

Features :

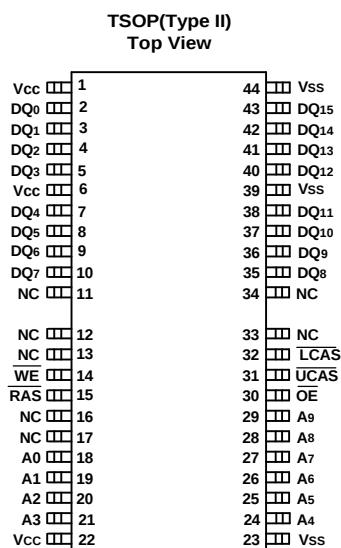
- * 1,048,576 words by 16 bits organization.
- * Fast access time and cycle time.
- * Dual CAS Input.
- * Low power dissipation.
- * Read-Modify-Write, $\overline{\text{RAS}}$ -Only Refresh, $\overline{\text{CAS}}$ -Before-RAS Refresh, Hidden Refresh and Test Mode Capability.
- * 1024 refresh cycles per 16ms.
- * Available in 400 mil TSOPII Packages.
- * Single $2.5\text{V} \pm 0.2\text{V}$ Power Supply.
- * All inputs and Outputs are LVTTTL compatible.
- * Extended Data-Out(EDO) Page Mode operation.
- * Self – refresh capability. (S-Version).
- * Extended Temperature Available ($-25^{\circ}\text{C} \sim 85^{\circ}\text{C}$)

Description :

The GLT4160M16 is a 1,048,576 x 16 bit high-performance CMOS dynamic random access memory. The GLT4160M16 offers Fast Page mode with Extended Data Output, and has both BYTE WRITE and WORD WRITE access cycles via two $\overline{\text{CAS}}$ pins. The GLT4160M16 has symmetric address and accepts 1024-cycle refresh in 16ms interval.

All inputs are TTL compatible. EDO Page Mode operation allows random access up to 1024 x 16 bits within a page, with cycle times as short as 25ns.

HIGH PERFORMANCE	60	70	80
Max. $\overline{\text{RAS}}$ Access Time, (t_{RAC})	60 ns	70 ns	80 ns
Max. Column Address Access Time, (t_{CAA})	30 ns	35 ns	40 ns
Min. Extended Data Out Page Mode Cycle Time, (t_{PC})	25 ns	30 ns	35 ns
Min. Read/Write Cycle Time, (t_{RC})	104 ns	124 ns	144 ns
Max. $\overline{\text{CAS}}$ Access Time (t_{CAC})	15 ns	20 ns	20 ns

Pin Configuration :

Pin Descriptions:

Name	Function
A ₀ - A ₉	Address Inputs
$\overline{\text{RAS}}$	Row Address Strobe
$\overline{\text{UCAS}}$	Column Address Strobe/Upper Byte Control
$\overline{\text{LCAS}}$	Column Address Strobe/Lower Byte Control
$\overline{\text{WE}}$	Write Enable
$\overline{\text{OE}}$	Output Enable
DQ ₀ - DQ ₁₅	Data Inputs / Outputs
V _{CC}	+2.5V Power Supply
V _{SS}	Ground
NC	No Connection

Absolute Maximum Ratings*

Operating Temperature, T_A (ambient)
.....0°C to +70°C
.....(extended)..-25°C to +85°C
Storage Temperature(plastic).....-55°C to +150°C
Voltage Relative to V_{SS}-1.0V to + 3.5V
Short Circuit Output Current.....50mA
Power Dissipation.....1.0W

*Note: Operation above Absolute Maximum Ratings can adversely affect device reliability.

Capacitance*

$T_A=25^{\circ}\text{C}$, $V_{CC}=2.5\text{V}\pm 0.2\text{V}$, $V_{SS}=0\text{V}$

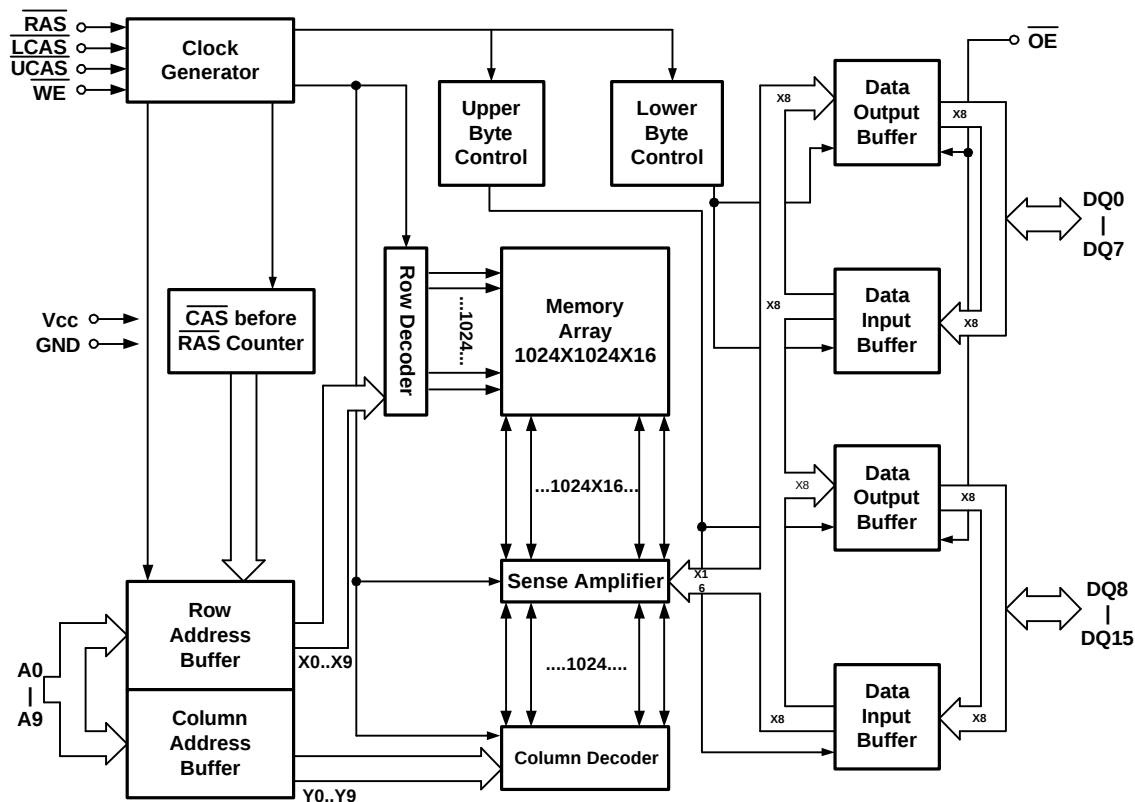
Symbol	Parameter	Max.	Unit
C_{IN1}	Address Input	5	pF
C_{IN2}	$\overline{\text{RAS}}$, $\overline{\text{LCAS}}$, $\overline{\text{UCAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$	7	pF
C_{OUT}	Data Input/Output	7	pF

*Note: Capacitance is sampled and not 100% tested

Electrical Specifications

- $\overline{\text{CAS}}$ means $\overline{\text{UCAS}}$ and $\overline{\text{LCAS}}$.
- All voltages are referenced to GND.
- After power up, wait more than 200 μs and then, execute eight $\overline{\text{CAS}}$ -before-RAS or RAS-only refresh cycles as dummy cycles to initialize internal circuit.

