

# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

## DESCRIPTION

The MH16V64AWJ is 16777216-word x 64-bit dynamic ram module. This consist of sixteen industry standard 16M x 4 dynamic RAMs in SOJ and one industry standard EEPROM in TSSOP.

The mounting of SOJs and TSSOP on a card edge dual in-line package provides any application where high densities and large of quantities memory are required.

This is a socket-type memory module ,suitable for easy interchange or addition of module.

## FEATURES

| Type name    | /RAS access time (max.ns) | /CAS access time (max.ns) | Address access time (max.ns) | /OE access time (max.ns) | Cycle time (min.ns) | Power dissipation (typ.W) |
|--------------|---------------------------|---------------------------|------------------------------|--------------------------|---------------------|---------------------------|
| MH16V64AWJ-5 | 50                        | 13                        | 25                           | 13                       | 90                  | 4.80                      |
| MH16V64AWJ-6 | 60                        | 15                        | 30                           | 15                       | 110                 | 4.00                      |

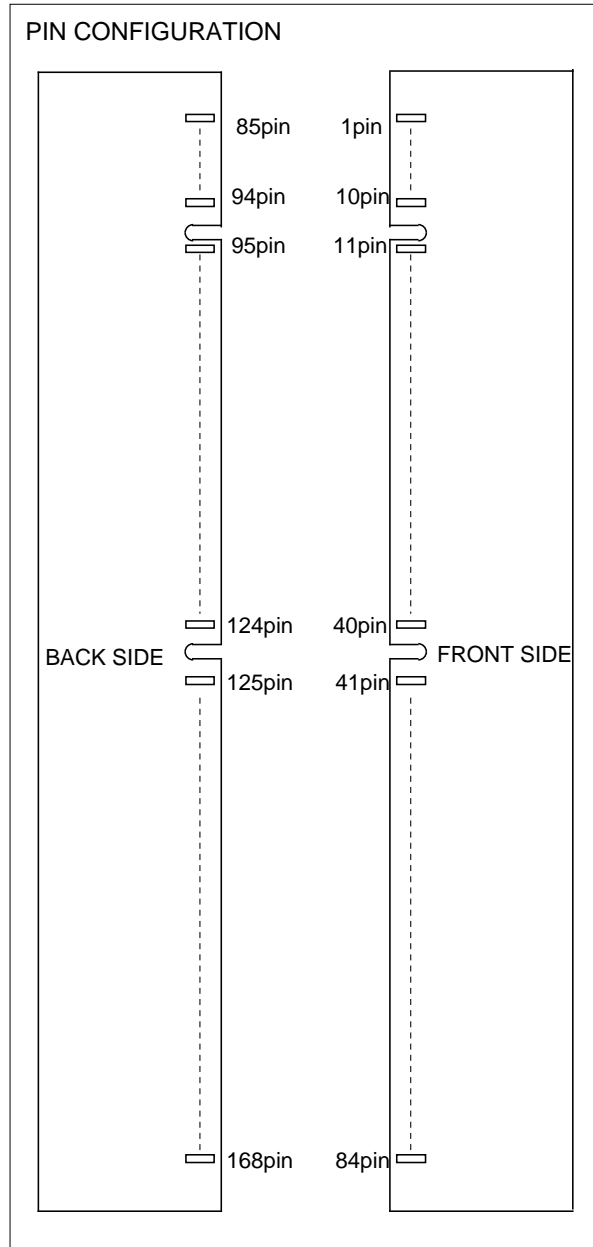
- Utilizes industry standard 16M x 4 RAMs in SOJ and industry standard EEPROM in TSSOP
- 168-pin (84-pin dual dual in-line package)
- Single +3.3V(±0.3V) supply operation
- Low stand-by power dissipation  
17.28mW(Max) . . . . . LVCMOS input level
- Low operation power dissipation  
MH16V64AWJ -5 . . . . . 5.76W(Max)  
MH16V64AWJ -6 . . . . . 5.19W(Max)
- All input are directly LVTTTL compatible
- All output are three-state and directly LVTTTL compatible
- Includes(0.22uF x 16) decoupling capacitors
- 4096 refresh cycle every 64ms
- Fast-page mode,Read-modify-write,  
/CAS before /RAS refresh,Hidden refresh capabilities
- Gold plating contact pads

|                |          |
|----------------|----------|
| Row Address    | A0 ~ A12 |
| Column Address | A0 ~ A10 |

## APPLICATION

Main memory unit for computers , Microcomputer memory

## PIN CONFIGURATION



**MH16V64AWJ -5, -6**

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

**PIN CONFIGURATION**

| Pin No. | Pin Name | Pin No. | Pin Name | Pin No. | Pin Name | Pin No. | Pin Name |
|---------|----------|---------|----------|---------|----------|---------|----------|
| 1       | Vss      | 43      | Vss      | 85      | Vss      | 127     | Vss      |
| 2       | DQ0      | 44      | /OE2     | 86      | DQ32     | 128     | DU       |
| 3       | DQ1      | 45      | /RAS2    | 87      | DQ33     | 129     | NC       |
| 4       | DQ2      | 46      | /CAS2    | 88      | DQ34     | 130     | /CAS6    |
| 5       | DQ3      | 47      | /CAS3    | 89      | DQ35     | 131     | /CAS7    |
| 6       | Vcc      | 48      | /WE2     | 90      | Vcc      | 132     | DU       |
| 7       | DQ4      | 49      | Vcc      | 91      | DQ36     | 133     | Vcc      |
| 8       | DQ5      | 50      | NC       | 92      | DQ37     | 134     | NC       |
| 9       | DQ6      | 51      | NC       | 93      | DQ38     | 135     | NC       |
| 10      | DQ7      | 52      | NC       | 94      | DQ39     | 136     | NC       |
| 11      | DQ8      | 53      | NC       | 95      | DQ40     | 137     | NC       |
| 12      | Vss      | 54      | Vss      | 96      | Vss      | 138     | Vss      |
| 13      | DQ9      | 55      | DQ16     | 97      | DQ41     | 139     | DQ48     |
| 14      | DQ10     | 56      | DQ17     | 98      | DQ42     | 140     | DQ49     |
| 15      | DQ11     | 57      | DQ18     | 99      | DQ43     | 141     | DQ50     |
| 16      | DQ12     | 58      | DQ19     | 100     | DQ44     | 142     | DQ51     |
| 17      | DQ13     | 59      | Vcc      | 101     | DQ45     | 143     | Vcc      |
| 18      | Vcc      | 60      | DQ20     | 102     | Vcc      | 144     | DQ52     |
| 19      | DQ14     | 61      | NC       | 103     | DQ46     | 145     | NC       |
| 20      | DQ15     | 62      | DU       | 104     | DQ47     | 146     | DU       |
| 21      | NC       | 63      | NC       | 105     | NC       | 147     | NC       |
| 22      | NC       | 64      | Vss      | 106     | NC       | 148     | Vss      |
| 23      | Vss      | 65      | DQ21     | 107     | Vss      | 149     | DQ53     |
| 24      | NC       | 66      | DQ22     | 108     | NC       | 150     | DQ54     |
| 25      | NC       | 67      | DQ23     | 109     | NC       | 151     | DQ55     |
| 26      | Vcc      | 68      | Vss      | 110     | Vcc      | 152     | Vss      |
| 27      | /WE0     | 69      | DQ24     | 111     | DU       | 153     | DQ56     |
| 28      | /CAS0    | 70      | DQ25     | 112     | /CAS4    | 154     | DQ57     |
| 29      | /CAS1    | 71      | DQ26     | 113     | /CAS5    | 155     | DQ58     |
| 30      | /RAS0    | 72      | DQ27     | 114     | NC       | 156     | DQ59     |
| 31      | /OE0     | 73      | Vcc      | 115     | DU       | 157     | Vcc      |
| 32      | Vss      | 74      | DQ28     | 116     | Vss      | 158     | DQ60     |
| 33      | A0       | 75      | DQ29     | 117     | A1       | 159     | DQ61     |
| 34      | A2       | 76      | DQ30     | 118     | A3       | 160     | DQ62     |
| 35      | A4       | 77      | DQ31     | 119     | A5       | 161     | DQ63     |
| 36      | A6       | 78      | Vss      | 120     | A7       | 162     | Vss      |
| 37      | A8       | 79      | NC       | 121     | A9       | 163     | NC       |
| 38      | A10      | 80      | NC       | 122     | A11      | 164     | NC       |
| 39      | A12      | 81      | NC       | 123     | NC       | 165     | SA0      |
| 40      | Vcc      | 82      | SDA      | 124     | Vcc      | 166     | SA1      |
| 41      | Vcc      | 83      | SCL      | 125     | DU       | 167     | SA2      |
| 42      | DU       | 84      | Vcc      | 126     | DU       | 168     | Vcc      |

