

**KMM372C213CK/CS Fast Page Mode**

2M x 72 DRAM DIMM with ECC using 2Mx8, 2K Refresh , 5V

**GENERAL DESCRIPTION**

The Samsung KMM372C213C is a 2Mx72bits Dynamic RAM high density memory module. The Samsung KMM372C213C consists of nine CMOS 2Mx8bits DRAMs in SOJ/TSOP-II 300mil package, and two 16bits driver IC in 48pin TSSOP package mounted on a 168-pin glass-epoxy substrate. A 0.1 or 0.22uF decoupling capacitor is mounted on the printed circuit board for each DRAM. The KMM372C213C is a Dual In-line Memory Module and is intended for mounting into 168 pin edge connector sockets.

**PERFORMANCE RANGE**

Speed	t <sub>RAC</sub>	t <sub>CAC</sub>	t <sub>RC</sub>	t <sub>PC</sub>
-5	50ns	18ns	90ns	35ns
-6	60ns	20ns	110ns	40ns

**FEATURES**

- Part Identification
  - KMM372C213CK (2048 cycles/32ms Ref. 300mil SOJ)
  - KMM372C213CS (2048 cycles/32ms Ref. 300mil TSOP)
- Fast Page Mode Operation
- CAS-before-RAS Refresh capability
- RAS-only and Hidden refresh capability
- TTL compatible inputs and outputs
- Single 5V±10% power supply
- JEDEC standard pinout & Buffered PDpin
- Buffered input except RAS and DQ
- PCB : Height(1000mil), single sided component

**PIN CONFIGURATIONS**

Pin	Front	Pin	Front	Pin	Front	Pin	Back	Pin	Back	Pin	Back
1	V <sub>ss</sub>	29	RSVD	57	DQ22	85	V <sub>ss</sub>	113	RSVD	141	DQ58
2	DQ0	30	RAS0	58	DQ23	86	DQ36	114	*RAS1	142	DQ59
3	DQ1	31	OE0	59	V <sub>cc</sub>	87	DQ37	115	RFU	143	V <sub>cc</sub>
4	DQ2	32	V <sub>ss</sub>	60	DQ24	88	DQ38	116	V <sub>ss</sub>	144	DQ60
5	DQ3	33	A0	61	RFU	89	DQ39	117	A1	145	RFU
6	V <sub>cc</sub>	34	A2	62	RFU	90	V <sub>cc</sub>	118	A3	146	RFU
7	DQ4	35	A4	63	RFU	91	DQ40	119	A5	147	RFU
8	DQ5	36	A6	64	RFU	92	DQ41	120	A7	148	RFU
9	DQ6	37	A8	65	DQ25	93	DQ42	121	A9	149	DQ61
10	DQ7	38	A10	66	DQ26	94	DQ43	122	*A11	150	DQ62
11	DQ8	39	*A12	67	DQ27	95	DQ44	123	*A13	151	DQ63
12	V <sub>ss</sub>	40	V <sub>cc</sub>	68	V <sub>ss</sub>	96	V <sub>ss</sub>	124	V <sub>cc</sub>	152	V <sub>ss</sub>
13	DQ9	41	RFU	69	DQ28	97	DQ45	125	RFU	153	DQ64
14	DQ10	42	RFU	70	DQ29	98	DQ46	126	B0	154	DQ65
15	DQ11	43	V <sub>ss</sub>	71	DQ30	99	DQ47	127	V <sub>ss</sub>	155	DQ66
16	DQ12	44	OE2	72	DQ31	100	DQ48	128	RFU	156	DQ67
17	DQ13	45	RAS2	73	V <sub>cc</sub>	101	DQ49	129	*RAS3	157	V <sub>cc</sub>
18	V <sub>cc</sub>	46	CAS4	74	DQ32	102	V <sub>cc</sub>	130	*CAS5	158	DQ68
19	DQ14	47	RSVD	75	DQ33	103	DQ50	131	RSVD	159	DQ69
20	DQ15	48	W2	76	DQ34	104	DQ51	132	PDE	160	DQ70
21	DQ16	49	V <sub>cc</sub>	77	DQ35	105	DQ52	133	V <sub>cc</sub>	161	DQ71
22	DQ17	50	RSVD	78	V <sub>ss</sub>	106	DQ53	134	RSVD	162	V <sub>ss</sub>
23	V <sub>ss</sub>	51	RSVD	79	PD1	107	V <sub>ss</sub>	135	RSVD	163	PD2
24	RSVD	52	DQ18	80	PD3	108	RSVD	136	DQ54	164	PD4
25	RSVD	53	DQ19	81	PD5	109	RSVD	137	DQ55	165	PD6
26	V <sub>cc</sub>	54	V <sub>ss</sub>	82	PD7	110	V <sub>cc</sub>	138	V <sub>ss</sub>	166	PD8
27	W0	55	DQ20	83	ID0	111	RFU	139	DQ56	167	ID1
28	CAS0	56	DQ21	84	V <sub>cc</sub>	112	*CAS1	140	DQ57	168	V <sub>cc</sub>

**PIN NAMES**

Pin Names	Function
A0, B0, A1 - A10	Address Input
DQ0 - DQ71	Data In/Out
W0, W2	Read/Write Enable
OE0, OE2	Output Enable
RAS0, RAS2	Row Address Strobe
CAS0, CAS7	Column Address Strobe
V <sub>cc</sub>	Power(+5V)
V <sub>ss</sub>	Ground
NC	No Connection
PDE	Presence Detect Enable
PD1 - 8	Presence Detect
ID0 - 1	ID bit
RSVD	Reserved Use
RFU	Reserved for Future Use

Pins marked "\*" are not used in this module.