Block Diagram :



DC and Operating Characteristics (1-2)

$T_A = 0^{\circ}\text{C}$ to 70°C , -25°C to 85°C (extended temperature) $V_{CC}=2.5\text{V}\pm 0.2\text{V}$, $V_{SS}=0\text{V}$, unless otherwise specified.

Sym.	Parameter	Test Conditions	Access Time	Min.	Typ	Max.	Unit	Notes
I_{LI}	Input Leakage Current (any input pin)	$0\text{V} \leq V_{IN} \leq V_{CC}+0.3\text{V}$ (All other pins not under test=0V)		-5		+5	μA	
I_{LO}	Output Leakage Current (for High-Z State)	$0\text{V} \leq V_{out} \leq V_{CC}$ Output is disabled (Hiz)		-5		+5	μA	
I_{CC1}	Operating Current, Random READ/WRITE	$t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 60\text{ns}$ $t_{RAC} = 70\text{ns}$ $t_{RAC} = 80\text{ns}$			140 130 120	mA	1,2
I_{CC2}	Standby Current,(TTL)	$\overline{\text{RAS}}, \overline{\text{UCAS}}, \overline{\text{LCAS}}$ at V_{IH} other inputs $\geq V_{SS}$				1	mA	
I_{CC3}	Refresh Current, RAS-Only	$\overline{\text{RAS}}$ cycling, $\overline{\text{UCAS}}, \overline{\text{LCAS}}$ at V_{IH} $t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 60\text{ns}$ $t_{RAC} = 70\text{ns}$ $t_{RAC} = 80\text{ns}$			140 130 120	mA	2
I_{CC4}	Operating Current, EDO Page Mode	$\overline{\text{RAS}}$ at V_{IL} , $\overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{PC}=t_{PC}(\text{min.})$	$t_{RAC} = 60\text{ns}$ $t_{RAC} = 70\text{ns}$ $t_{RAC} = 80\text{ns}$			140 130 120	mA	1,2
I_{CC5}	Refresh Current, CAS Before RAS	$\overline{\text{RAS}}, \overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{RC}=t_{RC}(\text{min.})$	$t_{RAC} = 60\text{ns}$ $t_{RAC} = 70\text{ns}$ $t_{RAC} = 80\text{ns}$			140 130 120	mA	1
I_{CC6}	Standby Current, (CMOS)	$\overline{\text{RAS}} \geq V_{CC}-0.2\text{V},$ $\overline{\text{UCAS}} \geq V_{CC}-0.2\text{V},$ $\overline{\text{LCAS}} \geq V_{CC}-0.2\text{V},$ All other inputs V_{SS}				200	μA	1,5
I_{CC7}	Self Refresh Current	$\overline{\text{RAS}} = \overline{\text{UCAS}} = \overline{\text{LCAS}} = V_{IL}$ $\overline{\text{WE}} = \overline{\text{OE}} = A_0 \sim A_9 = V_{CC}-0.2\text{V}$ or 0.2V $DQ_0 \sim DQ_{15} = V_{CC}-0.2\text{V}, 0.2\text{V}$ or Open				200	μA	
V_{IL}	Input Low Voltage			-0.3		+0.8	V	3
V_{IH}	Input High Voltage			2.0		$V_{CC}+0.3$	V	3
V_{OL}	Output Low Voltage	$I_{OL} = 2\text{mA}$				0.4	V	
V_{OH}	Output High Voltage	$I_{OH} = -2\text{mA}$		2			V	

Notes:

- I_{CC} is dependent on output loading when the device output is selected. Specified $I_{CC}(\text{max.})$ is measured with the output open.
- I_{CC} is dependent upon the number of address transitions specified $I_{CC}(\text{max.})$ is measured with a maximum of one transition per address cycle in random Read/Write and EDO Fast Page Mode.
- Specified $V_{IL}(\text{min.})$ is steady state operation. During transitions $V_{IL}(\text{min.})$ may undershoot to -1.0V for a period not to exceed 15ns. All AC parameters are measured with $V_{IL}(\text{min.}) \geq V_{SS}$ and $V_{IH}(\text{max.}) \leq V_{CC}$.
- Specified $V_{IH}(\text{max.})$ is steady state operation. During transitions $V_{IH}(\text{max.})$ may undershoot to $+1.0\text{V}$ for a period not to exceed 15ns. All AC parameters are measured with $V_{IL}(\text{min.}) \geq V_{SS}$ and $V_{IH}(\text{max.}) \leq V_{CC}$.
- S-Version.

AC Characteristics

$T_A = 0^\circ\text{C}$ to 70°C , -25°C to 85°C (extended temperature), $V_{CC} = 2.5\text{V} \pm 0.2\text{V}$, $V_{IH} / V_{IL} = 2.0/0\text{V}$, $V_{OH}/V_{OL} = 2.0/0.8\text{V}$

An initial pause of 100 μs and 8 CAS-before-RAS or RAS-only refresh cycles are required after power-up.

Parameter	Symbol	60		70		80		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
Read or Write Cycle Time	t_{RC}	104		124		144		ns	
Read Modify Write Cycle Time	t_{RWC}	140		170		190		ns	
RAS Precharge Time	t_{RP}	40		50		60		ns	
RAS Pulse Width	t_{RAS}	60	10k	70	10k	80	10k	ns	
Access Time from RAS	t_{RAC}		60		70		80	ns	1,2,3
Access Time from CAS	t_{CAC}		15		20		20	ns	1,5,10
Access Time from Column Address	t_{AA}		30		35		40	ns	1,5,6
CAS to Output Low-Z	t_{CLZ}	3		3		3		ns	
CAS to Output High-Z	t_{CEZ}	3	15	3	20	3	20	ns	
RAS Hold Time	t_{RSH}	15		20		20		ns	
RAS Hold Time Referenced to OE	t_{ROH}	10		10				ns	
CAS Hold Time	t_{CSH}	45		50		70		ns	
CAS Pulse Width	t_{CAS}	10	10k	15	10k	20	80k	ns	
RAS to CAS Delay Time	t_{RCD}	20	45	20	50	20	60	ns	
RAS to Column Address Delay Time	t_{RAD}	15	30	15	35	15	40	ns	7
CAS to 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}	10		10		10		ns	
Column Address Set-Up Time	t_{ASC}	0		0		0		ns	
Column Address Hold Time	t_{CAH}	10		15		15		ns	
Column Address to RAS Lead Time	t_{RAL}	30		35		40		ns	
Column Address Hold Time Referenced to RAS	t_{AR}	45		50		60		ns	
Read Command Set-Up Time	t_{RCS}	0		0		0		ns	
Read Command Hold Time Referenced to CAS	t_{RCH}	0		0		0		ns	4
Read Command Hold Time Referenced to RAS	t_{RRH}	0		0		0		ns	4
Write Command Set-Up Time	t_{WCS}	0		0		0		ns	8,9
Write Command Hold Time	t_{WCH}	10		15		15		ns	
Write Command Pulse Width	t_{WP}	10		15		15		ns	
Write Command to RAS Lead Time	t_{RWL}	15		30		20		ns	
Write Command to CAS Lead Time	t_{CWL}	13		15		20		ns	