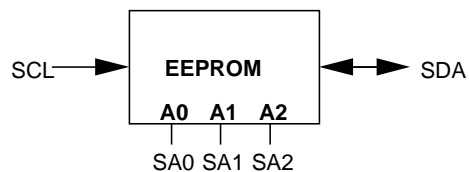
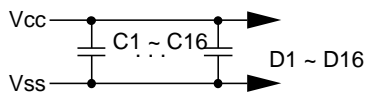
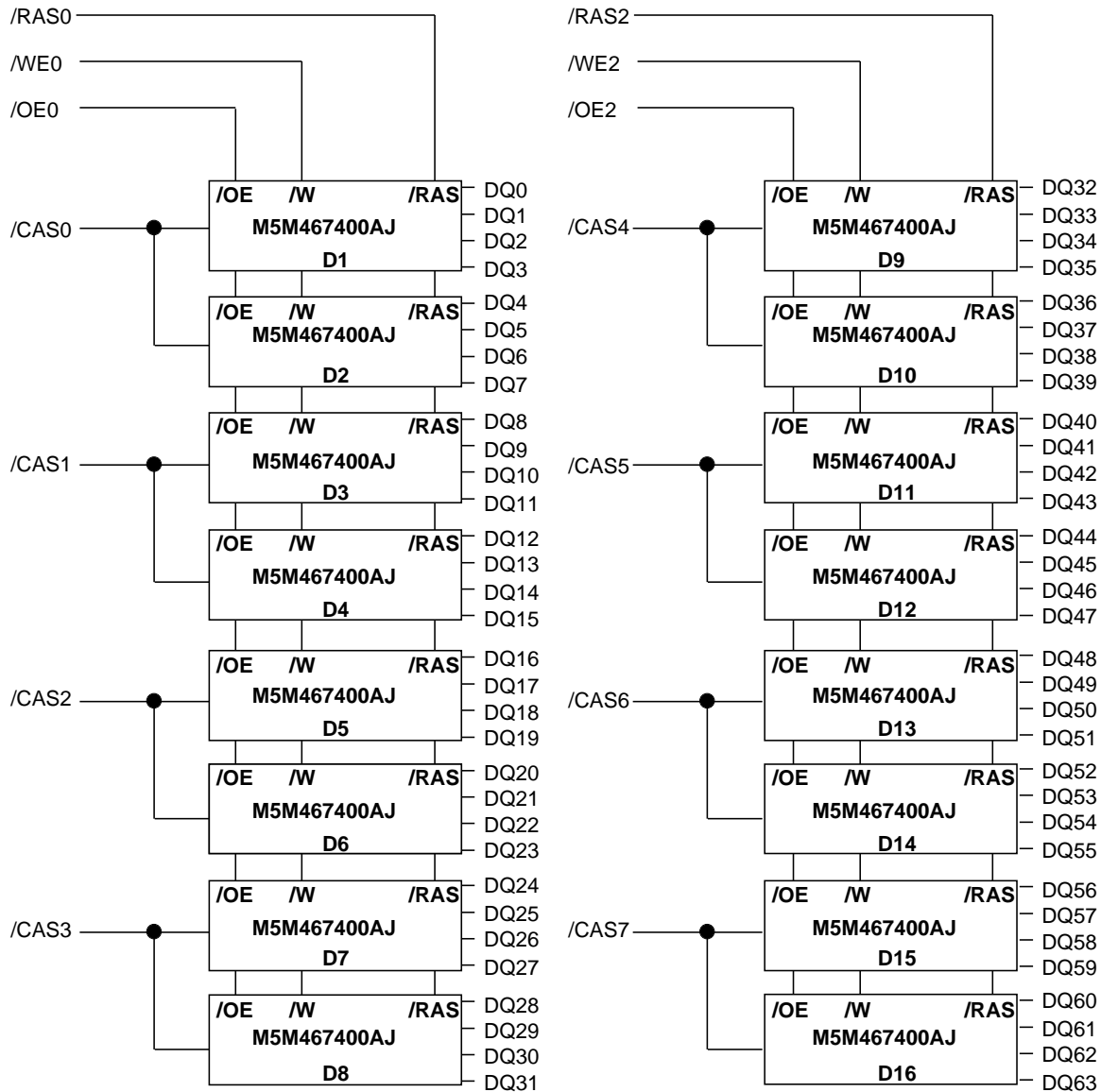
NC: No Connect

DU: Don't Use

# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

## BLOCK DIAGRAM



**Serial Presence Detect TABLE**

| Bytes   | Function described                                       | SPD entry data   | SPD DATA entry(Hex)                    |
|---------|--|------------------|--|
| 0       | Defines # bytes written into serial memory at module mfg | 128              | 80                                     |
| 1       | Total # bytes of SPD memory device                       | 256 Bytes        | 08                                     |
| 2       | Fundamental memory type                                  | FPM DRAM         | 01                                     |
| 3       | # Row Addresses on this assembly                         | A0-A12           | 0D                                     |
| 4       | # Column Addresses on this assembly                      | A0-A10           | 0B                                     |
| 5       | # Module Banks on this assembly                          | 1bank            | 01                                     |
| 6       | Data Width of this assembly...                           | x64              | 40                                     |
| 7       | ... Data Width continuation                              | 0                | 00                                     |
| 8       | Voltage interface standard of this assembly              | 3.3V LVTTTL      | 02                                     |
| 9       | RAS# access time of this assembly                        | -5 50ns          | 32                                     |
|         |  | -6 60ns          | 3C                                     |
| 10      | CAS# access time of this assembly                        | -5 13ns          | 0D                                     |
|         |  | -6 15ns          | 0F                                     |
| 11      | DIMM Configuration type (Non-parity,Parity,ECC)          | non parity       | 00                                     |
| 12      | Refresh Rate/Type  | N/R(15.625uS)    | 00                                     |
| 13      | DRAM width,Primary DRAM                                  | X4               | 04                                     |
| 14      | Error Checking DRAM data width                           | N/A              | 00                                     |
| 15-31   | Reserved for future offerings                            | open             | 00                                     |
| 32-61   | Superset Memory type(may be used in future)              | open             | 00                                     |
| 62      | SPD Data Revision Code                                   | Rev 1            | 01                                     |
| 63      | Checksum for bytes 0-62                                  | Check sum for -5 | 28                                     |
|         |  | Check sum for -6 | 34                                     |
| 64-71   | Manufacturers JEDEC ID code per JEP-106                  | MITSUBISHI       | 1CFFFFFFFFFFFFFF                       |
| 72      | Manufacturing location                                   | Miyoshi,Japan    | 01                                     |
|         |  | Tajima,Japan     | 02                                     |
|         |  | NC,USA           | 03                                     |
|         |  | Germany          | 04                                     |
| 73-90   | Manufacturer's Part Number                               | MH16V64AWJ-5     | 4D48313656363441574A2D352D352020202020 |
|         |  | MH16V64AWJ-6     | 4D48313656363441574A2D362D362020202020 |
| 91-92   | Revision Code  | PCB revision     | rrrr                                   |
| 93-94   | Manufacturing date                                       | year/week code   | yy/ww                                  |
| 95-98   | Assembly Serial Number                                   | serial number    | ssssssss                               |
| 99-125  | Manufacturer Specific Data                               | open             | 00                                     |
| 126-127 | Reserved   | open             | 00                                     |
| 128-255 | Open User Free-Form area not defined                     | open             | 00                                     |

# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

## FUNCTION

The MH16V64AWJ provide, in addition to normal read, write, and read-modify-write operations,

a number of other functions, e.g., Fsat page mode, /CAS before /RAS 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 |        | Refresh | Remark                   |
|--------------------------|--------|------|-----|-----|-------------|----------------|--------------|--------|---------|--------------------------|
|                          | /RAS   | /CAS | /W  | /OE | Row address | Column address | Input        | Output |         |                          |
| Read                     | ACT    | ACT  | NAC | ACT | APD         | APD            | OPN          | VLD    | YES     | Fast page mode identical |
| Write (Early write)      | ACT    | ACT  | ACT | DNC | APD         | APD            | VLD          | OPN    | YES     |                          |
| Write (Delayed write)    | ACT    | ACT  | ACT | DNC | APD         | APD            | VLD          | IVD    | YES     |                          |
| Read-modify-write        | ACT    | ACT  | ACT | ACT | APD         | APD            | VLD          | VLD    | YES     |                          |
| Hidden refresh           | ACT    | ACT  | DNC | ACT | DNC         | DNC            | OPN          | VLD    | YES     |                          |
| /CAS before /RAS refresh | ACT    | ACT  | NAC | DNC | DNC         | DNC            | DNC          | OPN    | YES     |                          |
| Standby                  | NAC    | DNC  | DNC | DNC | DNC         | DNC            | DNC          | OPN    | NO      |                          |

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

# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter             | Conditions          | Ratings   | Unit |
|--------|-----------------------|---------------------|-----------|------|
| Vcc    | Supply voltage        | With respect to Vss | -0.5~ 4.6 | V    |
| IO     | Output current        |                     | 50        | mA   |
| Pd     | Power dissipation     | Ta=25°C             | 16        | W    |
| Topr   | Operating temperature |                     | 0~70      | °C   |
| Tstg   | Storage temperature   |                     | -40~125   | °C   |

