K4E661612B, K4E641612B   CMOS DRAM

4M x 16bit CMOS Dynamic RAM with Extended Data Out

DESCRIPTION

This is a family of 4,194,304 x 16 bit Extended Data Out Mode CMOS DRAMs. Extended Data Out Mode offers high speed random access of memory cells within the same row. Refresh cycle(4K Ref. or 8K Ref.), access time (-45, -50 or -60), power consumption(Normal or Low power) are optional features of this family. All of this family have $\overline{CAS}$-before-$\overline{RAS}$ refresh, $\overline{RAS}$-only refresh and Hidden refresh capabilities. Furthermore, Self-refresh operation is available in L-version. This 4Mx16 EDO Mode DRAM family is fabricated using Samsung's advanced CMOS process to realize high band-width, low power consumption and high reliability.

FEATURES

- **Part Identification**

  - K4E661612B-TC/L(3.3V, 8K Ref., TSOP)
  - K4E641612B-TC/L(3.3V, 4K Ref., TSOP)

- **Active Power Dissipation**

  Unit : mW

Speed	8K	4K
-45	360	468
-50	324	432
-60	288	396

- **Refresh Cycles**

Part NO.	Refresh cycle	Refresh time	
		Normal	L-ver
K4E661612B*	8K	64ms	128ms
K4E641612B	4K		

* Access mode & $\overline{RAS}$ only refresh mode
  : 8K cycle/64ms(Normal), 8K cycle/128ms(L-ver.)
  $\overline{CAS}$-before-$\overline{RAS}$ & Hidden refresh mode
  : 4K cycle/64ms(Normal), 4K cycle/128ms(L-ver.)

- **Performance Range**

Speed	t_{RAC}	t_{CAC}	t_{RC}	t_{HPC}
-45	50ns	12ns	74ns	17ns
-50	50ns	13ns	84ns	20ns
-60	60ns	15ns	104ns	25ns

- Extended Data Out Mode operation
- 2 $\overline{CAS}$ Byte/Word Read/Write operation
- $\overline{CAS}$-before-$\overline{RAS}$ refresh capability
- $\overline{RAS}$-only and Hidden refresh capability
- Fast parallel test mode capability
- Self-refresh capability (L-ver only)
- LVTTL(3.3V) compatible inputs and outputs
- Early Write or output enable controlled write
- JEDEC Standard pinout
- Available in Plastic TSOP(II) packages
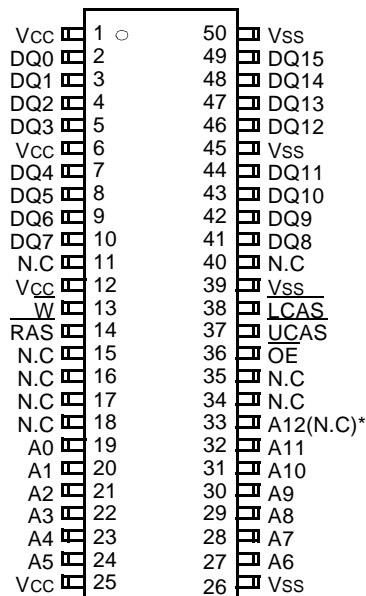- +3.3V±0.3V power supply

FUNCTIONAL BLOCK DIAGRAM

Note) *1 : 4K Refresh
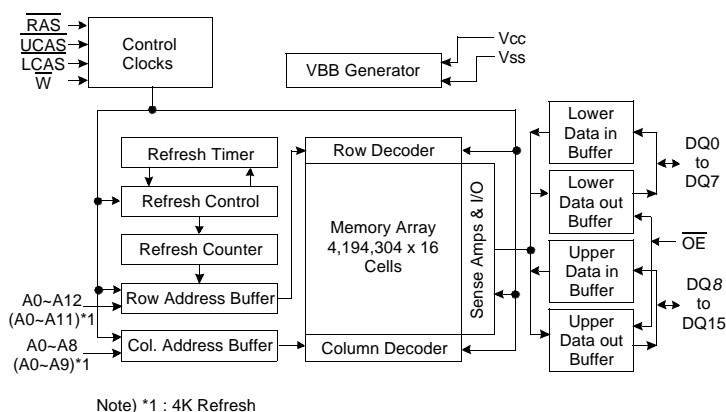
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PIN CONFIGURATION (Top Views)

• **K4E661612B-T**
• **K4E641612B-T**

Vcc	1 ○	50	Vss
DQ0	2	49	DQ15
DQ1	3	48	DQ14
DQ2	4	47	DQ13
DQ3	5	46	DQ12
Vcc	6	45	Vss
DQ4	7	44	DQ11
DQ5	8	43	DQ10
DQ6	9	42	DQ9
DQ7	10	41	DQ8
N.C	11	40	N.C
Vcc	12	39	Vss
W	13	38	LCAS
RAS	14	37	UCAS
N.C	15	36	OE
N.C	16	35	N.C
N.C	17	34	N.C
N.C	18	33	A12(N.C)*
A0	19	32	A11
A1	20	31	A10
A2	21	30	A9
A3	22	29	A8
A4	23	28	A7
A5	24	27	A6
Vcc	25	26	Vss

(400mil TSOP(II))

*(N.C) : N.C for 4K Refresh Product

Pin Name	Pin function
A0 - A12	Address Inputs(8K Product)
A0 - A11	Address Inputs(4K Product)
DQ0 - 15	Data In/Out
Vss	Ground
$\overline{RAS}$	Row Address Strobe
$\overline{UCAS}$	Upper Column Address Strobe
$\overline{LCAS}$	Lower Column Address Strobe
$\overline{W}$	Read/Write Input
$\overline{OE}$	Data Output Enable
Vcc	Power(+3.3V)
N.C	No Connection

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ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Units
Voltage on any pin relative to Vss	V_{IN}, V_{OUT}	-0.5 to +6.5	V
Voltage on Vcc supply relative to Vss	V_{CC}	-0.5 to +4.6	V
Storage Temperature	Tstg	-55 to +150	°C
Power Dissipation	P_D	1	W
Short Circuit Output Current	I_{OS} Address	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 extended periods may affect device reliability.

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

Parameter	Symbol	Min	Typ	Max	Units
Supply Voltage	V_{CC}	3.0	3.3	3.6	V
Ground	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.0	-	+5.5[*1]	V
Input Low Voltage	V_{IL}	-0.3[*2]	-	0.8	V

*1 : 6.5V at pulse width≤15ns which is measured at V_{CC}

*2 : -1.3 at pulse width≤15ns which is measured at V_{SS}

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

Parameter	Symbol	Min	Max	Units
Input Leakage Current (Any input 0≤V_{IN}≤Vcc+0.3V, all other pins not under test=0 Volt)	$I_{I(L)}$	-5	5	uA
Output Leakage Current (Data out is disabled, 0V≤V_{OUT}≤Vcc)	$I_{O(L)}$	-5	5	uA
Output High Voltage Level(IOH=-2mA)	V_{OH}	2.4	-	V
Output Low Voltage Level(IOL=2mA)	V_{OL}	-	0.4	V

DC AND OPERATING CHARACTERISTICS (Continued)

Symbol	Power	Speed	Max		Units
			K4E661612B	K4E641612B	
I_{CC1}	Don't care	-45 -50 -60	100 90 80	130 120 110	mA mA mA
I_{CC2}	Normal L	Don't care	2 2	2 2	mA mA
I_{CC3}	Don't care	-45 -50 -60	100 90 80	130 120 110	mA mA mA
I_{CC4}	Don't care	-45 -50 -60	110 100 90	120 110 100	mA mA mA
I_{CC5}	Normal L	Don't care	500 300	500 300	uA uA
I_{CC6}	Don't care	-45 -50 -60	100 90 80	130 120 110	mA mA mA
I_{CC7}	L	Don't care	400	400	uA
I_{CCS}	L	Don't care	400	400	uA

I_{CC1}* : Operating Current ($\overline{RAS}$ and $\overline{UCAS}$, $\overline{LCAS}$, Address cycling @t_{RC}=min.)

I_{CC2} : Standby Current ($\overline{RAS}$=$\overline{UCAS}$=$\overline{LCAS}$=$\overline{W}$=V_{IH})

I_{CC3}* : $\overline{RAS}$-only Refresh Current ($\overline{UCAS}$=$\overline{LCAS}$=V_{IH}, $\overline{RAS}$, Address cycling @t_{RC}=min.)

I_{CC4}* : Extended Data Out Mode Current ($\overline{RAS}$=V_{IL}, $\overline{UCAS}$ or $\overline{LCAS}$, Address cycling @t_{HPC}=min.)

I_{CC5} : Standby Current ($\overline{RAS}$=$\overline{UCAS}$=$\overline{LCAS}$=$\overline{W}$=V_{CC}-0.2V)

I_{CC6}* : $\overline{CAS}$-Before-$\overline{RAS}$ Refresh Current ($\overline{RAS}$ and $\overline{UCAS}$ or $\overline{LCAS}$ cycling @t_{RC}=min)

I_{CC7} : Battery back-up current, Average power supply current, Battery back-up mode

     Input high voltage(V_{IH})=V_{CC}-0.2V, Input low voltage(V_{IL})=0.2V, $\overline{UCAS}$, $\overline{LCAS}$=$\overline{CAS}$-before-$\overline{RAS}$ cycling or 0.2V

     $\overline{W}$, $\overline{OE}$=V_{IH}, Address=Don't care, DQ=Open, T_{RC}=31.25us

I_{CCS} : Self Refresh Current

     $\overline{RAS}$=$\overline{UCAS}$=$\overline{LCAS}$=0.2V, $\overline{W}$=$\overline{OE}$=A0 ~ A12(A11)=V_{CC}-0.2V or 0.2V, DQ0 ~ DQ15=V_{CC}-0.2V, 0.2V or Open

*Note : I_{CC1}, I_{CC3}, I_{CC4} and I_{CC6} are dependent on output loading and cycle rates. Specified values are obtained with the output open. I_{CC} is specified as an average current. In I_{CC1}, I_{CC3} and I_{CC6}, address can be changed maximum once while $\overline{RAS}$=V_{IL}. In I_{CC4}, address can be changed maximum once within one EDO mode cycle time, t_{HPC}.

CAPACITANCE (T_A=25°C, V_{CC}=3.3V, f=1MHz)

Parameter	Symbol	Min	Max	Units
Input capacitance [A0 ~ A12]	C_{IN1}	-	5	pF
Input capacitance [$\overline{RAS}$, $\overline{UCAS}$, $\overline{LCAS}$, $\overline{W}$, $\overline{OE}$]	C_{IN2}	-	7	pF
Output capacitance [DQ0 - DQ15]	C_{DQ}	-	7	pF

AC CHARACTERISTICS (0°C≤T_A≤70°C, See note 1,2)

Test condition : V_{CC}=3.3V±0.3V, Vih/Vil=2.2/0.7V, Voh/Vol=2.0/0.8V

Parameter	Symbol	-45 Min	-45 Max	-50 Min	-50 Max	-60 Min	-60 Max	Units	Note
Random read or write cycle time	t_{RC}	74		84		104		ns	
Read-modify-write cycle time	t_{RWC}	101		113		138		ns	
Access time from $\overline{RAS}$	t_{RAC}		45		50		60	ns	3,4,10
Access time from $\overline{CAS}$	t_{CAC}		12		13		15	ns	3,4,5
Access time from column address	t_{AA}		23		25		30	ns	3,10
$\overline{CAS}$ to output in Low-Z	t_{CLZ}	3		3		3		ns	3
Output buffer turn-off delay from $\overline{CAS}$	t_{CEZ}	3	13	3	13	3	13	ns	6,21
$\overline{OE}$ to output in Low-Z	t_{OLZ}	3		3		3		ns	3
Transition time (rise and fall)	t_T	1	50	1	50	1	50	ns	2
$\overline{RAS}$ precharge time	t_{RP}	25		30		40		ns	
$\overline{RAS}$ pulse width	t_{RAS}	45	10K	50	10K	60	10K	ns	
$\overline{RAS}$ hold time	t_{RSH}	8		8		10		ns	
$\overline{CAS}$ hold time	t_{CSH}	35		38		40		ns	
$\overline{CAS}$ pulse width	t_{CAS}	7	5K	8	10K	10	10K	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	t_{RCD}	11	33	11	37	14	45	ns	4
$\overline{RAS}$ to column address delay time	t_{RAD}	9	22	9	25	12	30	ns	10
$\overline{CAS}$ to $\overline{RAS}$ precharge time	t_{CRP}	5		5		5		ns	
Row address set-up time	t_{ASR}	0		0		0		ns	
Row address hold time	t_{RAH}	7		7		10		ns	
Column address set-up time	t_{ASC}	0		0		0		ns	13
Column address hold time	t_{CAH}	7		7		10		ns	13
Column address to $\overline{RAS}$ lead time	t_{RAL}	23		25		30		ns	
Read command set-up time	t_{RCS}	0		0		0		ns	
Read command hold time referenced to $\overline{CAS}$	t_{RCH}	0		0		0		ns	8
Read command hold time referenced to $\overline{RAS}$	t_{RRH}	0		0		0		ns	8
Write command hold time	t_{WCH}	7		7		10		ns	
Write command pulse width	t_{WP}	6		7		10		ns	
Write command to $\overline{RAS}$ lead time	t_{RWL}	8		8		10		ns	
Write command to $\overline{CAS}$ lead time	t_{CWL}	7		7		10		ns	16
Data set-up time	t_{DS}	0		0		0		ns	9,19

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AC CHARACTERISTICS (Continued)