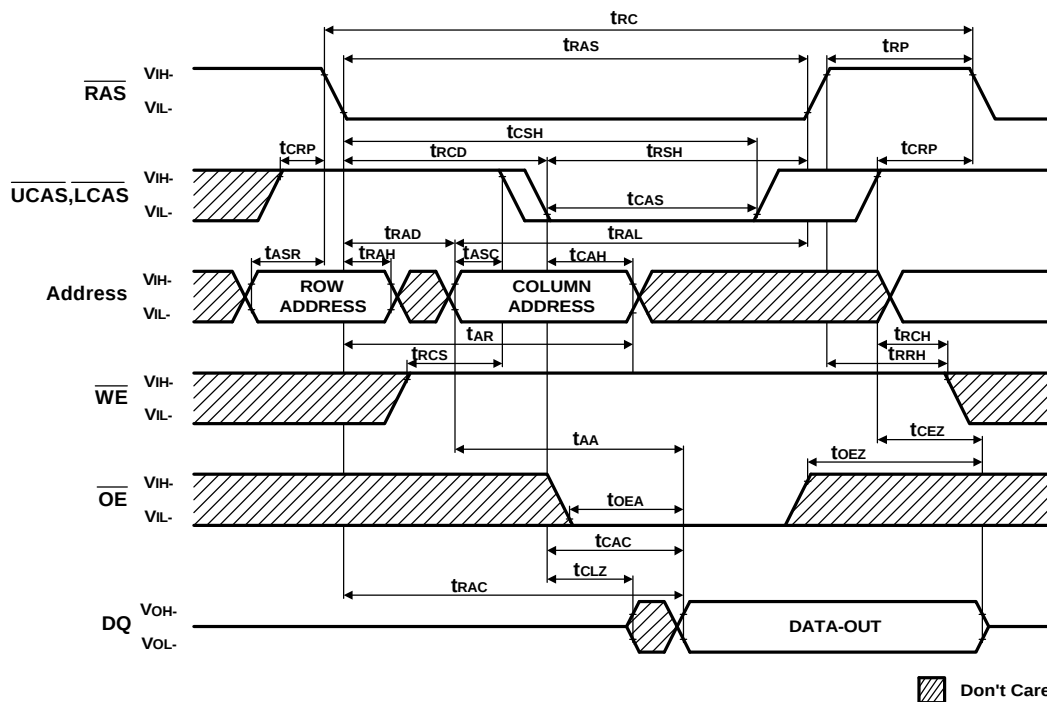
AC Characteristics

Parameter	Symbol	60		70		80		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
Data Set-Up Time	t_{DS}	0		0		0		ns	
Data Hold Time	t_{DH}	10		15		15		ns	
Data Hold Time Referenced to $\overline{RAS}$	t_{DHR}	45		50		60		ns	
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	79		94		99		ns	
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	34		44		44		ns	
Column Address to $\overline{WE}$ Delay Time	t_{AWD}	49		59		64		ns	
$\overline{RAS}$ to $\overline{CAS}$ Precharge Time	t_{RPC}	0		0		5		ns	
Access Time from $\overline{CAS}$ Precharge	t_{CPA}		35		40		45	ns	
EDO Page Mode Cycle Time	t_{PC}	25		30		35		ns	
EDO Page Mode Read-Modify-Write Cycle Time	t_{PRWC}	56		71		81		ns	
$\overline{CAS}$ Precharge Time (EDO Page Mode)	t_{CP}	10		10		10		ns	
$\overline{RAS}$ Pulse Width (EDO Page Mode Only)	t_{RASP}	60	100k	70	100k	80	100k	ns	
Access Time from $\overline{OE}$	t_{OEA}		15		20		20	ns	
$\overline{OE}$ to Data Delay Time	t_{OED}	15		20		20		ns	
$\overline{OE}$ to Output High-Z	t_{OEZ}	3	20	3	20	3	20	ns	
$\overline{OE}$ Command Hold Time	t_{OEH}	15		20		20		ns	
Data Output Hold after $\overline{CAS}$ low	t_{DOH}	5		5		5		ns	
$\overline{RAS}$ to Output High-Z	t_{REZ}	3	15	3	20	3	20	ns	
$\overline{WE}$ to Output High-Z	t_{WEZ}	3	15	3	20	3	20	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	
$\overline{CAS}$ Set-Up Time for $\overline{CAS}$ -before- $\overline{RAS}$ Cycle	t_{CSR}	5		5		5		ns	
$\overline{CAS}$ Hold Time for $\overline{CAS}$ -before- $\overline{RAS}$ Cycle	t_{CHR}	10		15		15		ns	
Transition Time	t_T	2	50	2	50	2	50	ns	
Refresh Period	t_{REF}		16		16		16	ms	
$\overline{RAS}$ pulse width ($\overline{CAS}$ -before- $\overline{RAS}$ Self refresh)	t_{RASS}	100		100		128		μs	
$\overline{RAS}$ precharge time ($\overline{CAS}$ -before- $\overline{RAS}$ Self refresh)	t_{RPS}	110		130		150		ns	
$\overline{CAS}$ precharge time ($\overline{CAS}$ -before- $\overline{RAS}$ Self refresh)	t_{CHS}	50		50		50		ns	

Notes:

