

**Features :**

- \* 262,144 words by 16 bits organization.
- \* Fast  $\overline{\text{RAS}}$  access time and cycle time.
- \* Dual  $\overline{\text{CAS}}$  Input.
- \* Low power dissipation.
- \*  $\overline{\text{Read-Modify-Write}}$ ,  $\overline{\text{RAS-Only Refresh}}$ ,  $\overline{\text{CAS-Before-RAS Refresh}}$ , Hidden Refresh and Test Mode Capability.
- \* 512 refresh cycles per 8ms.
- \* Available in 40-Pin 400 mil SOJ and 40/44 Pin TSOP(II)
- \* Single +3.3V±10% Power Supply.
- \* All inputs and Outputs are TTL compatible.
- \* Extended Data-Out(EDO) Page Mode operation.

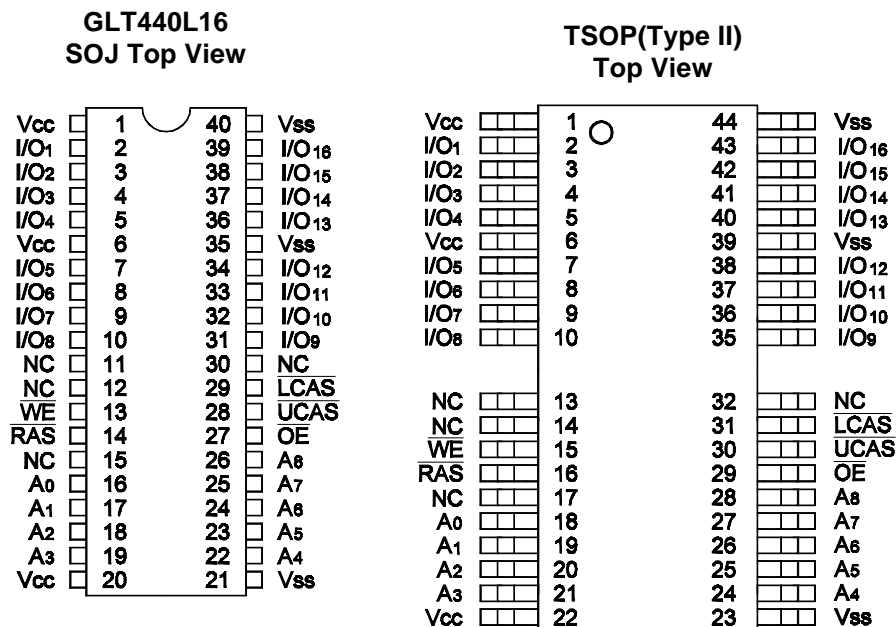
**Description :**

The GLT440L16 is a 262,144 x 16 bit high-performance CMOS dynamic random access memory. The GLT440L16 offers Fast Page mode with Extended Data Output, and has both  $\overline{\text{BYTE WRITE}}$  and  $\overline{\text{WORD WRITE}}$  access cycles via two  $\overline{\text{CAS}}$  pins. The GLT440L16 has symmetric address and accepts 512-cycle refresh in 8ms interval.

All inputs are TTL compatible. EDO Page Mode operation allows random access up to 512 x 16 bits within a page, with cycle time as short as 14ns.

The GLT440L16 is best suited for graphics, and DSP applications requiring high performance memories.

<b>HIGH PERFORMANCE</b>	<b>35</b>	<b>40</b>	<b>50</b>
Max. $\overline{\text{RAS}}$ Access Time, ( $t_{\text{RAC}}$ )	35 ns	40 ns	50 ns
Max. Column Address Access Time, ( $t_{\text{CAA}}$ )	13 ns	20 ns	25 ns
Min. Extended Data Out Page Mode Cycle Time, ( $t_{\text{PC}}$ )	14 ns	15 ns	19 ns
Min. Read/Write Cycle Time, ( $t_{\text{RC}}$ )	45 ns	75 ns	90 ns
Max. $\overline{\text{CAS}}$ Access Time, ( $t_{\text{CAC}}$ )	11 ns	12 ns	13 ns

**Pin Configuration :**

**Pin Descriptions:**

Name	Function
A <sub>0</sub> - A <sub>8</sub>	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 <sub>1</sub> - DQ <sub>16</sub>	Data Inputs / Outputs
V <sub>CC</sub>	+3.3V Power Supply
V <sub>SS</sub>	0V Supply
NC	No Connection

**Absolute Maximum Ratings\***

Operating Temperature,  $T_A$  (ambient)  
 .....-10°C to +70°C  
 Storage Temperature(plastic)....-55°C to +150°C  
 Voltage Relative to  $V_{SS}$ .....-1.0V to + 4.6V  
 Short Circuit Output Current.....50mA  
 Power Dissipation.....1.0W

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

**Capacitance\***

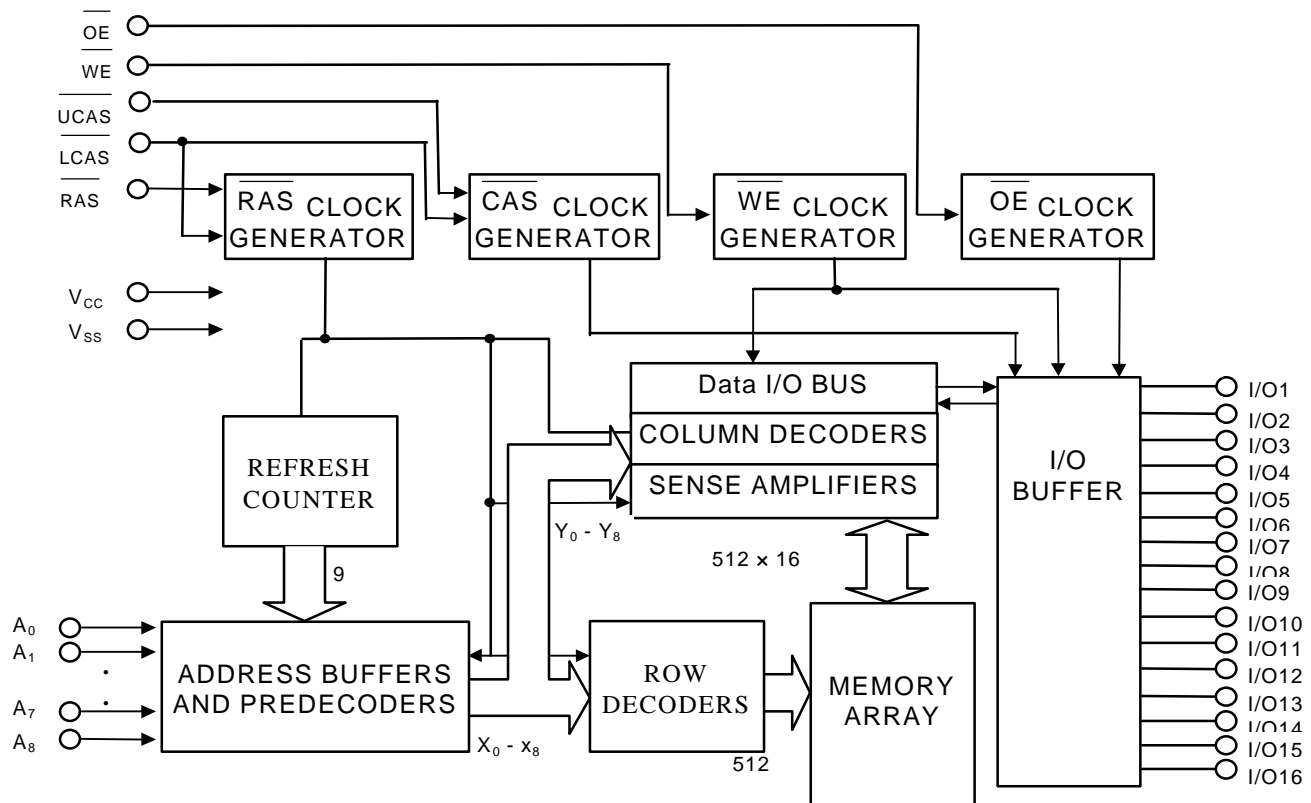
$T_A=25^\circ\text{C}$ ,  $V_{CC}=3.3\text{V}\pm 10\%$ ,  $V_{SS}=0\text{V}$