Parameter	Symbol	-45 Min	-45 Max	-50 Min	-50 Max	-60 Min	-60 Max	Units	Note
Data hold time	t_{DH}	7		7		10		ns	9,19
Refresh period (Normal)	t_{REF}		64		64		64	ms	
Refresh period (L-ver)	t_{REF}		128		128		128	ms	
Write command set-up time	t_{WCS}	0		0		0		ns	7
$\overline{CAS}$ to $\overline{W}$ delay time	t_{CWD}	24		27		32		ns	7,15
$\overline{RAS}$ to $\overline{W}$ delay time	t_{RWD}	57		64		77		ns	7
Column address to $\overline{W}$ delay time	t_{AWD}	35		39		47		ns	7
$\overline{CAS}$ set-up time ($\overline{CAS}$-before-$\overline{RAS}$ refresh)	t_{CSR}	5		5		5		ns	17
$\overline{CAS}$ hold time ($\overline{CAS}$-before-$\overline{RAS}$ refresh)	t_{CHR}	10		10		10		ns	18
$\overline{RAS}$ to $\overline{CAS}$ precharge time	t_{RPC}	5		5		5		ns	
Access time from $\overline{CAS}$ precharge	t_{CPA}		24		28		35	ns	3
Hyper Page cycle time	t_{HPC}	17		20		25		ns	20
Hyper Page read-modify-write cycle time	t_{HPRWC}	47		47		56		ns	20
$\overline{CAS}$ precharge time (Hyper page cycle)	t_{CP}	6.5		7		10		ns	14
$\overline{RAS}$ pulse width (Hyper page cycle)	t_{RASP}	45	200K	50	200K	60	200K	ns	
$\overline{RAS}$ hold time from $\overline{CAS}$ precharge	t_{RHCP}	24		30		35		ns	
$\overline{OE}$ access time	t_{OEA}		12		13		15	ns	
$\overline{OE}$ to data delay	t_{OED}	8		10		13		ns	
$\overline{CAS}$ precharge to $\overline{W}$ delay time	t_{CPWD}	36		41		52		ns	
Output buffer turn off delay time from $\overline{OE}$	t_{OEZ}	3	11	3	13	3	13	ns	6
$\overline{OE}$ command hold time	t_{OEH}	5		5		5		ns	
Write command set-up time (Test mode in)	t_{WTS}	10		10		10		ns	11
Write command hold time (Test mode in)	t_{WTH}	10		10		10		ns	11
$\overline{W}$ to $\overline{RAS}$ precharge time ($\overline{C}$-B-$\overline{R}$ refresh)	t_{WRP}	10		10		10		ns	
$\overline{W}$ to $\overline{RAS}$ hold time ($\overline{C}$-B-$\overline{R}$ refresh)	t_{WRH}	10		10		10		ns	
Output data hold time	t_{DOH}	4		5		5		ns	
Output buffer turn off delay from $\overline{RAS}$	t_{REZ}	3	13	3	13	3	13	ns	6,21
Output buffer turn off delay from $\overline{W}$	t_{WEZ}	3	13	3	13	3	13	ns	6
$\overline{W}$ to data delay	t_{WED}	8		15		15		ns	
$\overline{OE}$ to $\overline{CAS}$ hold time	t_{OCH}	5		5		5		ns	
$\overline{CAS}$ hold time to $\overline{OE}$	t_{CHO}	5		5		5		ns	
$\overline{OE}$ precharge time	t_{OEP}	5		5		5		ns	
$\overline{W}$ pulse width (Hyper Page Cycle)	t_{WPE}	5		5		5		ns	
$\overline{RAS}$ pulse width ($\overline{C}$-B-$\overline{R}$ self refresh)	t_{RASS}	100		100		100		us	22,23,24
$\overline{RAS}$ precharge time ($\overline{C}$-B-$\overline{R}$ self refresh)	t_{RPS}	74		90		110		ns	22,23,24
$\overline{CAS}$ hold time ($\overline{C}$-B-$\overline{R}$ self refresh)	t_{CHS}	-50		-50		-50		ns	22,23,24

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TEST MODE CYCLE   (Note 11)

Parameter	Symbol	-45		-50		-60		Units	Note
		Min	Max	Min	Max	Min	Max		
Random read or write cycle time	t_{RC}	79		89		109		ns	
Read-modify-write cycle time	t_{RWC}	110		121		145		ns	
Access time from $\overline{RAS}$	t_{RAC}		50		55		65	ns	3,4,10,12
Access time from $\overline{CAS}$	t_{CAC}		17		18		20	ns	3,4,5,12
Access time from column address	t_{AA}		28		30		35	ns	3,10,12
$\overline{RAS}$ pulse width	t_{RAS}	50	10K	55	10K	65	10K	ns	
$\overline{CAS}$ pulse width	t_{CAS}	12	10K	13	10K	15	10K	ns	
$\overline{RAS}$ hold time	t_{RSH}	18		18		20		ns	
$\overline{CAS}$ hold time	t_{CSH}	39		43		50		ns	
Column Address to $\overline{RAS}$ lead time	t_{RAL}	28		30		35		ns	
$\overline{CAS}$ to $\overline{W}$ delay time	t_{CWD}	29		35		39		ns	7
$\overline{RAS}$ to $\overline{W}$ delay time	t_{RWD}	62		72		84		ns	7
Column Address to $\overline{W}$ delay time	t_{AWD}	40		47		54		ns	7
Hyper Page cycle time	t_{HPC}	22		25		30		ns	20
Hyper Page read-modify-write cycle time	t_{HPRWC}	52		53		61		ns	20
$\overline{RAS}$ pulse width (Hyper page cycle)	t_{RASP}	50	200K	55	200K	65	200K	ns	
Access time from $\overline{CAS}$ precharge	t_{CPA}		29		33		40	ns	3
$\overline{OE}$ access time	t_{OEA}		17		18		20	ns	
$\overline{OE}$ to data delay	t_{OED}	13		18		20		ns	
$\overline{OE}$ command hold time	t_{OEH}	13		18		20		ns	

NOTES

1. An initial pause of 200us is required after power-up followed by any 8 $\overline{RAS}$-only refresh or $\overline{CAS}$-before-$\overline{RAS}$ refresh cycles before proper device operation is achieved.

2. V_{IH}(min) and V_{IL}(max) are reference levels for measuring timing of input signals. Transition times are measured between V_{IH}(min) and V_{IL}(max) and are assumed to be 2ns for all inputs.

3. Measured with a load equivalent to 1 TTL load and 100pF.

4. Operation within the t_{RCD}(max) limit insures that t_{RAC}(max) can be met, t_{RCD}(max) is specified as a reference point only.

    If t_{RCD} is greater than the specified t_{RCD}(max) limit, then access time is controlled exclusively by t_{CAC}.

5. Assumes that $t_{RCD} \geq t_{RCD}$(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_{WCS}, t_{RWD}, t_{CWD} and t_{AWD} are non restrictive operating parameters. They are included in the data sheet as electrical charac-teristics only. If $t_{WCS} \geq t_{WCS}$(min), the cycle is an early write cycle and the data output will remain high impedance for the dura-tion of the cycle. If $t_{CWD} \geq t_{CWD}$(min), $t_{RWD} \geq t_{RWD}$(min) and $t_{AWD} \geq t_{AWD}$(min), then the cycle is a read-modify-write cycle and the data output will contain the data read from the selected address. If neither of the above conditions is satisfied, the condition of the data out is indeterminate.

8. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.

9. These parameters are referenced to $\overline{CAS}$ falling edge in early write cycles and to $\overline{W}$ falling edge in $\overline{OE}$ controlled write cycle and read-modify-write cycles.

10. Operation within the t_{RAD}(max) limit insures that t_{RAC}(max) can be met. t_{RAD}(max) is specified as a reference point only.

    If t_{RAD} is greater than the specified t_{RAD}(max) limit, then access time is controlled by t_{AA}.

11. These specifications are applied in the test mode.

12. In test mode read cycle, the value of t_{RAC}, t_{AA}, t_{CAC} is delayed by 2ns to 5ns for the specified values. These parameters should be specified in test mode cycles by adding the above value to the specified value in this data sheet.

13. t_{ASC}, t_{CAH} are referenced to the earlier $\overline{CAS}$ falling edge.

14. t_{CP} is specified from the later $\overline{CAS}$ rising edge in the previous cycle to the earlier $\overline{CAS}$ falling edge in the next cycle.

15. t_{CWD} is referenced to the later $\overline{CAS}$ falling edge at word read-modify-write cycle.

K4E64(6)1612B Truth Table

$\overline{RAS}$	$\overline{LCAS}$	$\overline{UCAS}$	$\overline{W}$	$\overline{OE}$	DQ0 - DQ7	DQ8-DQ15	STATE
H	X	X	X	X	Hi-Z	Hi-Z	Standby
L	H	H	X	X	Hi-Z	Hi-Z	Refresh
L	L	H	H	L	DQ-OUT	Hi-Z	Byte Read
L	H	L	H	L	Hi-Z	DQ-OUT	Byte Read
L	L	L	H	L	DQ-OUT	DQ-OUT	Word Read
L	L	H	L	H	DQ-IN	-	Byte Write
L	H	L	L	H	-	DQ-IN	Byte Write
L	L	L	L	H	DQ-IN	DQ-IN	Word Write
L	L	L	H	H	Hi-Z	Hi-Z	-

16. t_{CWL} is specified from $\overline{W}$ falling edge to the earlier $\overline{CAS}$ rising edge.

17. t_{CSR} is referenced to the earlier $\overline{CAS}$ falling edge before $\overline{RAS}$ transition low.

18. t_{CHR} is referenced to the later $\overline{CAS}$ rising edge after $\overline{RAS}$ transition low.
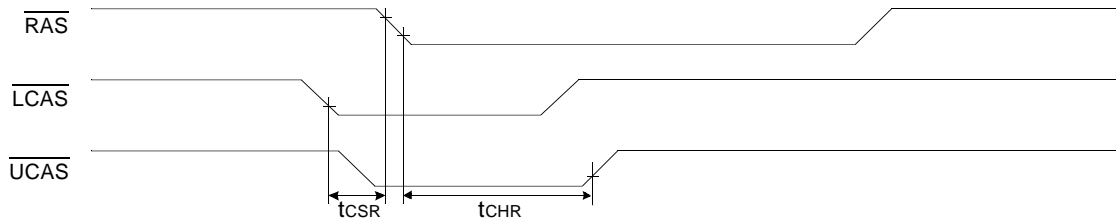
19. t_{DS} is specified for the earlier $\overline{CAS}$ falling edge and t_{DH} is specified by the later $\overline{CAS}$ falling edge in early write cycle.

20. $t_{ASC} \geq 6ns$, Assume $t_T = 2.0ns$

21. If $\overline{RAS}$ goes high before $\overline{CAS}$ high going, the open circuit condition of the output is achieved by $\overline{CAS}$ high going. If $\overline{CAS}$ goes high before $\overline{RAS}$ high going, the open circuit condition of the output is achieved by $\overline{RAS}$ high going.

22. If $t_{RASS} \geq 100us$, then $\overline{RAS}$ precharge time must use t_{RPS} instead of t_{RP}.

23. For $\overline{RAS}$-only refresh and burst $\overline{CAS}$-before-$\overline{RAS}$ refresh mode, 4096(4K/8K) cycles of burst refresh must be executed within 64ms before and after self refresh, in order to meet refresh specification.

24. For distributed $\overline{CAS}$-before-$\overline{RAS}$ with 15.6us interval $\overline{CAS}$-before-$\overline{RAS}$ refresh should be executed with in 15.6us immediately before and after self refresh in order to meet refresh specification.

WORD READ CYCLE
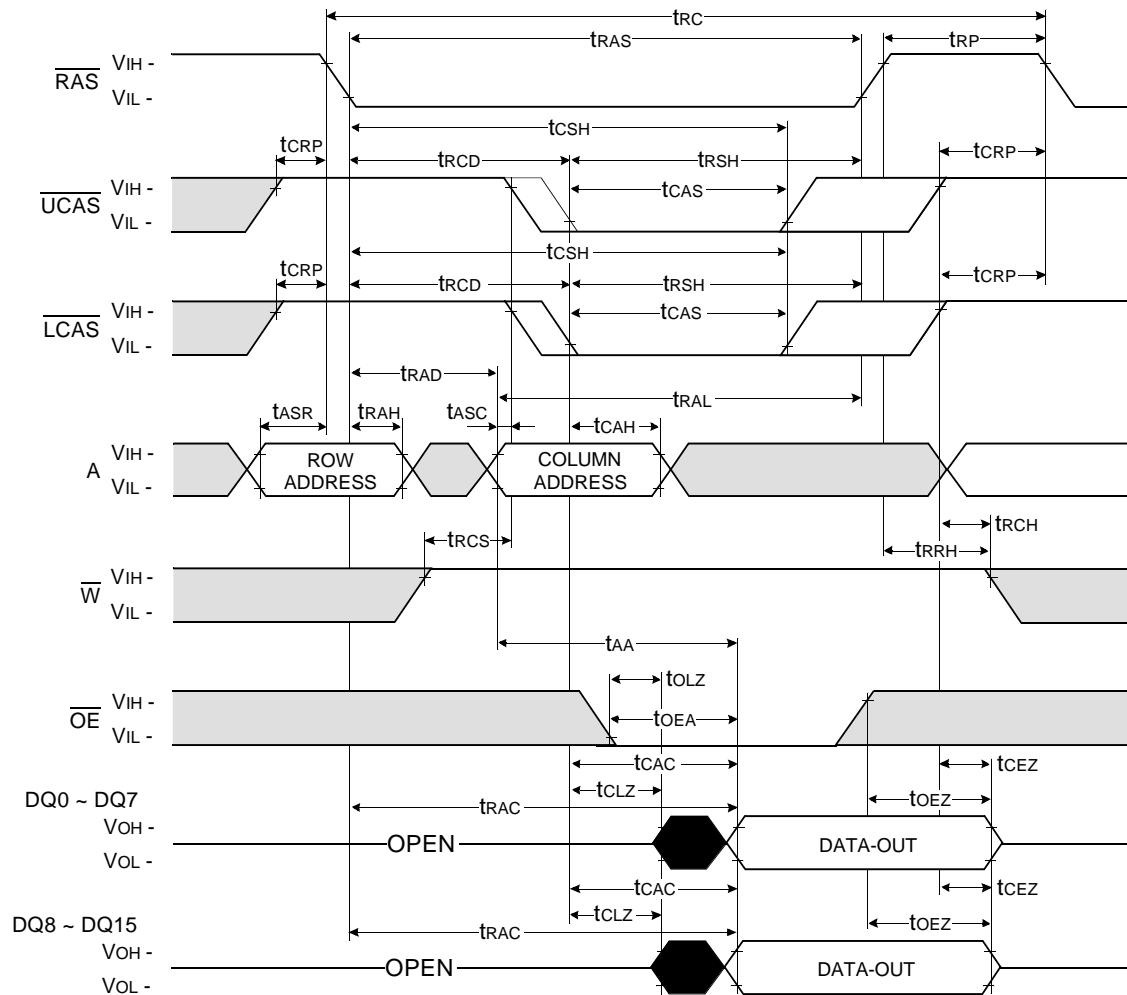
LOWER BYTE READ CYCLE
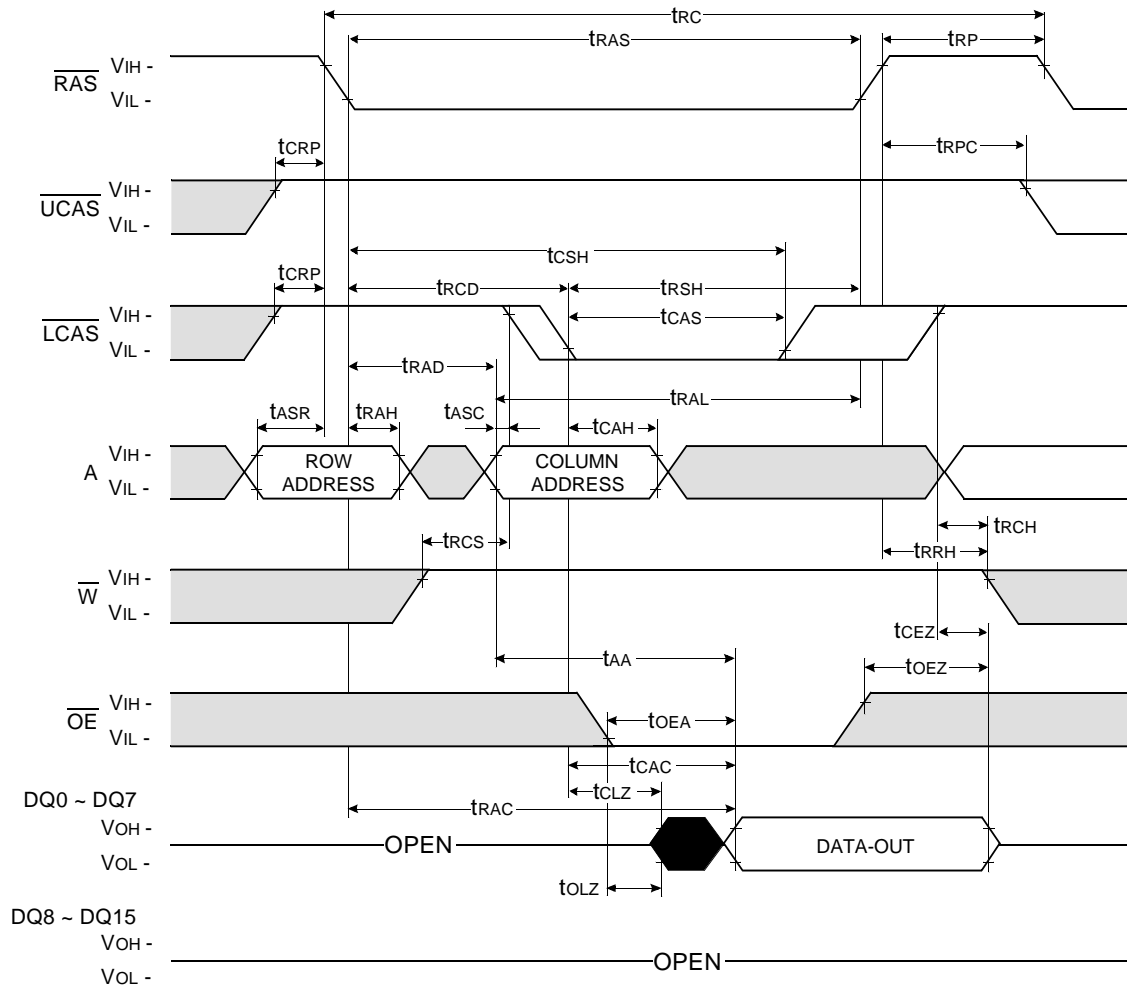
NOTE : D_{IN} = OPEN

