

# SIEMENS

**1M x 16-Bit EDO- Dynamic RAM  
(1k & 4k -Refresh)**

**HYB3116165BSJ/BST(L)-50/-60/-70  
HYB3118165BSJ/BST(L)-50/-60/-70**

## Advanced Information

- 1 048 576 words by 16-bit organization
- 0 to 70 °C operating temperature
- Performance:

		-50	-60	-70	
t <sub>RAC</sub>	$\overline{\text{RAS}}$ access time	50	60	70	ns
t <sub>CAC</sub>	$\overline{\text{CAS}}$ access time	13	15	20	ns
t <sub>AA</sub>	Access time from address	25	30	35	ns
t <sub>RC</sub>	Read/Write cycle time	84	104	124	ns
t <sub>HPC</sub>	Hyper page mode (EDO) cycle time	20	25	30	ns

- Single + 3.3 V ( $\pm 0.3$  V) supply
- Low power dissipation
  - max. 720 active mW ( HYB3118165BSJ/BST-50)
  - max. 648 active mW ( HYB3118165BSJ/BST-60)
  - max. 576 active mW ( HYB3118165BSJ/BST-70)
  - max. 360 active mW ( HYB3116165BSJ/BST-50)
  - max. 324 active mW ( HYB3116165BSJ/BST-60)
  - max. 288 active mW ( HYB3116165BSJ/BST-70)
  - 7.2 mW standby (LV-TTL)
  - 3.6 mW standby (LV-CMOS)
  - 720  $\mu$ W standby for L-version
- Output unlatched at cycle end allows two-dimensional chip selection
- Read, write, read-modify-write,  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh,  $\overline{\text{RAS}}$ -only refresh, hidden refresh, self refresh
- Hyper page mode (EDO) capability
- 2  $\overline{\text{CAS}}$  / 1  $\overline{\text{WE}}$
- All inputs, outputs and clocks fully LV-TTL-compatible
- 1024 refresh cycles / 16 ms for HYB 3118165BSJ
- 4096 refresh cycles / 64 ms for HYB 3116165BSJ
- Plastic Package:
  - P-SOJ-42-1 400 mil
  - P-TSOPII-50/44-1 400mil

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- 1024 refresh cycles / 16 ms for HYB 3118165BSJ
- 4096 refresh cycles / 64 ms for HYB 3116165BSJ
- Plastic Package: P-SOJ-42-1 400 mil  
P-TSOPII-50/44-1 400mil

The HYB 3116(8)165BSJ/BST is a 16 MBit dynamic RAM organized as 1 048 576 words by 16 bits. The HYB 3116(8)165BSJ/BST utilizes a submicron CMOS silicon gate process technology, as well as advanced circuit techniques to provide wide operating margins, both internally and for the system user. Multiplexed address inputs permit the HYB 3116(8)165BSJ/BST to be packaged in standard SOJ-42 and TSOPII-50/44 plastic package with 400mil width. These packages provide high system bit densities and are compatible with commonly used automatic testing and insertion equipment. System-oriented features include single + 3.3 V ( $\pm 0.3$  V) power supply, direct interfacing with high-performance logic device families. The HYB3116166BSTL parts have a very low power „sleep mode“ supported by Self Refresh.

### Ordering Information

Type	Ordering Code	Package	Descriptions
HYB 3116165BSJ-50	on request	P-SOJ-42 400 mil	DRAM (access time 50 ns)
HYB 3116165BSJ-60	on request	P-SOJ-42 400 mil	DRAM (access time 60 ns)
HYB 3116165BSJ-70	on request	P-SOJ-42 400 mil	DRAM (access time 70 ns)
HYB 3118165BSJ-50	Q67100-Q1159	P-SOJ-42 400 mil	DRAM (access time 50 ns)
HYB 3118165BSJ-60	Q67100-Q1160	P-SOJ-42 400 mil	DRAM (access time 60 ns)
HYB 3118165BSJ-70		P-SOJ-42 400 mil	DRAM (access time 70 ns)
HYB 3116165BST-50	Q67100-Q1190	P-TSOPII-50/44 400 mil	DRAM (access time 50 ns)
HYB 3116165BST-60	Q67100-Q1192	P-TSOPII-50/44 400 mil	DRAM (access time 60 ns)
HYB 3116165BST-70		P-TSOPII-50/44 400 mil	DRAM (access time 70 ns)
HYB 3118165BST-50	Q67100-Q1167	P-TSOPII-50/44 400 mil	DRAM (access time 50 ns)
HYB 3118165BST-60	Q67100-Q1168	P-TSOPII-50/44 400 mil	DRAM (access time 60 ns)
HYB 3118165BST-70	Q67100-Q1188	P-TSOPII-50/44 400 mil	DRAM (access time 70 ns)

### Pin Names

A0 to A9	Row Address Inputs for 1k-refresh version HYB3118165BSJ/BST
A0 to A9	Column Address Inputs for 1k-refresh version HYB3118165BSJ/BST
A0 to A11	Row Address Inputs for 4k-refresh version HYB3116165BSJ/BST
A0 to A7	Column Address Inputs for 4k-refresh version HYB3116165BSJ/BST
$\overline{RAS}$	Row Address Strobe
$\overline{OE}$	Output Enable
I/O1-I/O16	Data Input/Output
$\overline{UCAS}$	Upper Column Address Strobe
$\overline{LCAS}$	Lower Column Address Strobe
$\overline{WE}$	Read/Write Input
$V_{CC}$	Power Supply (+ 3.3 V)
$V_{SS}$	Ground (0 V)
N.C.	not connected

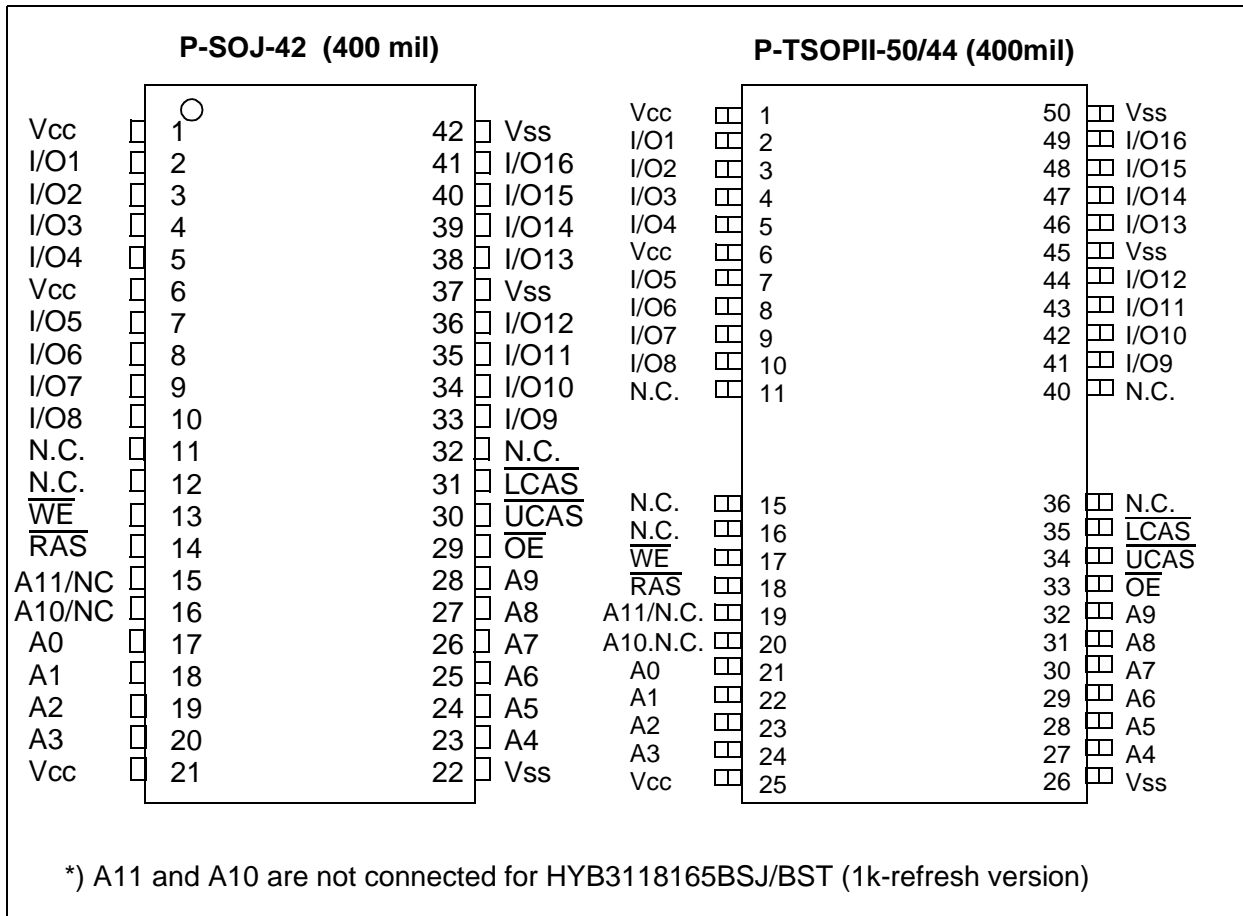
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### Ordering Information

Type	Ordering Code	Package	Descriptions
HYB 3116165BSJ-50	on request	P-SOJ-42 400 mil	DRAM (access time 50 ns)
HYB 3116165BSJ-60	on request	P-SOJ-42 400 mil	DRAM (access time 60 ns)
HYB 3116165BSJ-70	on request	P-SOJ-42 400 mil	DRAM (access time 70 ns)
HYB 3118165BSJ-50	Q67100-Q1159	P-SOJ-42 400 mil	DRAM (access time 50 ns)
HYB 3118165BSJ-60	Q67100-Q1160	P-SOJ-42 400 mil	DRAM (access time 60 ns)
HYB 3118165BSJ-70		P-SOJ-42 400 mil	DRAM (access time 70 ns)
HYB 3116165BST-50	Q67100-Q1190	P-TSOPII-50/44 400 mil	DRAM (access time 50 ns)
HYB 3116165BST-60	Q67100-Q1192	P-TSOPII-50/44 400 mil	DRAM (access time 60 ns)
HYB 3116165BST-70		P-TSOPII-50/44 400 mil	DRAM (access time 70 ns)
HYB 3118165BST-50	Q67100-Q1167	P-TSOPII-50/44 400 mil	DRAM (access time 50 ns)
HYB 3118165BST-60	Q67100-Q1168	P-TSOPII-50/44 400 mil	DRAM (access time 60 ns)
HYB 3118165BST-70	Q67100-Q1188	P-TSOPII-50/44 400 mil	DRAM (access time 70 ns)

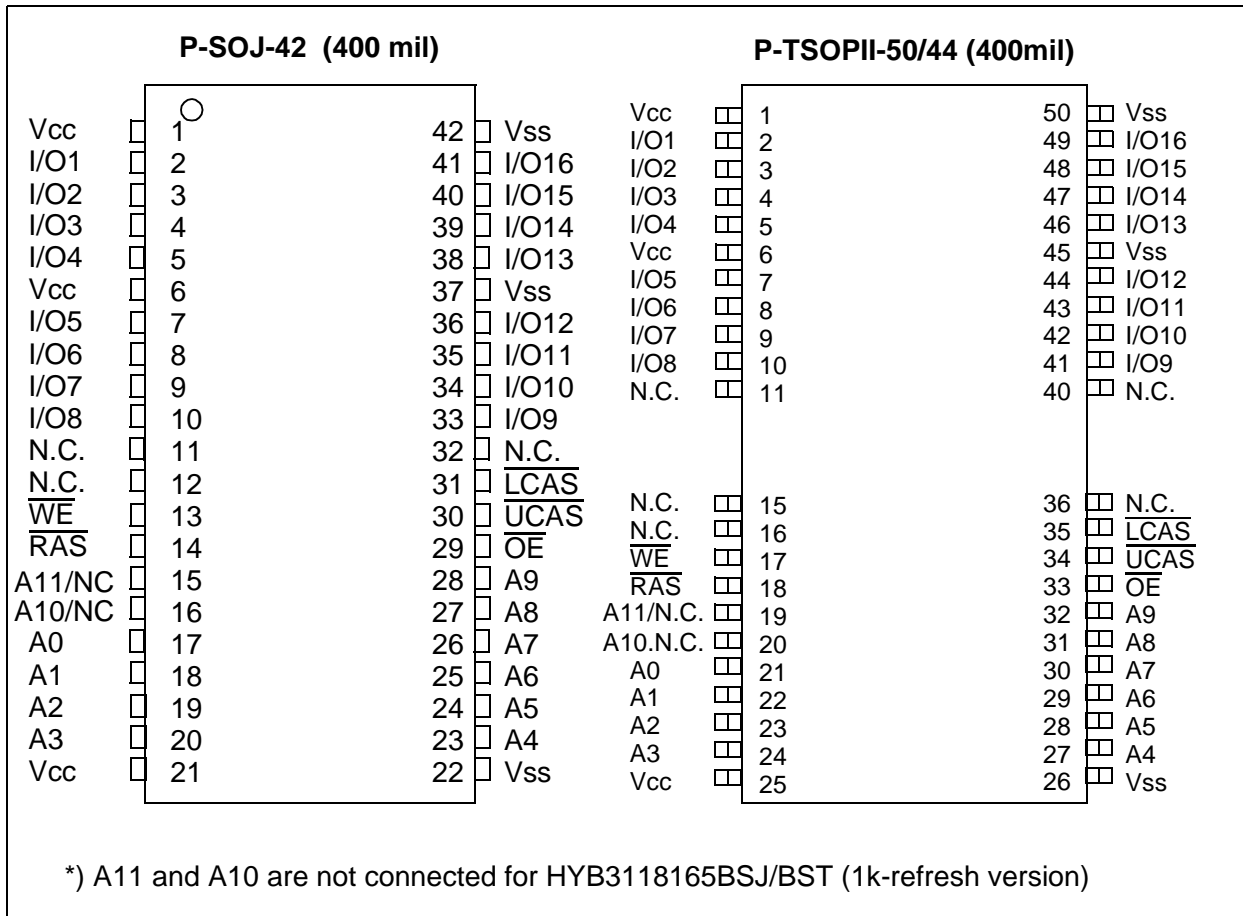
### Pin Names

A0 to A9	Row Address Inputs for 1k-refresh version HYB3118165BSJ/BST
A0 to A9	Column Address Inputs for 1k-refresh version HYB3118165BSJ/BST
A0 to A11	Row Address Inputs for 4k-refresh version HYB3116165BSJ/BST
A0 to A7	Column Address Inputs for 4k-refresh version HYB3116165BSJ/BST
$\overline{RAS}$	Row Address Strobe
$\overline{OE}$	Output Enable
I/O1-I/O16	Data Input/Output
$\overline{UCAS}$	Upper Column Address Strobe
$\overline{LCAS}$	Lower Column Address Strobe
$\overline{WE}$	Read/Write Input
$V_{CC}$	Power Supply (+ 3.3 V)
$V_{SS}$	Ground (0 V)
N.C.	not connected



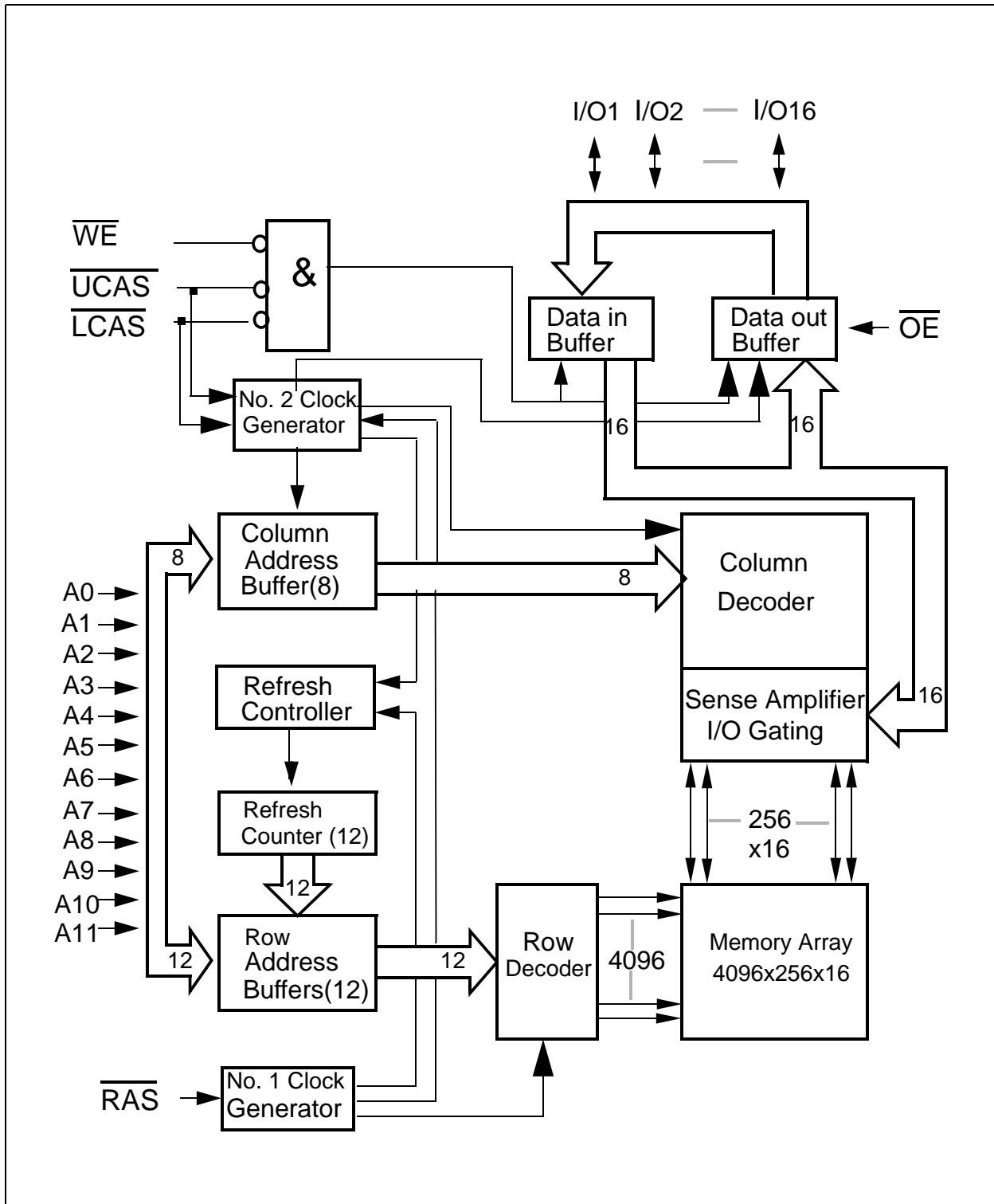
### Truth Table

<u>RAS</u>	<u>LCAS</u>	<u>UCAS</u>	<u>WE</u>	<u>OE</u>	I/O1-I/O8	I/O9-I/O16	Operation
H	H	H	H	H	High-Z	High-Z	Standby
L	H	H	H	H	High-Z	High-Z	Refresh
L	L	H	H	L	Dout	High-Z	Lower byte read
L	H	L	H	L	High-Z	Dout	Upper byte read
L	L	L	H	L	Dout	Dout	Word read
L	L	H	L	H	Din	Don't care	Lower byte write
L	H	L	L	H	Don't care	Din	Upper byte write
L	L	L	L	H	Din	Din	Word write
L	L	L	H	H	High-Z	High-Z	NOP

