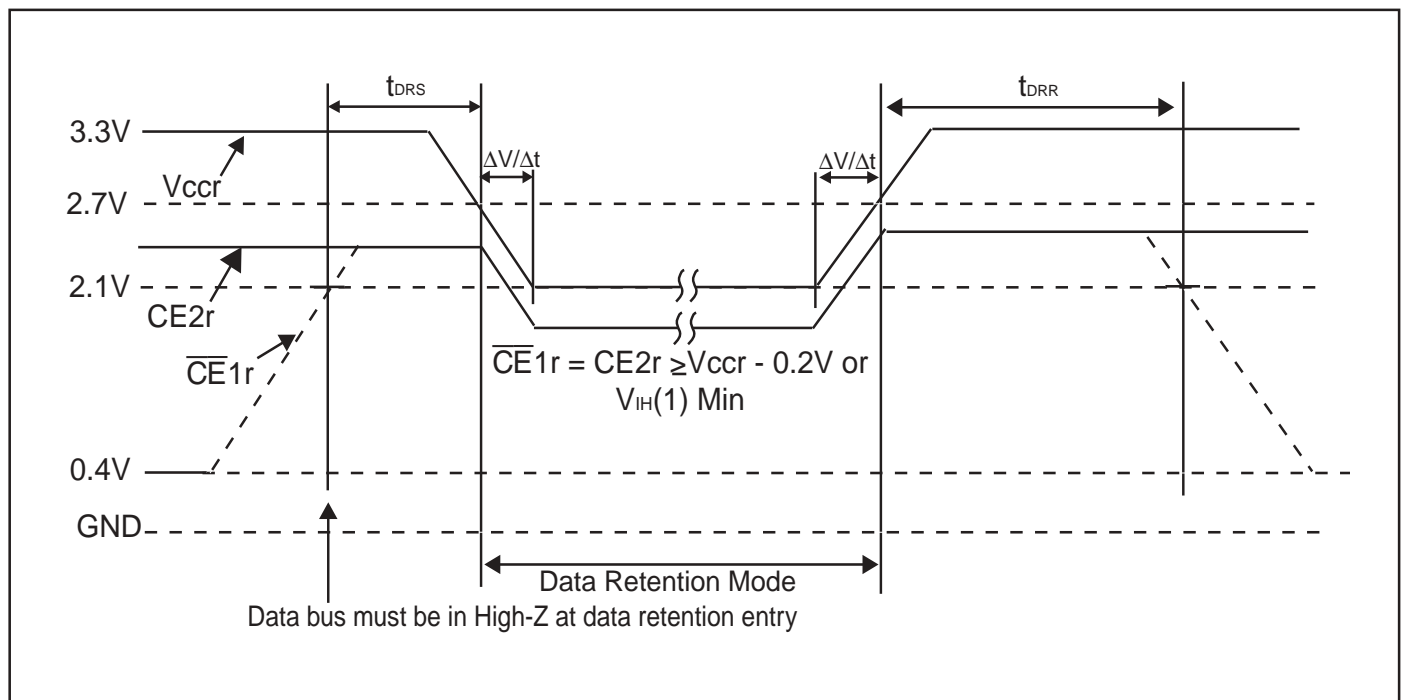
## PSRAM DATA RETENTION SWITCHING CHARACTERISTICS

Symbol	Parameter	Conditions	Min.	Max.	Unit
V <sub>DR</sub>	V <sub>CCR</sub> Data Retention Supply Voltage	$\overline{CE1r} = CE2r \geq V_{CCR} - 0.2V$ OR, $\overline{CE1r} = CE2r = V_{IH}$	2.1	3.3	V
I <sub>DR</sub>	V <sub>CCR</sub> Data Retention Supply Current	$2.1V \leq V_{CCR} \leq 2.7V$ , $V_{IN} = V_{IH}^{(1)}$ or $V_{IL}$ $\overline{CE1r} = CE2r = V_{IH}^{(1)}$ , $I_{OUT} = 0$ mA	—	1.5	mA
I <sub>DR1</sub>	V <sub>CCR</sub> Data Retention Supply Current	$2.1V \leq V_{CCR} \leq 2.7V$ , $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CCR} - 0.2V$ , $\overline{CE1r} = CE2r \geq V_{CCR} - 0.2V$ $I_{OUT} = 0$ mA	—	100	μA
t <sub>DRS</sub>	Data Retention SetupTime	$2.7V \leq V_{CCR} \leq 3.3V$ , At Data Retention Entry	0	—	ns
t <sub>DRR</sub>	Data Retention RecoveryTime	$2.7V \leq V_{CCR} \leq 3.3V$ , After Data Retention	200	—	ns
ΔV/Δt	V <sub>CCR</sub> Voltage Transition Time	—	0.2	—	V/μs

**Note:**

1.  $2.0V \leq V_{IN} \leq V_{CCR} + 0.3$

## PSRAM DATA RETENTION TIMING

**Note:**

1.  $2.0V \leq V_{IH} \leq V_{CCR} + 0.3V$

**PIN CAPACITANCE**

Symbol	Parameter	Conditions	Min.	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0 V	-	20	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0 V	-	25	pF
C <sub>IN2</sub>	Control Pin Capacitance	V <sub>IN</sub> = 0 V	-	25	pF