UPPER BYTE READ CYCLE

NOTE : D$_{IN}$ = OPEN
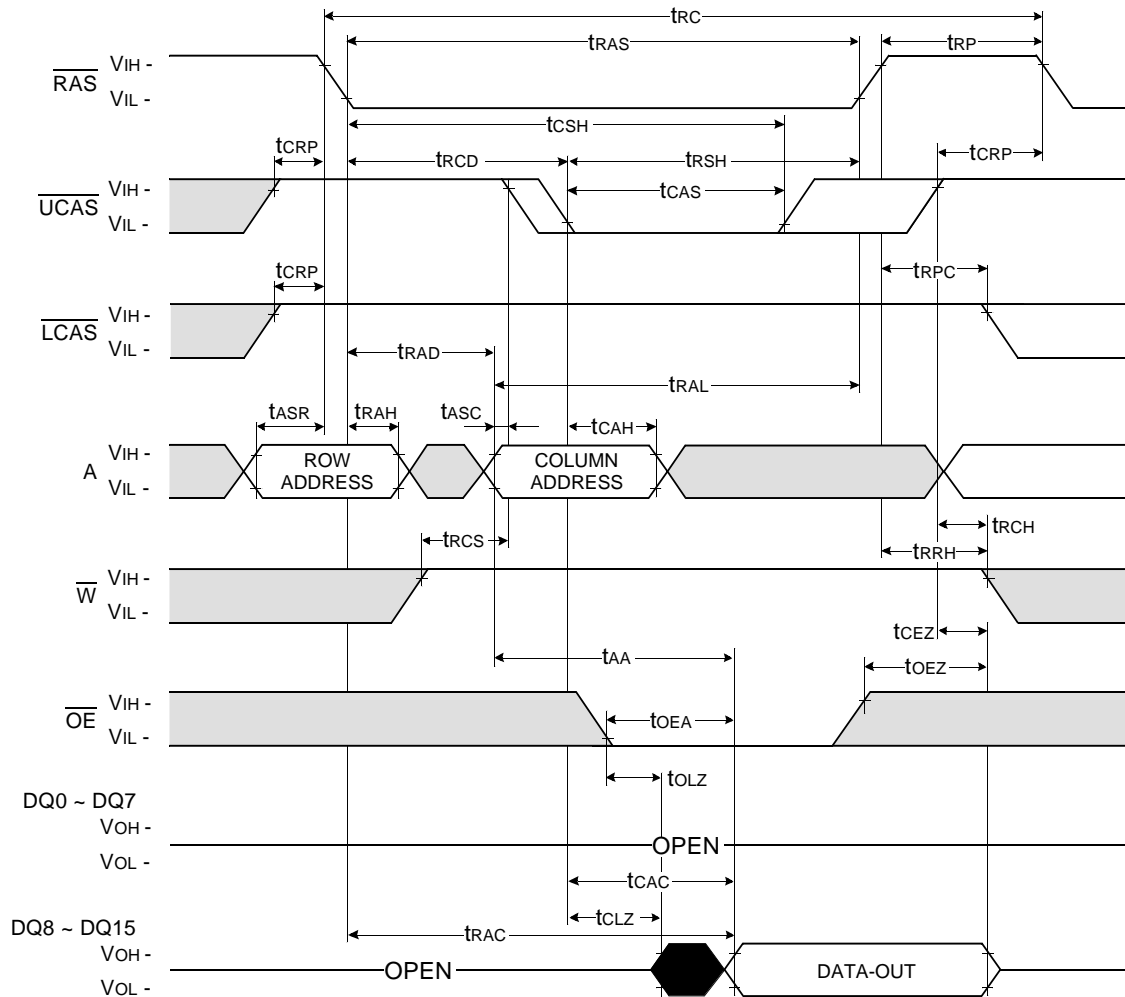
Don't care

Undefined

WORD WRITE CYCLE (EARLY WRITE)
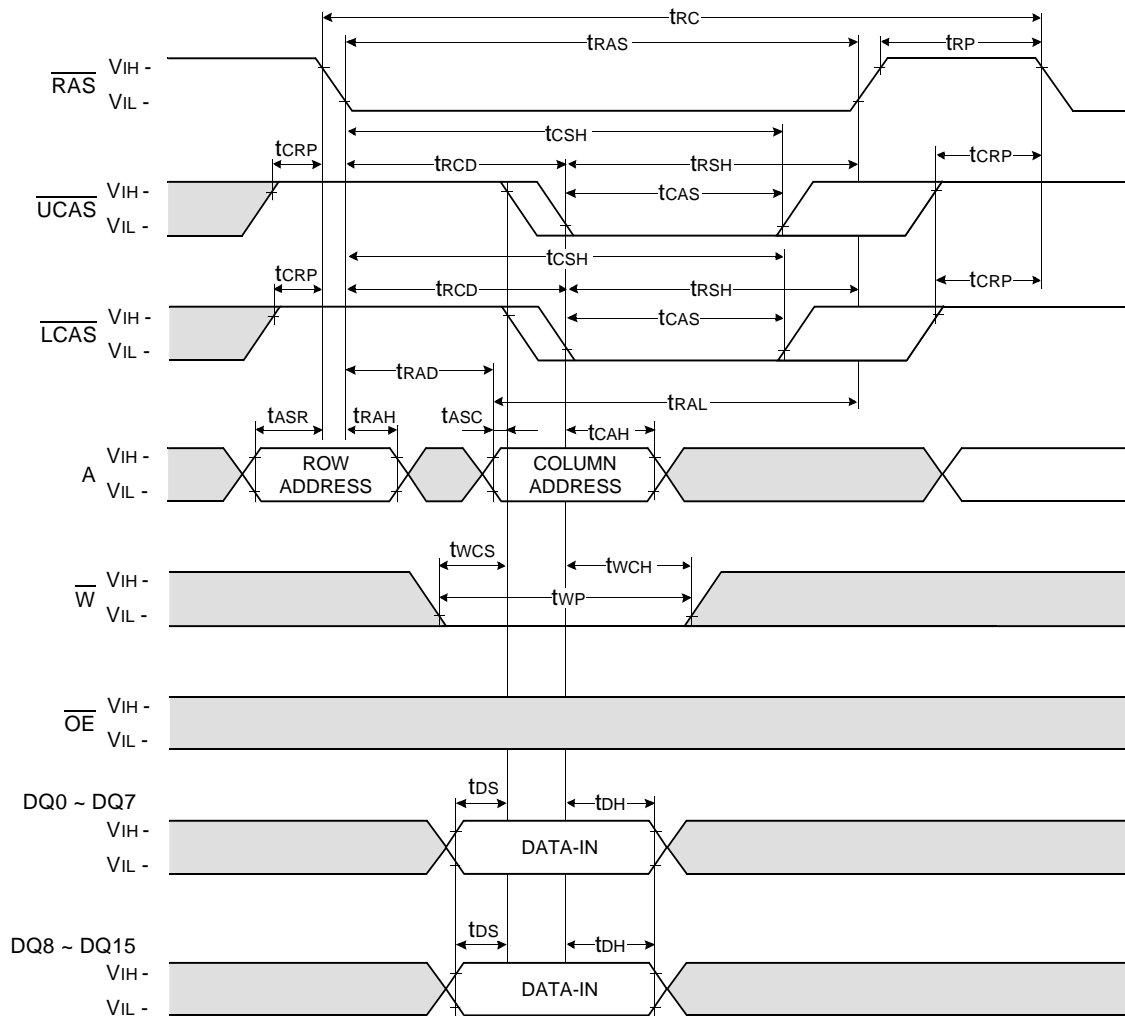
NOTE : D_{OUT} = OPEN

Don't care

Undefined

LOWER BYTE WRITE CYCLE (EARLY WRITE)
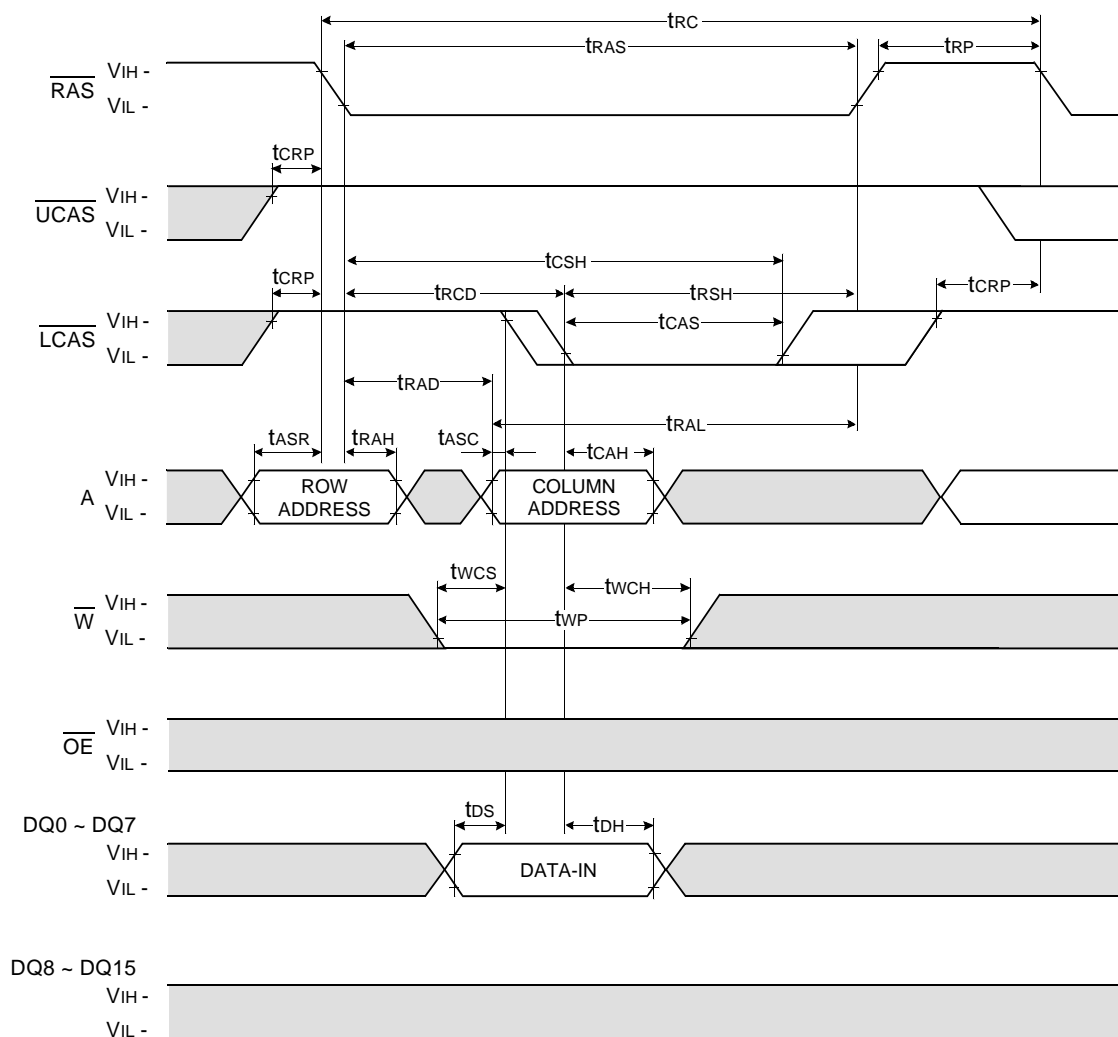
NOTE : D_{OUT} = OPEN

