

Features :

- * 262,144 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- $\overline{\text{RAS}}$ 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 5.0V $\pm$ 10% Power Supply.
- * All inputs and Outputs are TTL compatible.
- * Extended Data-Out(EDO) Page Mode operation.

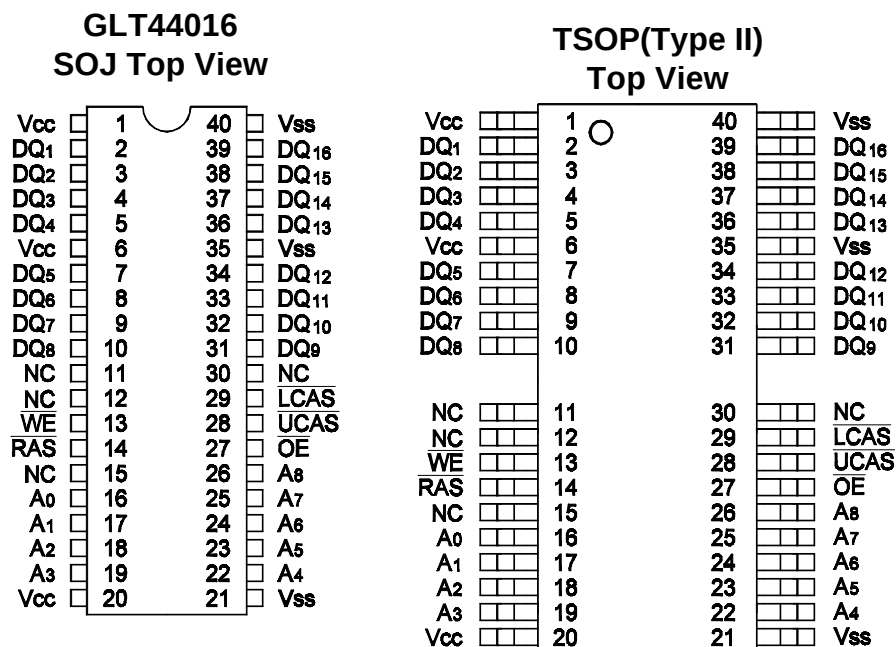
Description :

The GLT44016 is a 262,144 x 16 bit high-performance CMOS dynamic random access memory. The GLT44016 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 GLT44016 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 times as short as 10ns.

The GLT44016 is best suited for graphics, and DSP applications requiring high performance memories.

HIGH PERFORMANCE	25	28	30	35	40	50
Max. $\overline{\text{RAS}}$ Access Time, (t_{RAC})	25 ns	28 ns	30 ns	35 ns	40 ns	50 ns
Max. Column Address Access Time, (t_{CAA})	13 ns	13 ns	16 ns	18 ns	20 ns	25 ns
Min. Extended Data Out Page Mode Cycle Time, (t_{PC})	10 ns	10 ns	12 ns	13 ns	15 ns	20 ns
Min. Read/Write Cycle Time, (t_{RC})	45 ns	45 ns	60 ns	65 ns	70 ns	85 ns
Max. $\overline{\text{CAS}}$ Access Time (t_{CAC})	8 ns	8 ns	10 ns	11 ns	12 ns	14 ns

Pin Configuration :

Pin Descriptions:

Name	Function
A ₀ - A ₈	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 ₁ - DQ ₁₆	Data Inputs / Outputs
V _{CC}	+5V Power Supply
V _{SS}	Ground
NC	No Connection

Absolute Maximum Ratings*

Operating Temperature, T_A (ambient)
.....-0°C to +70°C
Storage Temperature(plastic)....-55°C to +150°C
Voltage Relative to V_{SS}-1.0V to + 7.0V
Short Circuit Output Current.....50mA
Power Dissipation.....1.0W

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

Capacitance*

$T_A=25^{\circ}\text{C}$, $V_{CC}=5\text{V}\pm 10\%$, $V_{SS}=0\text{V}$

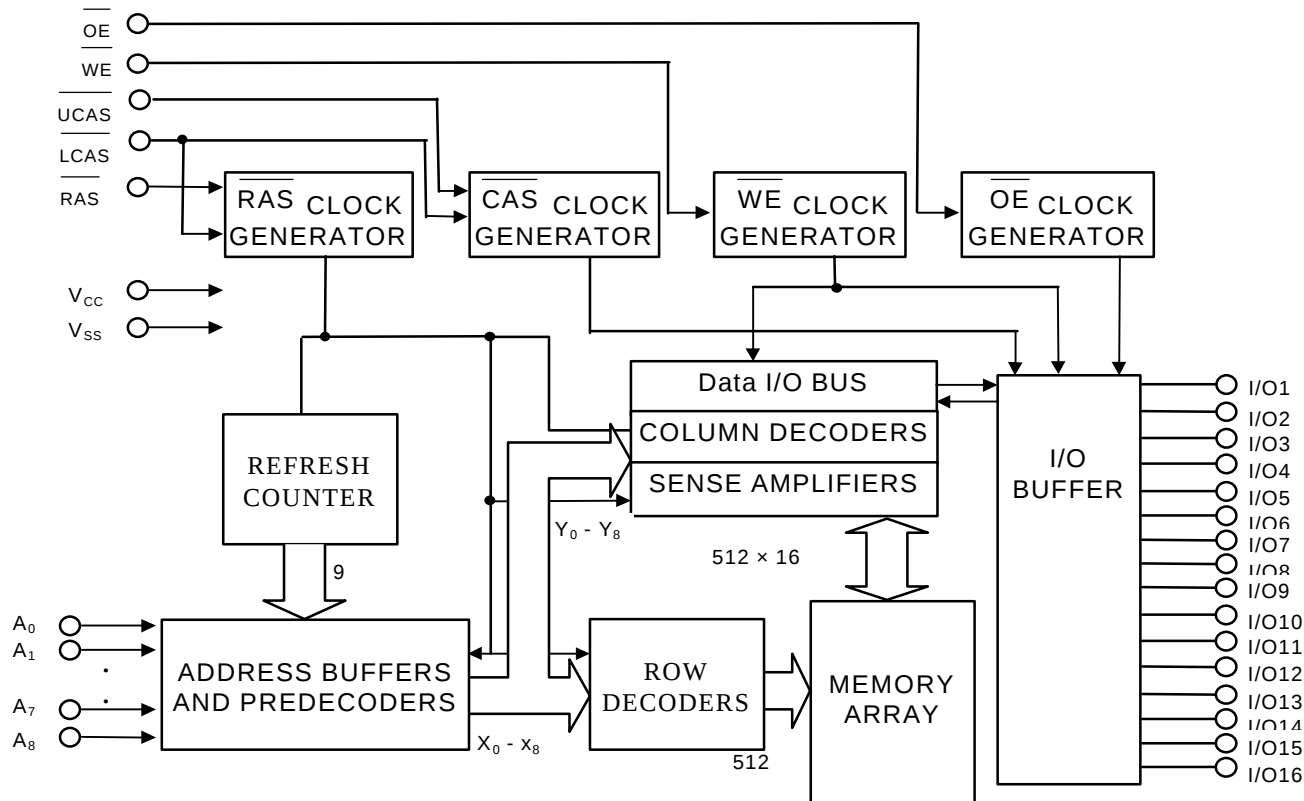
Symbol	Parameter	Max.	Unit
C_{IN1}	Address Input	5	pF
C_{IN2}	$\overline{\text{RAS}}$, $\overline{\text{LCAS}}$, $\overline{\text{UCAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$	7	pF
C_{OUT}	Data Input/Output	7	pF