Symbol	Parameter	Typ	Max.	Unit
$C_{IN1}$	Address Input	3	4	pF
$C_{IN2}$	$\overline{\text{RAS}}$ , $\overline{\text{LCAS}}$ , $\overline{\text{UCAS}}$ , $\overline{\text{WE}}$ , $\overline{\text{OE}}$	4	5	pF
$C_{OUT}$	Data Input/Output	5	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 100 $\mu\text{s}$  and then, execute eight  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  or  $\overline{\text{RAS}}$ -only refresh cycles as dummy cycles to initialize internal circuit.

**Block Diagram :**


**Truth Table: GLT440L16**

Function		$\overline{\text{RAS}}$	$\overline{\text{CASL}}$	$\overline{\text{CASH}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	ADDRESS	DQs	Notes
Standby		H	H	H	X	X		High-Z	
Read: Word		L	L	L	H	L	ROW/COL	Data Out	
Read: Lower Byte		L	L	H	H	L	ROW/COL	Lower Byte,Data-Out Upper Byte,High-Z	
Read: Upper Byte		L	H	L	H	L	ROW/COL	Lower Byte,High-Z Upper Byte,Data-Out	
Write: Word(Early Write)		L	L	L	L	X	ROW/COL	Data-In	
Write: Lower Byte (Early)		L	L	H	L	X	ROW/COL	Lower Byte,Data-In Upper Byte,High-Z	
Write: Upper Byte (Early)		L	H	L	L	X	ROW/COL	Lower Byte,High-Z Upper Byte,Data-In	
Read Write		L	L	L	H→L	L→H	ROW/COL	Data-Out,Data-In	1,2
EDO-Page-Mode Read	1st Cycle	L	H→L	H→L	H	L	ROW/COL	Data-Out	2
	2nd Cycle	L	H→L	H→L	H	L	COL	Data-Out	2
EDO-Page-Mode Write	1st Cycle	L	H→L	H→L	L	X	ROW/COL	Data-In	2
	2nd Cycle	L	H→L	H→L	L	X	COL	Data-In	2
EDO-Page-Mode Read-Write	1st Cycle	L	H→L	H→L	H→L	L→H	ROW/COL	Data-Out,Data-In	1,2
	2nd Cycle	L	H→L	H→L	H→L	L→H	COL	Data-Out,Data-In	1,2
Hidden Refresh	Read	L→H→L	L	L	H	L	ROW/COL	Data-Out	2
	Write	L→H→L	L	L	H	L	ROW/COL	Data-In	2
$\overline{\text{RAS}}$ -Only Refresh		L	H	H	X	X	ROW	High-Z	
CBR Refresh		H→L	L	L	X	X		High-Z	3

**Notes:**

1. These READ cycles may also be BYTE READ cycles (either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$  active).
2. These WRITE cycles may also be BYTE READ cycles (either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$  active).
3. EARLY WRITE only.
4. At least one of the two CAS signals must be active ( $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ ).

**DC and Operating Characteristics (1-2)**
 $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V} \pm 10\%$ ,  $V_{SS} = 0\text{V}$ , unless otherwise specified.

Sym.	Parameter	Test Conditions	Access Time	Min.	Typ	Max.	Unit	Notes
$I_{LI}$	Input Leakage Current (any input pin)	$0\text{V} \leq V_{IN} \leq 5.5\text{V}$ (All other pins not under test=0V)		-10		+10	$\mu\text{A}$	
$I_{LO}$	Output Leakage Current (for High-Z State)	$0\text{V} \leq V_{out} \leq 5.5\text{V}$ Output is disabled (Hiz)		-10		+10	$\mu\text{A}$	
$I_{CC1}$	Operating Current, Random READ/WRITE	$t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			160 145 125	mA	1,2
$I_{CC2}$	Standby Current,(TTL)	$\overline{\text{RAS}}, \overline{\text{UCAS}}, \overline{\text{LCAS}}$ at $V_{IH}$ other inputs $\geq V_{SS}$				4	mA	
$I_{CC3}$	Refresh Current, RAS-Only	$\overline{\text{RAS}}$ cycling, $\overline{\text{UCAS}},$ $\overline{\text{LCAS}}$ at $V_{IH}$ $t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			160 145 125	mA	2
$I_{CC4}$	Operating Current, EDO Page Mode	$\overline{\text{RAS}}$ at $V_{IL},$ $\overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{PC} = t_{PC}(\text{min.})$	$t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			160 145 125	mA	1,2
$I_{CC5}$	Refresh Current, CAS Before RAS	$\overline{\text{RAS}}, \overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			160 145 125	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 $V_{SS}$				1	mA	
$V_{CC}$	Supply Voltage			3.0		3.6	V	
$V_{IL}$	Input Low Voltage			-0.3		0.8	V	3
$V_{IH}$	Input High Voltage			2.0V		$V_{CC} + 0.3$	V	3
$V_{OL}$	Output Low Voltage	$I_{OL} = 2\text{mA}$				0.4	V	
$V_{OH}$	Output High Voltage	$I_{OH} = -2\text{mA}$		2.4			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  $-0.3\text{V}$  for a period not to exceed 20ns. All AC parameters are measured with  $V_{IL}(\text{min.}) \geq V_{SS}$  and  $V_{IH}(\text{max.}) \leq V_{CC}$ .

**AC Characteristics**

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6F, No. 24-2, Industry E, RD, IV, Science Based  
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$T_A = 0^\circ\text{C to } 70^\circ\text{C}$  ,  $V_{CC} = 3.3\text{ V} \pm 10\%$   $V_{IH}/V_{IL} = 2.0/0.8\text{V}$  ,  $V_{OH}/V_{OL} = 2.0/0.8\text{V}$ 

 An initial pause of 100  $\mu\text{s}$  and 8 CAS -before-RAS or RAS-only refresh cycles are required after power-up.