Don't care

Undefined

UPPER BYTE WRITE CYCLE (EARLY WRITE)
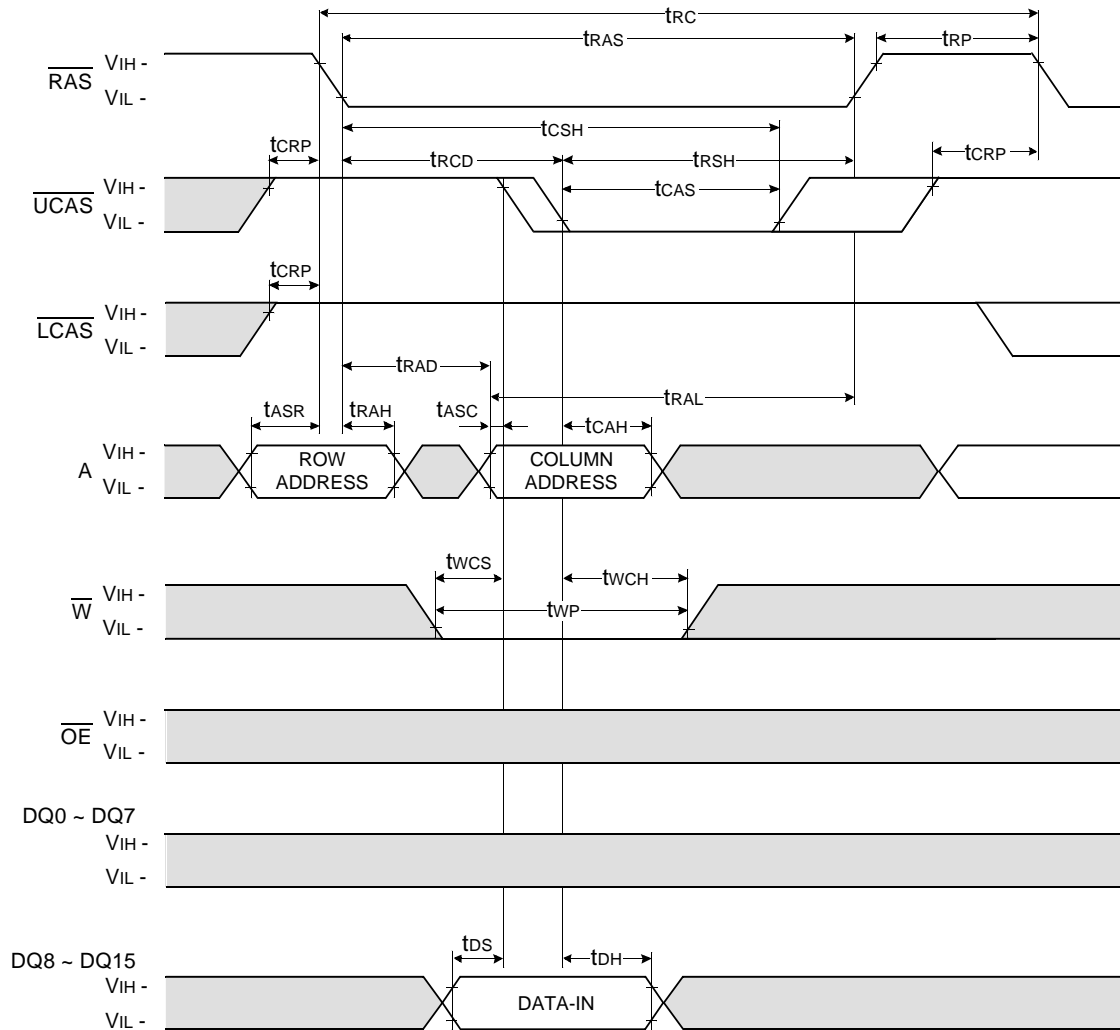
NOTE : D_{OUT} = OPEN

Don't care

Undefined

WORD WRITE CYCLE ($\overline{\text{OE}}$ CONTROLLED WRITE)
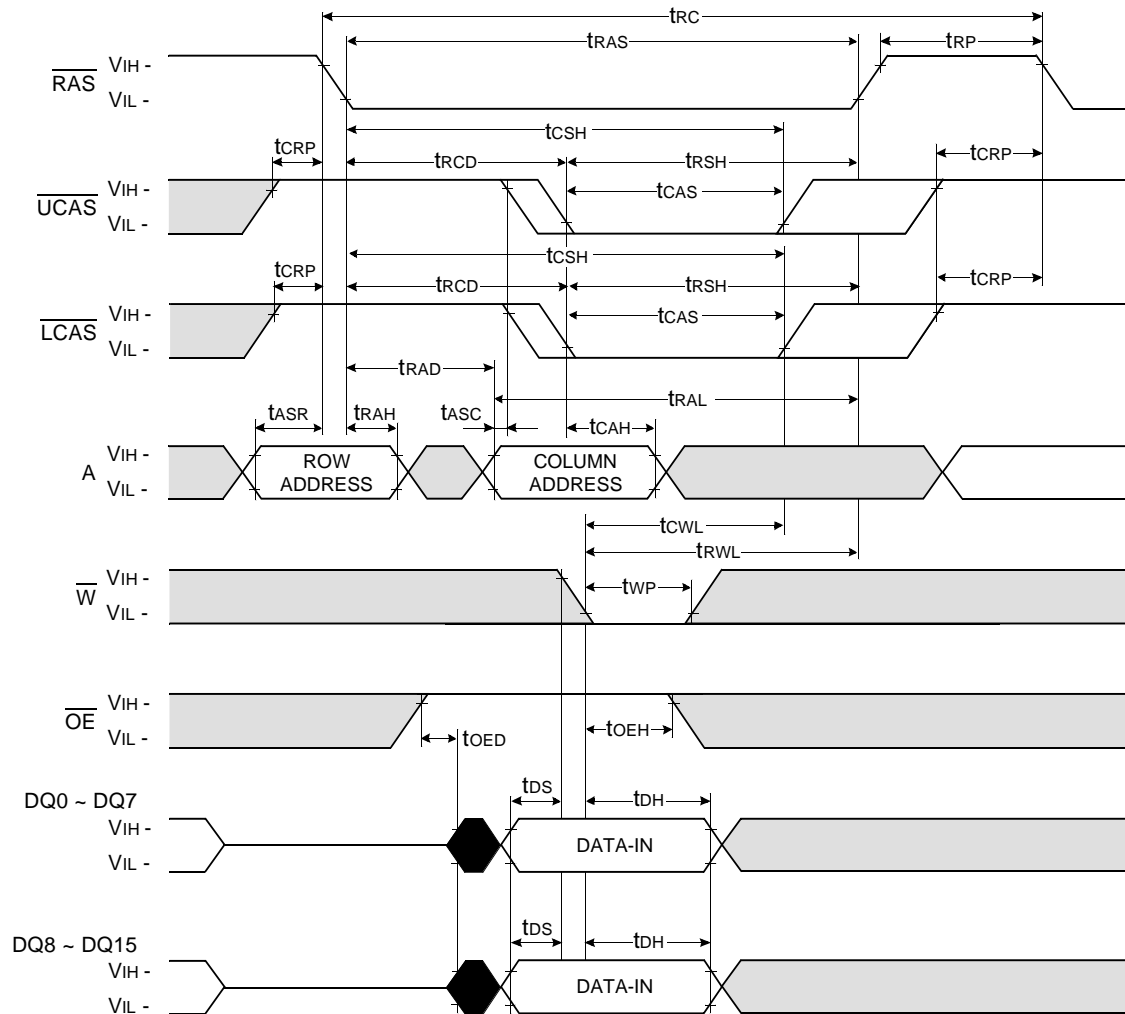
NOTE : D$_{OUT}$ = OPEN

Don't care

Undefined

LOWER BYTE WRITE CYCLE ($\overline{\text{OE}}$ CONTROLLED WRITE)

NOTE : D_{OUT} = OPEN

| | Don't care |
| | Undefined |
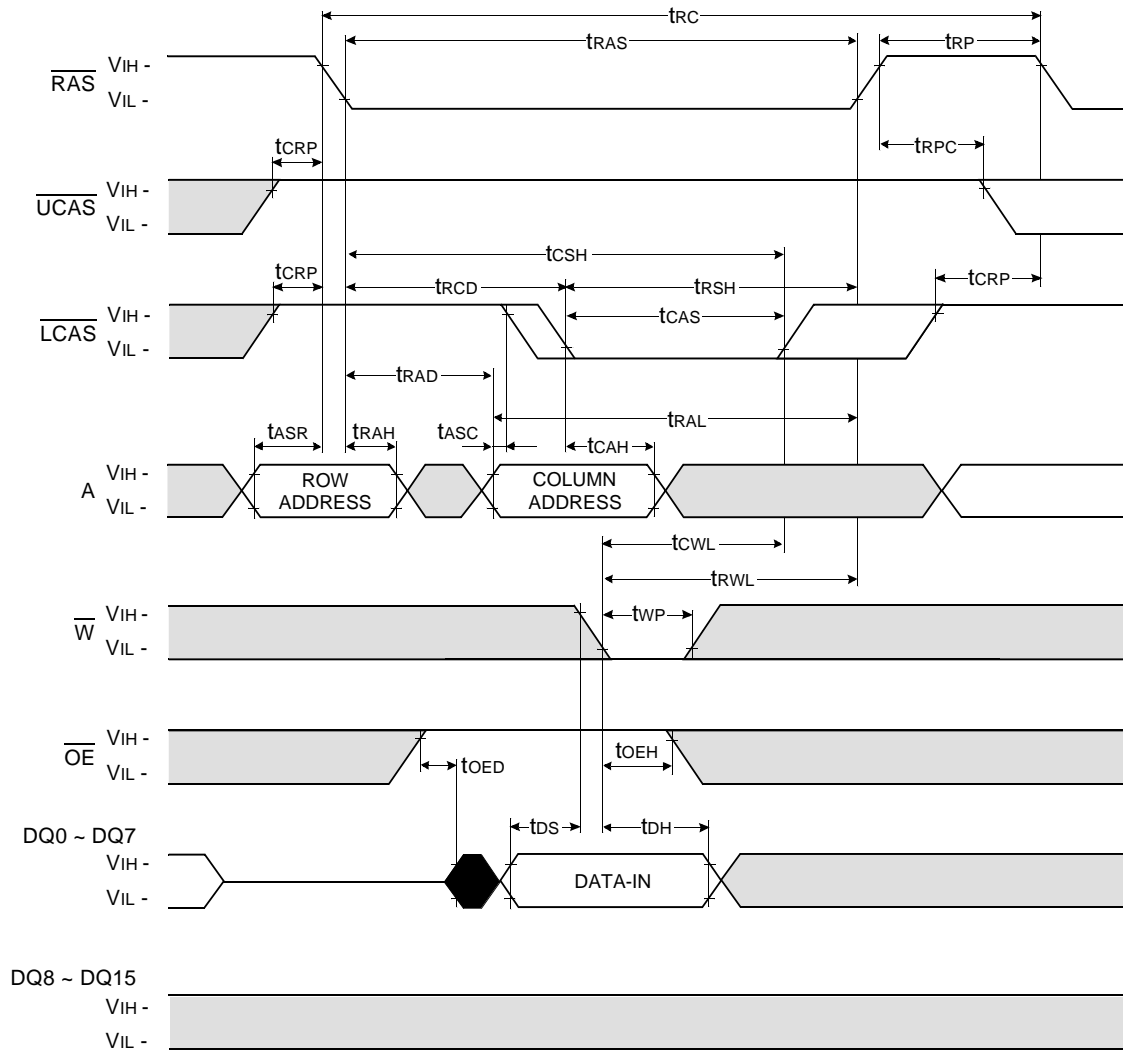
UPPER BYTE WRITE CYCLE ($\overline{OE}$ CONTROLLED WRITE)