**PD & ID Table**

Pin	50NS	60NS
PD1	1	1
PD2	0	0
PD3	0	0
PD4	1	1
PD5	0	0
PD6	0	1
PD7	0	1
PD8	0	0
ID0	0	0

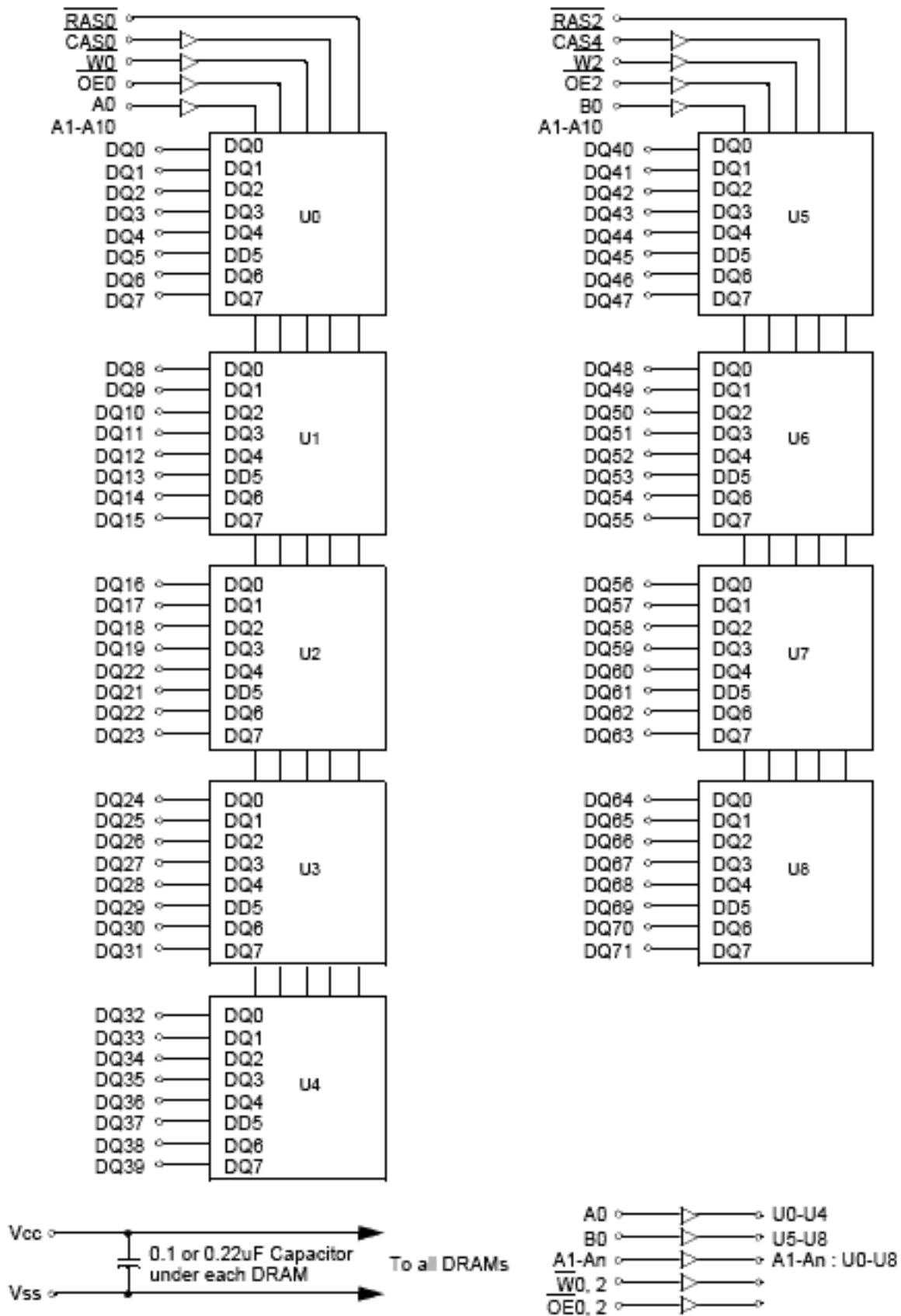
PD Note : PD & ID Terminals must each be pulled up through a resistor to V<sub>cc</sub> at the next higher level assembly. PDs will be either open (NC) or driven to V<sub>ss</sub> via on-board buffer circuits.

ID Note : IDs will be either open (NC) or connected directly to V<sub>ss</sub> without a buffer.

PD : 0 for Vol of Drive IC & 1 for N.C

ID : 0 for V<sub>ss</sub> & 1 for N.C

FUNCTIONAL BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS \*

Item	Symbol	Rating	Unit
Voltage on any pin relative Vss	V <sub>IN</sub> , V <sub>OUT</sub>	-1 to +7.0	V
Voltage on Vcc supply relative to Vss	V <sub>CC</sub>	-1 to +7.0	V
Storage Temperature	T <sub>stg</sub>	-55 to +125	°C
Power Dissipation	PD	9	W
Short Circuit Output Current	I <sub>OS</sub>	50	mA

\* Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for intended periods may affect device reliability.

## RECOMMENDED OPERATING CONDITIONS (Voltage referenced to Vss, TA = 0 to 70°C)

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V
Ground	V <sub>SS</sub>	0	0	0	V
Input High Voltage	V <sub>IH</sub>	2.4	-	V <sub>CC</sub> +1* <sup>1</sup>	V
Input Low Voltage	V <sub>IL</sub>	-1.0* <sup>2</sup>	-	0.8	V

\*1 : V<sub>CC</sub>+2.0V/20ns, Pulse width is measured at V<sub>CC</sub>.

\*2 : -2.0V/20ns, Pulse width is measured at V<sub>SS</sub>.

## DC AND OPERATING CHARACTERISTICS (Recommended operating conditions unless otherwise noted)

Symbol	Speed	KMM372C213CK/CS		Unit
		Min	Max	
I <sub>CC1</sub>	-5	-	990	mA
	-6	-	900	mA
I <sub>CC2</sub>	Don't care	-	100	mA
I <sub>CC3</sub>	-5	-	990	mA
	-6	-	900	mA
I <sub>CC4</sub>	-5	-	810	mA
	-6	-	720	mA
I <sub>CC5</sub>	Don't care	-	30	mA
I <sub>CC6</sub>	-5	-	990	mA
	-6	-	900	mA
I <sub>I(L)</sub>	Don't care	-25	25	uA
I <sub>O(L)</sub>		-5	5	uA
V <sub>OH</sub>	Don't care	2.4	-	V
V <sub>OL</sub>		-	0.4	V

I<sub>CC1</sub>\* : Operating Current \* ( $\overline{\text{RAS}}$ ,  $\overline{\text{CAS}}$ , Address cycling @trc=min)

I<sub>CC2</sub> : Standby Current ( $\overline{\text{RAS}}=\overline{\text{CAS}}=\overline{\text{W}}=V_{IH}$ )

I<sub>CC3</sub>\* : RAS Only Refresh Current \* ( $\overline{\text{CAS}}=V_{IH}$ ,  $\overline{\text{RAS}}$  cycling @trc=min)

I<sub>CC4</sub>\* : Fast Page Mode Current \* ( $\overline{\text{RAS}}=V_{IL}$ ,  $\overline{\text{CAS}}$  cycling : tpc=min)

I<sub>CC5</sub> : Standby Current ( $\overline{\text{RAS}}=\overline{\text{CAS}}=\overline{\text{W}}=V_{CC}-0.2V$ )

I<sub>CC6</sub>\* :  $\overline{\text{CAS}}$ -Before- $\overline{\text{RAS}}$  Refresh Current \* ( $\overline{\text{RAS}}$  and  $\overline{\text{CAS}}$  cycling @trc=min)

I<sub>I(L)</sub> : Input Leakage Current (Any input  $0 \leq V_{IN} \leq V_{CC}+0.5V$ , all other pins not under test=0 V)

I<sub>O(L)</sub> : Output Leakage Current(Data Out is disabled,  $0V \leq V_{OUT} \leq V_{CC}$ )

V<sub>OH</sub> : Output High Voltage Level (I<sub>OH</sub> = -5mA)

V<sub>OL</sub> : Output Low Voltage Level (I<sub>OL</sub> = 4.2mA)

\* **NOTE** : I<sub>CC1</sub>, I<sub>CC3</sub>, I<sub>CC4</sub> and I<sub>CC6</sub> are dependent on output loading and cycle rates. Specified values are obtained with the output open. I<sub>CC</sub> is specified as an average current. In I<sub>CC1</sub> and I<sub>CC3</sub>, address can be changed maximum once while  $\overline{\text{RAS}}=V_{IL}$ . In I<sub>CC4</sub>, address can be changed maximum once within one page mode cycle, tpc.