*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 100 μs 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: GLT44016

Function		$\overline{\text{RAS}}$	$\overline{\text{CASL}}$	$\overline{\text{CASH}}$	$\overline{\text{WE}}$	$\overline{\text{OE}}$	ADDRESS	DQs	Notes
Stanby		H	H→X	H→X	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	1
	2nd Cycle	L	H→L	H→L	H	L	COL	Data-Out	1
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	1
	Write	L→H→L	L	L	L	X	ROW/COL	Data-In	2,3
RAS-Only Refresh		L	H	H	X	X	ROW	High-Z	
CBR Refresh		H→L	L	L	X	X		High-Z	4

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°C , $V_{CC}=5\text{V}\pm 10\%$, $V_{SS}=0\text{V}$, 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	μA	
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	μA	
I_{CC1}	Operating Current, Random READ/WRITE	$t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 25\text{ns}$ $t_{RAC} = 28\text{ns}$ $t_{RAC} = 30\text{ns}$ $t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			270 270 250 210 190 170	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, $\overline{\text{RAS}}$ -Only	$\overline{\text{RAS}}$ cycling, $\overline{\text{UCAS}},$ $\overline{\text{LCAS}}$ at V_{IH} $t_{RC} = t_{RC}(\text{min.})$	$t_{RAC} = 25\text{ns}$ $t_{RAC} = 28\text{ns}$ $t_{RAC} = 30\text{ns}$ $t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			270 270 250 210 190 170	mA	2
I_{CC4}	Operating Current, EDO Page Mode	$\overline{\text{RAS}}$ at V_{IL} , $\overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{PC}=t_{PC}(\text{min.})$	$t_{RAC} = 25\text{ns}$ $t_{RAC} = 28\text{ns}$ $t_{RAC} = 30\text{ns}$ $t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			270 270 250 210 190 170	mA	1,2
I_{CC5}	Refresh Current, $\overline{\text{CAS}}$ Before $\overline{\text{RAS}}$	$\overline{\text{RAS}}, \overline{\text{UCAS}}, \overline{\text{LCAS}}$ address cycling: $t_{RC}=t_{RC}(\text{min.})$	$t_{RAC} = 25\text{ns}$ $t_{RAC} = 28\text{ns}$ $t_{RAC} = 30\text{ns}$ $t_{RAC} = 35\text{ns}$ $t_{RAC} = 40\text{ns}$ $t_{RAC} = 50\text{ns}$			270 270 250 210 190 170	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}				2	mA	
V_{IL}	Input Low Voltage			-1		+0.8	V	3
V_{IH}	Input High Voltage			2.4		$V_{CC}+1$	V	3
V_{OL}	Output Low Voltage	$I_{OL} = 4.2\text{mA}$				0.4	V	
V_{OH}	Output High Voltage	$I_{OH} = -5.0\text{mA}$		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 -1.0V 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

 $T_A = 0^{\circ}\text{C to } 70^{\circ}\text{C}$, $V_{CC} = 5\text{ V} \pm 10\%$, $V_{IH}/V_{IL} = 2.4/0.8\text{ V}$, $V_{OH}/V_{OL} = 2.0/0.8\text{ V}$