Parameter	Symbol	35		40		50		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
Read or Write Cycle Time	$t_{RC}$	70		75		90		ns	
Read Modify write Cycle Time	$t_{RWC}$	90		93		109		ns	
RAS Precharge Time	$t_{RP}$	25		25		30		ns	
RAS Pulse Width	$t_{RAS}$	35	75k	40	100k	50	100k	ns	
Access Time from RAS	$t_{RAC}$		35		40		50	ns	1,2,3
Access Time from CAS	$t_{CAC}$		11		12		13	ns	1,5,10
Access Time from Column Address	$t_{AA}$		18		20		25	ns	1,5,6
CAS to Output Low-Z	$t_{CLZ}$	0		0		0		ns	
CAS to Output High-Z	$t_{CEZ}$	3	8	3	8	3	8	ns	
RAS Hold Time	$t_{RSH}$	10		12		14		ns	
RAS Hold Time Referenced to OE	$t_{ROH}$	7		8		9		ns	
CAS Hold Time	$t_{CSH}$	34		34		45		ns	
CAS Pulse width	$t_{CAS}$	6		6		8		ns	
RAS to CAS Delay Time	$t_{RCD}$	13	24	18	28	19	37	ns	
RAS to Column Address Delay Time	$t_{RAD}$	10	17	13	20	14	25	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	$t_{RAH}$	6		8		9		ns	
Column Address Set-Up Time	$t_{ASC}$	0		0		0		ns	
Column Address Hold Time	$t_{CAH}$	5		6		7		ns	
Column Address to RAS Lead Time	$t_{RAL}$	18		20		25		ns	
Column Address Hold Time Referenced to RAS	$t_{AR}$	25		34		44		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	$t_{WCH}$	5		6		7		ns	
Write Command Pulse Width	$t_{WCP}$	5		6		7		ns	
Write Command to RAS Lead Time	$t_{RWL}$	10		12		13		ns	

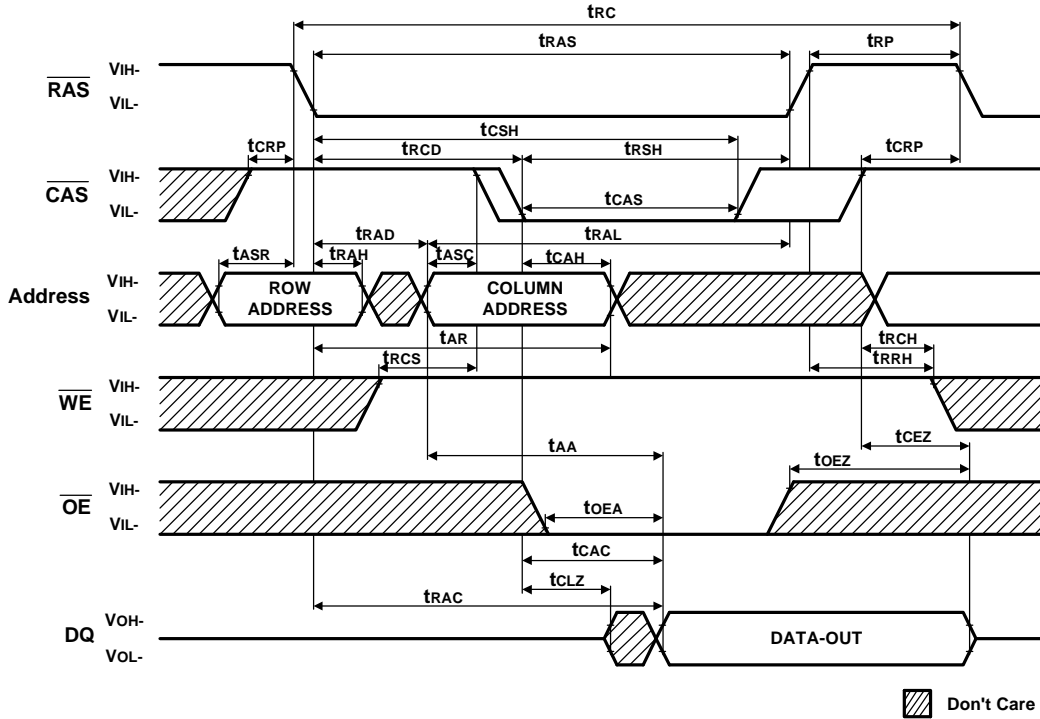
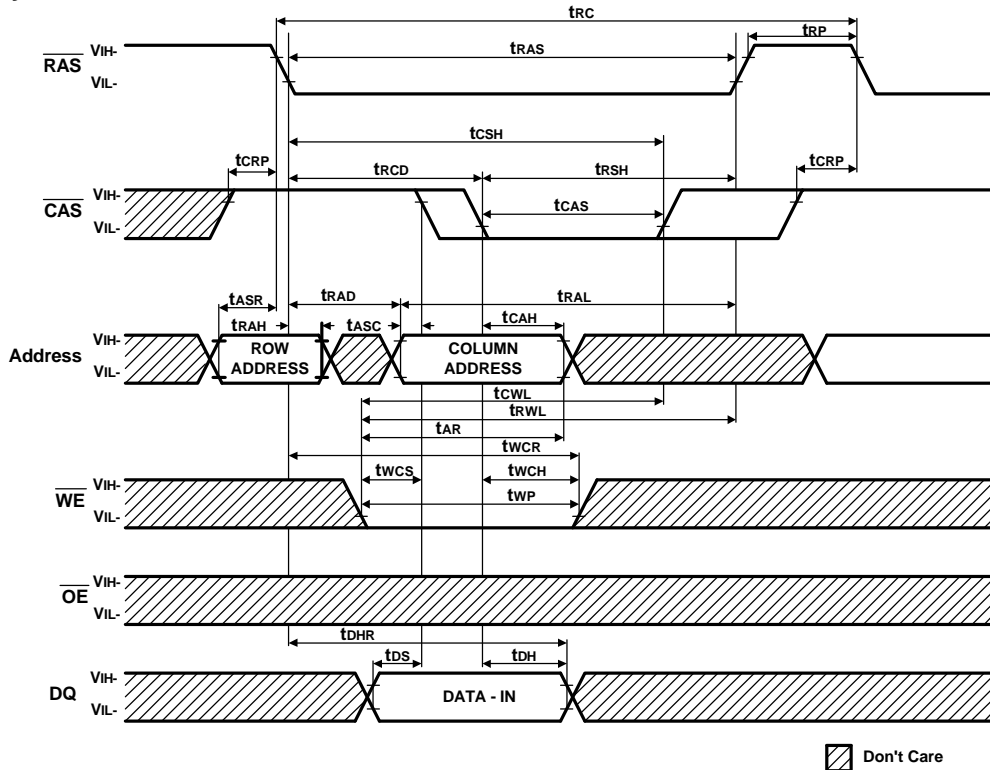
## AC Characteristics