## CAPACITANCE (TA = 25°C, VCC=5V, f = 1MHz)

Item	Symbol	Min	Max	Unit
Input capacitance[A0-A10, B0]	CIN1	-	15	pF
Input capacitance[W0, W2, OE0, OE2]	CIN2	-	17	pF
Input capacitance[RAS0, RAS2]	CIN3	-	38	pF
Input capacitance[CAS0, CAS4]	CIN4	-	17	pF
Input/Output capacitance[ $\overline{\text{DQ0}} - 71$ ]	CDQ1	-	17	pF

## AC CHARACTERISTICS (0°C ≤ TA ≤ 70°C, VCC=5.0V ± 10%. See notes 1,2.)

Test condition :  $V_{ih}/V_{il}=2.4/0.8V$ ,  $V_{oh}/V_{ol}=2.4/0.4V$ , Output loading  $CL=100pF$

Parameter	Symbol	-5		-6		Unit	Note
		Min	Max	Min	Max		
Random read or write cycle time	tRC	90		110		ns	
Read-modify-write cycle time	tRWC	133		155		ns	
Access time from $\overline{\text{RAS}}$	tRAC		50		60	ns	3,4
Access time from $\overline{\text{CAS}}$	tCAC		18		20	ns	3,4,5,11
Access time from column address	tAA		30		35	ns	3,10,11
$\overline{\text{CAS}}$ to output in Low-Z	tCLZ	5		5		ns	3,11
Output buffer turn-off delay	tOFF	5	18	5	20	ns	6,11
Transition time(rise and fall)	tT	2	50	2	50	ns	2
$\overline{\text{RAS}}$ precharge time	tRP	30		40		ns	
$\overline{\text{RAS}}$ pulse width	tRAS	50	10K	60	10K	ns	
$\overline{\text{RAS}}$ hold time	tRSH	18		20		ns	11
$\overline{\text{CAS}}$ hold time	tCSH	48		58		ns	11
$\overline{\text{CAS}}$ pulse width	tCAS	13	10K	15	10K	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay time	tRCD	18	32	18	40	ns	4,11
$\overline{\text{RAS}}$ to column address delay time	tRAD	13	20	13	25	ns	10,11
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ precharge time	tCRP	10		10		ns	11
Row address set-up time	tASR	5		5		ns	11
Row address hold time	tRAH	8		8		ns	11
Column address set-up time	tASC	0		0		ns	
Column address hold time	tCAH	10		10		ns	
Column address to $\overline{\text{RAS}}$ lead time	tRAL	30		35		ns	11
Read command set-up time	tRCS	0		0		ns	
Read command hold referenced to $\overline{\text{CAS}}$	tRCH	0		0		ns	8
Read command hold referenced to $\overline{\text{RAS}}$	tRRH	-2		-2		ns	8,11
Write command hold time	tWCH	10		10		ns	
Write command pulse width	tWP	10		10		ns	
Write command to $\overline{\text{RAS}}$ lead time	tRWL	18		20		ns	11
Write command to $\overline{\text{CAS}}$ lead time	tCWL	13		15		ns	
Data set-up time	tDS	-2		-2		ns	9,11
Data hold time	tDH	15		20		ns	9,11
Refresh period (2K refresh)	tREF		32		32	ms	
Write command set-up time	tWCS	0		0		ns	7
$\overline{\text{CAS}}$ to $\overline{\text{W}}$ delay time	tCWD	36		40		ns	7
Column address to $\overline{\text{W}}$ delay time	tAWD	48		55		ns	7
$\overline{\text{CAS}}$ precharge to $\overline{\text{W}}$ delay time	tCPWD	53		60		ns	7

## AC CHARACTERISTICS (0°C ≤ T<sub>A</sub> ≤ 70°C, V<sub>CC</sub> = 5.0V ± 10%. See notes 1,2.)

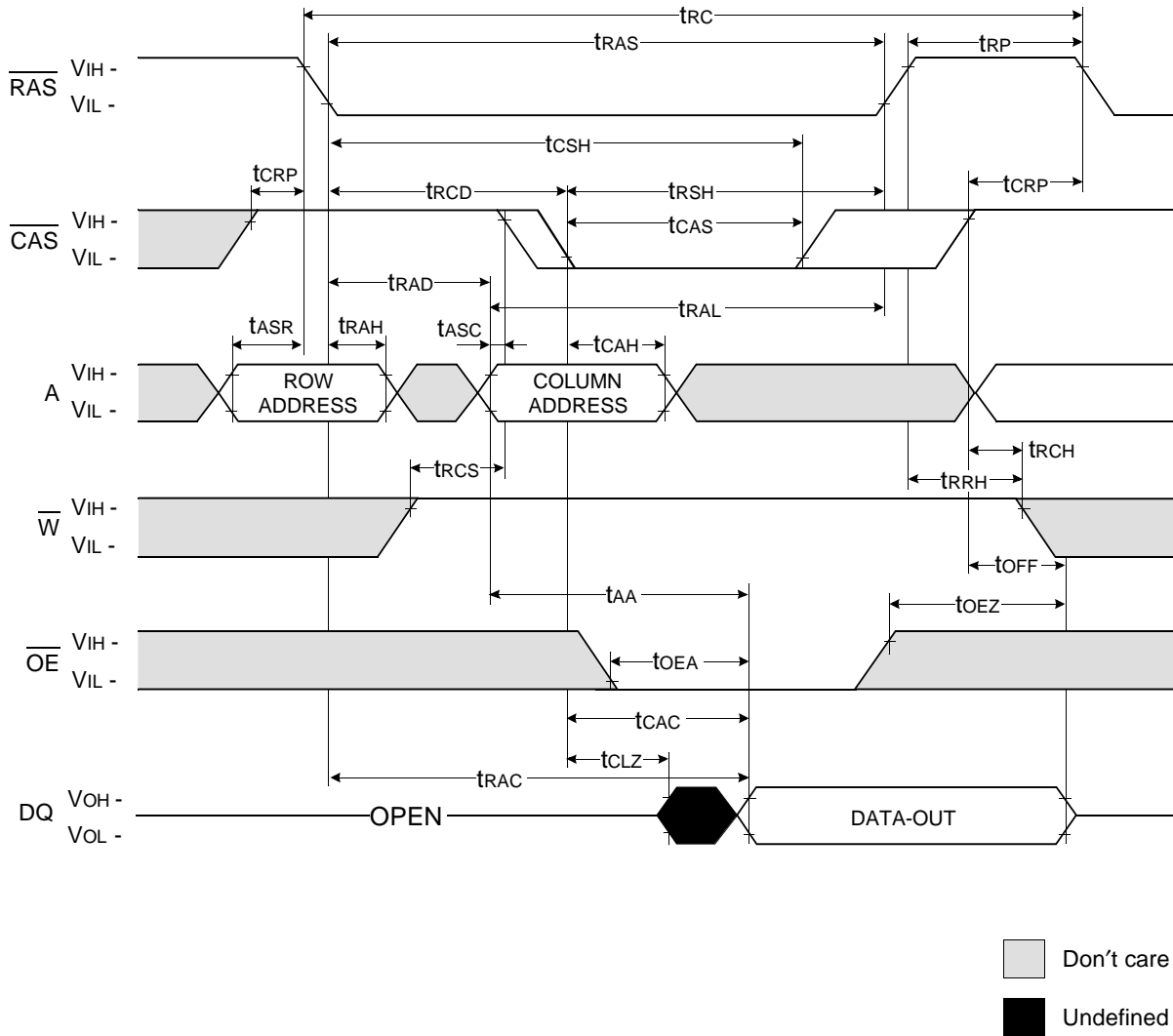
Test condition : V<sub>ih</sub>/V<sub>il</sub> = 2.4/0.8V, V<sub>oh</sub>/V<sub>ol</sub> = 2.4/0.4V, Output loading CL = 100pF