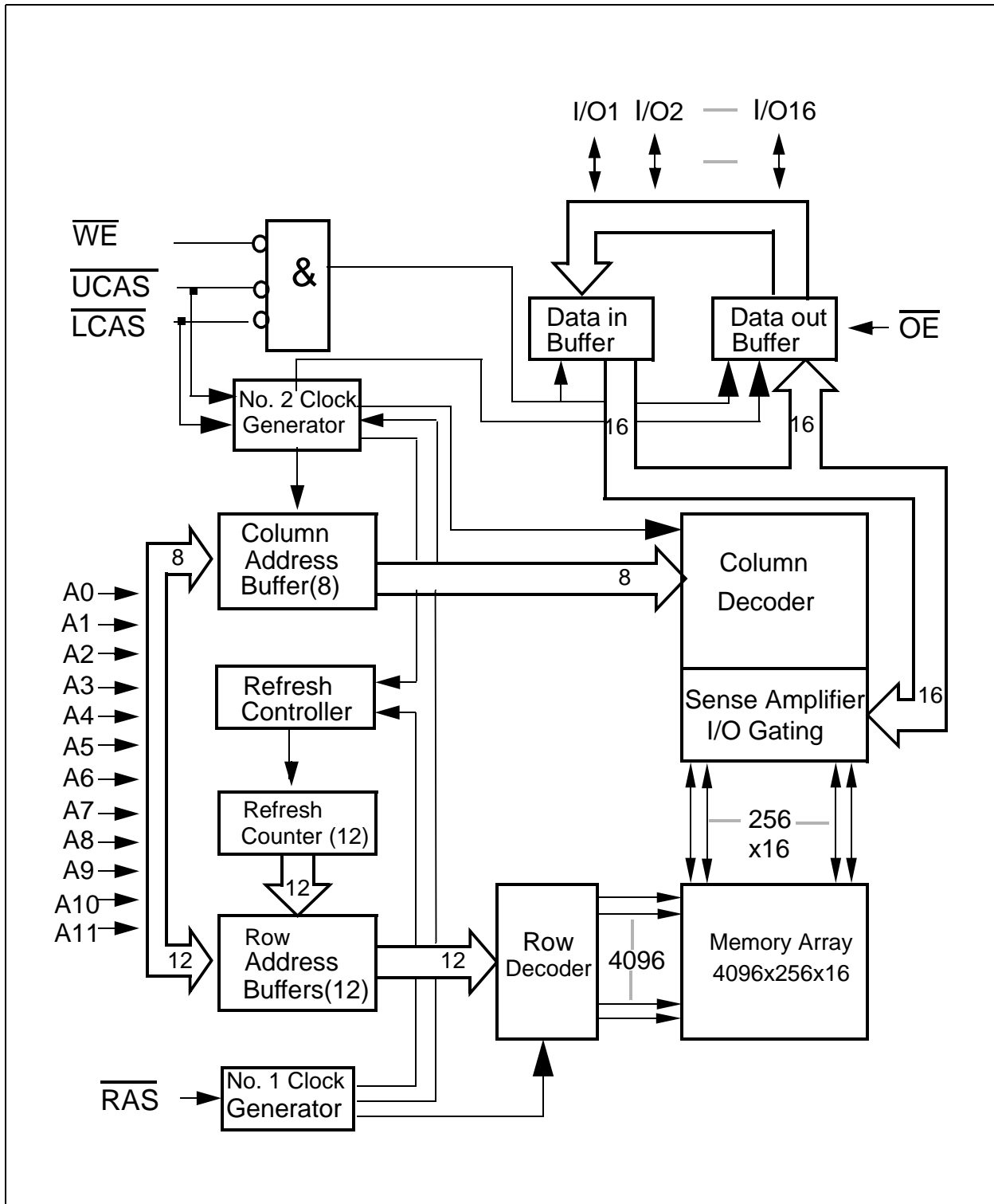


### Truth Table

<u>RAS</u>	<u>LCAS</u>	<u>UCAS</u>	<u>WE</u>	<u>OE</u>	I/O1-I/O8	I/O9-I/O16	Operation
H	H	H	H	H	High-Z	High-Z	Standby
L	H	H	H	H	High-Z	High-Z	Refresh
L	L	H	H	L	Dout	High-Z	Lower byte read
L	H	L	H	L	High-Z	Dout	Upper byte read
L	L	L	H	L	Dout	Dout	Word read
L	L	H	L	H	Din	Don't care	Lower byte write
L	H	L	L	H	Don't care	Din	Upper byte write
L	L	L	L	H	Din	Din	Word write
L	L	L	H	H	High-Z	High-Z	NOP

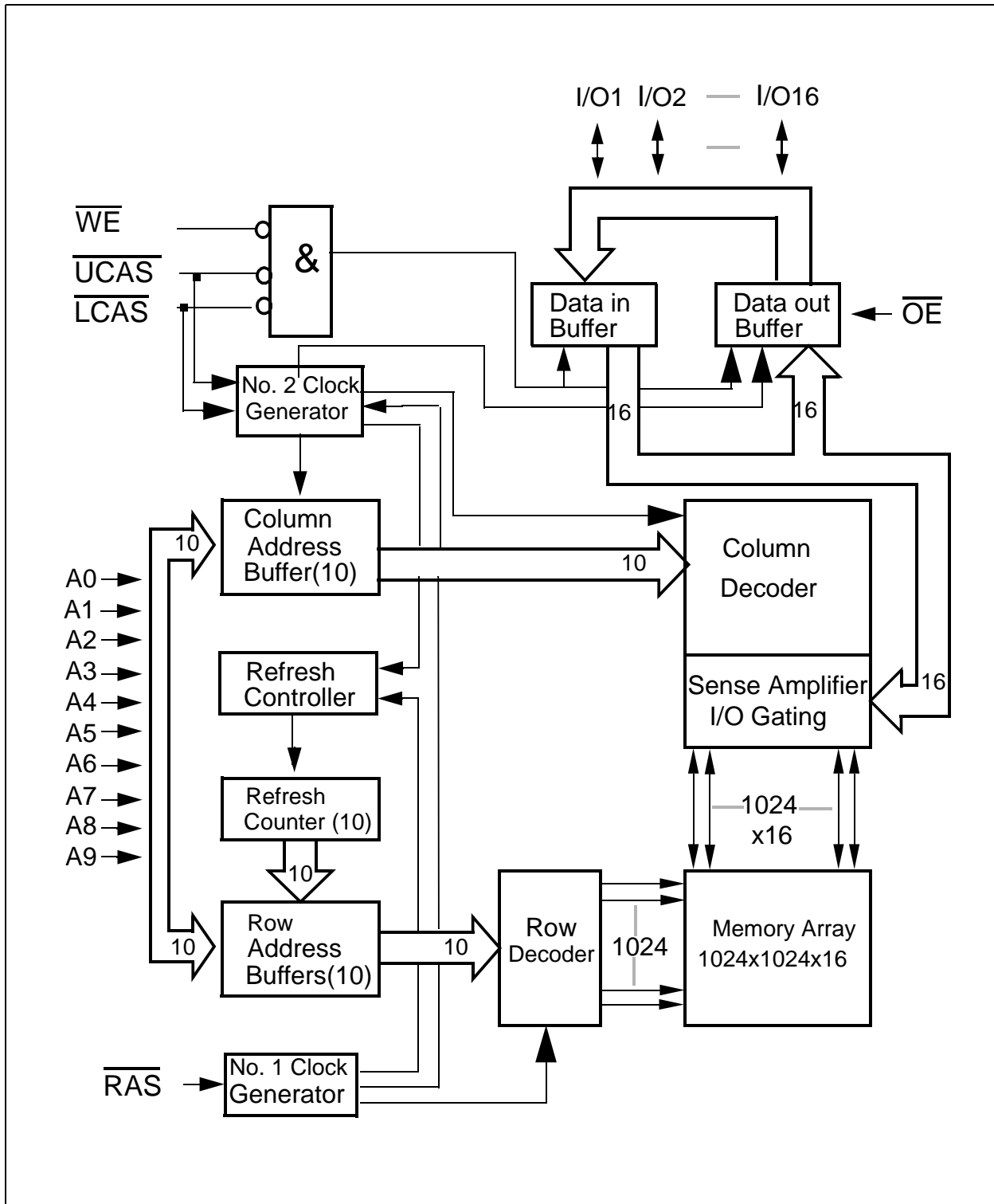


**Block Diagram for HYB 3116165BSJ**

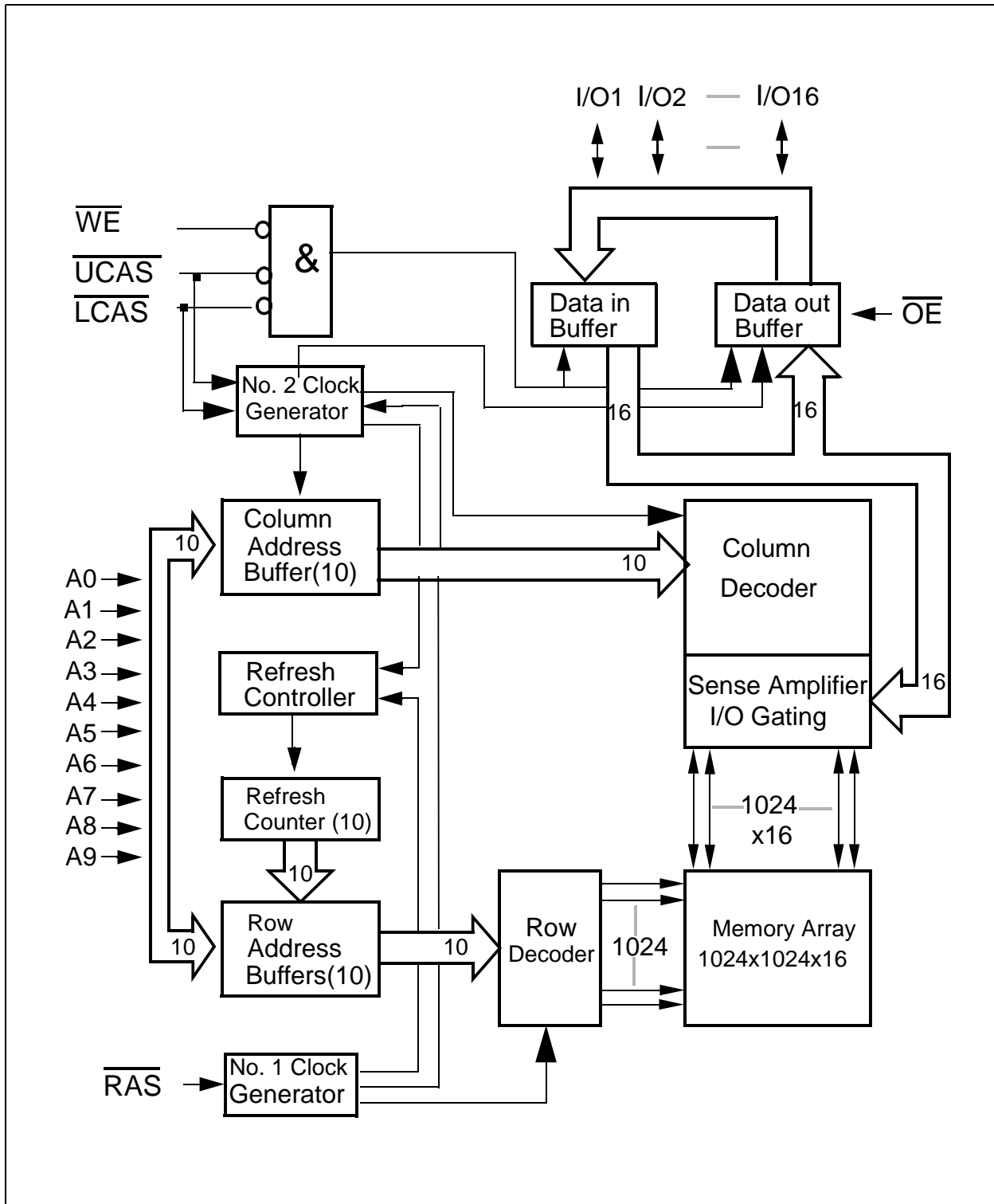


**Block Diagram for HYB 3116165BSJ**





**Block Diagram for HYB 3118165BSJ**



**Block Diagram for HYB 3118165BSJ**

### Absolute Maximum Ratings

Operating temperature range .....	0 to 70 °C
Storage temperature range.....	- 55 to 150 °C
Soldering time .....	10 s
Input/output voltage .....	-0.5 to min (V <sub>CC</sub> +0.5,4.6) V
Power supply voltage.....	-0.5 V to 4.6 V
Power dissipation.....	1.0 W
Data out current (short circuit) .....	50 mA

### Note:

Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage of the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### DC Characteristics (values in brackets for HYB3116165BSJ)

T<sub>A</sub> = 0 to 70 °C, V<sub>SS</sub> = 0 V, V<sub>CC</sub> = 3.3 V ± 0.3 V, t<sub>T</sub> = 2 ns

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Input high voltage	V <sub>IH</sub>	2.0	V <sub>CC</sub> +0.5	V	1)
Input low voltage	V <sub>IL</sub>	- 0.5	0.8	V	1)
TTL Output high voltage (I <sub>OUT</sub> = - 2 mA)	V <sub>OH</sub>	2.4	-	V	1)
TTL Output low voltage (I <sub>OUT</sub> = 2 mA)	V <sub>OL</sub>	-	0.4	V	1)
CMOS Output high voltage (I <sub>OUT</sub> = - 100 μA)	V <sub>OH</sub>	V <sub>CC</sub> -0.2	-	V	1)
CMOS Output low voltage (I <sub>OUT</sub> = 100 μA)	V <sub>OL</sub>	-	0.2	V	1)
Input leakage current, any input (0 V ≤ V <sub>IH</sub> ≤ V <sub>CC</sub> + 0.3V, all other pins = 0 V)	I <sub>I(L)</sub>	- 10	10	μA	1)
Output leakage current (DO is disabled, 0 V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> + 0.3V)	I <sub>O(L)</sub>	- 10	10	μA	1)
Average V <sub>CC</sub> supply current: -50 ns version -60 ns version -70 ns version	I <sub>CC1</sub>	-	200(100) 180 (90) 160 (80)	mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4)
( $\overline{RAS}$ , $\overline{CAS}$ , address cycling, t <sub>RC</sub> = t <sub>RC</sub> min.)					
Standby V <sub>CC</sub> supply current ( $\overline{RAS} = \overline{CAS} = V_{IH}$ )	I <sub>CC2</sub>	-	2	mA	-

### Absolute Maximum Ratings

Operating temperature range .....	0 to 70 °C
Storage temperature range.....	- 55 to 150 °C
Soldering time .....	10 s
Input/output voltage .....	-0.5 to min (V <sub>CC</sub> +0.5,4.6) V
Power supply voltage.....	-0.5 V to 4.6 V
Power dissipation.....	1.0 W
Data out current (short circuit) .....	50 mA

### Note:

Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage of the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### DC Characteristics (values in brackets for HYB3116165BSJ)

$T_A = 0$  to 70 °C,  $V_{SS} = 0$  V,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $t_T = 2$  ns

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Input high voltage	$V_{IH}$	2.0	$V_{CC}+0.5$	V	1)
Input low voltage	$V_{IL}$	- 0.5	0.8	V	1)
TTL Output high voltage ( $I_{OUT} = - 2$ mA)	$V_{OH}$	2.4	-	V	1)
TTL Output low voltage ( $I_{OUT} = 2$ mA)	$V_{OL}$	-	0.4	V	1)
CMOS Output high voltage ( $I_{OUT} = - 100$ $\mu$ A)	$V_{OH}$	$V_{CC}-0.2$	-	V	1)
CMOS Output low voltage ( $I_{OUT} = 100$ $\mu$ A)	$V_{OL}$	-	0.2	V	1)
Input leakage current, any input ( $0$ V $\leq V_{IH} \leq V_{CC} + 0.3$ V, all other pins = 0 V)	$I_{I(L)}$	- 10	10	$\mu$ A	1)
Output leakage current (DO is disabled, $0$ V $\leq V_{OUT} \leq V_{CC} + 0.3$ V)	$I_{O(L)}$	- 10	10	$\mu$ A	1)
Average $V_{CC}$ supply current: -50 ns version -60 ns version -70 ns version	$I_{CC1}$	-	200(100) 180 (90) 160 (80)	mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4)
( $\overline{RAS}$ , $\overline{CAS}$ , address cycling, $t_{RC} = t_{RC}$ min.)					
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{IH}$ )	$I_{CC2}$	-	2	mA	-

### DC Characteristics (values in brackets for HYB3116165BSJ) (cont'd)

$T_A = 0$  to  $70$  °C,  $V_{SS} = 0$  V,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $t_T = 2$  ns