## RECOMMENDED OPERATING CONDITIONS

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

| Symbol | Parameter                            | Limits |     |         | Unit |
|--------|--------------------------------------|--------|-----|---------|------|
|        |                                      | Min    | Nom | Max     |      |
| Vcc    | Supply voltage                       | 3.0    | 3.3 | 3.6     | V    |
| Vss    | Supply voltage                       | 0      | 0   | 0       | V    |
| VIH    | High-level input voltage, all inputs | 2.0    |     | Vcc+0.3 | V    |
| VIL    | Low-level input voltage              | -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  |      |
| VOH       | High-level output voltage   | IOH=-2.0mA  | 2.4    |     | Vcc  | V    |
| VOL       | Low-level output voltage  | IOL=2.0mA   | 0      |     | 0.4  | V    |
| IOZ       | Off-state output current  | Q floating 0V VOUT Vcc  | -10    |     | 10   | µA   |
| II        | Input current (except /CAS)   | 0V VIN Vcc+0.3, Other input pins=0V                             | -160   |     | 160  | µA   |
| II (CAS)  | Input current (/CAS)  | 0V VIN Vcc+0.3, Other input pins=0V                             | -20    |     | 20   | µA   |
| ICC1 (AV) | Average supply current from Vcc operating<br>(Note 3,4,5)                   | - 5 /RAS, /CAS cycling<br>tRC=tWC=min.<br>output open           |        |     | 1600 | mA   |
|           |   |   |        |     | 1440 |      |
| ICC2      | Supply current from Vcc, stand-by   | /RAS=/CAS =VIH, output open                                     |        |     | 16   | mA   |
|           |   | /RAS=/CAS=WE Vcc -0.2, output open                              |        |     | 8    |      |
| ICC4(AV)  | Average supply current from Vcc Hyper-Page-Mode<br>(Note 3,4,5)             | - 5 /RAS=VIL,/CAS cycling<br>tPC=min.<br>output open            |        |     | 1440 | mA   |
|           |   |   |        |     | 1280 |      |
| ICC6(AV)  | Average supply current from Vcc /CAS before /RAS refresh mode<br>(Note 3,5) | - 5 /CAS before /RAS refresh cycling<br>tRC=min.<br>output open |        |     | 2080 | mA   |
|           |   |   |        |     | 1920 |      |

Note 2: Current flowing into an IC is positive, out is negative.

3: Icc1 (AV), Icc4 (AV) and Icc6 (AV) are dependent on cycle rate. Maximum current is measured at the fastest cycle rate.

4: Icc1 (AV) and Icc4 (AV) are dependent on output loading. Specified values are obtained with the output open.

5: Under condition of column address being changed once or less while /RAS=VIL and /CAS=VIH

## CAPACITANCE (Ta = 0~70°C, Vcc = 3.3V±0.3V, Vss = 0V, unless otherwise noted)

| Symbol    | Parameter                            | Test conditions                | Limits |     |     | Unit |
|-----------|--------------------------------------|--------------------------------|--------|-----|-----|------|
|           |                                      |                                | Min    | Typ | Max |      |
| CI (/CAS) | Input capacitance, /CAS input        | VI=Vss<br>f=1MHZ<br>Vi=25mVrms |        |     | 20  | pF   |
| CI        | Input capacitance, except /CAS input |                                |        |     | 130 | pF   |
| C(DQ)     | Input/Output capacitance, DATA       |                                |        |     | 22  | pF   |
| C(SCL)    | Input capacitance, SPD clock         |                                |        |     | 7   | pF   |
| C(SDA)    | Input/Output capacitance, SPD DATA   |                                |        |     | 7   | pF   |
| C(SA0-3)  | Input capacitance, SPD address       |                                |        |     | 7   | pF   |

# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

## SWITCHING CHARACTERISTICS (Ta=0~70°C, Vcc=3.3V±0.3V, Vss=0V, unless otherwise noted, see notes 6,13,14)

| Symbol | Parameter                                     | Limits |     |     |     | Unit |
|--------|---|--------|-----|-----|-----|------|
|        |   | - 5    |     | - 6 |     |      |
|        |   | Min    | Max | Min | Max |      |
| tCAC   | Access time from /CAS (Note 7,8)              |        | 13  |     | 15  | ns   |
| tRAC   | Access time from /RAS (Note 7,9)              |        | 50  |     | 60  | ns   |
| tAA    | Column address access time (Note 7,10)        |        | 25  |     | 30  | ns   |
| tCPA   | Access time from /CAS precharge (Note 7,11)   |        | 30  |     | 35  | ns   |
| tOEA   | Access time from /OE (Note 7)                 |        | 13  |     | 15  | ns   |
| tCLZ   | Output low impedance time /CAS low (Note 7)   | 5      |     | 5   |     | ns   |
| tOEZ   | Output disable time after /OE high (Note 12)  |        | 13  |     | 15  | ns   |
| tOFF   | Output disable time after /CAS high (Note 12) |        | 13  |     | 15  | ns   |

Note 6: An initial pause of 500us is required after power-up followed by a minimum of eight initialization cycles (any combination of cycles containing /CAS before /RAS refresh).

Note the /RAS may be cycled during the initial pause. And any 8 /RAS or /RAS /CAS cycles are required after prolonged periods (greater than 64 ms) of /RAS inactivity before proper device operation is achieved.

7: Measured with a load circuit equivalent to 1 TTL load and 100pF, VOH=2.4V (IOH=-2mA) and VOL=0.4V (IOL=-2mA).

The reference levels for measuring of output signals are 2.0V (VOH) and 0.8V (VOL).

8: Assumes that tRCD tRCD(max), tASC tASC(max) and tCP tCP(max).

9: Assumes that tRCD tRCD(max) and tRAD tRAD(max). If tRCD or tRAD is greater than the maximum recommended value shown in this table, tRAC will increase by amount that tRCD exceeds the value shown.

10: Assumes that tRAD tRAD(max) and tASC tASC(max).

11: Assumes that tCP tCP(max) and tASC tASC(max).

12: tOEZ (max) and tOFF(max) defines the time at which the output achieves the high impedance state (IOUT I ± 10uA I) and is not reference to VOH(min) or VOL(max).

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

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

| Symbol | Parameter  | Limits |     |     |     | Unit |
|--------|--|--------|-----|-----|-----|------|
|        |  | -5     |     | -6  |     |      |
|        |  | Min    | Max | Min | Max |      |
| tREF   | Refresh cycle time                                 |        | 64  |     | 64  | ms   |
| tRP    | /RAS high pulse width                              | 30     |     | 40  |     | ns   |
| tRCD   | Delay time, /RAS low to /CAS low (Note15)          | 18     | 37  | 20  | 45  | ns   |
| tCRP   | Delay time, /CAS high to /RAS low                  | 5      |     | 10  |     | ns   |
| tRPC   | Delay time, /RAS high to /CAS low                  | 0      |     | 0   |     | ns   |
| tCPN   | /CAS high pulse width                              | 10     |     | 10  |     | ns   |
| tRAD   | Column address delay time from /RAS low (Note16)   | 13     | 25  | 15  | 30  | ns   |
| tASR   | Row address setup time before /RAS low             | 0      |     | 0   |     | ns   |
| tASC   | Column address setup time before /CAS low (Note17) | 0      | 5   | 0   | 10  | ns   |
| tRAH   | Row address hold time after /RAS low               | 8      |     | 10  |     | ns   |
| tCAH   | Column address hold time after /CAS low            | 13     |     | 15  |     | ns   |
| tDZC   | Delay time, data to /CAS low (Note18)              | 0      |     | 0   |     | ns   |
| tDZO   | Delay time, data to /OE low (Note18)               | 0      |     | 0   |     | ns   |
| tCDD   | Delay time, /CAS high to data (Note19)             | 13     |     | 15  |     | ns   |
| tODD   | Delay time, /OE high to data (Note19)              | 13     |     | 15  |     | ns   |
| tT     | Transition time (Note20)                           | 1      | 50  | 1   | 50  | ns   |

Note 13: The timing requirements are assumed tT =5ns.

14: VIH(min) and VIL(max) are reference levels for measuring timing of input signals. VIH(min) and VIL(max) of the switching characteristics are 2.0V and 0.8V respectively.

15: 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.

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

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

18: Either tDZC or tDZO must be satisfied.

19: Either tCDD or tODD must be satisfied.

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

**Read and Refresh Cycles**

| Symbol | Parameter                               | Limits |       |     |       | Unit |
|--------|---|--------|-------|-----|-------|------|
|        |   | -5     |       | -6  |       |      |
|        |   | Min    | Max   | Min | Max   |      |
| tRC    | Read cycle time                         | 90     |       | 110 |       | ns   |
| tRAS   | /RAS low pulse width                    | 50     | 10000 | 60  | 10000 | ns   |
| tCAS   | /CAS low pulse width                    | 15     | 10000 | 15  | 10000 | ns   |
| tCSH   | /CAS hold time after /RAS low           | 50     |       | 60  |       | ns   |
| tRSH   | /RAS hold time after /CAS low           | 15     |       | 15  |       | ns   |
| tRCS   | Read Setup time after /CAS high         | 0      |       | 0   |       | ns   |
| tRCH   | Read hold time after /CAS low (Note 21) | 0      |       | 0   |       | ns   |
| tRRH   | Read hold time after /RAS low (Note 21) | 10     |       | 10  |       | ns   |
| tRAL   | Column address to /RAS hold time        | 25     |       | 30  |       | ns   |
| tORH   | /RAS hold time after /OE low            | 13     |       | 15  |       | ns   |
| tOCH   | /CAS hold time after /OE low            | 13     |       | 15  |       | ns   |

Note 21: Either tRCH or tRRH must be satisfied for a read cycle.