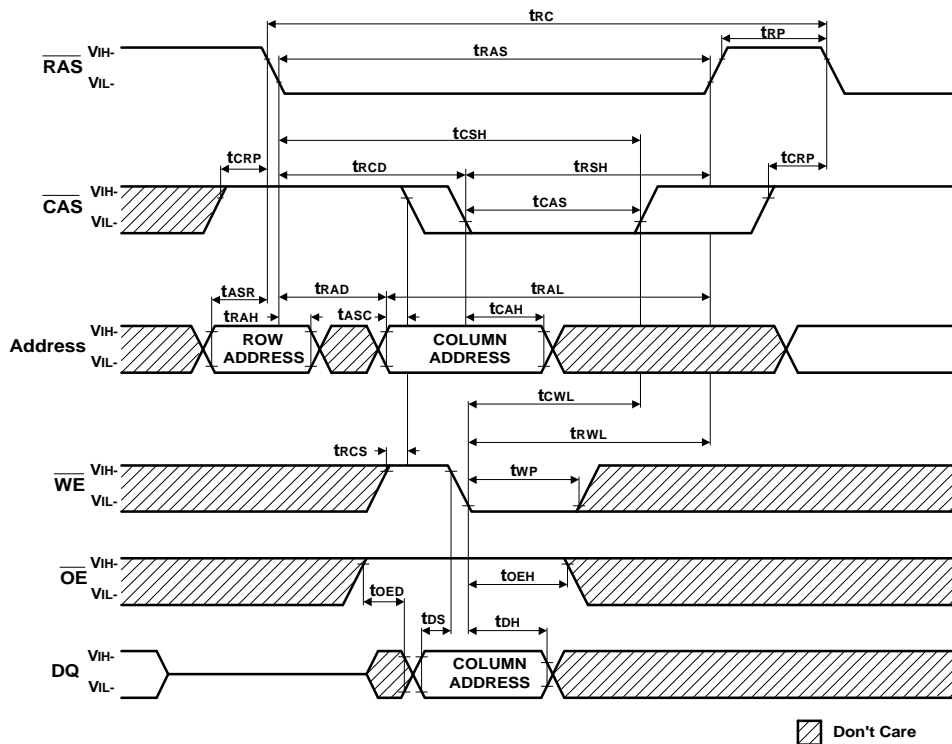
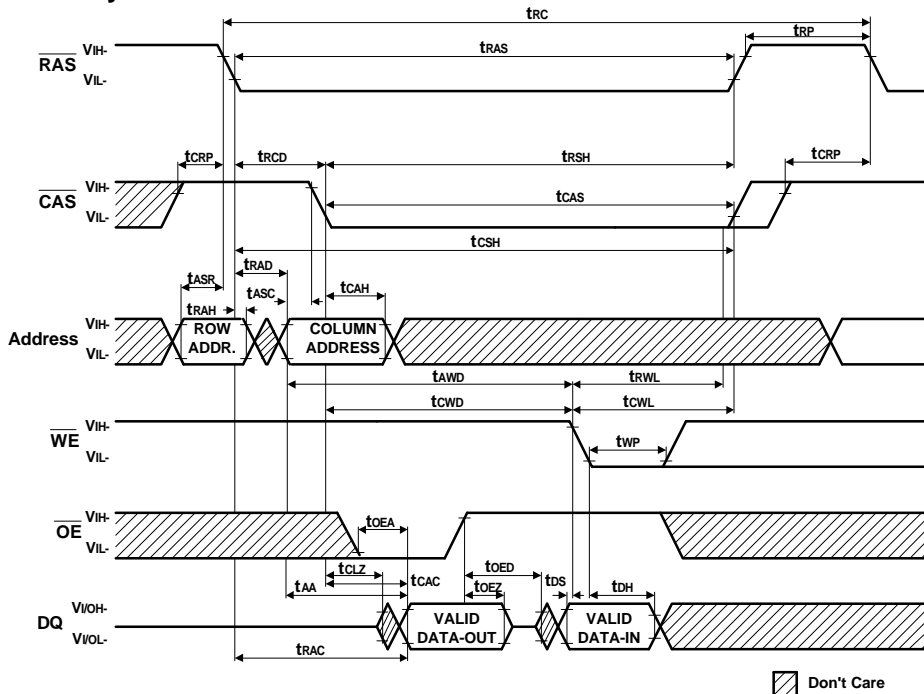
Parameter	Symbol	35		40		50		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
Write Command to $\overline{\text{CAS}}$ Lead Time	$t_{\text{CWL}}$	8		12		13		ns	
Data Set-Up Time	$t_{\text{DS}}$	0		0		0		ns	
Data Hold Time	$t_{\text{DH}}$	5		8		9		ns	
Data Hold Time Referenced to $\overline{\text{RAS}}$	$t_{\text{DHR}}$	25		36		46		ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	$t_{\text{RWD}}$	46		54		64		ns	
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	$t_{\text{CWD}}$	23		24		25		ns	
Column Address to $\overline{\text{WE}}$ Delay Time	$t_{\text{AWD}}$	29		32		37		ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Precharge Time	$t_{\text{RPC}}$	0		0		0		ns	
Access Time from $\overline{\text{CAS}}$ Precharge	$t_{\text{CPA}}$		20		22		30	ns	
EDO Page Mode Cycle Time	$t_{\text{PC}}$	14		15		20		ns	
EDO Page Mode Read-Modify-write Cycle Time	$t_{\text{PRWC}}$	45		50		59		ns	
$\overline{\text{CAS}}$ Precharge Time (EDO Page Mode)	$t_{\text{CP}}$	4		5		8		ns	
$\overline{\text{RAS}}$ Pulse Width (EDO Page Mode Only)	$t_{\text{RASP}}$	35	100k	40	100k	50	100k	ns	
Access Time from $\overline{\text{OE}}$	$t_{\text{OEA}}$		11		12		13	ns	
$\overline{\text{OE}}$ to Data Delay Time	$t_{\text{OED}}$	5		8		8		ns	
$\overline{\text{OE}}$ to Output High-Z	$t_{\text{OEZ}}$	3	8	3	8	3	8	ns	
$\overline{\text{OE}}$ Command Hold Time	$t_{\text{OEH}}$	5		7		7		ns	
Data Output Hold after $\overline{\text{CAS}}$ Low	$t_{\text{DOH}}$	3		3		5		ns	
$\overline{\text{RAS}}$ to Output High-Z	$t_{\text{REZ}}$	3	8	3	8	3	8	ns	
$\overline{\text{WE}}$ to Output High-Z	$t_{\text{WEZ}}$	3	10	3	10	3	12	ns	
$\overline{\text{OE}}$ to $\overline{\text{CAS}}$ Hold Time	$t_{\text{OCH}}$	8		8		8		ns	
$\overline{\text{CAS}}$ Hold Time to $\overline{\text{OE}}$	$t_{\text{CHO}}$	8		8		8		ns	
$\overline{\text{OE}}$ Precharge Time	$t_{\text{OEP}}$	8		8		8		ns	
$\overline{\text{CAS}}$ Set-Up Time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Cycle	$t_{\text{CSR}}$	8		10		10		ns	
$\overline{\text{CAS}}$ Hold Time for $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Cycle	$t_{\text{CHR}}$	8		10		10		ns	
Transition Time	$t_{\text{T}}$	2	50	2	50	2	50	ns	
Refresh Period	$t_{\text{REF}}$		8		8		8	ms	

