M5M4V16165BTP-6,-7,-6S,-7S

HYPER PAGE MODE 16777216-BIT (1048576-WORD BY 16-BIT) DYNAMIC RAM

DESCRIPTION

This is a family of 1048576-word by 16-bit dynamic RAMS, fabricated with the high performance CMOS process, and is ideal for large-capacity memory systems where high speed, low power dissipation, and low costs are essential.

The use of double-layer aluminum process combined with triple-well CMOS technology and a single-transistor dynamic storage stacked capacitor cell provide high circuit density at reduced costs. Multiplexed address inputs permit both a reduction in pins and an increase in system densities.

FEATURES

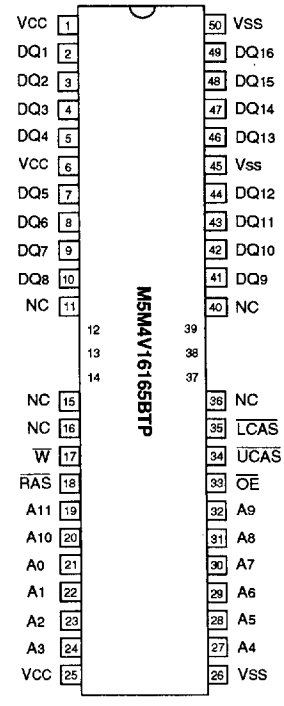
Type name	$\overline{RAS}$ access time (max.ns)	$\overline{CAS}$ access time (max.ns)	Address access time (max.ns)	$\overline{OE}$ access time (max.ns)	Cycle time (min.ns)	Power dissipation (typ.mW)
M5M4V16165BTP-6,-6S	60	15	30	15	110	285
M5M4V16165BTP-7,-7S	70	20	35	20	130	255

- Standard 50 pin TSOP
- Single 3.3V ±0.3V supply
- Low stand-by power dissipation
  1.8mW (Max) ---------- CMOS Input level
- Low operating power dissipation
  M5M4V16165BTP-6,-6S ---------- 345.0mW (Max)
  M5M4V16165BTP-7,-7S ---------- 310.0mW (Max)
- Hyper-page mode, Read-modify-write, $\overline{RAS}$-only refresh
  $\overline{CAS}$ before $\overline{RAS}$ refresh, Hidden refresh capabilities
- Early-write mode and $\overline{OE}$ to control output buffer impedance
  All inputs, output TTL compatible and low capacitance
- 4096 refresh cycles every 64ms (A_0~A_{11})

APPLICATION

Main memory unit for computers, Microcomputer memory, Refresh memory for CRT

PIN CONFIGURATION (TOP VIEW)



Outline 50P3W-L (400mil TSOP Normal Bend)

NC : NO CONNECTION

PIN DESCRIPTION

Pin name	Function
A_0~A_{11}	Address inputs
DQ_1~DQ_{16}	Data inputs/outputs
$\overline{RAS}$	Row address strobe input
$\overline{UCAS}$	Upper byte control column address strobe input
$\overline{LCAS}$	Lower byte control column address strobe input
$\overline{W}$	Write control input
$\overline{OE}$	Output enable input
Vcc	Power supply (+3.3V)
Vss	Ground (0V)

FUNCTION

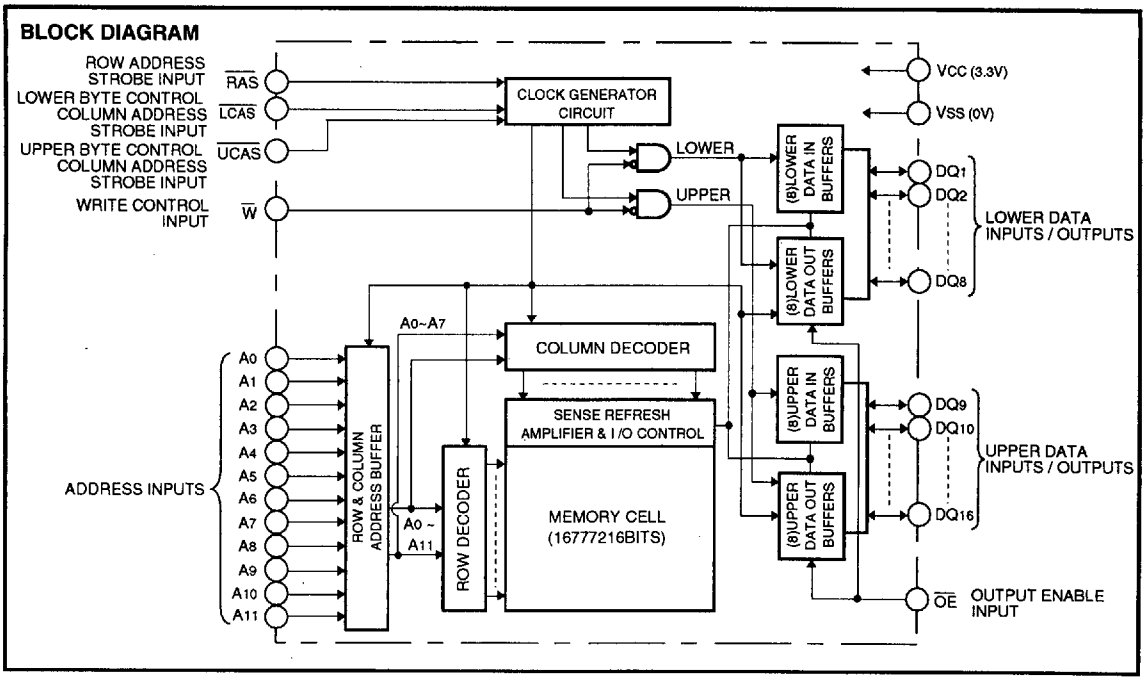
The M5M4V16165BTP provide, in addition to normal read, write, and read-modify-write operations, a number of other functions, e.g., hyper page mode, $\overline{RAS}$-only refresh, and delayed-write. The input conditions for each are shown in Table 1.

Table 1 Input conditions for each mode

Operation	Inputs					Input/Output	
	$\overline{RAS}$	$\overline{LCAS}$	$\overline{UCAS}$	$\overline{W}$	$\overline{OE}$	DQ1~DQ8	DQ9~DQ16
Lower byte read	ACT	ACT	NAC	NAC	ACT	DOUT	OPN
Upper byte read	ACT	NAC	ACT	NAC	ACT	OPN	DOUT
Word read	ACT	ACT	ACT	NAC	ACT	DOUT	DOUT
Lower byte write	ACT	ACT	NAC	ACT	NAC	DIN	DNC
Upper byte write	ACT	NAC	ACT	ACT	NAC	DNC	DIN
Word write	ACT	ACT	ACT	ACT	NAC	DIN	DIN
$\overline{RAS}$-only refresh	ACT	NAC	NAC	DNC	DNC	OPN	OPN
Hidden refresh	ACT	ACT	ACT	NAC	ACT	DOUT	DOUT
$\overline{CAS}$ before $\overline{RAS}$ refresh	ACT	ACT	ACT	DNC	DNC	OPN	OPN
Stand-by	NAC	DNC	DNC	DNC	DNC	OPN	OPN

Note : ACT : active, NAC : nonactive, DNC : don' t care, VLD : valid, IVD : invalid, APD : applied, OPN : open

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage	With respect to Vss	-0.5~4.6	V
V_I	Input voltage		-0.5~4.6	V
V_O	Output voltage		-0.5~4.6	V
I_O	Output current		50	mA
P_d	Power dissipation	Ta=25 °C	1000	mW
T_{opr}	Operating temperature		0 ~ 70	°C
T_{stg}	Storage temperature		-65 ~ 150	°C

RECOMMENDED OPERATING CONDITIONS (Ta=0~70°C, unless otherwise noted) (Note 1)

Symbol	Parameter	Limits			Unit
		Min	Nom	Max	
V_{CC}	Supply voltage	3.0	3.3	3.6	V
Vss	Supply voltage	0	0	0	V
V_{IH}	High-level input voltage, all inputs	2.0		V_{CC}+0.3	V
V_{IL}	Low-level input voltage, all inputs	-0.3		0.8	V

Note 1 : All voltage values are with respect to Vss.

ELECTRICAL CHARACTERISTICS (Ta=0~70°C, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted) (Note 2)

Symbol	Parameter		Test conditions	Limits			Unit
				Min	Typ	Max	
V_{OH}	High-level output voltage		I_{OH}=-2.0mA	2.4		Vcc	V
V_{OL}	Low-level output voltage		I_{OL}=2.0mA	0		0.4	V
I_{OZ}	Off-state output current		Q floating 0V≦V_{OUT}≦Vcc	-10		10	μA
I_I	Input current		0V≦V_{IN}≦Vcc+0.3V, Other inputs pins=0V	-10		10	μA
$I_{CC1(AV)}$	Average supply current from Vcc, operating (Note 3,4,5)	M5M4V16165B-6,-6S	$\overline{RAS}$, $\overline{CAS}$ cycling t_{RC}=t_{WC}=min. output open			95	mA
		M5M4V16165B-7,-7S				85	
I_{CC2}	Supply current from Vcc, stand-by (Note 6)		$\overline{RAS}$= $\overline{CAS}$ =V_{IH}, output open			2	mA
		M5M4V16165B-6,-7	$\overline{RAS}$= $\overline{CAS}$≧Vcc -0.2V, output open			0.5	
		M5M4V16165B-6S,-7S	$\overline{RAS}$= $\overline{CAS}$≧Vcc -0.2V, output open			0.15	
$I_{CC3\ (AV)}$	Average supply current from Vcc, refreshing (Note 3,5)	M5M4V16165B-6,-6S	$\overline{RAS}$ cycling, $\overline{CAS}$=V_{IH} t_{RC}=min. output open			95	mA
		M5M4V16165B-7,-7S				85	
$I_{CC4(AV)}$	Average supply current from Vcc Hyper-Page-Mode (Note 3,4,5)	M5M4V16165B-6,-6S	$\overline{RAS}$=V_{IL}, $\overline{CAS}$ cycling t_{PC}=min. output open			130	mA
		M5M4V16165B-7,-7S				110	
$I_{CC6(AV)}$	Average supply current from Vcc $\overline{CAS}$ before $\overline{RAS}$ refresh mode (Note 3)	M5M4V16165B-6,-6S	$\overline{CAS}$ before $\overline{RAS}$ refresh cycling t_{RC}=min. output open			95	mA
		M5M4V16165B-7,-7S				85	

Note 2: Current flowing into an IC is positive, out is negative.
3: I_{CC1} (AV), I_{CC3} (AV) and I_{CC4} (AV) are dependent on cycle rate. Maximum current is measured at the fastest cycle rate.
4: I_{CC1} (AV) and I_{CC4} (AV) are dependent on output loading. Specified values are obtained with the output open.
5: Column address can be changed once or less while $\overline{RAS}$=V_{IL} and $\overline{LCAS}$/$\overline{UCAS}$=V_{IH} .

CAPACITANCE (Ta=00~70℃, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$C_{I(A)}$	Input capacitance, address inputs	VI=Vss f=1MHz VI=25mVrms			5	pF
$C_{I(\overline{OE})}$	Input capacitance, $\overline{OE}$ input				7	pF
$C_{I(\overline{W})}$	Input capacitance, write control input				7	pF
$C_{I(\overline{RAS})}$	Input capacitance, $\overline{RAS}$ input				7	pF
$C_{I(\overline{CAS})}$	Input capacitance, $\overline{CAS}$ input				7	pF
$C_{I/O}$	Input/Output capacitance, data ports				8	pF

SWITCHING CHARACTERISTICS (Ta=00~70℃, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted, see notes 6,14,15)

Symbol	Parameter		Limits				Unit
			M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
			Min	Max	Min	Max	
t_{CAC}	Access time from $\overline{CAS}$	(Note 7,8)		15		20	ns
t_{RAC}	Access time from $\overline{RAS}$	(Note 7,9)		60		70	ns
t_{AA}	Columu address access time	(Note 7,10)		30		35	ns
t_{CPA}	Access time from $\overline{CAS}$ precharge	(Note 7,11)		35		40	ns
t_{OEA}	Access time from $\overline{OE}$	(Note 7)		15		20	ns
t_{OHC}	Output hold time from $\overline{CAS}$		5		5		ns
t_{OHR}	Output hold time from $\overline{RAS}$	(Note 13)	5		5		ns
t_{CLZ}	Output low impedance time from $\overline{CAS}$ low	(Note 7)	5		5		ns
t_{OEZ}	Output disable time after $\overline{OE}$ high	(Note 12)	0	15	0	20	ns
t_{WEZ}	Output disable time after $\overline{WE}$ high	(Note 12)	0	15	0	20	ns
t_{OFF}	Output disable time after $\overline{CAS}$ high	(Note 12,13)	0	15	0	20	ns
t_{REZ}	Output disable time after $\overline{RAS}$ high	(Note 12,13)	0	15	0	20	ns

Note 6: An initial pause of 500 μs is required after power-up followed by a minimum of eight initialization cycles (any combination of cycles containing a $\overline{RAS}$ clock such as $\overline{RAS}$-Only refresh).
Note the $\overline{RAS}$ may be cycled during the initial pause . And any 8 $\overline{RAS}$ or $\overline{RAS}/\overline{CAS}$ cycles are required after prolonged periods (greater than 64ms) of $\overline{RAS}$ inactivity before proper device operation is achieved.

7: Measured with a load circuit equivalent to VOH=2.4V(IOH=-2mA) / VOL=0.4V(IOL=2mA) load 100pF.
The reference levels for measuring of output signal are 2.0V(VOH) and 0.8V(VOL).

8: Assumes that $t_{RCD} \geq t_{RCD(max)}$ and $t_{ASC} \geq t_{ASC(max)}$. and $t_{CP} \geq t_{CP(max)}$.

