

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

PRELIMINARY

Some of contents are subject to change without notice.

DESCRIPTION

The MH16S72PHB is 16777216 - word x 72-bit Synchronous DRAM module. This consist of nine industry standard 16M x 8 Synchronous DRAMs in TSOP.

The TSOP 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.

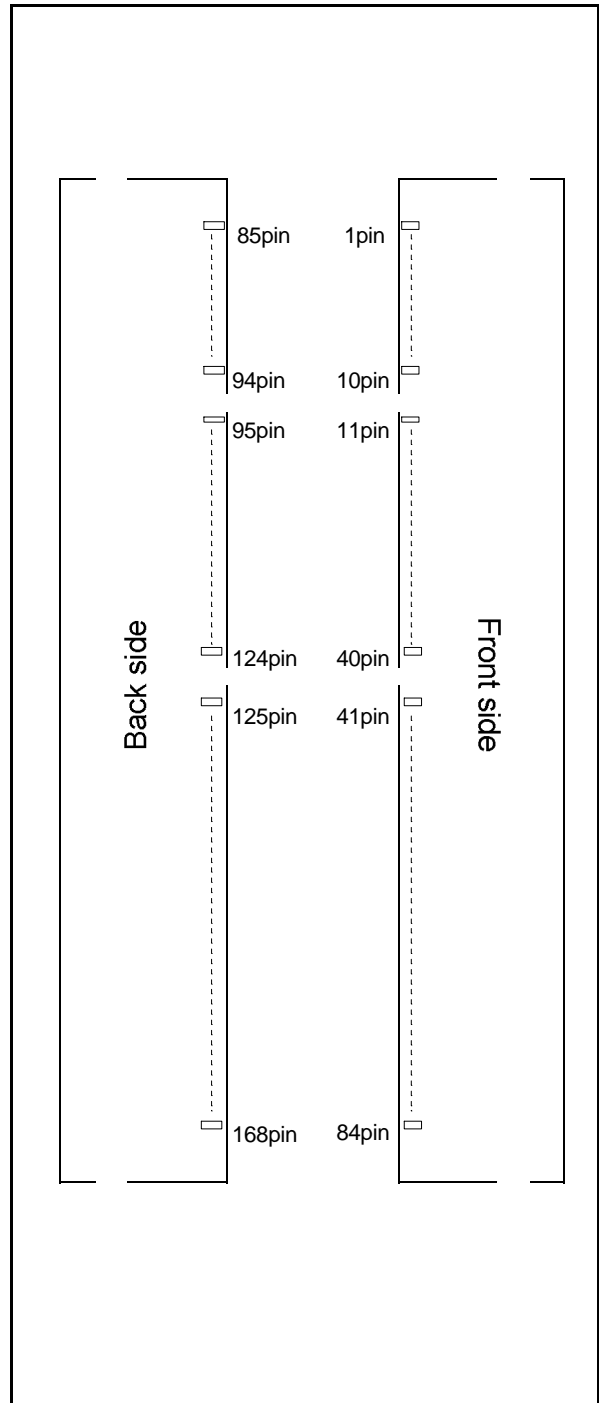
FEATURES

| Type name | Max. Frequency | Access Time from CLK [component level] |
|--------------|----------------|--|
| MH16S72PHB-6 | 133MHz | 5.4ns (CL = 3) |

- Utilizes industry standard 16M X 8 Synchronous DRAMs in TSOP package
- Single 3.3V +/- 0.3V supply
- Max.Clock frequency 133MHz
- Fully synchronous operation referenced to clock rising edge
- 4-bank operation controlled by BA0,BA1(Bank Address)
- /CAS latency -2/3(programmable,at buffer mode)
- LVTTTL Interface
- Burst length 1/2/4/8/Full Page(programmable)
- Burst type- Sequential and interleave burst (programmable)
- Random column access
- Burst Write / Single Write(programmable)
- Auto precharge / All bank precharge controlled by A10
- Auto refresh and Self refresh
- 4096 refresh cycles every 64ms

APPLICATION

Main memory or graphic memory in computer systems



Preliminary
Spec.**MH16S72PHB-6**

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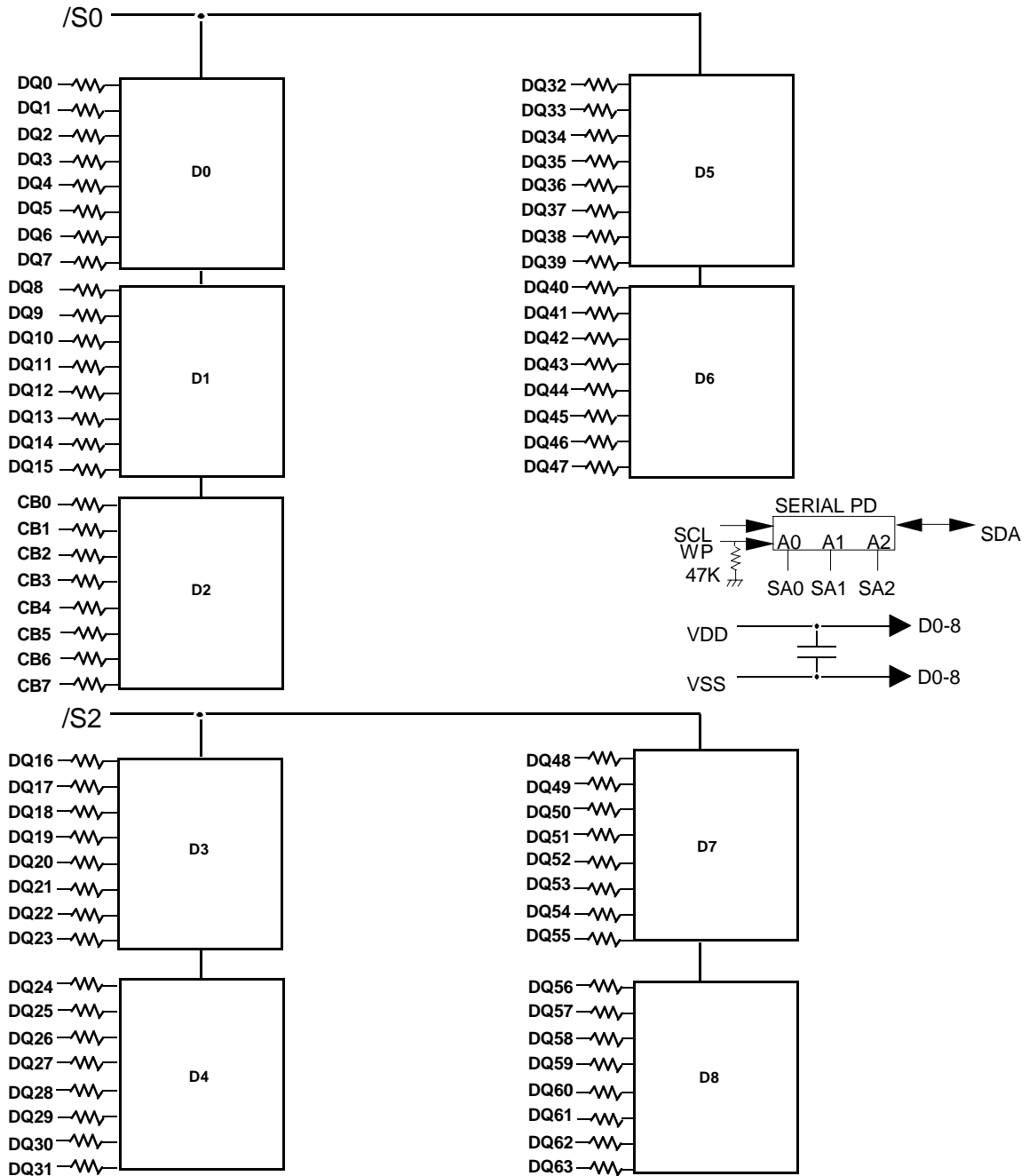
| PIN NO. | PIN NAME | PIN NO. | PIN NAME | PIN NO. | PIN NAME | PIN NO. | PIN NAME |
|---------|----------|---------|----------|---------|----------|---------|----------|
| 1 | VSS | 43 | VSS | 85 | VSS | 127 | VSS |
| 2 | DQ0 | 44 | NC | 86 | DQ32 | 128 | CKE0 |
| 3 | DQ1 | 45 | /S2 | 87 | DQ33 | 129 | NC |
| 4 | DQ2 | 46 | DQMB2 | 88 | DQ34 | 130 | DQMB6 |
| 5 | DQ3 | 47 | DQMB3 | 89 | DQ35 | 131 | DQMB7 |
| 6 | VDD | 48 | NC | 90 | VDD | 132 | NC |
| 7 | DQ4 | 49 | VDD | 91 | DQ36 | 133 | VDD |
| 8 | DQ5 | 50 | NC | 92 | DQ37 | 134 | NC |
| 9 | DQ6 | 51 | NC | 93 | DQ38 | 135 | NC |
| 10 | DQ7 | 52 | CB2 | 94 | DQ39 | 136 | CB6 |
| 11 | DQ8 | 53 | CB3 | 95 | DQ40 | 137 | CB7 |
| 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 | VDD | 101 | DQ45 | 143 | VDD |
| 18 | VDD | 60 | DQ20 | 102 | VDD | 144 | DQ52 |
| 19 | DQ14 | 61 | NC | 103 | DQ46 | 145 | NC |
| 20 | DQ15 | 62 | NC | 104 | DQ47 | 146 | NC |
| 21 | CB0 | 63 | NC | 105 | CB4 | 147 | NC |
| 22 | CB1 | 64 | VSS | 106 | CB5 | 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 | VDD | 68 | VSS | 110 | VDD | 152 | VSS |
| 27 | /WE | 69 | DQ24 | 111 | /CAS | 153 | DQ56 |
| 28 | DQMB0 | 70 | DQ25 | 112 | DQMB4 | 154 | DQ57 |
| 29 | DQMB1 | 71 | DQ26 | 113 | DQMB5 | 155 | DQ58 |
| 30 | /S0 | 72 | DQ27 | 114 | NC | 156 | DQ59 |
| 31 | NC | 73 | VDD | 115 | /RAS | 157 | VDD |
| 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 | CK2 | 121 | A9 | 163 | CK3 |
| 38 | A10 | 80 | NC | 122 | BA0 | 164 | NC |
| 39 | BA1 | 81 | WP | 123 | A11 | 165 | SA0 |
| 40 | VDD | 82 | SDA | 124 | VDD | 166 | SA1 |
| 41 | VDD | 83 | SCL | 125 | CK1 | 167 | SA2 |
| 42 | CK0 | 84 | VDD | 126 | NC | 168 | VDD |

NC = No Connection

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM



- | | | | | | |
|--------------|--------|-------|--------|-----|----------------|
| CKE0 | → D0-8 | DQM 0 | → D0 | CK0 | → 5DRAMs |
| A11-0, BA0-1 | → D0-8 | DQM 1 | → D1,2 | CK1 | → TERMINATION |
| /RAS | → D0-8 | DQM 2 | → D3 | CK2 | → 4DRAMs+3.3pF |
| /CAS | → D0-8 | DQM 3 | → D4 | CK3 | → TERMINATION |
| /WE | → D0-8 | DQM 4 | → D5 | | |
| | | DQM 5 | → D6 | | |
| | | DQM 6 | → D7 | | |
| | | DQM 7 | → D8 | | |

Preliminary
Spec.**MH16S72PHB-6**

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

PIN FUNCTION

| | | |
|-----------------|--------------|---|
| CK0,2 | Input | Master Clock:All other inputs are referenced to the rising edge of CK |
| CKE0 | Input | Clock Enable:CKE controls internal clock.When CKE is low,internal clock for the following cycle is ceased. CKE is also used to select auto / self refresh. After self refresh mode is started, CKE E becomes asynchronous input.Self refresh is maintained as long as CKE is low. |
| /S0,2 | Input | Chip Select: When /S is high,any command means No Operation. |
| /RAS,/CAS,/W | Input | Combination of /RAS,/CAS,/W defines basic commands. |
| A0-11 | Input | A0-11 specify the Row/Column Address in conjunction with BA.The Row Address is specified by A0-11.The Column Address is specified by A0-9.A10 is also used to indicate precharge option.When A10 is high at a read / write command, an auto precharge is performed. When A10 is high at a precharge command, both banks are precharged. |
| BA0-1 | Input | Bank Address:BA0,1 is specifies the four bank to which a command is applied.BA must be set with ACT ,PRE ,READ ,WRITE commands |
| DQ0-63 CB0-7 | Input/Output | Data In and Data out are referenced to the rising edge of CK |
| DQM0-7 | Input | Din Mask/Output Disable:When DQMB is high in burst write.Din for the current cycle is masked.When DQMB is high in burst read,Dout is disabled at the next but one cycle. |
| Vdd,Vss | Power Supply | Power Supply for the memory mounted module. |

Preliminary
Spec.**MH16S72PHB-6**

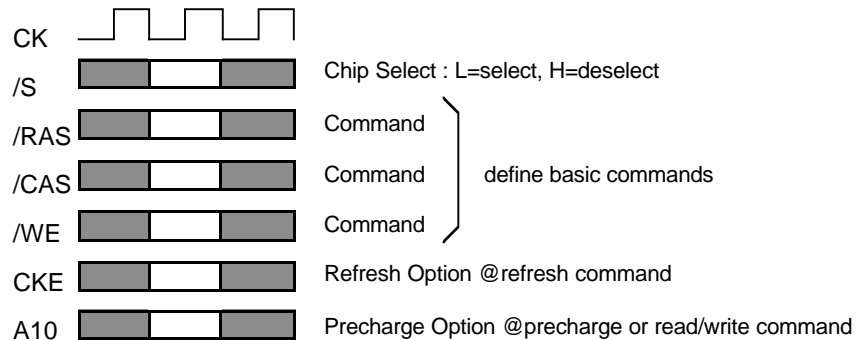
1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

BASIC FUNCTIONS

The MH16S72PHB provides basic functions, bank(row) activate, burst read / write, bank(row) precharge, and auto / self refresh.

Each command is defined by control signals of /RAS, /CAS and /WE at CK rising edge. In addition to 3 signals, /S, CKE and A10 are used as chip select, refresh option, and precharge option, respectively.

To know the detailed definition of commands please see the command truth table.

**Activate(ACT) [/RAS =L, /CAS = /WE =H]**

ACT command activates a row in an idle bank indicated by BA.

Read(READ) [/RAS =H, /CAS =L, /WE =H]

READ command starts burst read from the active bank indicated by BA. First output data appears after /CAS latency. When A10 =H at this command, the bank is deactivated after the burst read(auto-precharge, **READA**).

Write(WRITE) [/RAS =H, /CAS = /WE =L]

WRITE command starts burst write to the active bank indicated by BA. Total data length to be written is set by burst length. When A10 =H at this command, the bank is deactivated after the burst write(auto-precharge, **WRITEA**).