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Average $V_{CC}$ supply current, during $\overline{RAS}$ -only refresh cycles: -50 ns version -60 ns version -70 ns version	$I_{CC3}$	–	200(100) 180 (90) 160 (80)	mA mA mA	2) 4) 2) 4) 2) 4)
( $\overline{RAS}$ cycling: $\overline{CAS} = V_{IH}$ , $t_{RC} = t_{RC}$ min.)					
Average $V_{CC}$ supply current, during hyper page mode EDO): -50 ns version -60 ns version -70 ns version	$I_{CC4}$	–	90 (70) 75 (55) 60 (45)	mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4)
( $\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling, $t_{PC} = t_{PC}$ min.)					
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{CC} - 0.2$ V)	$I_{CC5}$	–	1 200	mA $\mu$ A	1) L-version
Average $V_{CC}$ supply current, during $\overline{CAS}$ -before-RAS refresh mode: -50 ns version -60 ns version -70 ns version	$I_{CC6}$	–	200(100) 180 (90) 160 (80)	mA mA mA	2) 4) 2) 4) 2) 4)
( $\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = t_{RC}$ min.)					
Average Self Refresh Current  (CBR cycle with $t_{RAS} > TRASS_{min.}$ , $\overline{CAS}$ held low, $\overline{WE} = V_{CC} - 0.2$ V, Address and Din = $V_{CC} - 0.2$ V or 0.2V)	$I_{CC7}$	–	1 250	mA $\mu$ A	L-version

### Capacitance

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $f = 1$  MHz

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Input capacitance (A0 to A11)	$C_{I1}$	–	5	pF
Input capacitance ( $\overline{RAS}$ , $\overline{UCAS}$ , $\overline{LCAS}$ , $\overline{WE}$ , $\overline{OE}$ )	$C_{I2}$	–	7	pF
I/O capacitance (I/O1-I/O16)	$C_{IO}$	–	7	pF

### DC Characteristics (values in brackets for HYB3116165BSJ) (cont'd)

$T_A = 0$  to  $70$  °C,  $V_{SS} = 0$  V,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $t_T = 2$  ns

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Average $V_{CC}$ supply current, during $\overline{RAS}$ -only refresh cycles: -50 ns version -60 ns version -70 ns version	$I_{CC3}$	–	200(100) 180 (90) 160 (80)	mA mA mA	2) 4) 2) 4) 2) 4)
( $\overline{RAS}$ cycling: $\overline{CAS} = V_{IH}$ , $t_{RC} = t_{RC}$ min.)					
Average $V_{CC}$ supply current, during hyper page mode EDO): -50 ns version -60 ns version -70 ns version	$I_{CC4}$	–	90 (70) 75 (55) 60 (45)	mA mA mA	2) 3) 4) 2) 3) 4) 2) 3) 4)
( $\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling, $t_{PC} = t_{PC}$ min.)					
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{CC} - 0.2$ V)	$I_{CC5}$	–	1 200	mA $\mu$ A	1) L-version
Average $V_{CC}$ supply current, during $\overline{CAS}$ -before-RAS refresh mode: -50 ns version -60 ns version -70 ns version	$I_{CC6}$	–	200(100) 180 (90) 160 (80)	mA mA mA	2) 4) 2) 4) 2) 4)
( $\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = t_{RC}$ min.)					
Average Self Refresh Current  (CBR cycle with $t_{RAS} > TRASS_{min.}$ , $\overline{CAS}$ held low, $\overline{WE} = V_{CC} - 0.2$ V, Address and Din = $V_{CC} - 0.2$ V or 0.2V)	$I_{CC7}$	–	1 250	mA $\mu$ A	L-version

### Capacitance

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $f = 1$  MHz

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Input capacitance (A0 to A11)	$C_{I1}$	–	5	pF
Input capacitance ( $\overline{RAS}$ , $\overline{UCAS}$ , $\overline{LCAS}$ , $\overline{WE}$ , $\overline{OE}$ )	$C_{I2}$	–	7	pF
I/O capacitance (I/O1-I/O16)	$C_{IO}$	–	7	pF

### AC Characteristics <sup>5)6)</sup>

16E

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $t_T = 2$  ns

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		

#### common parameters

Random read or write cycle time	$t_{RC}$	84	–	104	–	124	–	ns	
$\overline{RAS}$ precharge time	$t_{RP}$	30	–	40	–	50	–	ns	
$\overline{RAS}$ pulse width	$t_{RAS}$	50	10k	60	10k	70	10k	ns	
$\overline{CAS}$ pulse width	$t_{CAS}$	8	10k	10	10k	12	10k	ns	
Row address setup time	$t_{ASR}$	0	–	0	–	0	–	ns	
Row address hold time	$t_{RAH}$	8	–	10	–	10	–	ns	
Column address setup time	$t_{ASC}$	0	–	0	–	0	–	ns	
Column address hold time	$t_{CAH}$	8	–	10	–	12	–	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	$t_{RCD}$	12	37	14	45	14	53	ns	
$\overline{RAS}$ to column address delay	$t_{RAD}$	10	25	12	30	12	35	ns	
$\overline{RAS}$ hold time	$t_{RSH}$	13		15	–	17	–	ns	
$\overline{CAS}$ hold time	$t_{CSH}$	40		50	–	60	–	ns	
$\overline{CAS}$ to $\overline{RAS}$ precharge time	$t_{CRP}$	5	–	5	–	5	–	ns	
Transition time (rise and fall)	$t_T$	1	50	1	50	1	50	ns	7
Refresh period for HYB3116165	$t_{REF}$	–	64	–	64	–	64	ms	
Refresh period for HYB3118165	$t_{REF}$	–	16	–	16	–	16	ms	
Refresh period for L-versions	$t_{REF}$	–	256	–	256	–	256	ms	

#### Read Cycle

Access time from $\overline{RAS}$	$t_{RAC}$	–	50	–	60	–	70	ns	8, 9
Access time from $\overline{CAS}$	$t_{CAC}$	–	13	–	15	–	17	ns	8, 9
Access time from column address	$t_{AA}$	–	25	–	30	–	35	ns	8,10
$\overline{OE}$ access time	$t_{OEA}$	–	13	–	15	–	17	ns	
Column address to $\overline{RAS}$ lead time	$t_{RAL}$	25	–	30	–	35	–	ns	
Read command setup time	$t_{RCS}$	0	–	0	–	0	–	ns	
Read command hold time	$t_{RCH}$	0	–	0	–	0	–	ns	11
Read command hold time referenced to $\overline{RAS}$	$t_{RRH}$	0	–	0	–	0	–	ns	11
$\overline{CAS}$ to output in low-Z	$t_{CLZ}$	0	–	0	–	0	–	ns	8

### AC Characteristics <sup>5)6)</sup>

16E

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3$  V  $\pm$  0.3 V,  $t_T = 2$  ns

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		

#### common parameters

Random read or write cycle time	$t_{RC}$	84	–	104	–	124	–	ns	
$\overline{RAS}$ precharge time	$t_{RP}$	30	–	40	–	50	–	ns	
$\overline{RAS}$ pulse width	$t_{RAS}$	50	10k	60	10k	70	10k	ns	
$\overline{CAS}$ pulse width	$t_{CAS}$	8	10k	10	10k	12	10k	ns	
Row address setup time	$t_{ASR}$	0	–	0	–	0	–	ns	
Row address hold time	$t_{RAH}$	8	–	10	–	10	–	ns	
Column address setup time	$t_{ASC}$	0	–	0	–	0	–	ns	
Column address hold time	$t_{CAH}$	8	–	10	–	12	–	ns	
$\overline{RAS}$ to $\overline{CAS}$ delay time	$t_{RCD}$	12	37	14	45	14	53	ns	
$\overline{RAS}$ to column address delay	$t_{RAD}$	10	25	12	30	12	35	ns	
$\overline{RAS}$ hold time	$t_{RSH}$	13		15	–	17	–	ns	
$\overline{CAS}$ hold time	$t_{CSH}$	40		50	–	60	–	ns	
$\overline{CAS}$ to $\overline{RAS}$ precharge time	$t_{CRP}$	5	–	5	–	5	–	ns	
Transition time (rise and fall)	$t_T$	1	50	1	50	1	50	ns	7
Refresh period for HYB3116165	$t_{REF}$	–	64	–	64	–	64	ms	
Refresh period for HYB3118165	$t_{REF}$	–	16	–	16	–	16	ms	
Refresh period for L-versions	$t_{REF}$	–	256	–	256	–	256	ms	

#### Read Cycle

Access time from $\overline{RAS}$	$t_{RAC}$	–	50	–	60	–	70	ns	8, 9
Access time from $\overline{CAS}$	$t_{CAC}$	–	13	–	15	–	17	ns	8, 9
Access time from column address	$t_{AA}$	–	25	–	30	–	35	ns	8,10
$\overline{OE}$ access time	$t_{OEA}$	–	13	–	15	–	17	ns	
Column address to $\overline{RAS}$ lead time	$t_{RAL}$	25	–	30	–	35	–	ns	
Read command setup time	$t_{RCS}$	0	–	0	–	0	–	ns	
Read command hold time	$t_{RCH}$	0	–	0	–	0	–	ns	11
Read command hold time referenced to $\overline{RAS}$	$t_{RRH}$	0	–	0	–	0	–	ns	11
$\overline{CAS}$ to output in low-Z	$t_{CLZ}$	0	–	0	–	0	–	ns	8



### AC Characteristics (cont'd) 5)6)

16E

 $T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}, V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, t_T = 2 \text{ ns}$ 

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		
Output buffer turn-off delay	$t_{OFF}$	0	13	0	15	0	17	ns	12
Output turn-off delay from $\overline{OE}$	$t_{OEZ}$	0	13	0	15	0	17	ns	12
Data to $\overline{CAS}$ low delay	$t_{DZC}$	0	–	0	–	0	–	ns	13
Data to $\overline{OE}$ low delay	$t_{DZO}$	0	–	0	–	0	–	ns	13
$\overline{CAS}$ high to data delay	$t_{CDD}$	10	–	13	–	15	–	ns	14
$\overline{OE}$ high to data delay	$t_{ODD}$	10	–	13	–	15	–	ns	14

### Write Cycle

Write command hold time	$t_{WCH}$	8	–	10	–	10	–	ns	
Write command pulse width	$t_{WP}$	8	–	10	–	10	–	ns	
Write command setup time	$t_{WCS}$	0	–	0	–	0	–	ns	15
Write command to $\overline{RAS}$ lead time	$t_{RWL}$	13	–	15	–	17	–	ns	
Write command to $\overline{CAS}$ lead time	$t_{CWL}$	13	–	15	–	17	–	ns	
Data setup time	$t_{DS}$	0	–	0	–	0	–	ns	16
Data hold time	$t_{DH}$	8	–	10	–	12	–	ns	16

### Read-modify-Write Cycle

Read-write cycle time	$t_{RWC}$	113	–	138	–	162	–	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	$t_{RWD}$	64	–	77	–	89	–	ns	15
$\overline{CAS}$ to $\overline{WE}$ delay time	$t_{CWD}$	27	–	32	–	36	–	ns	15
Column address to $\overline{WE}$ delay time	$t_{AWD}$	39	–	47	–	54	–	ns	15
$\overline{OE}$ command hold time	$t_{OEH}$	10	–	13	–	15	–	ns	

### Hyper Page Mode (EDO) Cycle

Hyper page mode (EDO) cycle time	$t_{HPC}$	20	–	25	–	30	–	ns	
$\overline{CAS}$ precharge time	$t_{CP}$	8	–	10	–	10	–	ns	
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	–	27	–	32	–	37	ns	7
Output data hold time	$t_{COH}$	5	–	5	–	5	–	ns	
$\overline{RAS}$ pulse width in EDO mode	$t_{RAS}$	50	200k	60	200k	70	200k	ns	

### AC Characteristics (cont'd) 5)6)

16E

 $T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}, V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, t_T = 2 \text{ ns}$ 

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		
Output buffer turn-off delay	$t_{OFF}$	0	13	0	15	0	17	ns	12
Output turn-off delay from $\overline{OE}$	$t_{OEZ}$	0	13	0	15	0	17	ns	12
Data to $\overline{CAS}$ low delay	$t_{DZC}$	0	–	0	–	0	–	ns	13
Data to $\overline{OE}$ low delay	$t_{DZO}$	0	–	0	–	0	–	ns	13
$\overline{CAS}$ high to data delay	$t_{CDD}$	10	–	13	–	15	–	ns	14
$\overline{OE}$ high to data delay	$t_{ODD}$	10	–	13	–	15	–	ns	14

### Write Cycle

Write command hold time	$t_{WCH}$	8	–	10	–	10	–	ns	
Write command pulse width	$t_{WP}$	8	–	10	–	10	–	ns	
Write command setup time	$t_{WCS}$	0	–	0	–	0	–	ns	15
Write command to $\overline{RAS}$ lead time	$t_{RWL}$	13	–	15	–	17	–	ns	
Write command to $\overline{CAS}$ lead time	$t_{CWL}$	13	–	15	–	17	–	ns	
Data setup time	$t_{DS}$	0	–	0	–	0	–	ns	16
Data hold time	$t_{DH}$	8	–	10	–	12	–	ns	16

### Read-modify-Write Cycle

Read-write cycle time	$t_{RWC}$	113	–	138	–	162	–	ns	
$\overline{RAS}$ to $\overline{WE}$ delay time	$t_{RWD}$	64	–	77	–	89	–	ns	15
$\overline{CAS}$ to $\overline{WE}$ delay time	$t_{CWD}$	27	–	32	–	36	–	ns	15
Column address to $\overline{WE}$ delay time	$t_{AWD}$	39	–	47	–	54	–	ns	15
$\overline{OE}$ command hold time	$t_{OEH}$	10	–	13	–	15	–	ns	

### Hyper Page Mode (EDO) Cycle

Hyper page mode (EDO) cycle time	$t_{HPC}$	20	–	25	–	30	–	ns	
$\overline{CAS}$ precharge time	$t_{CP}$	8	–	10	–	10	–	ns	
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	–	27	–	32	–	37	ns	7
Output data hold time	$t_{COH}$	5	–	5	–	5	–	ns	
$\overline{RAS}$ pulse width in EDO mode	$t_{RAS}$	50	200k	60	200k	70	200k	ns	

### AC Characteristics (cont'd) 5)6)

16E

 $T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}, V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, t_T = 2 \text{ ns}$ 

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		
$\overline{\text{CAS}}$ precharge to $\overline{\text{RAS}}$ Delay	$t_{RHPC}$	27	–	32	–	37	–	ns	

### Hyper Page Mode (EDO) Read-modify-Write Cycle

Hyper page mode (EDO) read-write cycle time	$t_{PRWC}$	58	–	68	–	77	–	ns	
$\overline{\text{CAS}}$ precharge to $\overline{\text{WE}}$	$t_{CPWD}$	41	–	49	–	56	–	ns	

### $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle

$\overline{\text{CAS}}$ setup time	$t_{CSR}$	10	–	10	–	10	–	ns	
$\overline{\text{CAS}}$ hold time	$t_{CHR}$	10	–	10	–	10	–	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	$t_{RPC}$	5	–	5	–	5	–	ns	
Write to $\overline{\text{RAS}}$ precharge time	$t_{WRP}$	10	–	10	–	10	–	ns	
Write hold time referenced to $\overline{\text{RAS}}$	$t_{WRH}$	10	–	10	–	10	–	ns	

### $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Counter Test Cycle

$\overline{\text{CAS}}$ precharge time	$t_{CPT}$	35	–	40	–	40	–	ns	
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### Self Refresh Cycle

$\overline{\text{RAS}}$ pulse width	$t_{RASS}$	100k	–	100k	–	100k	–	ns	17
$\overline{\text{RAS}}$ precharge	$t_{RPS}$	95	–	110	–	130	–	ns	17
$\overline{\text{CAS}}$ hold time	$t_{CHS}$	-50	–	-50	–	-50	–	ns	17

### AC Characteristics (cont'd) 5)6)

16E

 $T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}, V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, t_T = 2 \text{ ns}$ 

Parameter	Symbol	Limit Values						Unit	Note
		-50		-60		-70			
		min.	max.	min.	max.	min.	max.		
$\overline{\text{CAS}}$ precharge to $\overline{\text{RAS}}$ Delay	$t_{RHPC}$	27	–	32	–	37	–	ns	

### Hyper Page Mode (EDO) Read-modify-Write Cycle

Hyper page mode (EDO) read-write cycle time	$t_{PRWC}$	58	–	68	–	77	–	ns	
$\overline{\text{CAS}}$ precharge to $\overline{\text{WE}}$	$t_{CPWD}$	41	–	49	–	56	–	ns	

### $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle

$\overline{\text{CAS}}$ setup time	$t_{CSR}$	10	–	10	–	10	–	ns	
$\overline{\text{CAS}}$ hold time	$t_{CHR}$	10	–	10	–	10	–	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	$t_{RPC}$	5	–	5	–	5	–	ns	
Write to $\overline{\text{RAS}}$ precharge time	$t_{WRP}$	10	–	10	–	10	–	ns	
Write hold time referenced to $\overline{\text{RAS}}$	$t_{WRH}$	10	–	10	–	10	–	ns	

### $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Counter Test Cycle

$\overline{\text{CAS}}$ precharge time	$t_{CPT}$	35	–	40	–	40	–	ns	
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### Self Refresh Cycle

$\overline{\text{RAS}}$ pulse width	$t_{RASS}$	100k	–	100k	–	100k	–	ns	17
$\overline{\text{RAS}}$ precharge	$t_{RPS}$	95	–	110	–	130	–	ns	17
$\overline{\text{CAS}}$ hold time	$t_{CHS}$	-50	–	-50	–	-50	–	ns	17

**Notes:**

- 1) All voltages are referenced to VSS.
- 2) ICC1, ICC3, ICC4 and ICC6 depend on cycle rate.
- 3) ICC1 and ICC4 depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while  $\overline{\text{RAS}} = \text{VIL}$ . In the case of ICC4 it can be changed once or less during a hyper page mode (EDO) cycle (tHPC).
- 5) An initial pause of 200  $\mu\text{s}$  is required after power-up followed by 8  $\overline{\text{RAS}}$  cycles of which at least one cycle has to be a refresh cycle, before proper device operation is achieved. In case of using 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.
- 6) AC measurements assume  $t_T = 2 \text{ ns}$ .
- 7) VIH (min.) and VIL (max.) are reference levels for measuring timing of input signals. Transition times are also measured between VIH and VIL.
- 8) Measured with the specified current load and 100 pF at  $V_{\text{ol}} = 0.8 \text{ V}$  and  $V_{\text{oh}} = 2.0 \text{ V}$ . Access time is determined by the latter of  $t_{\text{RAC}}$ ,  $t_{\text{CAC}}$ ,  $t_{\text{AA}}$ ,  $t_{\text{CPA}}$ ,  $t_{\text{OEA}}$ .  $t_{\text{CAC}}$  is measured from tristate.
- 9) Operation within the  $t_{\text{RCD}}$  (max.) limit ensures that  $t_{\text{RAC}}$  (max.) can be met.  $t_{\text{RCD}}$  (max.) is specified as a reference point only: If  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}$  (max.) limit, then access time is controlled by  $t_{\text{CAC}}$ .
- 10) Operation within the  $t_{\text{RAD}}$  (max.) limit ensures that  $t_{\text{RAC}}$  (max.) can be met.  $t_{\text{RAD}}$  (max.) is specified as a reference point only: If  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}$  (max.) limit, then access time is controlled by  $t_{\text{AA}}$ .
- 11) Either  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
- 12)  $t_{\text{OFF}}$  (max.) and  $t_{\text{OEZ}}$  (max.) define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 13) Either  $t_{\text{DZC}}$  or  $t_{\text{DZO}}$  must be satisfied.
- 14) Either  $t_{\text{CDD}}$  or  $t_{\text{ODD}}$  must be satisfied.
- 15)  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{CWD}}$ ,  $t_{\text{AWD}}$  and  $t_{\text{CPWD}}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $t_{\text{WCS}} > t_{\text{WCS}} (\text{min.})$ , the cycle is an early write cycle and the I/O pin will remain open-circuit (high impedance) through the entire cycle; if  $t_{\text{RWD}} > t_{\text{RWD}} (\text{min.})$ ,  $t_{\text{CWD}} > t_{\text{CWD}} (\text{min.})$ ,  $t_{\text{AWD}} > t_{\text{AWD}} (\text{min.})$  and  $t_{\text{CPWD}} > t_{\text{CPWD}} (\text{min.})$ , the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 16) These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in early write cycles and to the  $\overline{\text{WE}}$  leading edge in read-write cycles.
- 17) When using Self Refresh mode, the following refresh operations must be performed to ensure proper DRAM operation:  
  
If row addresses are being refreshed on an evenly distributed manner over the refresh interval using CBR refresh cycles, then only one CBR cycle must be performed immediately after exit from Self Refresh.  
  