9: Assumes that $t_{RCD} \leq t_{RCD(max)}$ and $t_{RAD} \leq t_{RAD(max)}$. If t_{RCD} or t_{RAD} is greater than the maximum recommended value shown in this table, t_{RAC} will increase by amount that t_{RCD} exceeds the value shown.

10: Assumes that $t_{RAD} \geq t_{RAD(max)}$ and $t_{ASC} \leq t_{ASC(max)}$.

11: Assumes that $t_{CP} \leq t_{CP(max)}$ and $t_{ASC} \geq t_{ASC(max)}$.

12: $t_{OEZ(max)}$, $t_{WEZ(max)}$, $t_{OFF(max)}$ and $t_{REZ(max)}$ defines the time at which the output achieves the high impedance state ($I_{OUT} \leq |\pm 10uA|$) and is not reference to $V_{OH(min)}$ or $V_{OL(max)}$.

13: Output is disabled after both $\overline{RAS}$ and $\overline{CAS}$ go to high.

TIMING REQUIREMENTS (For Read, Write, Read-Modify-Write, Refresh and Hyper-Page Mode Cycles)

(Ta=0~70℃, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted, see notes 14,15)

Symbol	Parameter		Limits				Unit
			M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
			Min	Max	Min	Max	
tREF	Refresh cycle time	-6, -7		64		64	ms
tREF	Refresh cycle time	-6S, -7S		128		128	ms
tRP	$\overline{RAS}$ high pulse width		40		50		ns
tRCD	Delay time, $\overline{RAS}$ low to $\overline{CAS}$ low	(Note 16)	20	45	20	50	ns
tCRP	Delay time, $\overline{CAS}$ high to $\overline{RAS}$ low		5		5		ns
tRPC	Delay time, $\overline{RAS}$ high to $\overline{CAS}$ low		0		0		ns
tCPN	$\overline{CAS}$ high pulse width		10		10		ns
tRAD	Column address delay time from $\overline{RAS}$ low	(Note 17)	15	30	15	35	ns
tASR	Row address setup time before $\overline{RAS}$ low		0		0		ns
tASC	Column address setup time before $\overline{CAS}$ low	(Note 18)	0	13	0	13	ns
tRAH	Row address hold time after $\overline{RAS}$ low		10		10		ns
tCAH	Column address hold time after $\overline{CAS}$ low		10		10		ns
tDZC	Delay time, data to $\overline{CAS}$ low	(Note 19)	0		0		ns
tDZO	Delay time, data to $\overline{OE}$ low	(Note 19)	0		0		ns
tRDD	Delay time, $\overline{RAS}$ high to data	(Note 20)	15		20		ns
tCDD	Delay time, $\overline{CAS}$ high to data	(Note 20)	15		20		ns
tODD	Delay time, $\overline{OE}$ high to data	(Note 20)	15		20		ns
tT	Transition time	(Note 21)	1	50	1	50	ns

Note 14: The timing requirements are assumed tT =2ns.

15: VIH(min) and VIL(max) are reference levels for measuring timing of input signals.

16: tRCD(max) is specified as a reference point only. If tRCD is less than tRCD(max), access time is tRAC. If tRCD is greater than tRCD(max), access time is controlled exclusively by tCAC or tAA.

17: tRAD(max) is specified as a reference point only. If tRAD ≧ tRAD(max) and tASC ≦ tASC(max), access time is controlled exclusively by tAA.

18: tASC(max) is specified as a reference point only. If tRCD ≧ tRCD(max) and tASC ≧ tASC(max), access time is controlled exclusively by tCAC.

19: Either tDZC or tDZO must be satisfied.

20: Either tRDD or tCDD or tODD must be satisfied.

21: tT is measured between VIH(min) and VIL(max).

Read and Refresh Cycles

Symbol	Parameter		Limits				Unit
			M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
			Min	Max	Min	Max	
tRC	Read cycle time		110		130		ns
tRAS	$\overline{RAS}$ low pulse width		60	10000	70	10000	ns
tCAS	$\overline{CAS}$ low pulse width		10	10000	13	10000	ns
tCSH	$\overline{CAS}$ hold time after $\overline{RAS}$ low		48		55		ns
tRSH	$\overline{RAS}$ hold time after $\overline{CAS}$ low		15		20		ns
tRCS	Read setup time before $\overline{CAS}$ low		0		0		ns
tRCH	Read hold time after $\overline{CAS}$ high	(Note 22)	0		0		ns
tRRH	Read hold time after $\overline{RAS}$ high	(Note 22)	10		10		ns
tRAL	Column address to $\overline{RAS}$ hold time		30		35		ns
tCAL	Column address to $\overline{CAS}$ hold time		18		23		ns
tORH	$\overline{RAS}$ hold time after $\overline{OE}$ low		15		20		ns
tOCH	$\overline{CAS}$ hold time after $\overline{OE}$ low		15		20		ns

Note 22: Either tRCH or tRRH must be satisfied for a read cycle.

Write Cycle (Early Write and Delayed Write)

Symbol	Parameter	Limits				Unit
		M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
		Min	Max	Min	Max	
tWC	Write cycle time	110		130		ns
tRAS	$\overline{RAS}$ low pulse width	60	10000	70	10000	ns
tCAS	$\overline{CAS}$ low pulse width	10	10000	13	10000	ns
tCSH	$\overline{CAS}$ hold time after $\overline{RAS}$ low	48		55		ns
tRSH	$\overline{RAS}$ hold time after $\overline{CAS}$ low	15		20		ns
tWCS	Write setup time before $\overline{CAS}$ low (Note 24)	0		0		ns
tWCH	Write hold time after $\overline{CAS}$ low	10		13		ns
tCWL	$\overline{CAS}$ hold time after $\overline{W}$ low	10		13		ns
tRWL	$\overline{RAS}$ hold time after $\overline{W}$ low	10		13		ns
tWP	Write pulse width	10		13		ns
tDS	Data setup time before $\overline{CAS}$ low or $\overline{W}$ low	0		0		ns
tDH	Data hold time after $\overline{CAS}$ low or $\overline{W}$ low	10		13		ns

Read-Write and Read-Modify-Write Cycles

Symbol	Parameter	Limits				Unit
		M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
		Min	Max	Min	Max	
tRWC	Read write/read modify write cycle time (Note 23)	133		161		ns
tRAS	$\overline{RAS}$ low pulse width	89	10000	107	10000	ns
tCAS	$\overline{CAS}$ low pulse width	44	10000	57	10000	ns
tCSH	$\overline{CAS}$ hold time after $\overline{RAS}$ low	82		99		ns
tRSH	$\overline{RAS}$ hold time after $\overline{CAS}$ low	44		57		ns
tRCS	Read setup time before $\overline{CAS}$ low	0		0		ns
tCWD	Delay time, $\overline{CAS}$ low to $\overline{W}$ low (Note 24)	32		42		ns
tRWD	Delay time, $\overline{RAS}$ low to $\overline{W}$ low (Note 24)	77		92		ns
tAWD	Delay time, address to $\overline{W}$ low (Note 24)	47		57		ns
tOEH	$\overline{OE}$ hold time after $\overline{W}$ low	15		20		ns

Note 23: tRWC is specified as tRWC(min)=tRAC(max)+tODD(min)+tRWL(min)+tRP(min)+4tT.
24: tWCS, tCWD, tRWD and tAWD and, tCPWD are specified as reference points only. If tWCS≧tWCS(min) the cycle is an early write cycle and the DQ pins will remain high impedance throughout the entire cycle. If tCWD≧tCWD(min), tRWD≧tRWD(min), tAWD≧tAWD(min) and tCPWD≧tCPWD(min) (for hyper page mode cycle only), the cycle is a read-modify-write cycle and the DQ will contain the data read from the selected address. If neither of the above condition (delayed write) of the DQ (at access time and until $\overline{CAS}$ or $\overline{OE}$ goes back to VIH) is indeterminate.

Hyper page Mode Cycle

(Read, Early Write, Read-Write, Read-Modify-Write Cycle, Read Write Mix Cycle, Hi-Z control by $\overline{OE}$ or $\overline{W}$) (Note 25)

Symbol	Parameter		Limits				Unit
			M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
			Min	Max	Min	Max	
t_{HPC}	Hyper page mode read/write cycle time		25		30		ns
t_{HPRWC}	Hyper page mode read write/read modify write cycle time		66		79		ns
t_{DOH}	Output hold time from $\overline{CAS}$ low		5		5		ns
t_{RAS}	$\overline{RAS}$ low pulse width for read write cycle	(Note 26)	77	100000	92	100000	ns
t_{CP}	$\overline{CAS}$ high pulse width	(Note 27)	10	18	13	18	ns
t_{CPRH}	$\overline{RAS}$ hold time after $\overline{CAS}$ precharge		35		40		ns
t_{CPWD}	Delay time, $\overline{CAS}$ precharge to $\overline{W}$ low	(Note 24)	52		62		ns
t_{CHOL}	Hold time to maintain the data Hi-Z until $\overline{CAS}$ access		7		7		ns
t_{OEPE}	$\overline{OE}$ Pulse width (Hi-Z control)		7		7		ns
t_{WPE}	$\overline{W}$ Pulse width (Hi-Z control)		7		7		ns
t_{HCWD}	Delay time, $\overline{CAS}$ low to $\overline{W}$ low after read		32		42		ns
t_{HAWD}	Delay time, address to $\overline{W}$ low after read		62		72		ns
t_{HPWD}	Delay time, $\overline{CAS}$ precharge to $\overline{W}$ low after read		72		82		ns
t_{HCOD}	Delay time, $\overline{CAS}$ low to $\overline{OE}$ high after read		15		20		ns
t_{HAOD}	Delay time, address to $\overline{OE}$ high after read		30		35		ns
t_{HPOD}	Delay time, $\overline{CAS}$ precharge to $\overline{OE}$ high after read		35		40		ns

Note 25: All previously specified timing requirements and switching characteristics are applicable to their respective Hyper page mode cycle.
26: $t_{RAS(min)}$ is specified as two cycles of $\overline{CAS}$ input are performed.
27: $t_{CP(max)}$ is specified as a reference point only.

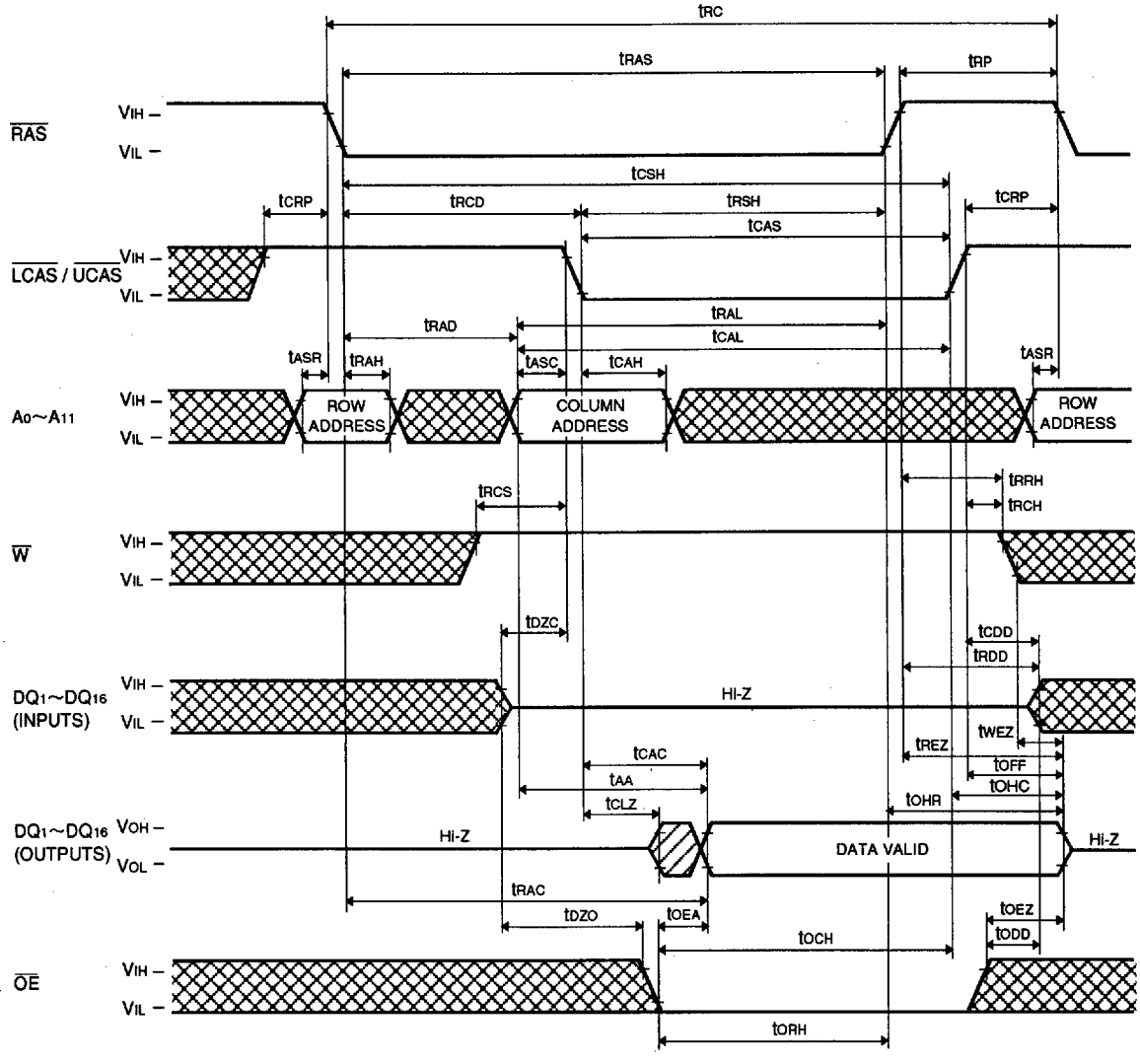
$\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle (Note 28)

Symbol	Parameter	Limits				Unit
		M5M4V16165B-6,-6S		M5M4V16165B-7,-7S		
		Min	Max	Min	Max	
t_{CSR}	$\overline{CAS}$ setup time before $\overline{RAS}$ low	10		10		ns
t_{CHR}	$\overline{CAS}$ hold time after $\overline{RAS}$ low	10		15		ns

Note 28: Eight or more $\overline{CAS}$ before $\overline{RAS}$ cycles instead of eight $\overline{RAS}$ cycles are necessary for proper operation of $\overline{CAS}$ before $\overline{RAS}$ refresh mode.