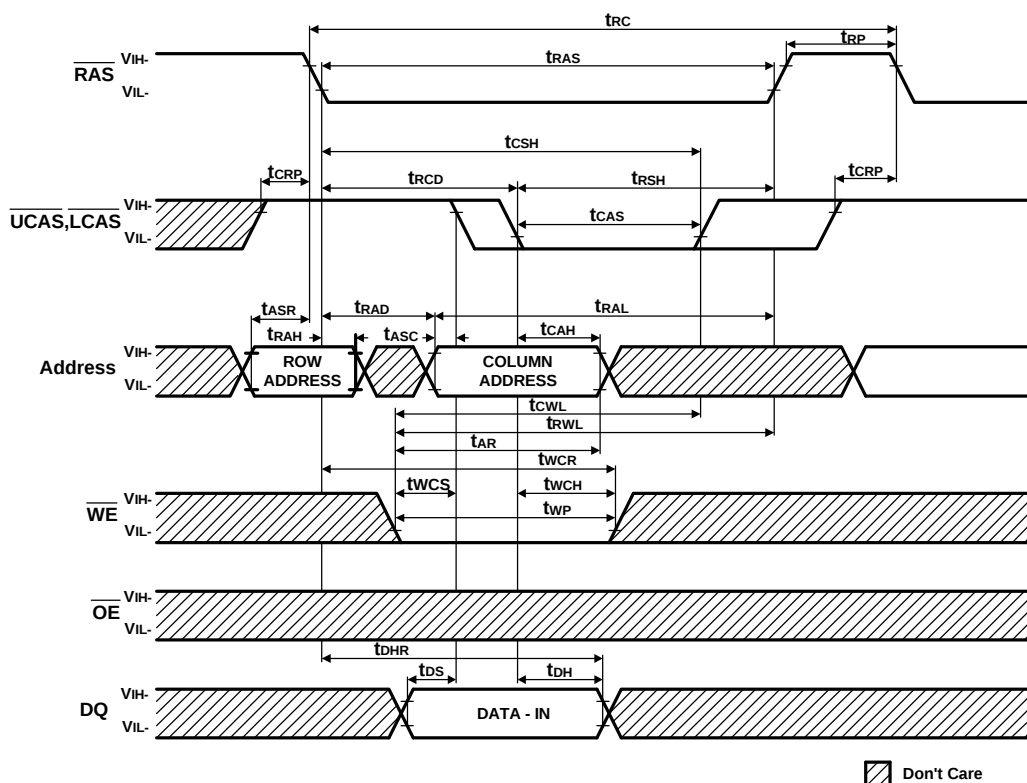
1. Measure with a load equivalent to one TTL inputs and 50 pF.
2. Assumes that $t_{RCD} \leq t_{RCD}(\text{max.})$. If t_{RCD} is greater than $t_{RCD}(\text{max.})$, access time will be t_{AA} dominant.
3. Assumes that $t_{RAD} \leq t_{RAD}(\text{max.})$. If t_{RAD} is greater than $t_{RCD}(\text{max.})$, access time will be controlled by t_{CAC} .
4. Either t_{RRH} or t_{RCH} must be satisfied for a Read Cycle.
5. Access time is determined by the longest of t_{CAA} , t_{CAC} and t_{CPA} .
6. Assumes that $t_{RAD} \geq t_{RAD}(\text{max.})$.
7. Operation within the $t_{RAD}(\text{max.})$ limit ensures that $t_{RAC}(\text{max.})$ can be met. $t_{RAD}(\text{max.})$ is specified as a reference point only. If t_{RAD} is greater than the specified $t_{RAD}(\text{max.})$ limit, the access time is controlled by t_{CAA} and t_{CAC} .
8. t_{WCS} , t_{RWD} , t_{AWD} and t_{CWD} are not restrictive operating parameters.
9. $t_{WCS}(\text{min.})$ must be satisfied in an Early Write Cycle.
10. t_{DS} and t_{DH} are referenced to the latter occurrence of $\overline{\text{CAS}}$ or $\overline{\text{WE}}$.
11. t_T is measured between $V_{IH}(\text{min.})$ and $V_{IL}(\text{max.})$. AC-measurements assume $t_T = 1.5 \text{ ns}$.

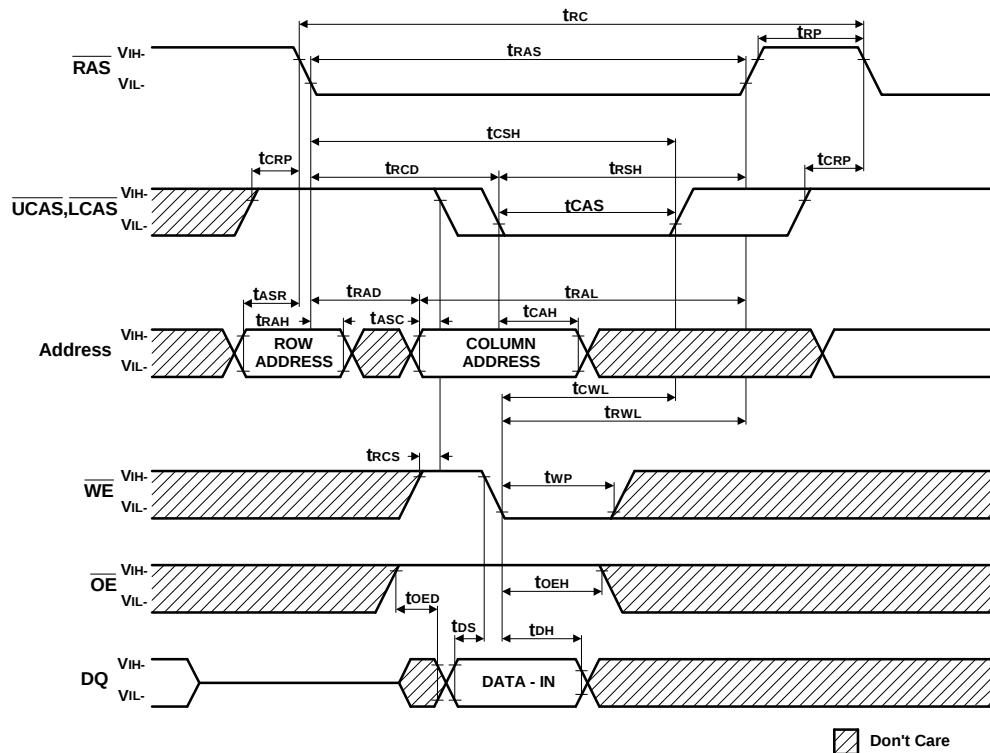
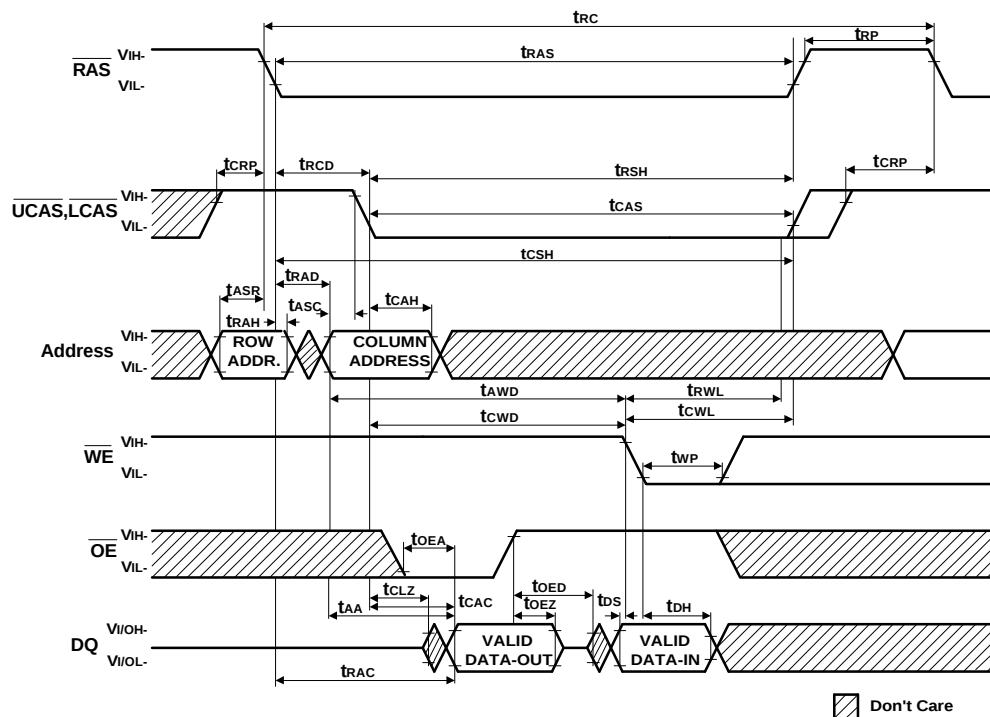
Read CYCLE Note : D_{IN} = OPEN



