

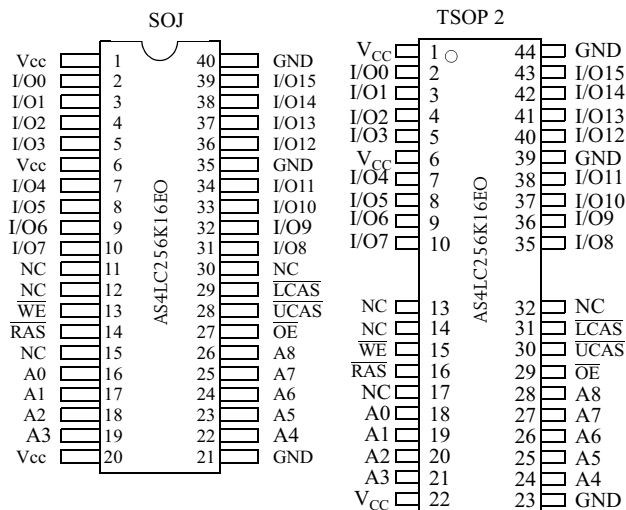


3.3V 256K X 16 CMOS DRAM (EDO)

Features

- Organization: 262,144 words × 16 bits
- High speed
 - 45/50/60 ns $\overline{\text{RAS}}$ access time
 - 10/12/15/20 ns column address access time
 - 7/10/10 ns $\overline{\text{CAS}}$ access time
- Low power consumption
 - Active: 280 mW max (AS4LC256K16EO-45)
 - Standby: 2.8 mW max, CMOS I/O (AS4LC256K16EO-45)
- EDO page mode
- 5V I/O tolerant
- 512 refresh cycles, 8 ms refresh interval
 - $\overline{\text{RAS}}$ -only or $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh or self refresh
- Read-modify-write
- LVTTTL-compatible, three-state I/O
- JEDEC standard packages
 - 400 mil, 40-pin SOJ
 - 400 mil, 40/44-pin TSOP 2
- 3.3V power supply
- Latch-up current > 200 mA

Pin arrangement



Pin designation

Pin(s)	Description
A0 to A8	Address inputs
$\overline{\text{RAS}}$	Row address strobe
I/O0 to I/O15	Input/output
$\overline{\text{OE}}$	Output enable
$\overline{\text{UCAS}}$	Column address strobe, upper byte
$\overline{\text{LCAS}}$	Column address strobe, lower byte
$\overline{\text{WE}}$	Read/write control
V _{CC}	Power (3.3V ± 0.3V)
GND	Ground

Selection guide

	Symbol	-45	-50	-60	Unit
Maximum $\overline{\text{RAS}}$ access time	t _{RAC}	45	50	60	ns
Maximum column address access time	t _{CAA}	20	20	25	ns
Maximum $\overline{\text{CAS}}$ access time	t _{CAC}	10	10	10	ns
Maximum output enable ($\overline{\text{OE}}$) access time	t _{OEA}	10	10	10	ns
Minimum read or write cycle time	t _{RC}	80	80	100	ns
Minimum EDO page mode cycle time	t _{PC}	17	17	30	ns
Maximum operating current	I _{CC1}	60	60	50	mA
Maximum CMOS standby current	I _{CC2}	200	200	200	μA



Functional description

The AS4LC256K16EO is a high-performance 4 megabit CMOS Dynamic Random Access Memory (DRAM) organized as 262,144 words by 16 bits. The AS4LC256K16EO is fabricated with advanced CMOS technology and designed with innovative design techniques resulting in high speed, extremely low power and wide operating margins at component and system levels.

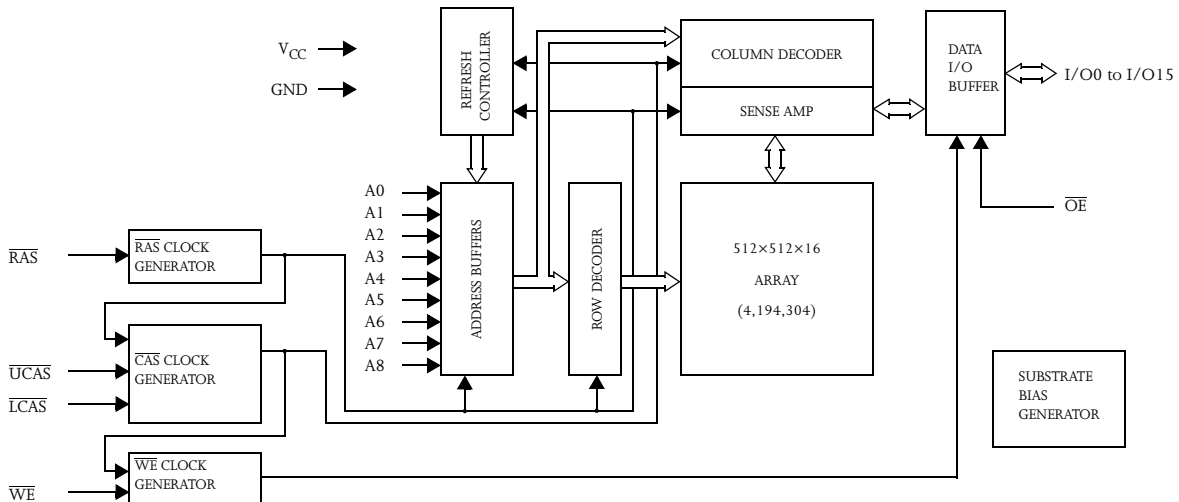
The AS4LC256K16EO features a high speed page mode operation in which high speed read, write and read-write are performed on any of the 512×16 bits defined by the column address. The asynchronous column address uses an extremely short row address capture time to ease the system level timing constraints associated with multiplexed addressing. Very fast $\overline{\text{CAS}}$ to output access time eases system design.

Refresh on the 512 address combinations of A0 to A8 during an 8 ms period is accomplished by performing any of the following:

- $\overline{\text{RAS}}$ -only refresh cycles
- Hidden refresh cycles
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ refresh cycles
- Normal read or write cycles
- Self refresh cycles

The AS4LC256K16EO is available in standard 40-pin plastic SOJ and 40/44-pin TSOP 2 packages compatible with widely available automated testing and insertion equipment. System level features include single power supply of $3.3\text{V} \pm 0.3\text{V}$ tolerance and direct interface with TTL logic families.

Logic block diagram



Recommended operating conditions

($T_a = 0^\circ\text{C}$ to $+70^\circ\text{C}$)

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V _{CC}	3.0	3.3	3.6	V
	GND	0.0	0.0	0.0	V
Input voltage	V _{IH}	2.0	—	V _{CC} + 1	V
	V _{IL}	-1.0	—	0.8	V



Absolute maximum ratings

Parameter	Symbol	Min	Max	Unit
Input voltage	V_{in}	-1.0	+7.0	V
Output voltage	V_{out}	-1.0	+7.0	V
Power supply voltage	V_{CC}	-1.0	+7.0	V
Operating temperature	T_{OPR}	0	+70	°C
Storage temperature (plastic)	T_{STG}	-55	+150	°C
Soldering temperature × time	T_{SOLDER}	–	260×10	°C × sec
Power dissipation	P_D	–	1	W
Short circuit output current	I_{out}	–	50	mA
Latch-up current		200	–	mA

NOTE: Stresses greater than those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

DC electrical characteristics

Parameter	Symbol	Test conditions	-45		-50		-60		Unit	Note
			Min	Max	Min	Max	Min	Max		
Input leakage current	I_{IL}	$0V \leq V_{in} \leq +5.5V$ pins not under test = 0V	-10	10	-10	10	-10	10	μA	
Output leakage current	I_{OL}	D_{OUT} disabled, $0V \leq V_{out} \leq +5.5V$	-10	10	-10	10	-10	10	μA	
Operating power supply current	I_{CC1}	\overline{RAS} , \overline{UCAS} , \overline{LCAS} , address cycling; $t_{RC} = \min$	–	60	–	60	–	50	mA	1,2
TTL standby power supply current	I_{CC2}	$\overline{RAS} = \overline{UCAS} = \overline{LCAS} = V_{IH}$	–	200	–	200	–	200	μA	
Average power supply current, \overline{RAS} refresh mode	I_{CC3}	\overline{RAS} cycling, $\overline{UCAS} = \overline{LCAS} = V_{IH}$, $t_{RC} = \min$	–	45	–	45	–	40	mA	1
EDO page mode average power supply current	I_{CC4}	$\overline{RAS} = \overline{UCAS} = \overline{LCAS} = V_{IL}$, address cycling; $t_{SC} = \min$	–	35	–	35	–	35	mA	1,2
CMOS standby power supply current	I_{CC5}	$\overline{RAS} = \overline{UCAS} = \overline{LCAS} = V_{CC} - 0.2V$	–	400	–	400	–	400	μA	
\overline{CAS} -before- \overline{RAS} refresh power supply current	I_{CC6}	\overline{RAS} , \overline{UCAS} , \overline{LCAS} , cycling; $t_{RC} = \min$	–	50	–	50	–	50	mA	1
Output Voltage	V_{OH}	$I_{OUT} = -2 \text{ mA}$	2.4	–	2.4	–	2.4	–	V	
	V_{OL}	$I_{OUT} = 2 \text{ mA}$	–	0.4	–	0.4	–	0.4	V	
Self refresh current	I_{CC7}	$\overline{RAS} = \overline{UCAS} = \overline{LCAS} = V_{IL}$, $\overline{WE} = \overline{OE} = A0-A8 = V_{CC} - 0.2V$, $DQ0-DQ15 = V_{CC} - 0.2V$, 0.2V are open	–	400	–	400	–	400	μA	



AC parameters common to all waveforms

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{RC}	Random read or write cycle time	80	–	80	–	100	–	ns	
t_{RP}	\overline{RAS} precharge time	20	–	20	–	20	–	ns	
t_{RAS}	\overline{RAS} pulse width	45	75K	45	75K	60	75K	ns	
t_{CAS}	\overline{CAS} pulse width	10	–	10	–	10	–	ns	
t_{RCD}	\overline{RAS} to \overline{CAS} delay time	18	32	18	32	15	45	ns	6
t_{RAD}	\overline{RAS} to column address delay time	13	23	13	23	15	30	ns	7
$t_{RSH(R)}$	\overline{CAS} to \overline{RAS} hold time (read cycle)	10	–	10	–	12	–	ns	
t_{CSH}	\overline{RAS} to \overline{CAS} hold time	45	–	50	–	60	–	ns	
t_{CRP}	\overline{CAS} to \overline{RAS} precharge time	5	–	5	–	5	–	ns	
t_{ASR}	Row address setup time	0	–	0	–	0	–	ns	
t_{RAH}	Row address hold time	8	–	8	–	9	–	ns	
t_T	Transition time (rise and fall)	1.5	50	1.5	50	1.5	50	ns	4,5
t_{REF}	Refresh period	–	8	–	8	–	8	ms	3
t_{CLZ}	\overline{CAS} to output in low Z	3	–	3	–	3	–	ns	8

Read cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{RAC}	Access time from \overline{RAS}	–	45	–	50	–	60	ns	6
t_{CAC}	Access time from \overline{CAS}	–	10	–	10	–	10	ns	6,13
t_{AA}	Access time from address	–	22	–	22	–	30	ns	7,13
$t_{AR(R)}$	Column add hold from \overline{RAS}	35	–	35	–	40	–	ns	
t_{RCS}	Read command setup time	0	–	0	–	0	–	ns	
t_{RCH}	Read command hold time to \overline{CAS}	0	–	0	–	0	–	ns	9
t_{RRH}	Read command hold time to \overline{RAS}	0	–	0	–	0	–	ns	9
t_{RAL}	Column address to \overline{RAS} Lead time	25	–	25	–	30	–	ns	
t_{CPN}	\overline{CAS} precharge time	5	–	5	–	5	–	ns	
t_{OFF}	Output buffer turn-off time	0	10	0	10	0	10	ns	8,10