Parameter	Symbol	-5		-6		Unit	Note
		Min	Max	Min	Max		
$\overline{\text{RAS}}$ to $\overline{\text{W}}$ delay time	t <sub>RWD</sub>	71		83		ns	7,11
CAS setup time(CAS-before-RAS refresh)	t <sub>CSR</sub>	10		10		ns	11
CAS hold time(CAS-before-RAS refresh)	t <sub>CHR</sub>	8		8		ns	11
$\overline{\text{RAS}}$ precharge to $\overline{\text{CAS}}$ hold time	t <sub>RPC</sub>	3		3		ns	11
Access time from $\overline{\text{CAS}}$ precharge	t <sub>CPA</sub>		35		40	ns	3,11
Fast page mode cycle time	t <sub>PC</sub>	35		40		ns	
Fast page mode read-modify-write cycle time	t <sub>PRWC</sub>	75		80		ns	
$\overline{\text{CAS}}$ precharge time(Fast page cycle)	t <sub>CP</sub>	10		10		ns	
$\overline{\text{RAS}}$ pulse width (Fast page cycle)	t <sub>RASP</sub>	50	200K	60	200K	ns	
$\overline{\text{RAS}}$ hold time from $\overline{\text{CAS}}$ precharge	t <sub>RHCP</sub>	35		40		ns	11
$\overline{\text{W}}$ to $\overline{\text{RAS}}$ precharge time ( $\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ refresh)	t <sub>WRP</sub>	15		15		ns	11
$\overline{\text{W}}$ to $\overline{\text{RAS}}$ hold time ( $\overline{\text{C}}$ - $\overline{\text{B}}$ - $\overline{\text{R}}$ refresh)	t <sub>WRH</sub>	8		8		ns	11
$\overline{\text{OE}}$ access time	t <sub>OEA</sub>		18		20	ns	11
$\overline{\text{OE}}$ to data delay	t <sub>OED</sub>	18		20		ns	11
Output buffer turn off delay time from $\overline{\text{OE}}$	t <sub>OEZ</sub>	5	18	5	20	ns	11
$\overline{\text{OE}}$ command hold time	t <sub>OEH</sub>	13		15		ns	
<b>Present Detect Read Cycle</b>							
$\overline{\text{PDE}}$ to Valid PD bit	t <sub>PD</sub>		10		10	ns	
$\overline{\text{PDE}}$ to PD bit Inactive	t <sub>PDOFF</sub>	2	7	2	7	ns	

## NOTES

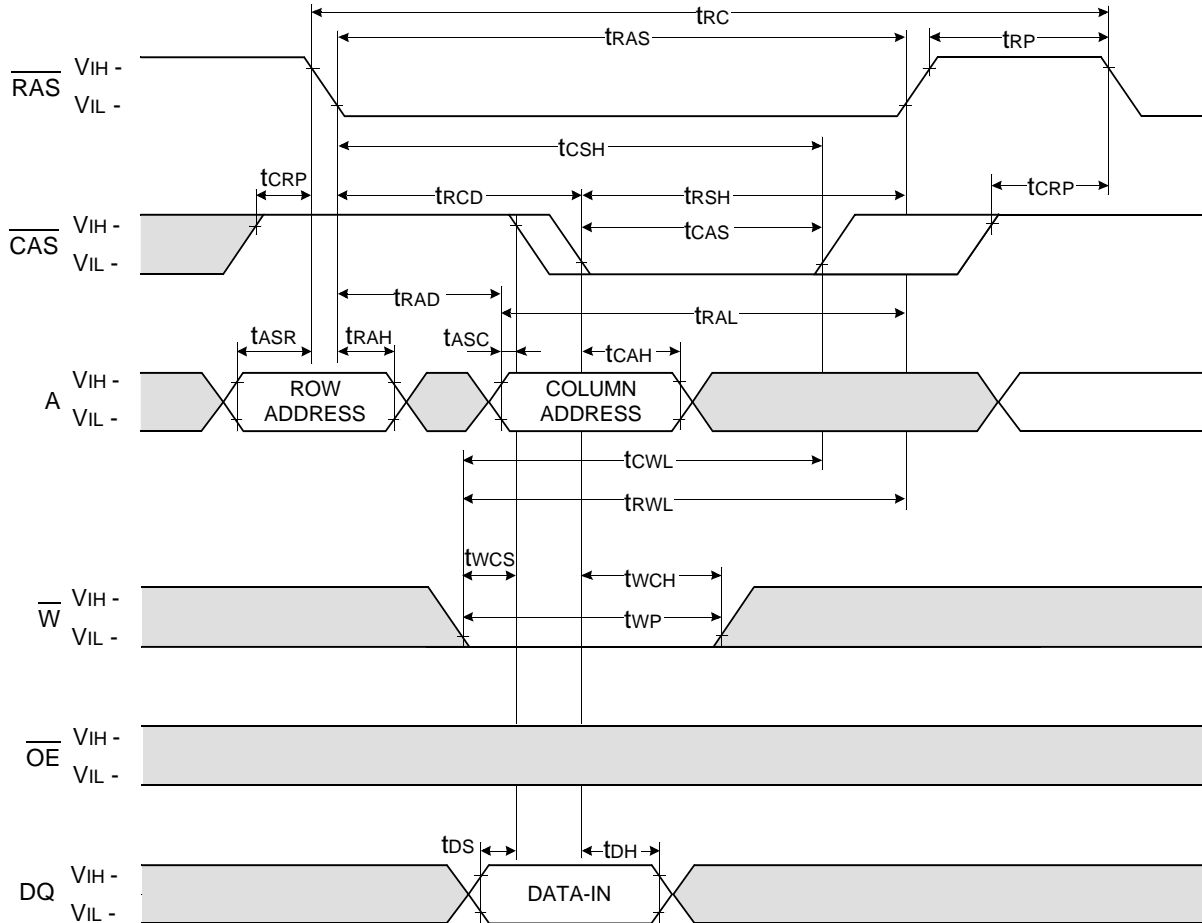
1. An initial pause of 200us is required after power-up followed by any 8  $\overline{\text{RAS}}$ -only or  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh cycles before proper device operation is achieved.
2. Input voltage levels are  $V_{ih}/V_{il}$ .  $V_{IH}(\text{min})$  and  $V_{IL}(\text{max})$  are reference levels for measuring timing of input signals. Transition times are measured between  $V_{IH}(\text{min})$  and  $V_{IL}(\text{max})$  and are assumed to be 5ns for all inputs.
3. Measured with a load equivalent to 2 TTL loads and 100pF.
4. Operation within the  $t_{\text{RCD}}(\text{max})$  limit insures that  $t_{\text{RAC}}(\text{max})$  can be met.  $t_{\text{RCD}}(\text{max})$  is specified as a reference point only. If  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}(\text{max})$  limit, then access time is controlled exclusively by  $t_{\text{CAC}}$ .
5. Assumes that  $t_{\text{RCD}} \geq t_{\text{RCD}}(\text{max})$ .
6. This parameter defines the time at which the output achieves the open circuit condition and is not referenced to  $V_{OH}$  or  $V_{OL}$ .
7.  $t_{\text{WCS}}$  is not restrictive operating parameter. It included in the data sheet as electrical characteristic only. If  $t_{\text{WCS}} \geq t_{\text{WCS}}(\text{min})$  the cycle is an early write cycle and the data out pin will remain high impedance for the duration of the cycle.
8. Either  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
9. These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in early write cycles.
10. Operation within the  $t_{\text{RAD}}(\text{max})$  limit insures that  $t_{\text{RAC}}(\text{max})$  can be met.  $t_{\text{RAD}}(\text{max})$  is specified as reference point only. If  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}(\text{max})$  limit, then access time is controlled by  $t_{\text{AA}}$ .
11. The timing skew from the DRAM to the DIMM resulted from the addition of buffers.