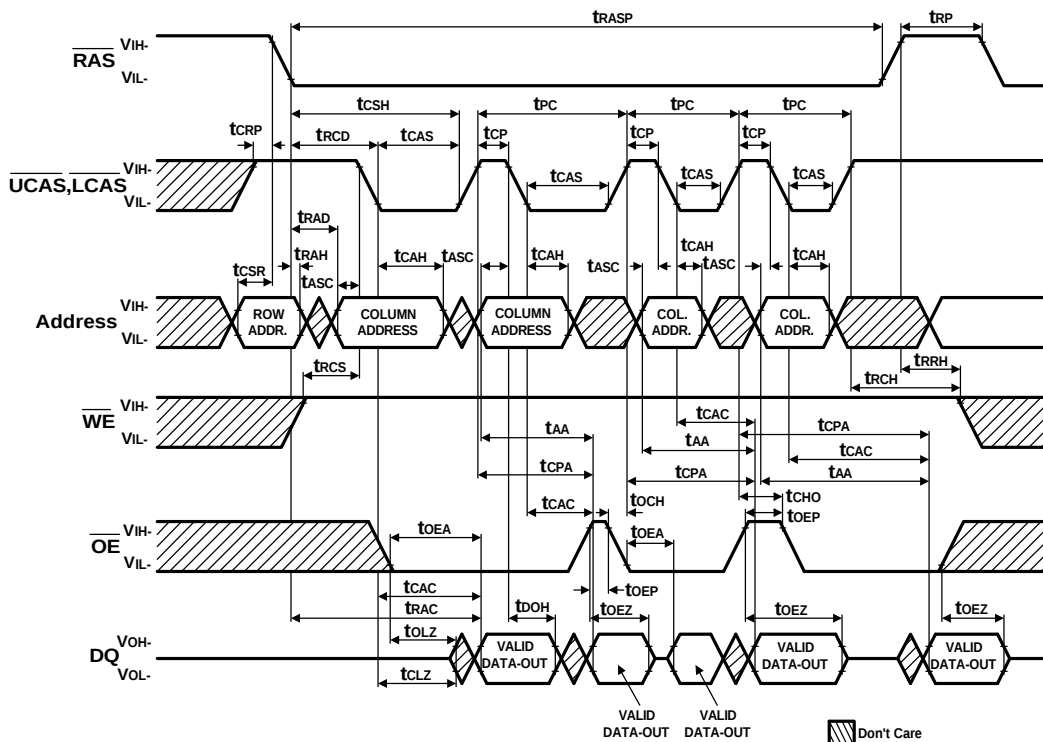
☐ Don't Care

Early Write Cycle NOTE : D_{OUT} = OPEN

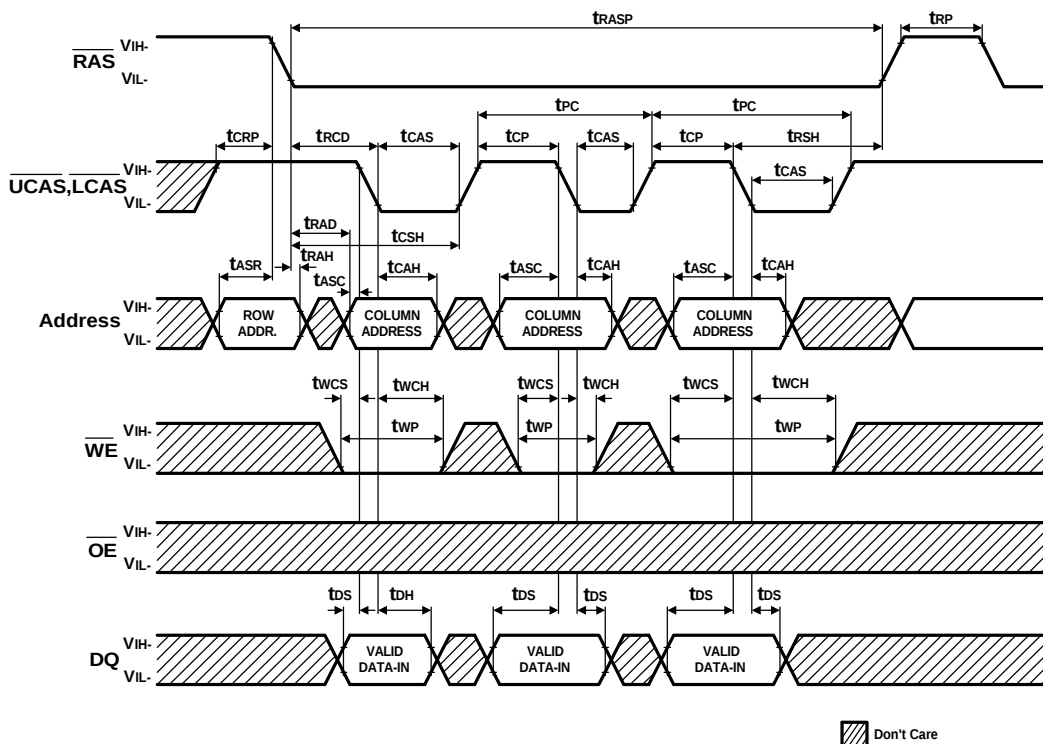
☐ Don't Care

OE Controlled Write Cycle NOTE : $D_{OUT} = OPEN$

Read - Modify - Write Cycle


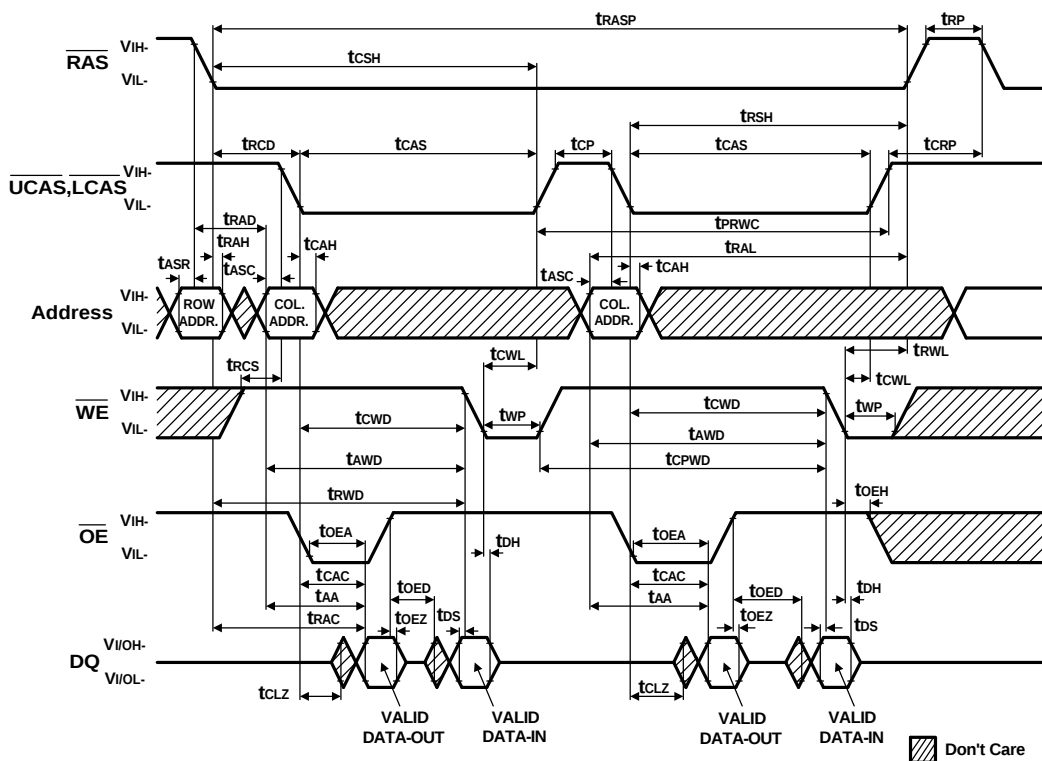
EDO Page Mode Read Cycle