NOTE : D$_{OUT}$ = OPEN

Don't care
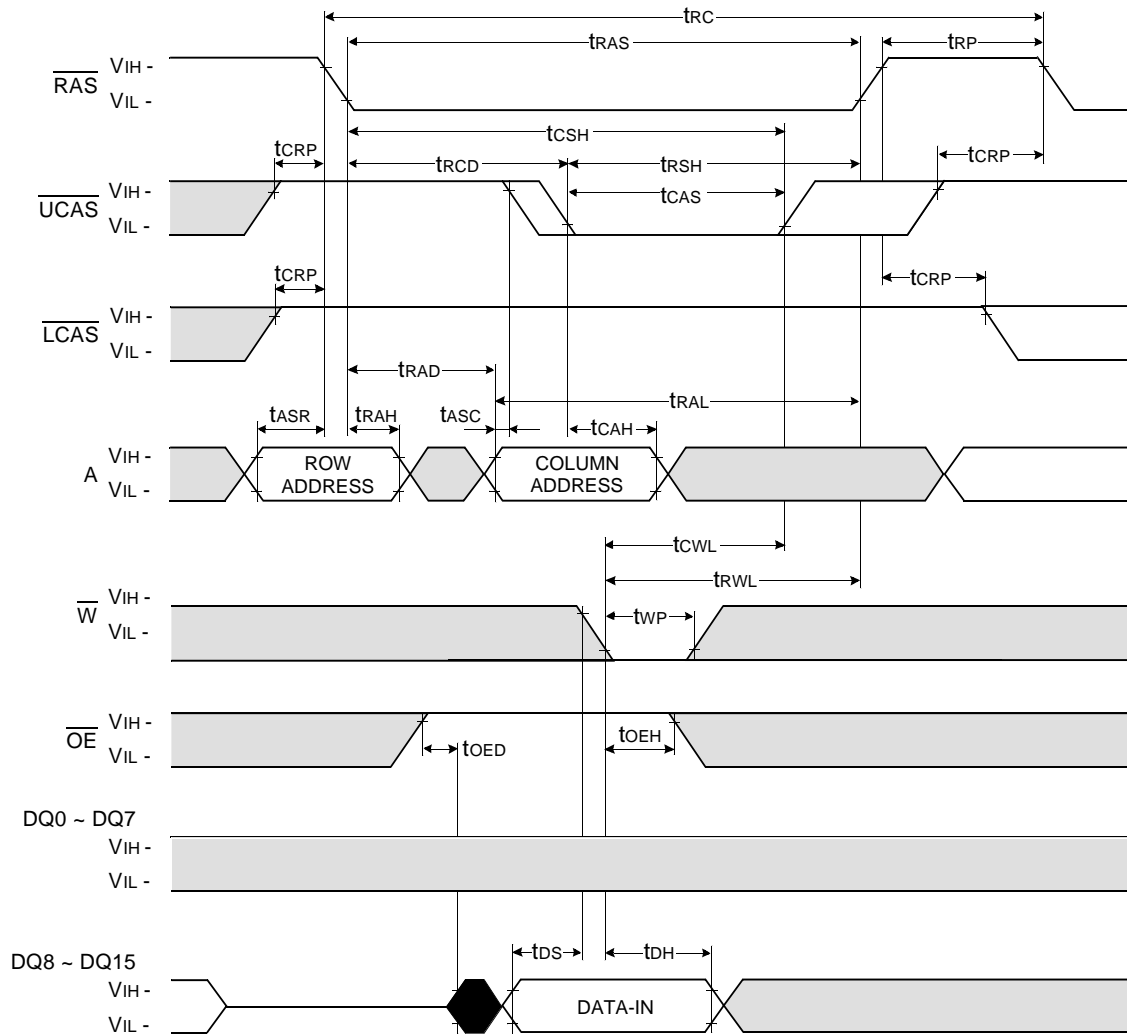
Undefined

WORD READ - MODIFY - WRITE CYCLE
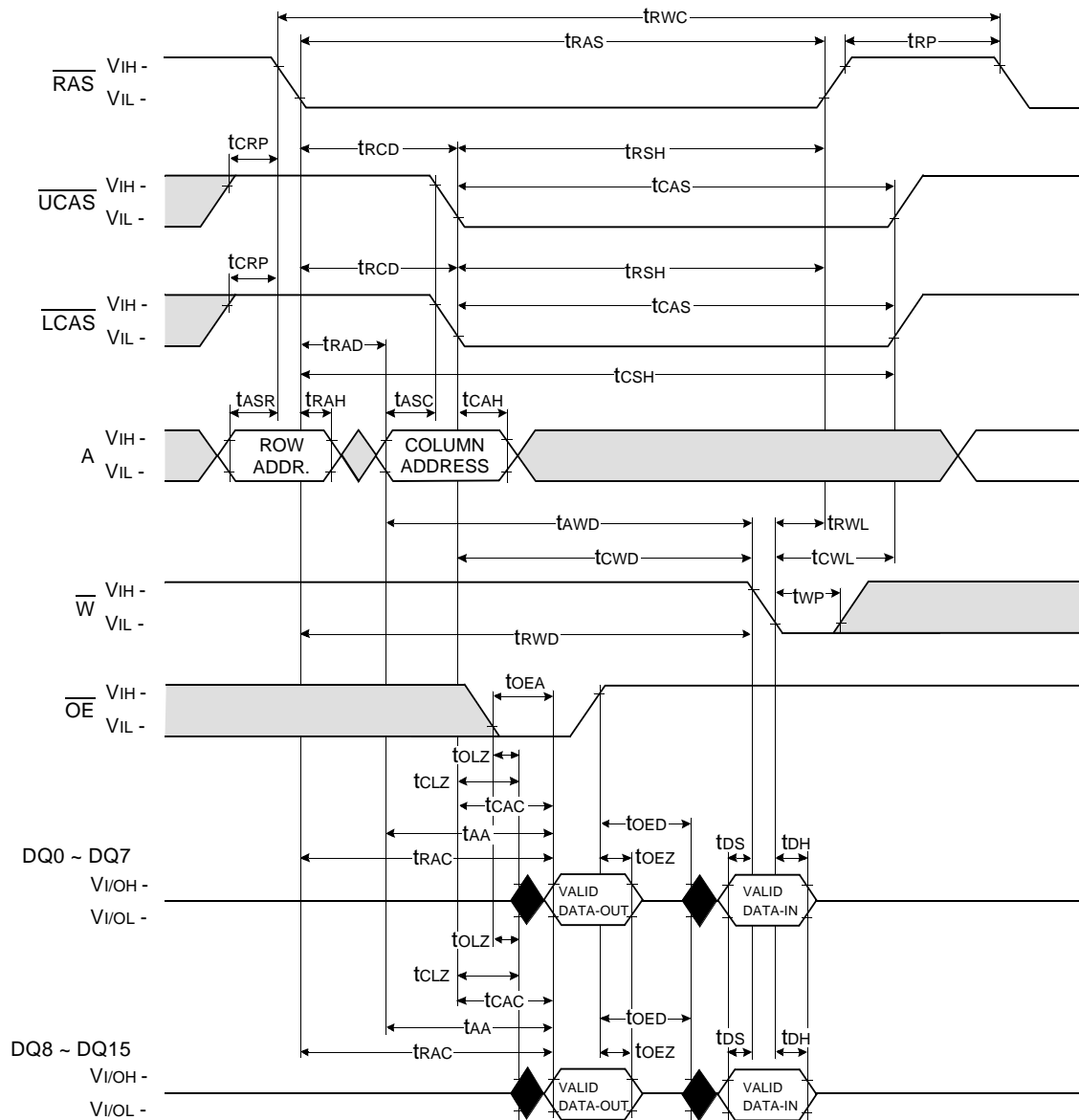
| | Don't care |
| | Undefined |

LOWER-BYTE READ - MODIFY - WRITE CYCLE
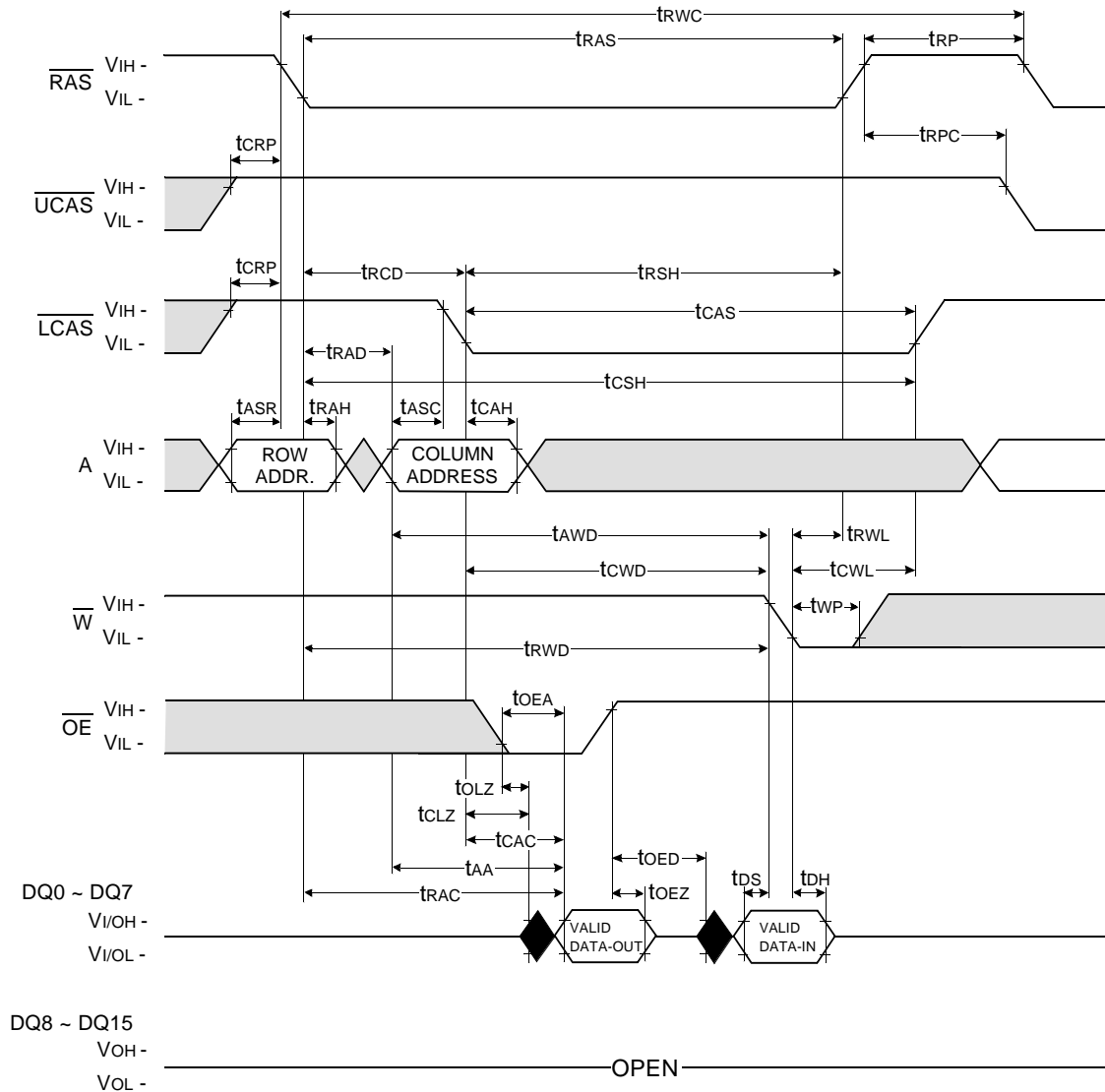
UPPER-BYTE READ - MODIFY - WRITE CYCLE

HYPER PAGE MODE WORD READ CYCLE
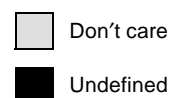
HYPER PAGE MODE LOWER BYTE READ CYCLE
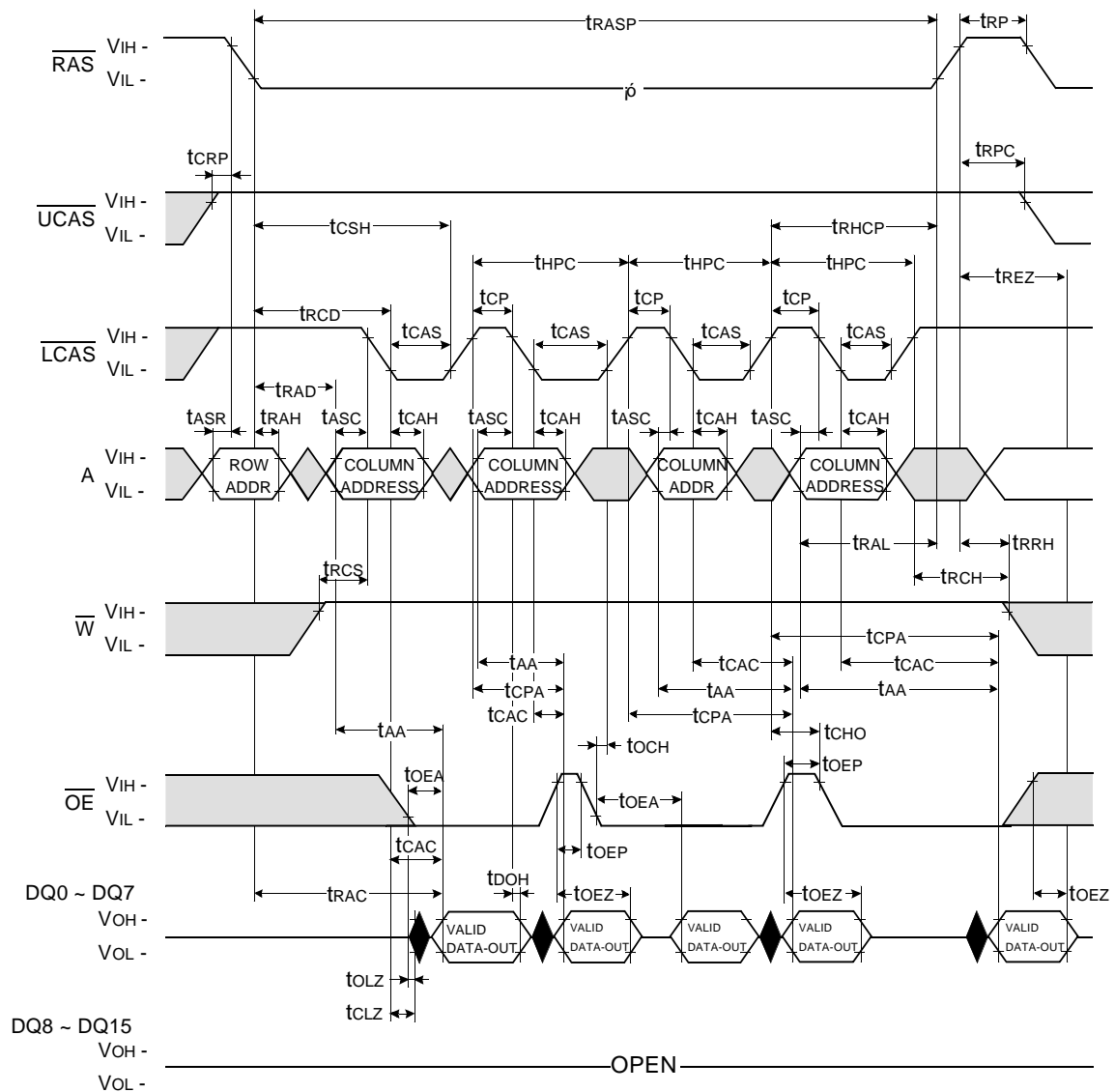
Don't care

Undefined

HYPER PAGE MODE UPPER BYTE READ CYCLE
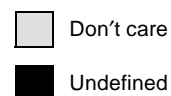
HYPER PAGE MODE WORD WRITE CYCLE (EARLY WRITE)