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

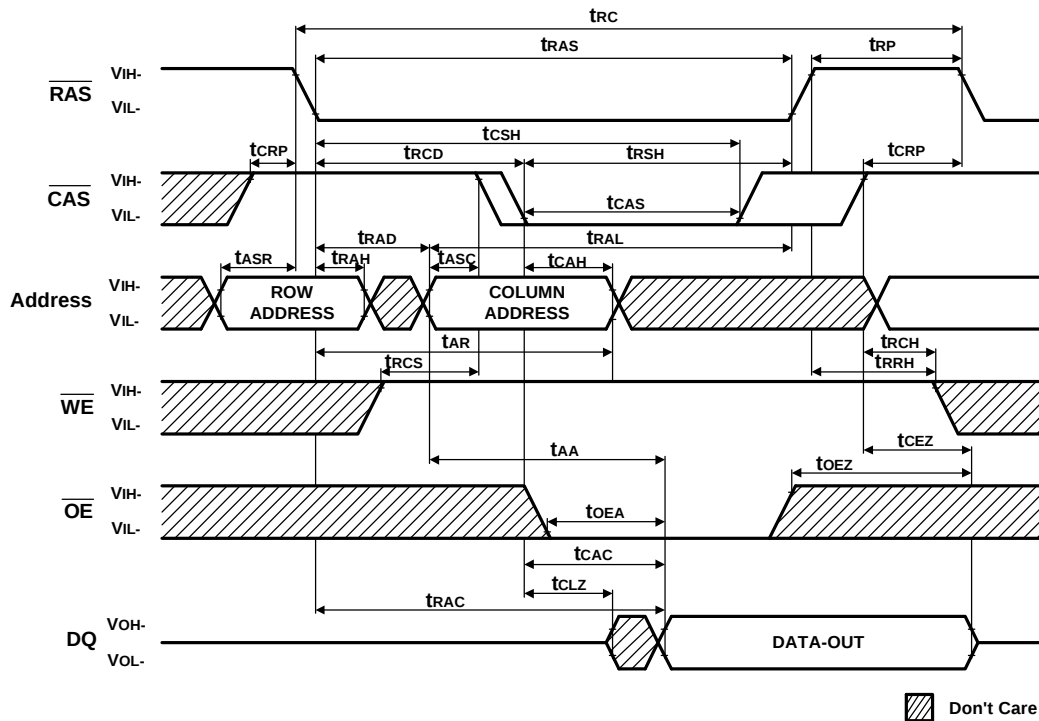
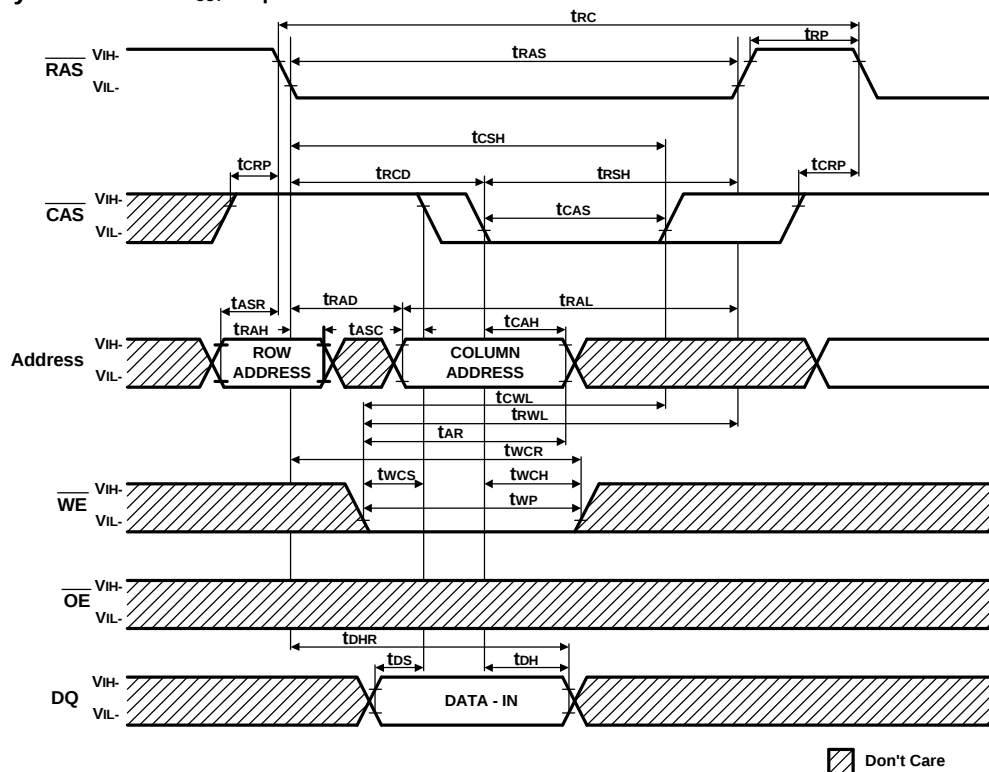
Parameter	Symbol	25		28		30		35		40		50		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Read or Write Cycle Time	t_{RC}	45		45		60		65		70		85		ns	
Read Modify Write Cycle Time	t_{RWC}	67		67		79		86		91		106		ns	
RAS Precharge Time	t_{RP}	15		15		25		25		25		30		ns	
RAS Pulse Width	t_{RAS}	25	100k	28	100k	30	100k	35	100k	40	100k	50	100k	ns	
Access Time from RAS	t_{RAC}		25		28		30		35		40		50	ns	1,2,3
Access Time from CAS	t_{CAC}		8		8		10		11		12		14	ns	1,5,10
Access Time from Column Address	t_{AA}		13		13		16		18		20		25	ns	1,5,6
CAS to Output Low-Z	t_{CLZ}		0		0	0		0		0		0		ns	
CAS to Output High-Z	t_{CEZ}	0	5	0	5	3	7	3	8	3	8	3	8	ns	
RAS Hold Time	t_{RSH}	7		7		7		8		8		8		ns	
RAS Hold Time Referenced to OE	t_{ROH}	4		4		7		8		8		8		ns	
CAS Hold Time	t_{CSH}	25		25		25		30		35		42		ns	
CAS Pulse Width	t_{CAS}	4		4		4.5		5		6		8		ns	
RAS to CAS Delay Time	t_{RCD}	10	17	10	17	10	20	11	24	12	28	13	36	ns	
RAS to Column Address Delay Time	t_{RAD}	8	12	8	12	8	14	9	17	10	20	11	25	ns	7
CAS to RAS Precharge Time	t_{CRP}	5		5		5		5		5		5		ns	
Row Address Set-Up Time	t_{ASR}	0		0		0		0		0		0		ns	
Row Address Hold Time	t_{RAH}	4		4		6		7		8		9		ns	
Column Address Set-Up Time	t_{ASC}	0		0		0		0		0		0		ns	
Column Address Hold Time	t_{CAH}	4		4		5		6		6		7		ns	
Column Address to RAS Lead Time	t_{RAL}	13		13		16		18		20		25		ns	
Column Address Hold Time Referenced to RAS	t_{AR}	19		19		25		30		34		35		ns	
Read Command Set-Up Time	t_{RCS}	0		0		0		0		0		0		ns	
Read Command Hold Time Referenced to CAS	t_{RCH}	0		0		0		0		0		0		ns	4
Read Command Hold Time Referenced to RAS	t_{RRH}	0		0		0		0		0		0		ns	4
Write Command Set-Up Time	t_{WCS}	0		0		0		0		0		0		ns	8,9
Write Command Hold Time	t_{WCH}	4		4		5		6		6		6		ns	
Write Command Pulse Width	t_{WP}	4		4		5		6		6		6		ns	
Write Command to RAS Lead Time	t_{RWL}	7		7		7		8		8		8		ns	
Write Command to CAS Lead Time	t_{CWL}	5		5		6		7		7		7		ns	