READ CYCLE



WRITE CYCLE ( EARLY WRITE )

NOTE : DOUT = OPEN



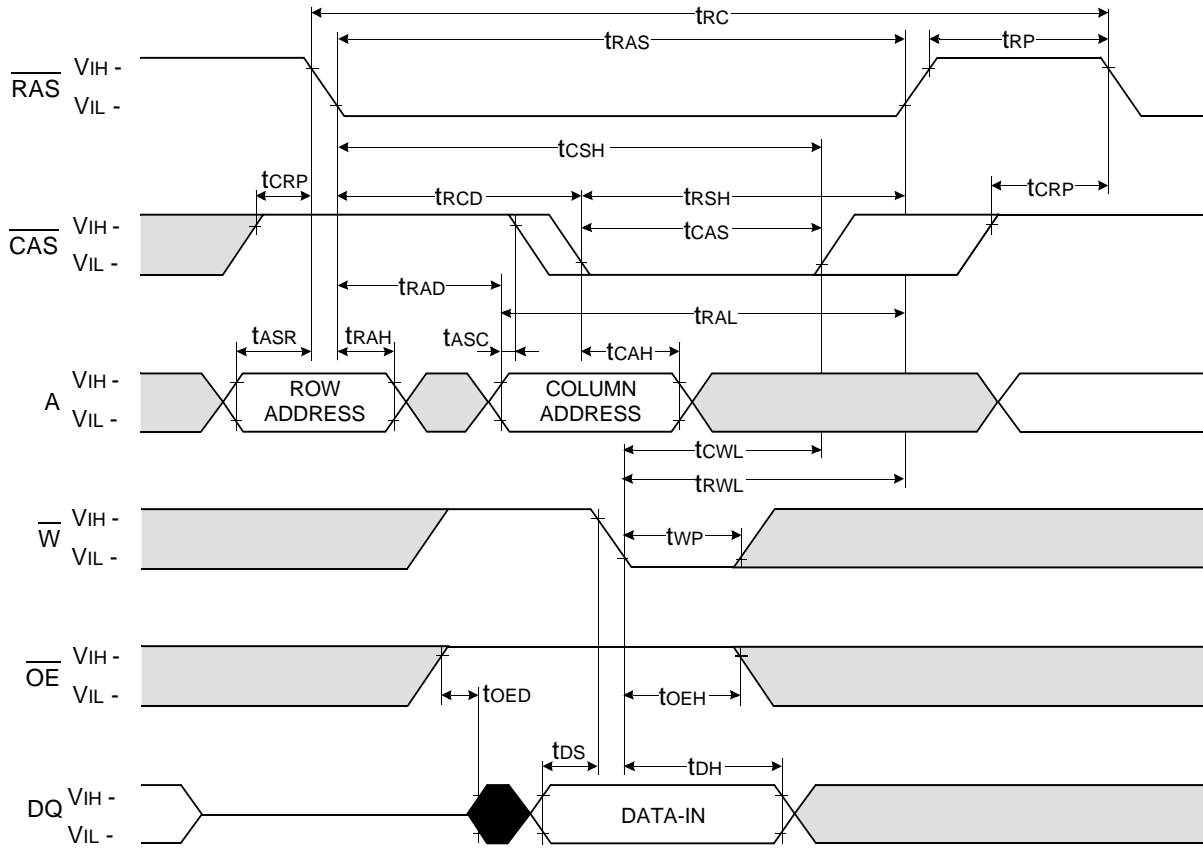
□ Don't care

■ Undefined



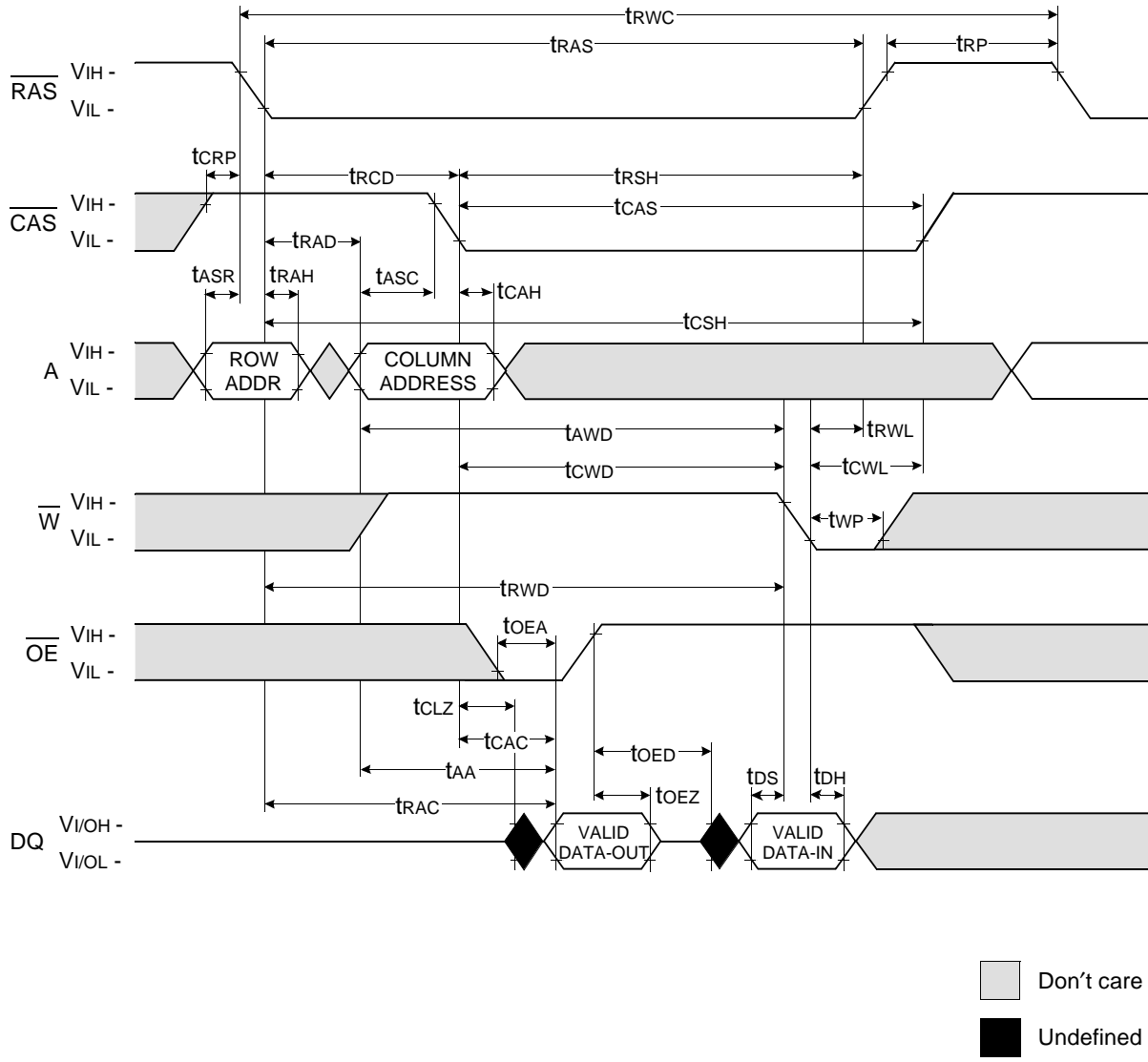
WRITE CYCLE (  $\overline{OE}$  CONTROLLED WRITE )