If row addresses are being refreshed in any other manner (ROR - Distributed/Burst; or CBR-Burst) over the refresh interval, then a full set of row refreshes must be performed immediately before entry to and immediately after exit from Self Refresh.

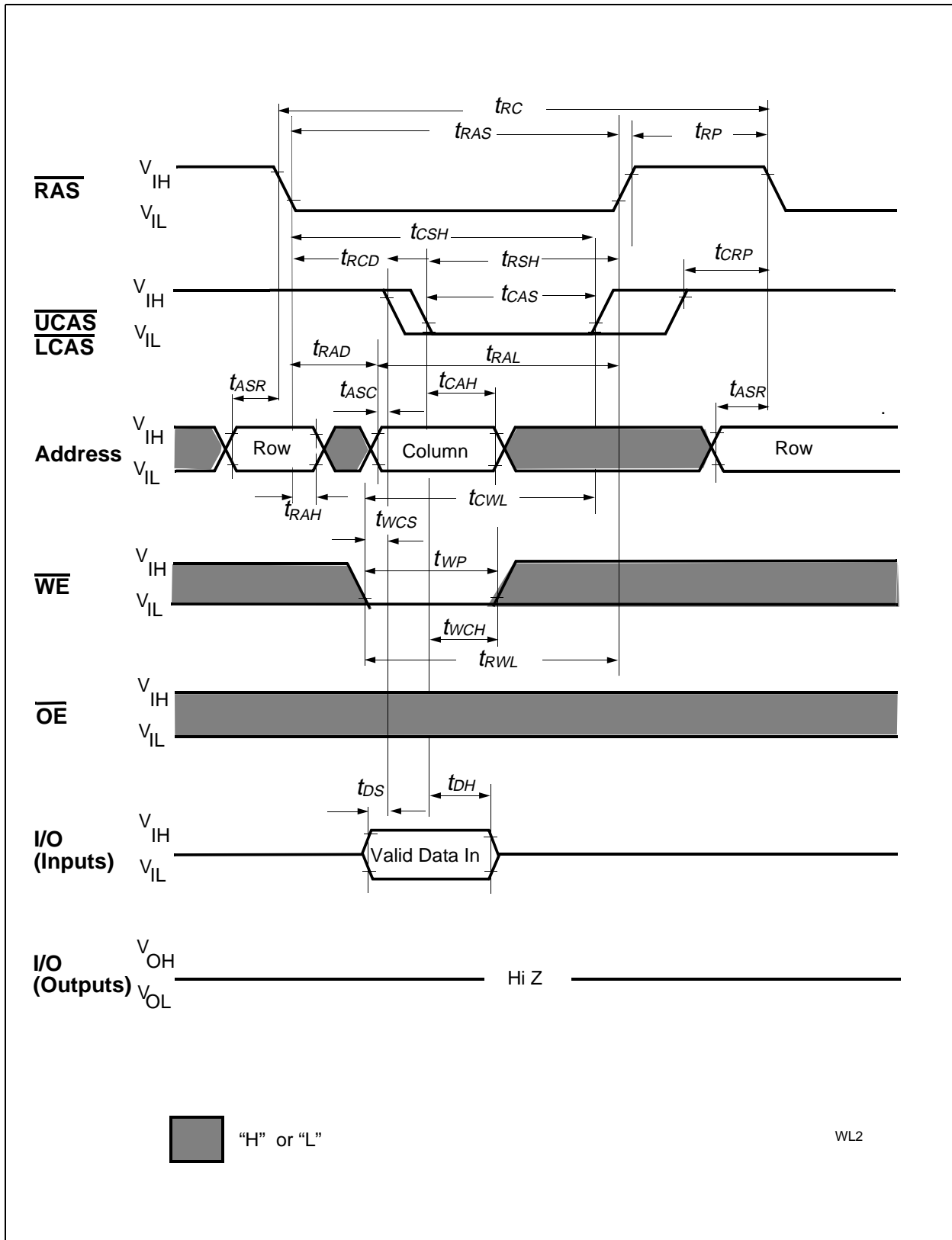
**Notes:**

- 1) All voltages are referenced to VSS.
- 2) ICC1, ICC3, ICC4 and ICC6 depend on cycle rate.
- 3) ICC1 and ICC4 depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while  $\overline{\text{RAS}} = \text{VIL}$ . In the case of ICC4 it can be changed once or less during a hyper page mode (EDO) cycle (tHPC).
- 5) An initial pause of 200  $\mu\text{s}$  is required after power-up followed by 8  $\overline{\text{RAS}}$  cycles of which at least one cycle has to be a refresh cycle, before proper device operation is achieved. In case of using 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.
- 6) AC measurements assume  $t_T = 2 \text{ ns}$ .
- 7) VIH (min.) and VIL (max.) are reference levels for measuring timing of input signals. Transition times are also measured between VIH and VIL.
- 8) Measured with the specified current load and 100 pF at Vol = 0.8 V and Voh = 2.0 V. Access time is determined by the latter of tRAC, tCAC, tAA, tCPA, tOEA. tCAC is measured from tristate.
- 9) Operation within the tRCD (max.) limit ensures that tRAC (max.) can be met. tRCD (max.) is specified as a reference point only: If tRCD is greater than the specified tRCD (max.) limit, then access time is controlled by tCAC.
- 10) Operation within the tRAD (max.) limit ensures that tRAC (max.) can be met. tRAD (max.) is specified as a reference point only: If tRAD is greater than the specified tRAD (max.) limit, then access time is controlled by tAA.
- 11) Either tRCH or tRRH must be satisfied for a read cycle.
- 12) tOFF (max.) and tOEZ (max.) define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 13) Either tDZC or tDZO must be satisfied.
- 14) Either tCDD or tODD must be satisfied.
- 15) tWCS, tRWD, tCWD, tAWD and tCPWD are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If tWCS > tWCS (min.), the cycle is an early write cycle and the I/O pin will remain open-circuit (high impedance) through the entire cycle; if tRWD > tRWD (min.), tCWD > tCWD (min.), tAWD > tAWD (min.) and tCPWD > tCPWD (min.), the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 16) These parameters are referenced to the  $\overline{\text{CAS}}$  leading edge in early write cycles and to the  $\overline{\text{WE}}$  leading edge in read-write cycles.
- 17) When using Self Refresh mode, the following refresh operations must be performed to ensure proper DRAM operation:  
  
If row addresses are being refreshed on an evenly distributed manner over the refresh interval using CBR refresh cycles, then only one CBR cycle must be performed immediately after exit from Self Refresh.  
  
If row addresses are being refreshed in any other manner (ROR - Distributed/Burst; or CBR-Burst) over the refresh interval, then a full set of row refreshes must be performed immediately before entry to and immediately after exit from Self Refresh.

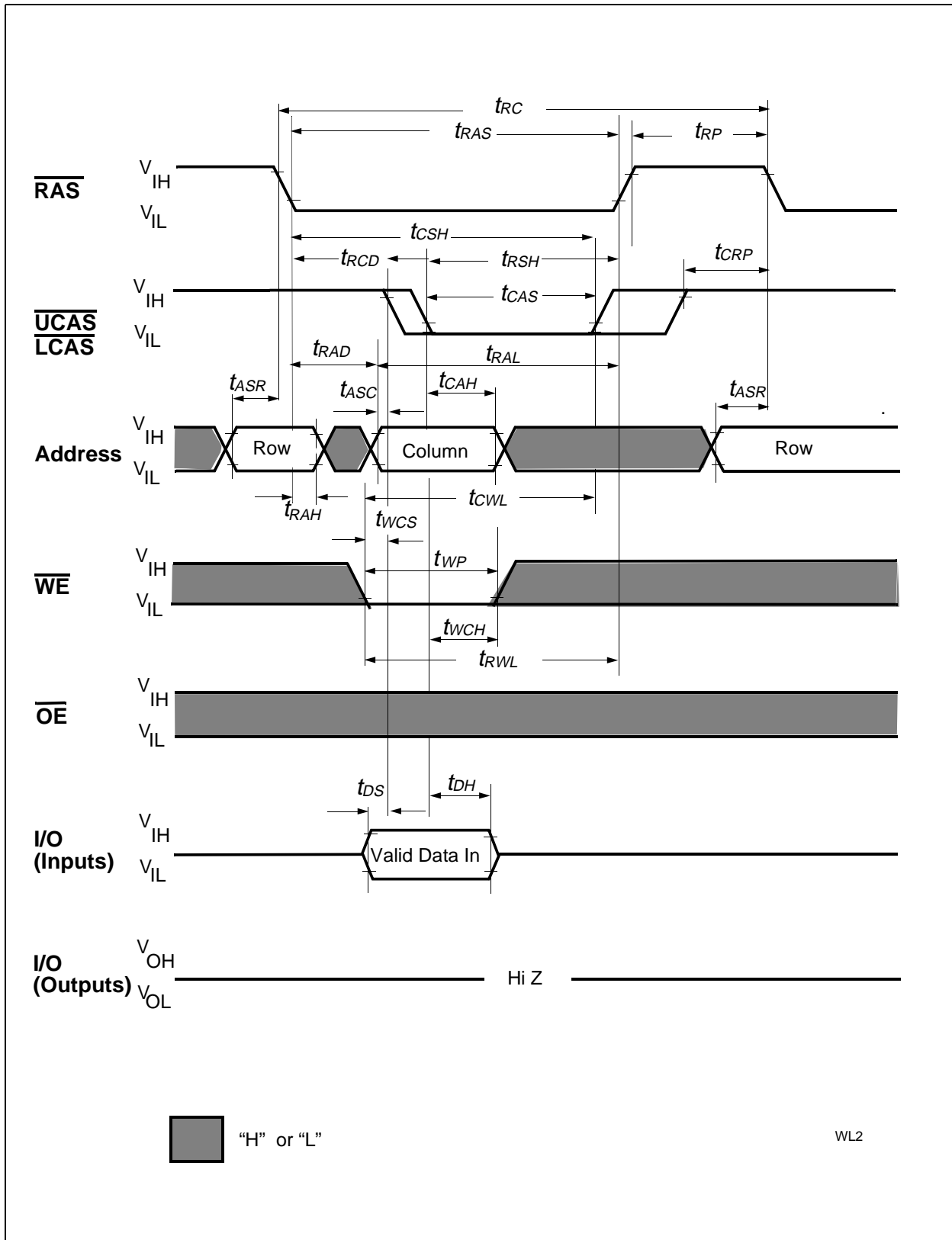




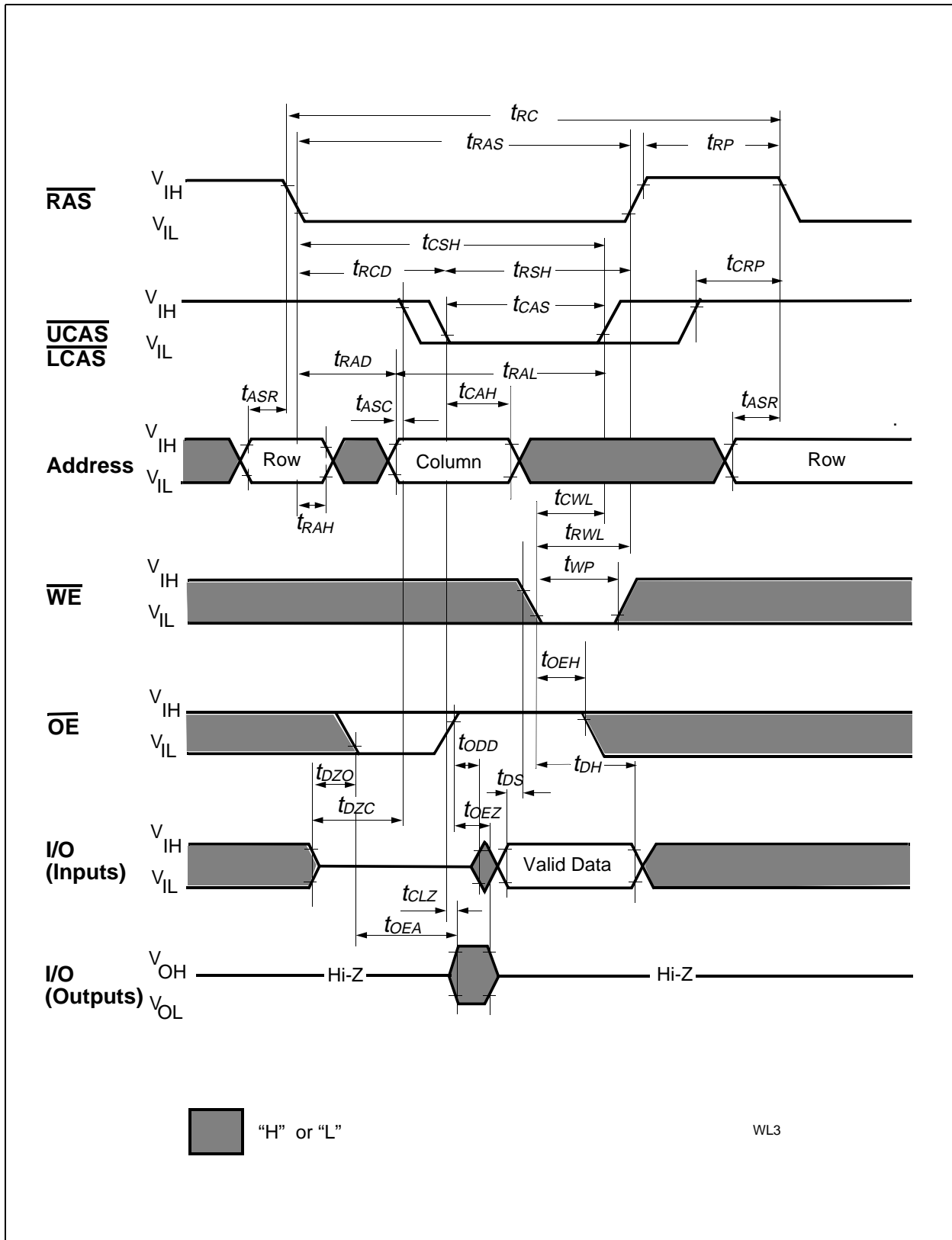




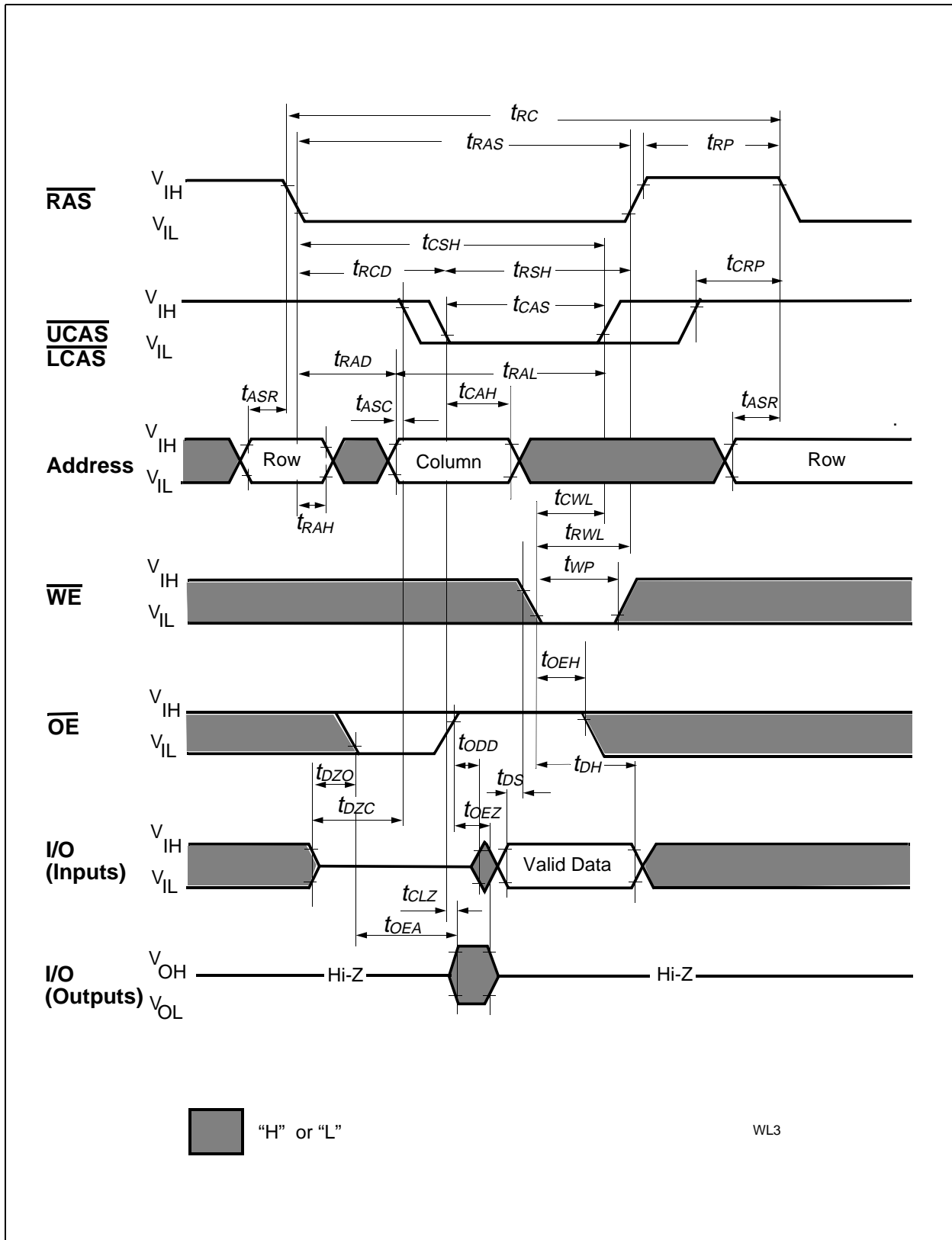
Write Cycle (Early Write)