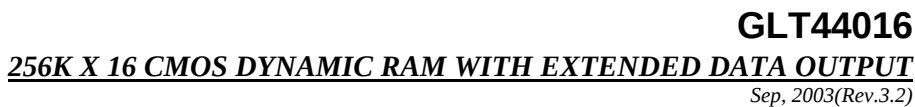
AC Characteristics

Parameter	Symbol	25		28		30		35		40		50		Unit	Notes
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
Data Set-Up Time	t _{DS}	0	0	0	0	0		0		0		0		ns	
Data Hold Time	t _{DH}	4		4		7		8		8		8		ns	
Data Hold Time Referenced to RAS	t _{DHR}	19		19		27		32		36		37		ns	
RAS to WE Delay Time	t _{RWD}	36		36		43		49		54		64		ns	
CAS to WE Delay Time	t _{CWD}	19		19		21		23		24		26		ns	
Column Address to WE Delay Time	t _{AWD}	24		24		27		30		32		37		ns	
RAS to CAS Precharge Time	t _{RPC}	0		0		0		0		0		0		ns	
Access Time from CAS Precharge	t _{CPA}	15		15			18		20		22		27	ns	
EDO Page Mode Cycle Time	t _{PC}	10		10		12		13		15		20		ns	
EDO Page Mode Read-Modify-Write Cycle Time	t _{PRWC}	35		35		39		43		45		50		ns	
CAS Precharge Time (EDO Page Mode)	t _{CP}	3		3		4.5		5		6		8		ns	
RAS Pulse Width (EDO Page Mode Only)	t _{RASP}	25	100k	28	100k	30	100K	35	100k	40	100k	50	100k	ns	
Access Time from OE	t _{OEA}		8		8		10		11		12		14	ns	
OE to Data Delay Time	t _{OED}	5		5		7		8		8		8		ns	
OE to Output High-Z	t _{OEZ}	3	7	3	7	3	7	3	8	3	8	0	8	ns	
OE Command Hold Time	t _{OEH}	5		5		6		6		7		7		ns	
Data Output Hold after CAS low	t _{DOH}	4		4		5		5		5		5		ns	
RAS to Output High-Z	t _{REZ}	3	7	3	7	3	7	3	8	3	8	3	8	ns	
WE to Output High-Z	t _{WEZ}	3	10	3	10	3	10	3	10	3	10	3	12	ns	
OE to CAS Hold Time	t _{OCH}	8		8		8		8		8		8		ns	
CAS Hold Time to OE	t _{CHO}	8		8		8		8		8		8		ns	
OE Precharge Time	t _{OEP}	8		8		8		8		8		8		ns	
CAS Set-Up Time for CAS-before-RAS Cycle	t _{CSR}	5		5		10		10		10		10		ns	
CAS Hold Time for CAS-before-RAS Cycle	t _{CHR}	6		6		7		8		8		10		ns	
Transition Time	t _T	1.5	50	1.5	50	1.5	50	1.5	50	1.5	50	2	50	ns	
Refresh Period	t _{REF}		8		8		8		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_{OUT} = Open




Sep, 2003(Rev.3.2)

Timing diagram for a 2D array memory access. The diagram shows the relationship between RAS, CAS, Address, WE, OE, and DQ signals. Key timing parameters are labeled: t_{RC} , t_{RAS} , t_{RP} , t_{CRP} , t_{CSH} , t_{RSH} , t_{CRP} , t_{RCD} , t_{CAS} , t_{ASR} , t_{RAH} , t_{RAD} , t_{ASC} , t_{CAH} , t_{AL} , t_{CWL} , t_{RWL} , t_{WPL} , t_{OE} , t_{OE} , t_{DS} , t_{DH} . The diagram is divided into sections for Row Address, Column Address, and Data Output. A legend indicates that hatched areas represent 'Don't Care' states.