**Write Cycle (Early Write and Delayed Write)**

| Symbol | Parameter                                  | Limits |       |     |       | Unit |
|--------|--|--------|-------|-----|-------|------|
|        |  | -5     |       | -6  |       |      |
|        |  | Min    | Max   | Min | Max   |      |
| tWC    | Write cycle time                           | 90     |       | 110 |       | ns   |
| tRAS   | /RAS low pulse width                       | 50     | 10000 | 60  | 10000 | ns   |
| tCAS   | /CAS low pulse width                       | 15     | 10000 | 15  | 10000 | ns   |
| tCSH   | /CAS hold time after /RAS low              | 50     |       | 60  |       | ns   |
| tRSH   | /RAS hold time after /CAS low              | 15     |       | 15  |       | ns   |
| tWCS   | Write setup time before /CAS low (Note 23) | 0      |       | 0   |       | ns   |
| tWCH   | Write hold time after /CAS low             | 10     |       | 10  |       | ns   |
| tCWL   | /CAS hold time after /W low                | 15     |       | 15  |       | ns   |
| tRWL   | /RAS hold time after /W low                | 15     |       | 15  |       | ns   |
| tWP    | Write pulse width                          | 10     |       | 10  |       | ns   |
| tDS    | Data setup time before /CAS low or /W low  | 0      |       | 0   |       | ns   |
| tDH    | Data hold time after /CAS low or /W low    | 10     |       | 10  |       | ns   |
| tOEH   | /OE hold time after /W low                 | 13     |       | 15  |       | ns   |

**Read-Write and Read-Modify-Write Cycles**

| Symbol | Parameter  | Limits |       |     |       | Unit |
|--------|--|--------|-------|-----|-------|------|
|        |  | -5     |       | -6  |       |      |
|        |  | Min    | Max   | Min | Max   |      |
| tRWC   | Read write/read modify write cycle time (Note22) | 130    |       | 150 |       | ns   |
| tRAS   | /RAS low pulse width                             | 85     | 10000 | 95  | 10000 | ns   |
| tCAS   | /CAS low pulse width                             | 50     | 10000 | 50  | 10000 | ns   |
| tCSH   | /CAS hold time after /RAS low                    | 85     |       | 95  |       | ns   |
| tRSH   | /RAS hold time after /CAS low                    | 50     |       | 50  |       | ns   |
| tRCS   | Read setup time before /CAS low                  | 0      |       | 0   |       | ns   |
| tCWD   | Delay time, /CAS low to /W low (Note23)          | 30     |       | 30  |       | ns   |
| tRWD   | Delay time, /RAS low to /W low (Note23)          | 65     |       | 75  |       | ns   |
| tAWD   | Delay time, address to /W low (Note23)           | 40     |       | 45  |       | ns   |
| tOEH   | /OE hold time after /W low                       | 10     |       | 15  |       | ns   |
| tCWL   | /CAS hold time after /W low                      | 15     |       | 15  |       | ns   |
| tRWL   | /RAS hold time after /W low                      | 15     |       | 15  |       | ns   |
| tWP    | Write pulse width                                | 10     |       | 10  |       | ns   |
| tDS    | Data setup time before /CAS low or /W low        | 0      |       | 0   |       | ns   |
| tDH    | Data hold time after /CAS low or /W low          | 10     |       | 10  |       | ns   |

Note 22:tRWC is specified as tRWC(min)=tRAC(max)+tODD(min)+tRWL(min)+tRP(min)+4t.

24:tWCS, tCWD, tRWD, 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 /CAS or /OE goes back to VIH) is indeterminate.



# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

### Fast Page Mode Cycle (Read, Early Write, Read -Write, Read-Modify-Write Cycle,) (Note 24)

| Symbol | Parameter  | Limits |        |     |        | Unit |
|--------|--|--------|--------|-----|--------|------|
|        |  | -5     |        | -6  |        |      |
|        |  | Min    | Max    | Min | Max    |      |
| tPC    | Fast page mode read/write cycle time                   | 35     |        | 40  |        | ns   |
| tPRWC  | Fast page mode read write/read modify write cycle time | 70     |        | 75  |        | ns   |
| tRAS   | /RAS low pulse width for read write cycle (Note25)     | 85     | 102400 | 100 | 102400 | ns   |
| tCP    | /CAS high pulse width (Note26)                         | 5      | 10     | 10  | 15     | ns   |
| tCPRH  | /RAS hold time after /CAS precharge                    | 30     |        | 35  |        | ns   |
| tCPWD  | Delay time, /CAS precharge to W low (Note23)           | 30     |        | 35  |        | ns   |

Note 24: All previously specified timing requirements and switching characteristics are applicable to their respective fast page mode cycle.

25: tRAS(min) is specified as two cycles of /CAS input are performed.

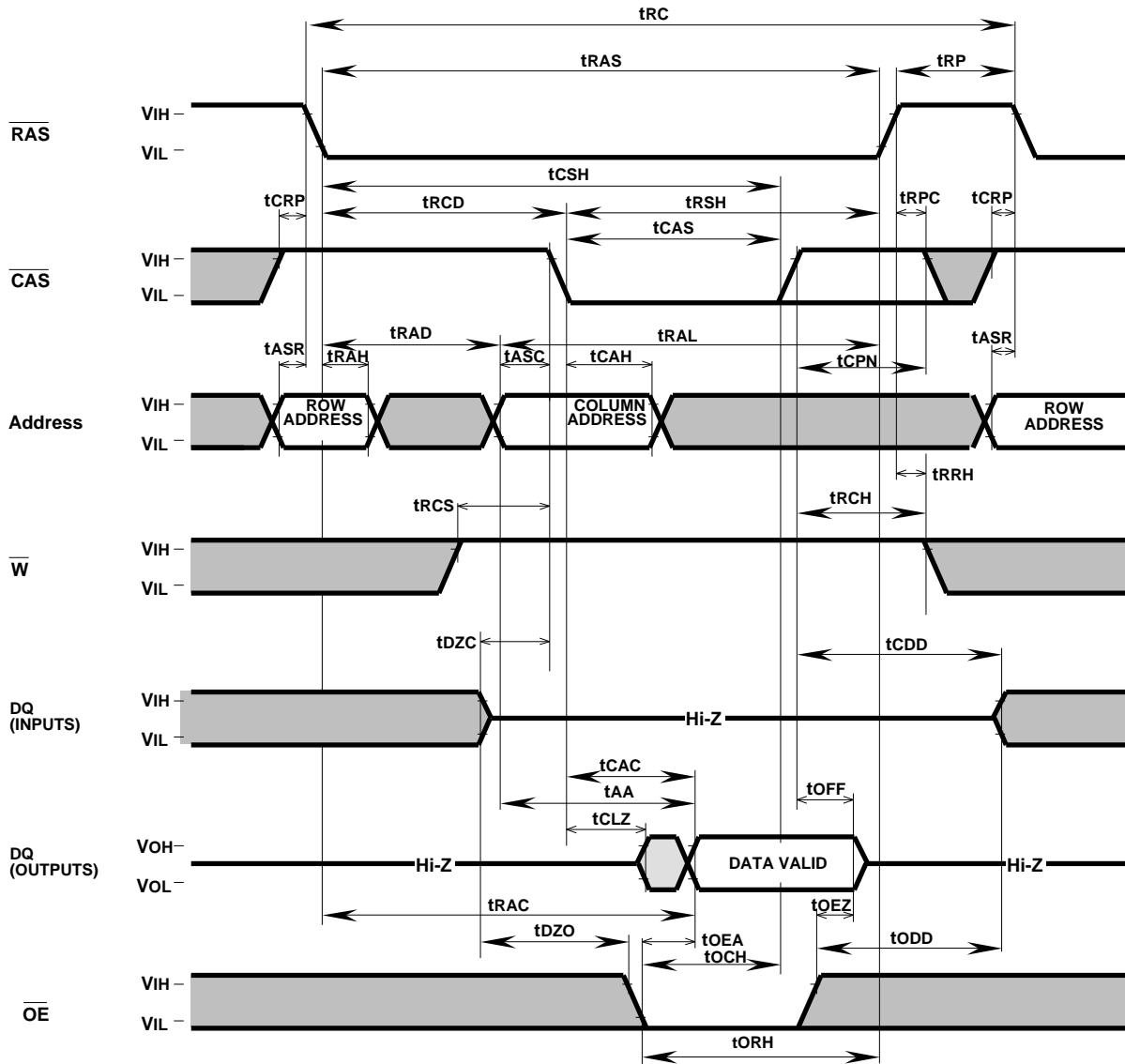
26: tCP(max) is specified as a reference point only. If tCP = tCP(max), access time is controlled exclusively by tCAC.