Precharge(PRE) [/RAS =L, /CAS =H, /WE =L]

PRE command deactivates the active bank indicated by BA. This command also terminates burst read / write operation. When A10 =H at this command, both banks are deactivated(precharge all, **PREA**).

Auto-Refresh(REFA) [/RAS =/CAS =L, /WE =CKE =H]

REFA command starts auto-refresh cycle. Refresh address including bank address are generated internally. After this command, the banks are precharged automatically.

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

COMMAND TRUTH TABLE

| COMMAND | MNEMONIC | CKE _{n-1} | CKE _n | /S | /RAS | /CAS | /WE | BA0,1 | A11 | A10 | A0-9 |
|--|----------|--------------------|------------------|----|------|------|-----|-------|-----|-----|------|
| Deselect | DESEL | H | X | H | X | X | X | X | X | X | X |
| No Operation | NOP | H | X | L | H | H | H | X | X | X | X |
| Row Adress Entry & Bank Activate | ACT | H | X | L | L | H | H | V | V | V | V |
| Single Bank Precharge | PRE | H | X | L | L | H | L | V | X | L | X |
| Precharge All Bank | PREA | H | X | L | L | H | L | X | X | H | X |
| Column Address Entry & Write | WRITE | H | X | L | H | L | L | V | X | L | V |
| Column Address Entry & Write with Auto-Precharge | WRITEA | H | X | L | H | L | L | V | X | H | V |
| Column Address Entry & Read | READ | H | X | L | H | L | H | V | X | L | V |
| Column Address Entry & Read with Auto Precharge | READA | H | X | L | H | L | H | V | X | H | V |
| Auto-Refresh | REFA | H | H | L | L | L | H | X | X | X | X |
| Self-Refresh Entry | REFS | H | L | L | L | L | H | X | X | X | X |
| Self-Refresh Exit | REFSX | L | H | H | X | X | X | X | X | X | X |
| | | L | H | L | H | H | H | X | X | X | X |
| Burst Terminate | TBST | H | X | L | H | H | L | X | X | X | X |
| Mode Register Set | MRS | H | X | L | L | L | L | L | L | L | V*1 |

H =High Level, L = Low Level, V = Valid, X = Don't Care, n = CK cycle number

NOTE:

1.A7-9 = 0, A0-6 = Mode Address

Preliminary
Spec.

MITSUBISHI LSIs

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

FUNCTION TRUTH TABLE

| Current State | /S | /RAS | /CAS | /WE | Address | Command | Action |
|---------------|----|------|------|-----|----------------------|------------------|---|
| IDLE | H | X | X | X | X | DESEL | NOP |
| | L | H | H | H | X | NOP | NOP |
| | L | H | H | L | BA | TBST | ILLEGAL*2 |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL*2 |
| | L | L | H | H | BA,RA | ACT | Bank Active,Latch RA |
| | L | L | H | L | BA,A10 | PRE/PREA | NOP*4 |
| | L | L | L | H | X | REFA | Auto-Refresh*5 |
| | L | L | L | L | Op-Code, Mode-Add | MRS | Mode Register Set*5 |
| ROW ACTIVE | H | X | X | X | X | DESEL | NOP |
| | L | H | H | H | X | NOP | NOP |
| | L | H | H | L | BA | TBST | NOP |
| | L | H | L | H | BA,CA,A10 | READ/READA | Begin Read,Latch CA, Determine Auto-Precharge |
| | L | H | L | L | BA,CA,A10 | WRITE/ WRITEA | Begin Write,Latch CA, Determine Auto-Precharge |
| | L | L | H | H | BA,RA | ACT | Bank Active/ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | Precharge/Precharge All |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| READ | H | X | X | X | X | DESEL | NOP(Continue Burst to END) |
| | L | H | H | H | X | NOP | NOP(Continue Burst to END) |
| | L | H | H | L | BA | TBST | Terminate Burst |
| | L | H | L | H | BA,CA,A10 | READ/READA | Terminate Burst,Latch CA, Begin New Read,Determine Auto-Precharge*3 |
| | L | H | L | L | BA,CA,A10 | WRITE/WRITEA | Terminate Burst,Latch CA, Begin Write,Determine Auto- Precharge*3 |
| | L | L | H | H | BA,RA | ACT | Bank Active/ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | Terminate Burst,Precharge |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |



Preliminary
Spec.

MITSUBISHI LSIs

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

FUNCTION TRUTH TABLE(continued)

| Current State | /S | /RAS | /CAS | /WE | Address | Command | Action |
|---------------------------------|----|------|------|-----|----------------------|------------------|---|
| WRITE | H | X | X | X | X | DESEL | NOP(Continue Burst to END) |
| | L | H | H | H | X | NOP | NOP(Continue Burst to END) |
| | L | H | H | L | BA | TBST | Terminate Burst |
| | L | H | L | H | BA,CA,A10 | READ/READA | Terminate Burst,Latch CA, Begin Read,Determine Auto-Precharge*3 |
| | L | H | L | L | BA,CA,A10 | WRITE/ WRITEA | Terminate Burst,Latch CA, Begin Write,Determine Auto-Precharge*3 |
| | L | L | H | H | BA,RA | ACT | Bank Active/ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | Terminate Burst,Precharge |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| READ with AUTO PRECHARGE | H | X | X | X | X | DESEL | NOP(Continue Burst to END) |
| | L | H | H | H | X | NOP | NOP(Continue Burst to END) |
| | L | H | H | L | BA | TBST | ILLEGAL |
| | L | H | L | H | BA,CA,A10 | READ/READA | ILLEGAL |
| | L | H | L | L | BA,CA,A10 | WRITE/ WRITEA | ILLEGAL |
| | L | L | H | H | BA,RA | ACT | Bank Active/ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL*2 |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| WRITE with AUTO PRECHARGE | H | X | X | X | X | DESEL | NOP(Continue Burst to END) |
| | L | H | H | H | X | NOP | NOP(Continue Burst to END) |
| | L | H | H | L | BA | TBST | ILLEGAL |
| | L | H | L | H | BA,CA,A10 | READ/READA | ILLEGAL |
| | L | H | L | L | BA,CA,A10 | WRITE/ WRITEA | ILLEGAL |
| | L | L | H | H | BA,RA | ACT | Bank Active/ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL*2 |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |

Preliminary
Spec.

MITSUBISHI LSIs

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

FUNCTION TRUTH TABLE(continued)

| Current State | /S | /RAS | /CAS | /WE | Address | Command | Action |
|-----------------------|----|------|------|-----|----------------------|------------|----------------------------|
| PRE - CHARGING | H | X | X | X | X | DESEL | NOP(Idle after tRP) |
| | L | H | H | H | X | NOP | NOP(Idle after tRP) |
| | L | H | H | L | BA | TBST | ILLEGAL*2 |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL*2 |
| | L | L | H | H | BA,RA | ACT | ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | NOP*4(Idle after tRP) |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| ROW ACTIVATING | H | X | X | X | X | DESEL | NOP(Row Active after tRCD) |
| | L | H | H | H | X | NOP | NOP(Row Active after tRCD) |
| | L | H | H | L | BA | TBST | ILLEGAL*2 |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL*2 |
| | L | L | H | H | BA,RA | ACT | ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL*2 |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| WRITE RE- COVERING | H | X | X | X | X | DESEL | NOP |
| | L | H | H | H | X | NOP | NOP |
| | L | H | H | L | BA | TBST | ILLEGAL*2 |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL*2 |
| | L | L | H | H | BA,RA | ACT | ILLEGAL*2 |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL*2 |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

FUNCTION TRUTH TABLE(continued)

| Current State | /S | /RAS | /CAS | /WE | Address | Command | Action |
|-----------------------|----|------|------|-----|-------------------|------------|----------------------|
| RE-FRESHING | H | X | X | X | X | DESEL | NOP(Idle after tRC) |
| | L | H | H | H | X | NOP | NOP(Idle after tRC) |
| | L | H | H | L | BA | TBST | ILLEGAL |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL |
| | L | L | H | H | BA,RA | ACT | ILLEGAL |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL |
| | L | L | L | H | X | REFA | ILLEGAL |
| MODE REGISTER SETTING | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |
| | H | X | X | X | X | DESEL | NOP(Idle after tRSC) |
| | L | H | H | H | X | NOP | NOP(Idle after tRSC) |
| | L | H | H | L | BA | TBST | ILLEGAL |
| | L | H | L | X | BA,CA,A10 | READ/WRITE | ILLEGAL |
| | L | L | H | H | BA,RA | ACT | ILLEGAL |
| | L | L | H | L | BA,A10 | PRE/PREA | ILLEGAL |
| | L | L | L | H | X | REFA | ILLEGAL |
| | L | L | L | L | Op-Code, Mode-Add | MRS | ILLEGAL |

ABBREVIATIONS:

H = High Level, L = Low Level, X = Don't Care

BA = Bank Address, RA = Row Address, CA = Column Address, NOP = No Operation

NOTES:

1. All entries assume that CKE was High during the preceding clock cycle and the current clock cycle.
2. ILLEGAL to bank in specified state; function may be legal in the bank indicated by BA, depending on the state of that bank.
3. Must satisfy bus contention, bus turn around, write recovery requirements.
4. NOP to bank precharging or in idle state. May precharge bank indicated by BA.
5. ILLEGAL if any bank is not idle.

ILLEGAL = Device operation and / or data-integrity are not guaranteed.

Preliminary
Spec.**MH16S72PHB-6**

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FUNCTION TRUTH TABLE FOR CKE

| Current State | CKE _{n-1} | CKE _n | /S | /RAS | /CAS | /WE | Add | Action |
|---|--------------------|------------------|----|------|------|-----|-----|-------------------------------------|
| SELF - REFRESH*1 | H | X | X | X | X | X | X | INVALID |
| | L | H | H | X | X | X | X | Exit Self-Refresh(Idle after tRC) |
| | L | H | L | H | H | H | X | Exit Self-Refresh(Idle after tRC) |
| | L | H | L | H | H | L | X | ILLEGAL |
| | L | H | L | H | L | X | X | ILLEGAL |
| | L | H | L | L | X | X | X | ILLEGAL |
| | L | L | X | X | X | X | X | NOP(Maintain Self-Refresh) |
| POWER DOWN | H | X | X | X | X | X | X | INVALID |
| | L | H | X | X | X | X | X | Exit Power Down to Idle |
| | L | L | X | X | X | X | X | NOP(Maintain Self-Refresh) |
| ALL BANKS IDLE*2 | H | H | X | X | X | X | X | Refer to Function Truth Table |
| | H | L | L | L | L | H | X | Enter Self-Refresh |
| | H | L | H | X | X | X | X | Enter Power Down |
| | H | L | L | H | H | H | X | Enter Power Down |
| | H | L | L | H | H | L | X | ILLEGAL |
| | H | L | L | H | L | X | X | ILLEGAL |
| | H | L | L | L | X | X | X | ILLEGAL |
| | L | X | X | X | X | X | X | Refer to Current State = Power Down |
| ANY STATE other than listed above | H | H | X | X | X | X | X | Refer to Function Truth Table |
| | H | L | X | X | X | X | X | Begin CK0 Suspend at Next Cycle*3 |
| | L | H | X | X | X | X | X | Exit CK0 Suspend at Next Cycle*3 |
| | L | L | X | X | X | X | X | Maintain CK0 Suspend |

ABBREVIATIONS:

H = High Level, L = Low Level, X = Don't Care

NOTES:

1. CKE Low to High transition will re-enable CK and other inputs **asynchronously**.
A minimum setup time must be satisfied before any command other than EXIT.
2. Power-Down and Self-Refresh can be entered only from the All banks idle State.
3. Must be legal command.

Preliminary
Spec.

MH16S72PHB-6

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POWER ON SEQUENCE

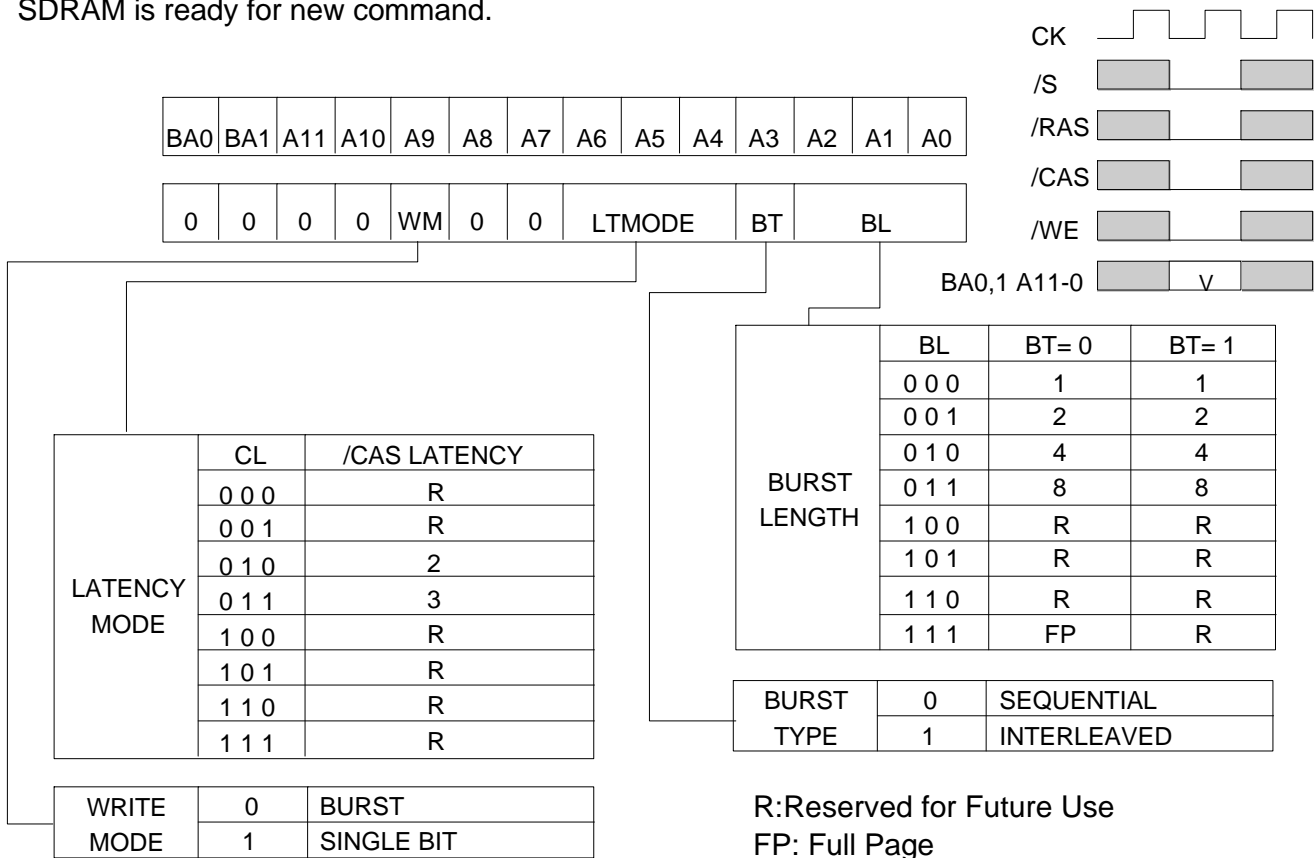
Before starting normal operation, the following power on sequence is necessary to prevent a SDRAM from damaged or malfunctioning.