Timing Diagrams (Note 29)

Read Cycle

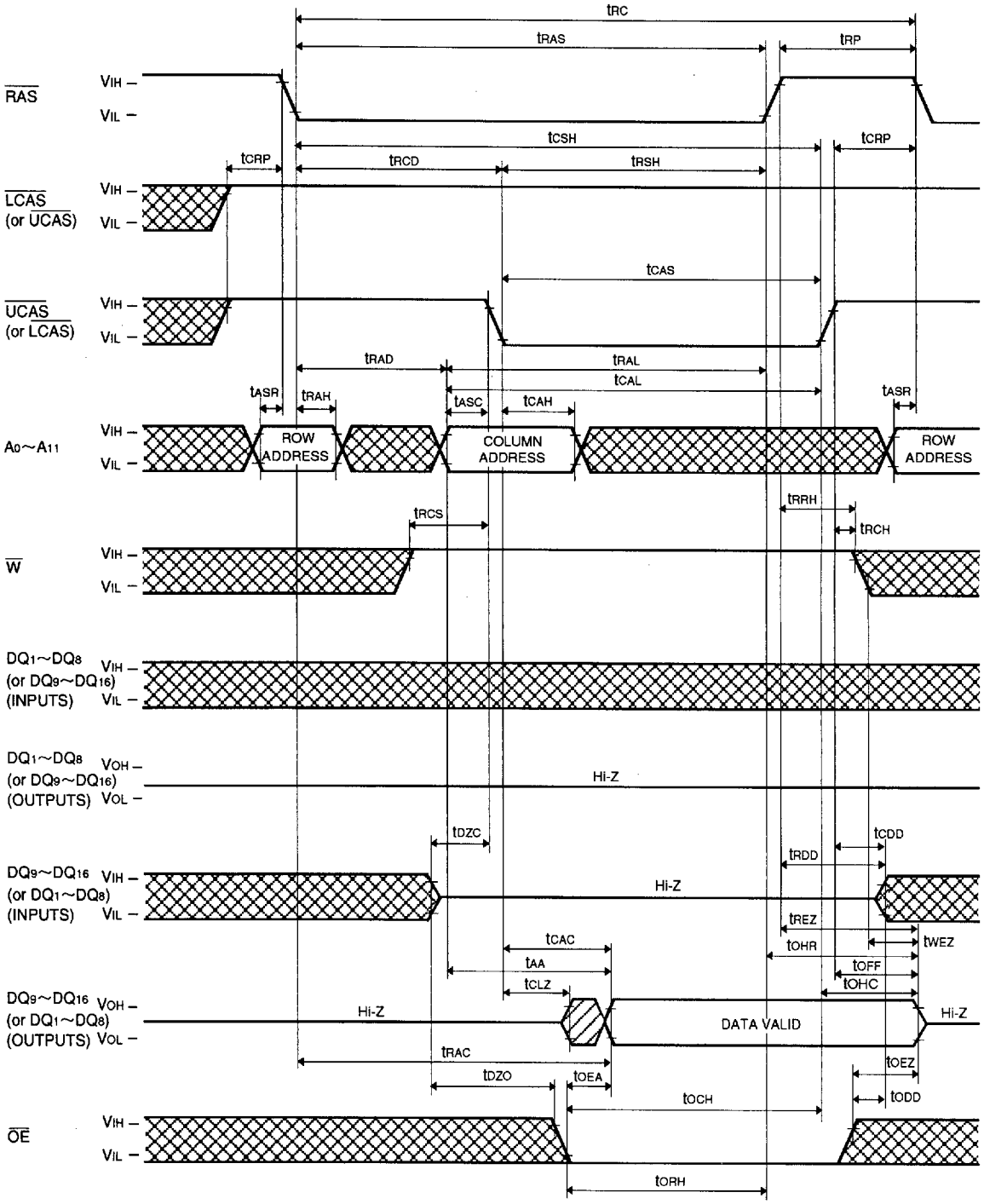


Note 29

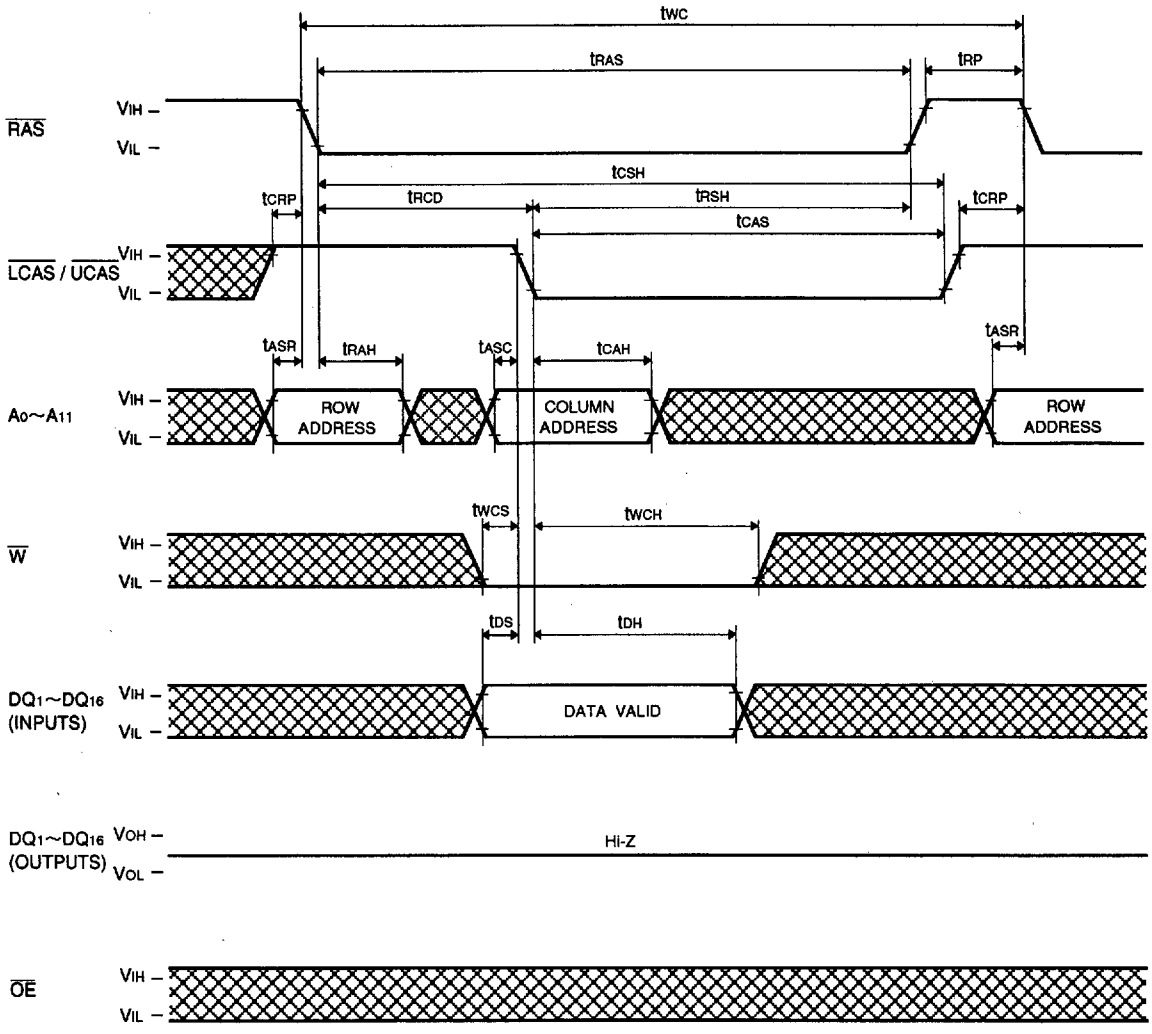
Indicates the don't care input.
VIH(min)≦VIN≦VIH(max) or VIL(min)≦VIN≦VIL(max)

Indicates the invalid output.