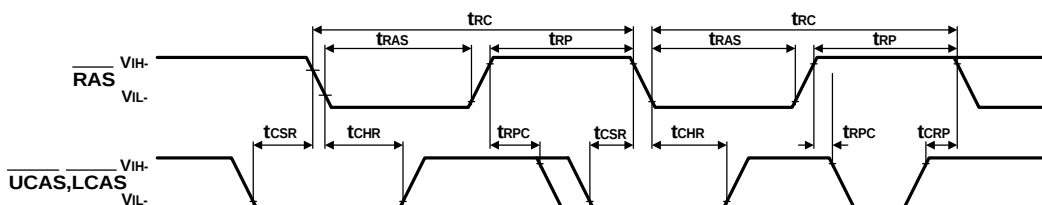
EDO Page Mode Early Write Cycle NOTE : D_{OUT} = OPEN



EDO Page Mode Read - Modify - Write Cycle

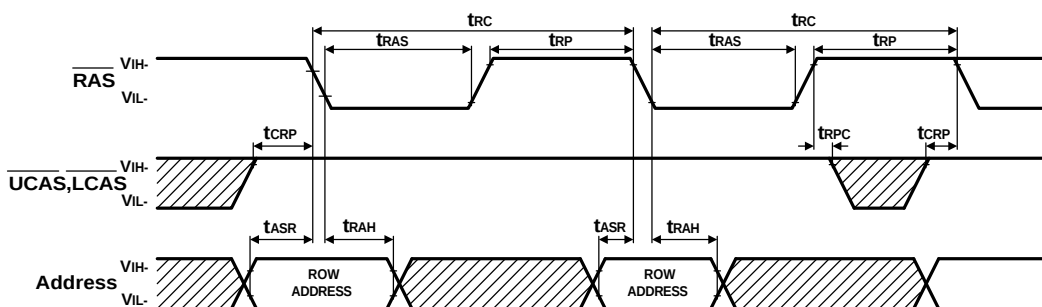


CAS - Before - **RAS** Refresh Cycle



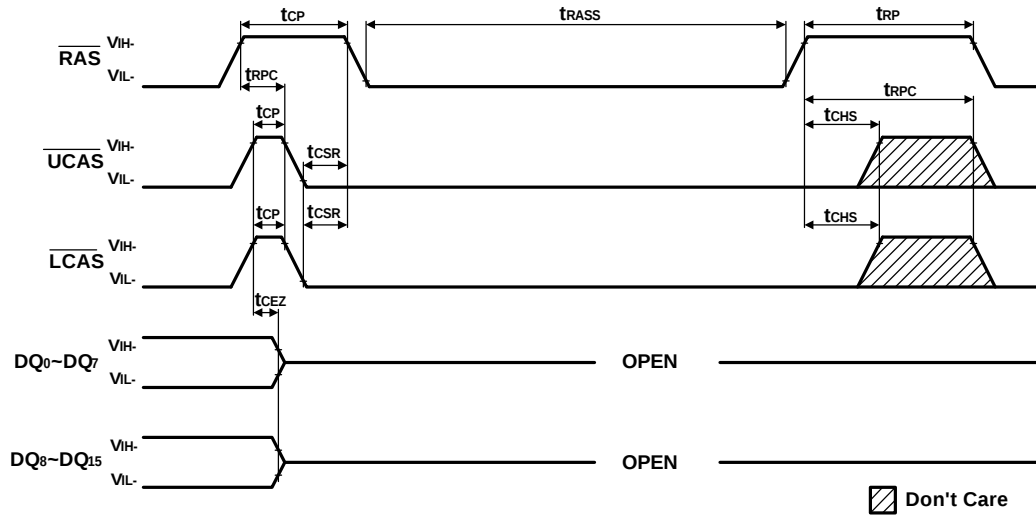
Remark Address, WE, OE : Don't care DO : Hi-Z