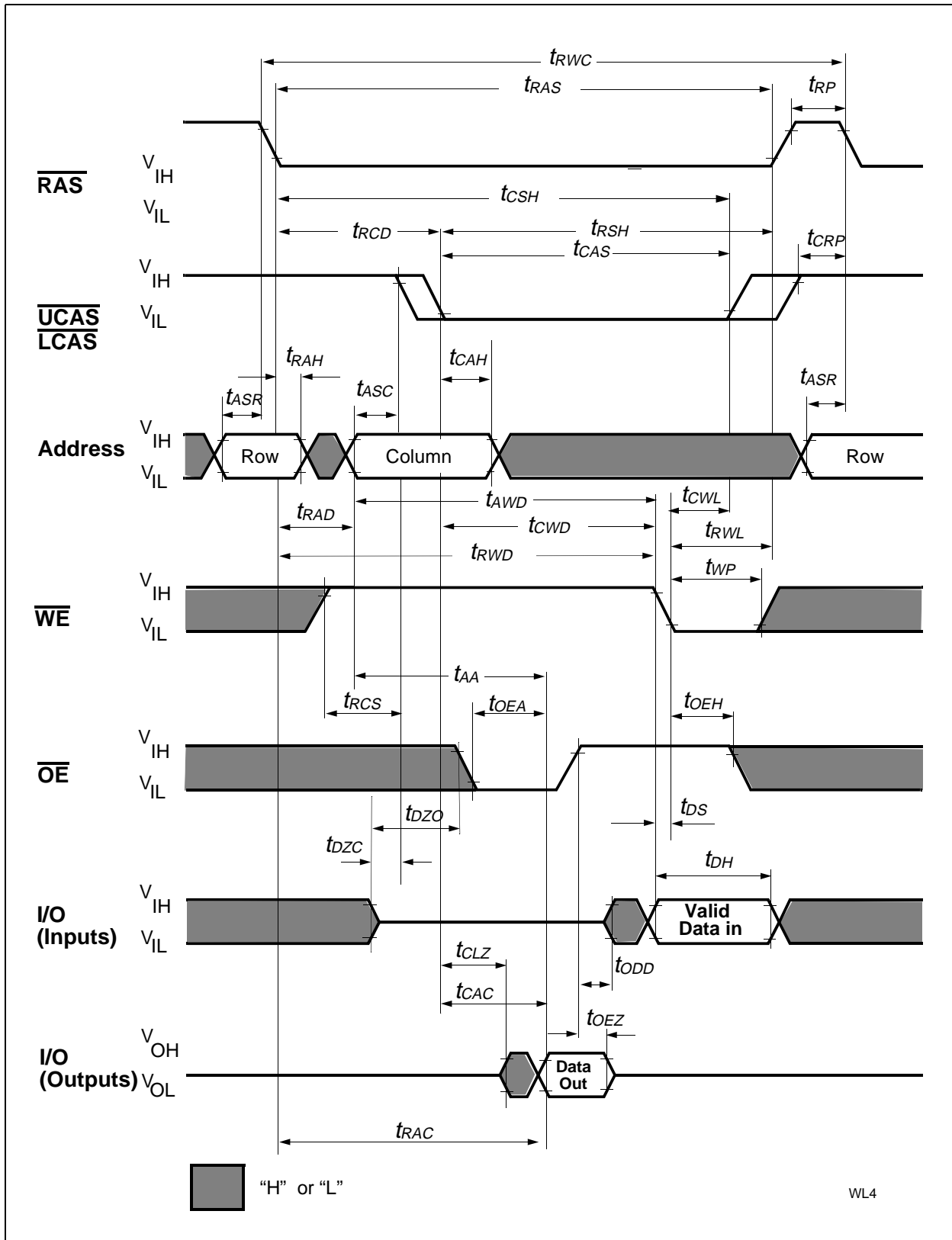
Write Cycle (Early Write)



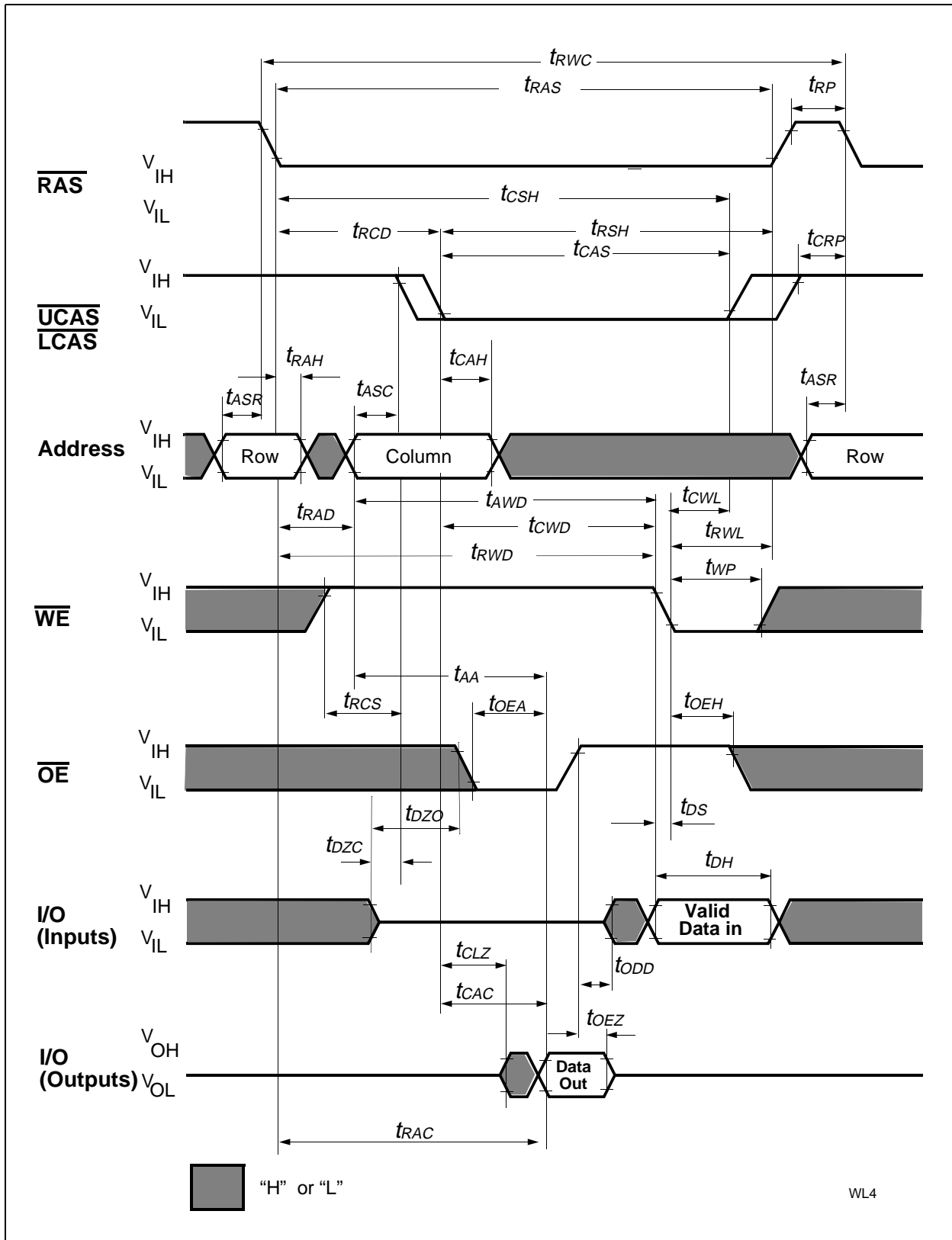
Write Cycle ( $\overline{OE}$  Controlled Write)



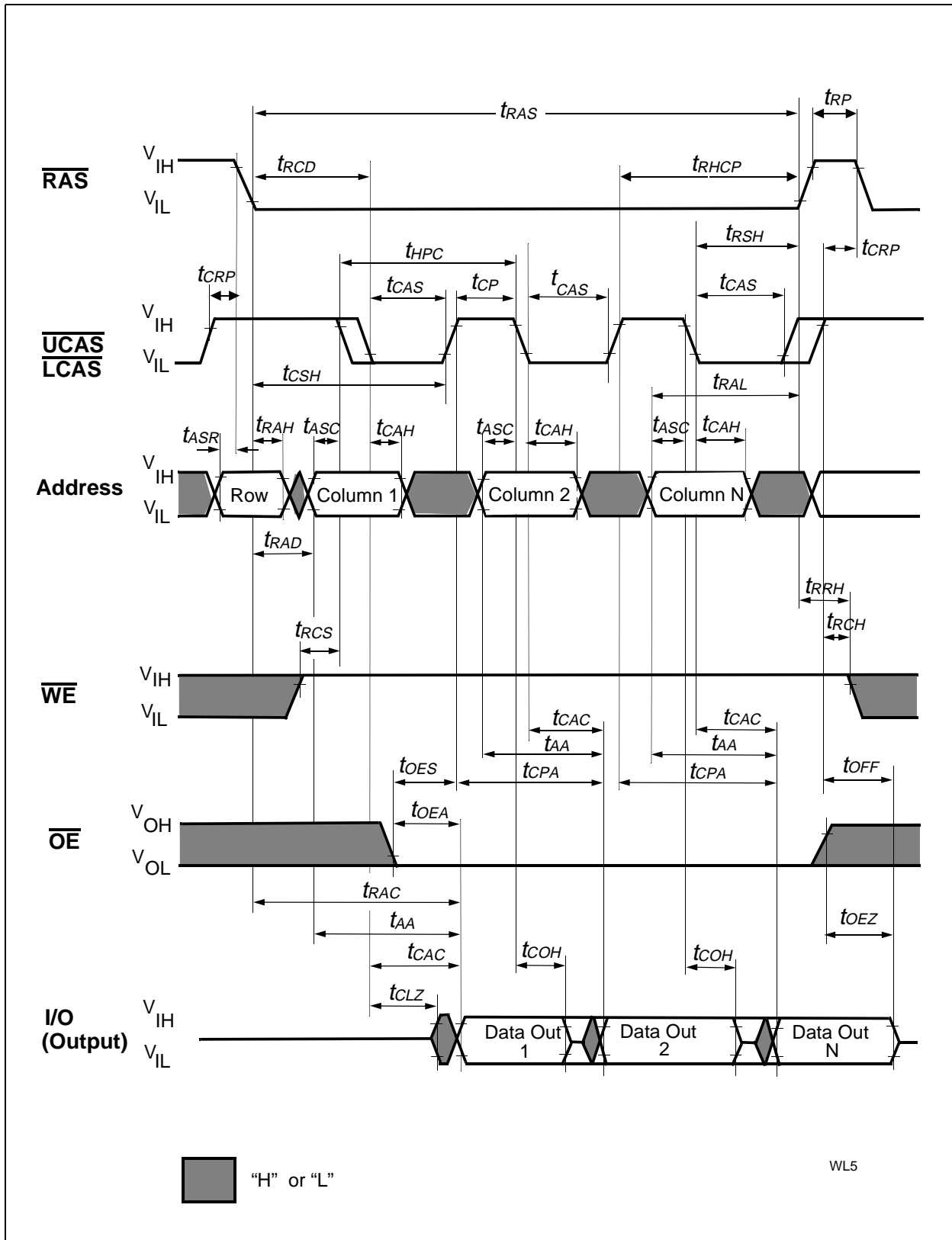
Write Cycle ( $\overline{OE}$  Controlled Write)