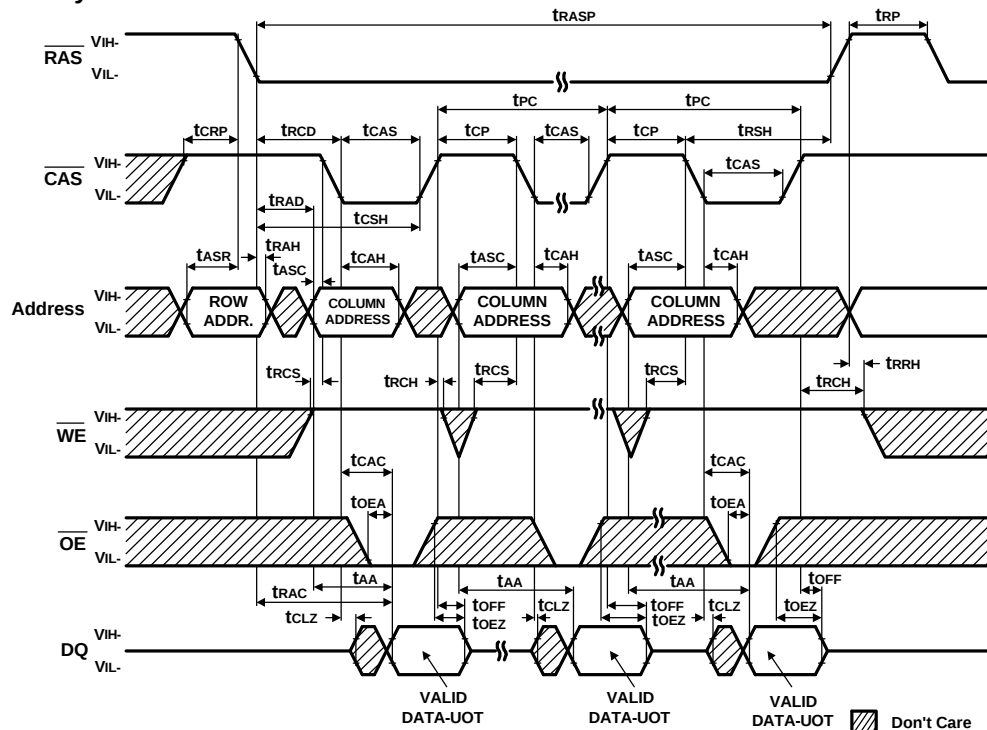
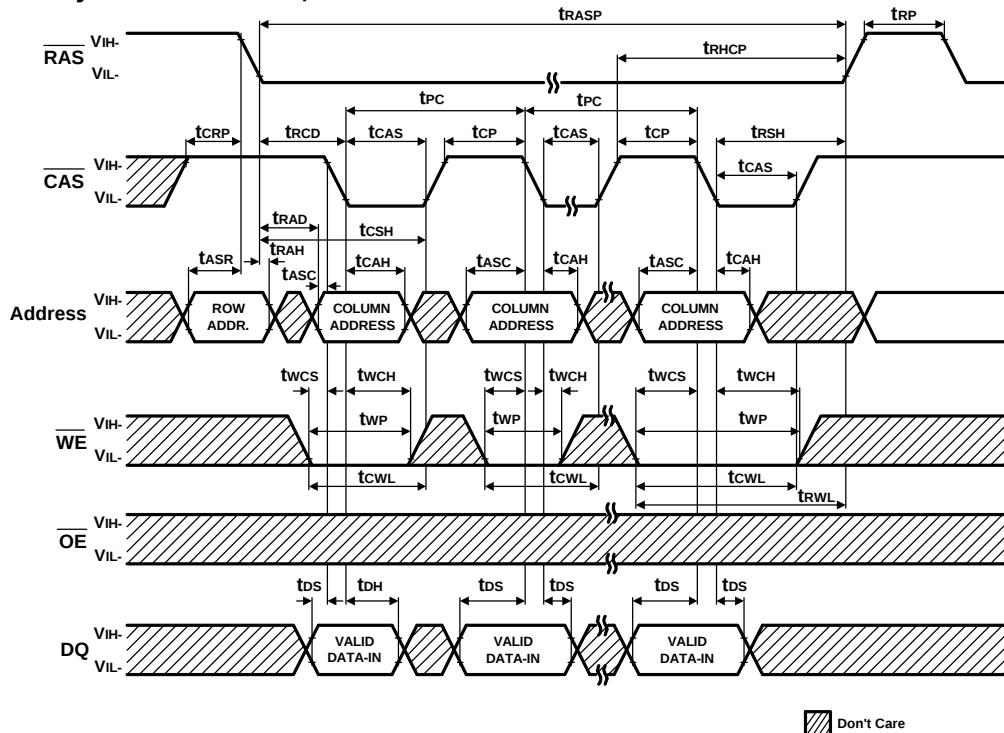
The diagram illustrates the timing relationships between several digital signals:

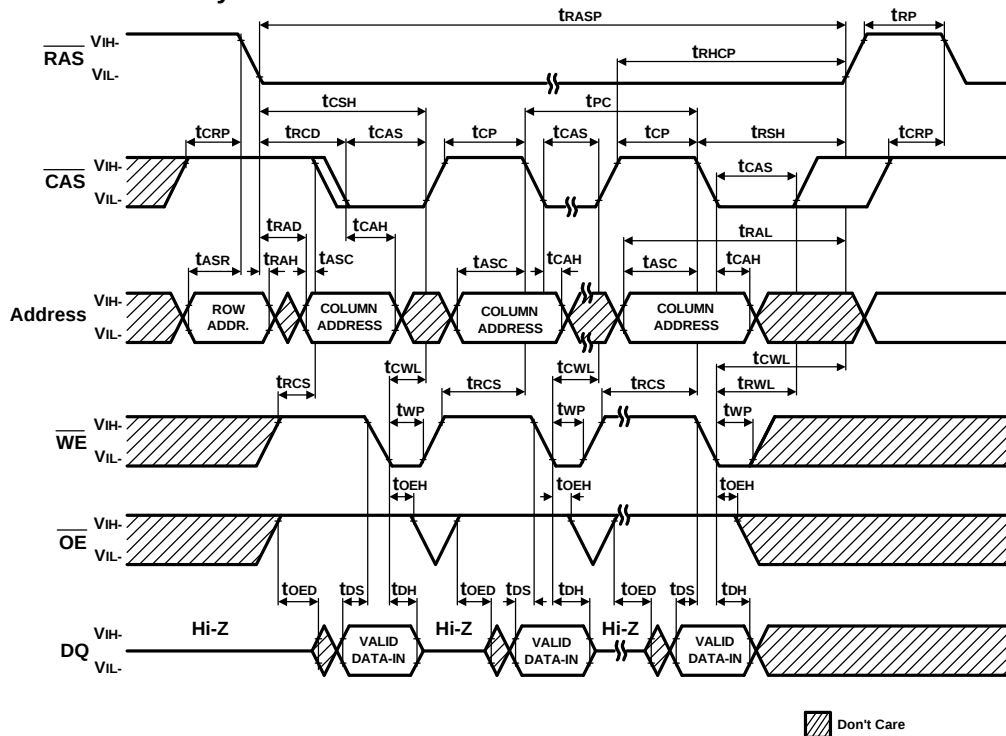
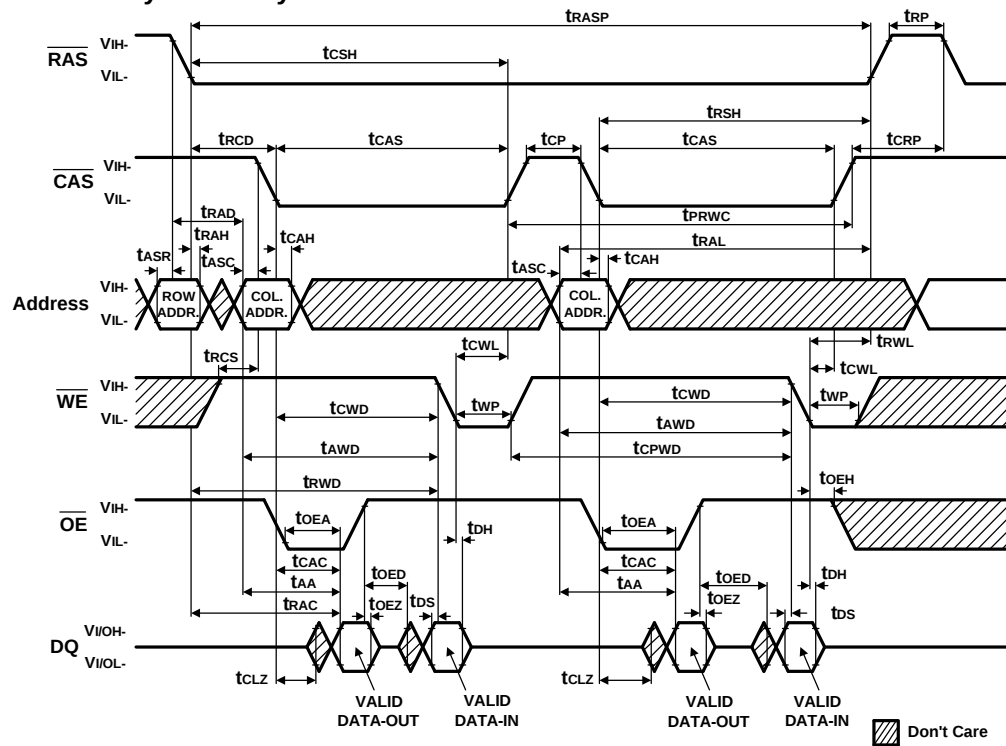
- RAS**: Row Address Strobe. High-to-low transition at t_{RAS} . Low pulse width is t_{RSP} .
- CAS**: Column Address Strobe. High-to-low transition at t_{CAS} . Low pulse width is t_{CSP} .
- Address**: Split into ROW ADDR. and COLUMN ADDRESS.
- WE**: Write Enable. High-to-low transition at t_{WEP} .
- OE**: Output Enable. High-to-low transition at t_{OEA} .
- DQ**: Data Bus. Shows VALID DATA-OUT and VALID DATA-IN periods.