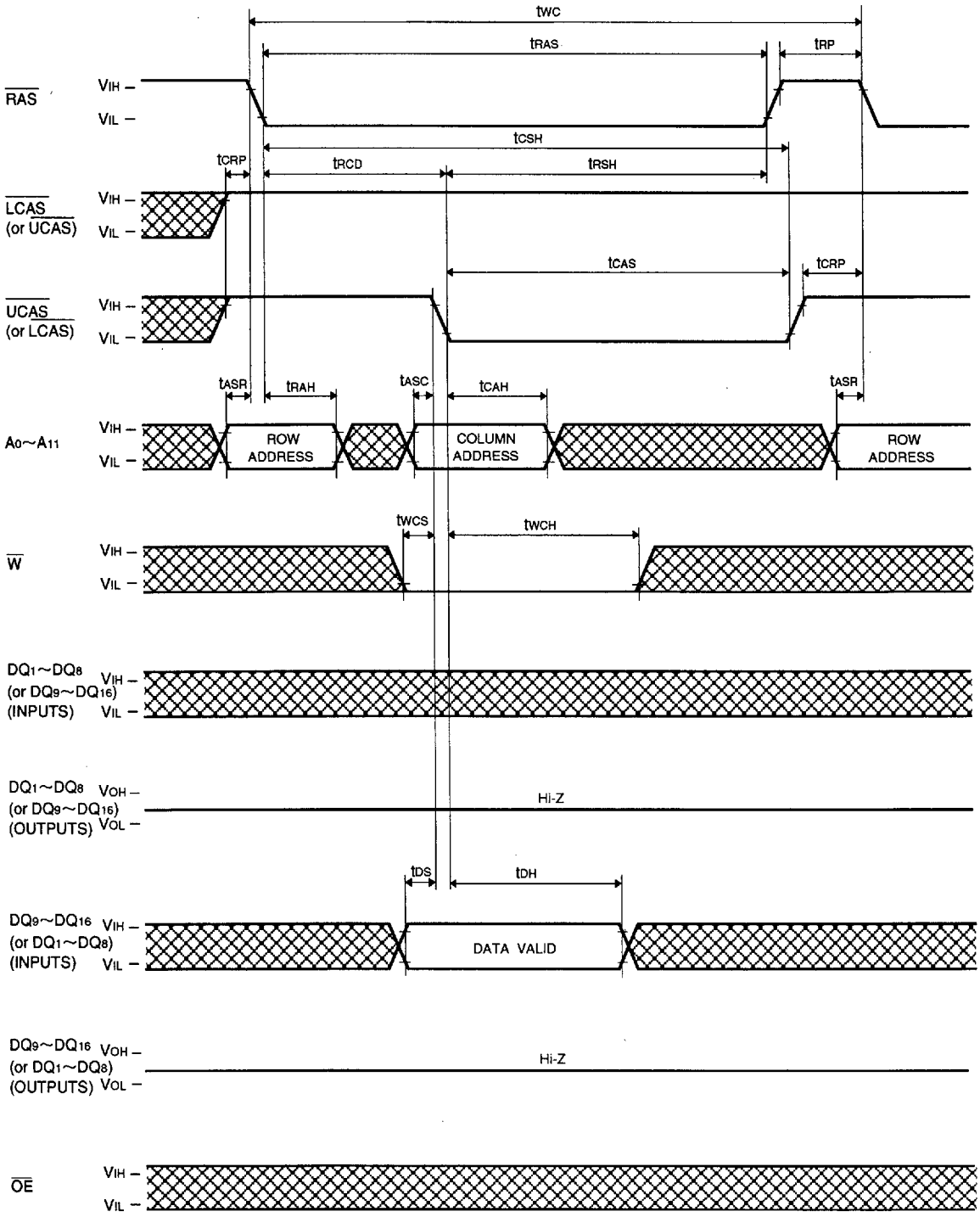
Byte Read Cycle



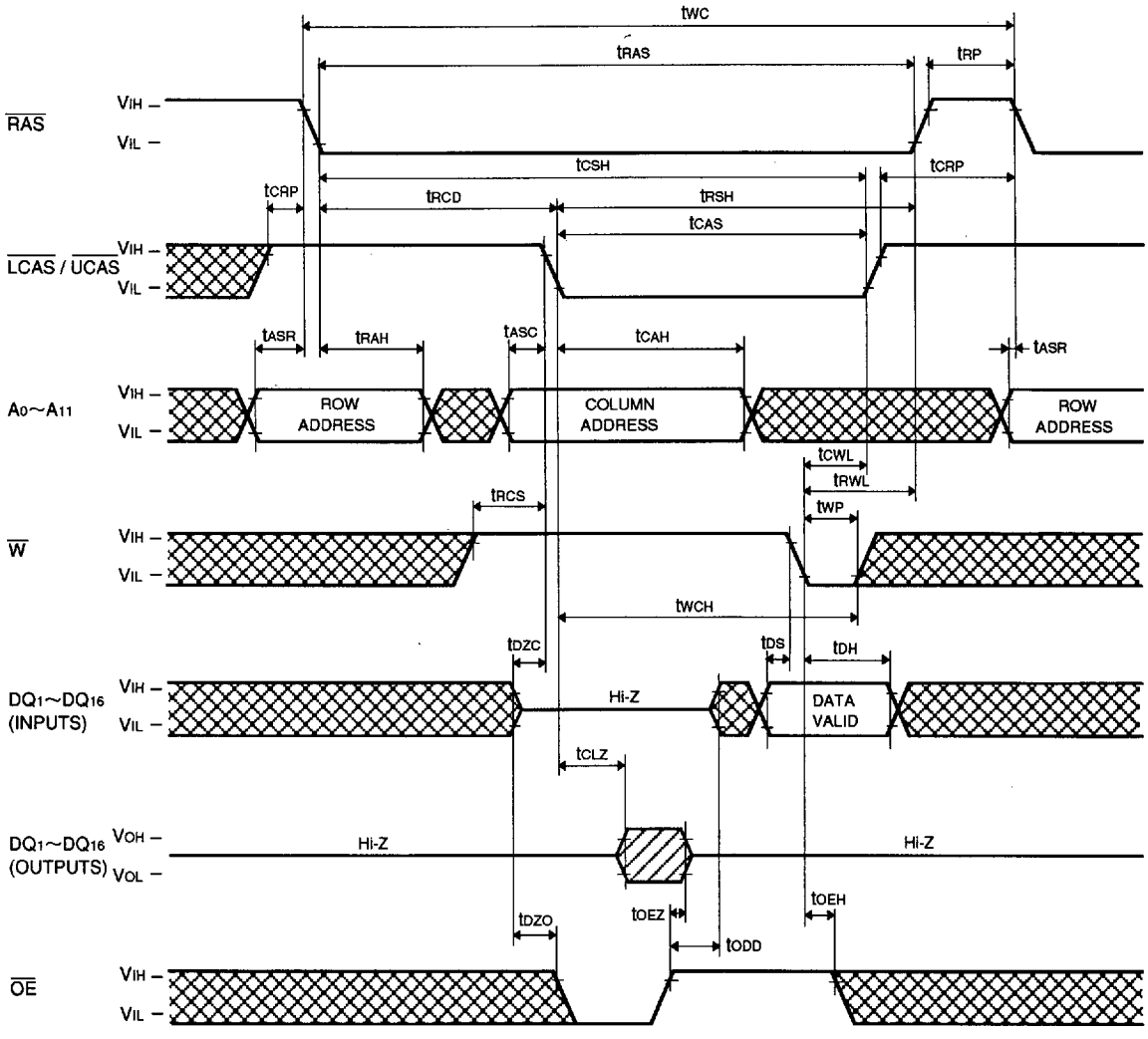
Early Write Cycle



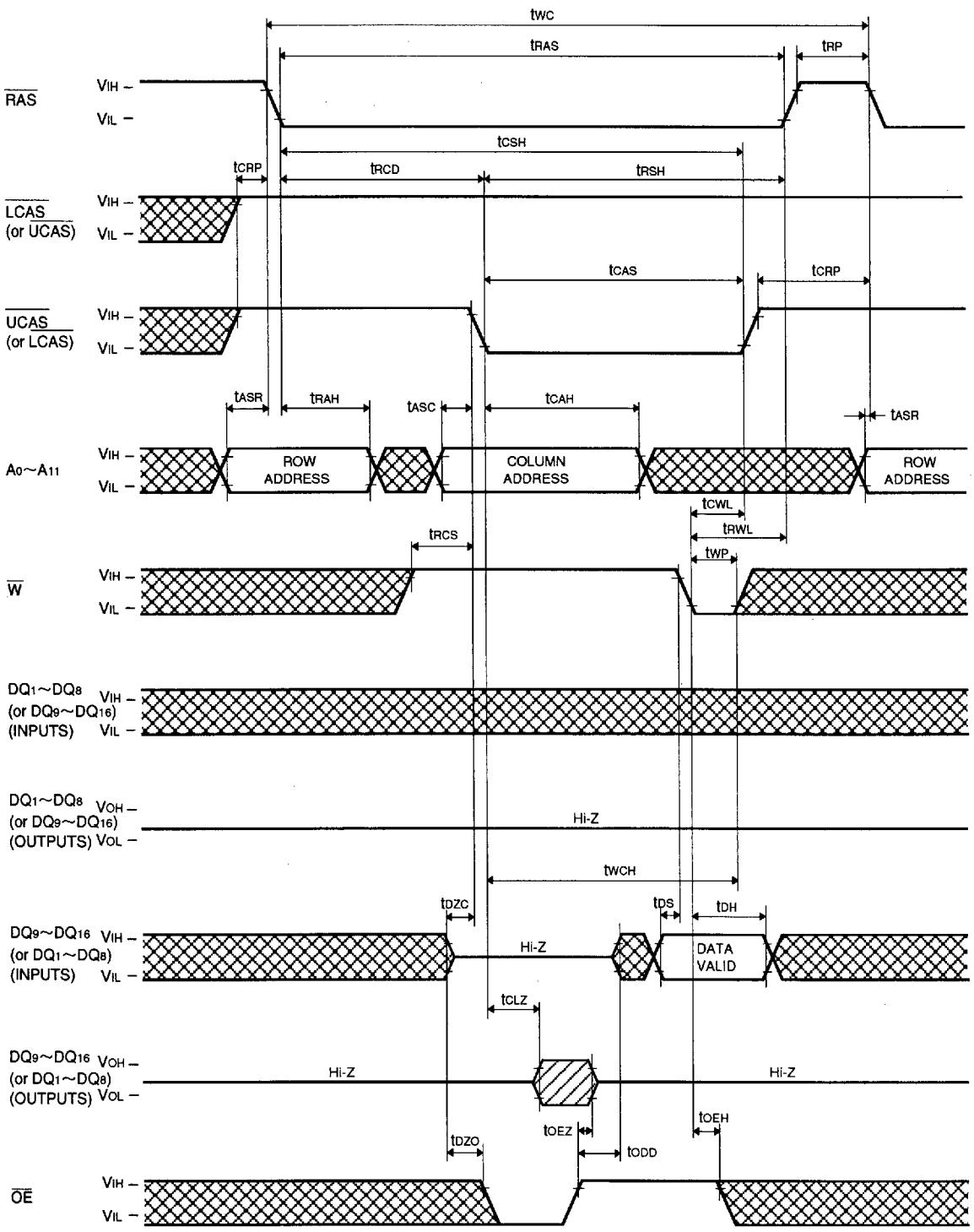
Byte Early Write Cycle



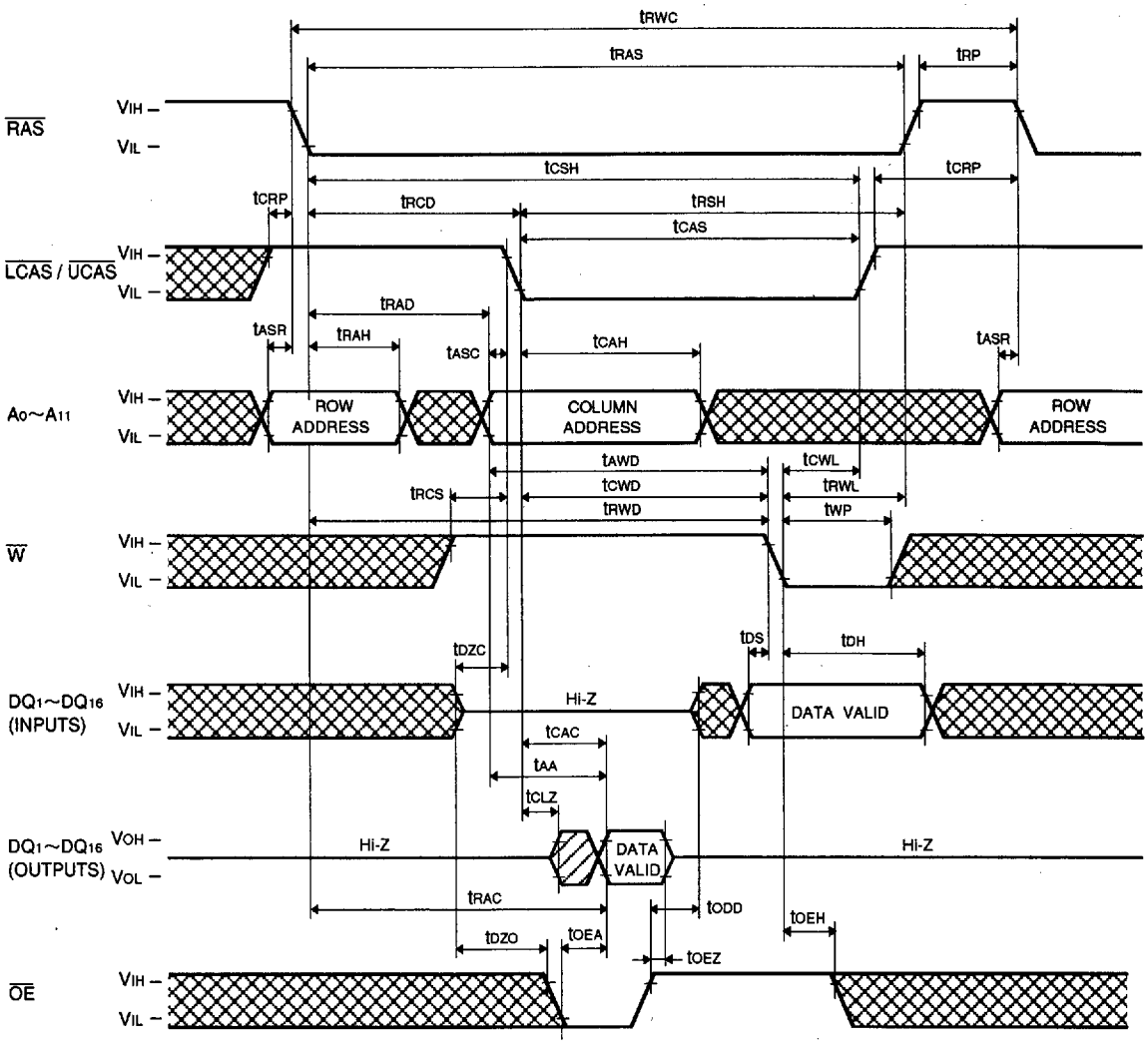
Delayed Write Cycle