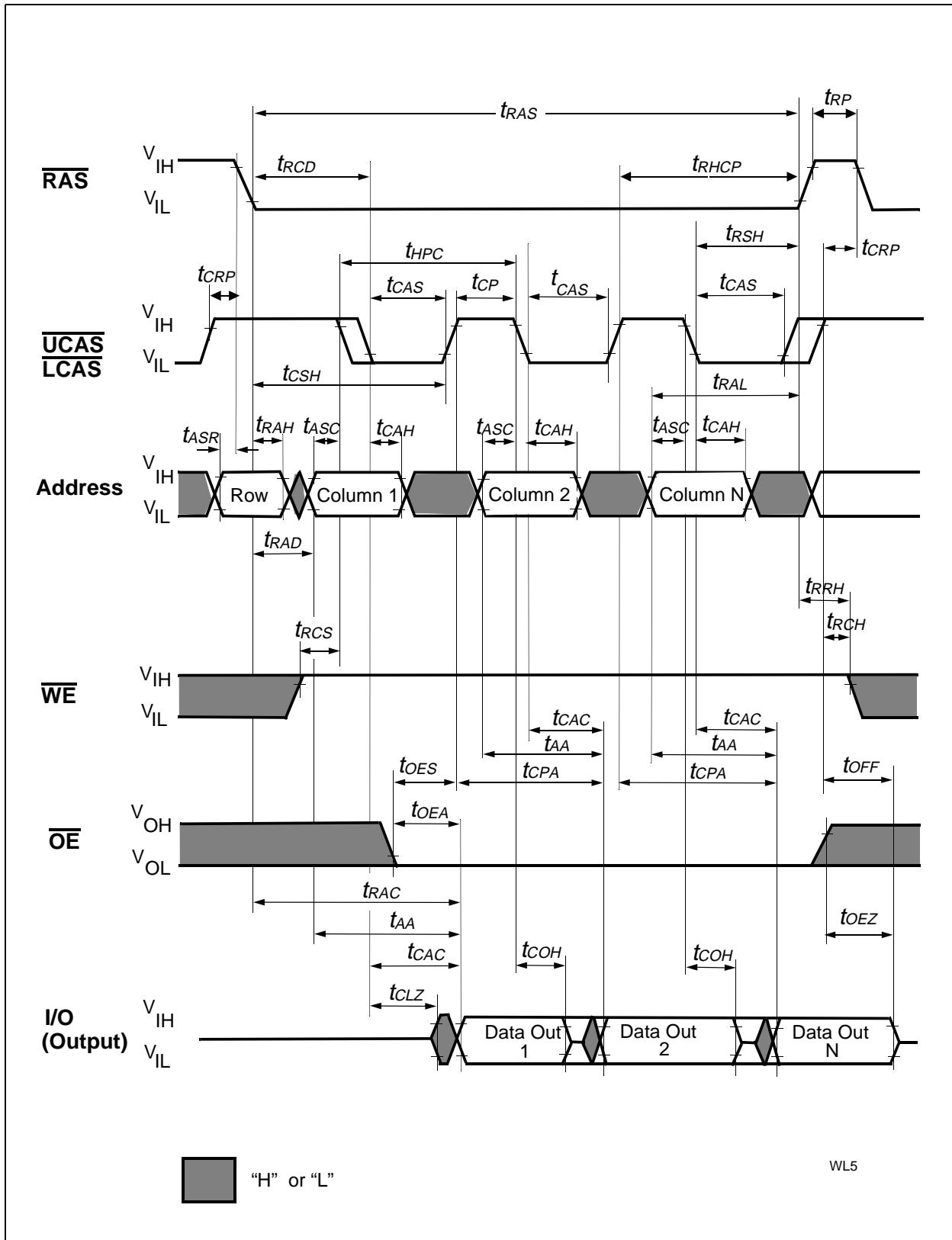
Read-Write (Read-Modify-Write) Cycle



Read-Write (Read-Modify-Write) Cycle

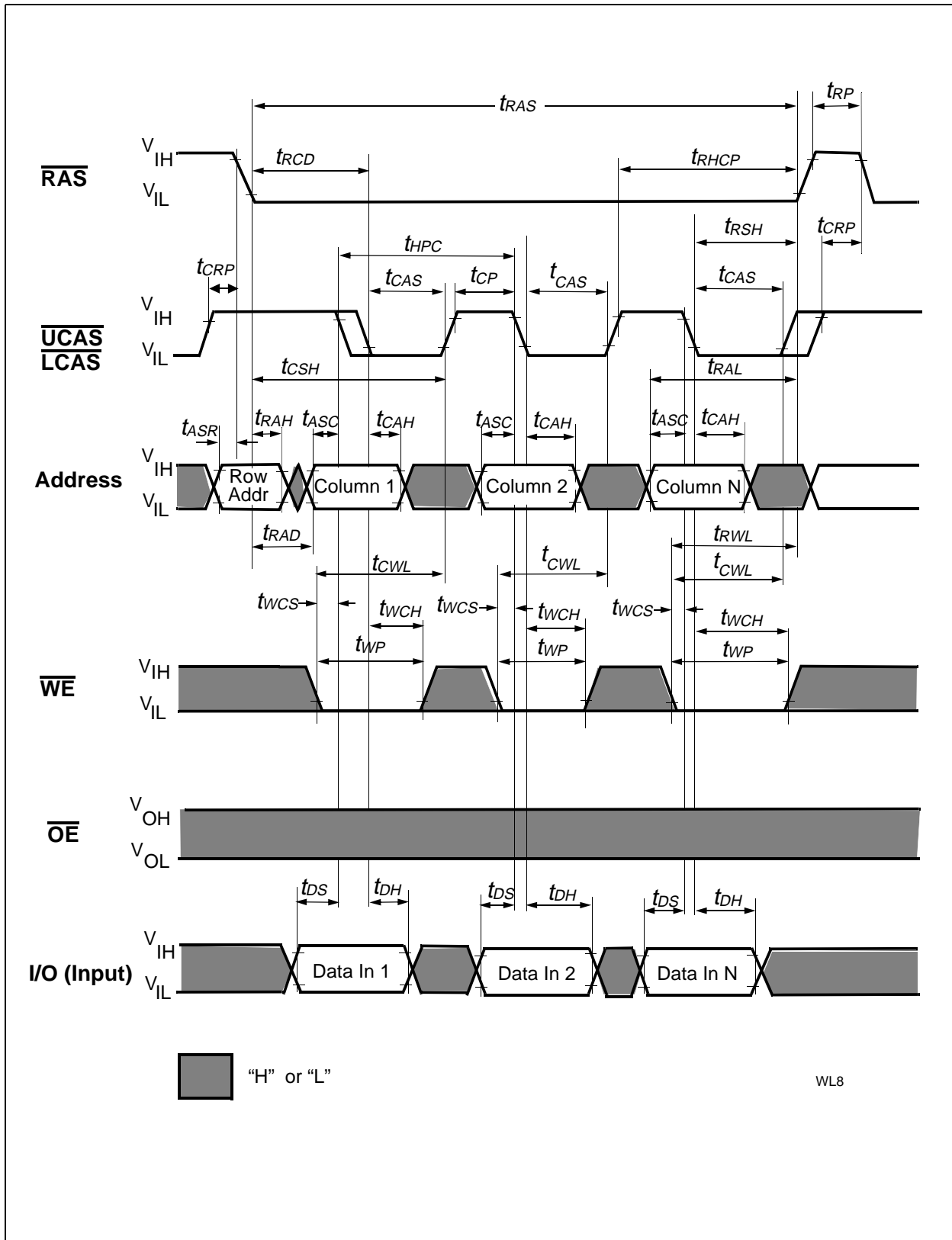


Hyper Page Mode (EDO) Read Cycle



Hyper Page Mode (EDO) Read Cycle

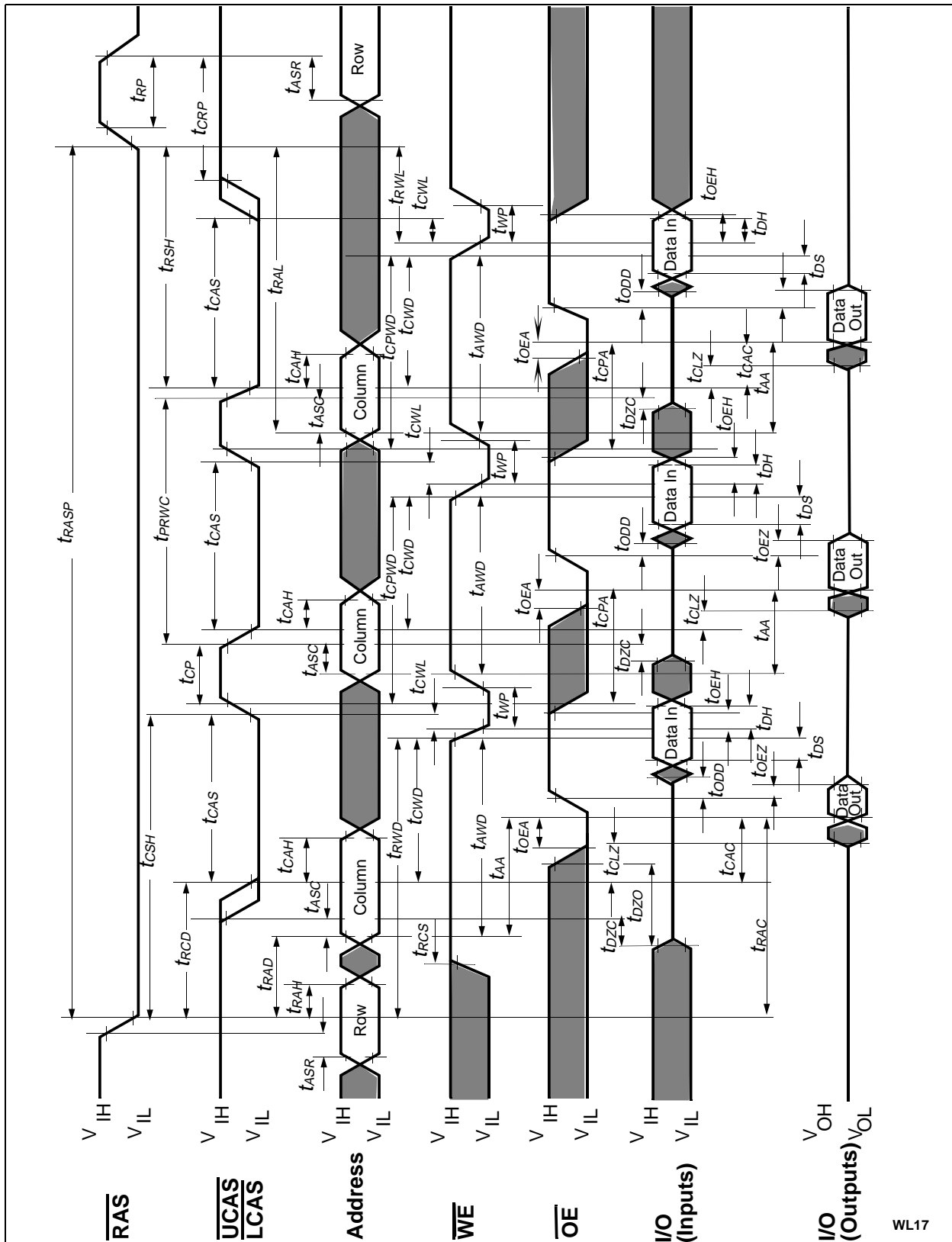




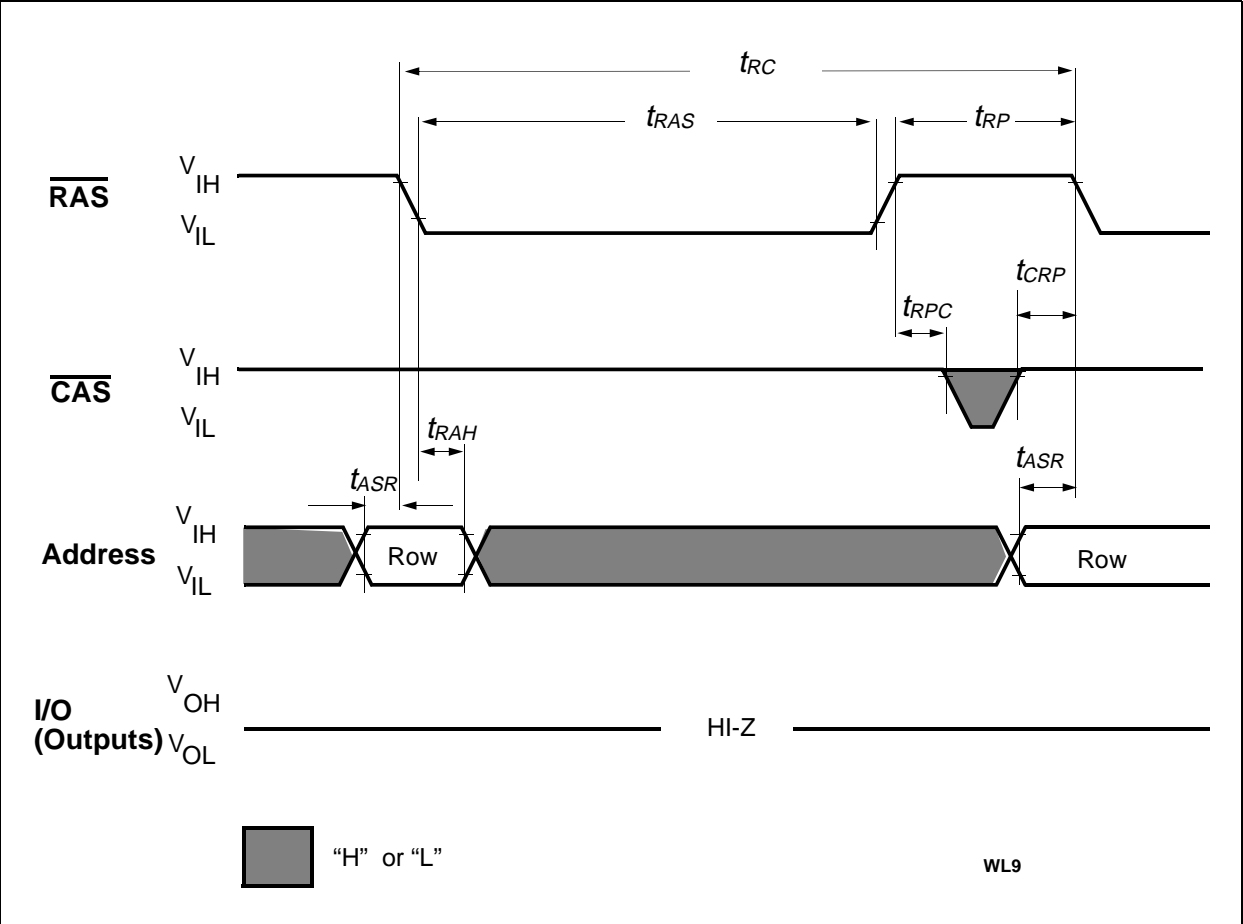
Hyper Page Mode (EDO) Early Write Cycle



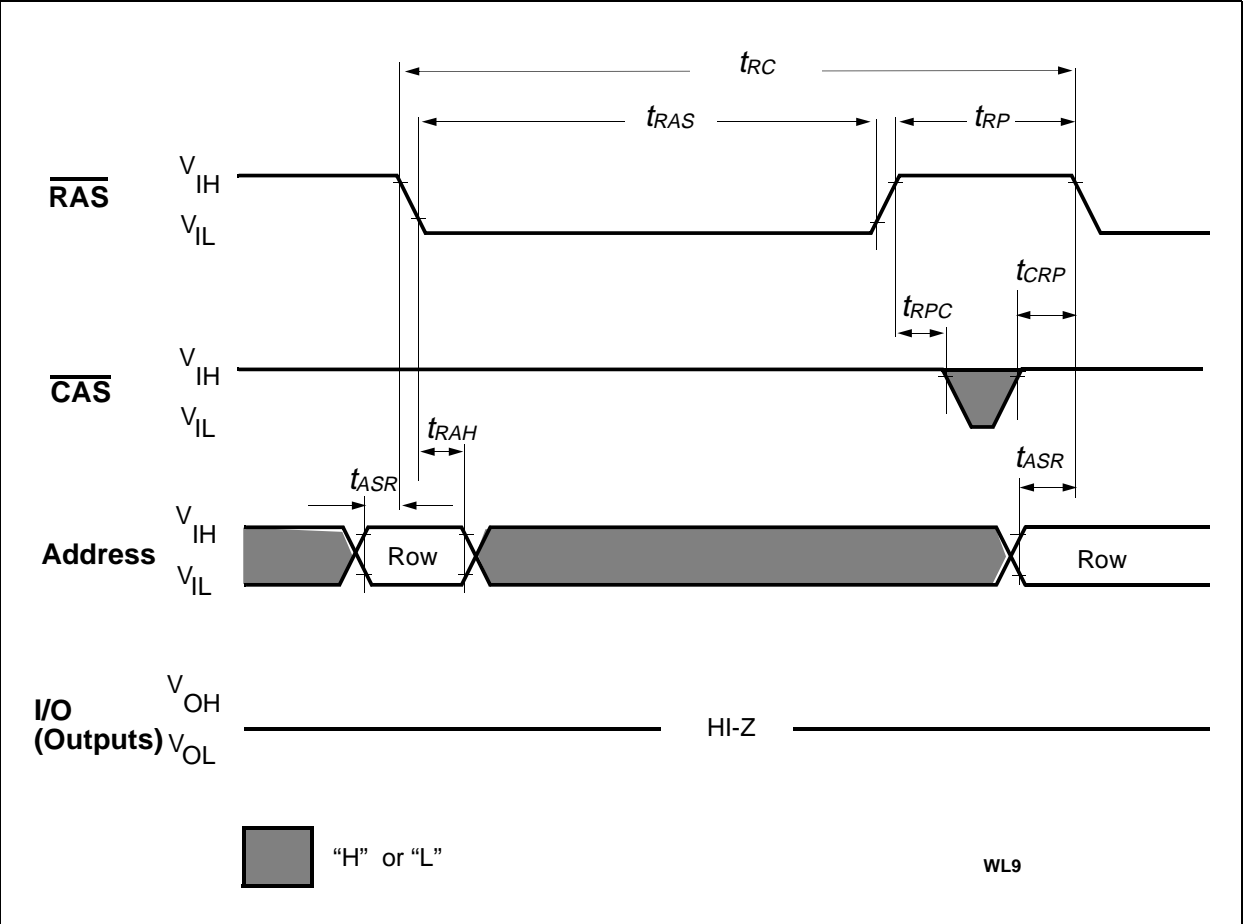




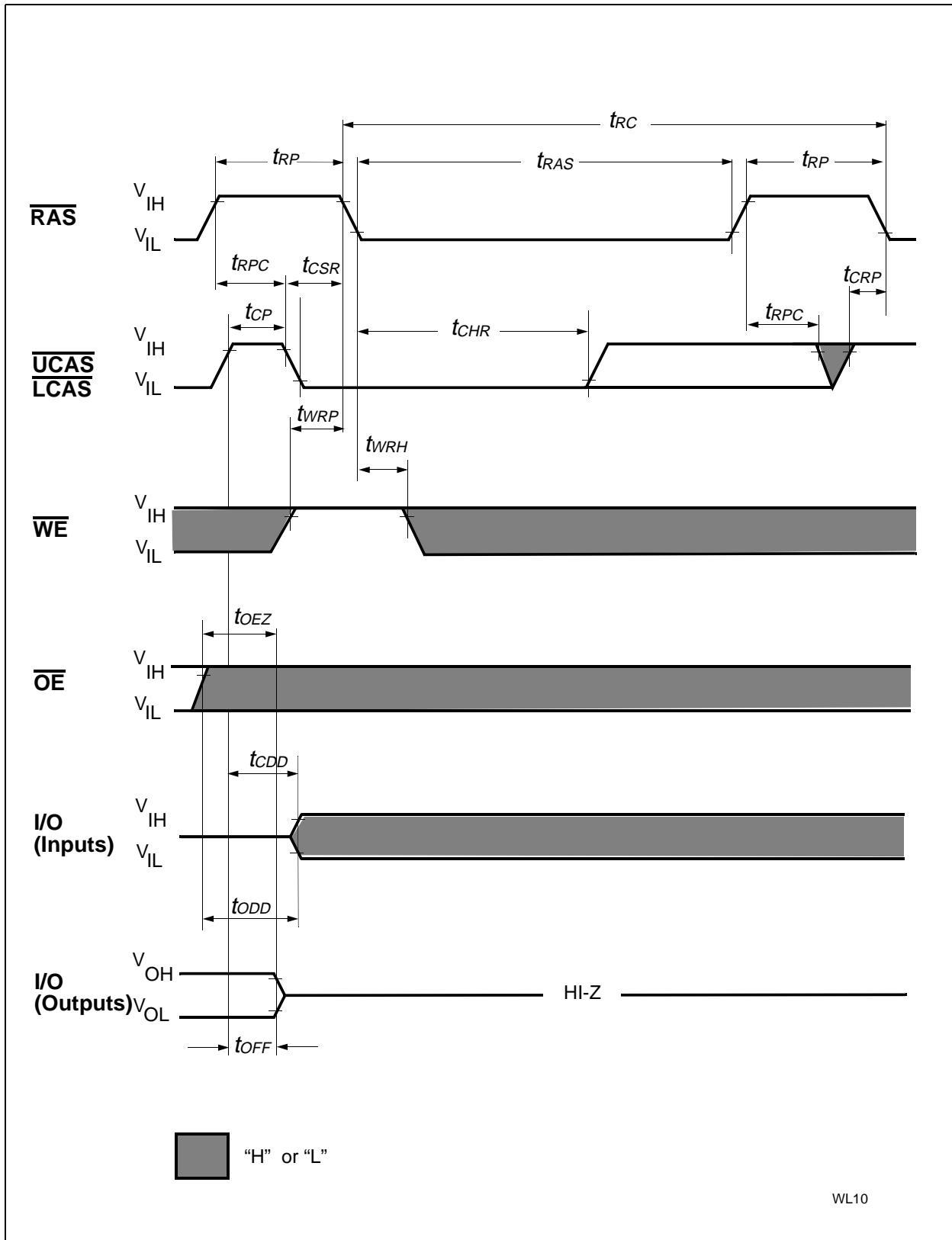
Hyper Page Mode (EDO) Late Write and Read-Modify- Write Cycle