Write cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{ASC}	Column address setup time	0	–	0	–	0	–	ns	
t_{CAH}	Column address hold time	6	–	6	–	10	–	ns	
t_{AWR}	Column address hold time to \overline{RAS}	35	–	35	–	40	–	ns	
t_{WCS}	Write command setup time	0	–	0	–	0	–	ns	11
t_{WCH}	Write command hold time	0	–	0	–	0	–	ns	11
t_{WCR}	Write command hold time to \overline{RAS}	35	–	35	–	40	–	ns	
t_{WP}	Write command pulse width	6	–	6	–	10	–	ns	
t_{RWL}	Write command to \overline{RAS} lead time	12	–	12	–	12	–	ns	
t_{CWL}	Write command to \overline{CAS} lead time	12	–	12	–	12	–	ns	
t_{DS}	Data-in setup time	0	–	0	–	0	–	ns	12
t_{DH}	Data-in hold time	6	–	6	–	10	–	ns	12
t_{DHR}	Data-in hold time to \overline{RAS}	35	–	35	–	45	–	ns	

Read-modify-write cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t_{RWC}	Read-write cycle time	115	–	115	–	120	–	ns	
t_{RWD}	\overline{RAS} to \overline{WE} delay time	58	–	58	–	60	–	ns	11
t_{CWD}	\overline{CAS} to \overline{WE} delay time	30	–	30	–	30	–	ns	11
t_{AWD}	Column address to \overline{WE} delay time	38	–	38	–	40	–	ns	11
$t_{RSH(W)}$	\overline{CAS} to \overline{RAS} hold time (write)	10	–	10	–	12	–	ns	
$t_{CAS(W)}$	\overline{CAS} pulse width (write)	15	–	15	–	15	–	ns	



EDO page mode cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t _{PC}	Read or write cycle time (fast page)	17	–	17	–	25	–	ns	14
t _{CAP}	Access time from $\overline{\text{CAS}}$ precharge	–	21	–	21	–	23	ns	13
t _{CP}	$\overline{\text{CAS}}$ precharge time (fast page)	5	–	5	–	6	–	ns	
t _{PCM}	EDO page mode RMW cycle	58	–	58	–	60	–	ns	
t _{CRW}	Page mode $\overline{\text{CAS}}$ pulse width (RMW)	46	–	46	–	50	–	ns	
t _{RASP}	$\overline{\text{RAS}}$ pulse width	45	75K	45	75K	60	75K	ns	

Refresh cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t _{CSR}	$\overline{\text{CAS}}$ setup time ($\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$)	10	–	10	–	10	–	ns	3
t _{CHR}	$\overline{\text{CAS}}$ hold time ($\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$)	8	–	8	–	10	–	ns	3
t _{RPC}	$\overline{\text{RAS}}$ precharge to $\overline{\text{CAS}}$ hold time	0	–	0	–	0	–	ns	
t _{CPT}	$\overline{\text{CAS}}$ precharge time ($\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ counter test)	8	–	8	–	8	–	ns	

Output enable

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t _{ROH}	$\overline{\text{RAS}}$ hold time referenced to $\overline{\text{OE}}$	5	–	5	–	5	–	ns	
t _{OEA}	$\overline{\text{OE}}$ access time	–	10	–	10	–	10	ns	
t _{OED}	$\overline{\text{OE}}$ to data delay	5	–	5	–	8	–	ns	
t _{OEZ}	Output buffer turnoff delay from $\overline{\text{OE}}$	–	8	–	8	–	8	ns	8
t _{OEH}	$\overline{\text{OE}}$ command hold time	8	–	8	–	8	–	ns	

Self refresh cycle

Std Symbol	Parameter	-45		-50		-60		Unit	Notes
		Min	Max	Min	Max	Min	Max		
t _{RASS}	$\overline{\text{RAS}}$ pulse width (CBR self refresh)	100K	–	100K	–	100K	–	ns	
t _{RPS}	$\overline{\text{RAS}}$ precharge time (CBR self refresh)	85	–	85	–	85	–	ns	
t _{CHS}	$\overline{\text{CAS}}$ hold time (CBR self refresh)	30	–	30	–	30	–	ns	



Notes

- I_{CC1} , I_{CC3} , I_{CC4} , and I_{CC6} depend on cycle rate.
- I_{CC1} and I_{CC4} depend on output loading. Specified values are obtained with the output open.
- An initial pause of 200 μ s is required after power-up followed by any 8 $\overline{\text{RAS}}$ cycles before proper device operation is achieved. In the case of an internal refresh counter, a minimum of 8 $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ initialization cycles instead of 8 $\overline{\text{RAS}}$ cycles are required. 8 initialization cycles are required after extended periods of bias without clocks (greater than 8 ms).
- AC Characteristics assume $t_T = 5$ ns. All AC parameters are measured with a load equivalent to two TTL loads and 60 pF, $V_{IL}(\text{min}) \geq \text{GND}$ and $V_{IH}(\text{max}) \leq V_{CC}$.
- $V_{IH}(\text{min})$ and $V_{IL}(\text{max})$ are reference levels for measuring timing of input signals. Transition times are measured between V_{IH} and V_{IL} .
- 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_{RCD} is greater than the specified $t_{\text{RCD}}(\text{max})$ limit, then access time is controlled exclusively by t_{CAC} .
- 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 a reference point only. If t_{RAD} is greater than the specified $t_{\text{RAD}}(\text{max})$ limit, then access time is controlled exclusively by t_{AA} .
- Assumes three state test load (5 pF and a 380 Ω Thevenin equivalent).
- Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
- $t_{\text{OFF}}(\text{max})$ defines the time at which the output achieves the open circuit condition; it is not referenced to output voltage levels.
- t_{WCS} , t_{WCH} , t_{RWD} , t_{CWD} and t_{AWD} are not restrictive operating parameters. They are included in the datasheet as electrical characteristics only. If $t_{\text{WS}} \geq t_{\text{WS}}(\text{min})$ and $t_{\text{WH}} \geq t_{\text{WH}}(\text{min})$, the cycle is an early write cycle and data out pins will remain open circuit, high impedance, throughout the cycle. If $t_{\text{RWD}} \geq t_{\text{RWD}}(\text{min})$, $t_{\text{CWD}} \geq t_{\text{CWD}}(\text{min})$ and $t_{\text{AWD}} \geq t_{\text{AWD}}(\text{min})$, the cycle is a read-write cycle and the data out will contain data read from the selected cell. If neither of the above conditions is satisfied, the condition of the data out at access time is indeterminate.
- These parameters are referenced to $\overline{\text{CAS}}$ leading edge in early write cycles and to $\overline{\text{WE}}$ leading edge in read-write cycles.
- Access time is determined by the longest of t_{CAA} or t_{CAC} or t_{CAP} .
- $t_{\text{ASC}} \geq t_{\text{CP}}$ to achieve $t_{\text{PC}}(\text{min})$ and $t_{\text{CAP}}(\text{max})$ values.
- These parameters are sampled and not 100% tested.