**Notes:**

1. Test conditions T<sub>A</sub> = +25 °C, f = 1.0 MHz

**HANDLING OF PACKAGE:**

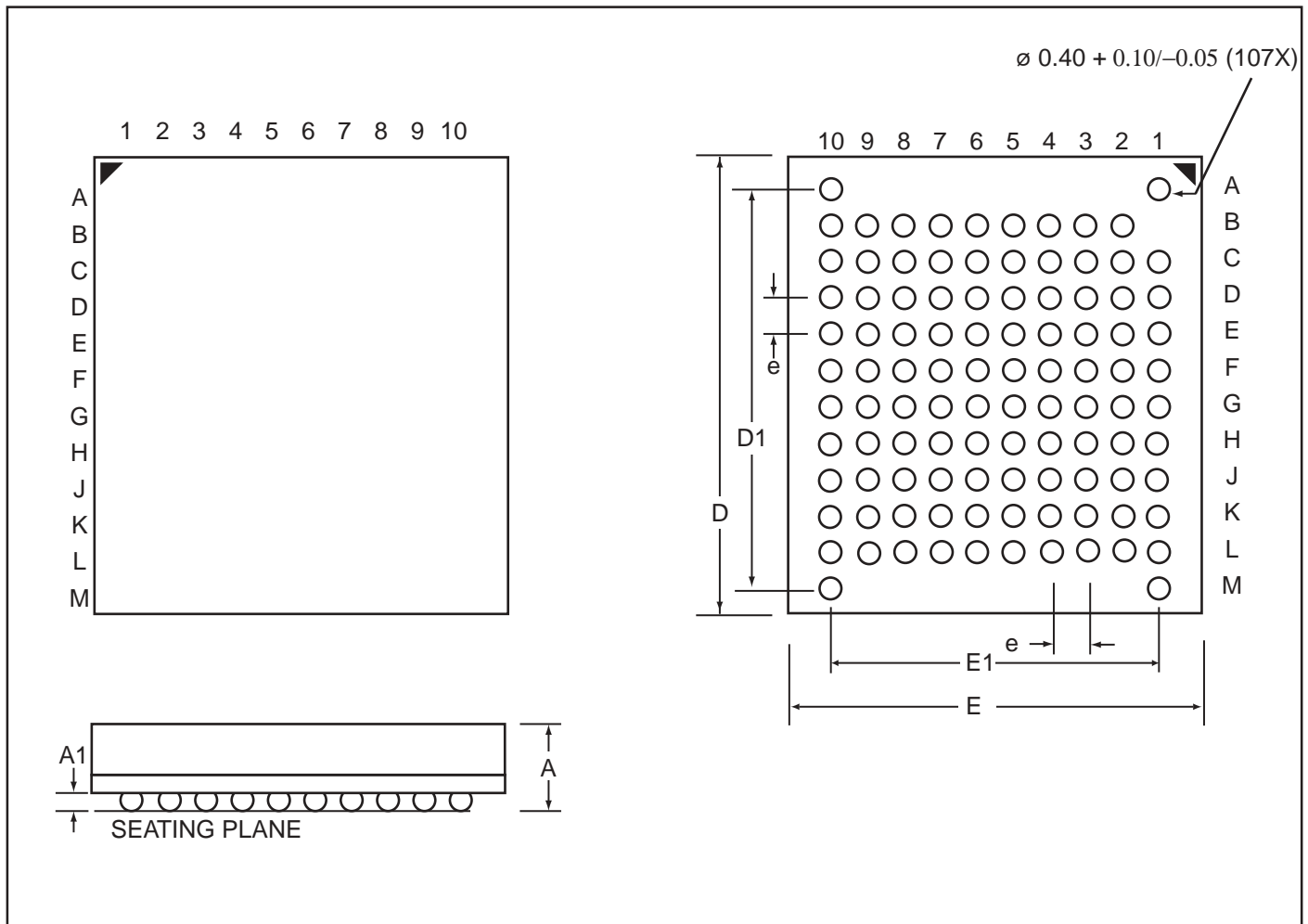
Please handle this package carefully because the sides of the package have acute angles.

**CAUTION:**

- 1) The high voltage (VID) cannot be applied to address pins and control pins except RESET. Exception is when autoselect and sector group protection function are used. Then the high voltage (VID) can be applied to RESET.
- 2) Without the high voltage (VID) sector group protection can be achieved by using the "Extended Sector Group Protection" command.

MINI BALL GRID ARRAY – 107-Ball BGA

PACKAGE CODE: B (9.00 mm x 10.00 mm Body, 0.8 mm Ball Pitch)



Symbol	Min.	Typ.	Max.	Units
A	1.15	1.25	1.40	mm
A1	0.05	0.10	0.15	mm
D	9.90	10.00	10.10	mm
D1	—	8.80	—	mm
E	8.90	9.00	9.10	mm
E1	—	7.20	—	mm
e	—	0.80	—	mm

**ORDERING INFORMATION**

**Industrial Range: -30°C to +85°C**

<b>Order Part No.</b>	<b>Flash Bank Organization</b>	<b>Flash Speed(ns)</b>	<b>PSRAM Speed(ns)</b>	<b>Package</b>
IS75V16F128GS32-7065BI	User Configurable	70	65	107-ball BGA