### /CAS before /RAS Refresh Cycle (Note 27)

| Symbol | Parameter                       | Limits |     |     |     | Unit |
|--------|---------------------------------|--------|-----|-----|-----|------|
|        |                                 | -5     |     | -6  |     |      |
|        |                                 | Min    | Max | Min | Max |      |
| tCSR   | /CAS setup time before /RAS low | 5      |     | 10  |     | ns   |
| tCHR   | /CAS hold time after /RAS low   | 10     |     | 10  |     | ns   |
| tRSR   | Read setup time before /RAS low | 10     |     | 10  |     | ns   |
| tRHR   | Read hold time after /RAS low   | 10     |     | 10  |     | ns   |

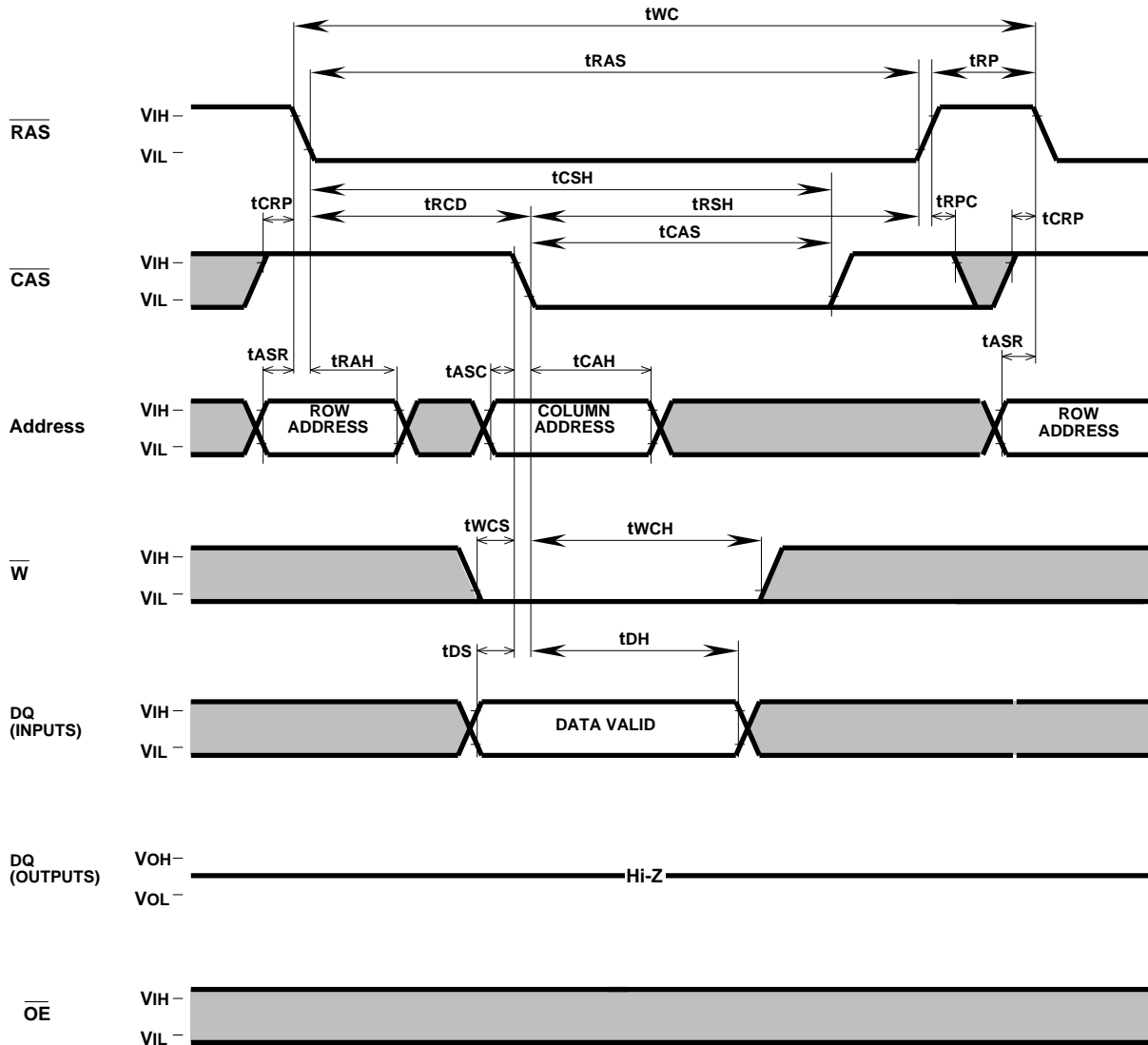
Note 27: Eight or more /CAS before /RAS cycles instead of eight /RAS cycles are necessary for proper operation of /CAS before /RAS refresh mode.

**Timing Diagrams (Note 28)**  
**Read Cycle**

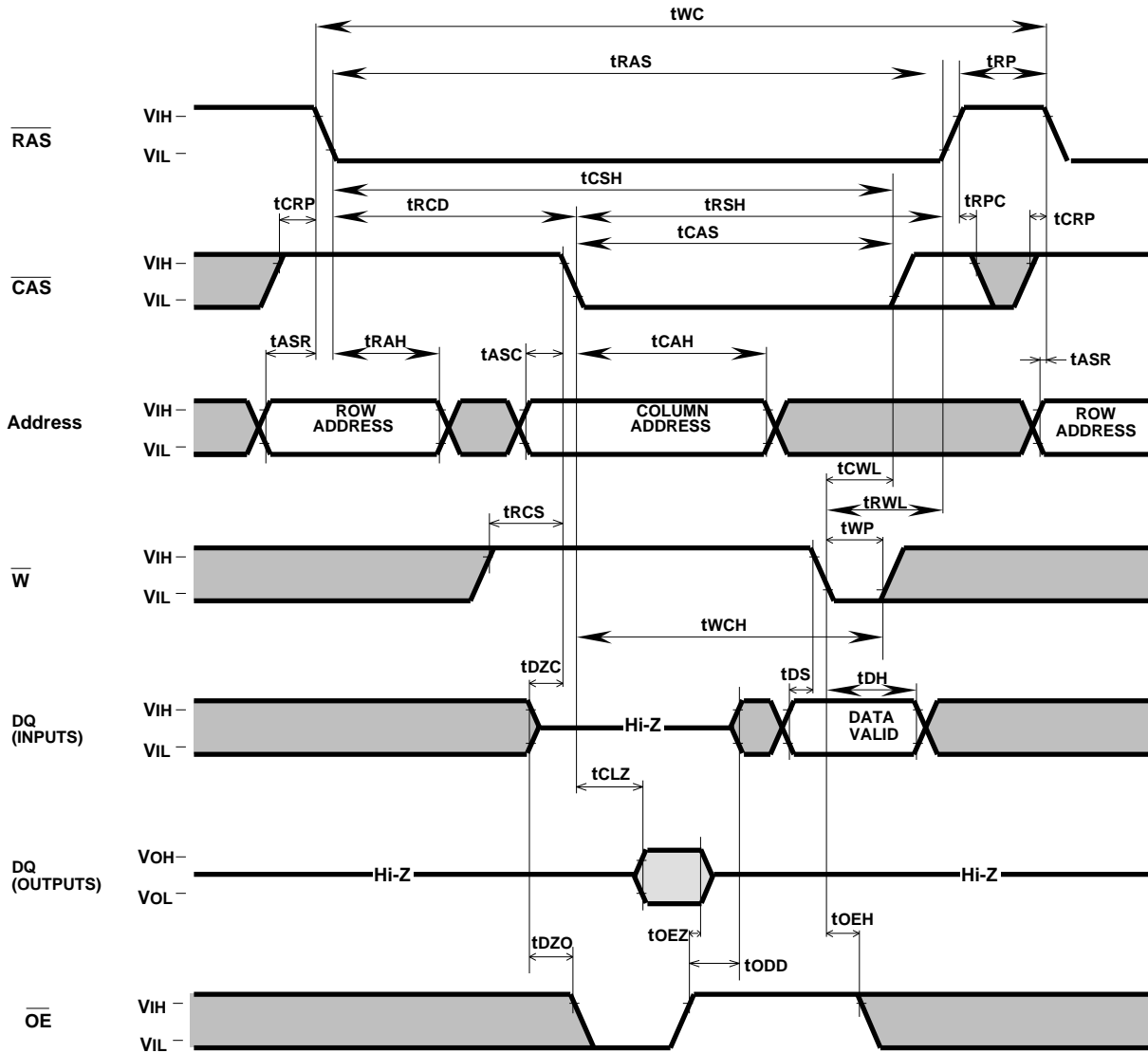


Note 28  Indicates the don't care input.  
 $V_{\text{IH}}(\text{min})$   $V_{\text{IN}}$   $V_{\text{IH}}(\text{max})$  or  $V_{\text{IL}}(\text{min})$   $V_{\text{IN}}$   $V_{\text{IL}}(\text{max})$   
 Indicates the invalid output.