Key to switching waveform



Undefined/don't care

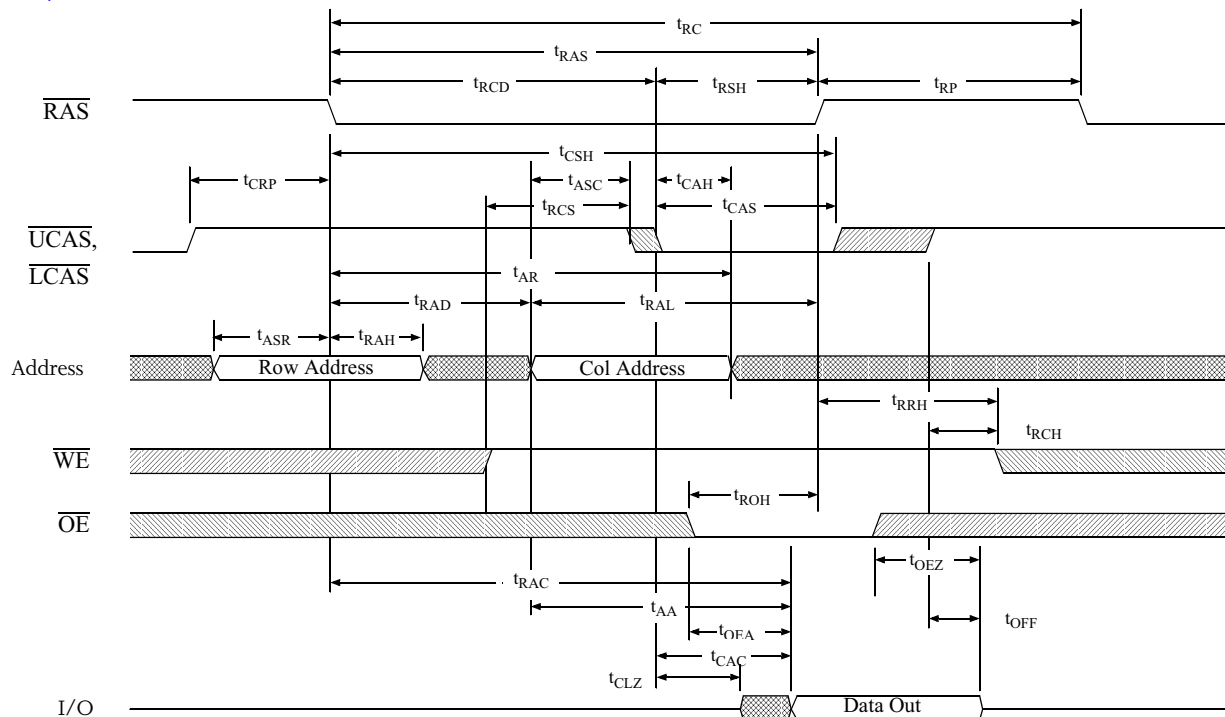


Rising input



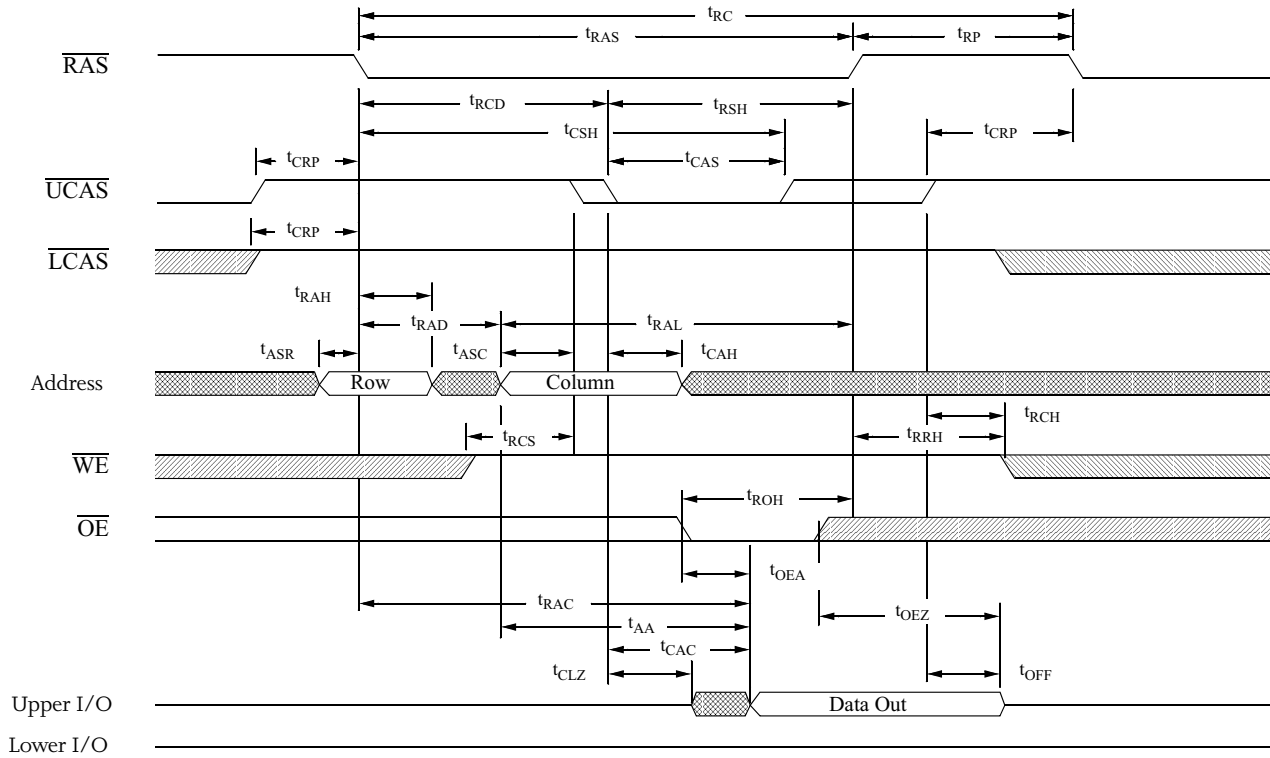
Falling input

Read cycle waveform

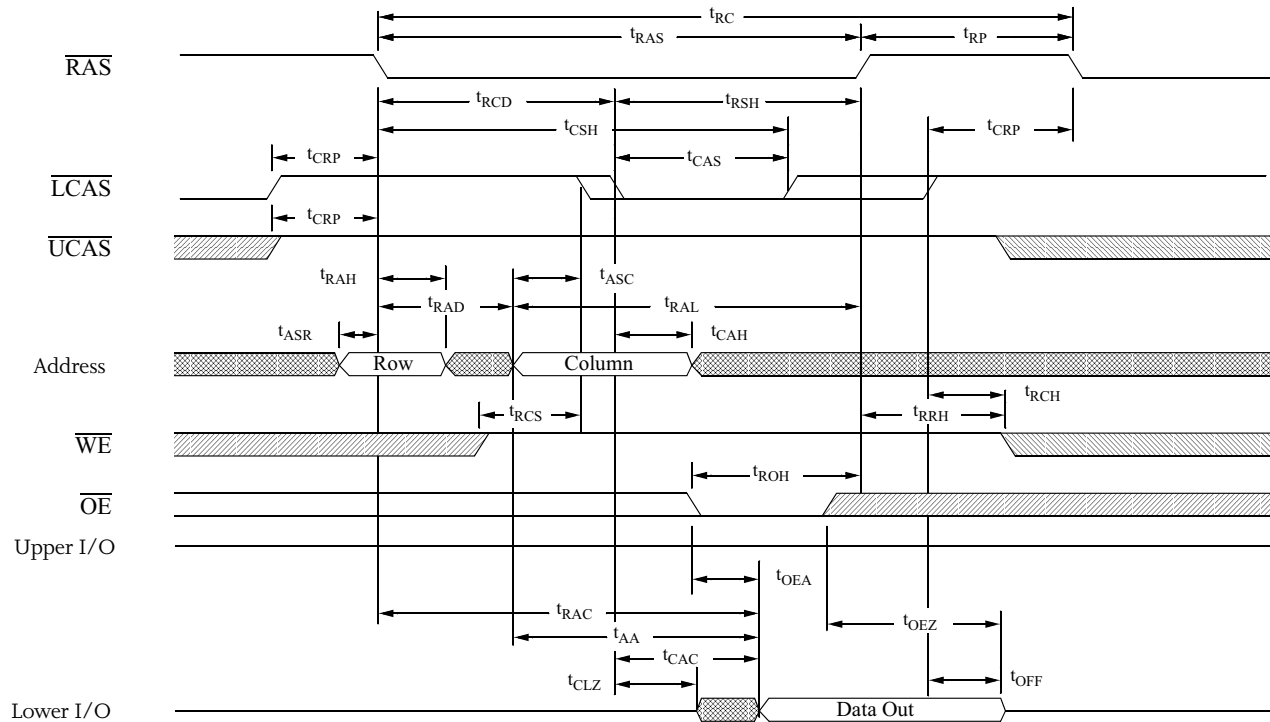




Upper byte read cycle waveform

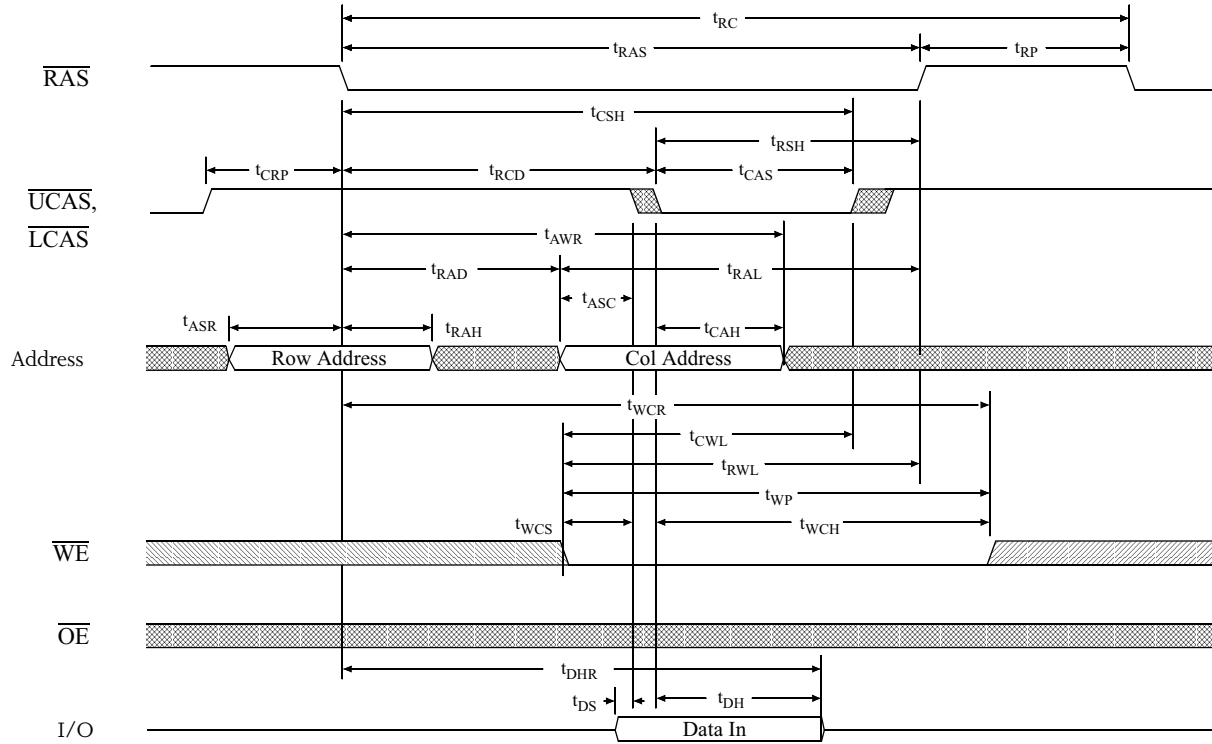


Lower byte read cycle waveform

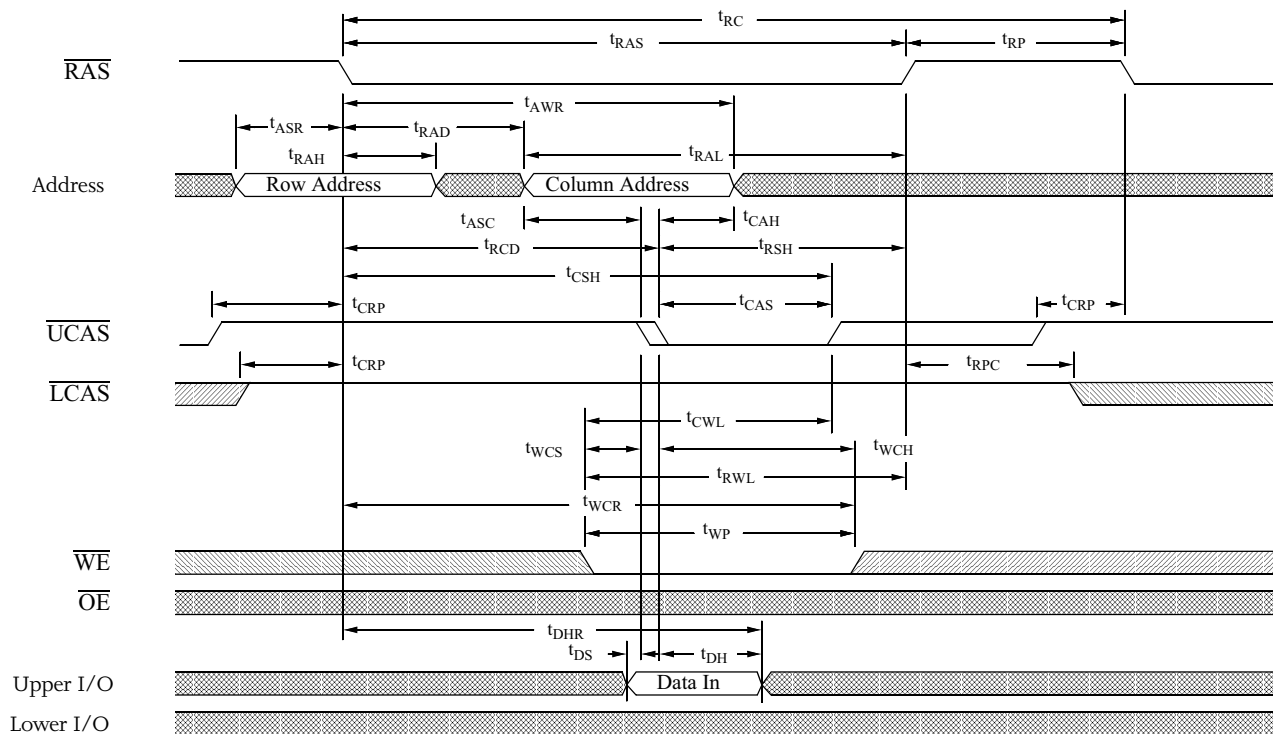




Early write cycle waveform

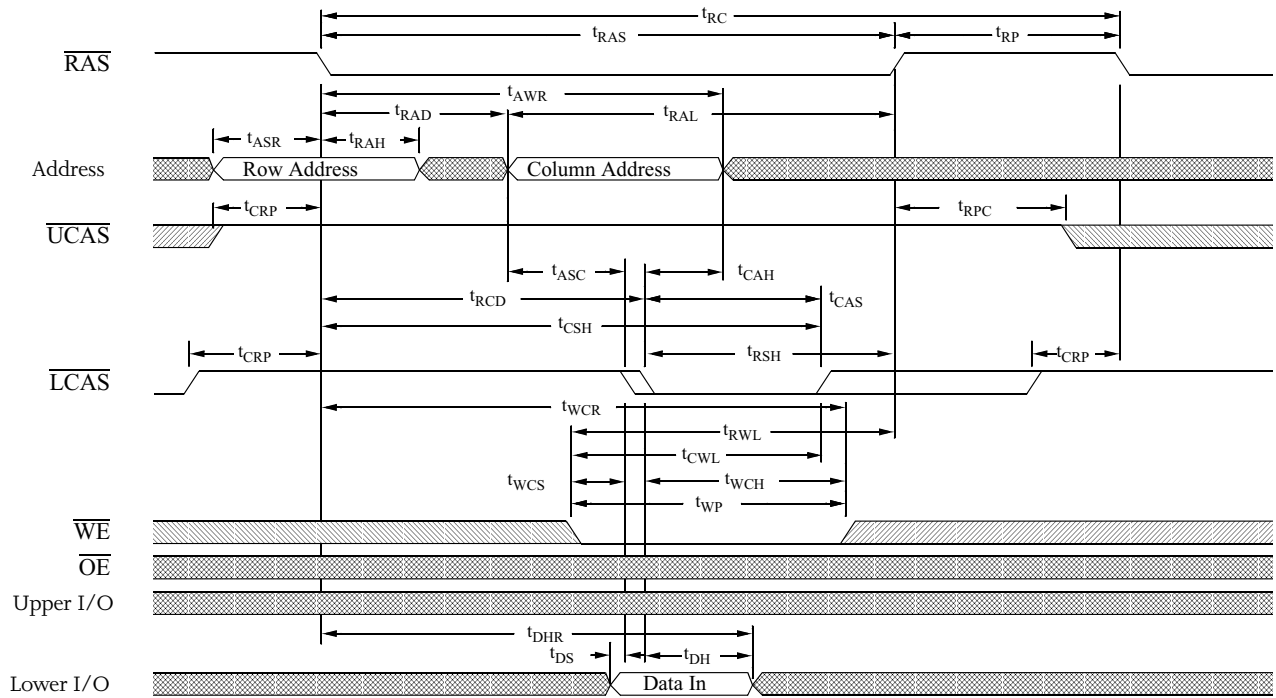