1. Clock will be applied at power up along with power. Attempt to maintain CKE high, DQMB high and NOP condition at the inputs along with power.
2. Maintain stable power, stable clock, and NOP input conditions for a minimum of 200µs.
3. Issue precharge commands for all banks. (PRE or PREA)
4. After all banks become idle state (after tRP), issue 8 or more auto-refresh commands.
5. Issue a mode register set command to initialize the mode register.

After these sequence, the SDRAM is idle state and ready for normal operation.

MODE REGISTER

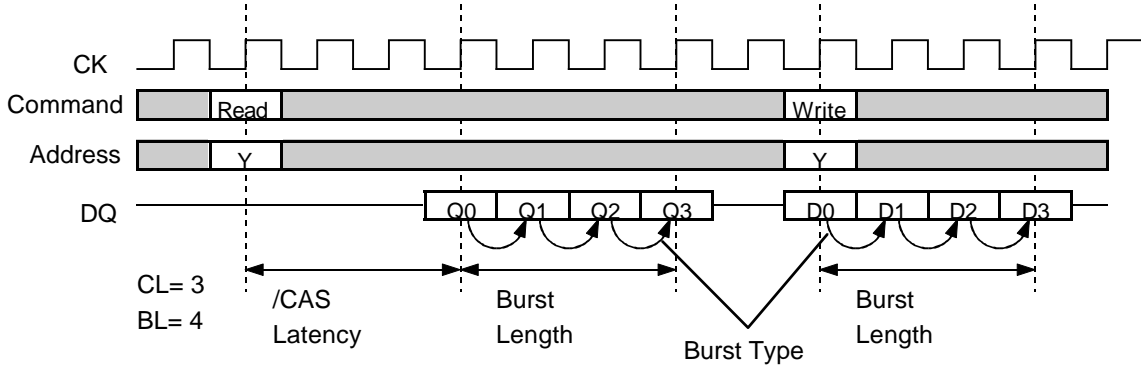
Burst Length, Burst Type and /CAS Latency can be programmed by setting the mode register(MRS). The mode register stores these data until the next MRS command, which may be issue when both banks are in idle state. After tRSC from a MRS command, the SDRAM is ready for new command.



Preliminary
Spec.

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| Initial Address | | | BL | Column Addressing | | | | | | | | | | | | | | | |
|-----------------|----|----|----|-------------------|---|---|---|---|---|---|---|-------------|---|---|---|---|---|---|---|
| A2 | A1 | A0 | | Sequential | | | | | | | | Interleaved | | | | | | | |
| 0 | 0 | 0 | 8 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 0 | 1 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 0 | 3 | 2 | 5 | 4 | 7 | 6 |
| 0 | 1 | 0 | | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 0 | 1 | 6 | 7 | 4 | 5 |
| 0 | 1 | 1 | | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 2 | 1 | 0 | 7 | 6 | 5 | 4 |
| 1 | 0 | 0 | | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 |
| 1 | 0 | 1 | | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 4 | 7 | 6 | 1 | 0 | 3 | 2 |
| 1 | 1 | 0 | | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 4 | 5 | 2 | 3 | 0 | 1 |
| 1 | 1 | 1 | | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | 0 | 0 | 4 | 0 | 1 | 2 | 3 | | | | | 0 | 1 | 2 | 3 | | | | |
| - | 0 | 1 | | 1 | 2 | 3 | 0 | | | | | 1 | 0 | 3 | 2 | | | | |
| - | 1 | 0 | | 2 | 3 | 0 | 1 | | | | | 2 | 3 | 0 | 1 | | | | |
| - | 1 | 1 | | 3 | 0 | 1 | 2 | | | | | 3 | 2 | 1 | 0 | | | | |
| - | - | 0 | 2 | 0 | 1 | | | | | | | 0 | 1 | | | | | | |
| - | - | 1 | | 1 | 0 | | | | | | | 1 | 0 | | | | | | |

Preliminary
Spec.**MH16S72PHB-6**

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Condition | Ratings | Unit |
|--------|-----------------------|---------------------|------------|------|
| Vdd | Supply Voltage | with respect to Vss | -0.5 ~ 4.6 | V |
| VI | Input Voltage | with respect to Vss | -0.5 ~ 4.6 | V |
| VO | Output Voltage | with respect to Vss | -0.5 ~ 4.6 | V |
| IO | Output Current | | 50 | mA |
| Pd | Power Dissipation | Ta=25C | 9 | W |
| Topr | Operating Temperature | | 0 ~ 70 | C |
| Tstg | Storage Temperature | | -45 ~ 100 | C |

RECOMMENDED OPERATING CONDITION

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

| Symbol | Parameter | Limits | | | Unit |
|--------|-------------------------------------|--------|------|---------|------|
| | | Min. | Typ. | Max. | |
| Vdd | Supply Voltage | 3.0 | 3.3 | 3.6 | V |
| Vss | Supply Voltage | 0 | 0 | 0 | V |
| VIH*1 | High-Level Input Voltage all inputs | 2.0 | | Vdd+0.3 | V |
| VIL*2 | Low-Level Input Voltage all inputs | -0.3 | | 0.8 | V |

NOTES)

1. VIH(max)=5.5V for pulse width less than 10ns.
2. VIL(min)= -1.0V for pulse width less than 10ns.

CAPACITANCE

(Ta=0 ~ 70C, Vdd = 3.3 +/- 0.3V, Vss = 0V, unless otherwise noted)

| Symbol | Parameter | Test Condition | Limits(max.) | Unit |
|--------|--------------------------------|----------------|--------------|------|
| CI(A) | Input Capacitance, address pin | 1Mhz | 49.2 | pF |
| CI(C) | Input Capacitance, control pin | 1.4V bias | 49.2 | pF |
| CI(K) | Input Capacitance, CK0 pin | 200mV swing | 32.5 | pF |
| CI/O | Input Capacitance, I/O pin | Vcc=3.3V | 16.5 | pF |

Preliminary
Spec.**MH16S72PHB-6**

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

AVERAGE SUPPLY CURRENT from Vdd

(Ta=0 ~70C, Vdd = 3.3 ± 0.3V, Vss = 0V, unless otherwise noted)

| Parameter | Symbol | Test Condition | Limits (max) | Unit | Note |
|---|--------|--|--------------|------|------|
| operating current single bank operation (discrete) | Icc1 | tRC=min,tCLK=min, BL=1, CL=3 | 1170 | mA | *1 |
| precharge stanby current in Non power-down mode /CS> Vcc-0.2V | Icc2N | CKE=H,tCLK=15ns,VIH> Vcc-0.2V, VIL<0.2V | 225 | mA | *1 |
| | Icc2NS | CLK=L & CKE=H, VIH> Vcc-0.2V, VIL<0.2V (fixed) | 135 | mA | *1 |
| precharge stanby current in Power-down mode /CS> Vcc-0.2V | Icc2P | CKE=L,tCLK=15ns | 18 | mA | *1 |
| | Icc2PS | CKE=CLK=L | 9 | mA | *1 |
| active stanby current | Icc3N | CKE=H,tCLK=15ns | 360 | mA | *1 |
| | Icc3NS | CKE=H,CLK=L | 315 | mA | *1 |
| burst current | Icc4 | tCLK=min, BL=4, CL=3 all banks active(discerte) | 1800 | mA | *1 |
| auto-refresh current | Icc5 | tRC=min, tCLK=min | 1800 | mA | *1 |
| self-refresh current | Icc6 | CKE <0.2V | 18 | mA | *1 |

Note)

1.Icc(max) is specified at the output open condition.

AC OPERATING CONDITIONS AND CHARACTERISTICS

(Ta=0 ~ 70C, Vdd = 3.3 ± 0.3V, Vss = 0V, unless otherwise noted)

| Symbol | Parameter | Test Condition | Limits | | Unit |
|---------|-------------------------------|-----------------------|--------|------|------|
| | | | Min. | Max. | |
| VOH(DC) | High-Level Output Voltage(DC) | IOH=-2mA | 2.4 | | V |
| VOL(DC) | Low-Level Output Voltage(DC) | IOL=2mA | | 0.4 | V |
| IOZ | Off-stare Output Current | Q floating VO=0 ~ Vdd | -10 | 10 | uA |
| Ii | Input Current | VIH=0 ~ Vdd+0.3V | -90 | 90 | uA |

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

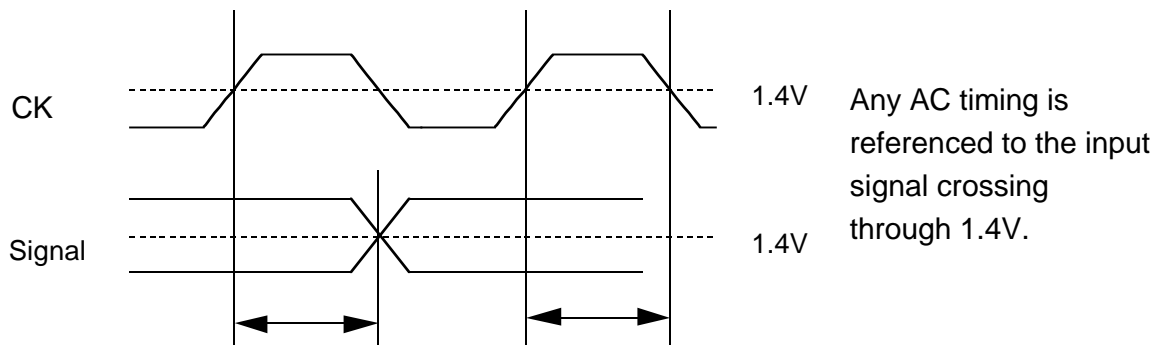
AC TIMING REQUIREMENTS

(Ta=0 ~ 70C, Vdd = 3.3 +/- 0.3V, Vss = 0V, unless otherwise noted)

Input Pulse Levels: 0.8V to 2.0V

Input Timing Measurement Level: 1.4V

| Symbol | Parameter | Limits | | Unit |
|--------|------------------------------|--------|------|------|
| | | Min. | Max. | |
| tCLK | CK cycle time | CL=3 | 7.5 | ns |
| | | CL=2 | - | ns |
| tCH | CK High pulse width | 2.5 | | ns |
| tCL | CK Low pulse width | 2.5 | | ns |
| tT | Transition time of CK | 1 | 10 | ns |
| tIS | Input Setup time(all inputs) | 1.5 | | ns |
| tIH | Input Hold time(all inputs) | 0.8 | | ns |
| tRC | Row Cycle time | 67.5 | | ns |
| tRFC | Row Refresh Cycle time | 80 | | ns |
| tRCD | Row to Column Delay | 22.5 | | ns |
| tRAS | Row Active time | 45 | 100K | ns |
| tRP | Row Precharge time | 22.5 | | ns |
| tWR | Write Recovery time | 15 | | ns |
| tRRD | Act to Act Deley time | 15 | | ns |
| tRSC | Mode Register Set Cycle time | 15 | | ns |
| tSRX | Self Refresh Exit time | 7.5 | | ns |
| tPDE | Power Down Exit time | 7.5 | | ns |
| tREF | Refresh Interval time | | 64 | ms |



Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

SWITCHING CHARACTERISTICS

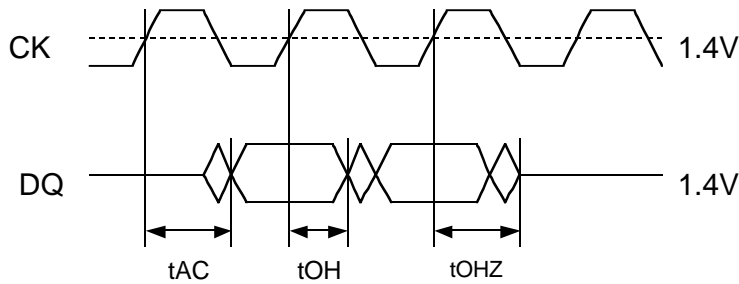
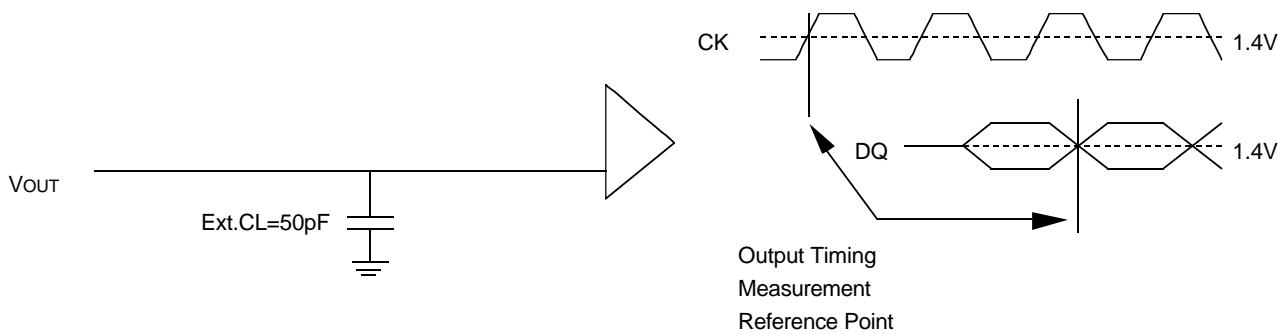
($T_a=0 \sim 70^\circ\text{C}$, $V_{dd} = 3.3 \pm 0.3\text{V}$, $V_{ss} = 0\text{V}$, unless otherwise noted)

| Symbol | Parameter | Limits | | Unit | Note |
|--------|---|--------|------|------|------|
| | | Min. | Max. | | |
| tAC | Access time from CK | CL=3 | 5.4 | ns | *1 |
| | | CL=2 | - | | |
| tOH | Output Hold time from CK | 2.7 | | ns | |
| tOLZ | Delay time, output low impedance from CK | 0 | | ns | |
| tOHZ | Delay time, output high impedance from CK | 2.7 | 5.4 | ns | |

NOTE)

1.If clock rising time is longer than 1ns, ($t_r / 2 - 0.5\text{ns}$) should be added to the parameter.