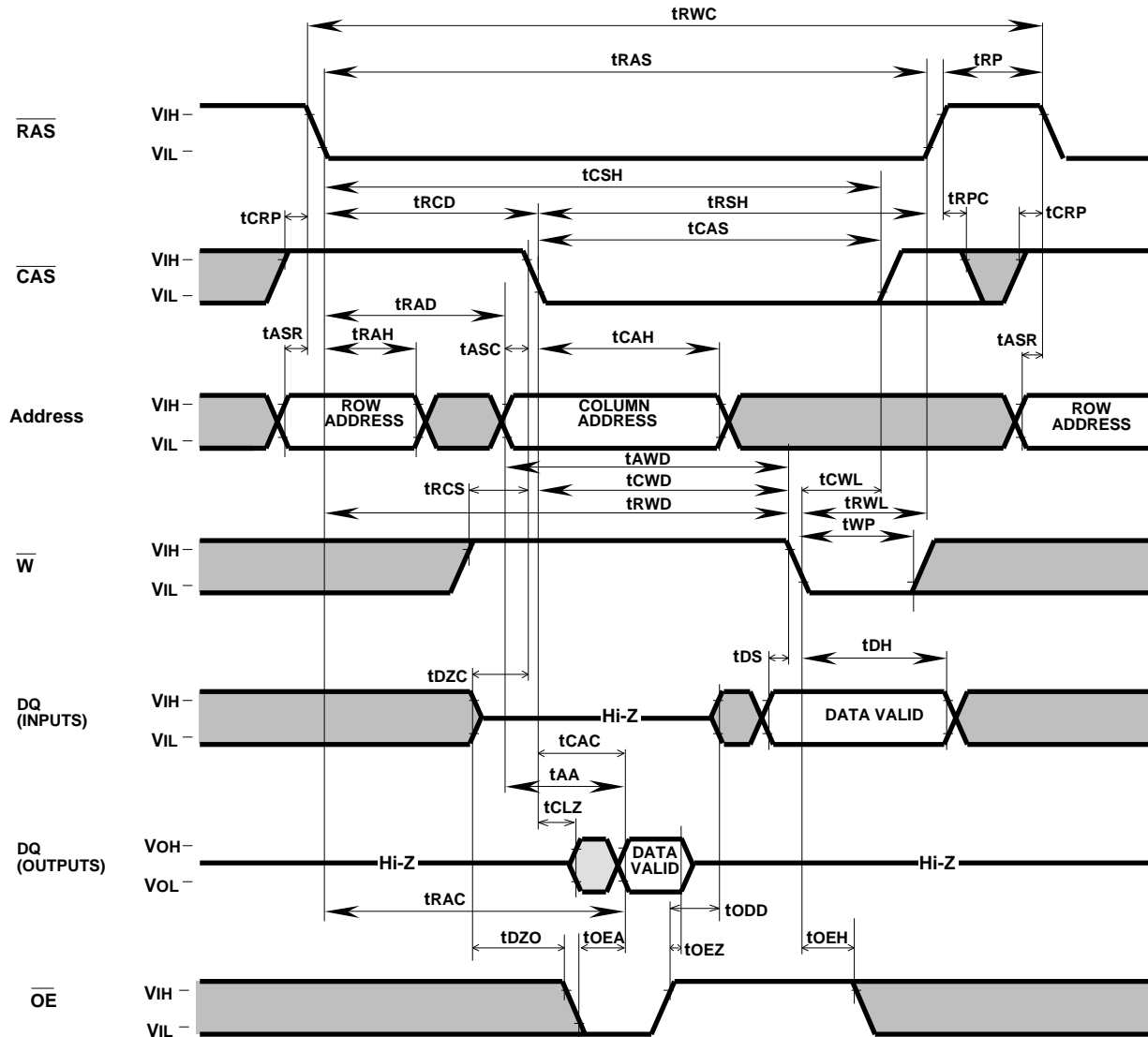
**Write Cycle (Early write)**



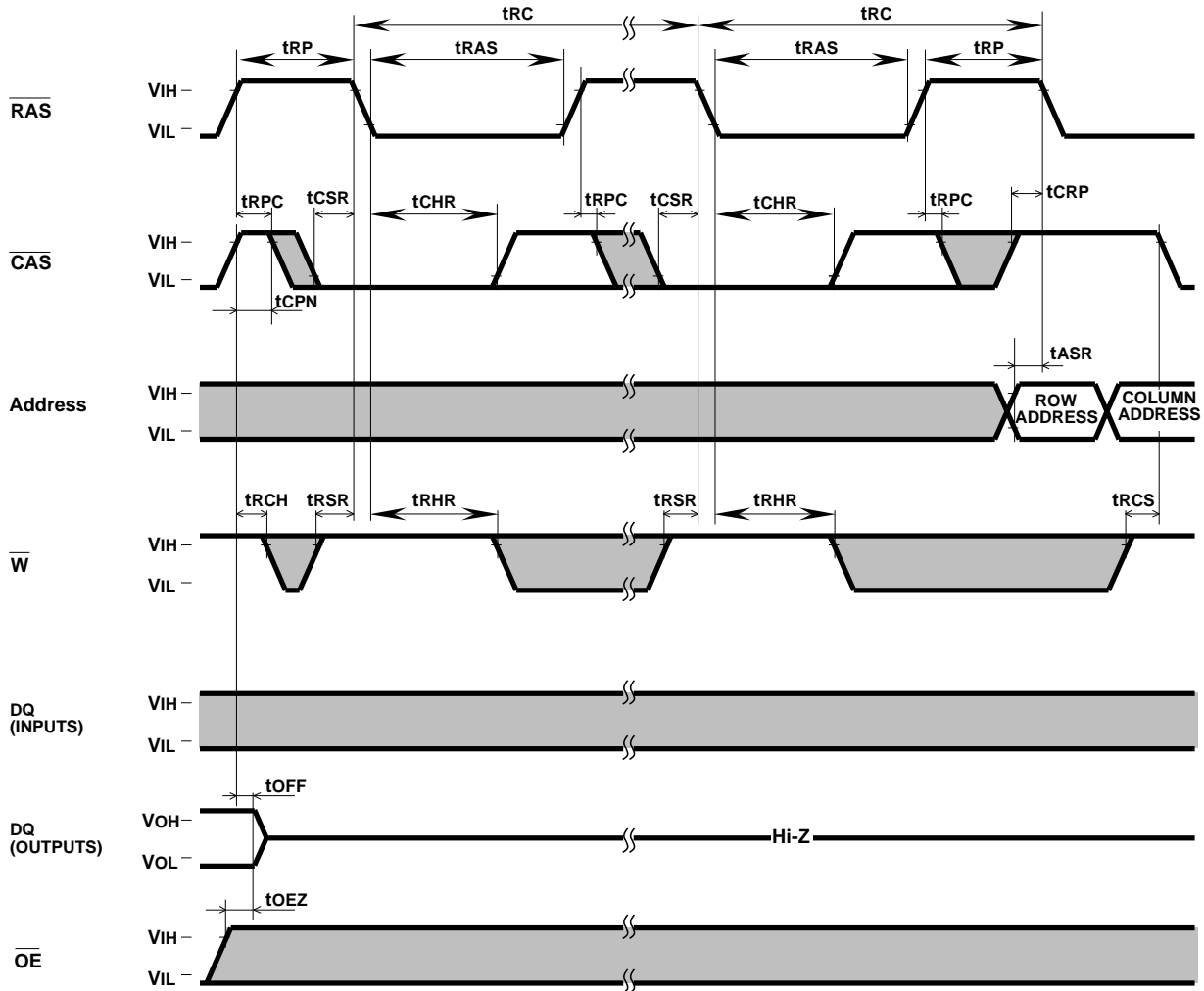
**Write Cycle (Delayed write)**



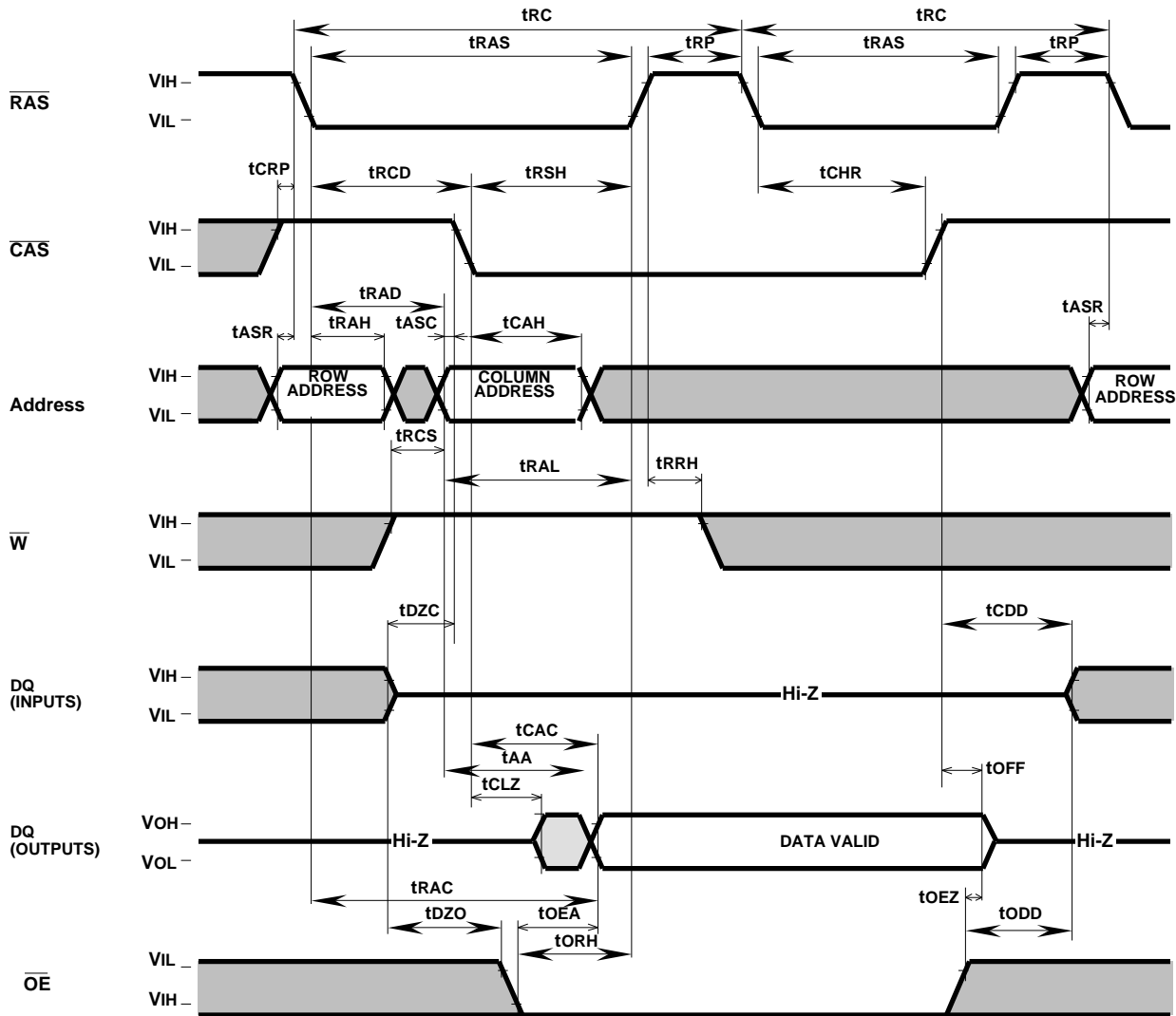
**Read-Write, Read-Modify-Write Cycle**



**CAS before RAS Refresh Cycle**

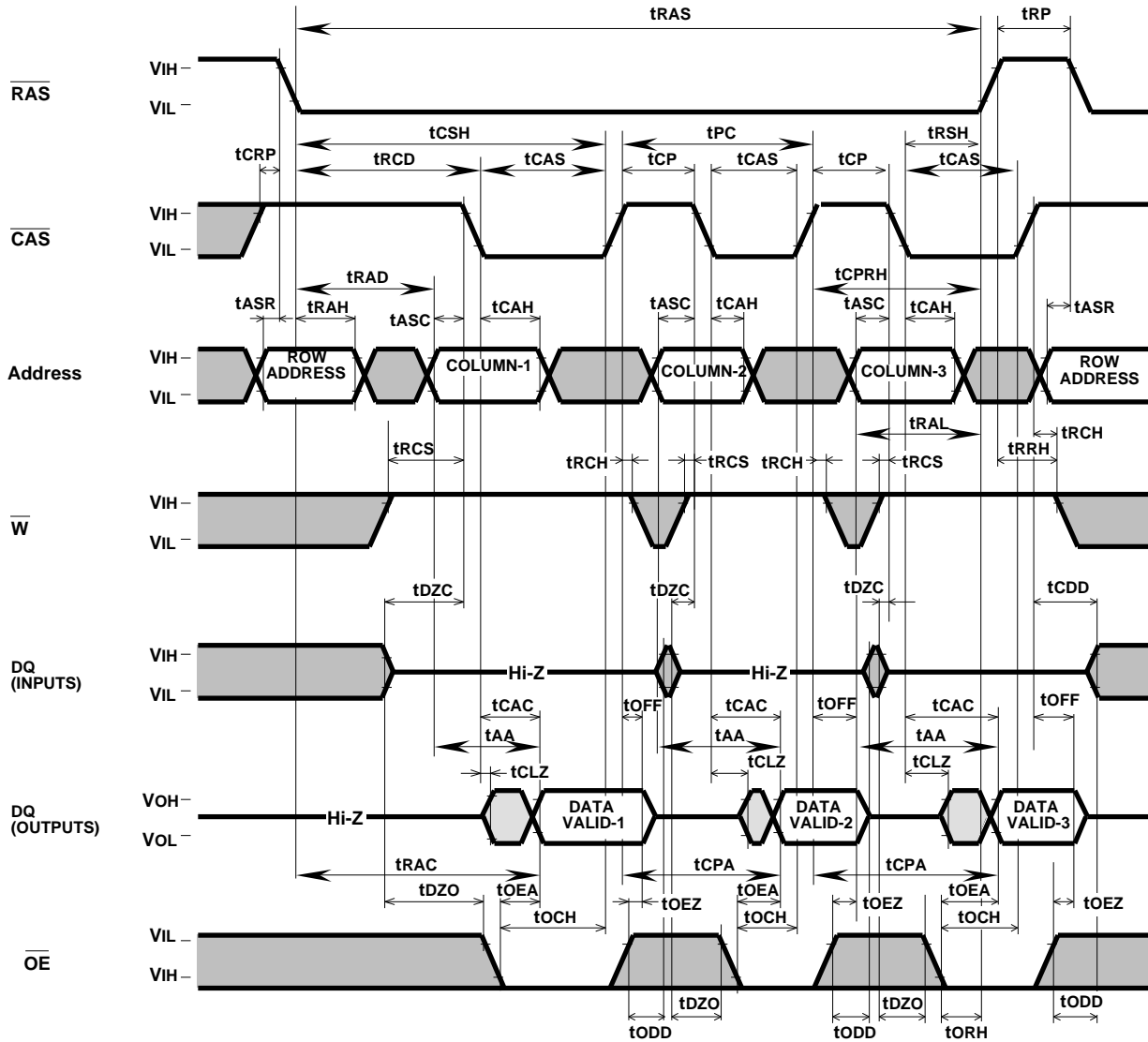