Upper byte early write cycle waveform



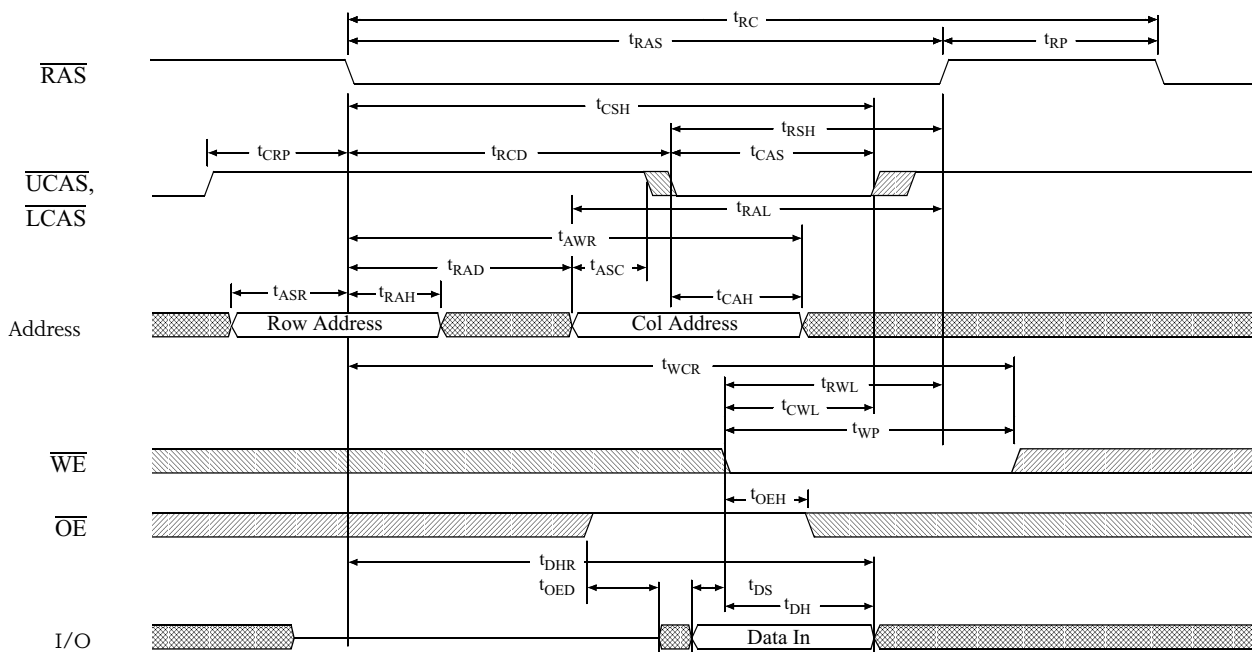


Lower byte early write cycle waveform



Write cycle waveform

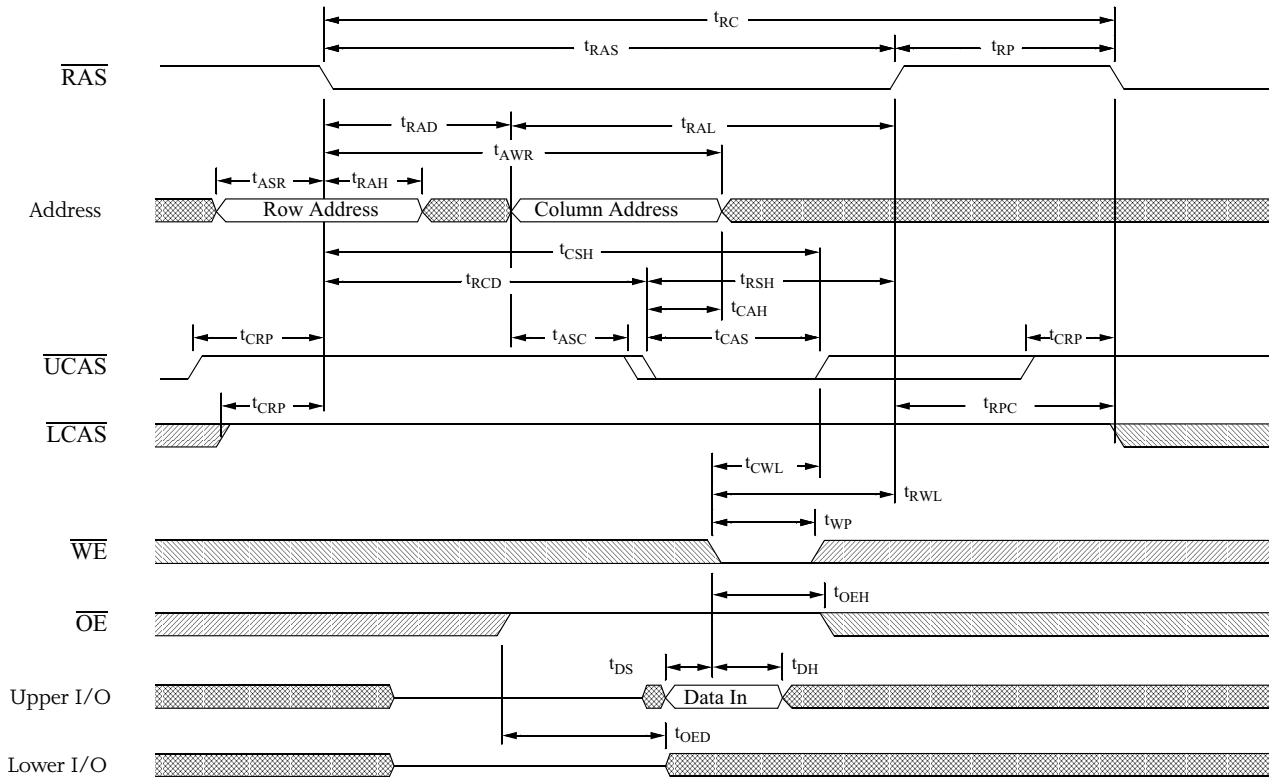
($\overline{\text{OE}}$ controlled)





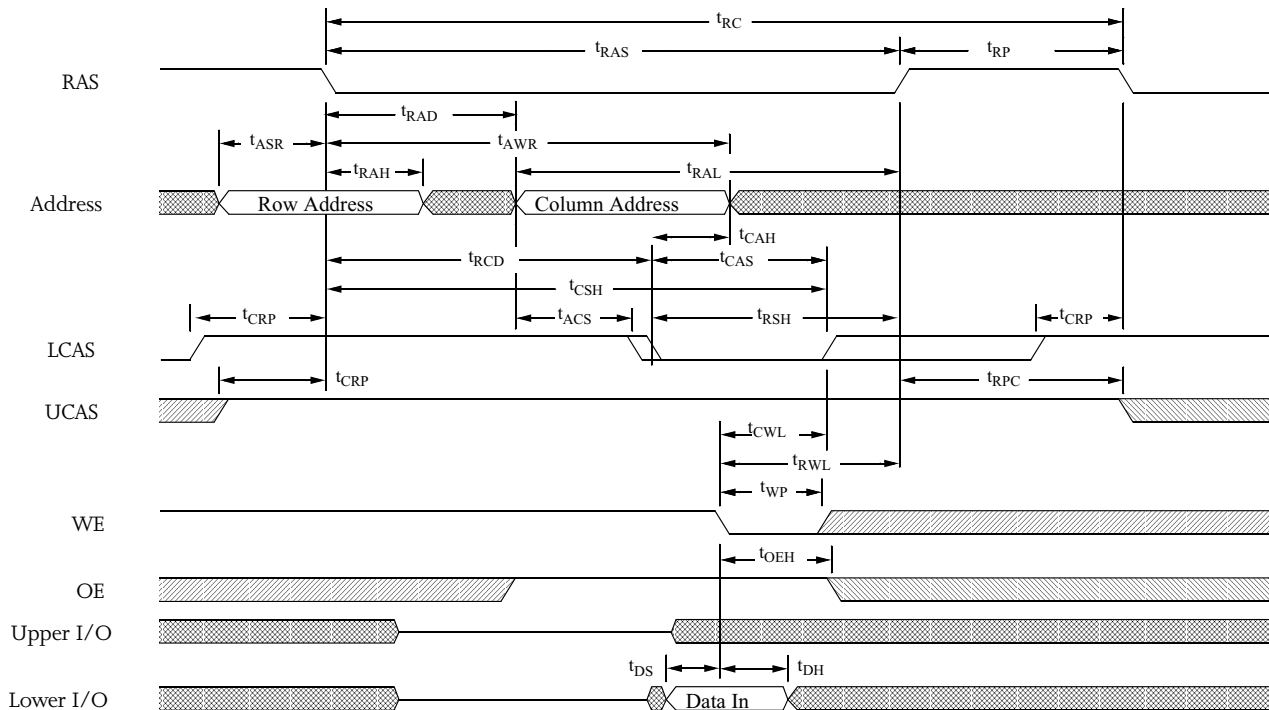
Upper byte write cycle waveform

(\overline{OE} controlled)



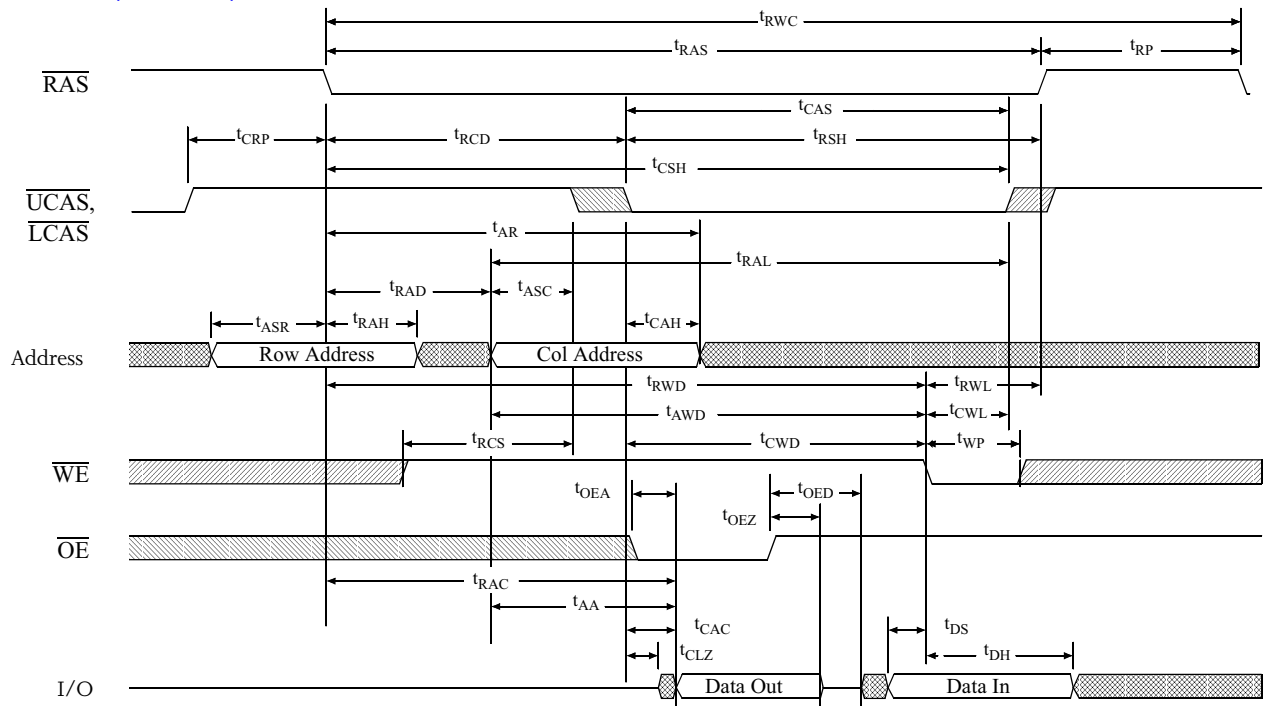
Lower byte write cycle waveform

(\overline{OE} controlled)