NOTE : D$_{OUT}$ = OPEN

Legend:
- Don't care
- Undefined
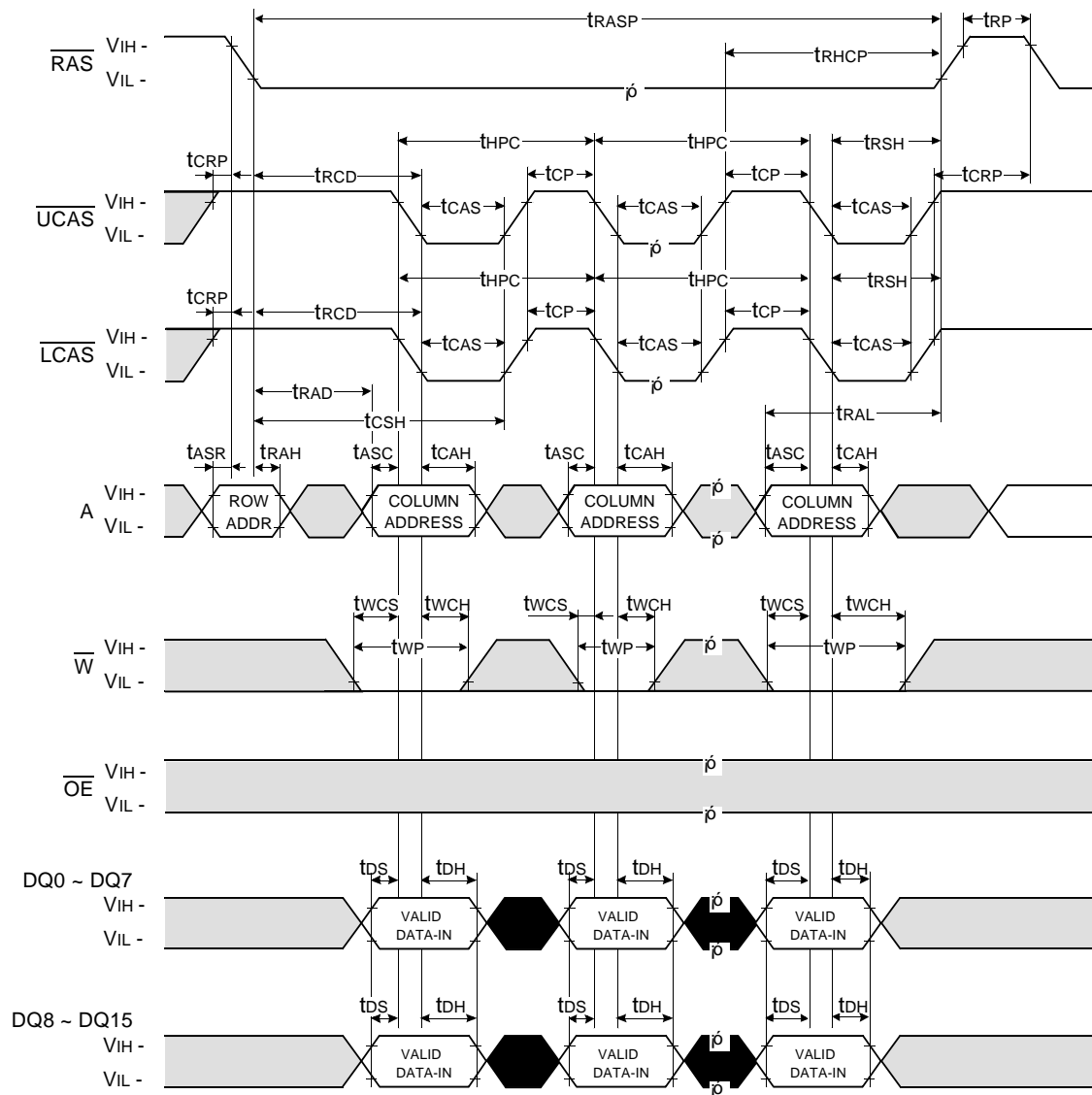
HYPER PAGE MODE LOWER BYTE WRITE CYCLE (EARLY WRITE)

NOTE : D_{OUT} = OPEN

Don't care
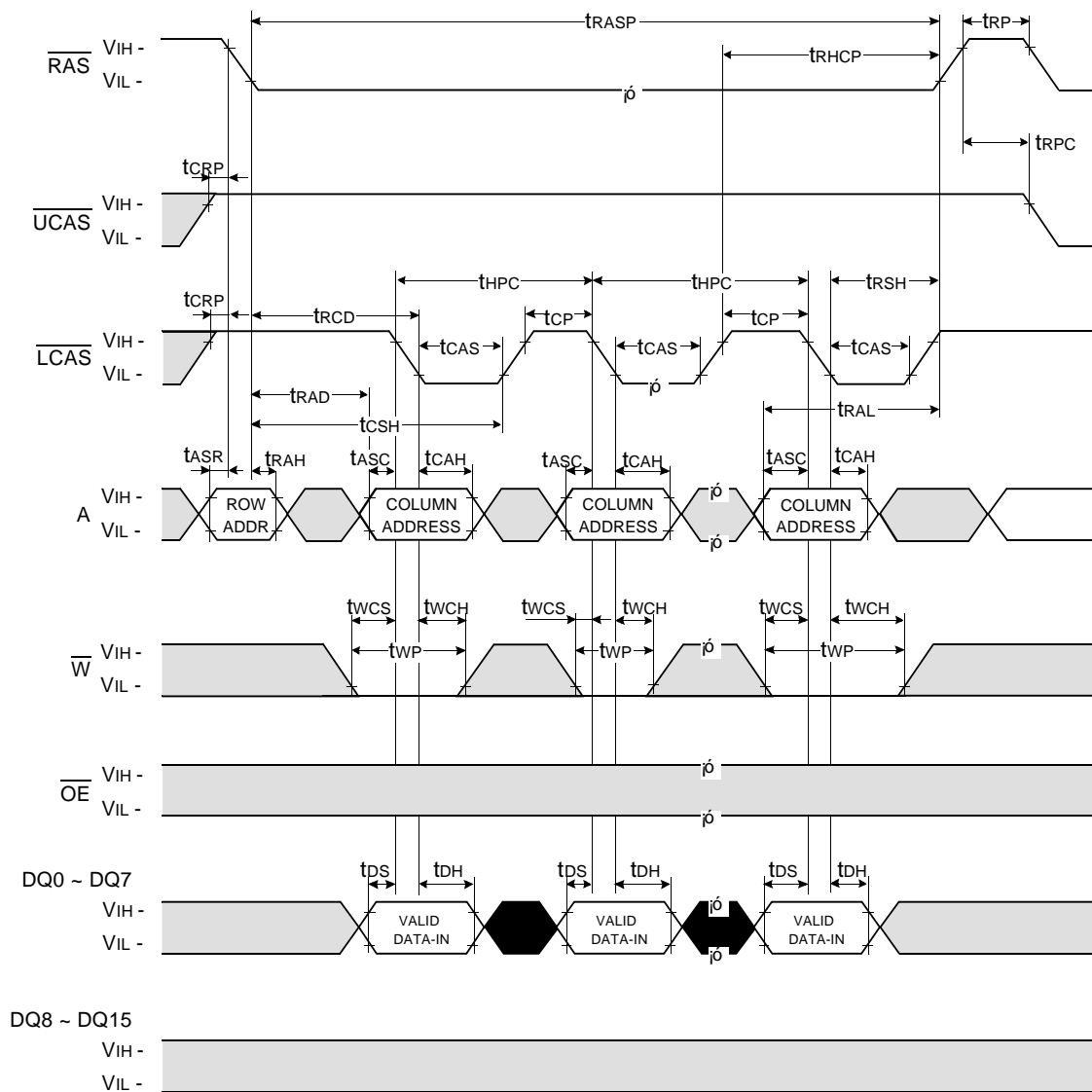
Undefined

HYPER PAGE MODE UPPER BYTE WRITE CYCLE (EARLY WRITE)