Key timing parameters labeled include:

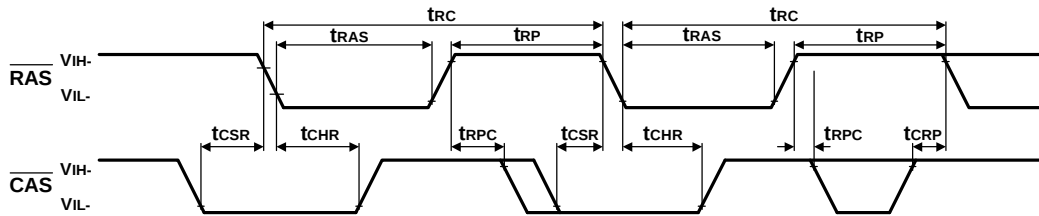
- t_{RC} , t_{RAS} , t_{RSP}
- t_{CRP} , t_{CD} , t_{RSH} , t_{CAS} , t_{CSH}
- t_{ASR} , t_{RAD} , t_{RAH} , t_{ASC} , t_{CAH}
- t_{AWD} , t_{CWD} , t_{RWL} , t_{CWL}
- t_{AA} , t_{CLZ} , t_{CAC} , t_{OED} , t_{OEZ} , t_{DS} , t_{DH}
- t_{TRAC}

A legend indicates that hatched areas represent "Don't Care" states.