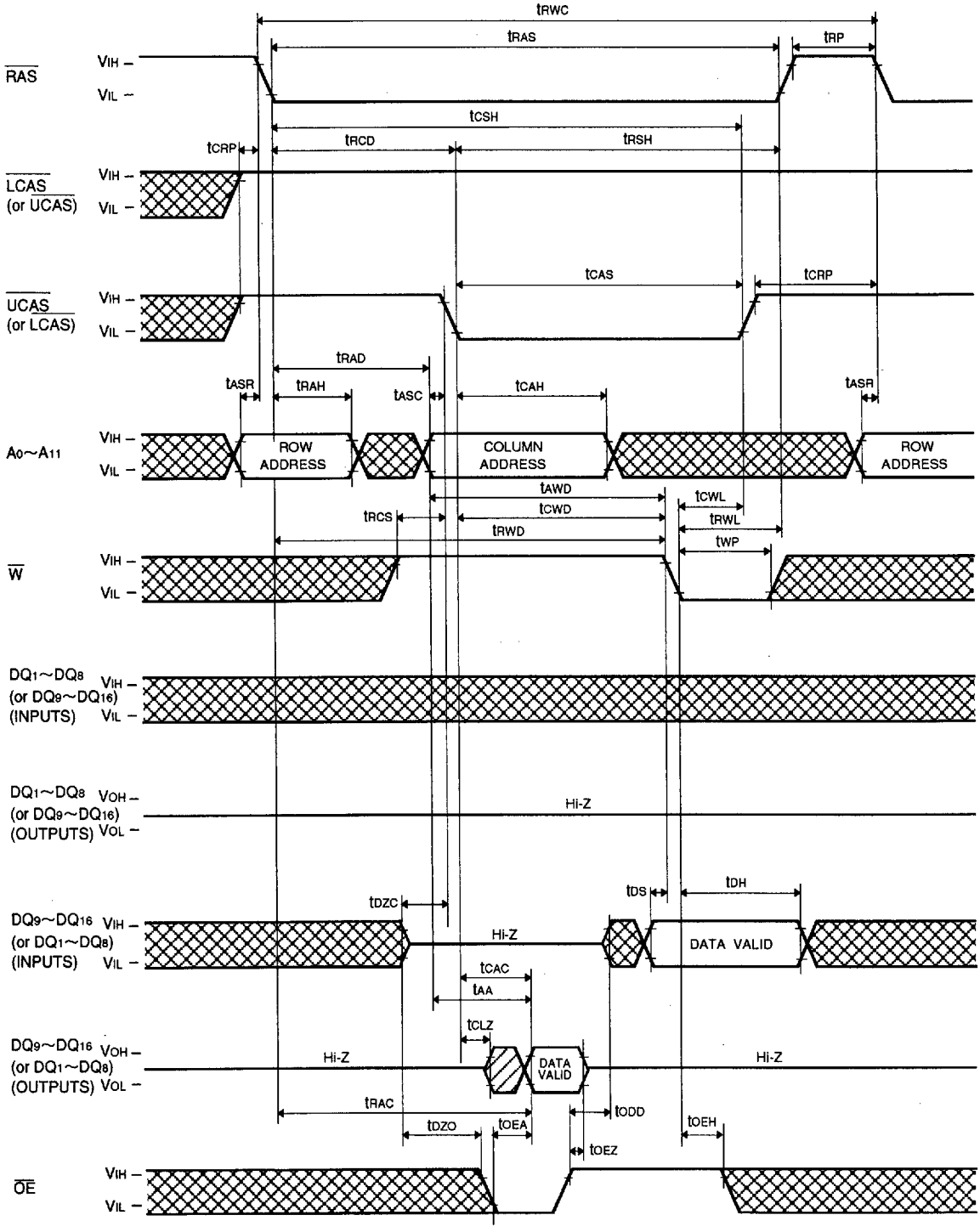
Byte Delayed Write Cycle



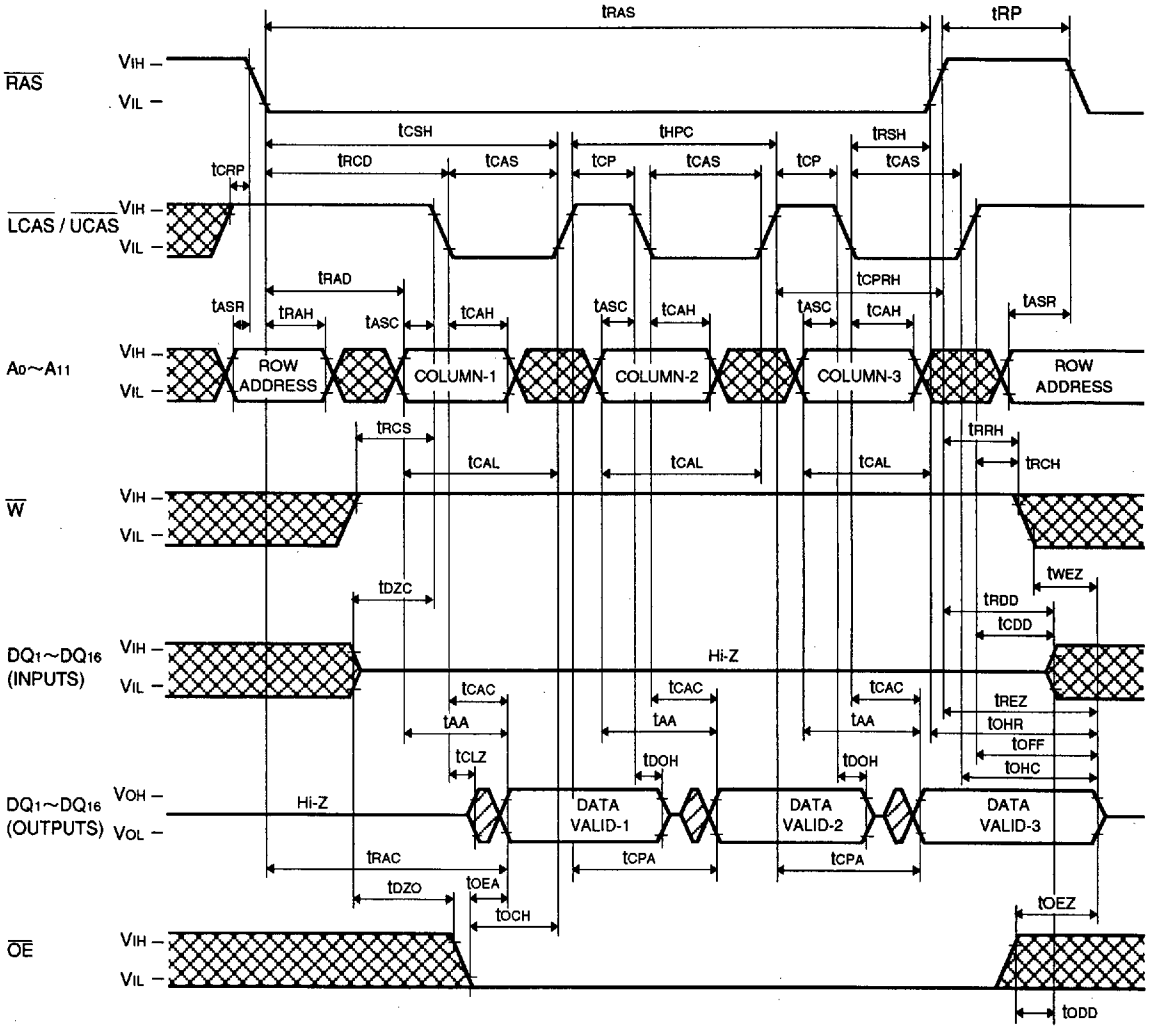
Read-Write, Read-Modify-Write Cycle



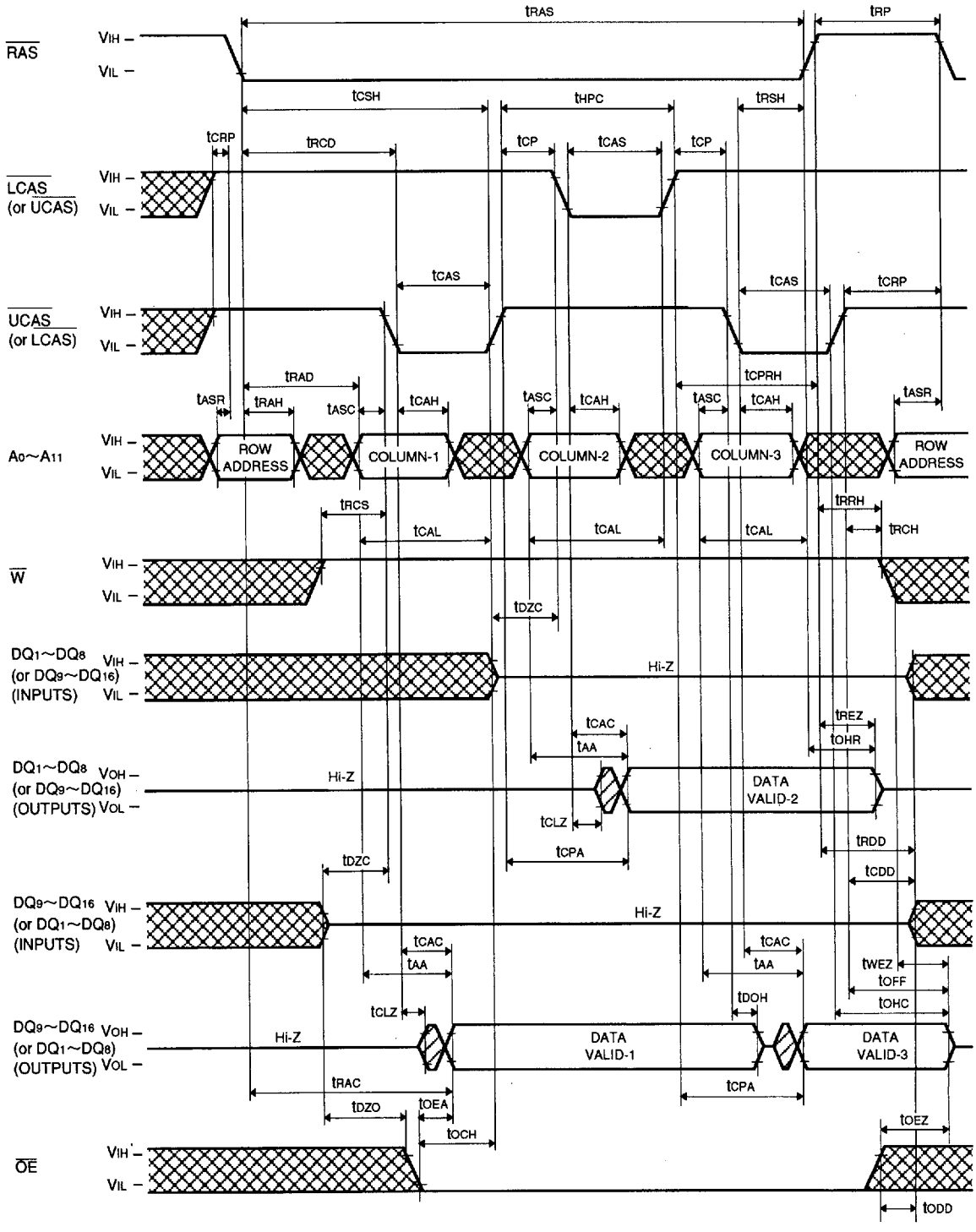
Byte Read-Write, Read-Modify-Write Cycle