NOTE : D$_{OUT}$ = OPEN
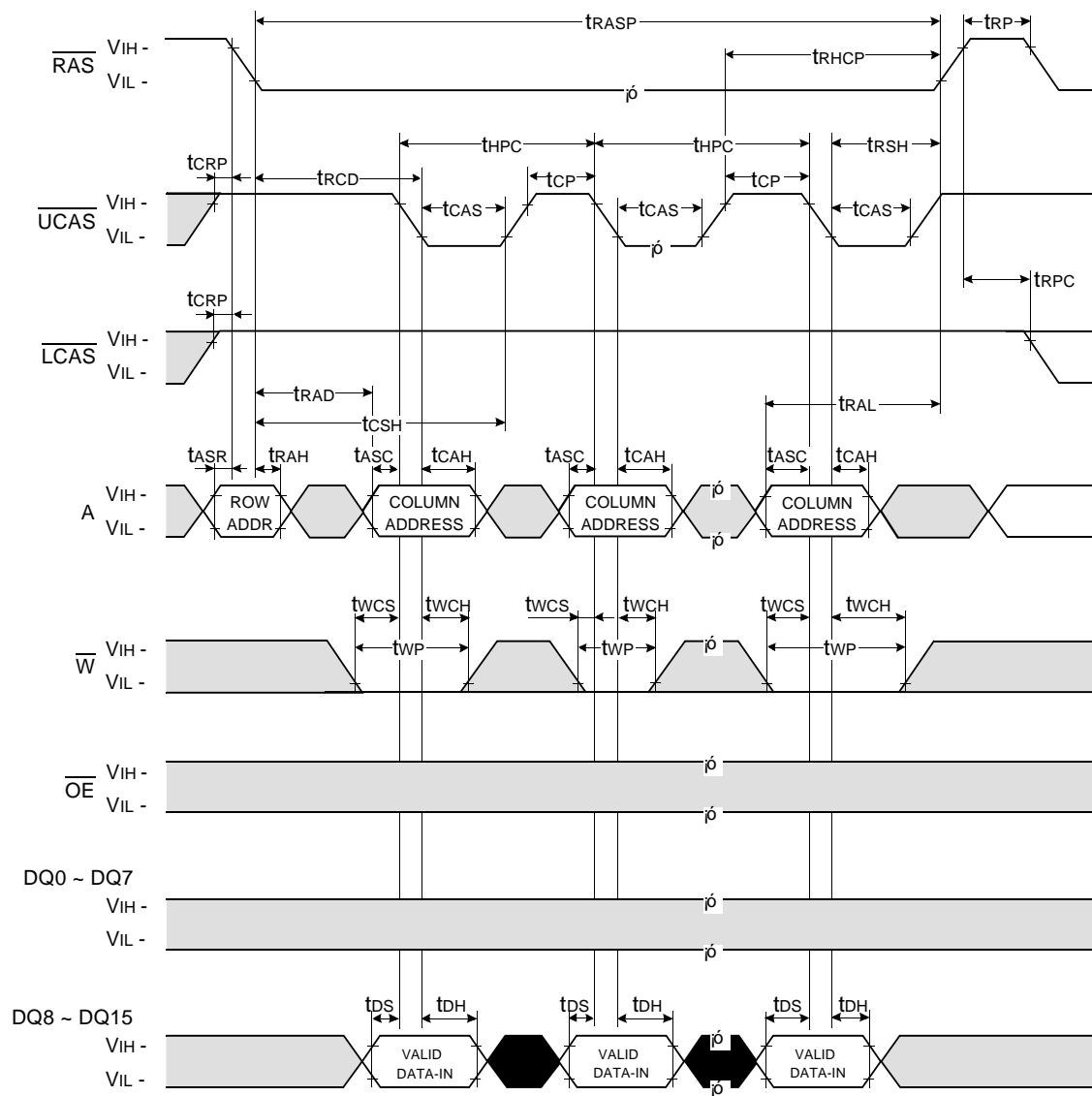
HYPER PAGE MODE WORD READ - MODIFY - WRITE CYCLE

Don't care
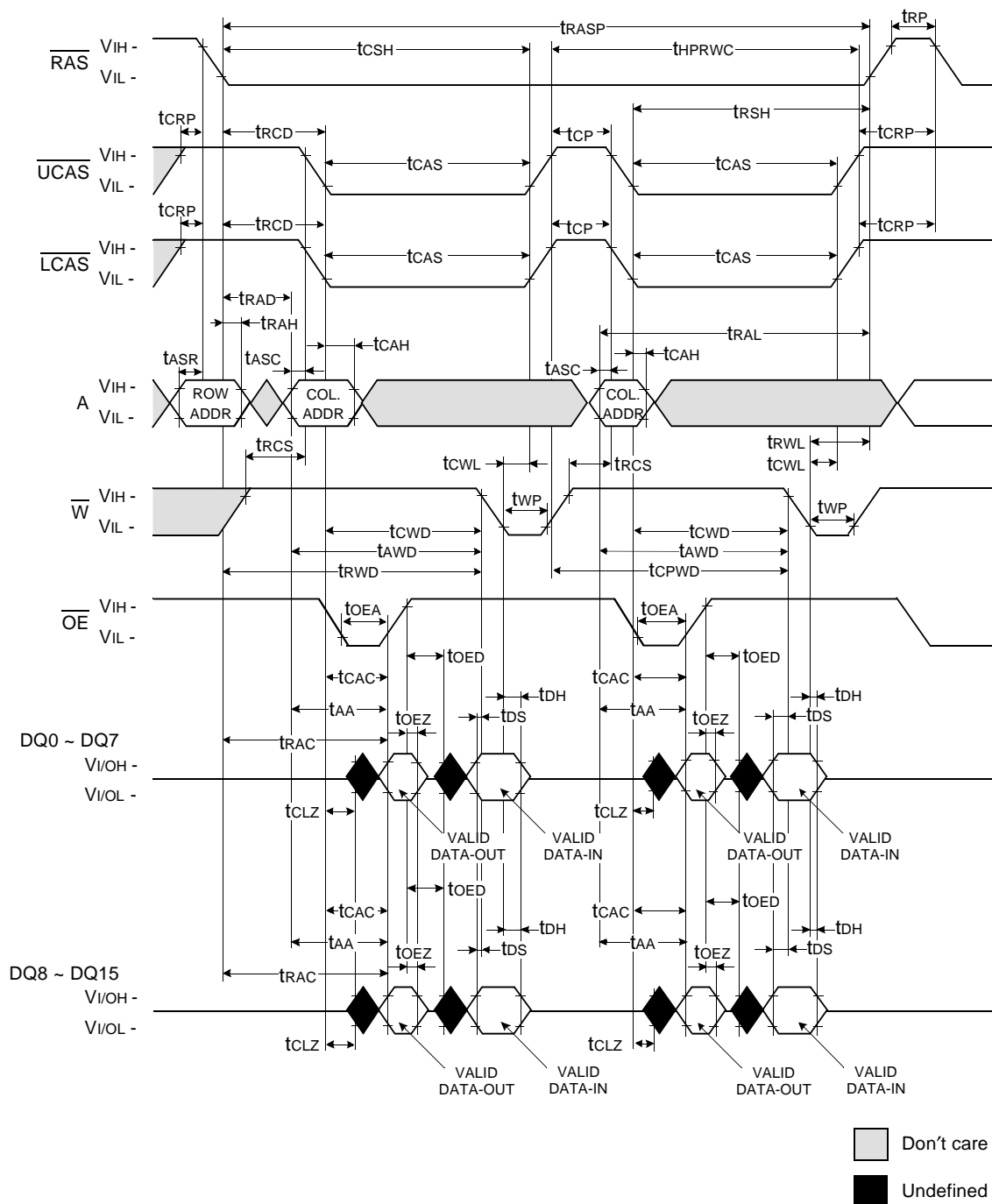
Undefined
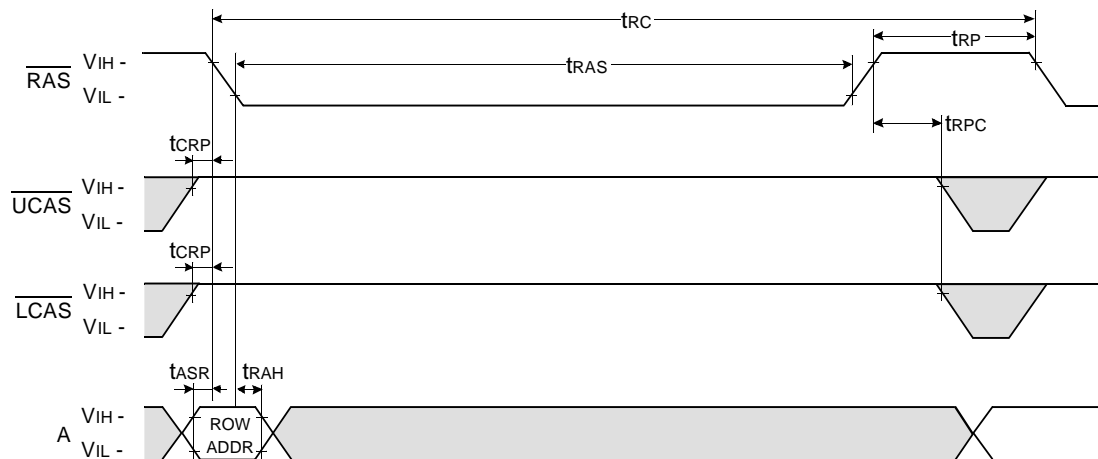
HYPER PAGE MODE LOWER BYTE READ - MODIFY - WRITE CYCLE
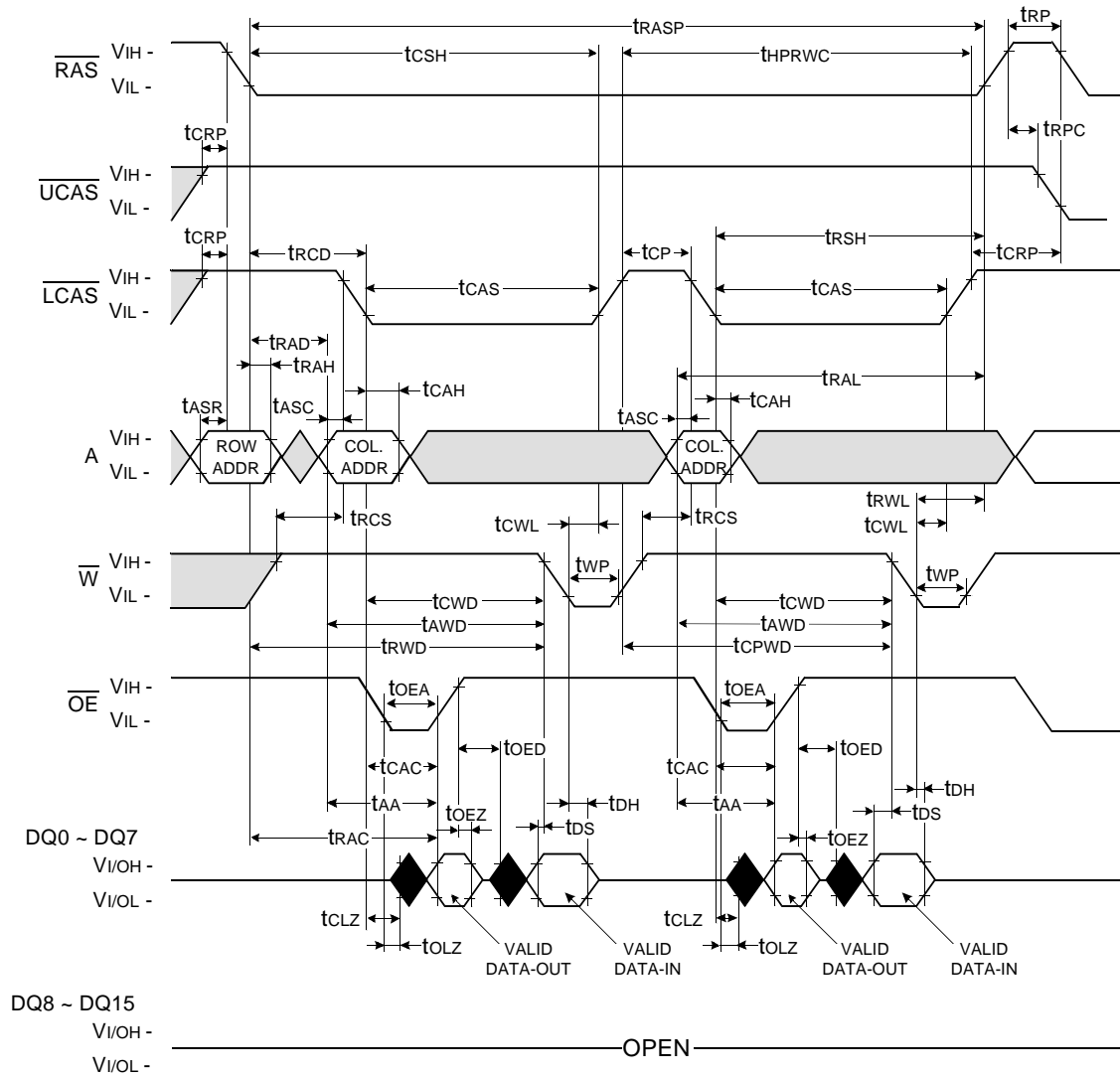
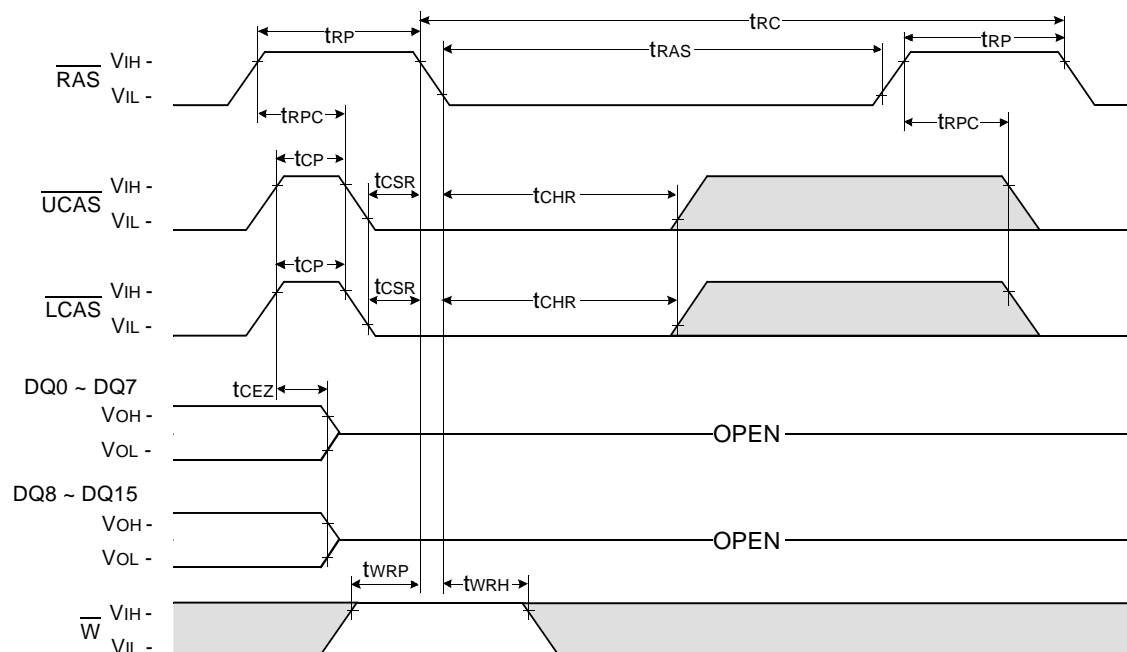## HYPER PAGE MODE UPPER BYTE READ - MODIFY - WRITE CYCLE
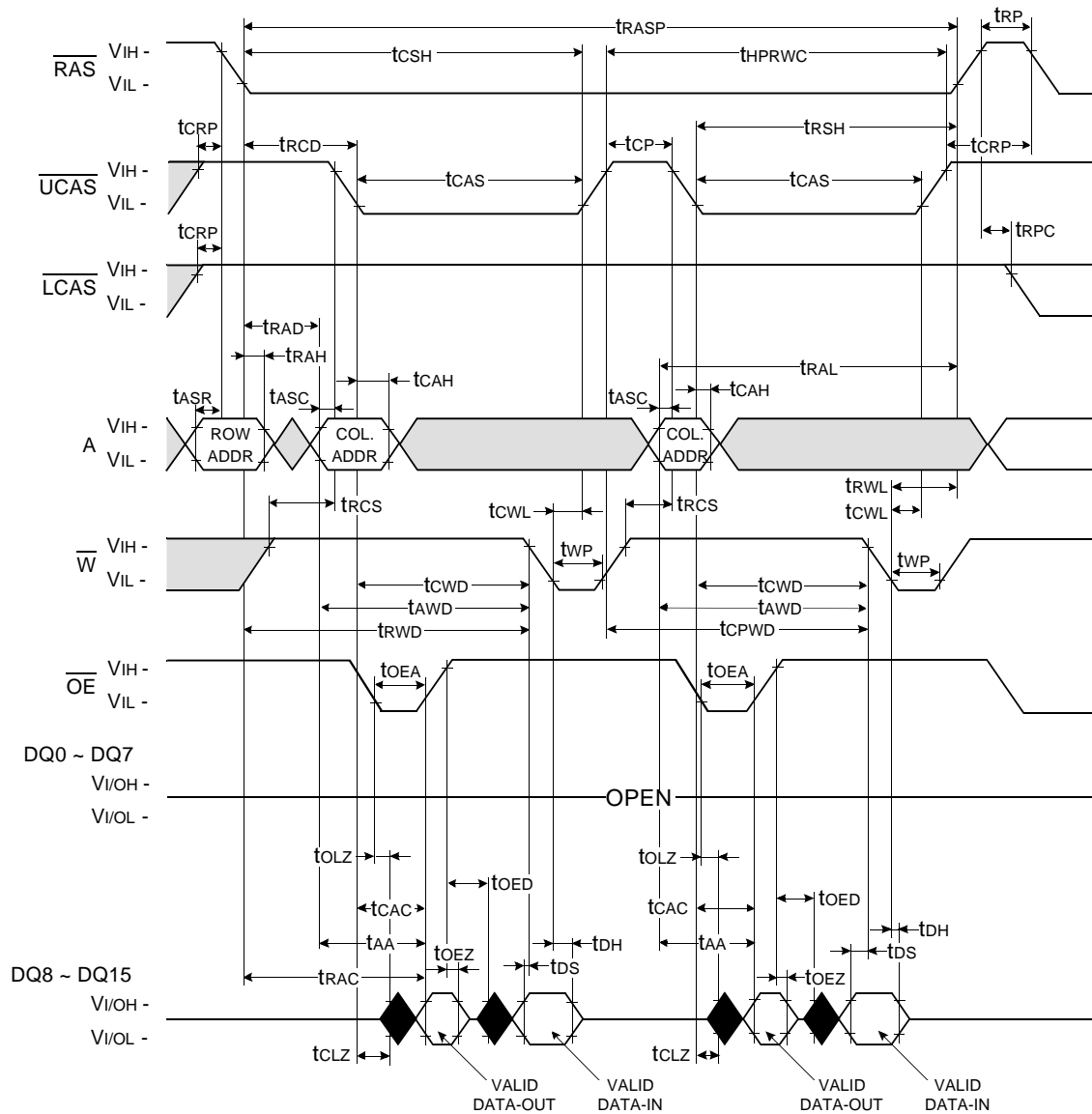
| | Don't care |
| | Undefined |

HYPER PAGE READ AND WRITE MIXED CYCLE
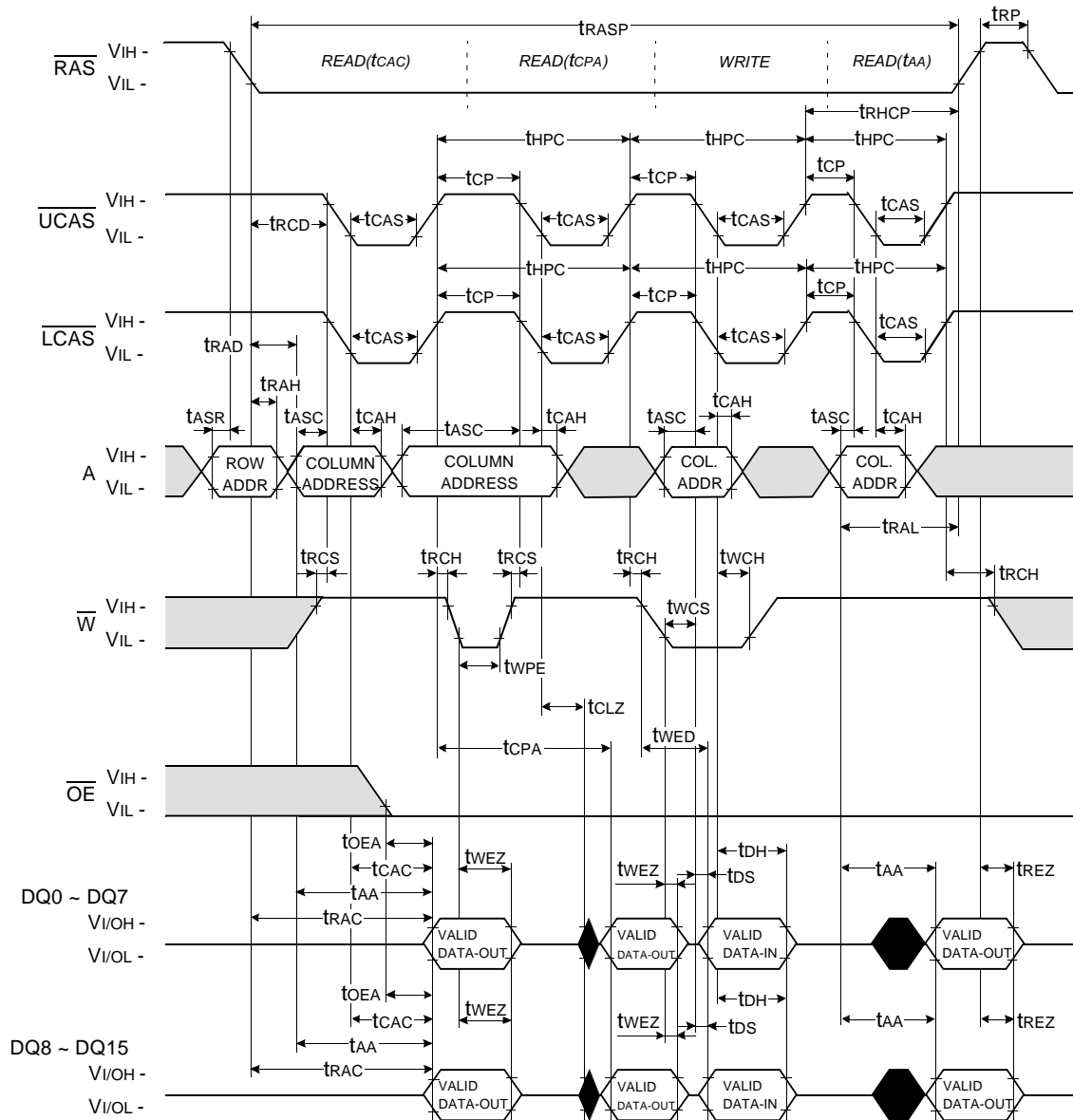
$\overline{RAS}$ - ONLY REFRESH CYCLE