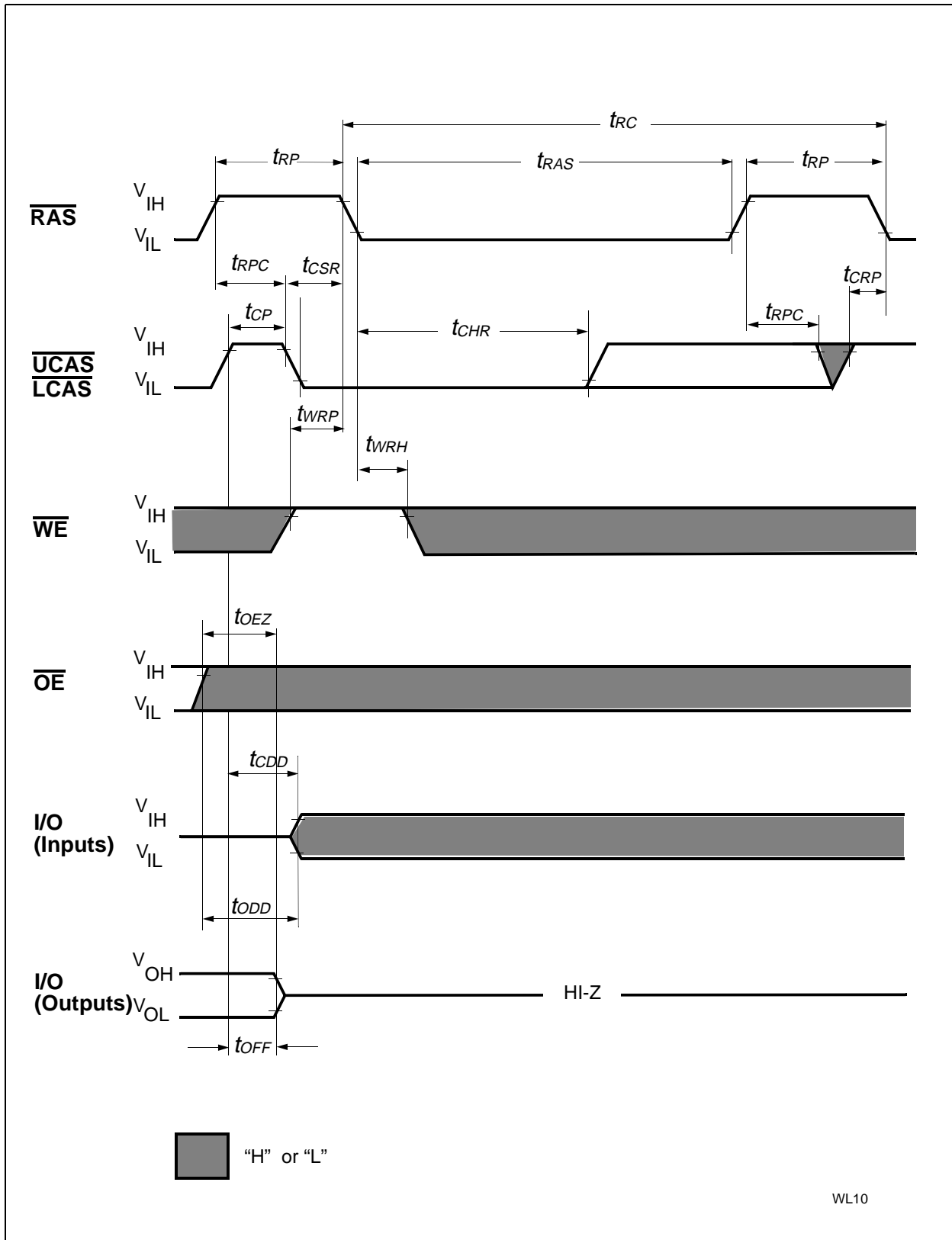
**$\overline{\text{RAS}}$ -Only Refresh Cycle**



**$\overline{\text{RAS}}$ -Only Refresh Cycle**

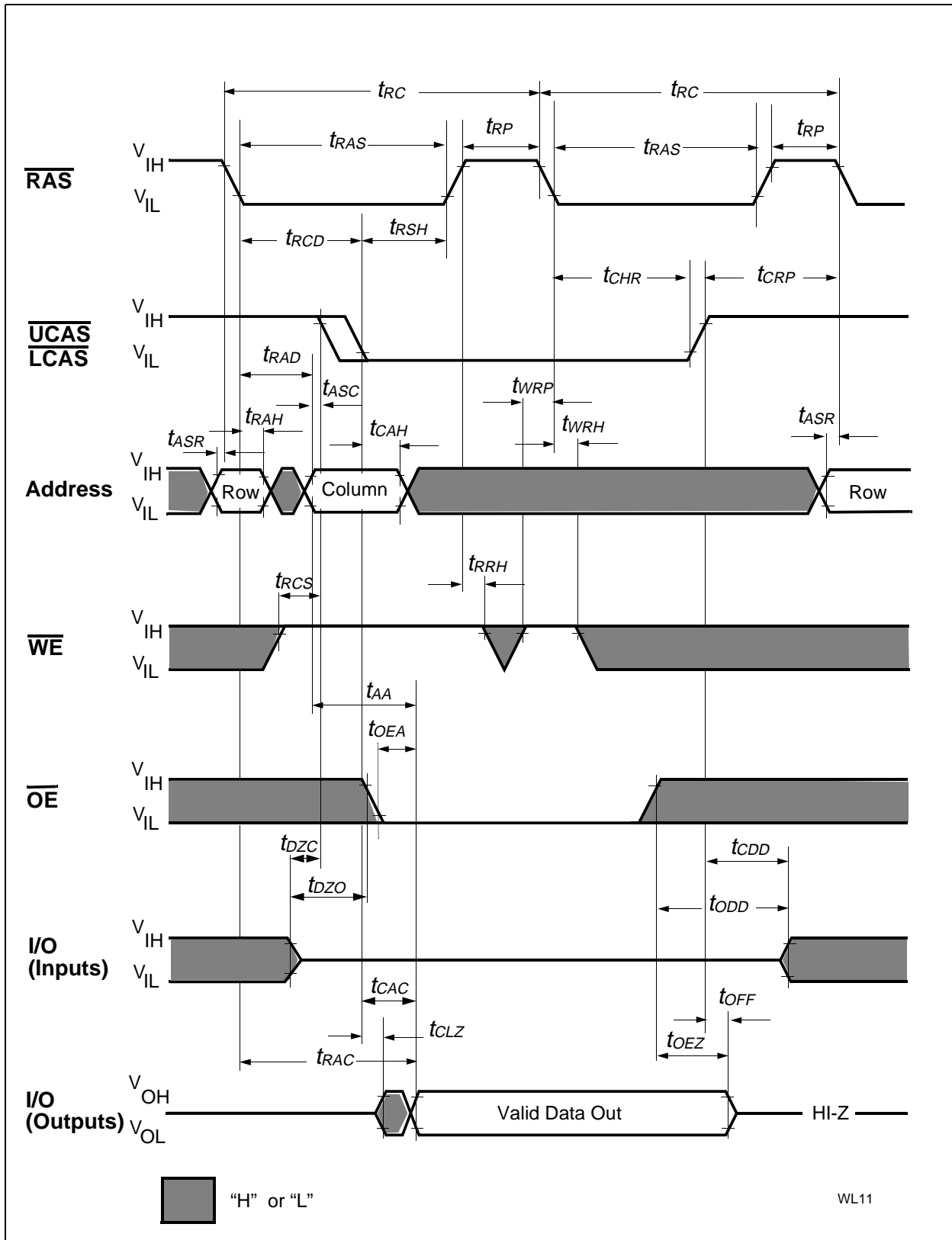


CAS-Before-RAS Refresh Cycle

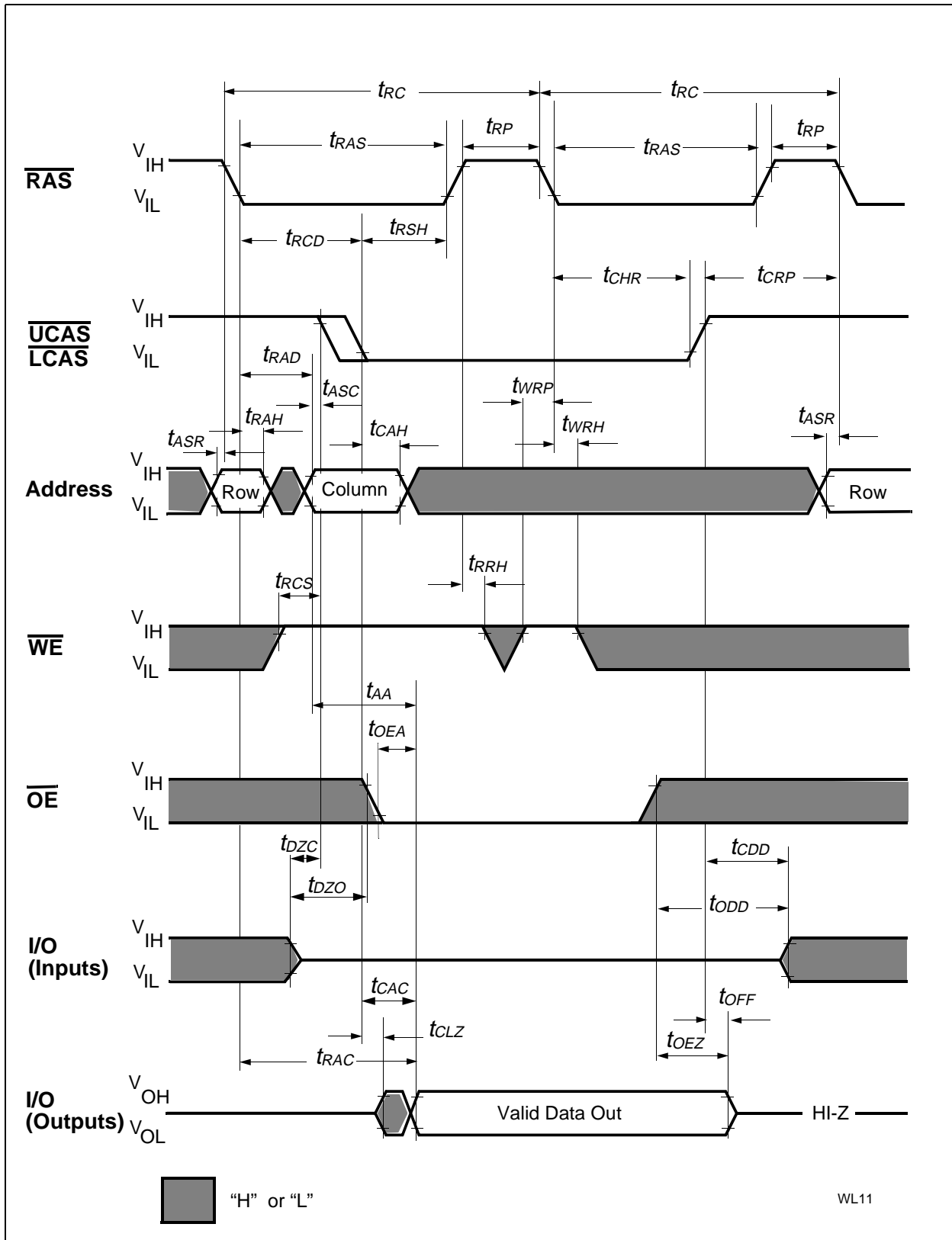


CAS-Before-RAS Refresh Cycle

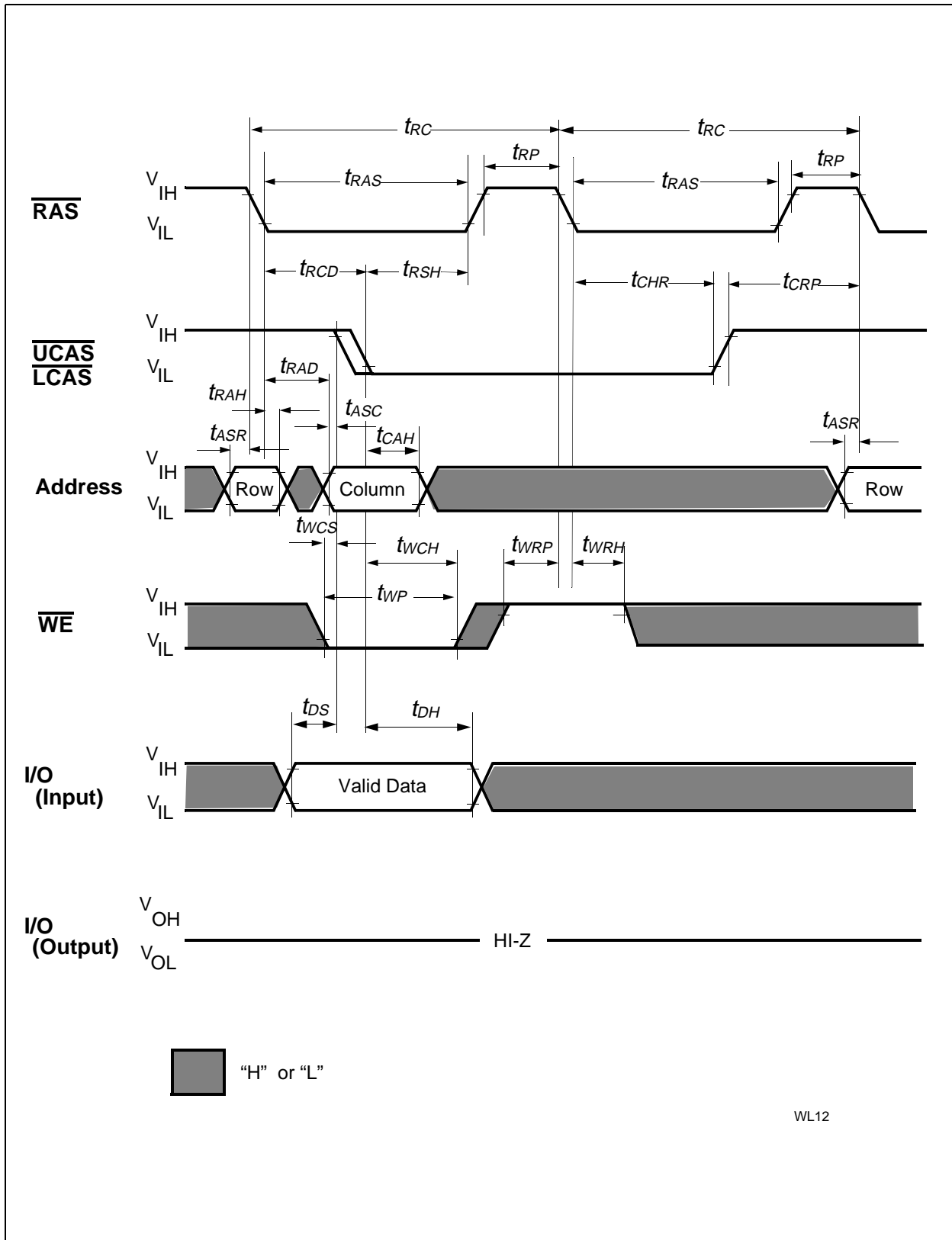




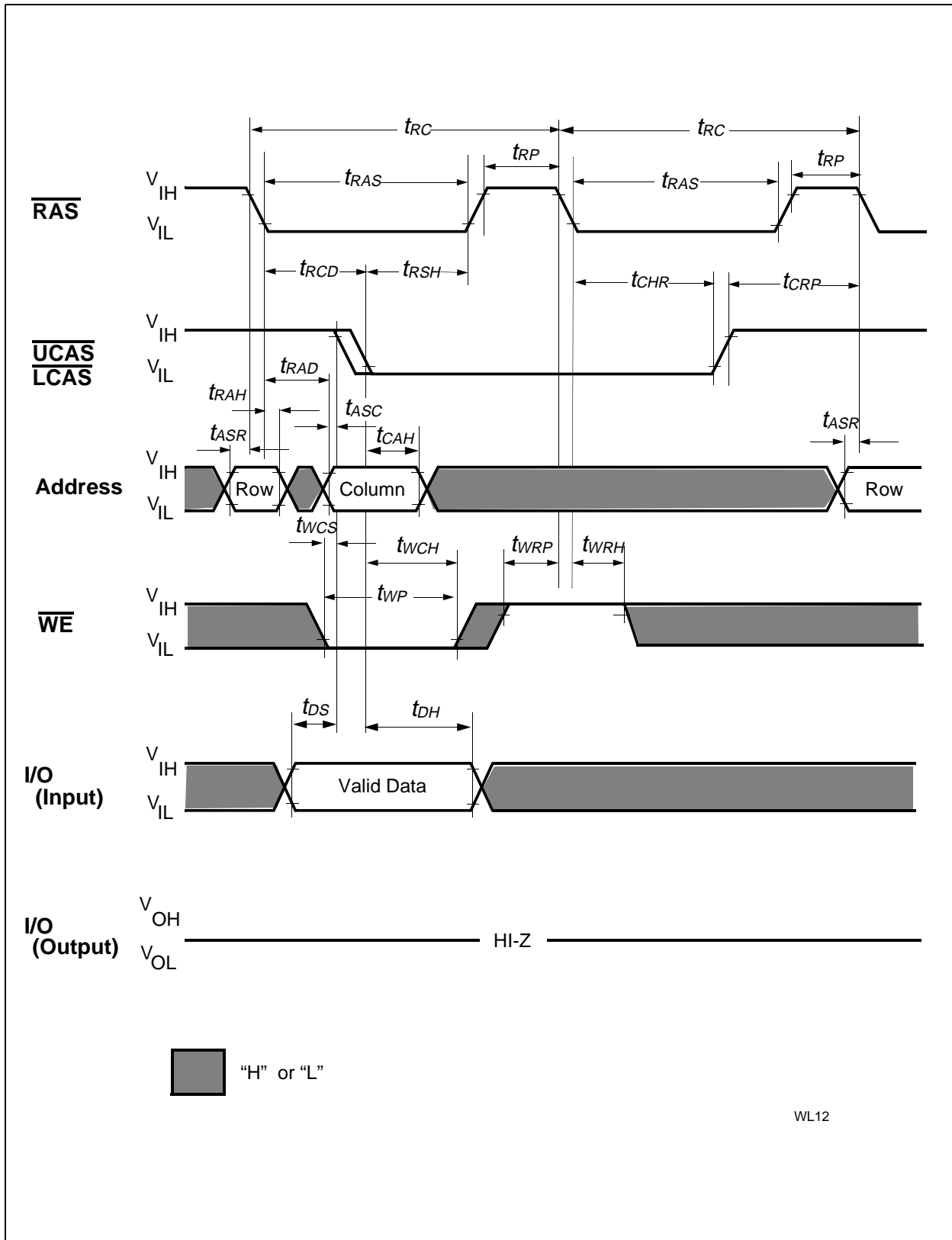
Hidden Refresh Cycle (Read)