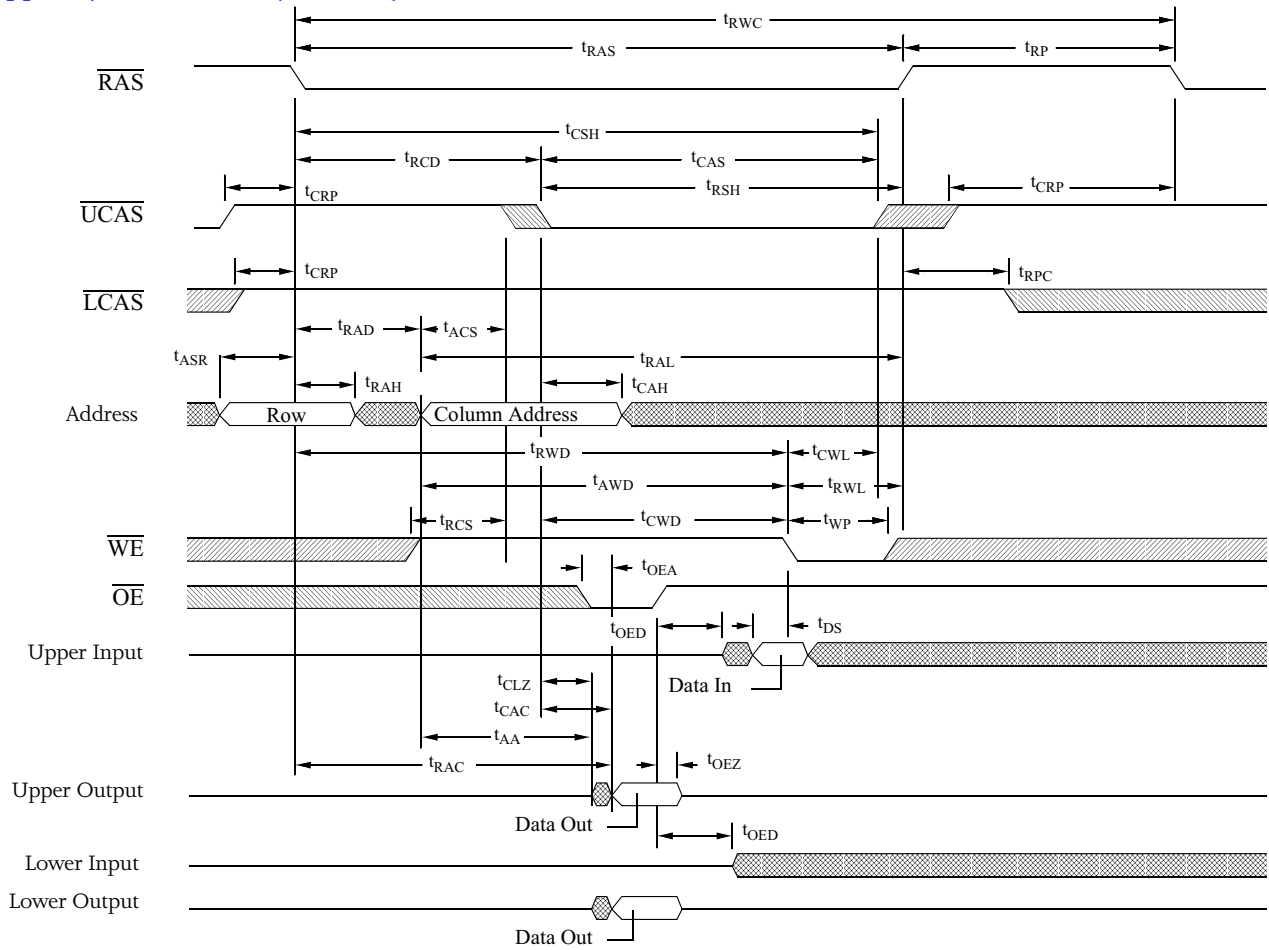


Read-modify-write cycle waveform



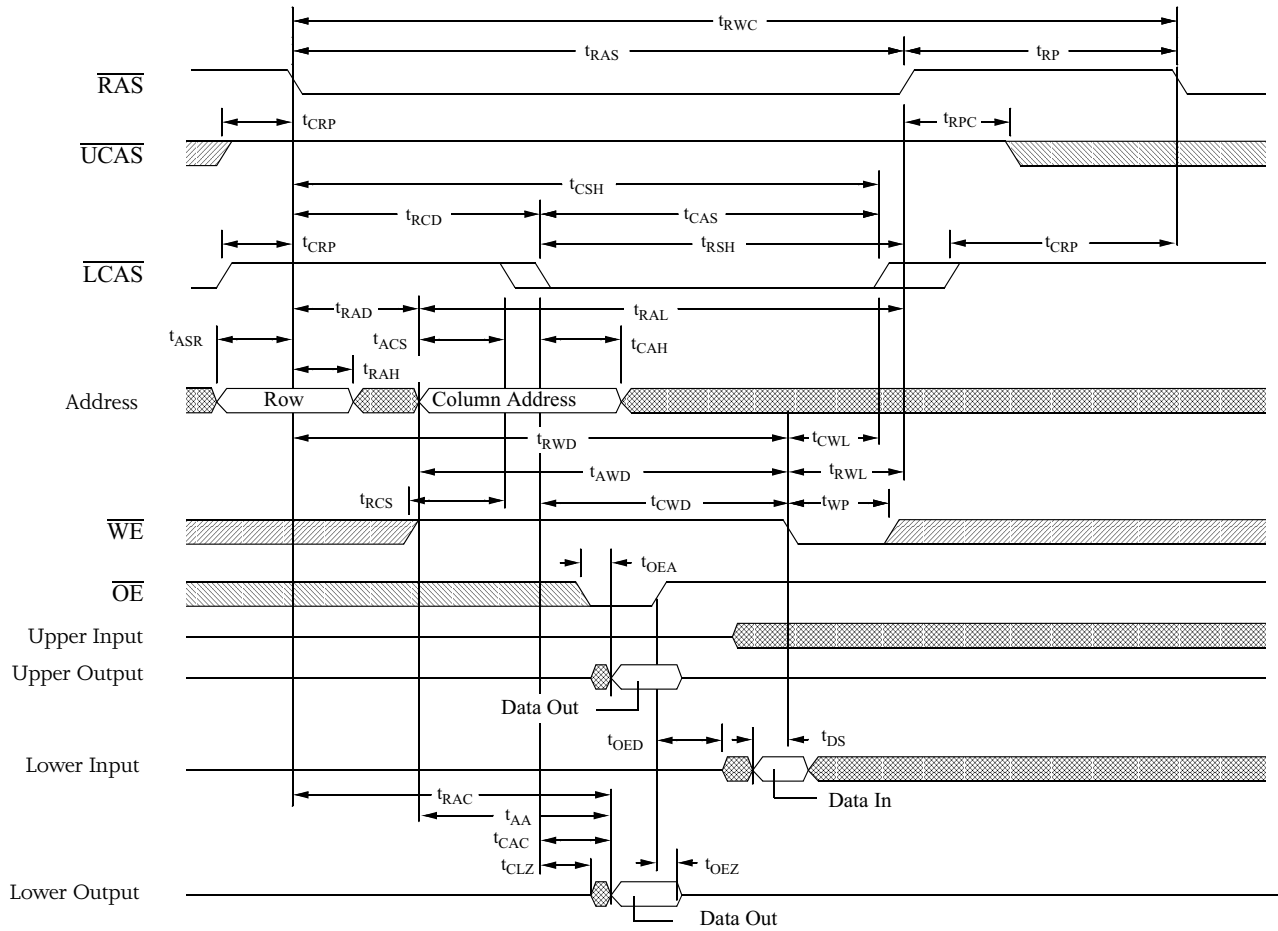


Upper byte read-modify-write cycle waveform



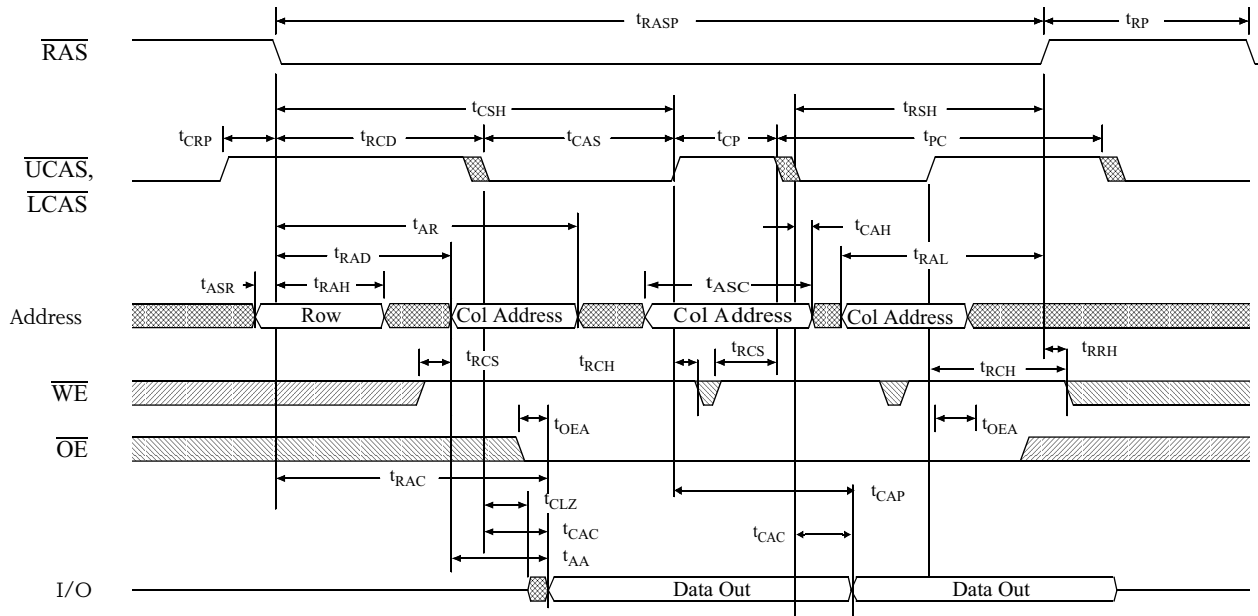


Lower byte read-modify-write cycle waveform

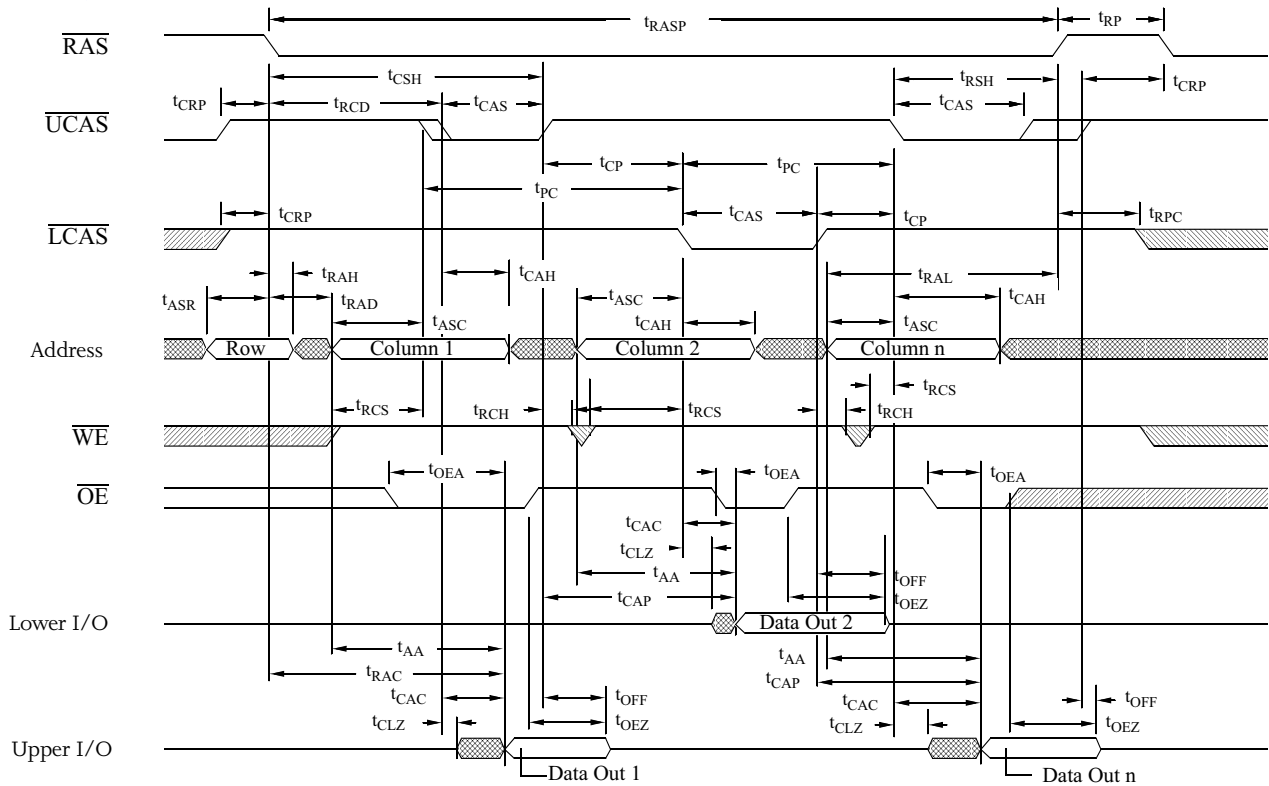




EDO page mode read cycle waveform

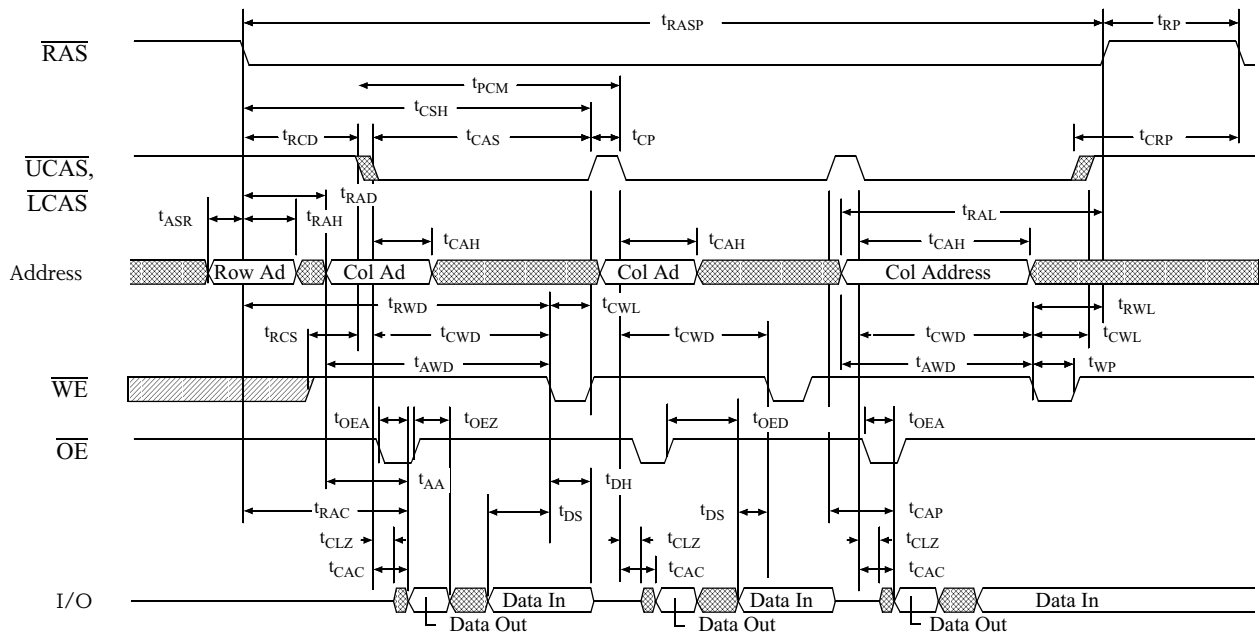