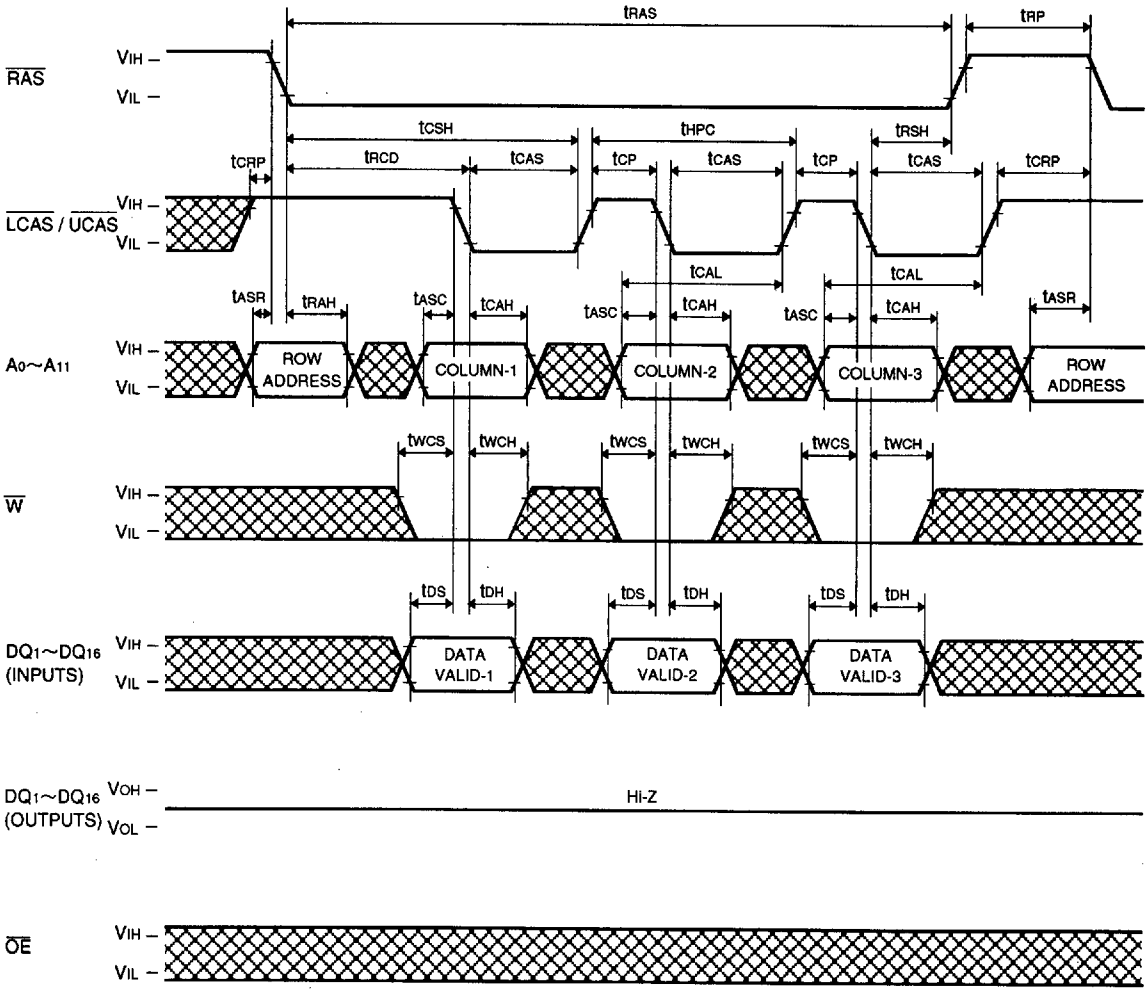
Hyper Page Mode Read Cycle



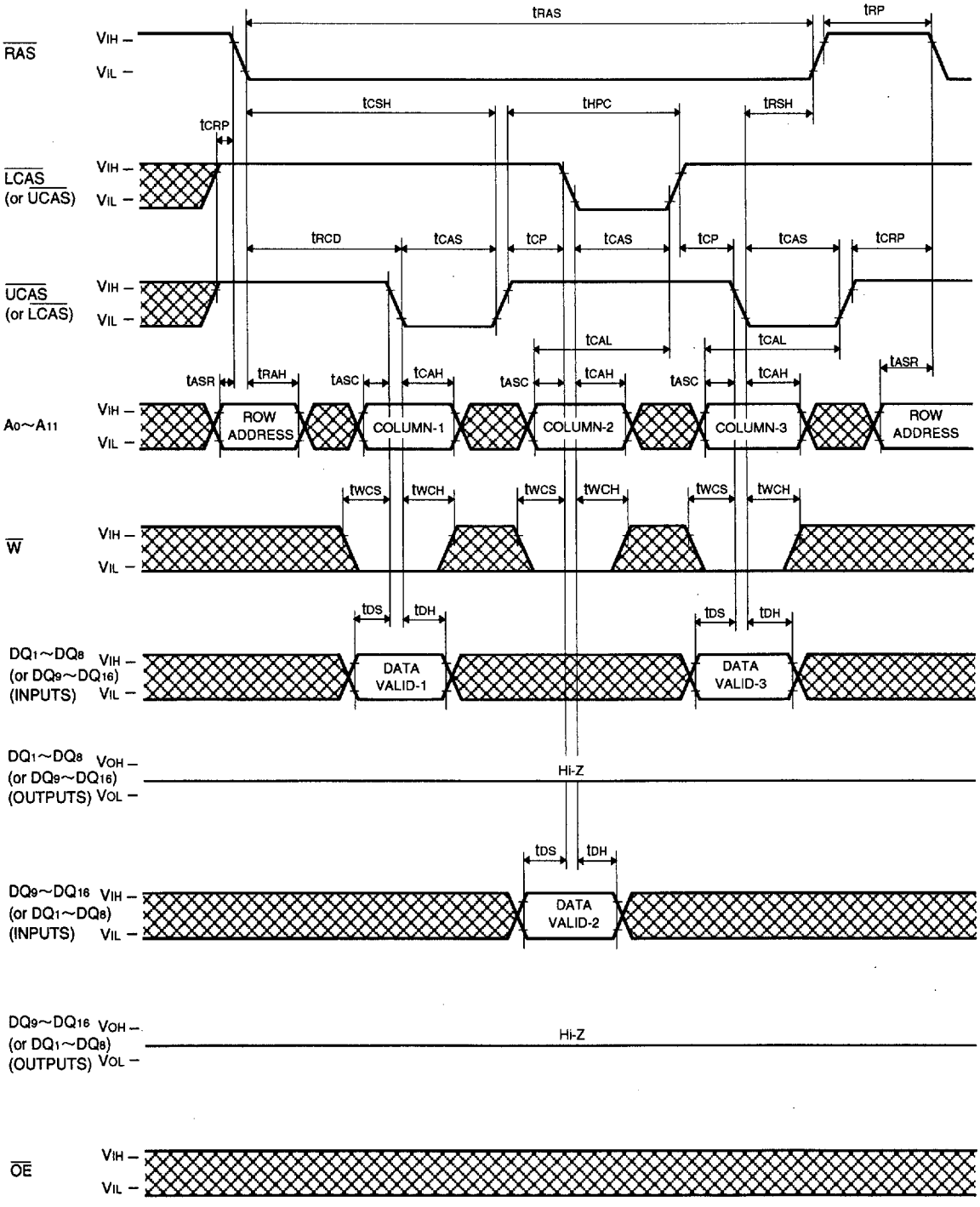
Hyper Page Mode Byte Read Cycle



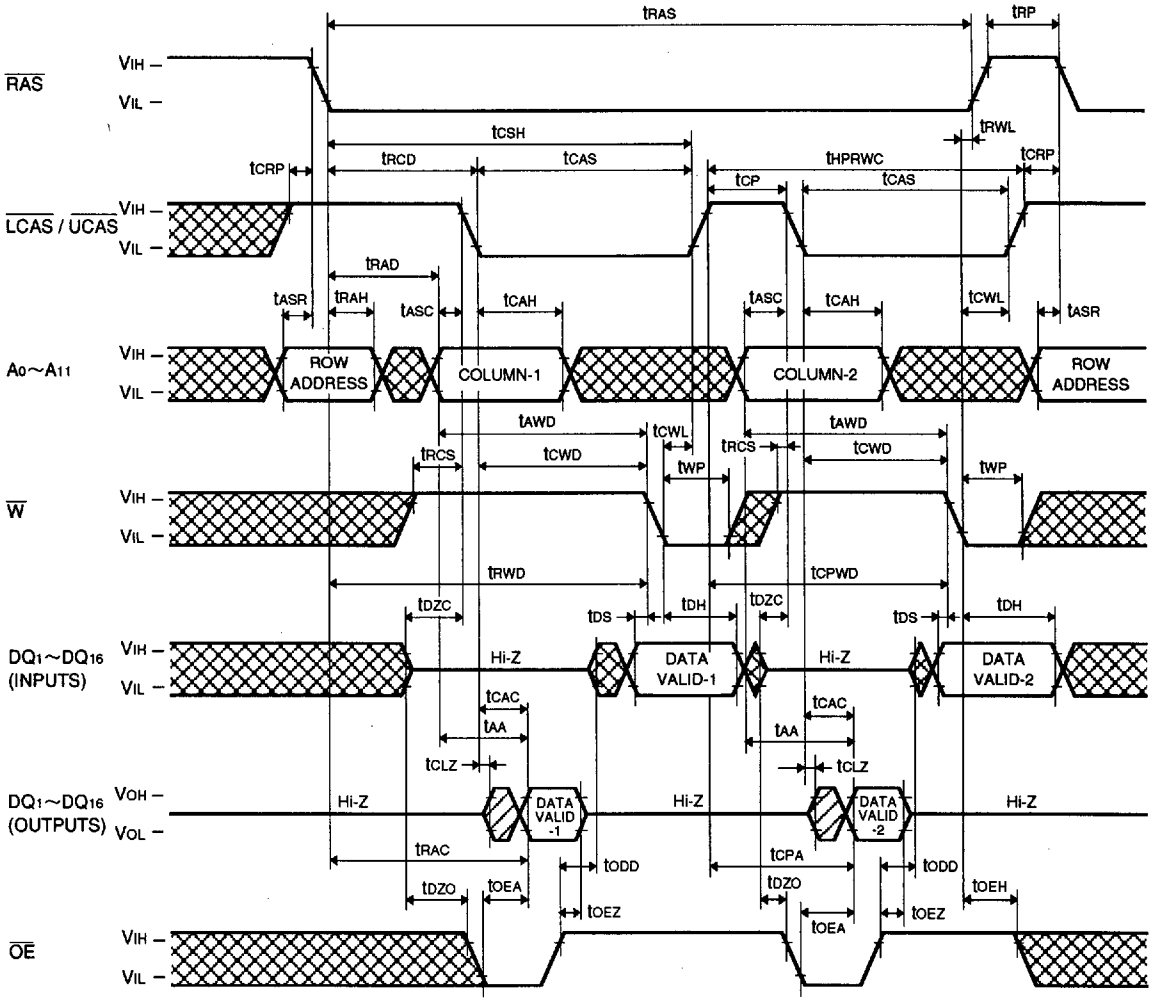
Hyper Page Mode Early Write Cycle



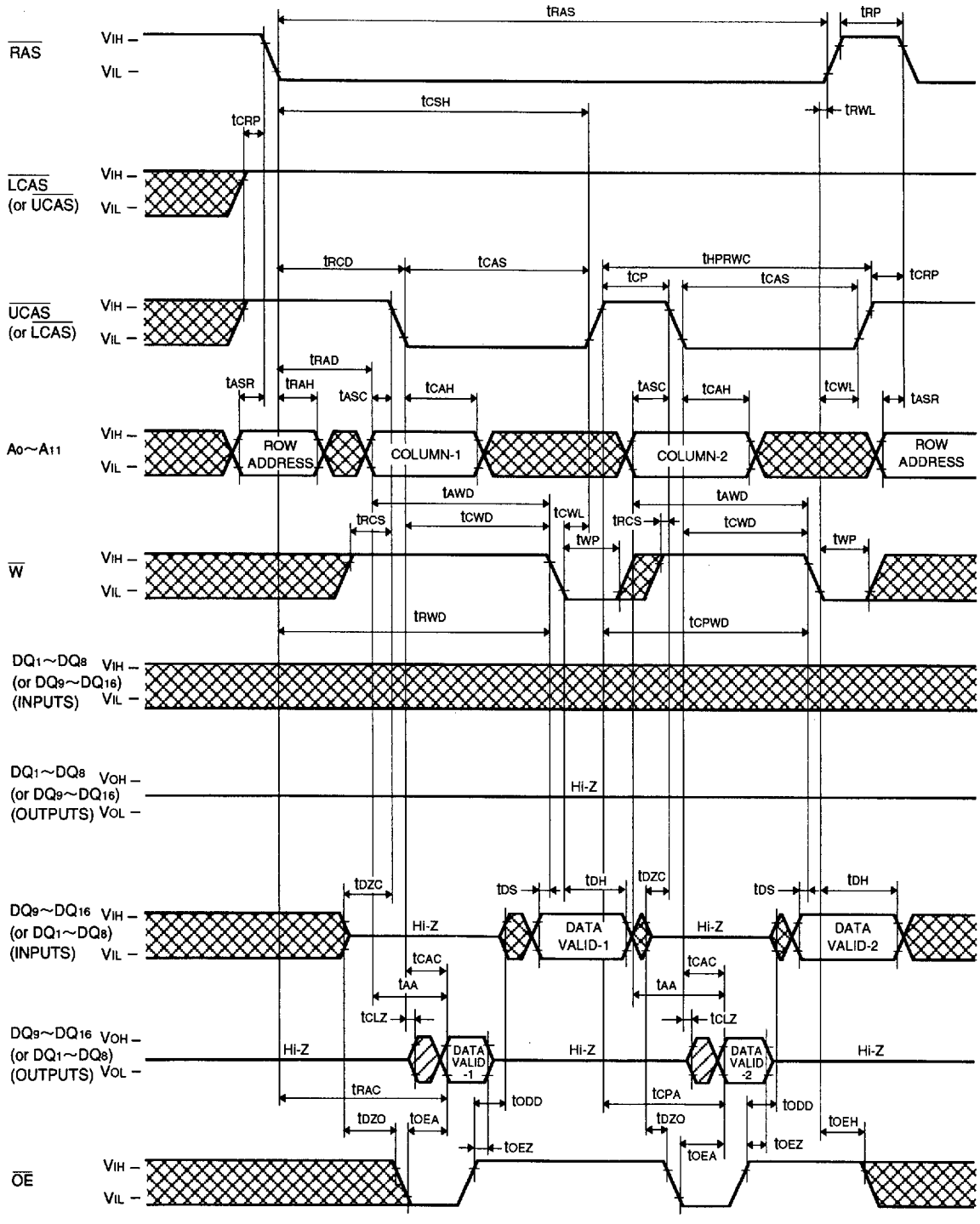
Hyper Page Mode Byte Early Write Cycle



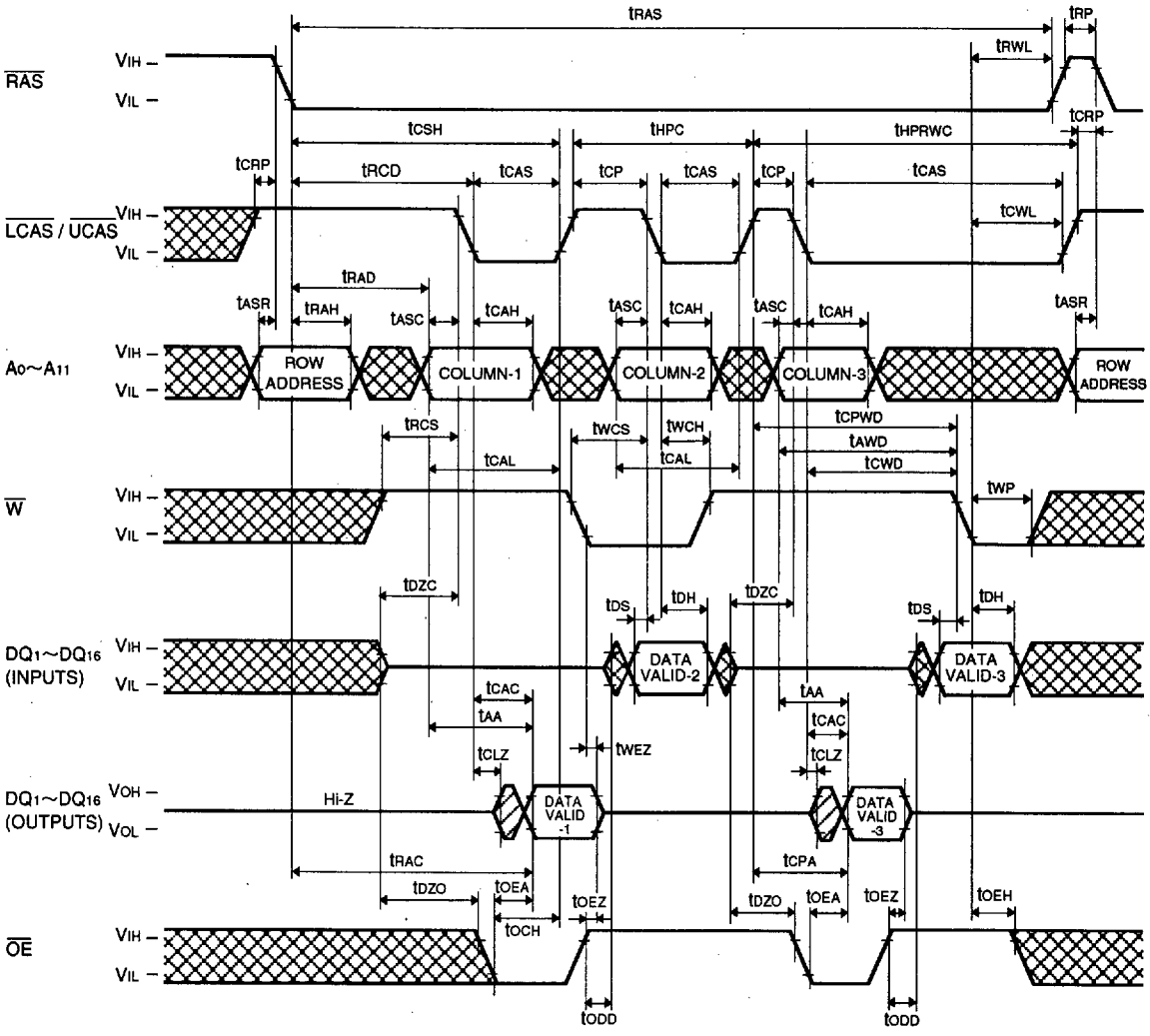
Hyper Page Mode Read-Write, Read-Modify-Write Cycle