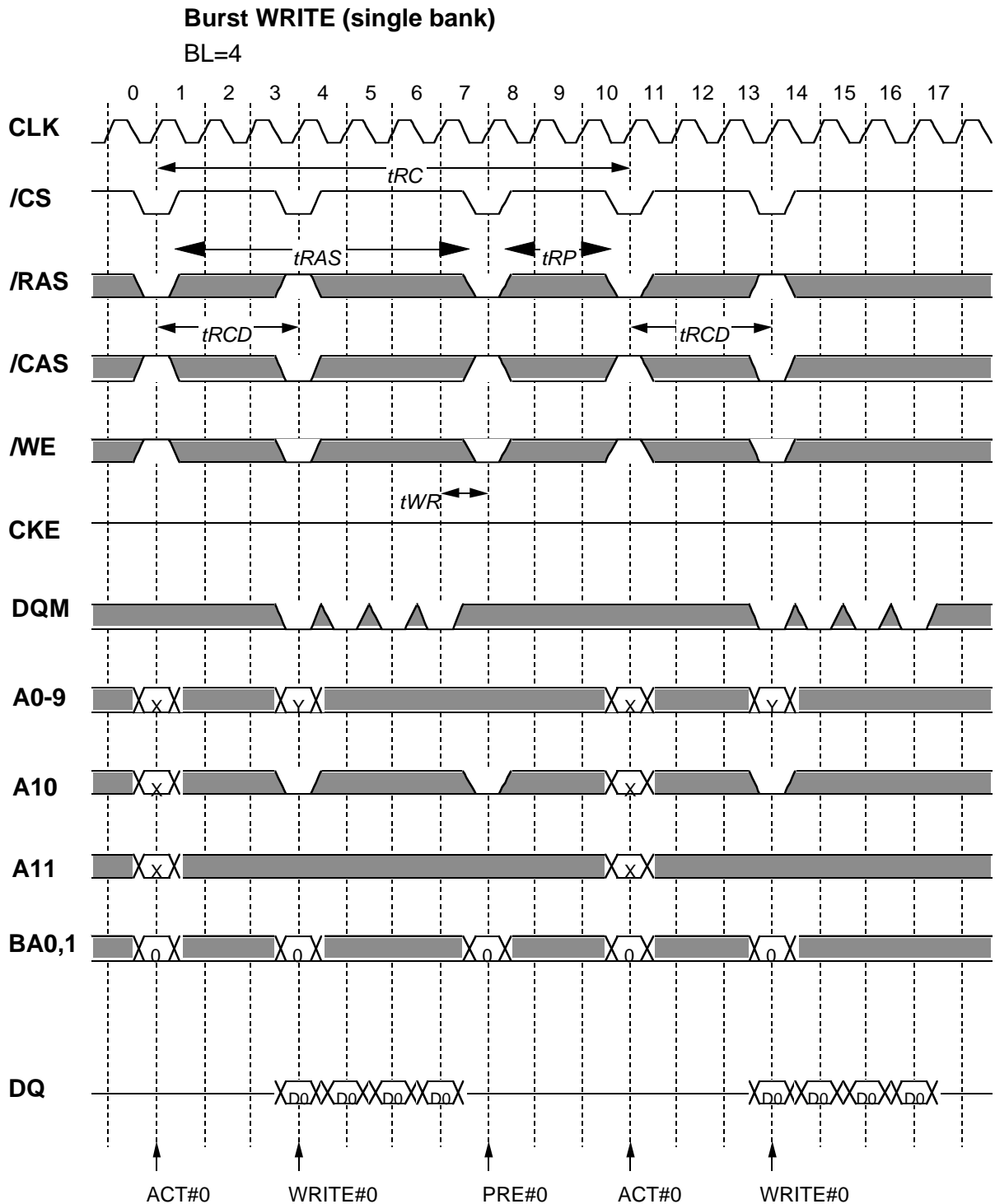
Output Load Condition



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MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM



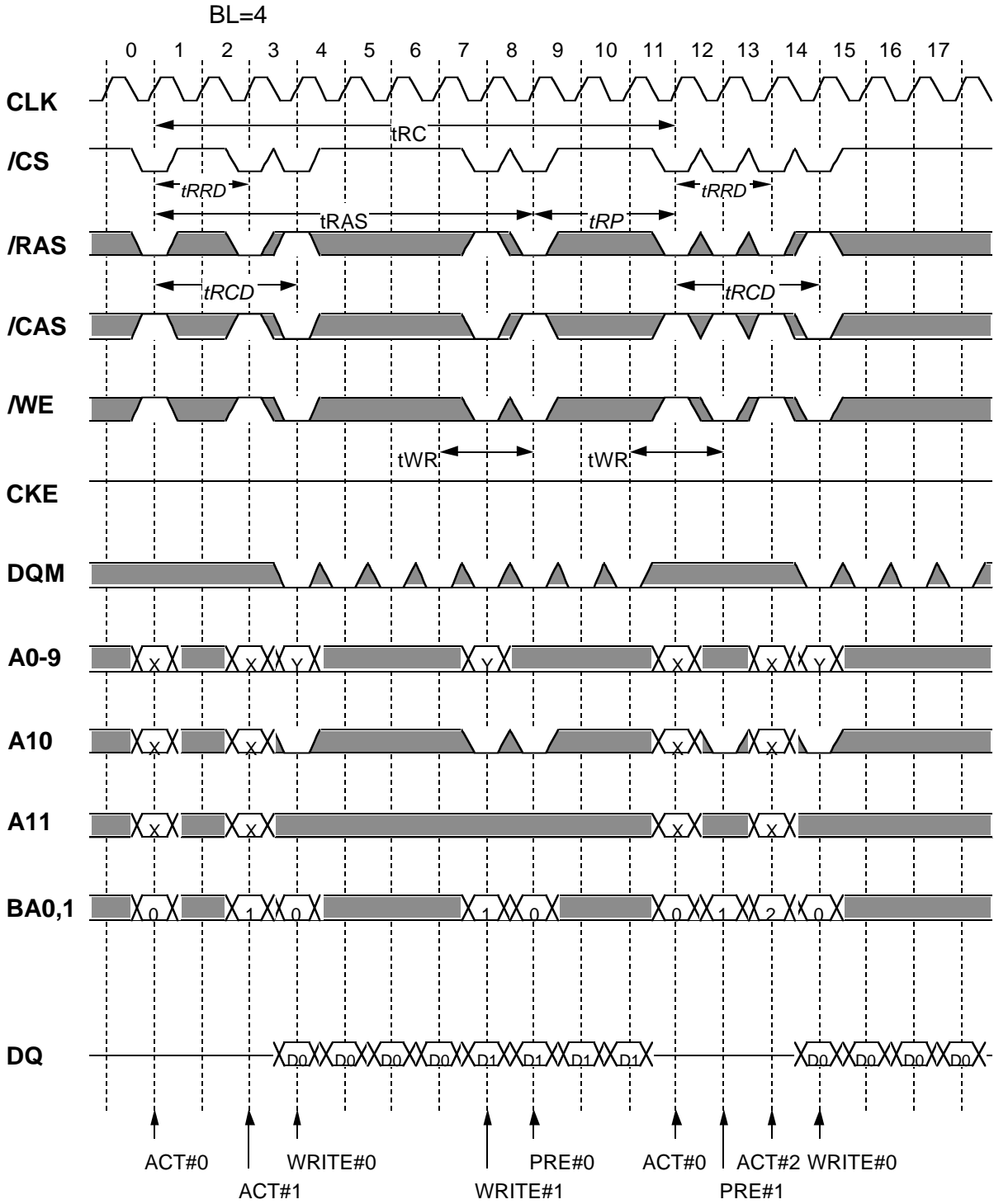
Italic parameter indicates minimum case

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Burst WRITE (multi bank)

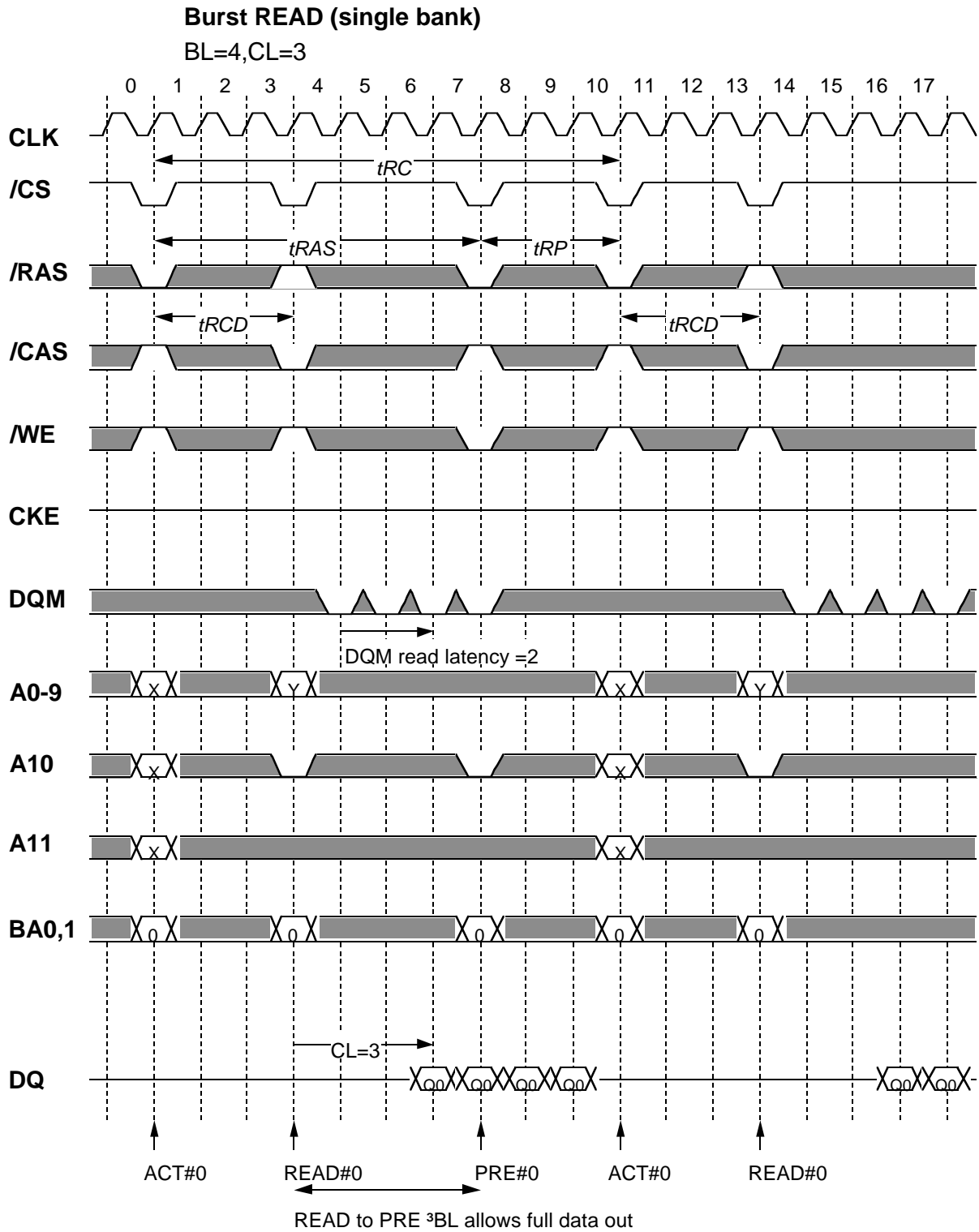


Italic parameter indicates minimum case

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM



Italic parameter indicates minimum case

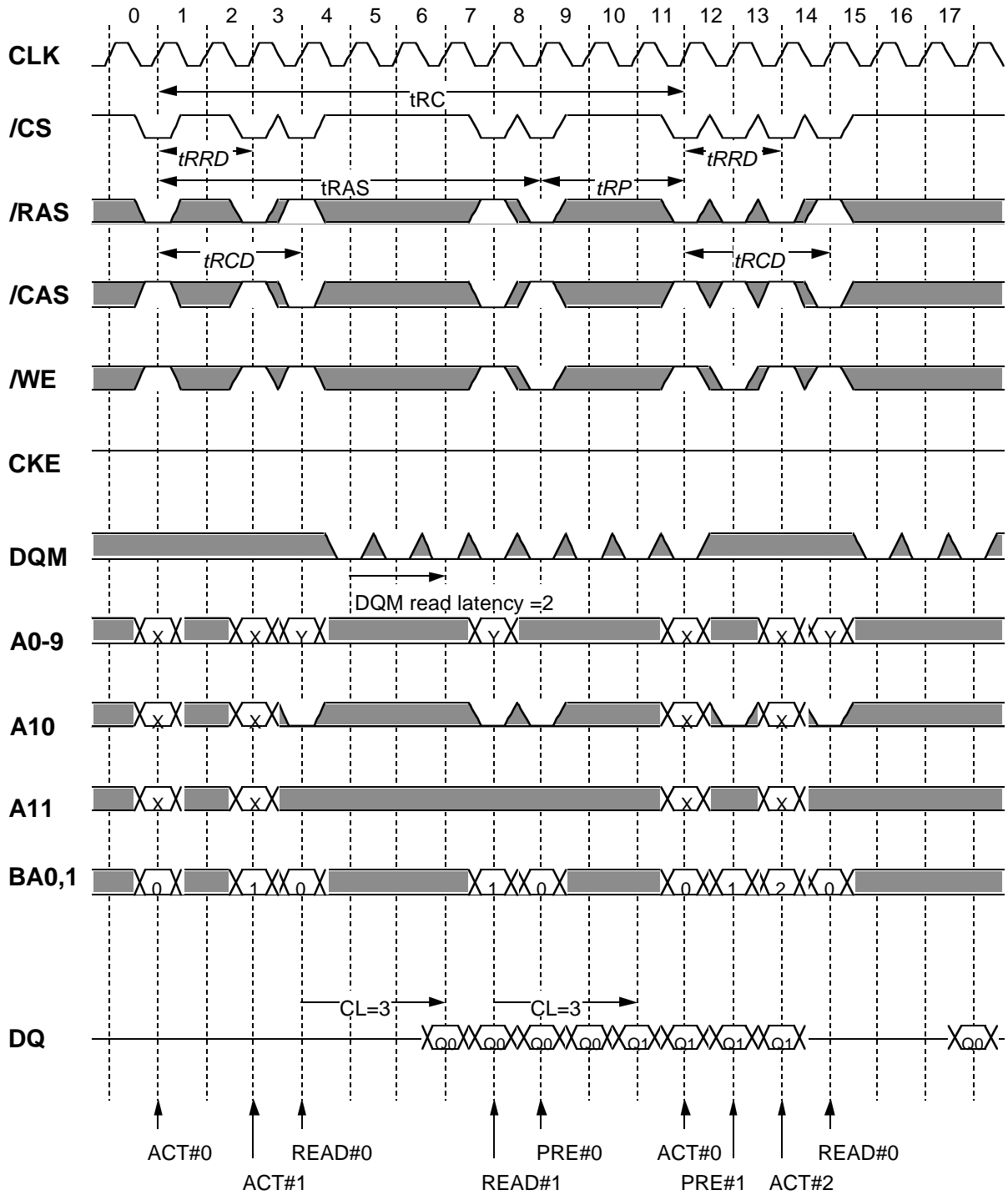
Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Burst READ (multi bank)