**Hidden Refresh Cycle (Read) (Note 29)**



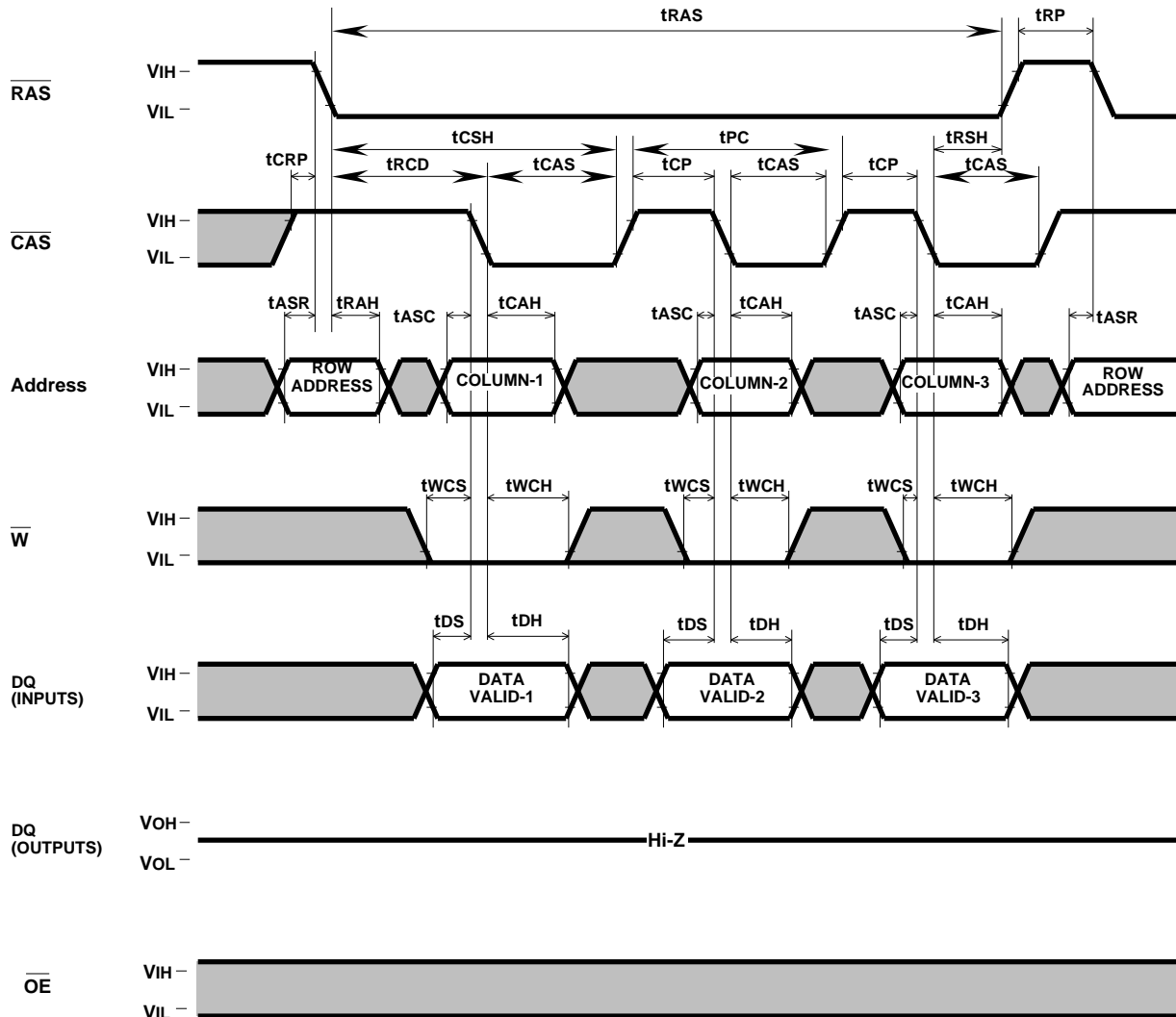
Note 29: Early write, delayed write, read write or read modify write cycle is applicable instead of read cycle. Timing requirements and output state are the same as that of each cycle shown above.