EDO page mode byte read cycle waveform



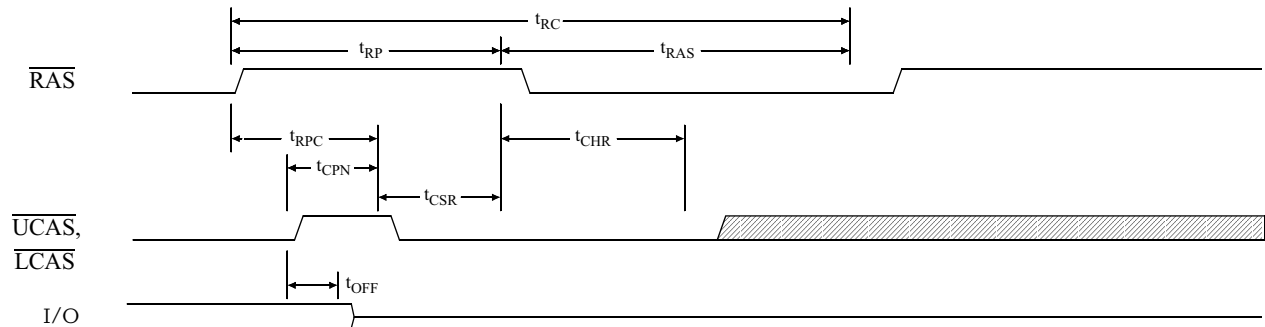


EDO page mode read-modify-write cycle waveform



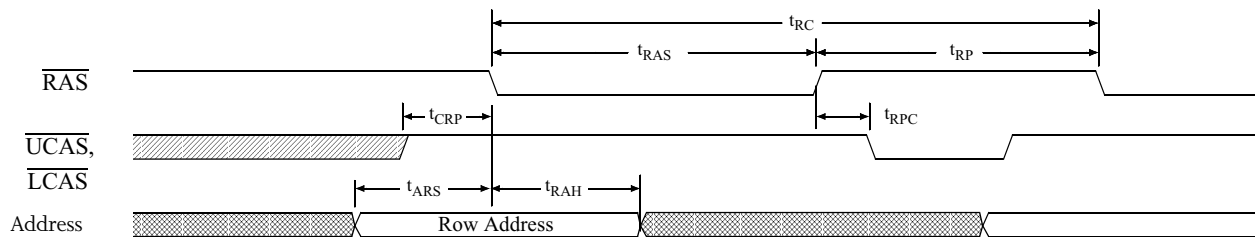
CAS-before-RAS refresh cycle waveform

($\overline{WE} = V_{IH}$)



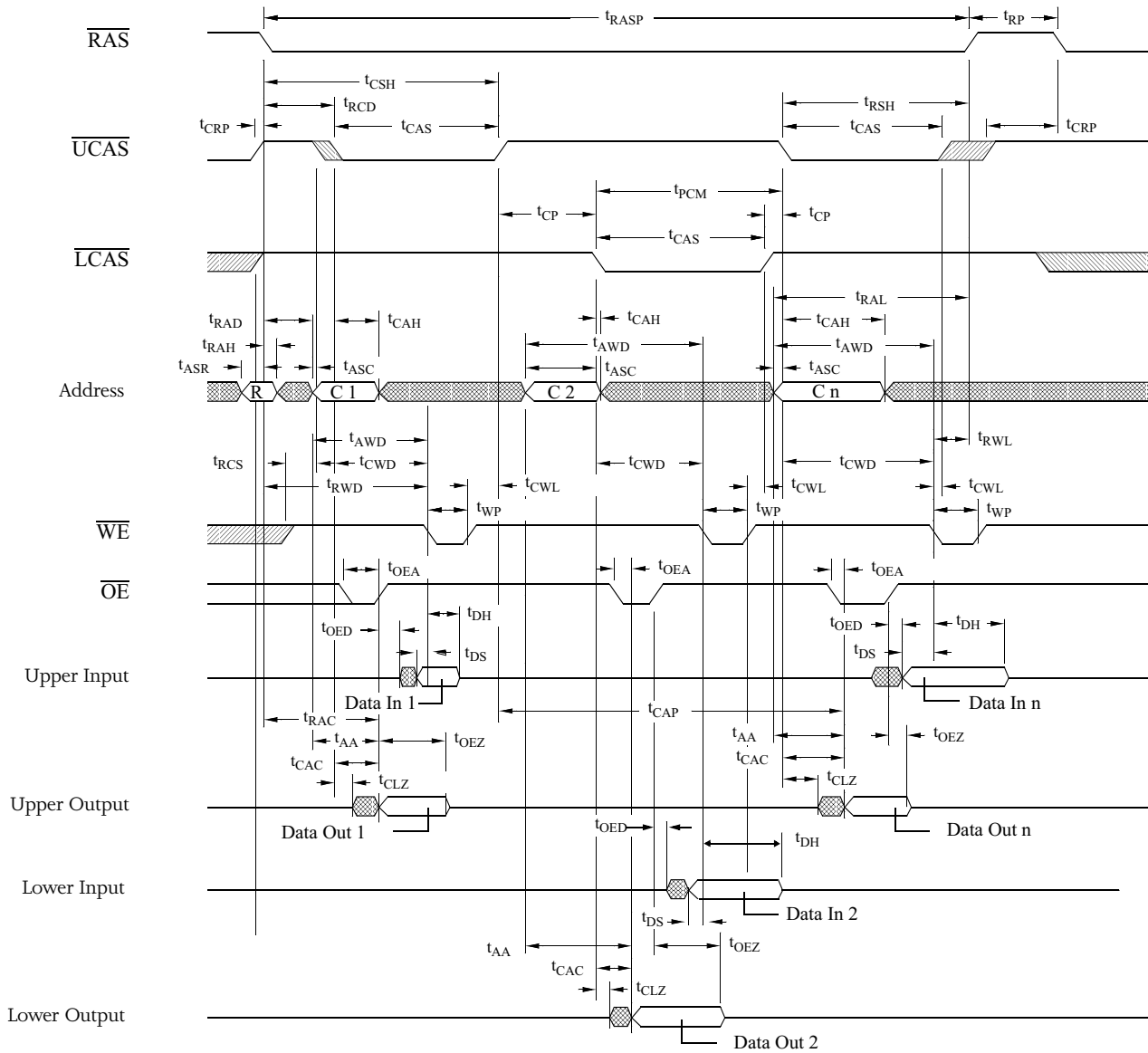
RAS only refresh cycle waveform

($\overline{WE} = \overline{OE} = V_{IH}$ or V_{IL})