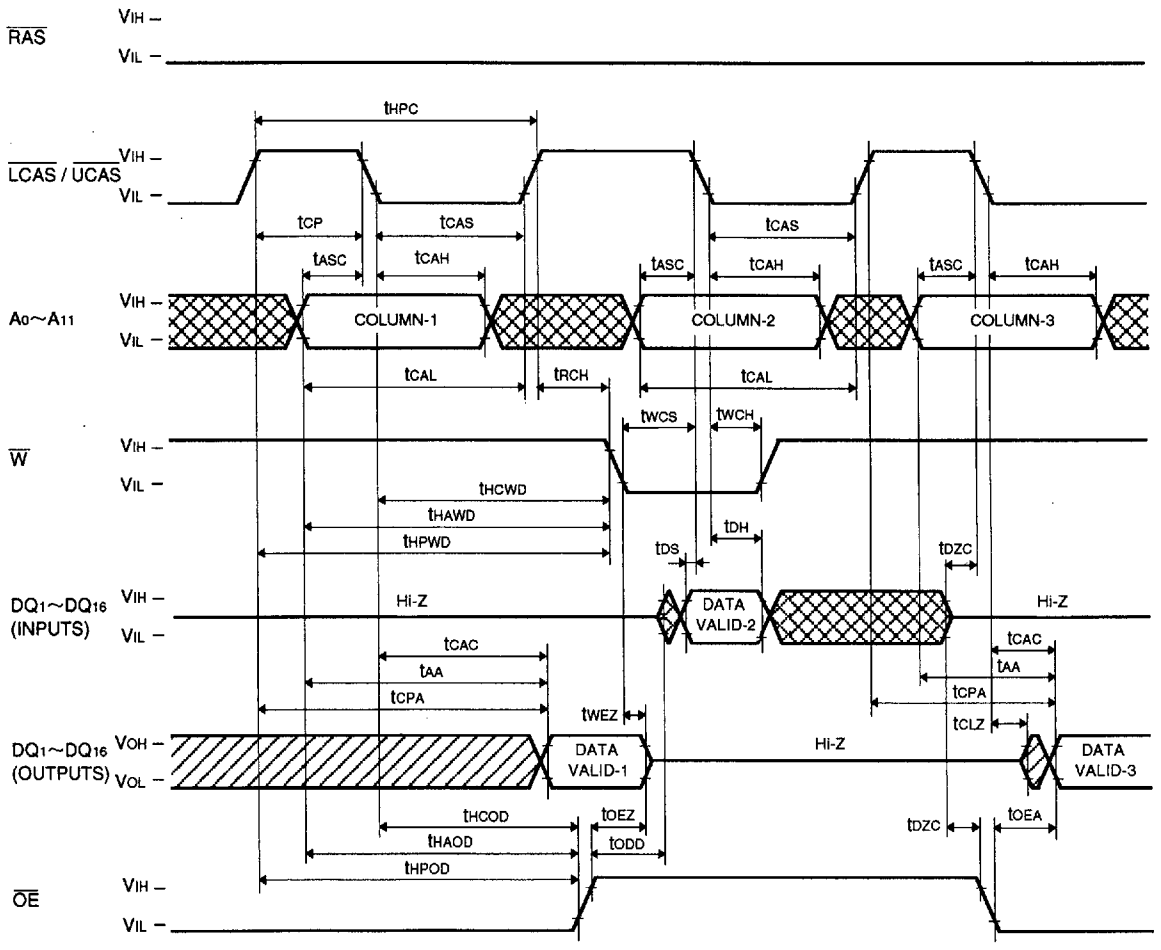
Hyper Page Mode Byte Read-Write, Read-Modify-Write Cycle



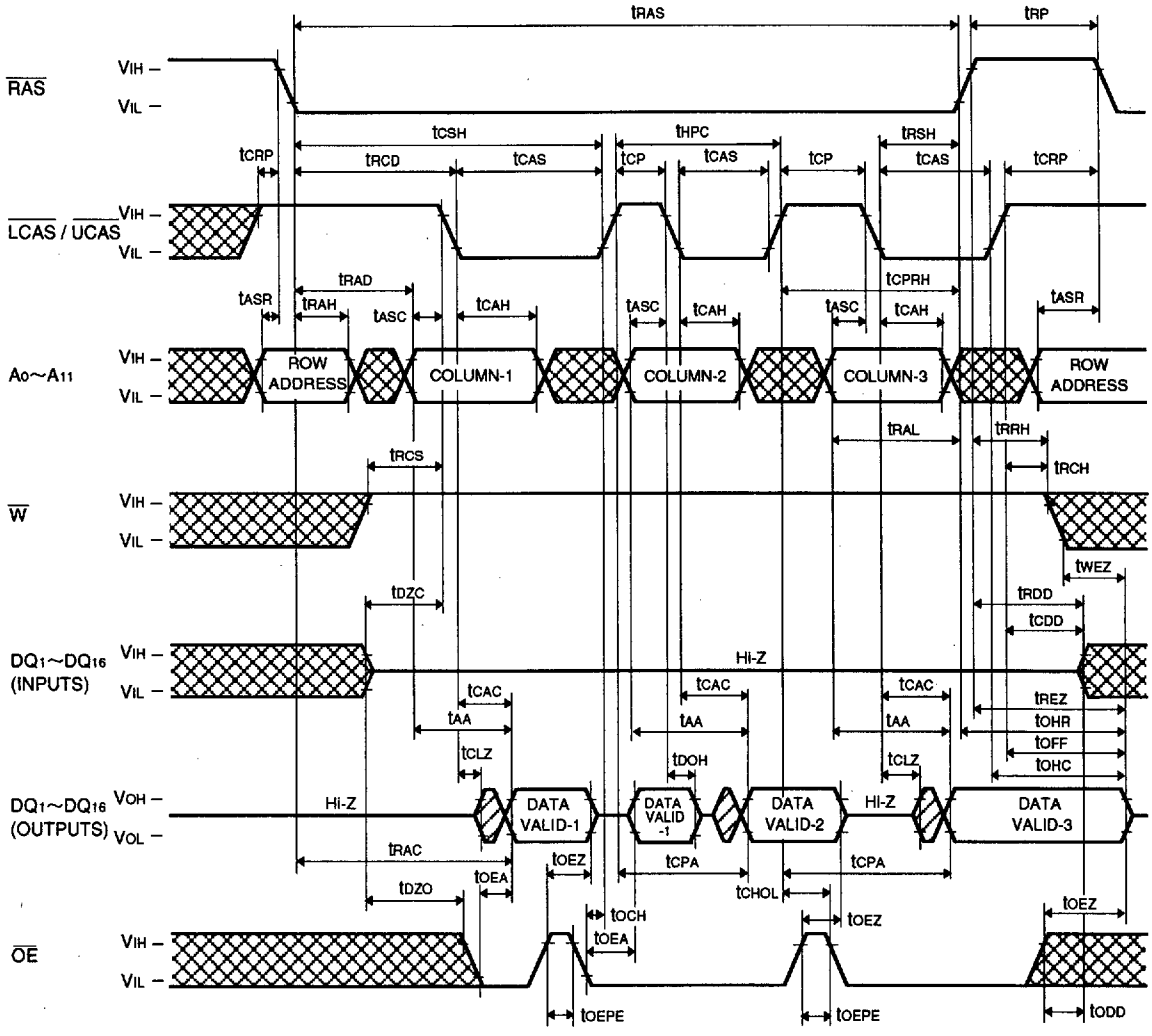
Hyper Page Mode Mix Cycle (1)



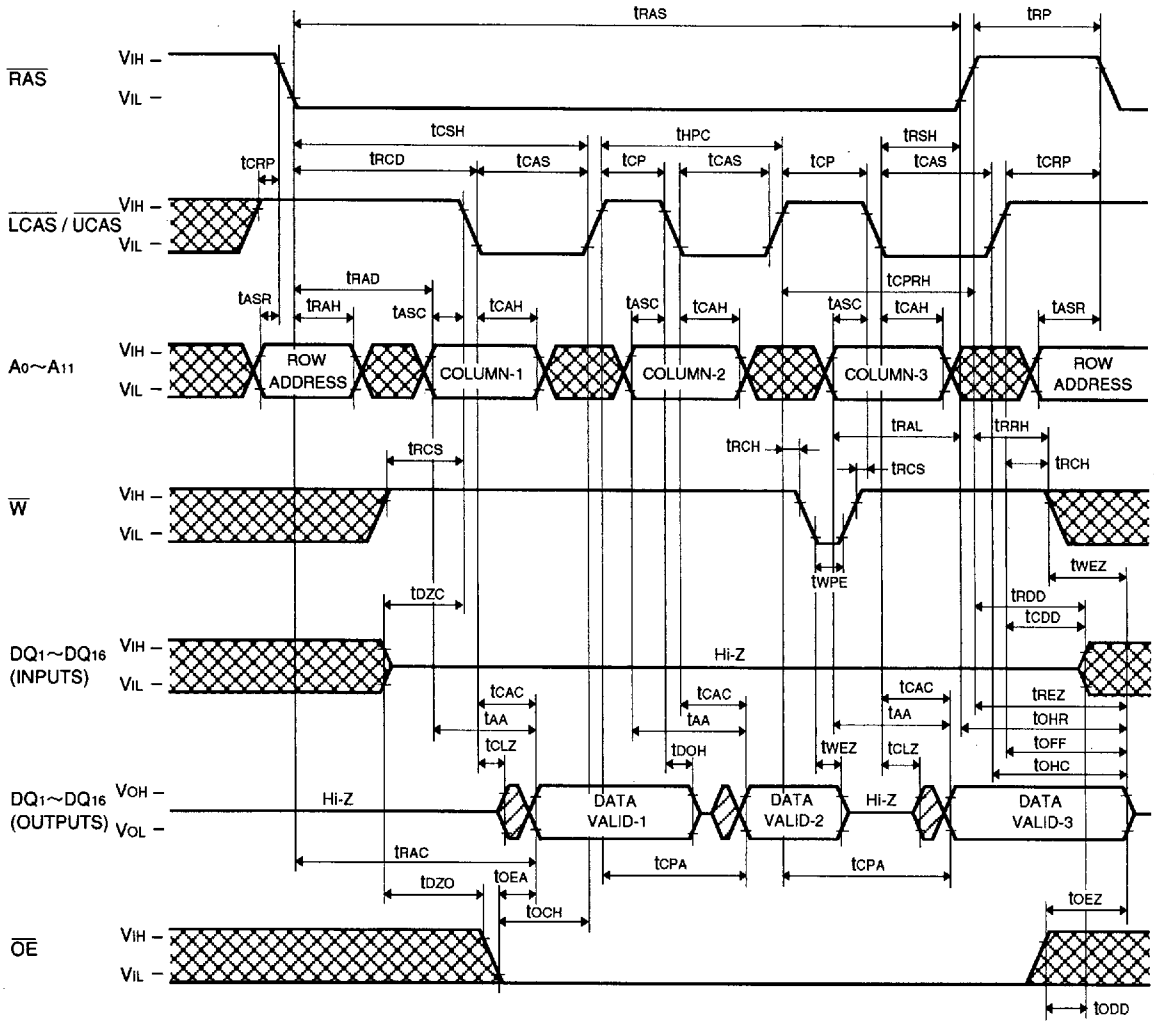
Hyper Page Mode Mix Cycle (2)



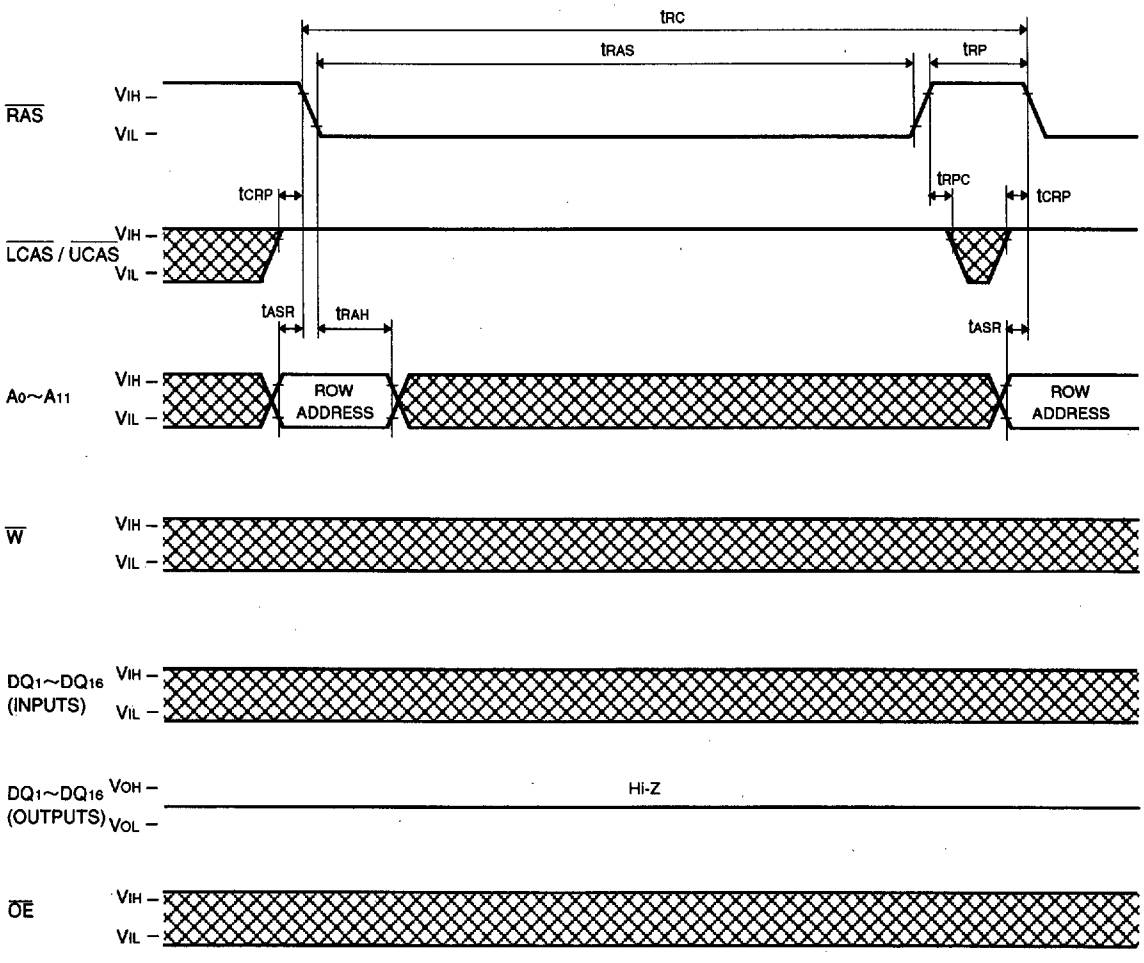
Hyper Page Mode Read Cycle (Hi-Z control by $\overline{OE}$)