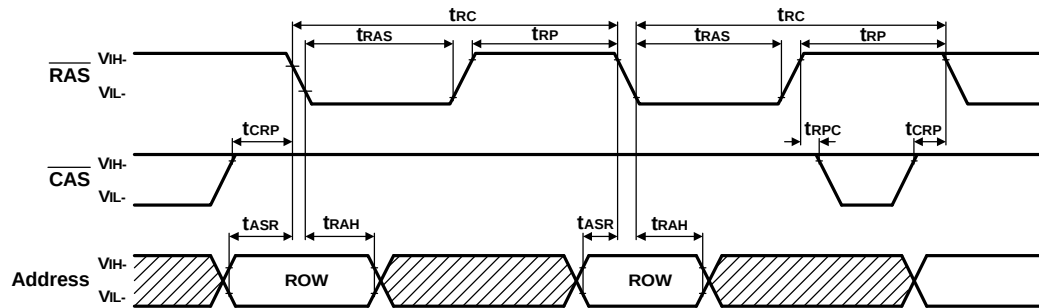
Fast Page Read Cycle

Fast Page Write Cycle NOTE : $D_{OUT} = \text{Open}$


Fast Page Mode Late Write Cycle

Fast Page Read - Modify - Write Cycle


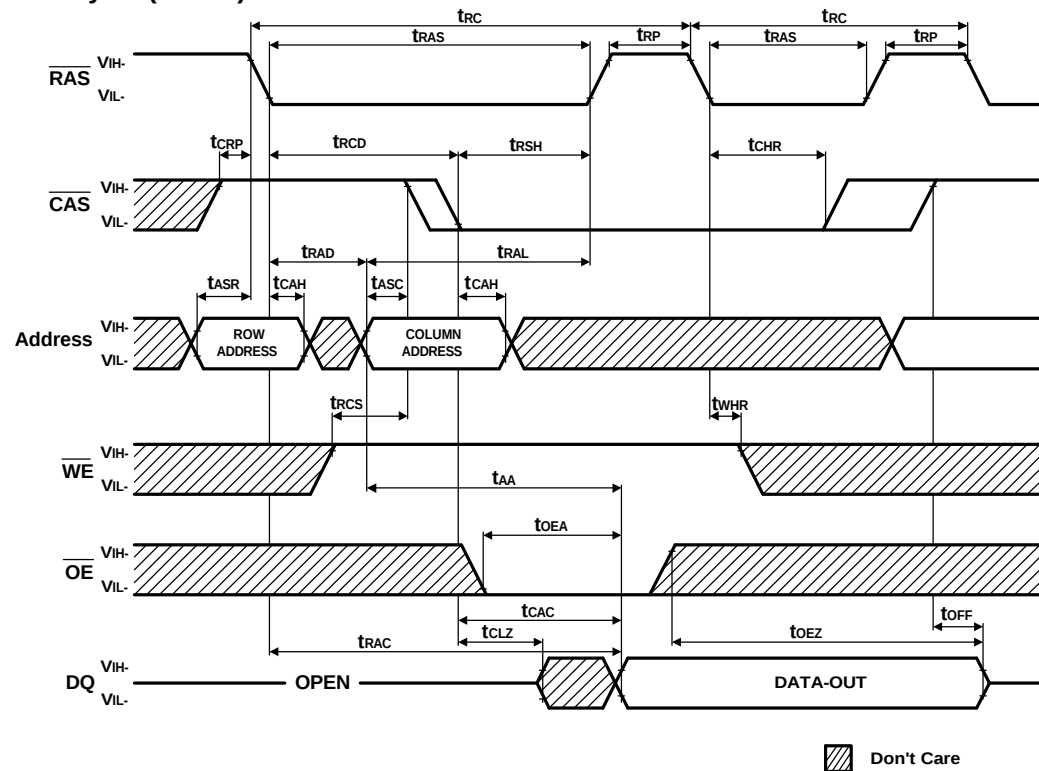
CAS Before RAS Refresh Cycle

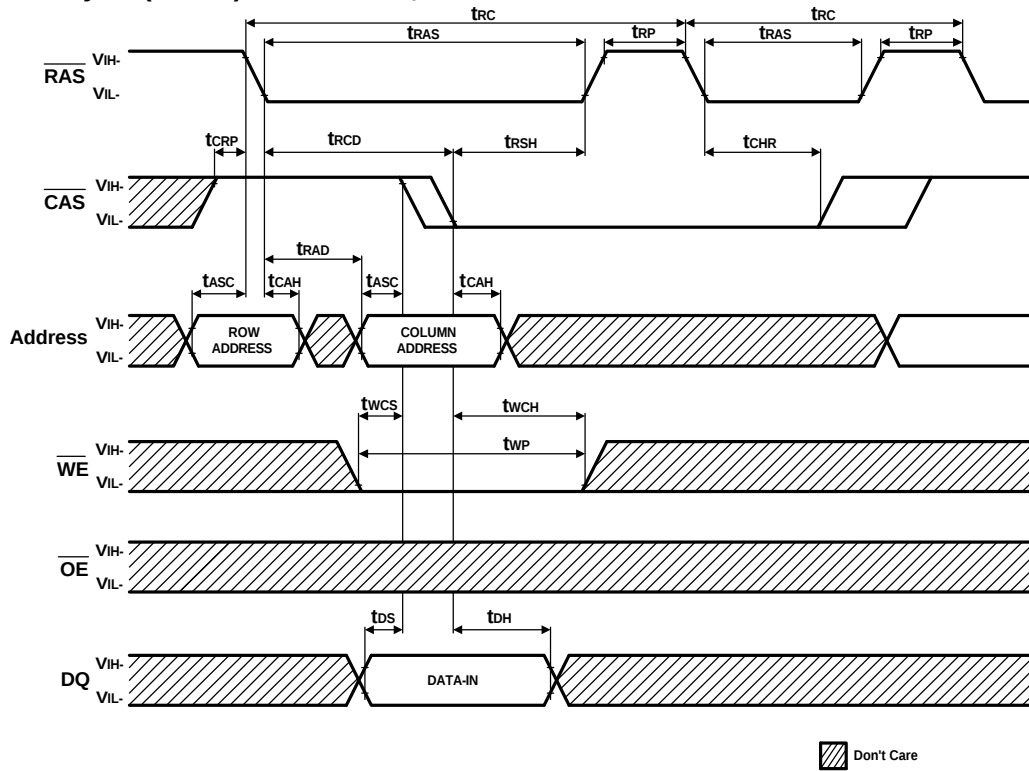


RAS -Only Refresh Cycle



Hidden Refresh Cycle (Read)



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




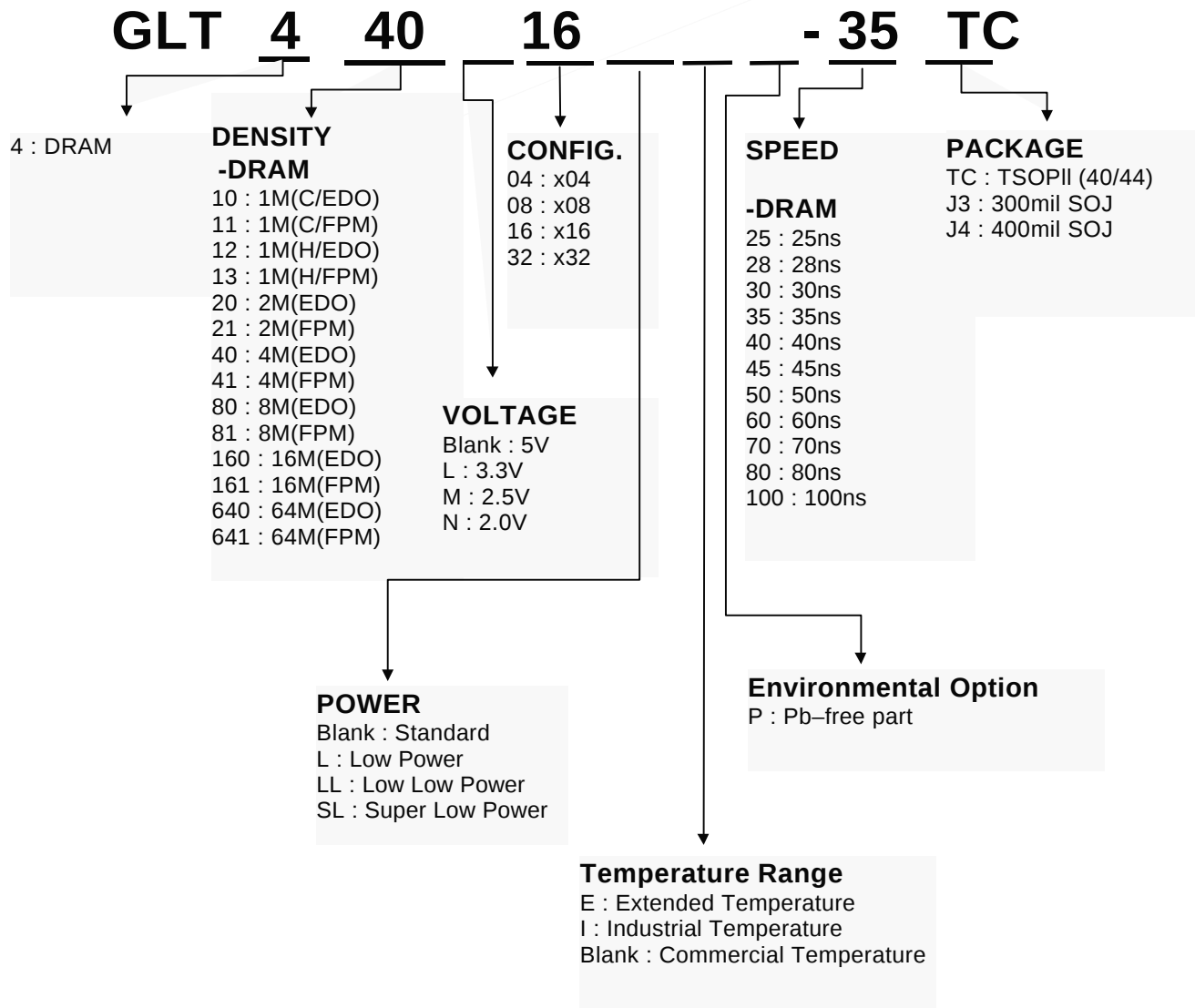
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Ordering Information