Hidden Refresh Cycle (Read)

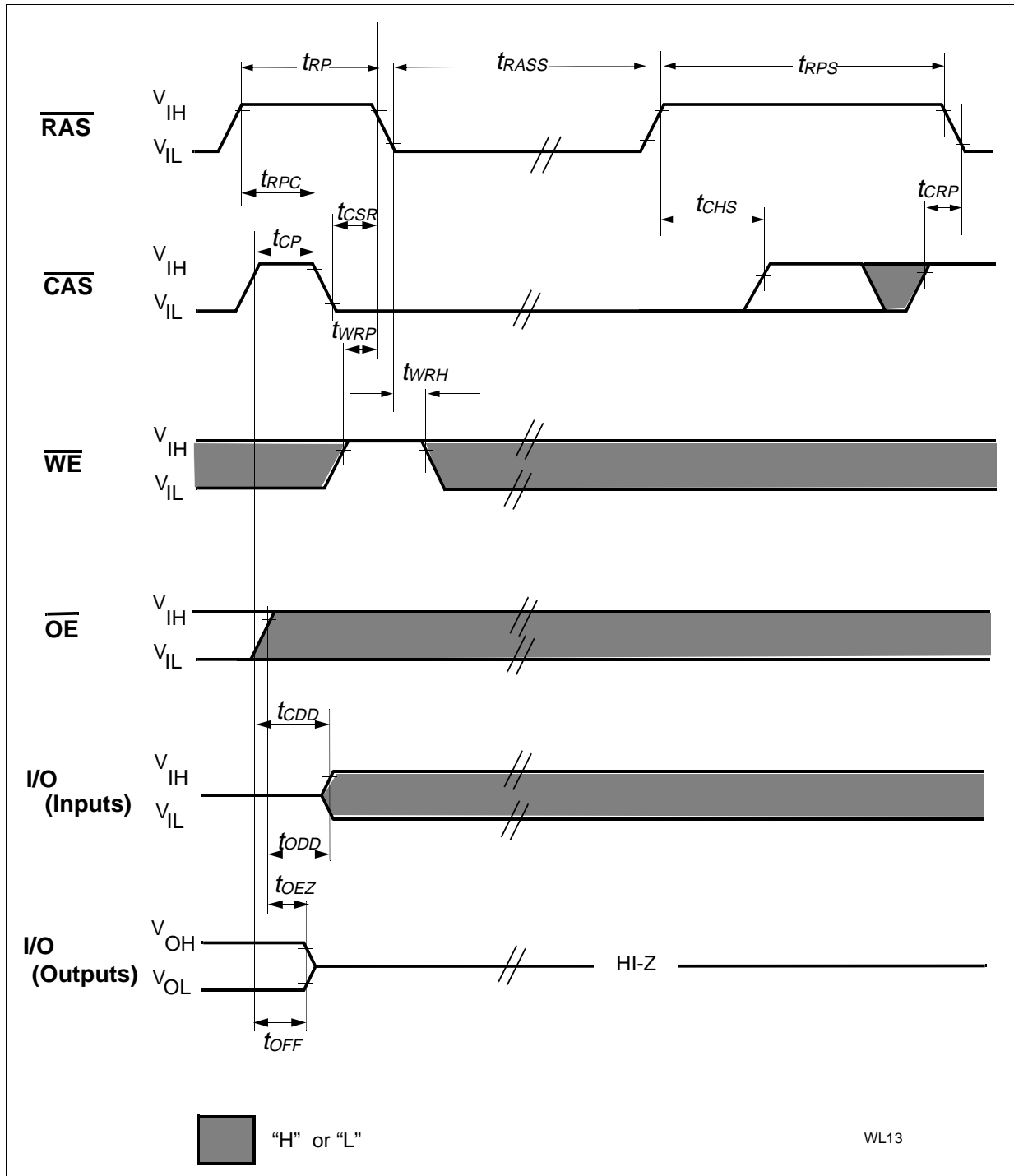


**Hidden Refresh Cycle (Early Write)**

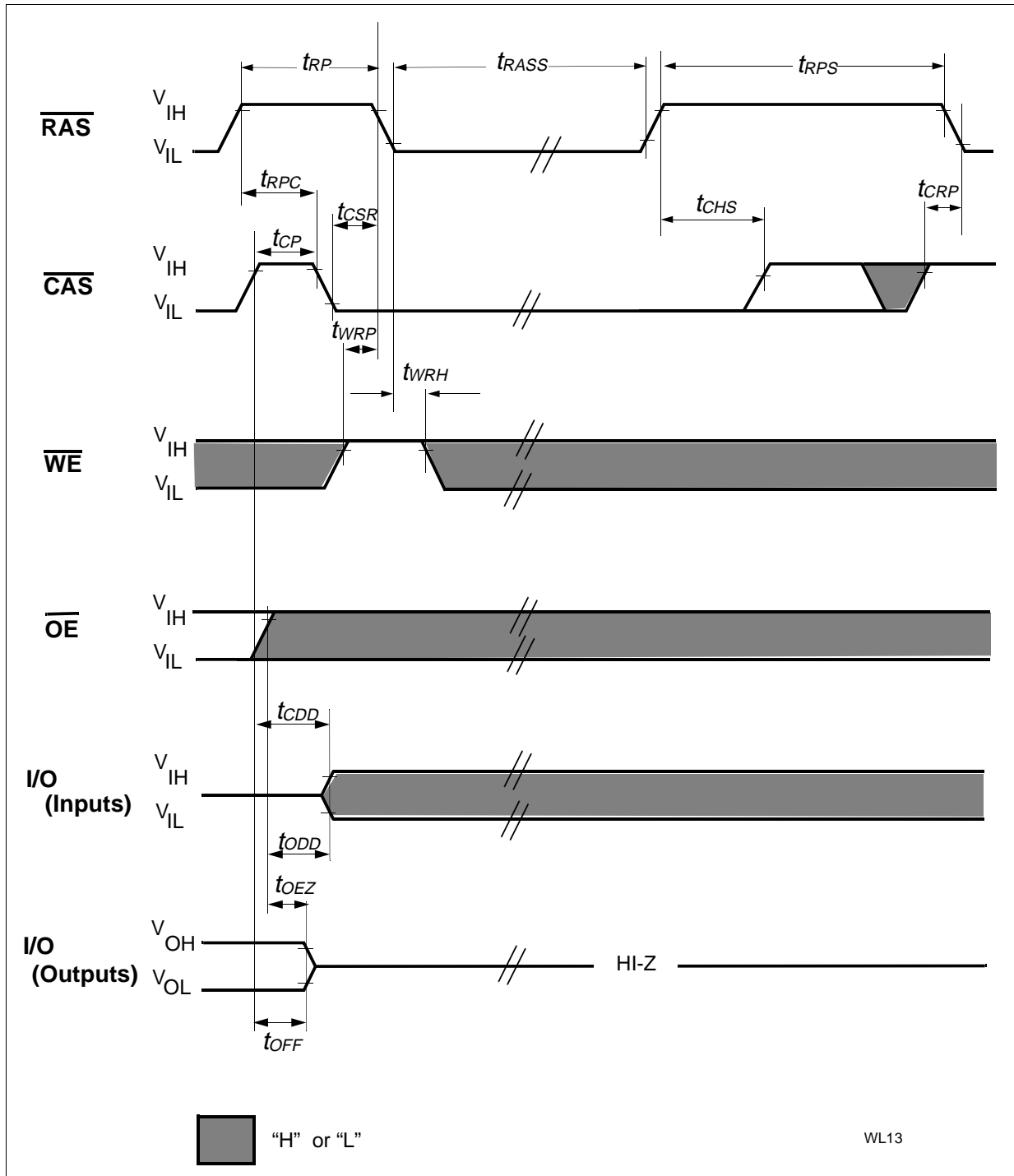


WL12

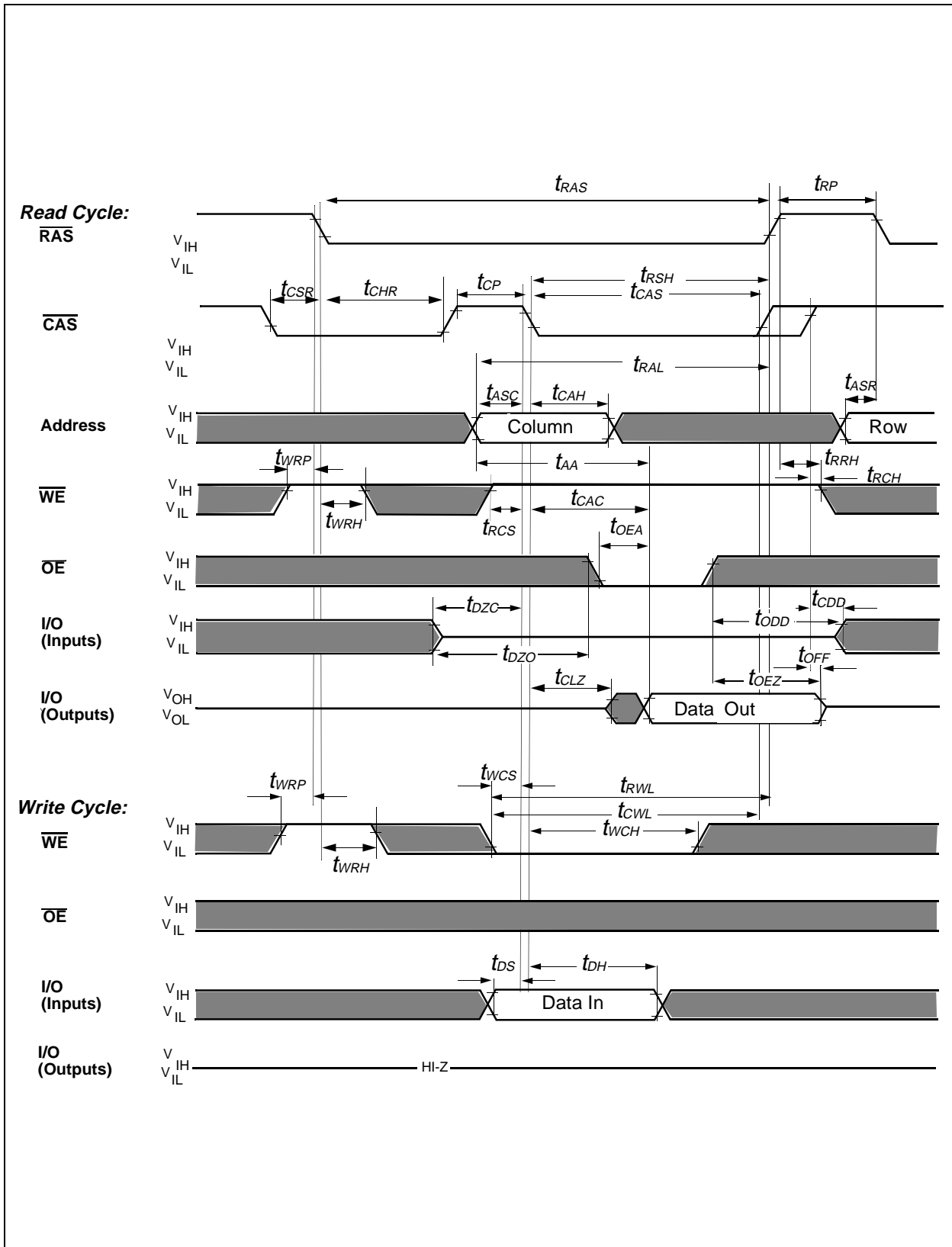
**Hidden Refresh Cycle (Early Write)**



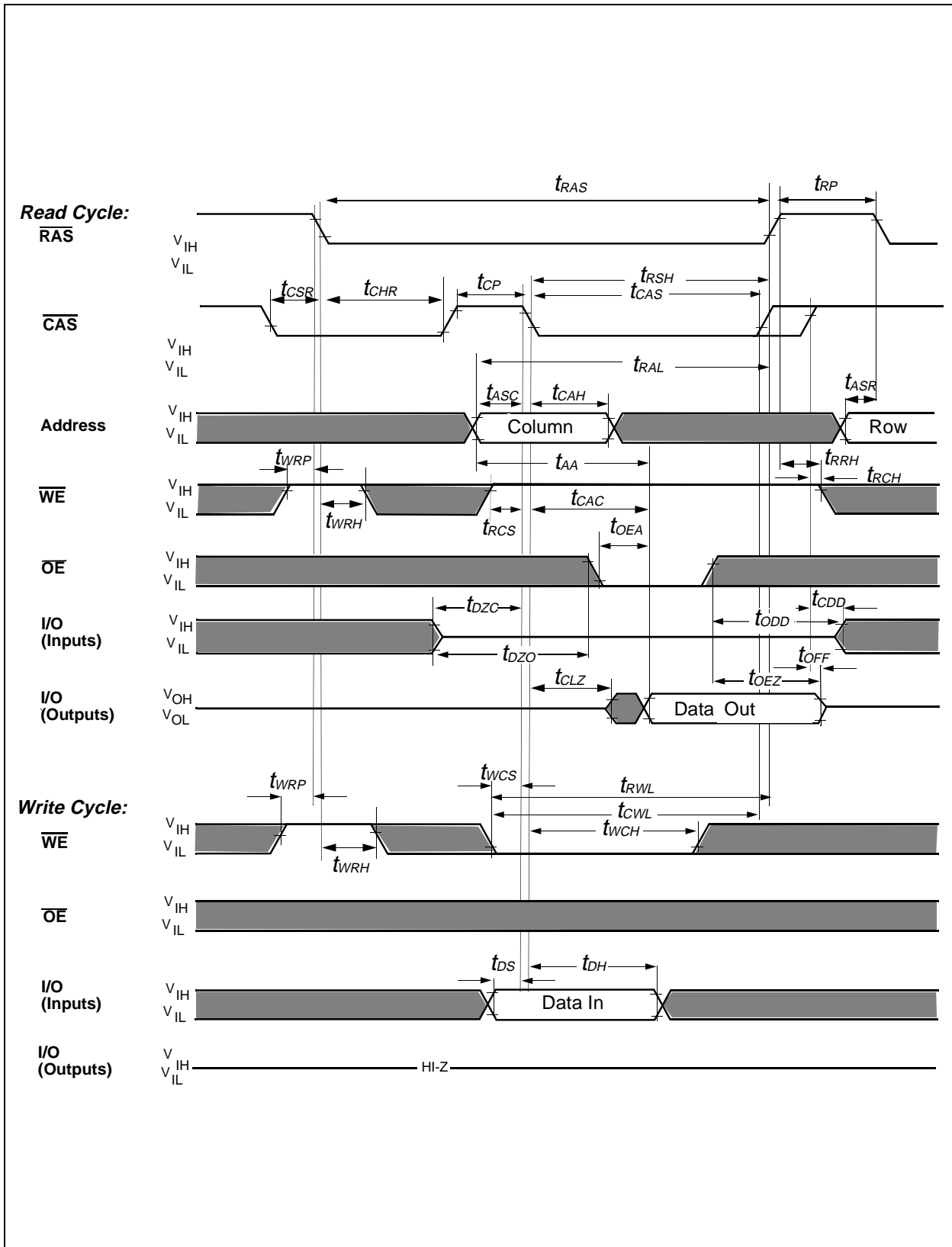
CAS before RAS Self Refresh Cycle



$\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Self Refresh Cycle



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



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

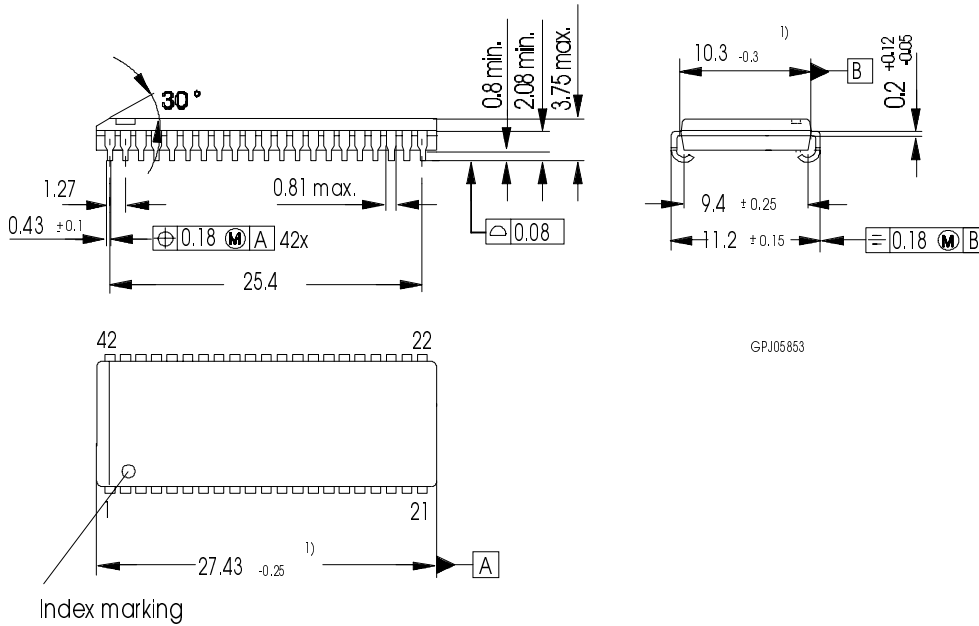






### Package Outlines

#### Plastic Package P-SOJ-42 (400 mil) (Small Outline J-lead, SMD)



1) does not include plastic or metal protusion of 0.15 max per side

### Package Outlines