BL=4,CL=3



Italic parameter indicates minimum case

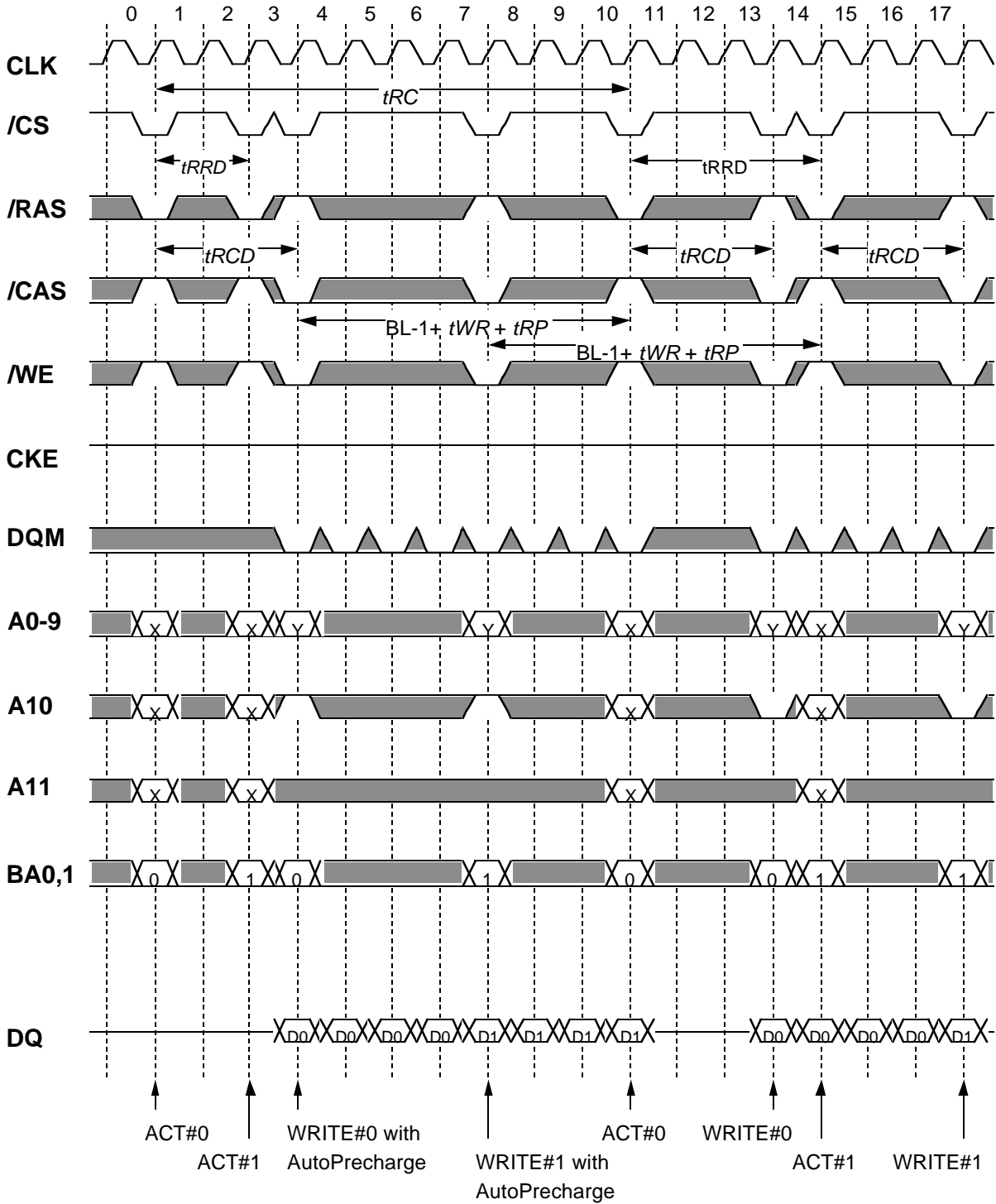
Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Burst WRITE (multi bank) with AUTO-PRECHARGE

BL=4



Italic parameter indicates minimum case

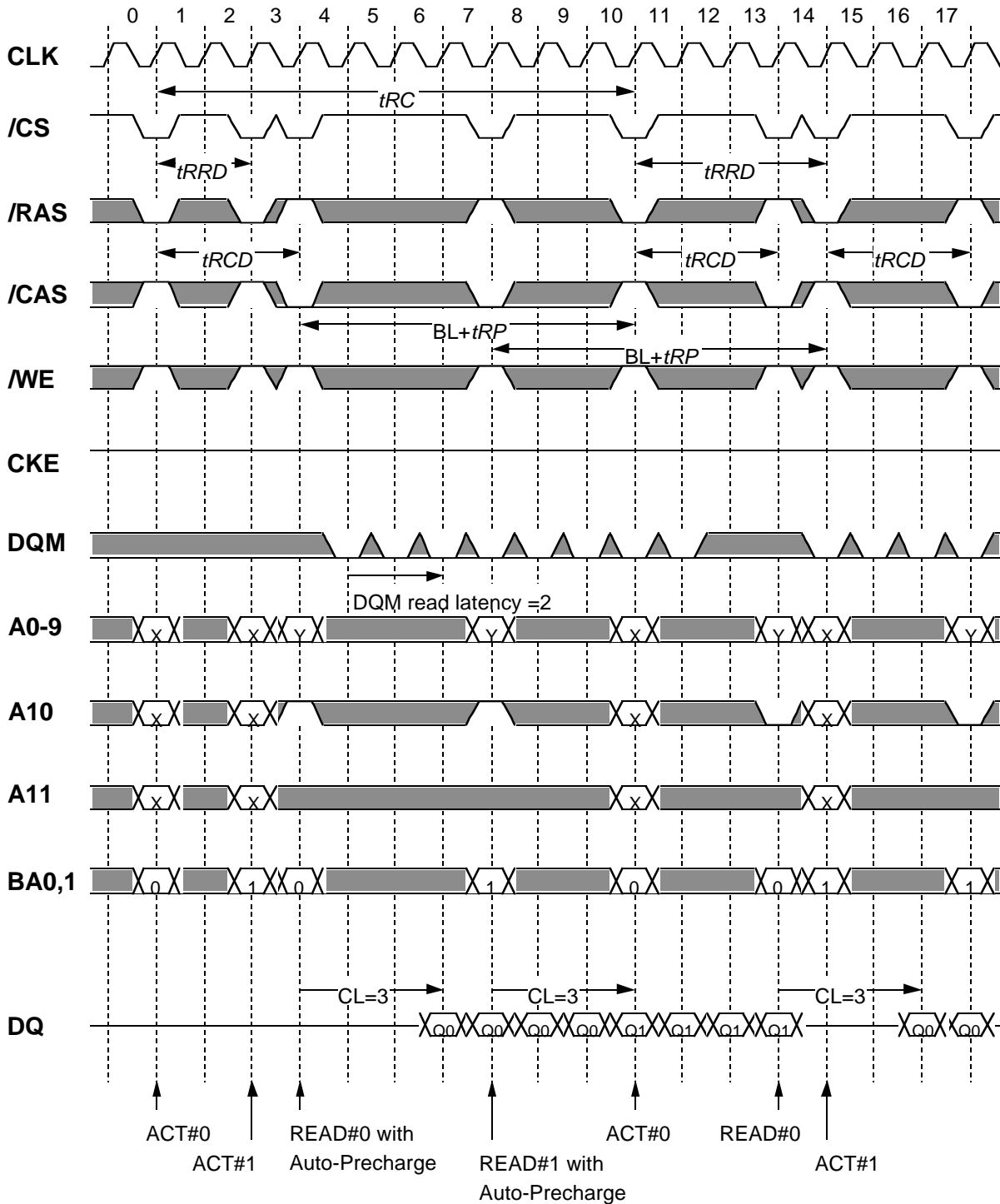
Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Burst READ (multi bank) with AUTO-PRECHARGE

BL=4,CL=3



Italic parameter indicates minimum case

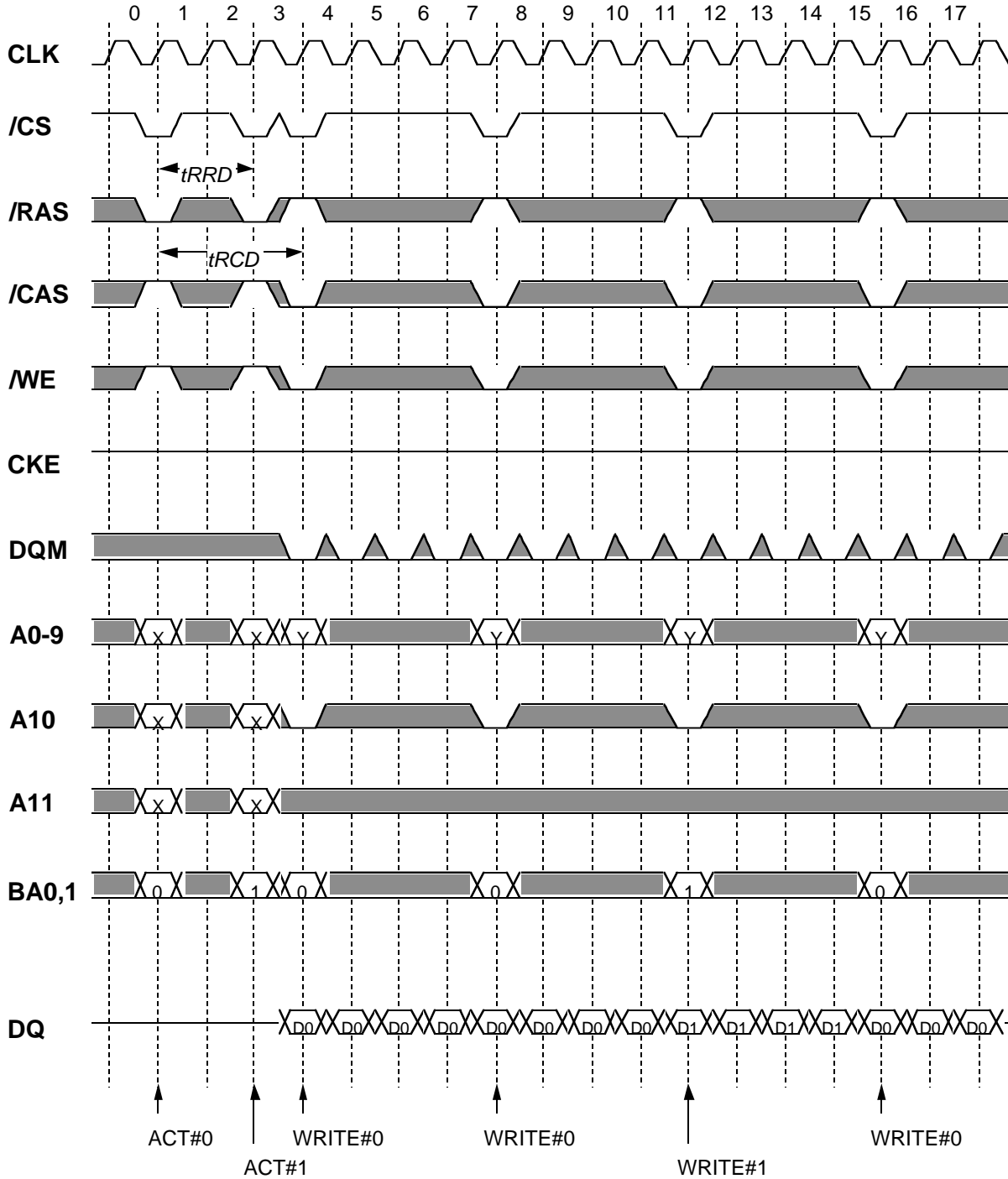
Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Page Mode Burst Write (multi bank)

BL=4



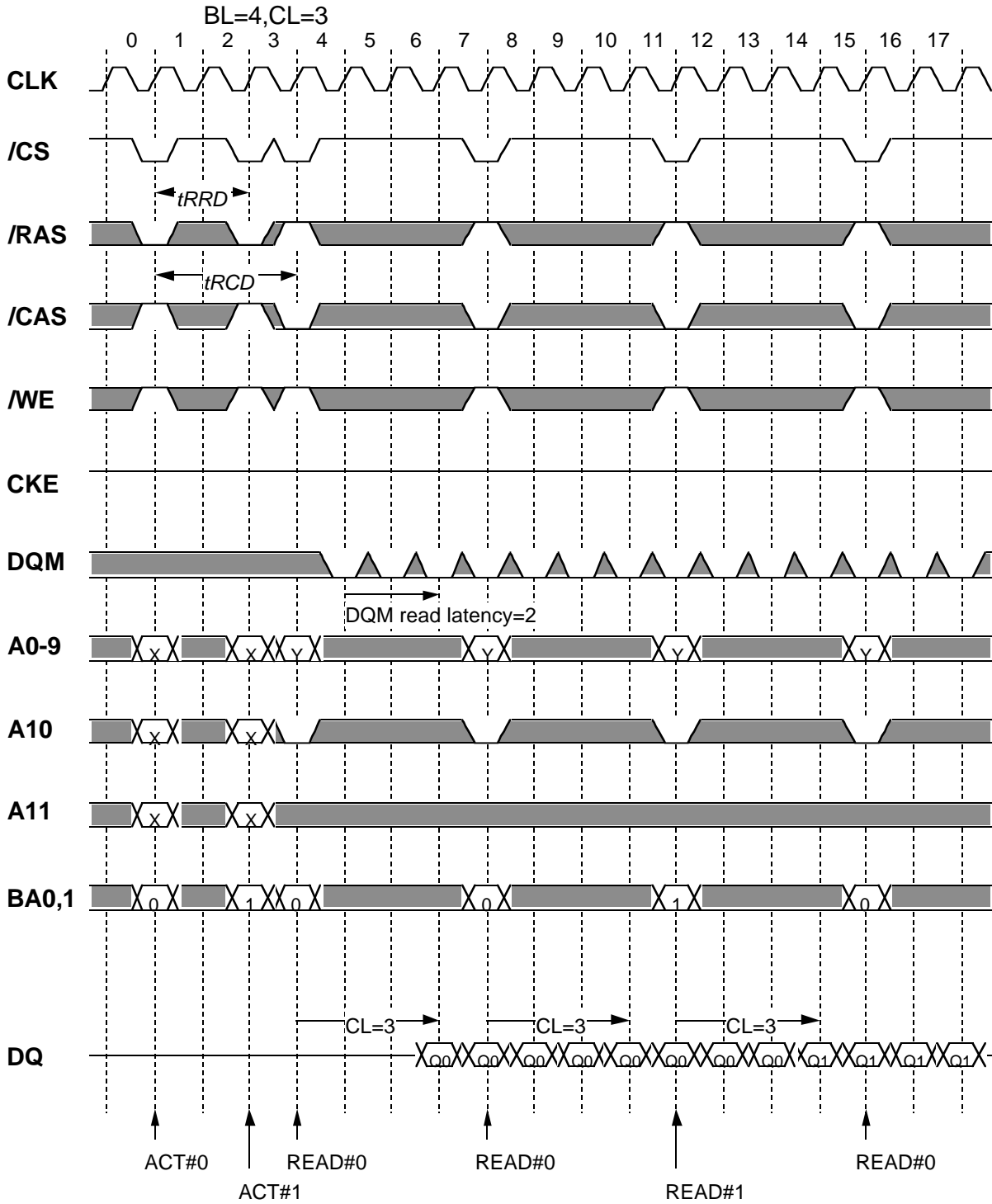
Italic parameter indicates minimum case

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Page Mode Burst Read (multi bank)