**Notes:**

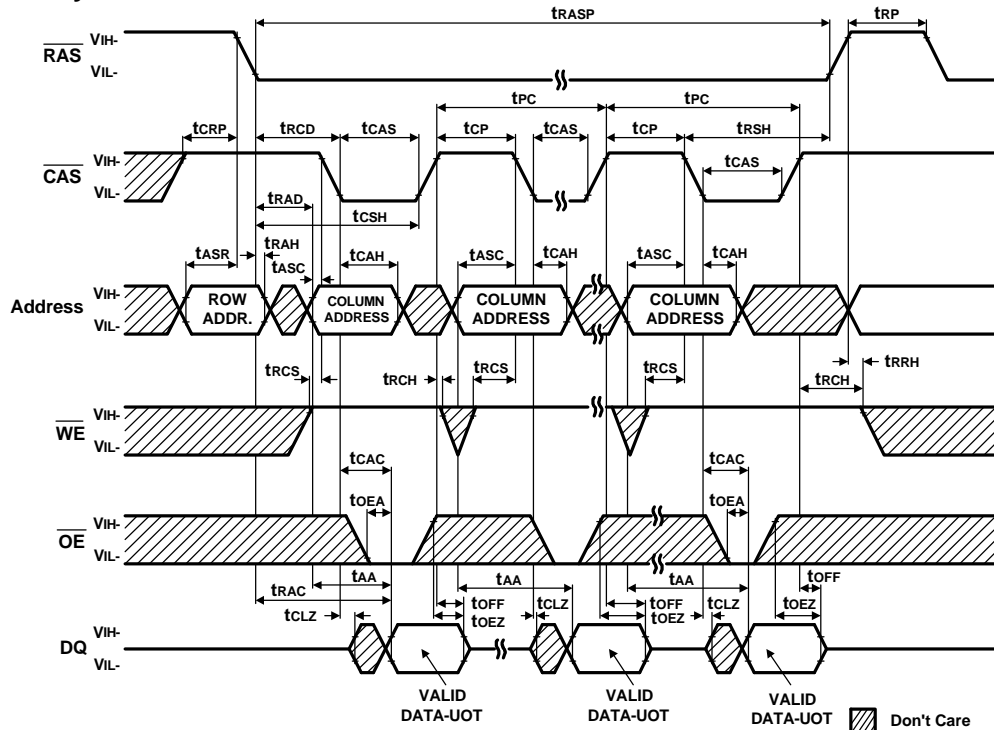
1. Measure with a load equivalent to one TTL inputs and 50 pF.
2. Assumes that  $t_{RCD} \leq t_{RCD}(\text{max.})$ . If  $t_{RCD}$  is greater than  $t_{RCD}(\text{max.})$ , access time will be  $t_{AA}$  dominant.
3. Assumes that  $t_{RAD} \leq t_{RAD}(\text{max.})$ . If  $t_{RAD}$  is greater than  $t_{RCD}(\text{max.})$ , 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  $\overline{\text{CAS}}$  of  $\overline{\text{WE}}$ .  
 $t_T$  is measured between  $V_{IH}(\text{min.})$  and  $V_{IL}(\text{max.})$ . AC-measurements assume  $t_T = 1.5 \text{ ns}$ .