NOTE : DOUT = OPEN



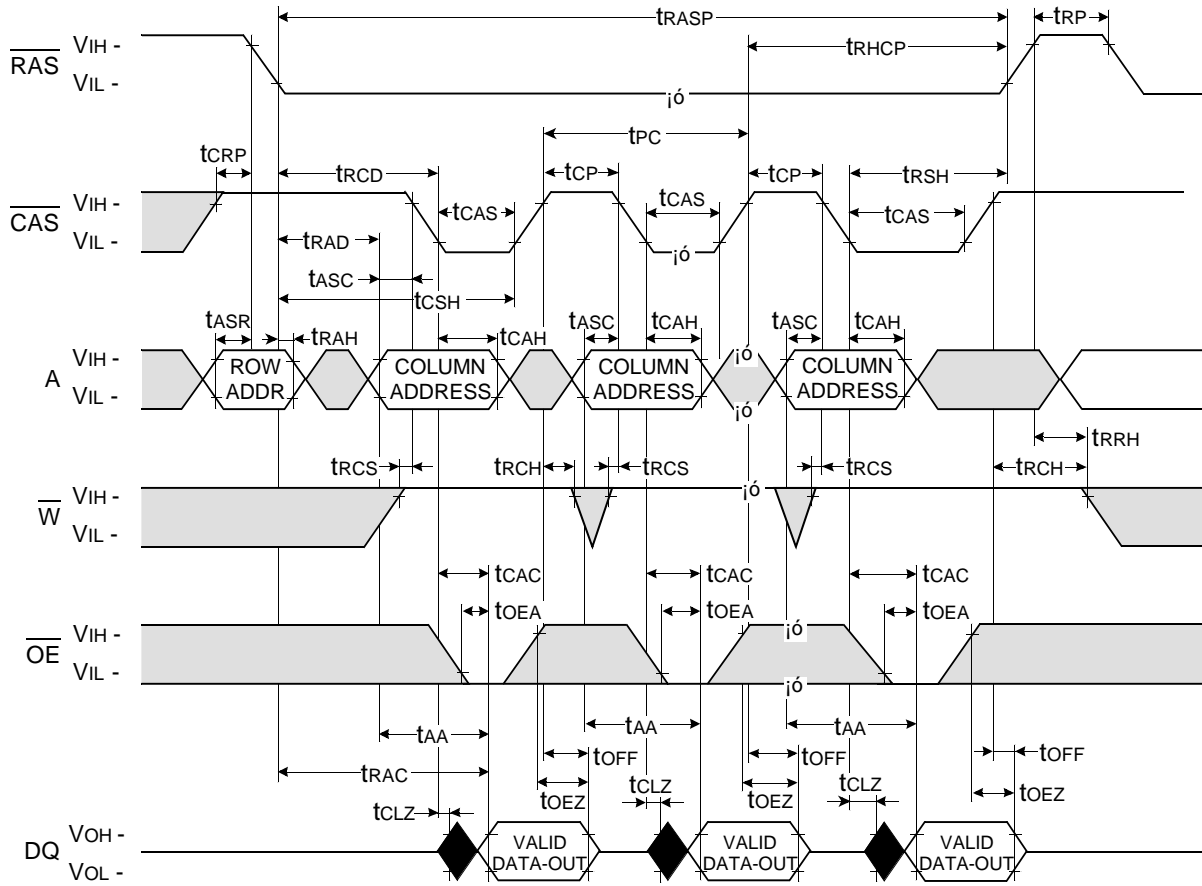
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READ - MODIFY - WRITE CYCLE



FAST PAGE READ CYCLE

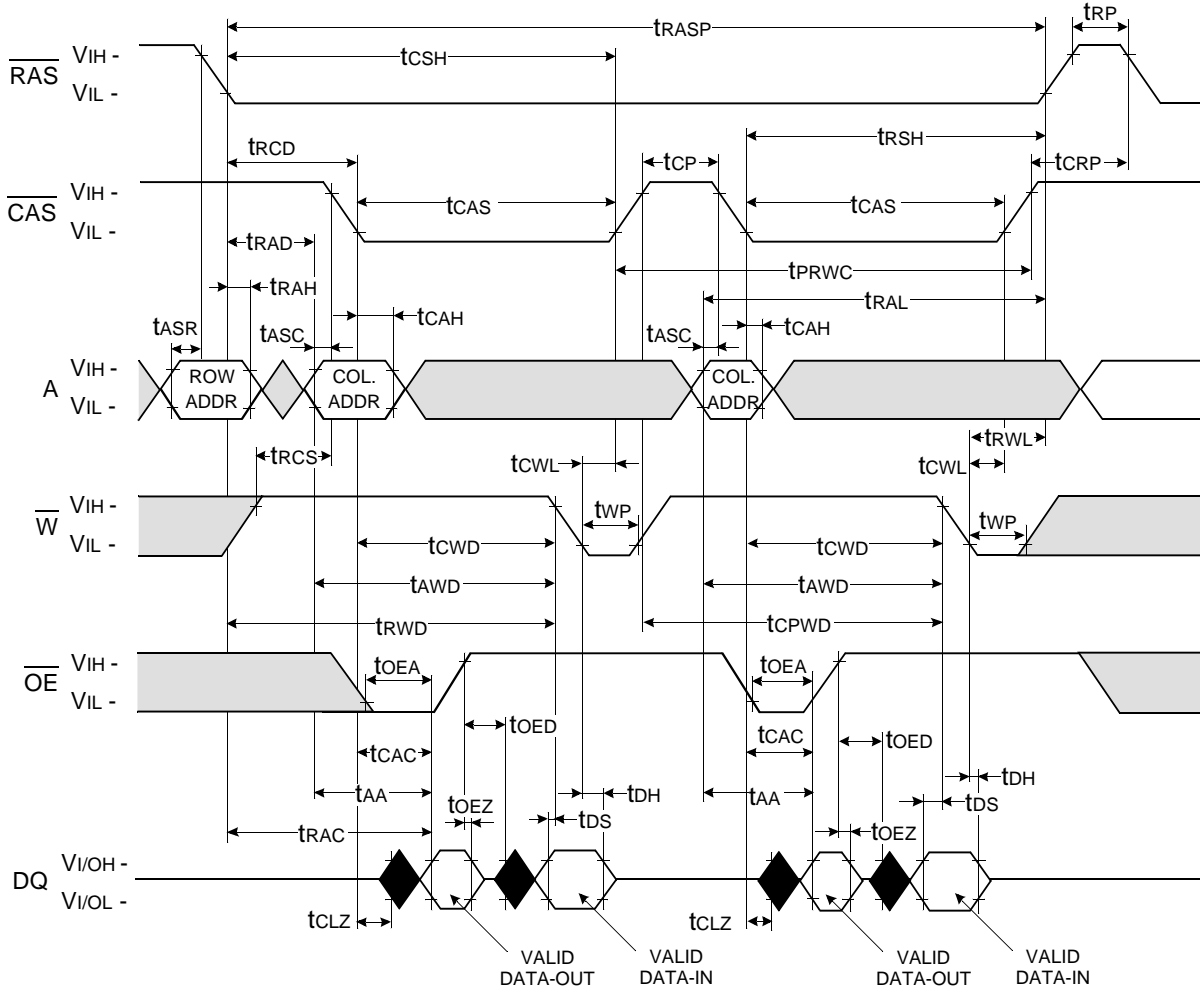
NOTE : DOUT = OPEN



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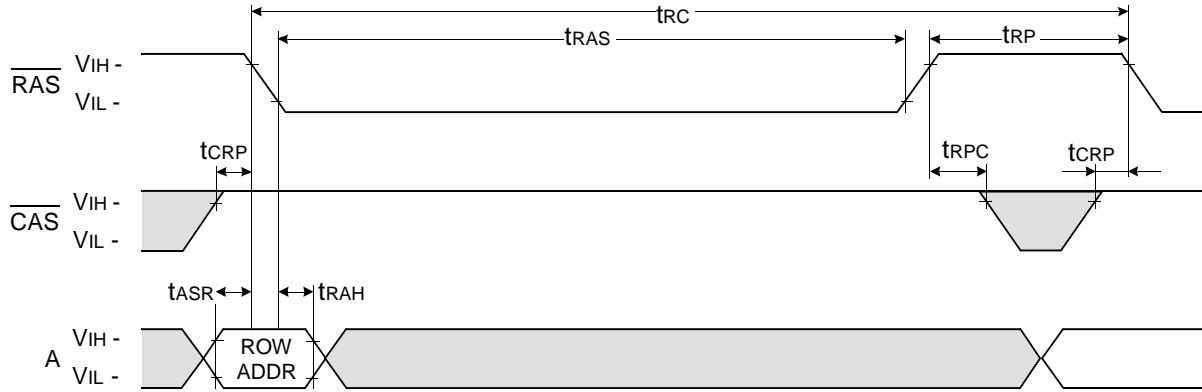
FAST PAGE READ - MODIFY - WRITE CYCLE