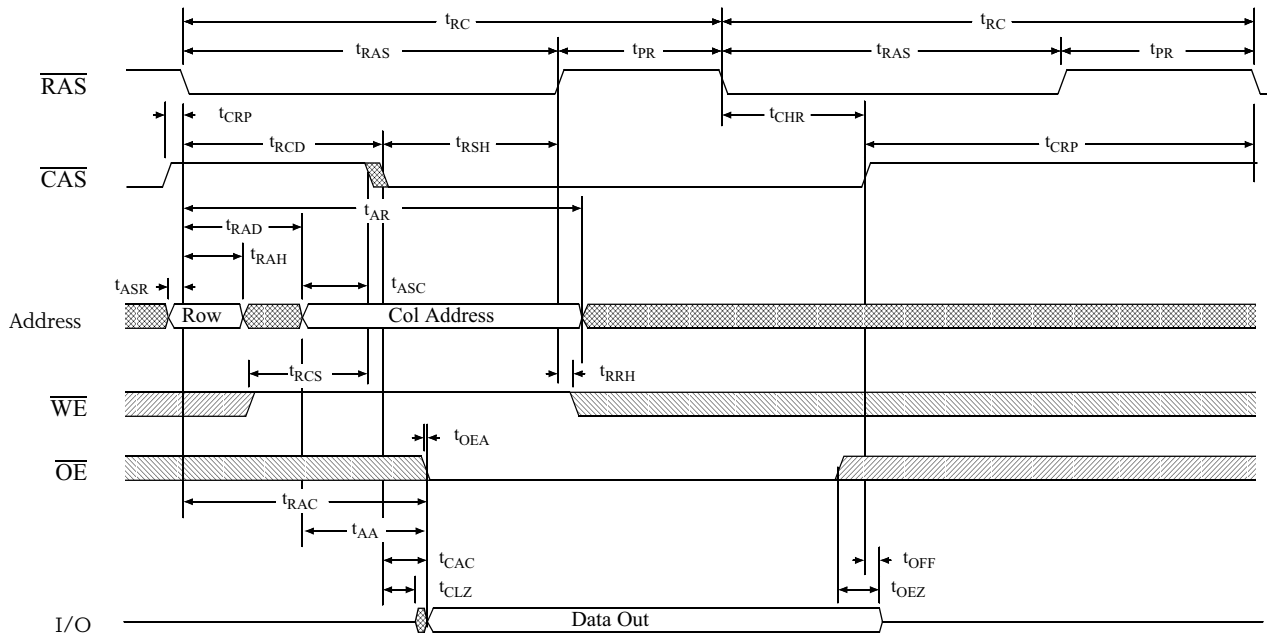


EDO page mode byte read-modify-write cycle

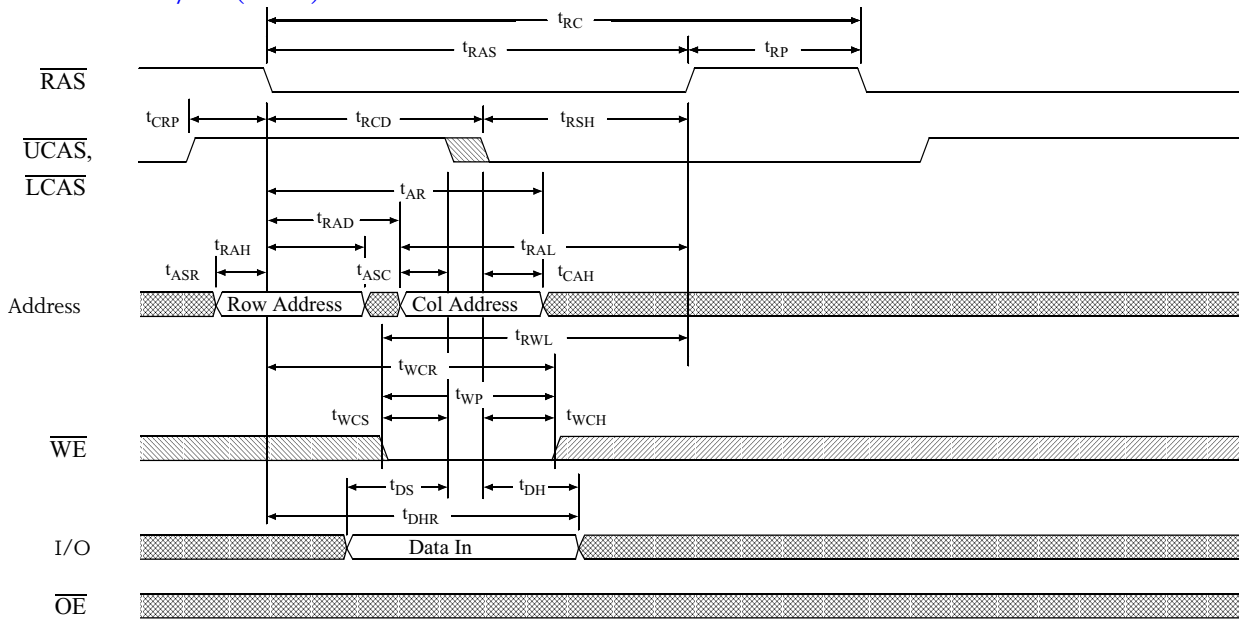




Hidden refresh cycle (read) waveform

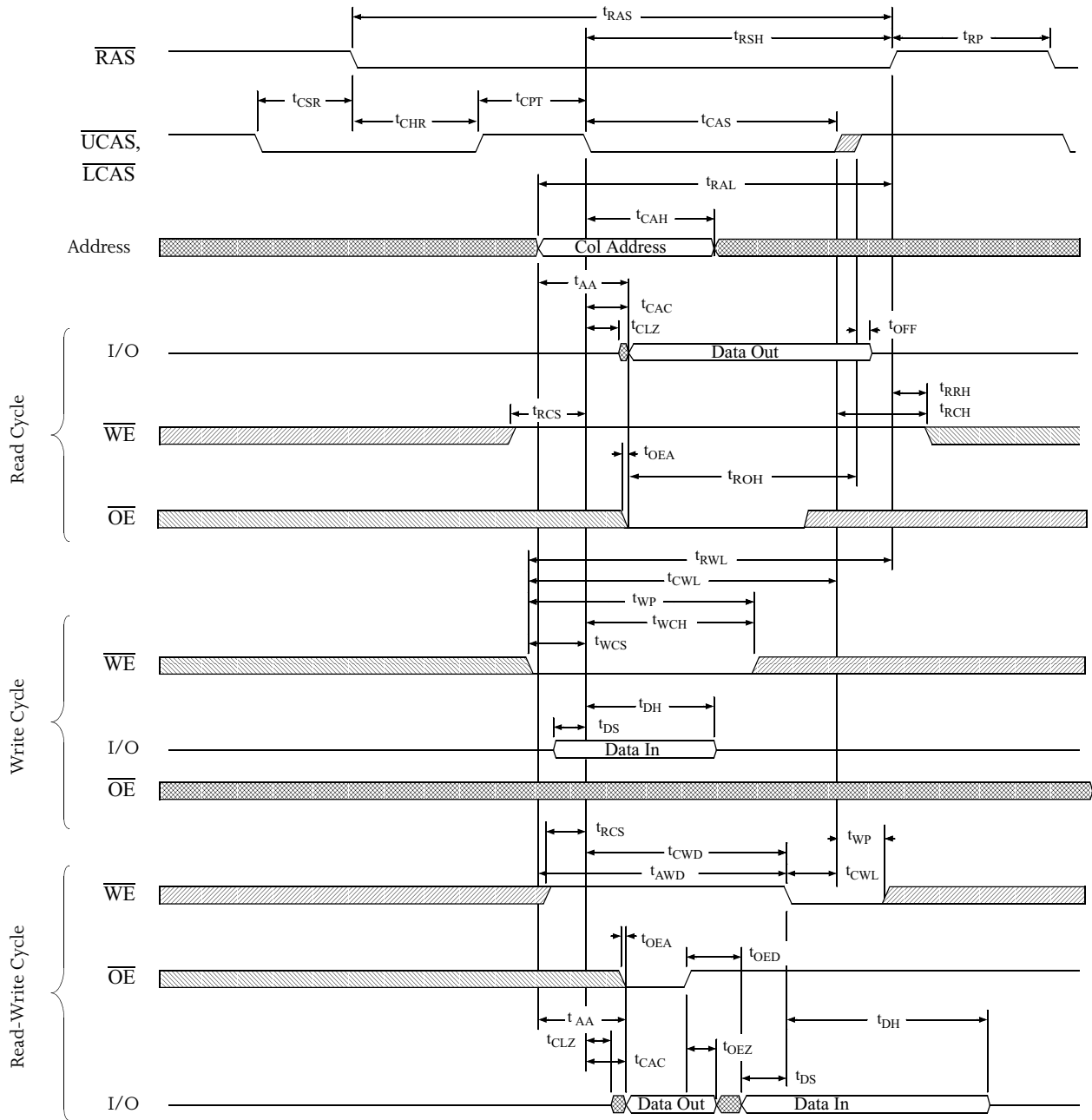


Hidden refresh cycle (write) waveform



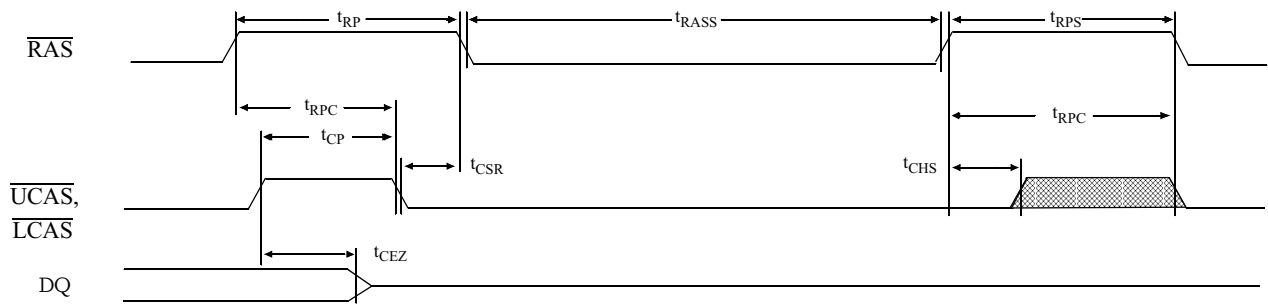


CAS-before-RAS refresh counter test cycle waveform



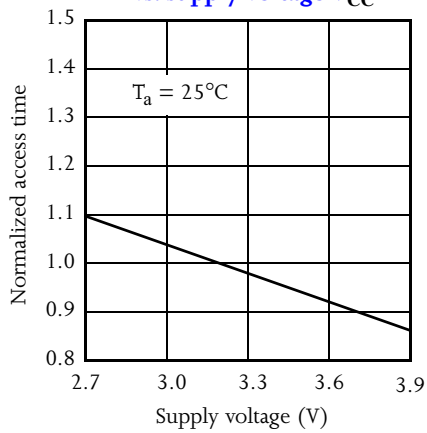


$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ self refresh cycle

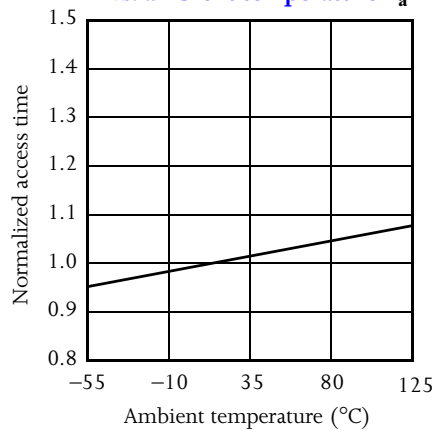


Typical DC and AC characteristics

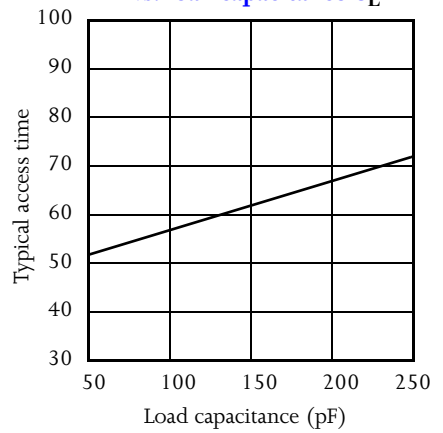
Normalized access time t_{RAC} vs. supply voltage V_{CC}