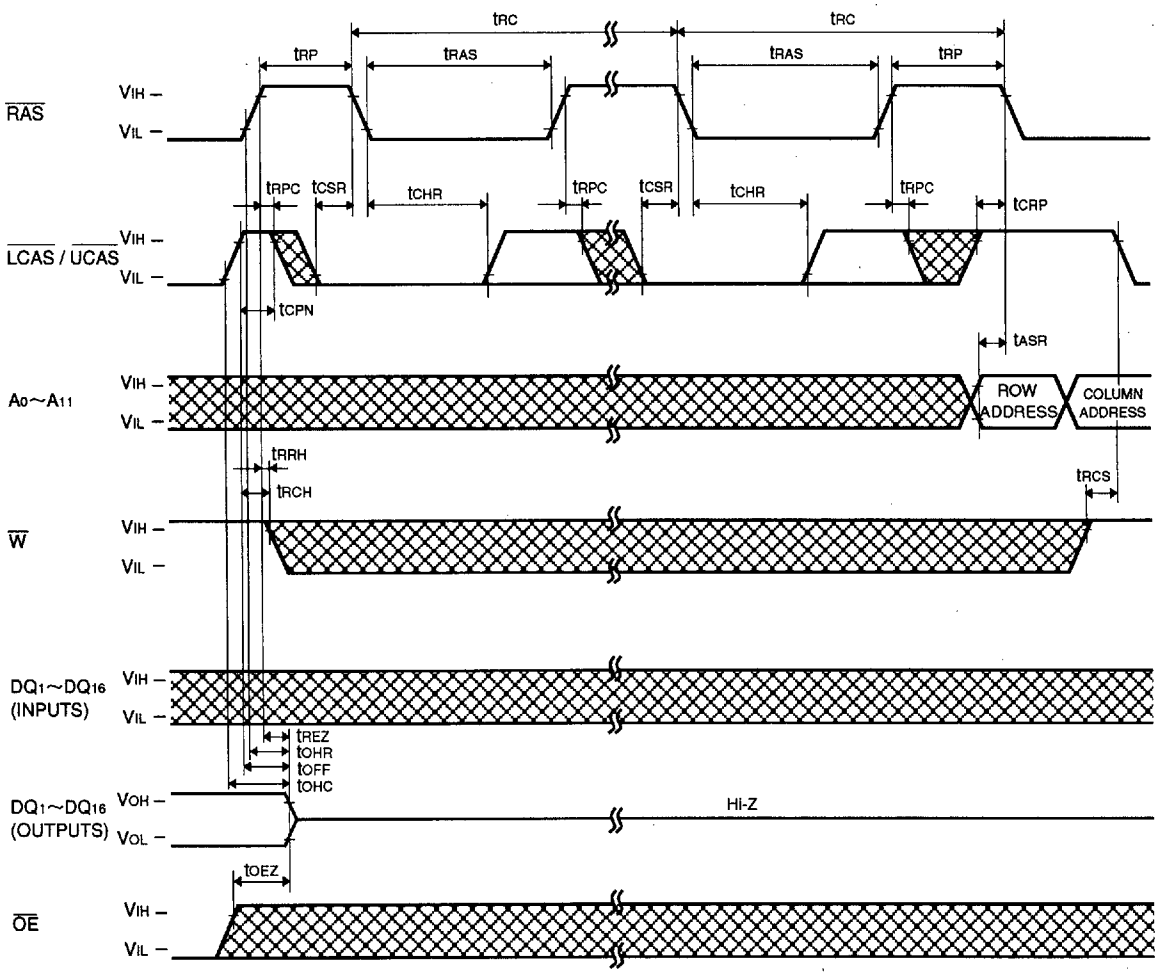
Hyper Page Mode Read Cycle (Hi-Z control by $\overline{W}$)



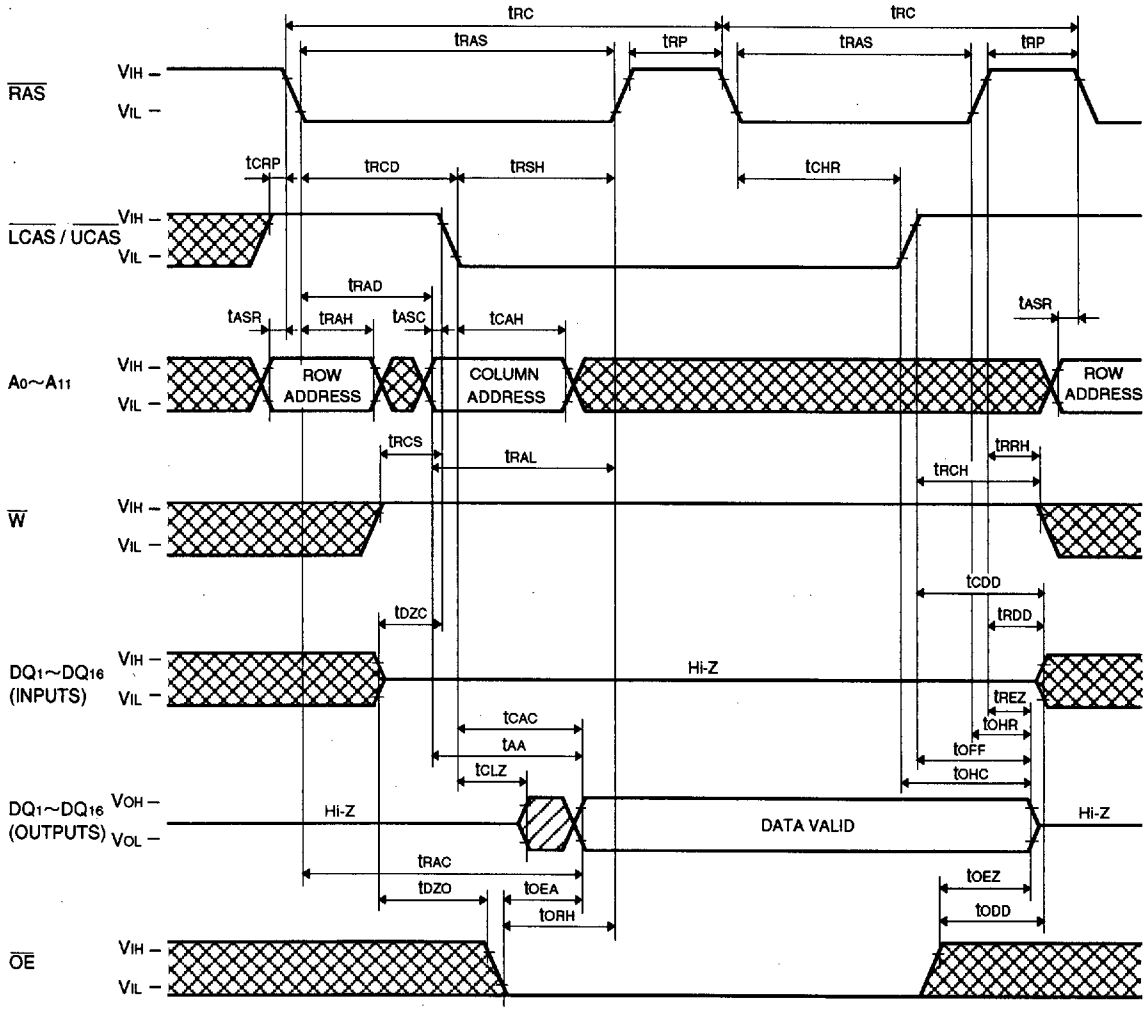
$\overline{\text{RAS}}$-only Refresh Cycle



$\overline{CAS}$ before $\overline{RAS}$ Refresh Cycle, Extended Refresh Cycle*

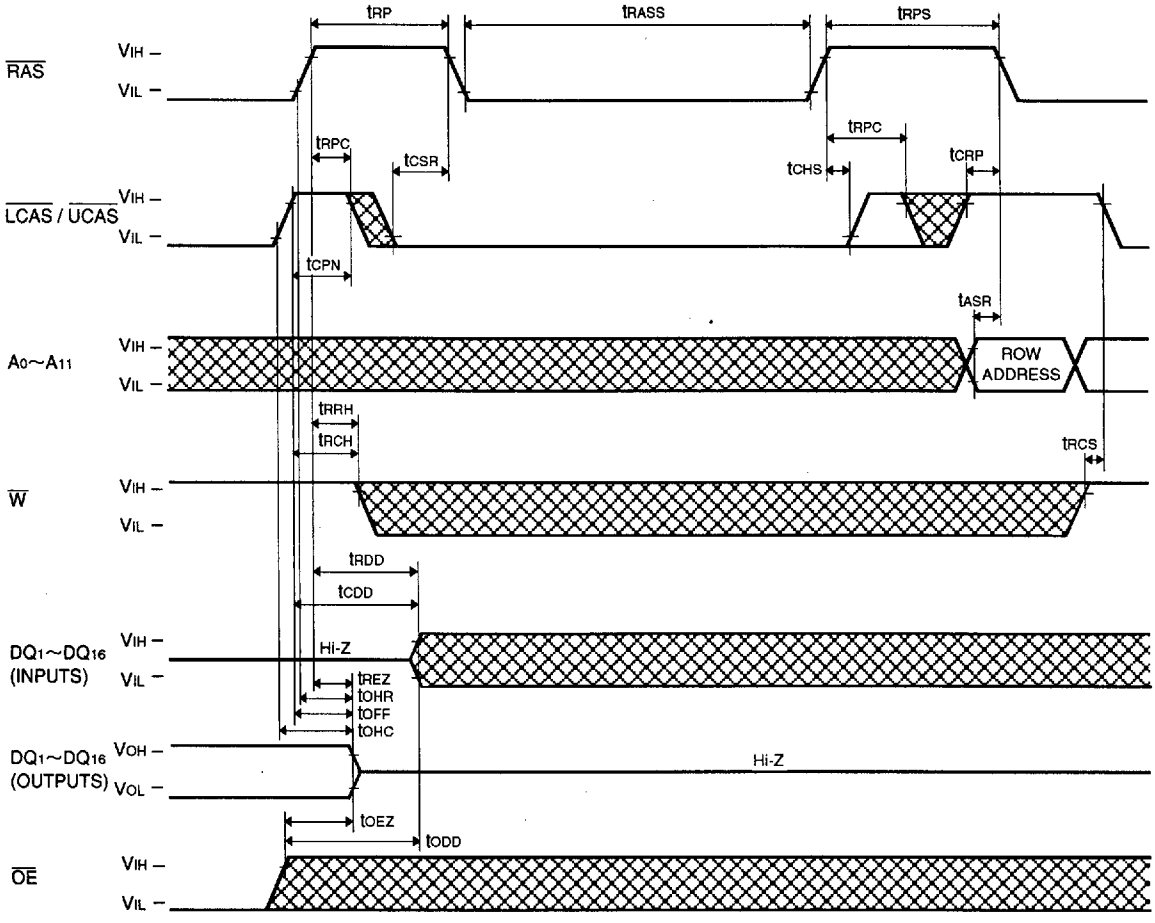


Hidden Refresh Cycle (Read) (Note 30)



Note 30: Early write, delayed write, read write or read modify write cycle is applicable instead of read cycle.
Timing requirements and output state are the same as that of each cycle shown above.

Self Refresh Cycle *



SELF REFRESH SPECIFICATIONS

Self refresh devices are denoted by "S" after speed item, like -6S/ -7S. The other characteristics and requirements than the below are same as normal devices.

ELECTRICAL CHARACTERISTICS (Ta=0~70℃, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted) (Note 2)

Symbol	Parameter		Test conditions	Limits			Unit
				Min	Typ	Max	
$I_{CC8(AV)}$	Average supply current from Vcc Extended refresh mode	M5M4V16165B (S)	$\overline{RAS}$ cycling $\overline{CAS}$≦0.2V or $\overline{CAS}$ before $\overline{RAS}$ refresh cycling $\overline{W}$≦0.2V or ≧Vcc-0.2V $\overline{OE}$≦0.2V or ≧Vcc-0.2V A_0~A_{11}≦0.2V or ≧Vcc-0.2V t_{REF}=128ms, output open t_{RAS}=t_{RASmin}~1 μs			400	μA
$I_{CC9(AV)}$	Average supply current from Vcc Self-refresh cycle	M5M4V16165B (S)	$\overline{RAS}$=$\overline{CAS}$≦0.2V			200	μA

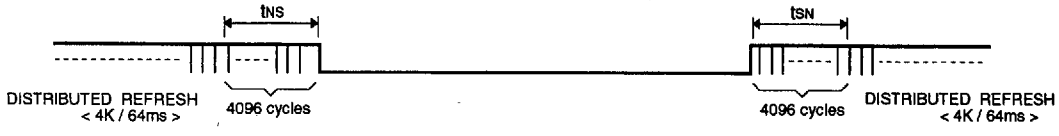
TIMING REQUIREMENTS (Ta=0~70℃, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted, see notes 13,14)

Symbol	Parameter	Limits				Unit
		M5M4V16165B-6S		M5M4V16165B-7S		
		Min	Max	Min	Max	
t_{RASS}	Self refresh $\overline{RAS}$ low pulse width	100		100		μs
t_{RPS}	Self refresh $\overline{RAS}$ high precharge time	110		130		ns
t_{CHS}	Self refresh $\overline{RAS}$ hold time	- 50		- 50		ns

SELF REFRESH ENTRY & EXIT CONDITIONS

(1) In case of distributed refresh

The last / first full refresh cycles (4K) must be made within t_{NS} / t_{SN} before / after self refresh, on the condition of t_{NS}≦64ms and t_{SN}≦64ms.



(2) In case of burst refresh

The last / first full refresh cycles (4K) must be made within t_{NS} / t_{SN} efore / after self refresh, on the condition of t_{NS} +t_{SN}≦64ms.