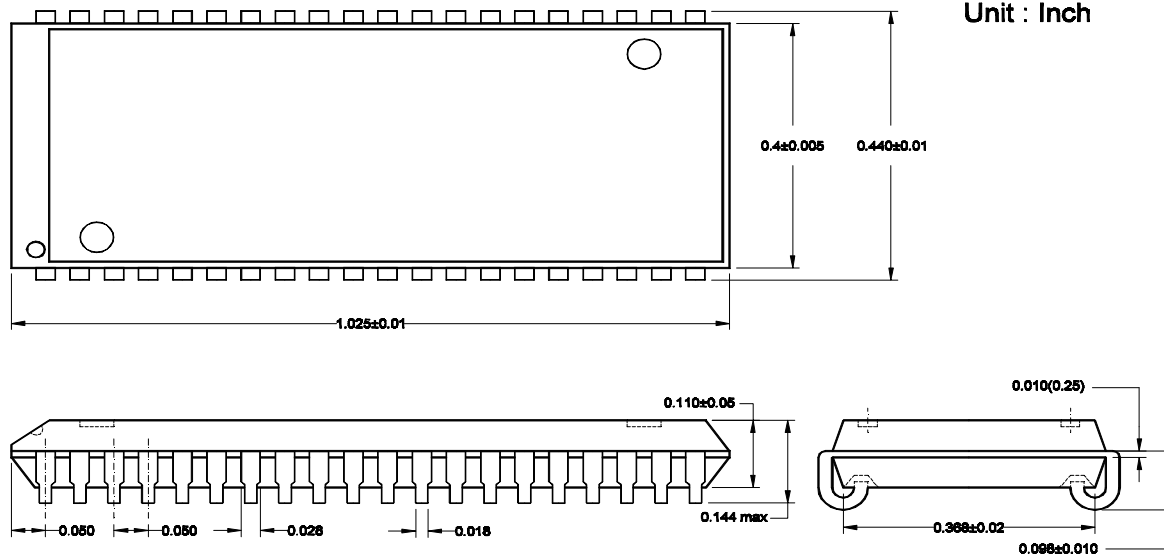
Part Number	SPEED	POWER	FEATURE	PACKAGE
GLT44016-25J4	25ns	Normal	EDO	40L 400mil SOJ
GLT44016-28J4	28ns	Normal	EDO	40L 400mil SOJ
GLT44016-30J4	30ns	Normal	EDO	40L 400mil SOJ
GLT44016-35J4	35ns	Normal	EDO	40L 400mil SOJ
GLT44016-40J4	40ns	Normal	EDO	40L 400mil SOJ
GLT44016-50J4	50ns	Normal	EDO	40L 400mil SOJ
GLT44016P-25J4	25ns	Normal	EDO	40L 400mil SOJ
GLT44016P-28J4	28ns	Normal	EDO	40L 400mil SOJ
GLT44016P-30J4	30ns	Normal	EDO	40L 400mil SOJ
GLT44016P-35J4	35ns	Normal	EDO	40L 400mil SOJ
GLT44016P-40J4	40ns	Normal	EDO	40L 400mil SOJ
GLT44016P-50J4	50ns	Normal	EDO	40L 400mil SOJ
GLT44016-25TC	25ns	Normal	EDO	44L 400mil TSOP
GLT44016-28TC	28ns	Normal	EDO	44L 400mil TSOP
GLT44016-30TC	30ns	Normal	EDO	44L 400mil TSOP
GLT44016-35TC	35ns	Normal	EDO	44L 400mil TSOP
GLT44016-40TC	40ns	Normal	EDO	44L 400mil TSOP
GLT44016-50TC	50ns	Normal	EDO	44L 400mil TSOP
GLT44016P-25TC	25ns	Normal	EDO	44L 400mil TSOP
GLT44016P-28TC	28ns	Normal	EDO	44L 400mil TSOP
GLT44016P-30TC	30ns	Normal	EDO	44L 400mil TSOP
GLT44016P-35TC	35ns	Normal	EDO	44L 400mil TSOP
GLT44016P-40TC	40ns	Normal	EDO	44L 400mil TSOP
GLT44016P-50TC	50ns	Normal	EDO	44L 400mil TSOP

Parts Numbers (Top Mark) Definition for DRAM :



Package Information

40/44 Lead Thin Small Outline Package SOJ



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