**$\overline{\text{RAS}}$  - ONLY REFRESH CYCLE**

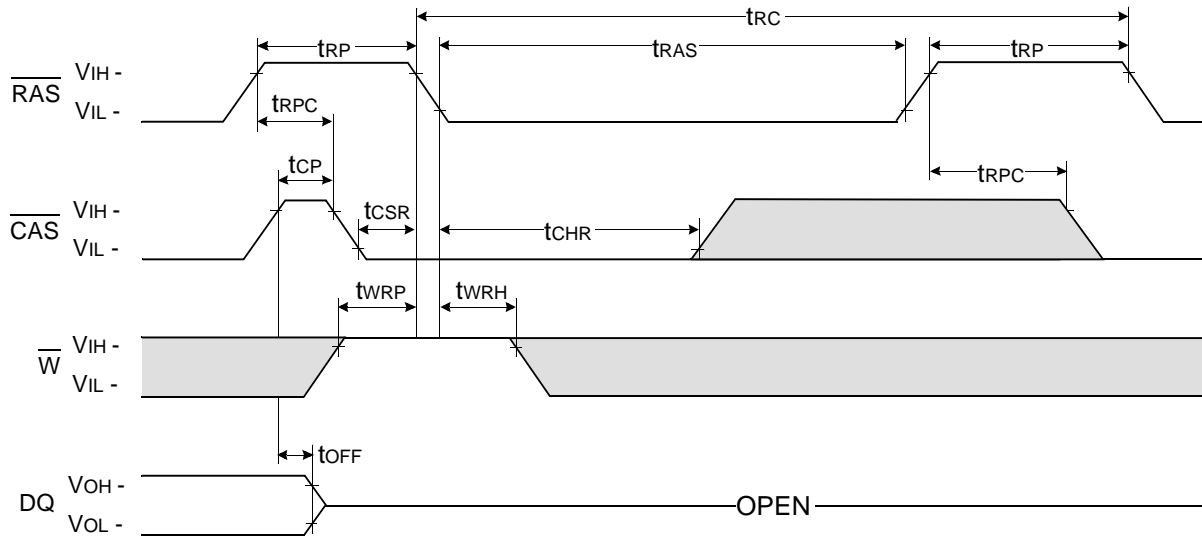
NOTE :  $\overline{\text{W}}$ ,  $\overline{\text{OE}}$ ,  $\text{DIN}$  = Don't care

DOUT = OPEN



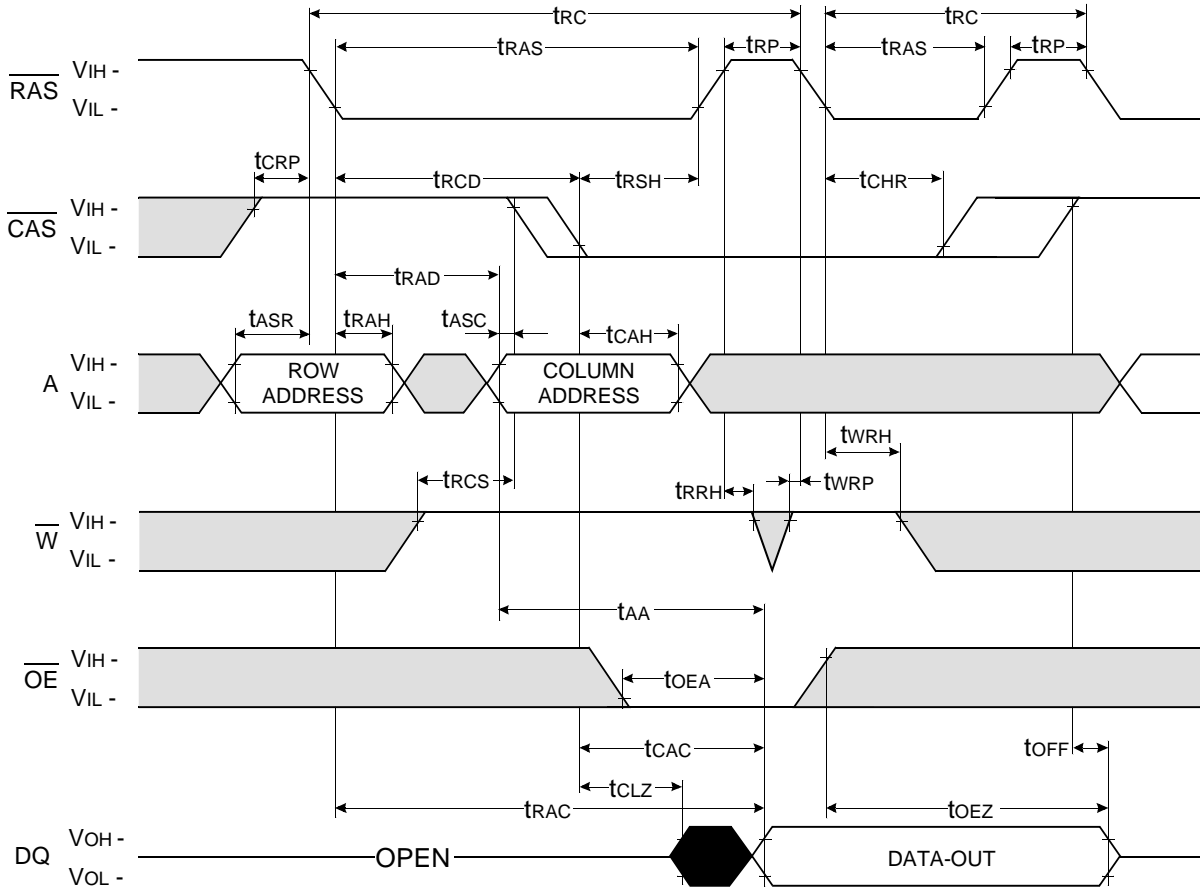
**$\overline{\text{CAS}}$  - BEFORE -  $\overline{\text{RAS}}$  REFRESH CYCLE**