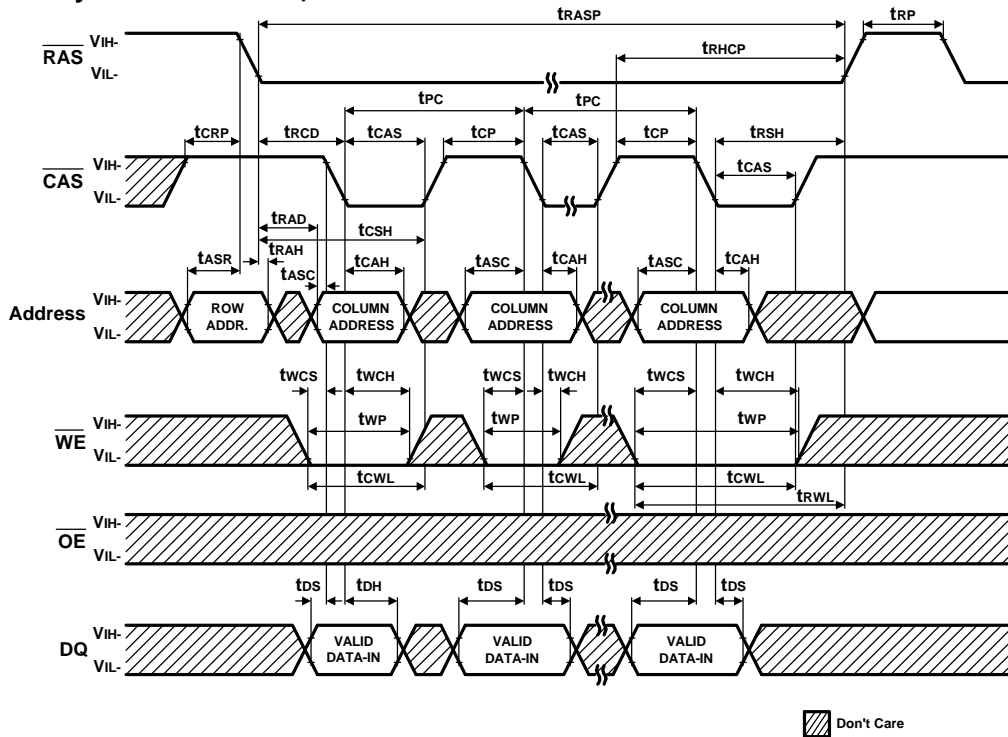
**Read Cycle**

**Early Write Cycle NOTE : D<sub>OUT</sub> = Open**


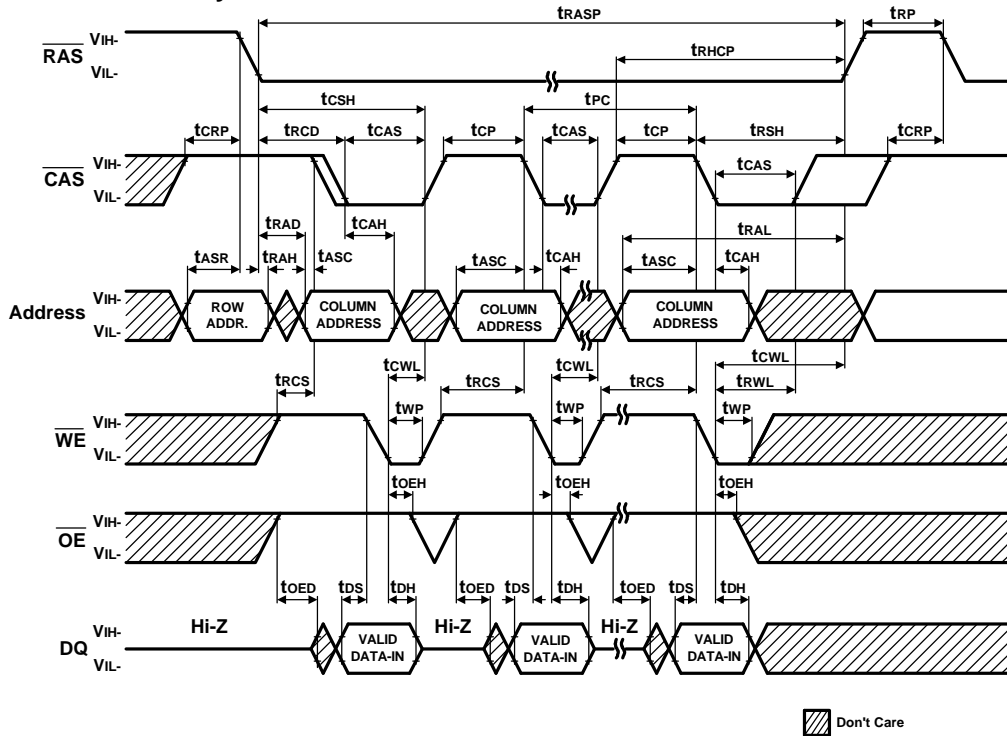
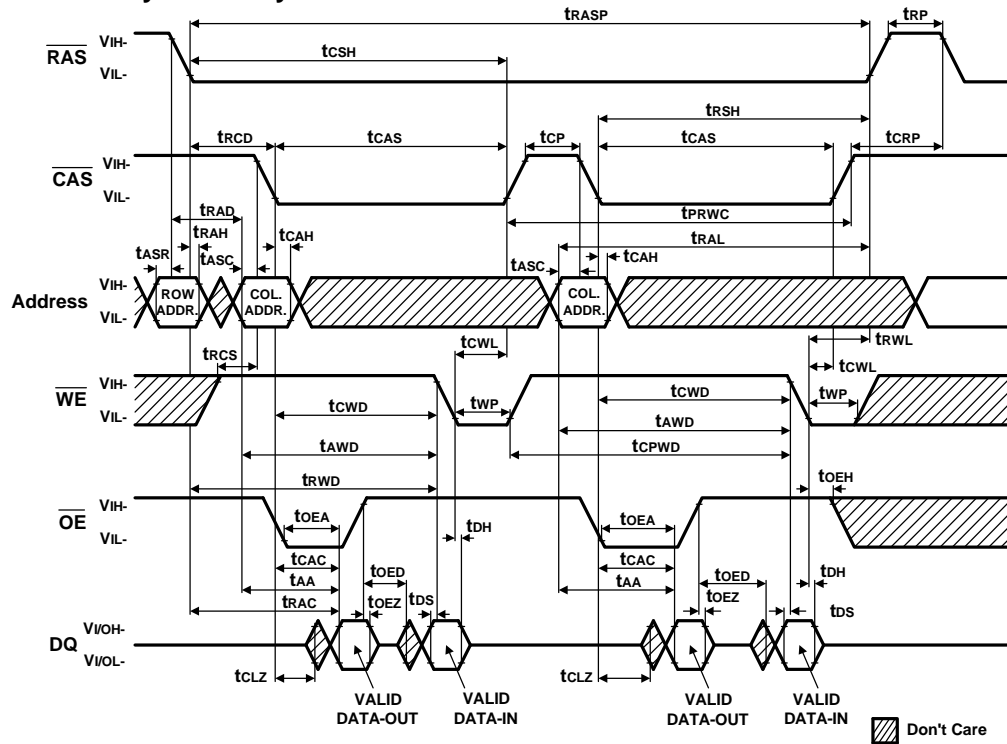
**Late Write Cycle (  $\overline{OE}$  Controlled Write) NOTE :  $D_{OUT} = \text{Open}$** 

**Read - Modify - Write Cycle**


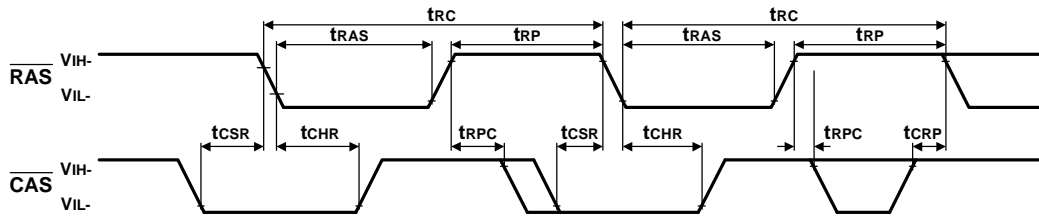
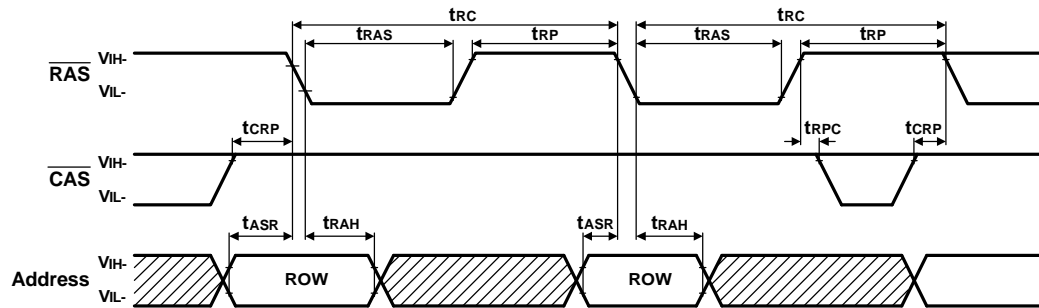
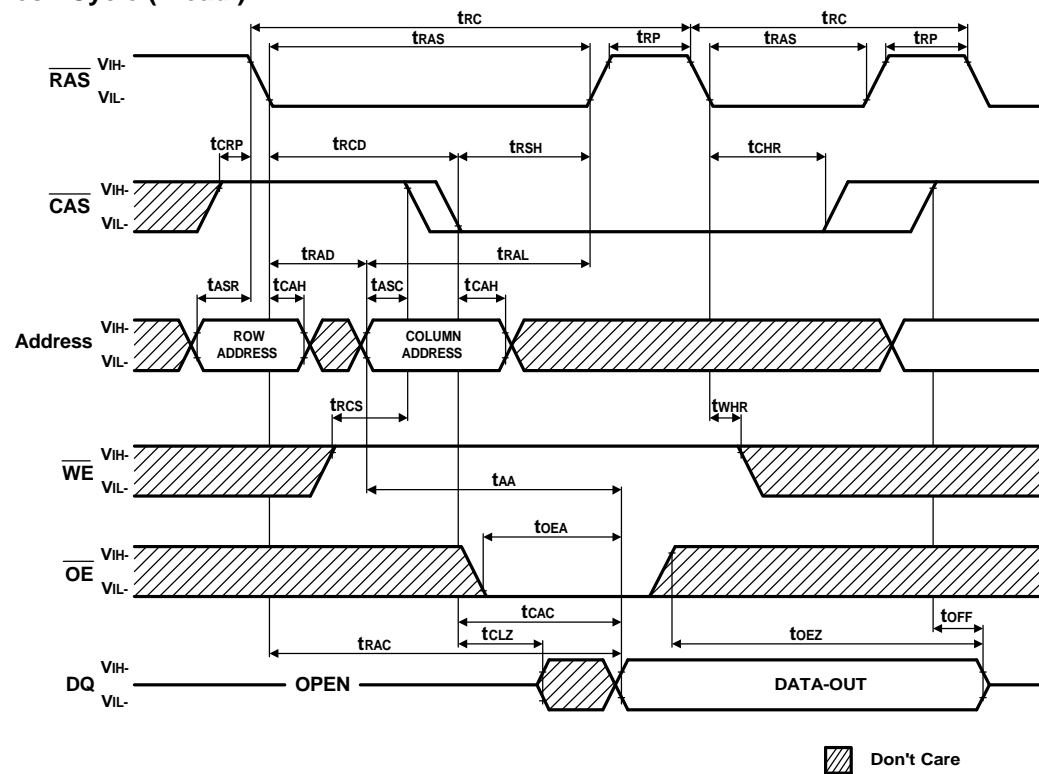
**Fast Page Read Cycle**