Fast Page Mode Read Cycle

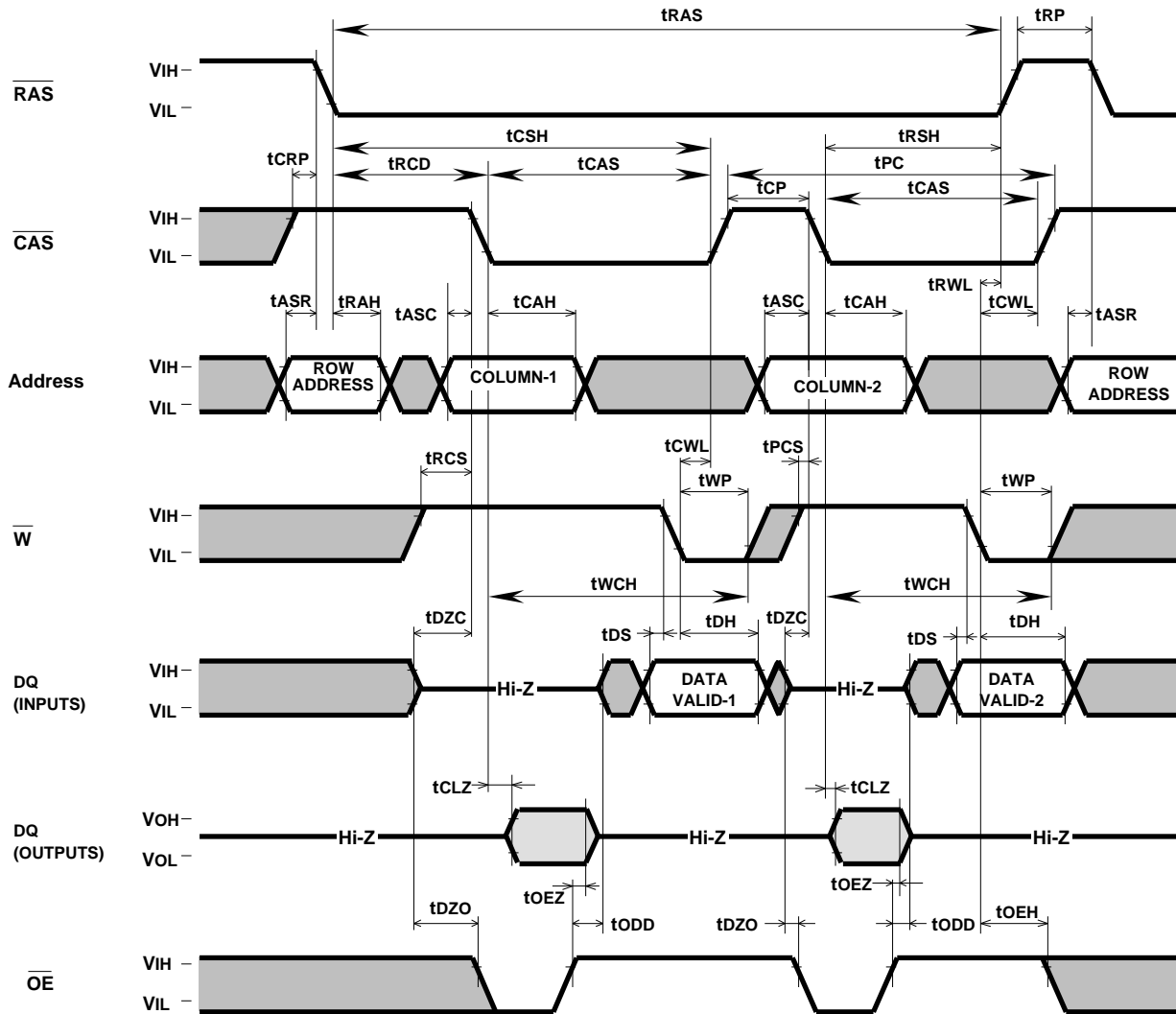




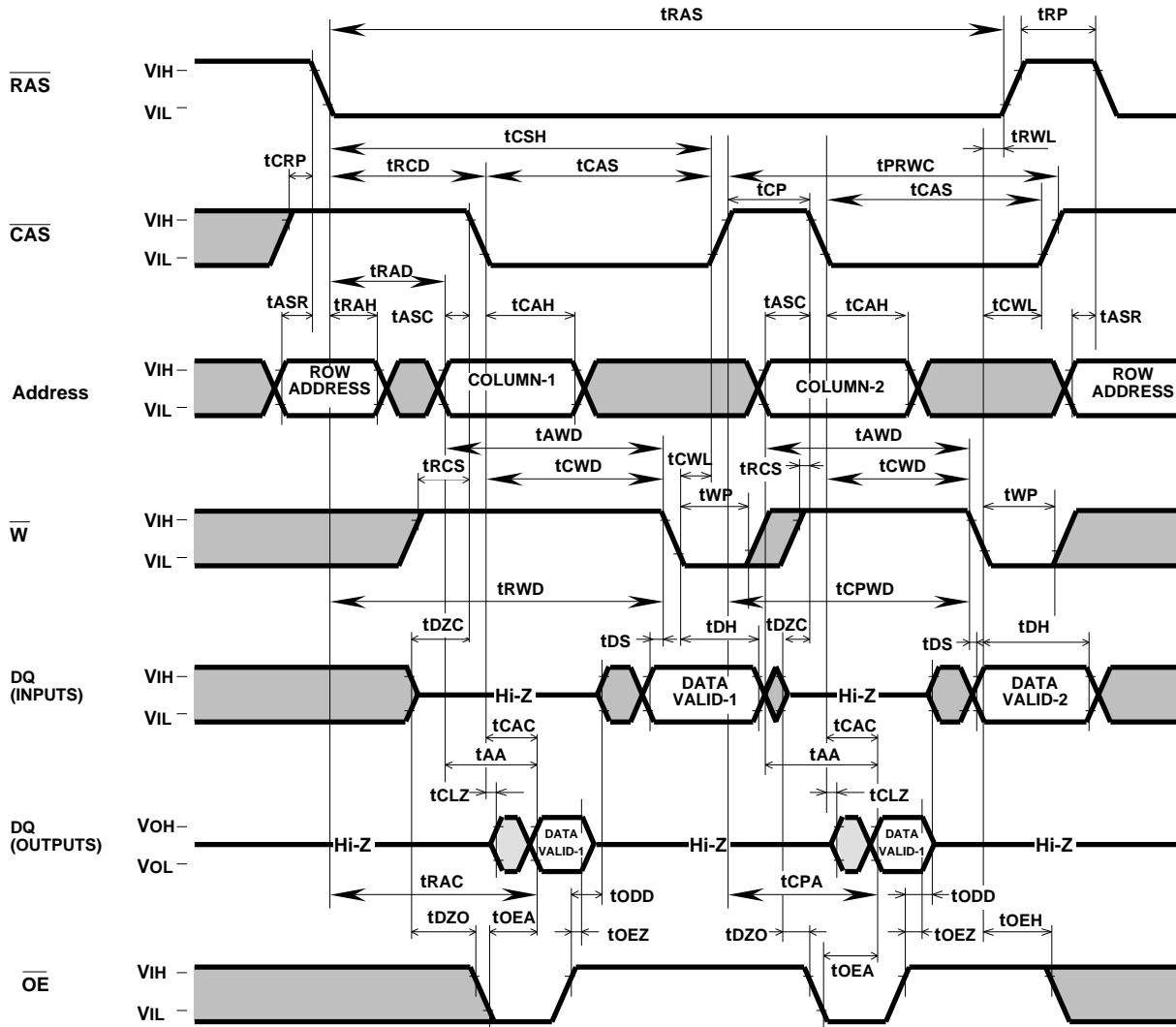
**Fast Page Mode Write Cycle (Early Write)**



**Fast-Page Mode Write Cycle (Delayed Write)**



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



# MH16V64AWJ -5, -6

FAST PAGE MODE 1073741824 - BIT ( 16777216 - WORD BY 64 - BIT ) DYNAMIC RAM

Unit:mm

## Package outline