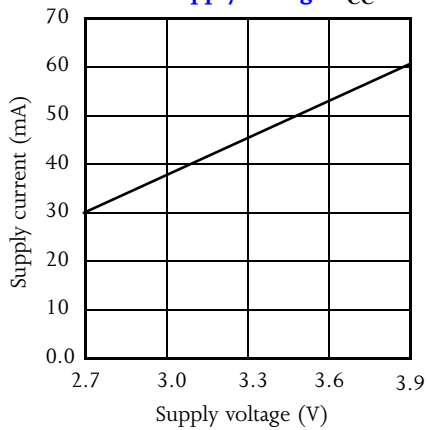
Normalized access time t_{RAC} vs. ambient temperature T_a



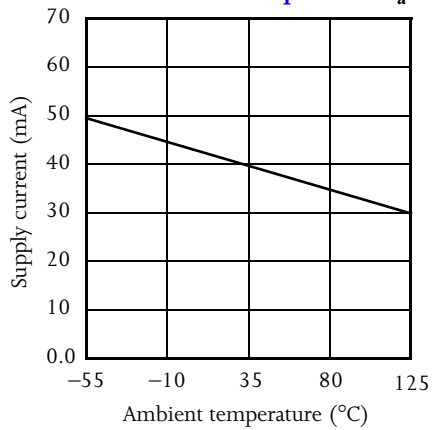
Typical access time t_{RAC} vs. load capacitance C_L



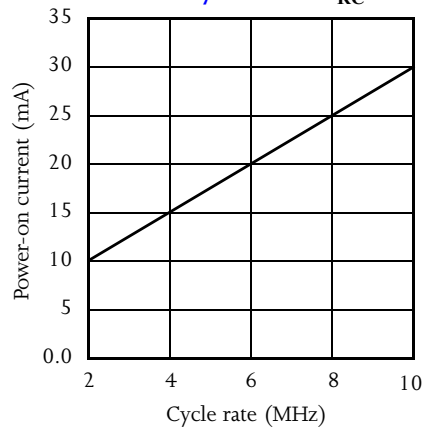
Typical supply current I_{CC} vs. supply voltage V_{CC}

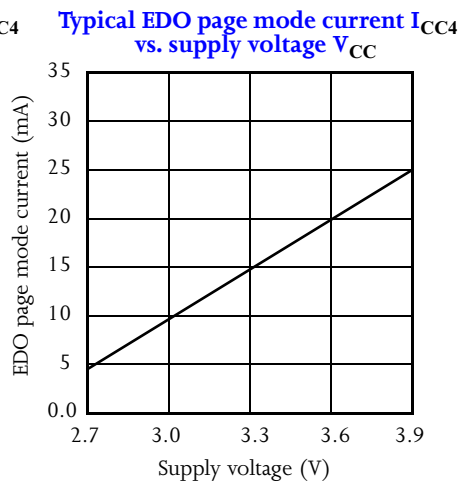
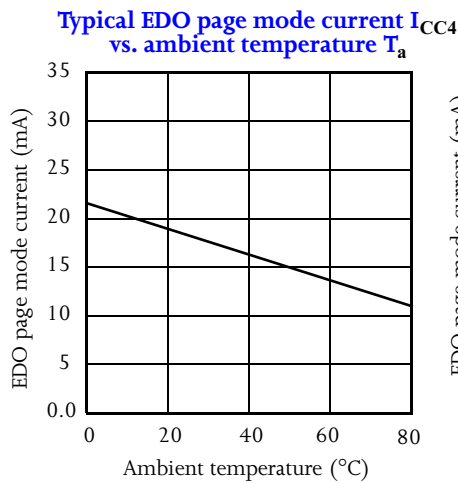
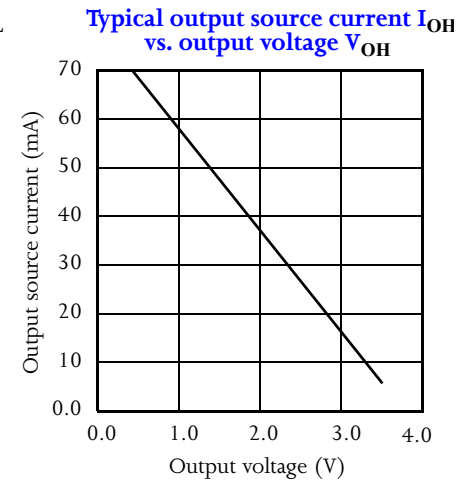
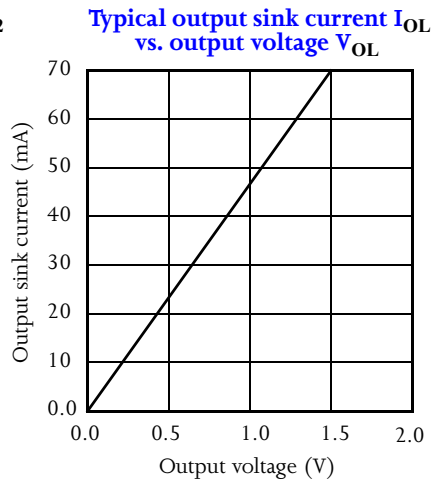
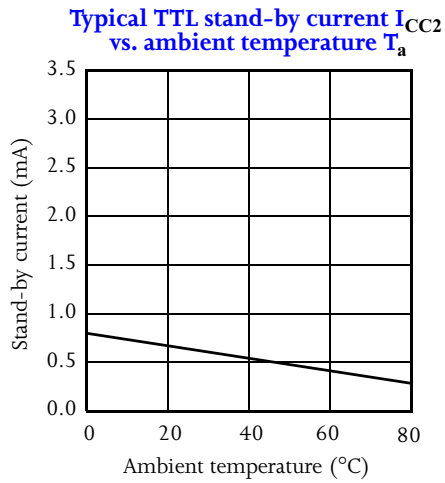
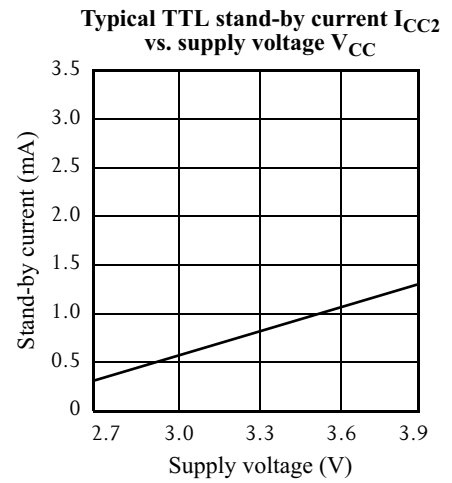
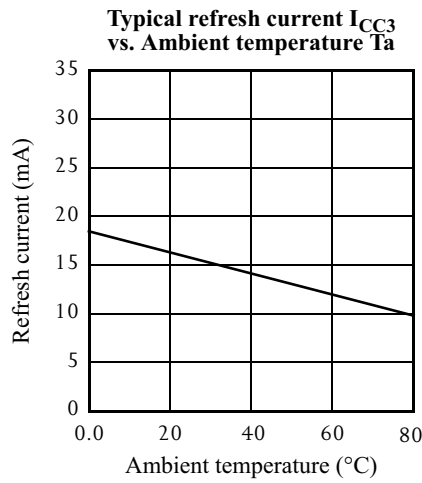
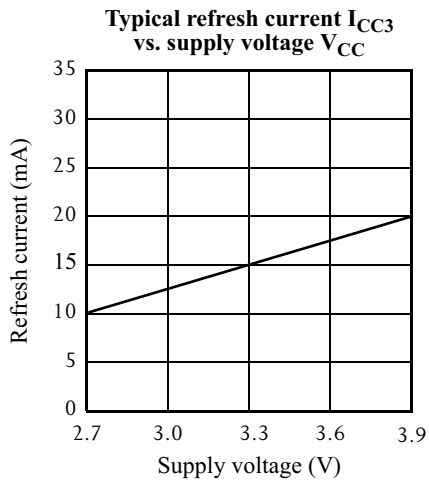


Typical supply current I_{CC} vs. ambient temperature T_a



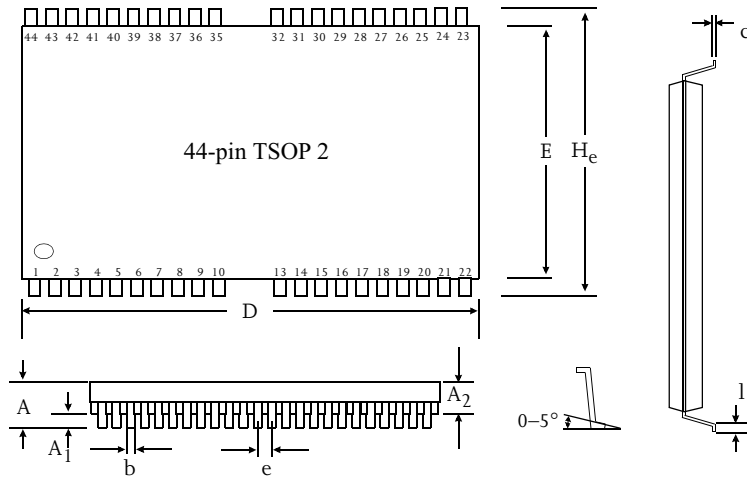
Typical power-on current I_{PO} vs. cycle rate $1/t_{RC}$



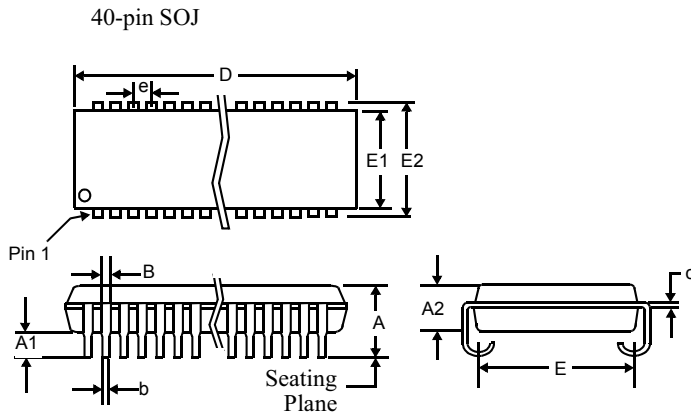




Package dimensions



	44-pin TSOP 2	
	Min (mm)	Max (mm)
A		1.2
A ₁	0.05	
A ₂	0.95	1.05
b	0.30	0.45
c	0.127 (typical)	
D	18.28	18.54
E	10.03	10.29
H _e	11.56	11.96
e	0.80 (typical)	
l	0.40	0.60



	40-pin SOJ 400 mil	
	Min	Max
A	0.128	0.148
A1	0.026	-
A2	1.105	1.115
B	0.026	0.032
b	0.015	0.020
c	0.007	0.013
D	1.020	1.035
E	0.370 (typical)	
E1	0.395	0.405
E2	0.435	0.445
e	0.050 (typical)	

Capacitance

f = 1 MHz, T_a = room temperature, V_{CC} = 3.3V ± 0.3V

Parameter	Symbol	Signals	Test conditions	Max	Unit
Input capacitance	C _{IN1}	A0 to A8	V _{in} = 0V	5	pF
	C _{IN2}	$\overline{\text{RAS}}$, $\overline{\text{UCAS}}$, $\overline{\text{LCAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$	V _{in} = 0V	7	pF
I/O capacitance	C _{I/O}	I/O0 to I/O15	V _{in} = V _{out} = 0V	7	pF



Ordering codes

Package \ Access time	45 ns	50 ns	60 ns
Plastic SOJ, 400 mil, 40-pin	AS4LC256K16EO-45JC	AS4LC256K16EO-50JC	AS4LC256K16EO-60JC
TSOP 2, 400 mil, 40/44-pin	AS4LC256K16EO-45TC	AS4LC256K16EO-50TC	AS4LC256K16EO-60TC

Part numbering system

AS4LC	256K16E0	-XX	X	C
3.3V DRAM prefix	Device number	$\overline{\text{RAS}}$ access time	Package: J = SOJ T = TSOP 2	Commercial temperature range, 0°C to 70 °C