Italic parameter indicates minimum case

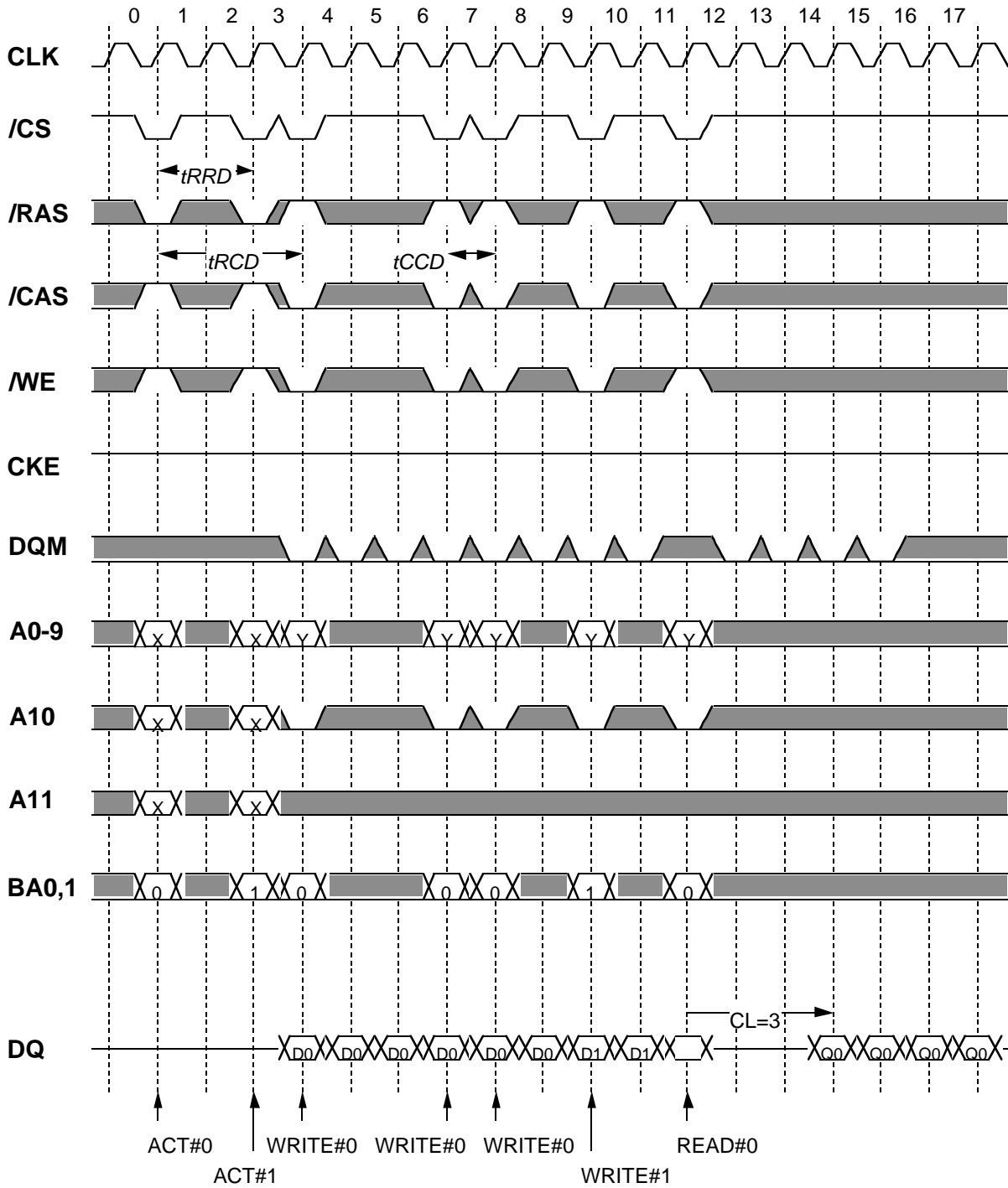
Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Write Interrupted by Write / Read

BL=4



Burst Write can be interrupted by Write or Read of any active bank.

Italic parameter indicates minimum case

Preliminary
Spec.

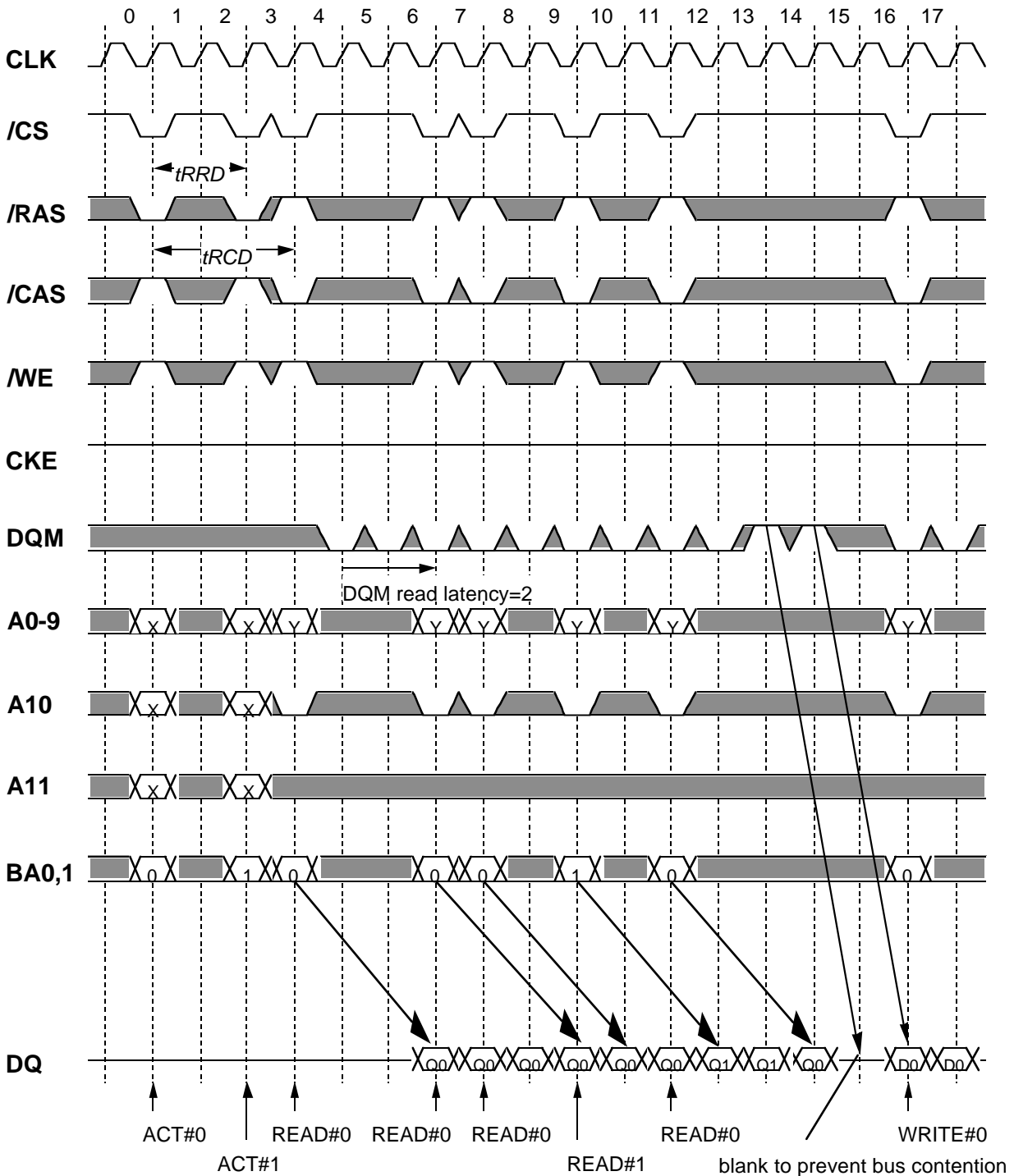
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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Read Interrupted by Read / Write

BL=4,CL=3



Burst Read can be interrupted by Read or Write of any active bank.

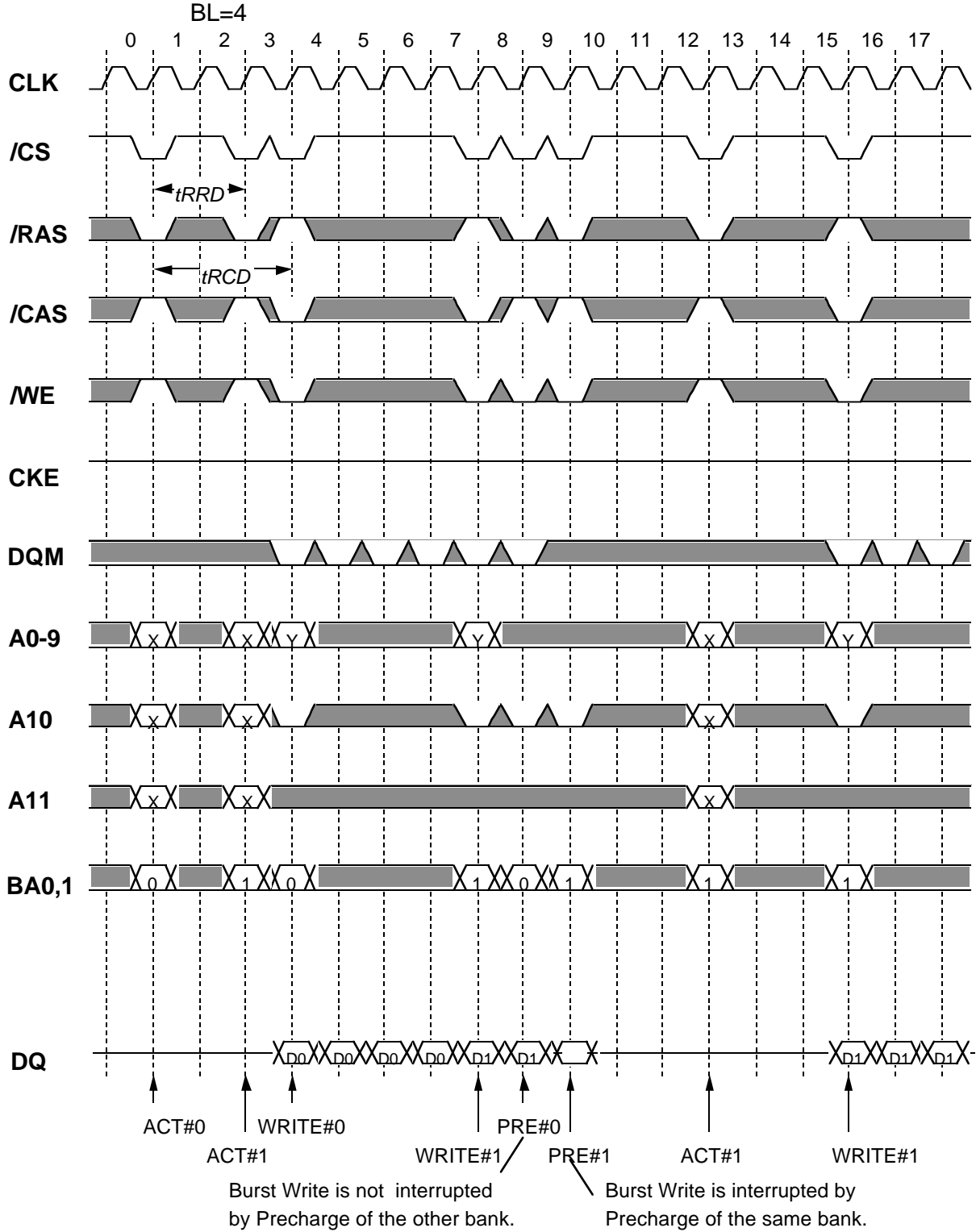
Italic parameter indicates minimum case

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Write Interrupted by Precharge



Italic parameter indicates minimum case

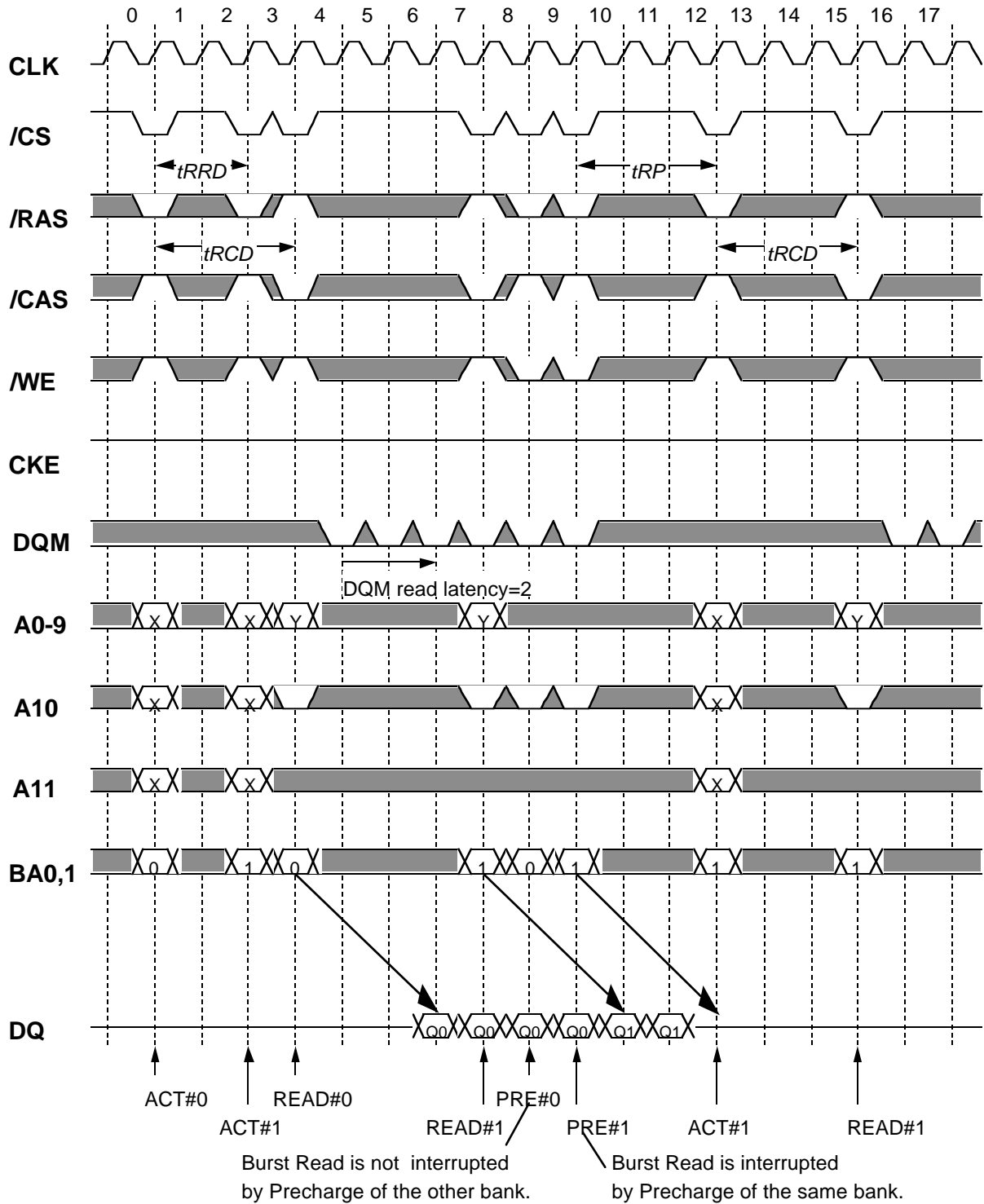
Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Read Interrupted by Precharge