RAS -Only Refresh Cycle

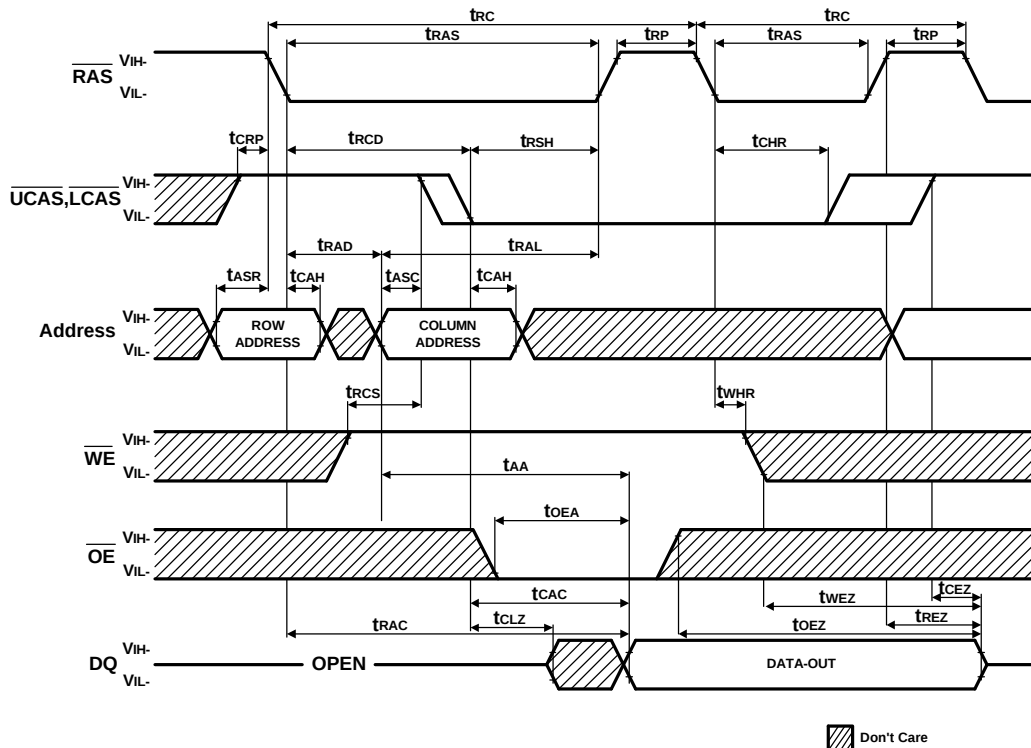


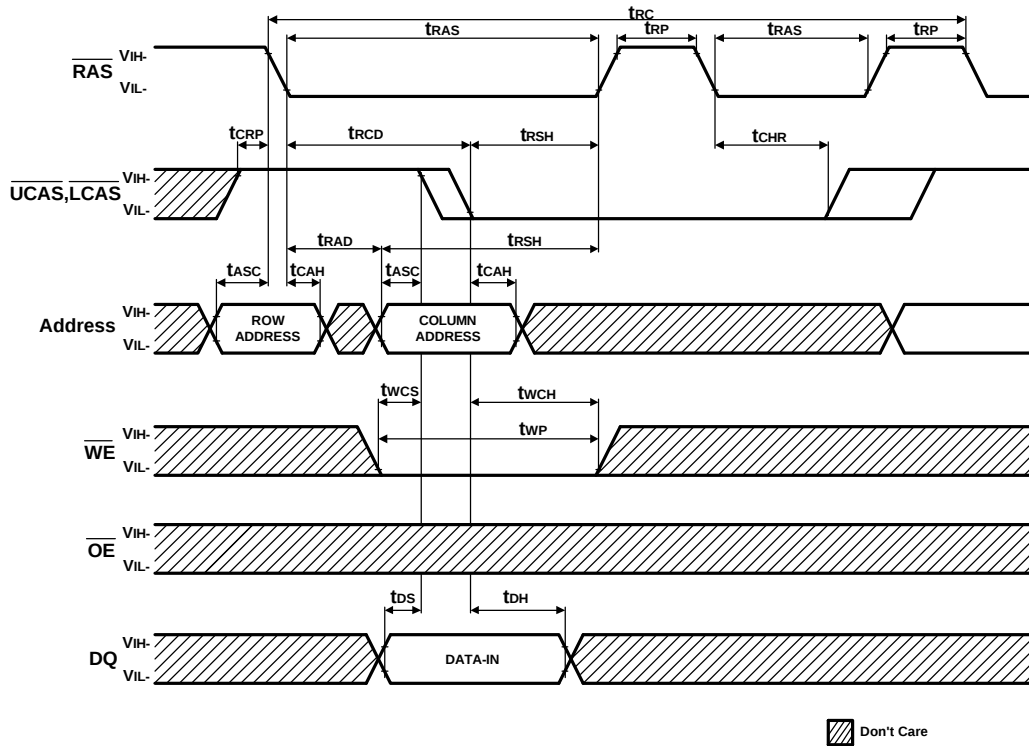
Remark WE, OE : Don't care DQ : Hi-Z

CAS - Before - RAS Self Refresh Cycle

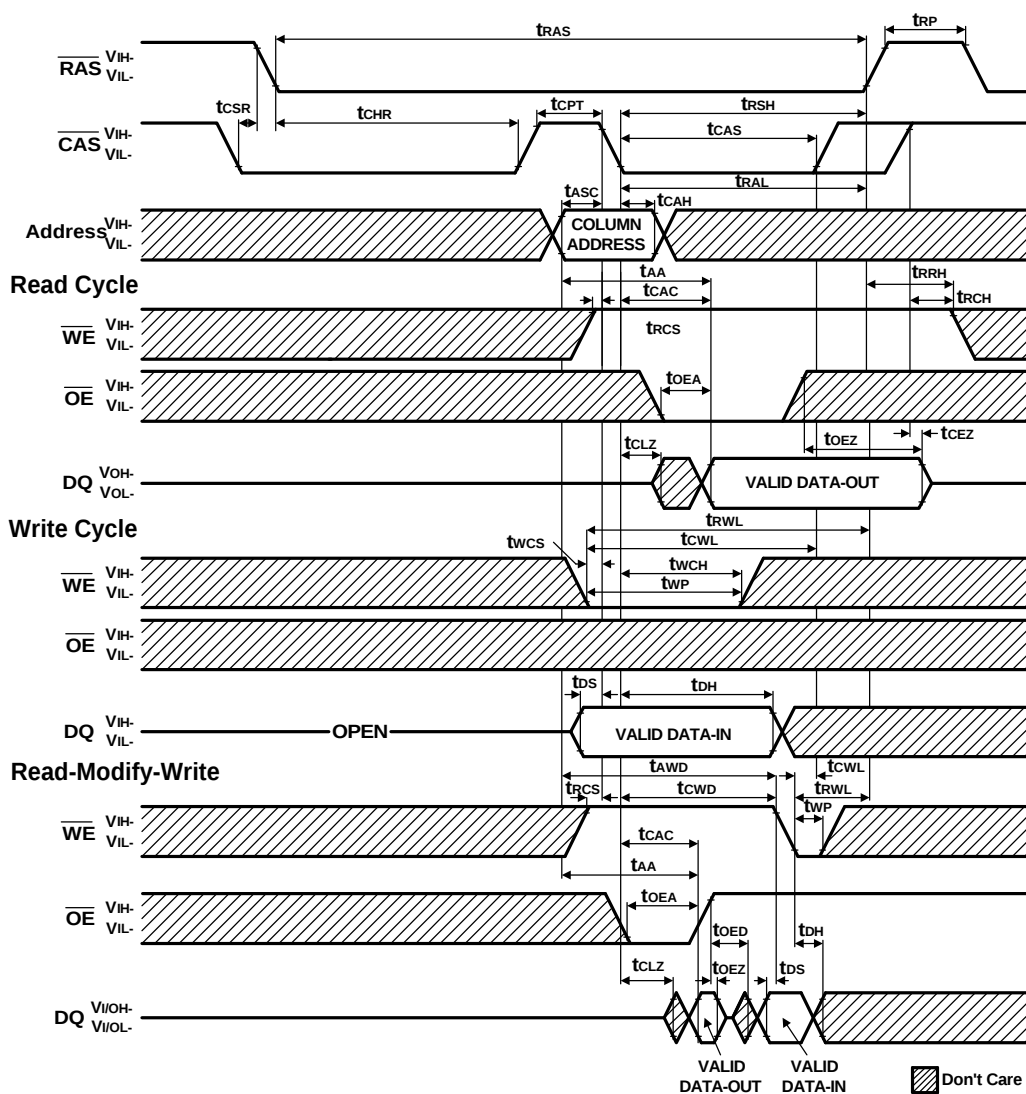


Hidden Refresh Cycle (Read)



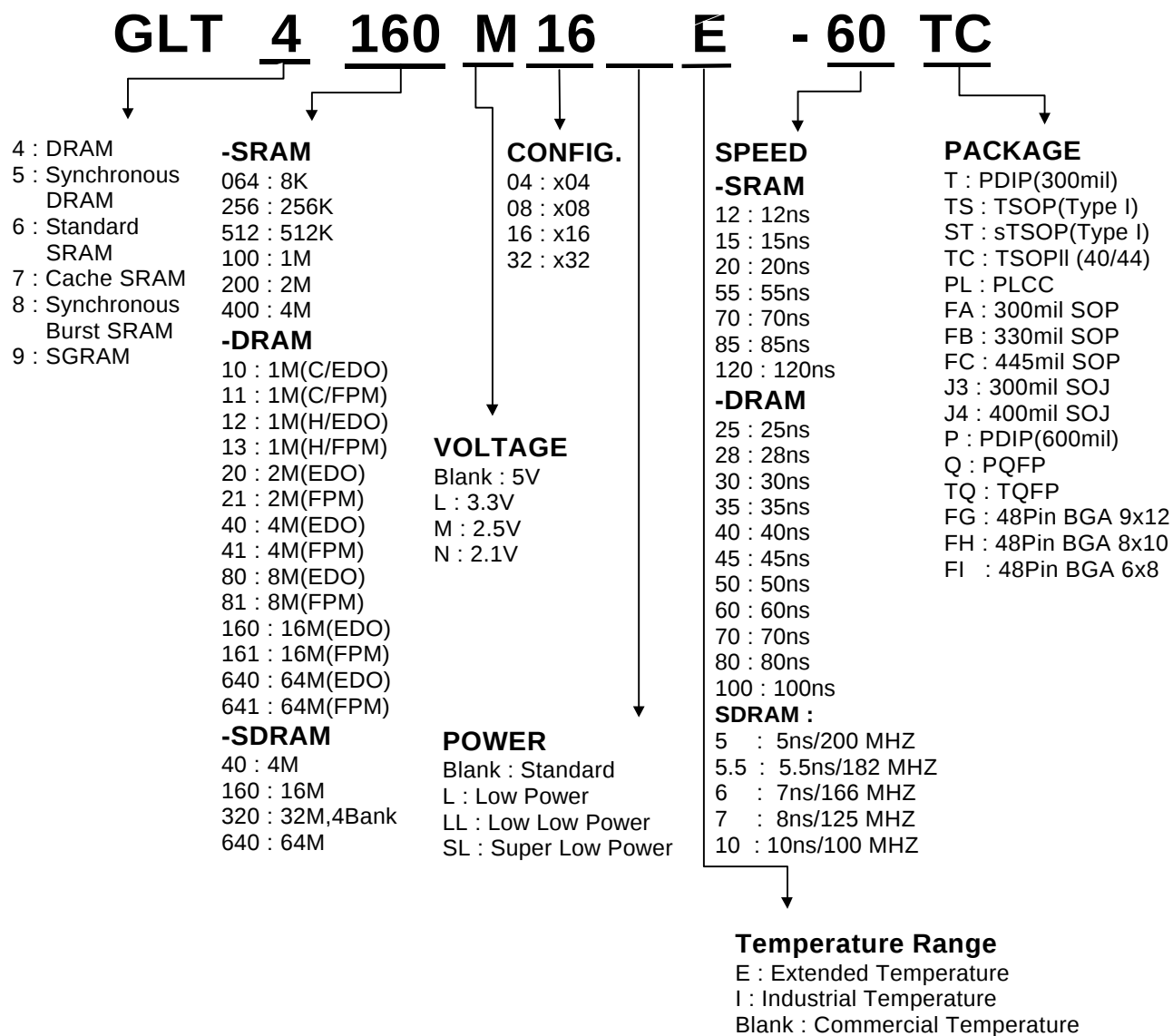
Hidden Refresh Cycle (Write) NOTE : D_{OUT} = OPEN


CAS –Before- RAS Refresh Counter Test Cycle



**GLT4160M16****1M X 16 CMOS DYNAMIC RAM WITH EXTENDED DATA OUTPUT***Dec 2001 (Rev.1.1)***Ordering Information**

<i>Part Number</i>	<i>SPEED</i>	<i>POWER</i>	<i>FEATURE</i>	<i>PACKAGE</i>
GLT4160M16-60TC	60ns	Normal	EDO	44/50L 400mil TSOPII
GLT4160M16-70TC	70ns	Normal	EDO	44/50L 400mil TSOPII
GLT4160M16-80TC	80ns	Normal	EDO	44/50L 400mil TSOPII
GLT4160M16E-60TC	60ns	Normal	EDO	44/50L 400mil TSOPII
GLT4160M16E-70TC	70ns	Normal	EDO	44/50L 400mil TSOPII
GLT4160M16E-80TC	80ns	Normal	EDO	44/50L 400mil TSOPII

Parts Numbers (Top Mark) Definition :


Package Information

44/50L TSOPII 400MIL