NOTE :  $\overline{\text{OE}}$ ,  $\text{A}$  = Don't care



Don't care  
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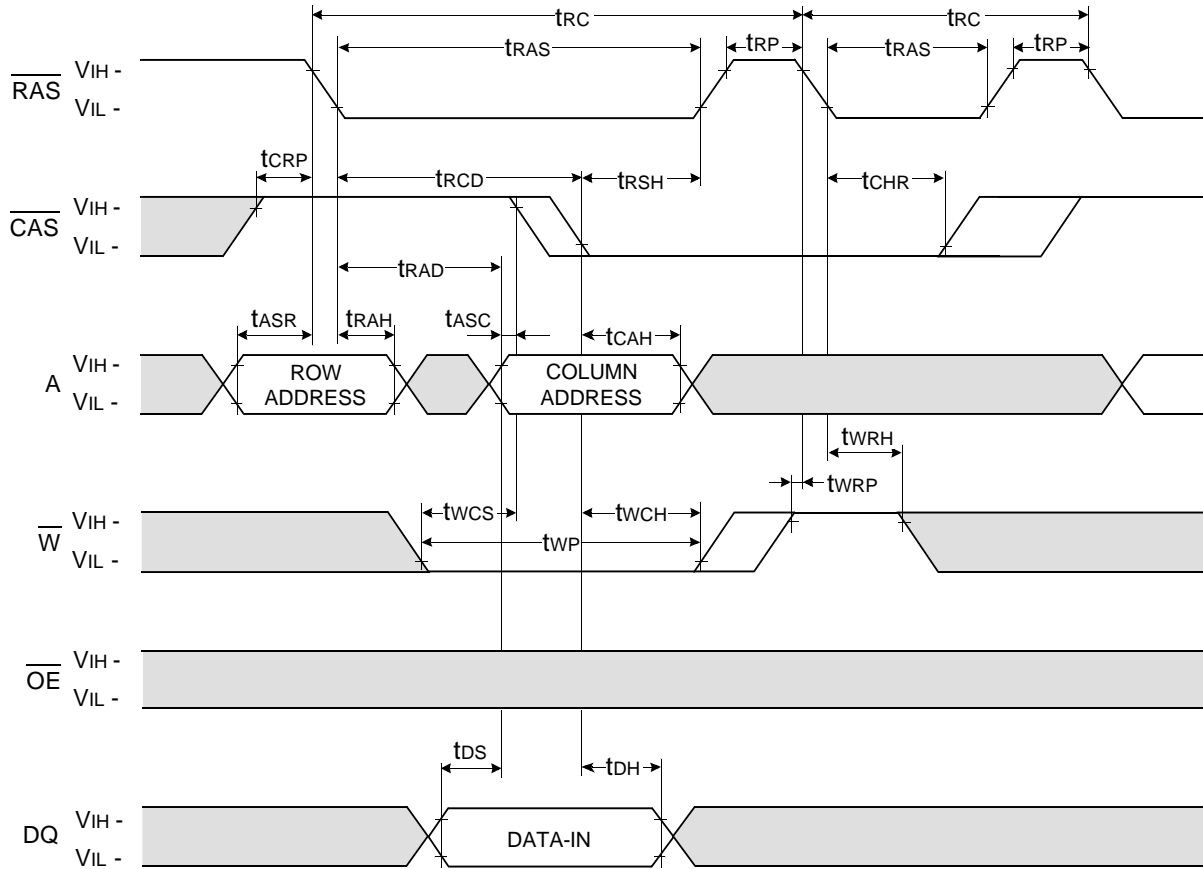
HIDDEN REFRESH CYCLE ( READ )



Don't care  
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HIDDEN REFRESH CYCLE ( WRITE )

NOTE : DOUT = OPEN



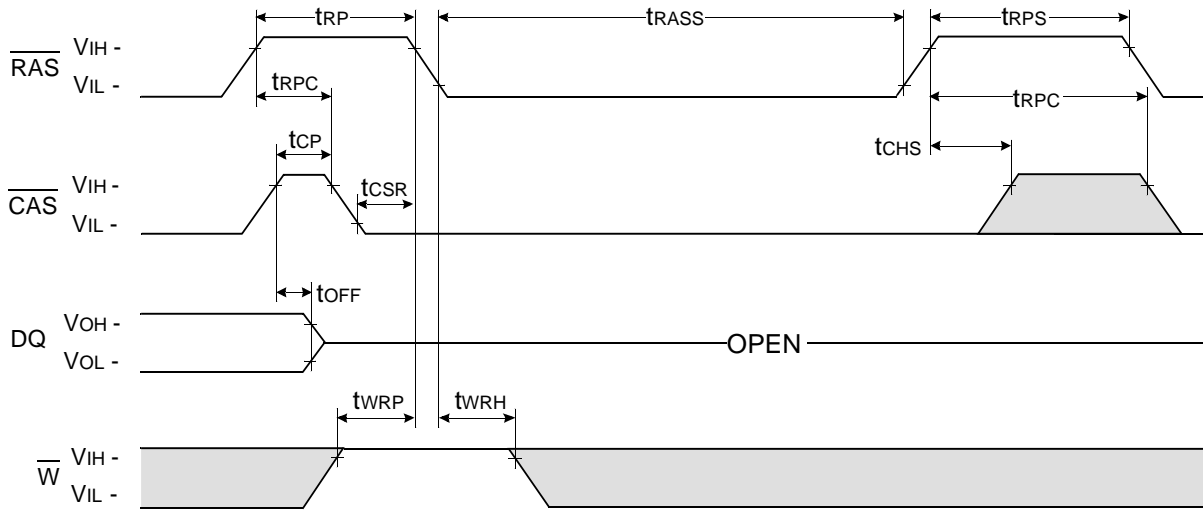
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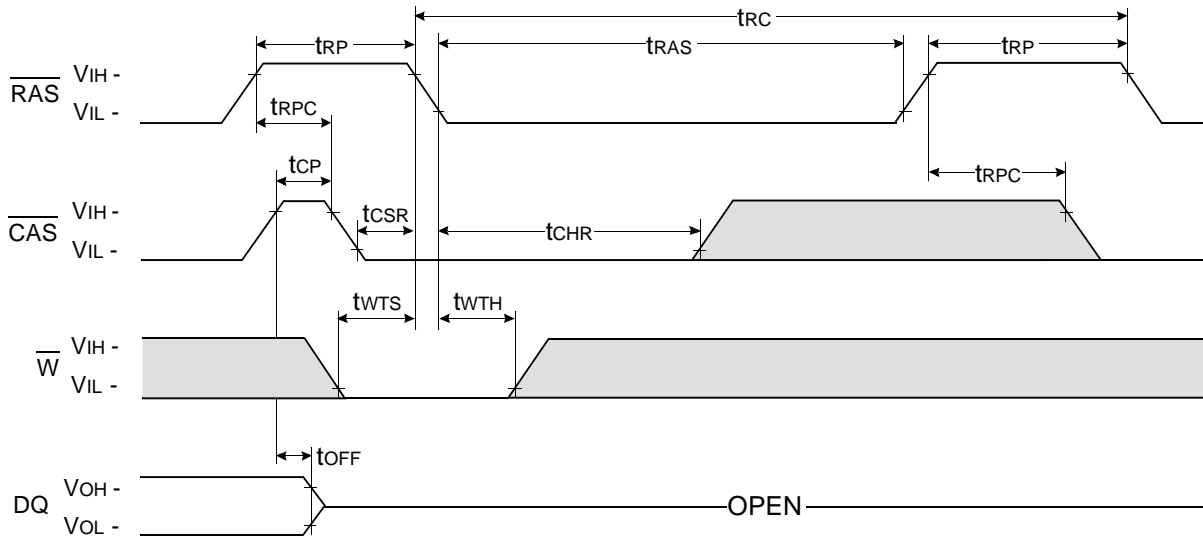
**$\overline{\text{CAS}}$  - BEFORE -  $\overline{\text{RAS}}$  SELF REFRESH CYCLE**

NOTE :  $\overline{\text{OE}}$ , A = Don't care



**TEST MODE IN CYCLE**

NOTE :  $\overline{\text{OE}}$ , A = Don't care



Don't care  
 Undefined