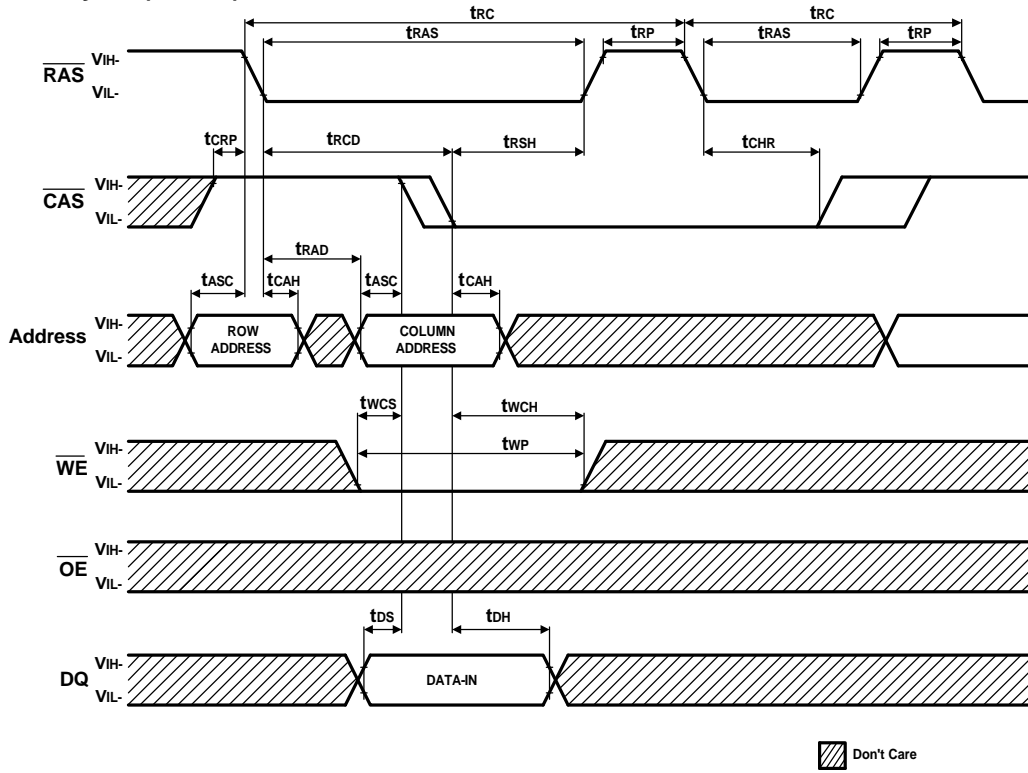
**Fast Page Write Cycle** NOTE : D<sub>OUT</sub> = Open