NOTE : $\overline{W}$, $\overline{OE}$, D$_{IN}$ = Don't care

D$_{OUT}$ = OPEN

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

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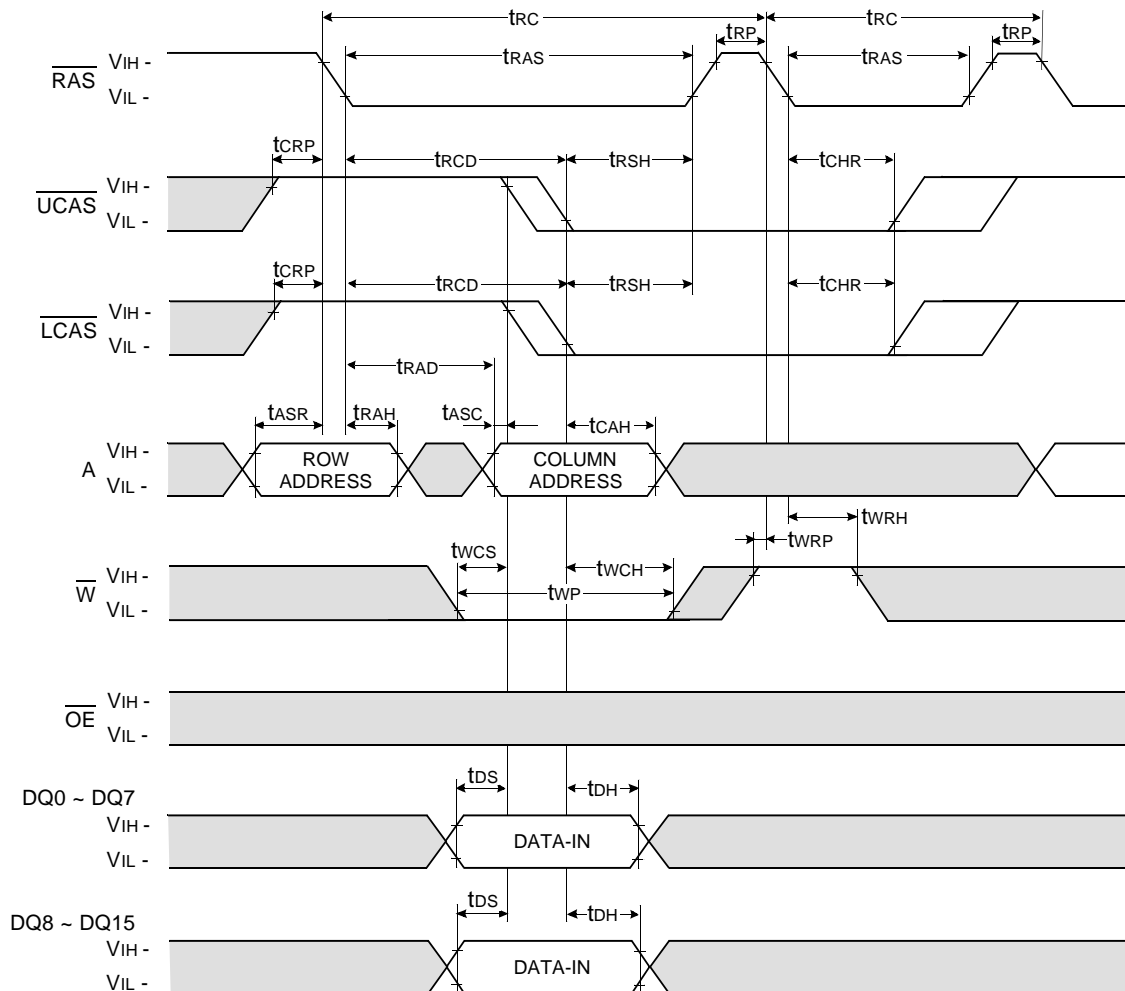

Don't care

Undefined
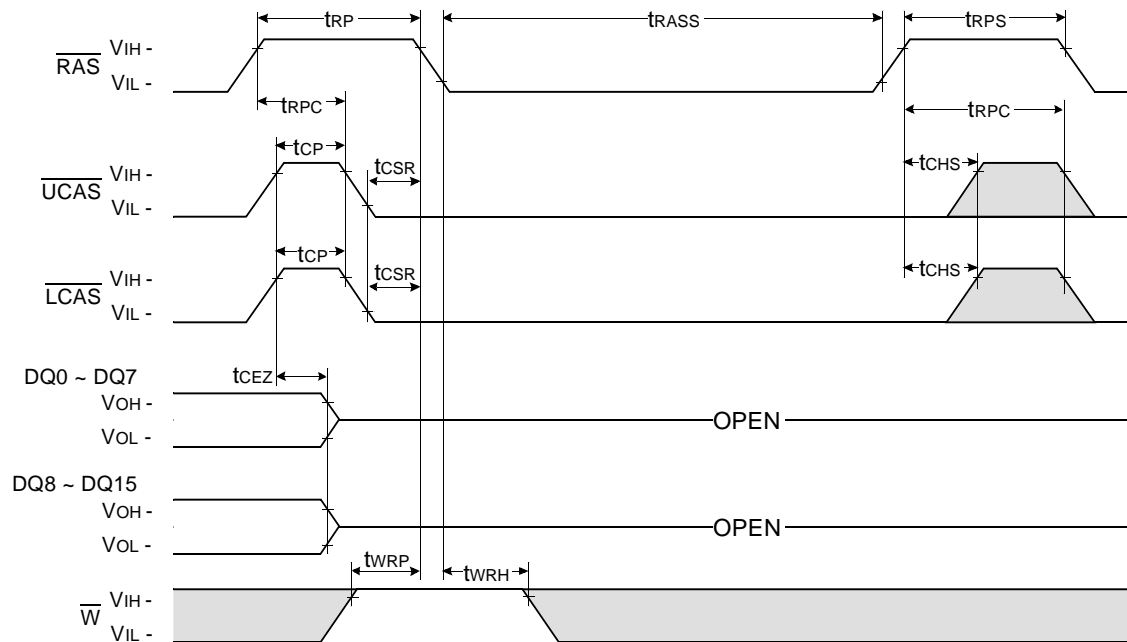
![SAMSUNG ELECTRONICS logo]

HIDDEN REFRESH CYCLE (READ)
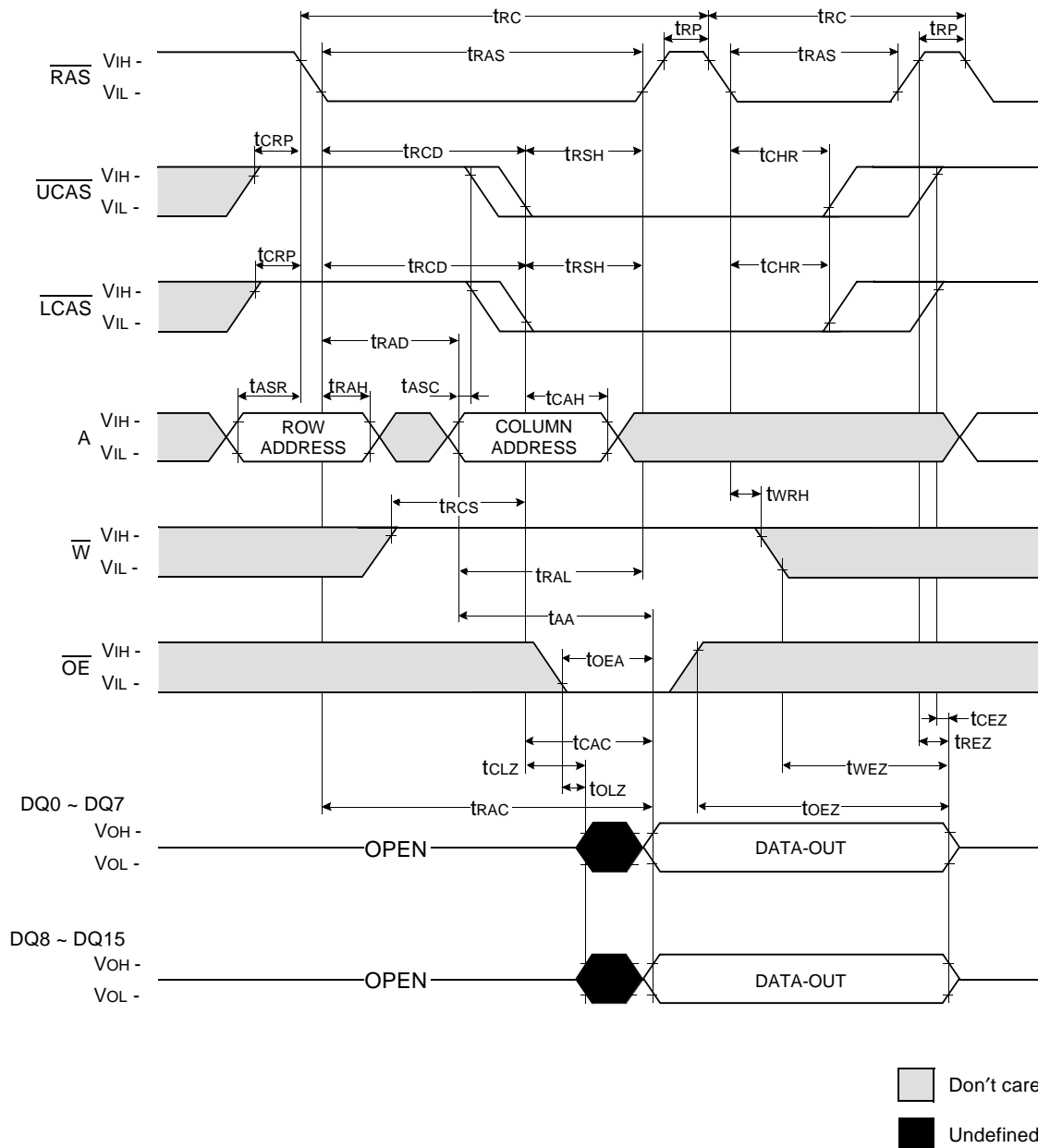
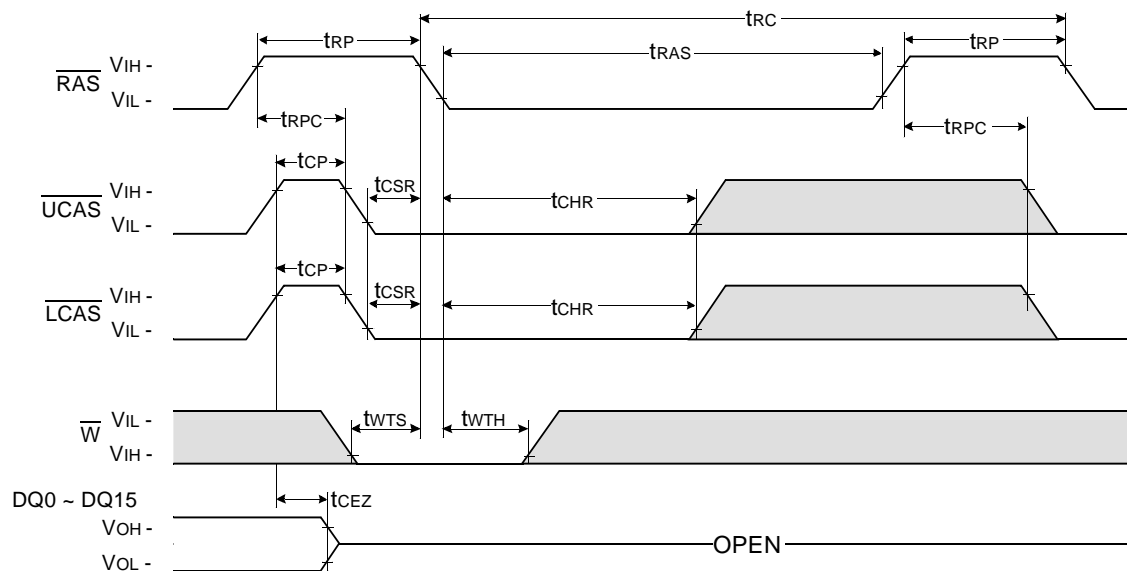* In Hidden refresh cycle of 64Mb A-die & B-die, when $\overline{CAS}$ signal transits from Low to High, the valid data may be cut off.

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HIDDEN REFRESH CYCLE (WRITE)

NOTE : D$_{OUT}$ = OPEN

Don't care

Undefined

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

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

TEST MODE IN CYCLE

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

Don't care

Undefined

PACKAGE DIMENSION

50 TSOP(II) 400mil

Units : Inches (millimeters)

0.455 (11.56)
0.471 (11.96)

0.400 (10.16)

0.004 (0.10)
0.010 (0.25)

0.841 (21.35)
MAX

0.821 (20.85)
0.829 (21.05)

0.047 (1.20)
MAX

0.010 (0.25)
TYP

0.034 (0.875)   0.0315 (0.80)

0.002 (0.05)
MIN

0.018 (0.45)
0.030 (0.75)

0~8°

0.010 (0.25)
0.018 (0.45)