BL=4,CL=3



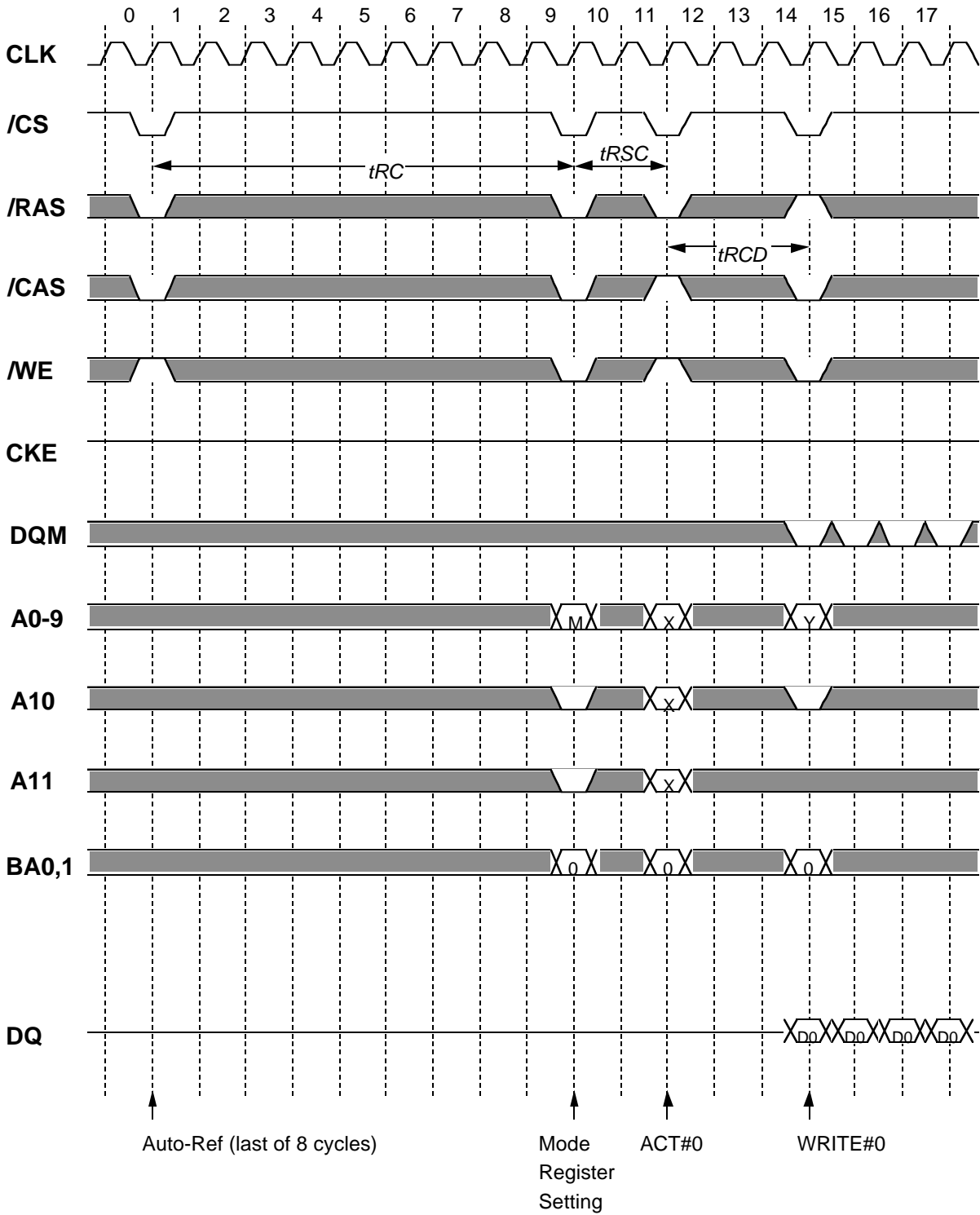
Italic parameter indicates minimum case

Preliminary
Spec.

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Mode Register Setting



Italic parameter indicates minimum case

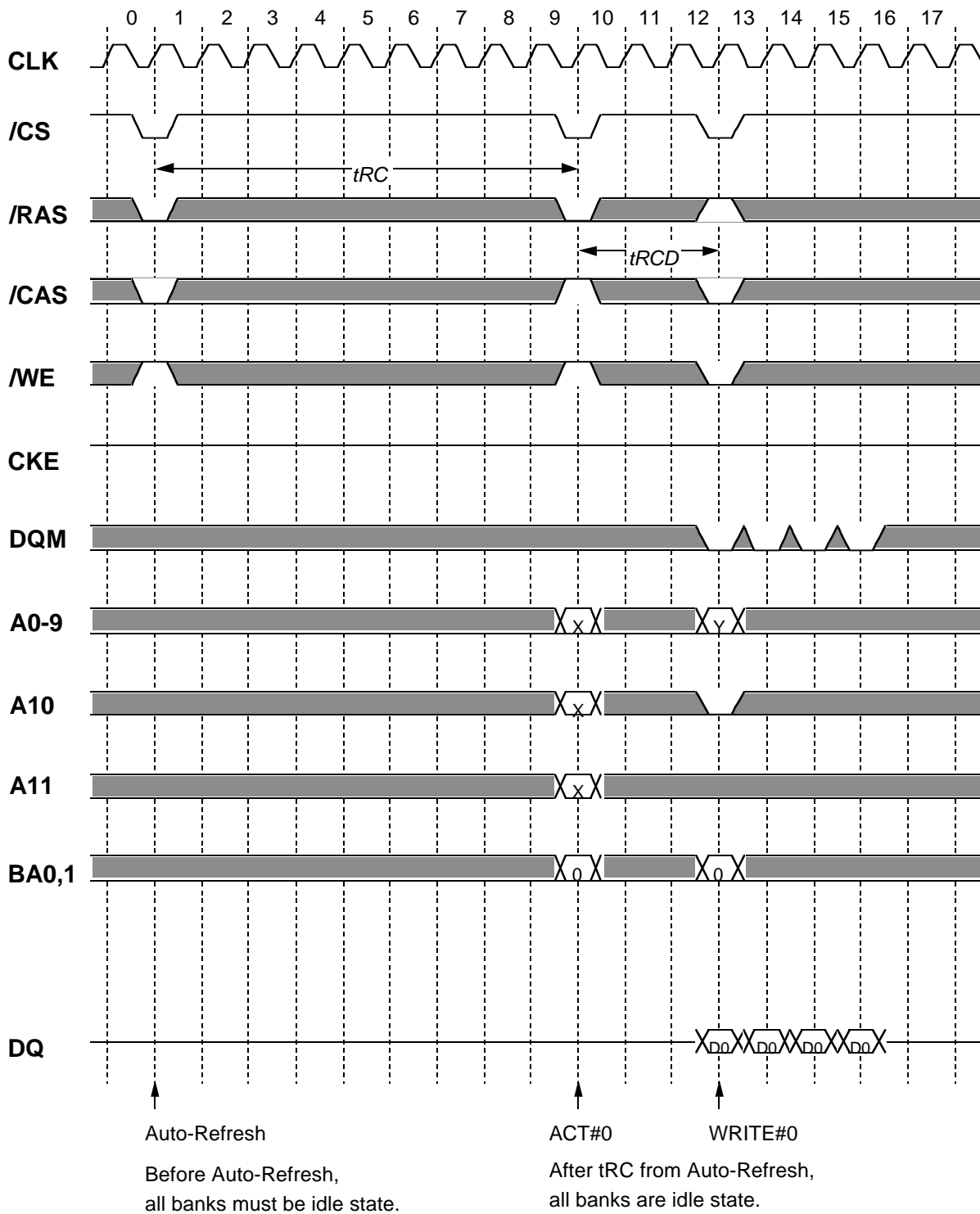
Preliminary
Spec.

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Auto-Refresh BL=4



Italic parameter indicates minimum case

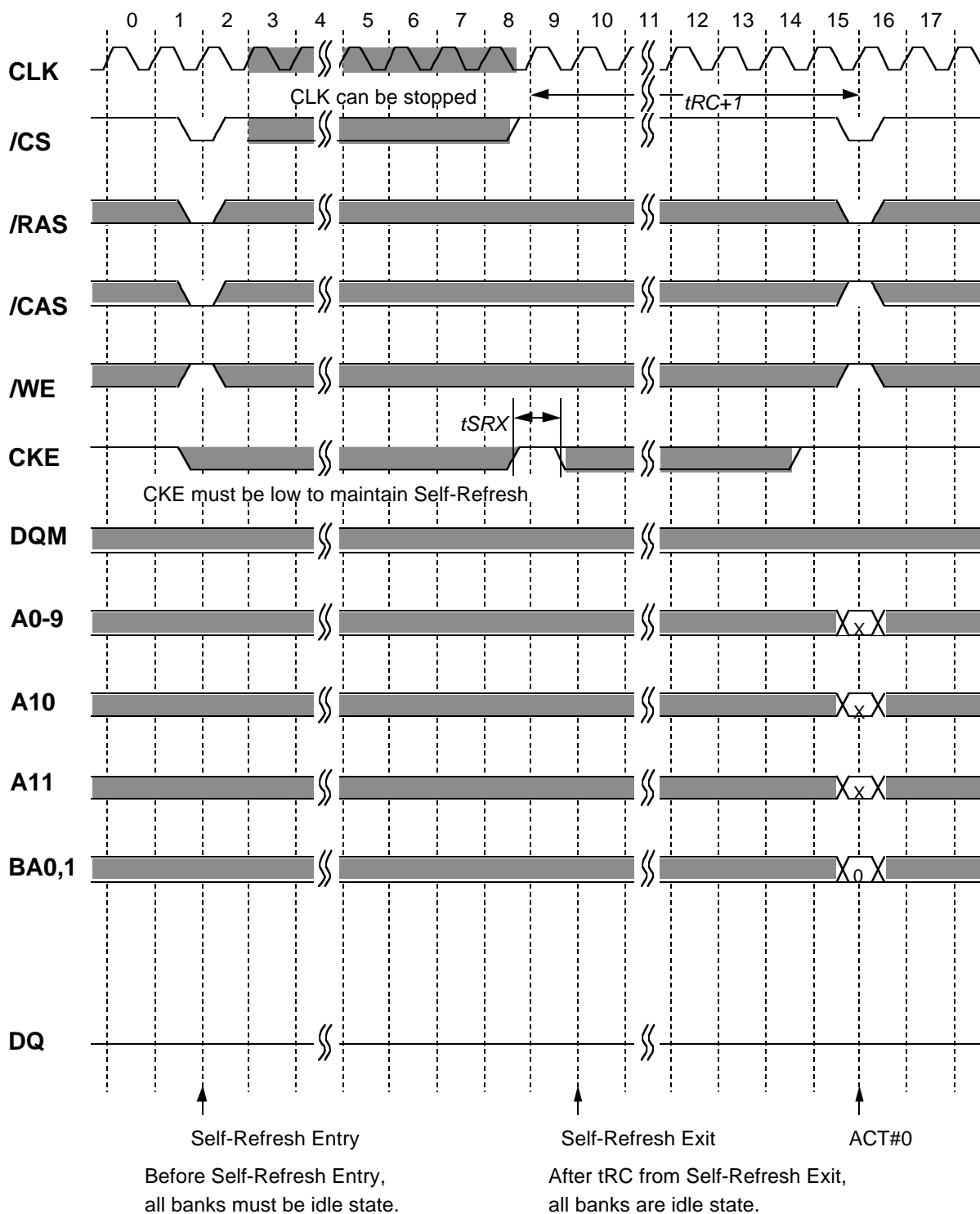
Preliminary
Spec.

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Self-Refresh



Italic parameter indicates minimum case

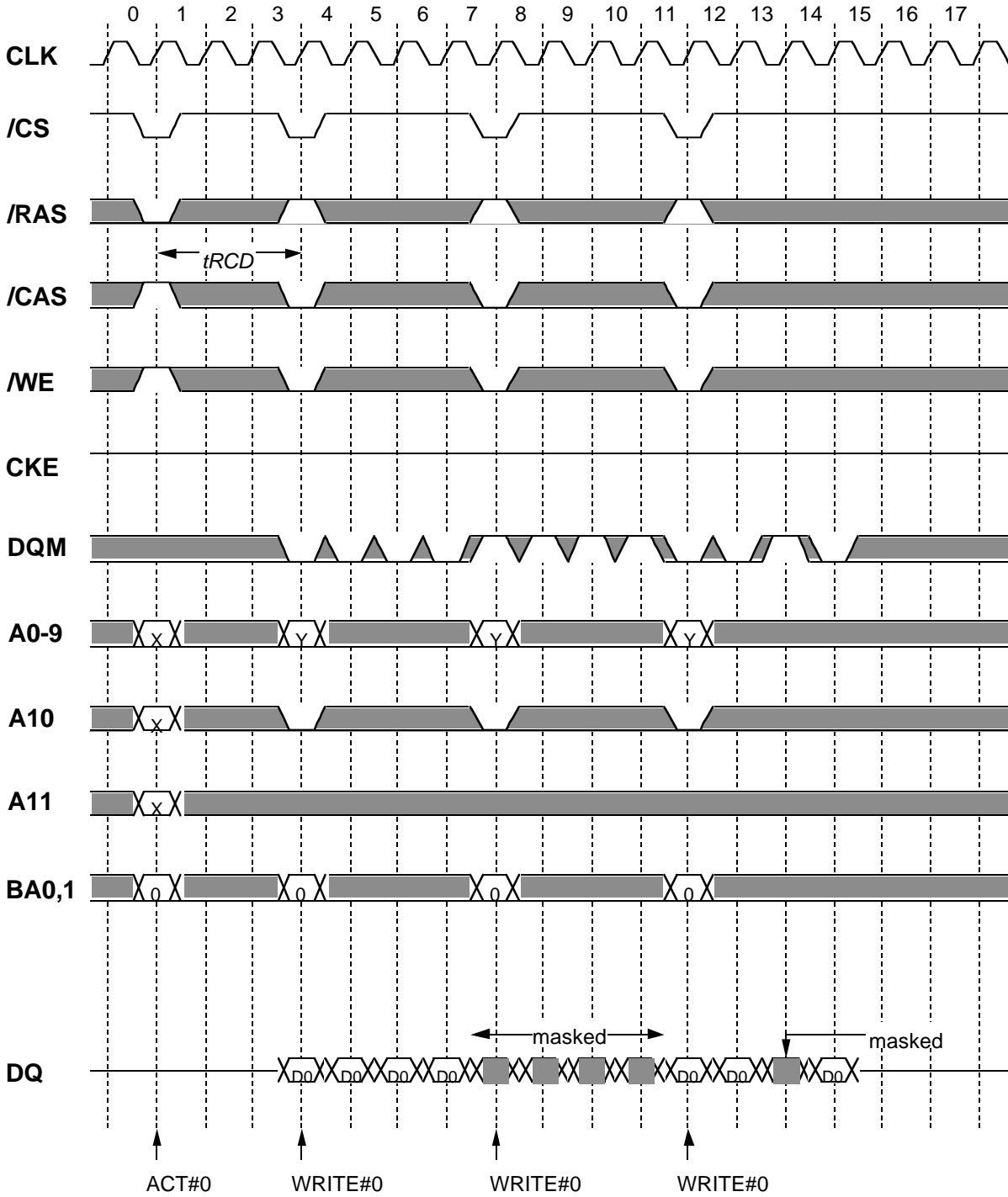
Preliminary
Spec.