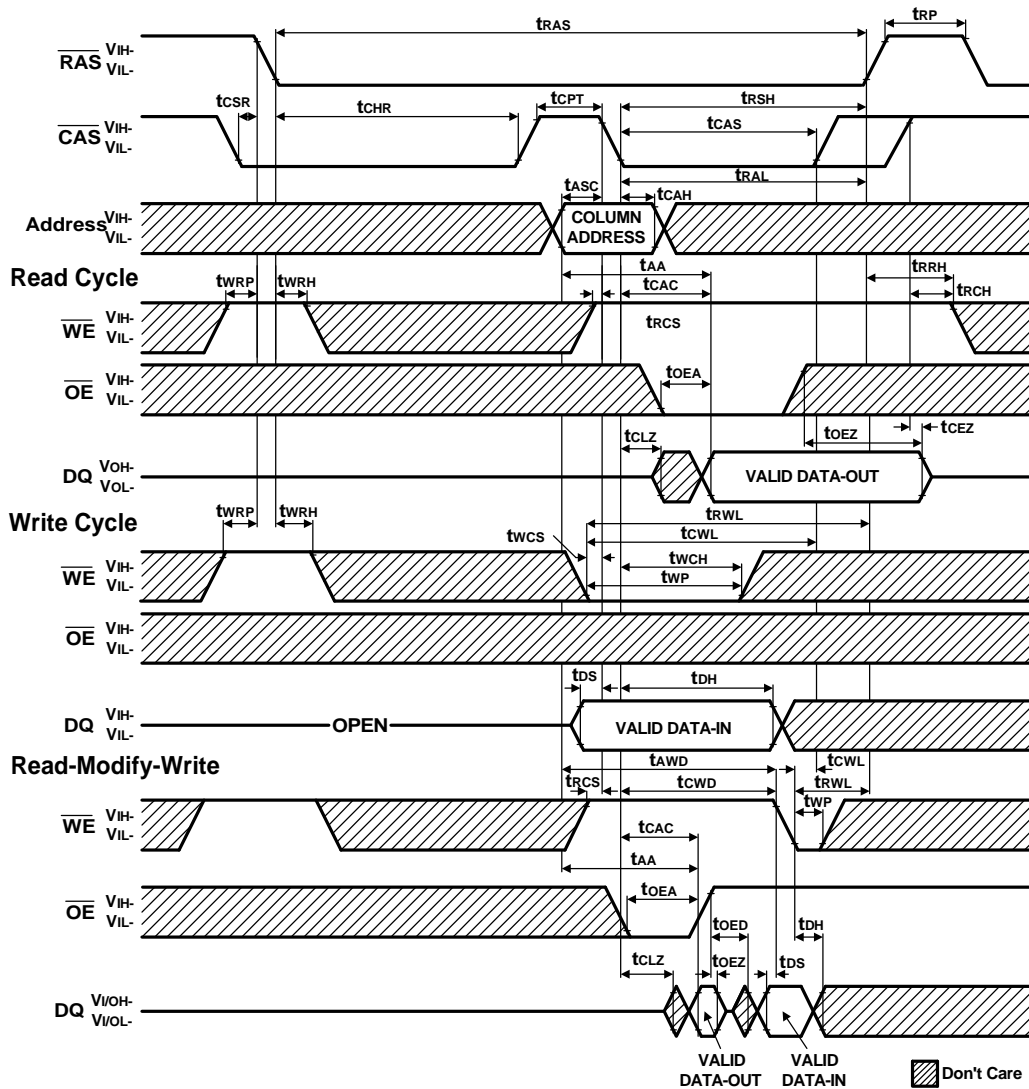
**Fast Page Mode Late Write Cycle**

**Fast Page Read - Modify - Write Cycle**


**CAS Before RAS Refresh Cycle**

**RAS -Only Refresh Cycle**

**Hidden Refresh Cycle ( Read )**


**Hidden Refresh Cycle ( Write ) NOTE : D<sub>OUT</sub> =Open**

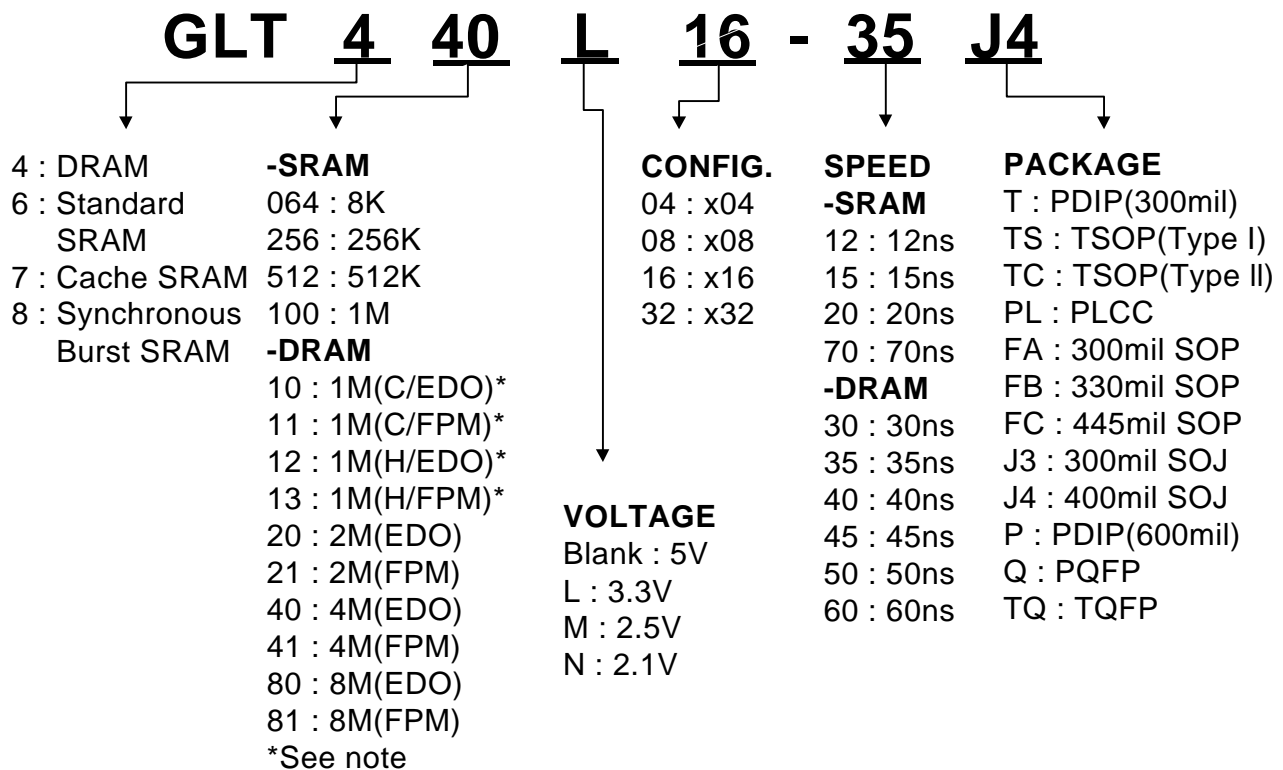


**CAS - Before RAS Refresh Counter Test Cycle**



**Ordering Information**

<b>Part Number</b>	<b>SPEED</b>	<b>POWER</b>	<b>FEATURE</b>	<b>PACKAGE</b>
GLT440L16-35J4	35ns	Normal	EDO	40L 400mil SOJ
GLT440L16-40J4	40ns	Normal	EDO	40L 400mil SOJ
GLT440L16-50J4	50ns	Normal	EDO	40L 400mil SOJ
GLT440L16-35TC	35ns	Normal	EDO	44L 400mil TSOP
GLT440L16-40TC	40ns	Normal	EDO	44L 400mil TSOP
GLT440L16-50TC	50ns	Normal	EDO	44L 400mil TSOP

**Parts Numbers (Top Mark) Definition :**


Note : C→CDROM , H→HDD.

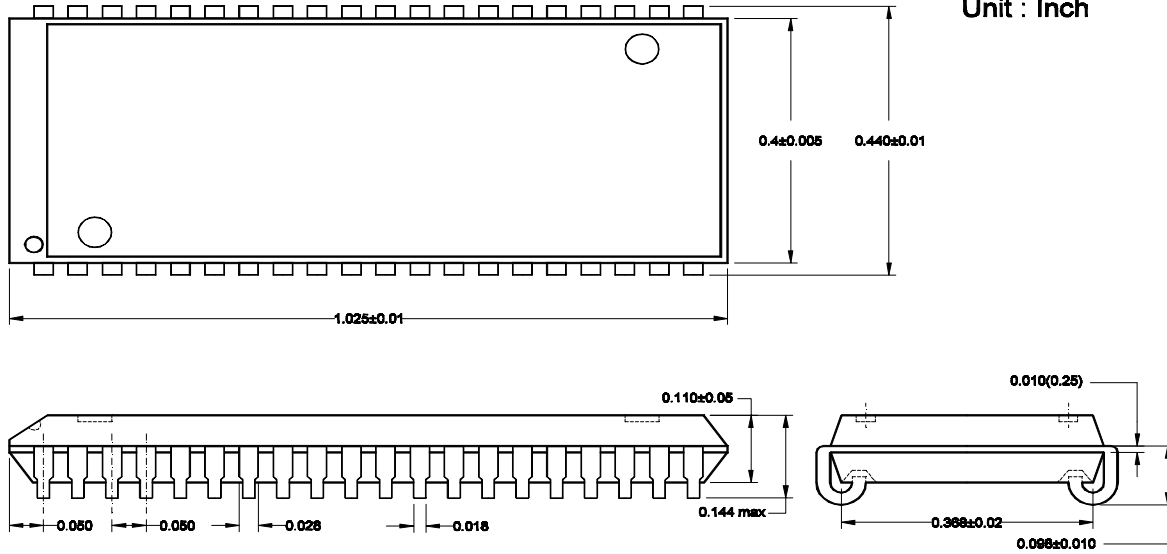
Example :

1. GLT710008-15T    1Mbit(128Kx8)15ns 5V SRAM PDIP(300mil)Package type.
2. GLT44016-40J4    4Mbit(256Kx16)40ns 5V DRAM SOJ(400mil)Package type.



**Package Information**

40/44 Lead Thin Small Outline Package SOJ



40/44 Lead Thin Small Outline Package TSOP(Type II)