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DQM Write Mask

BL=4

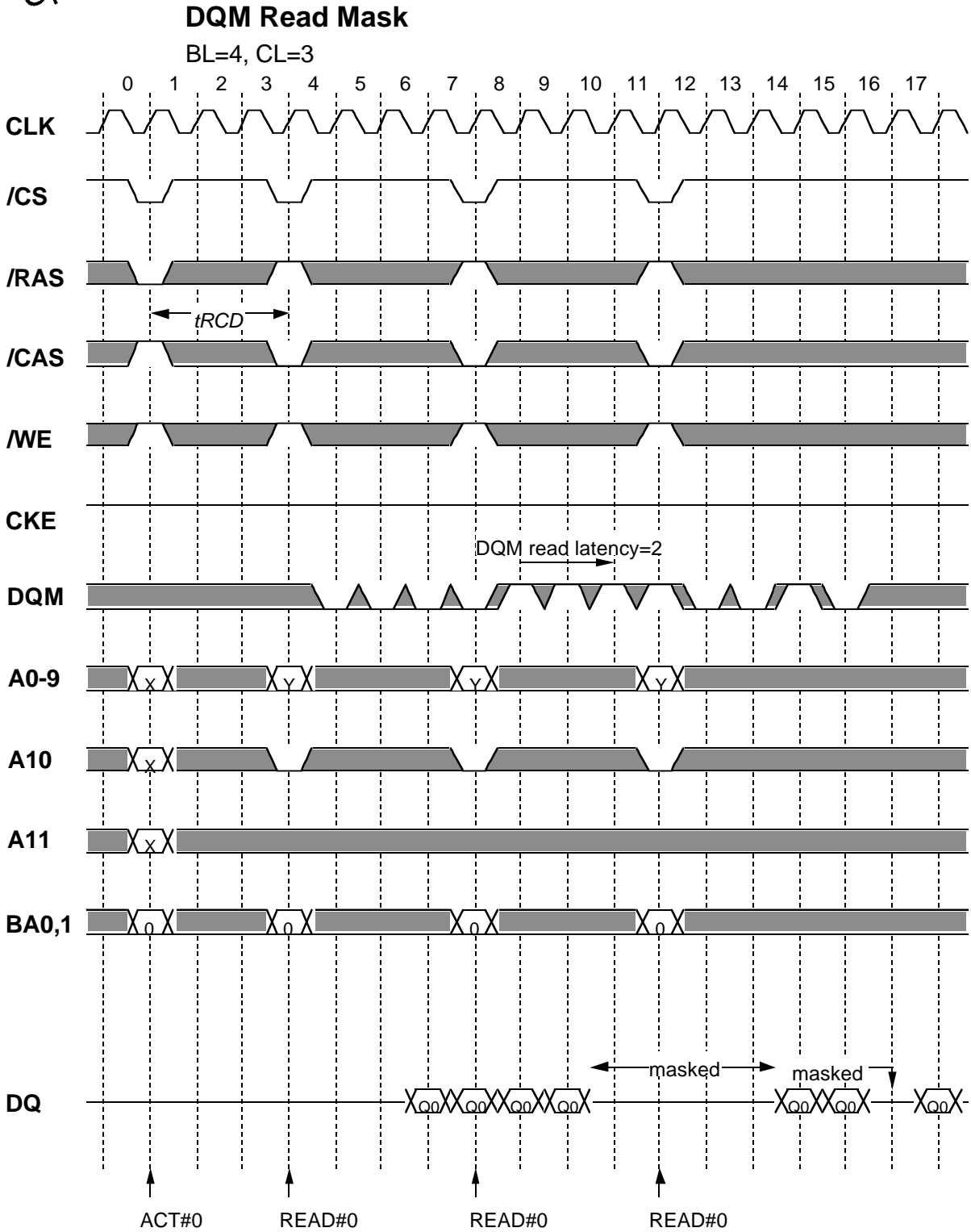


Italic parameter indicates minimum case

Preliminary
Spec.

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Italic parameter indicates minimum case

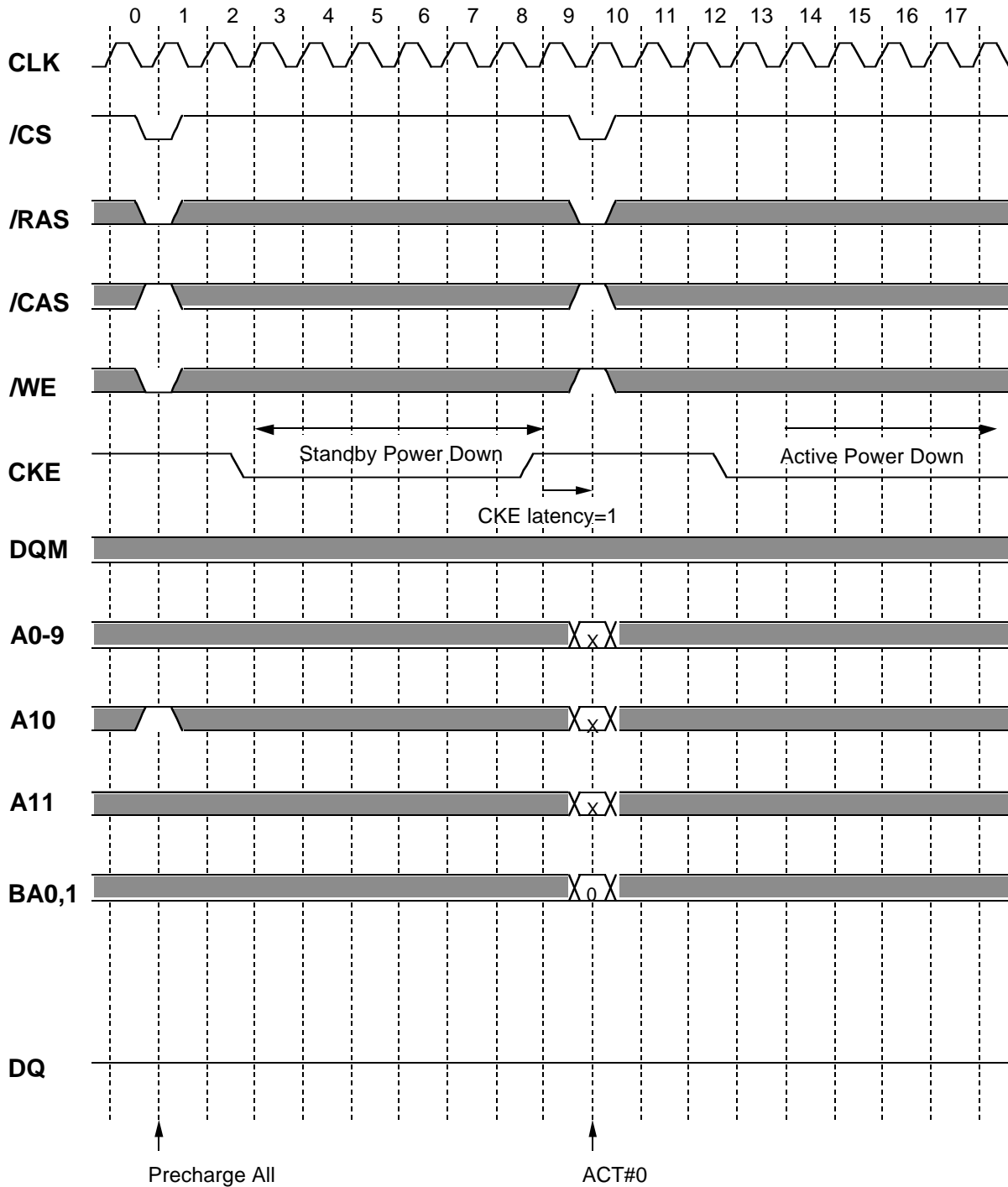
Preliminary
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Power Down



Italic parameter indicates minimum case

Preliminary
Spec.

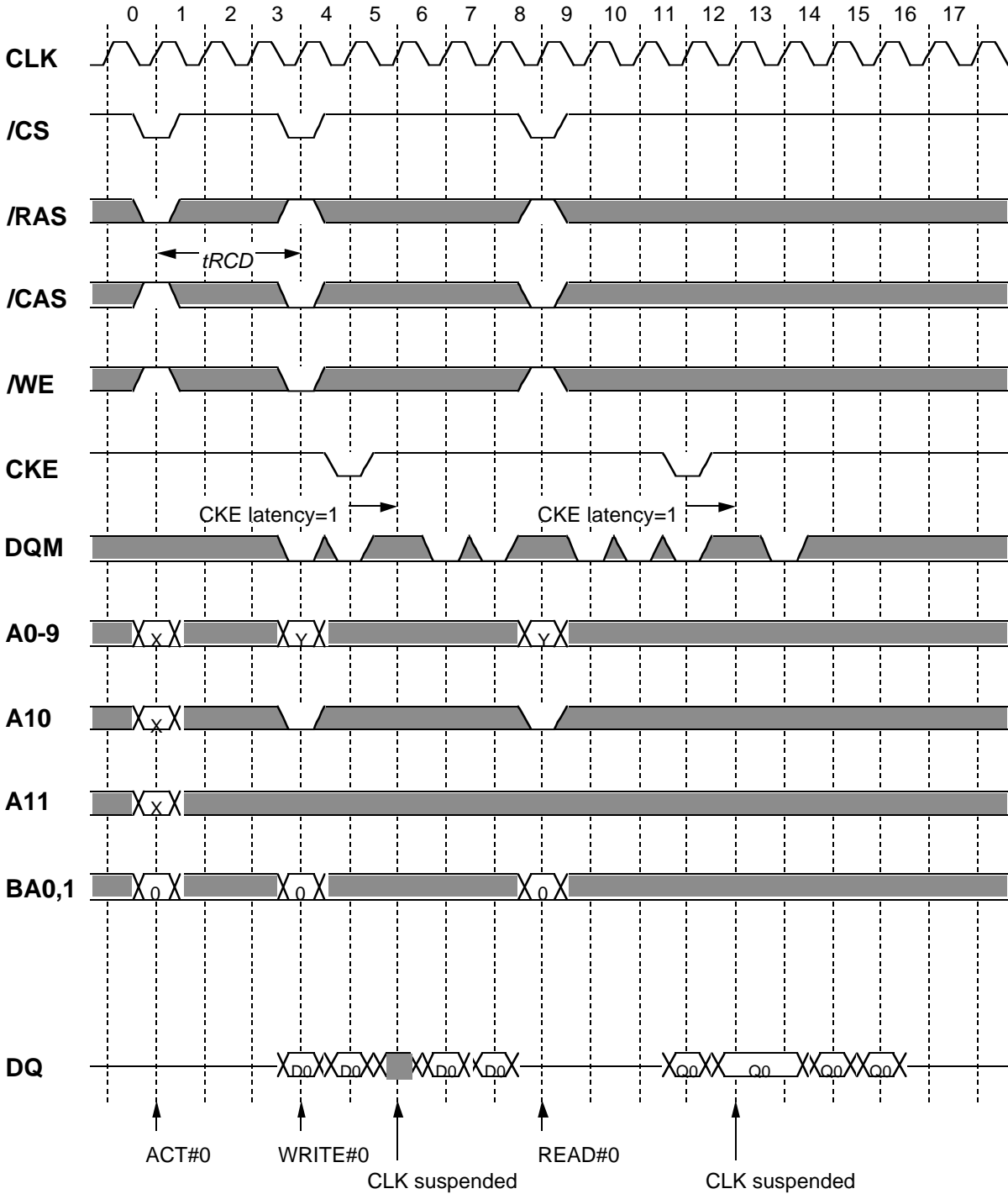
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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

CLK Suspend

BL=4,CL=3



Italic parameter indicates minimum case

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Serial Presence Detect Table I

| Byte | Function described | SPD entry data | SPD DATA(hex) |
|------|--|---|---------------|
| 0 | # of Serial PD Bytes Written during Production | 128 | 80 |
| 1 | Total # of Bytes in SPD device | 256 Bytes | 08 |
| 2 | Fundamental memory type | SDRAM | 04 |
| 3 | # Row Addresses on this assembly | A0-A11 | 0C |
| 4 | # Column Addresses on this assembly | A0-A9 | 0A |
| 5 | # Module Banks on this assembly | 1BANK | 01 |
| 6 | Data Width of this assembly... | x72 | 48 |
| 7 | ... Data Width continuation | 0 | 00 |
| 8 | Voltage interface standard of this assembly | LVTTL | 01 |
| 9 | SDRAM Cycletime at Max. Supported CAS Latency (CL). Cycle time for CL=3 | 7.5ns | 75 |
| 10 | SDRAM Access from Clock tAC for CL=3 | 5.4ns | 54 |
| 11 | DIMM Configuration type (Non-parity,Parity,ECC) | ECC | 02 |
| 12 | Refresh Rate/Type | self refresh(15.625uS) | 80 |
| 13 | SDRAM width.Primary DRAM | x8 | 08 |
| 14 | Error Checking SDRAM data width | x8 | 08 |
| 15 | Minimum Clock Delay,Back to Back Random Column Addresses | 1 | 01 |
| 16 | Burst Lengths Supported | 1/2/4/8/Full page | 8F |
| 17 | # Banks on Each SDRAM device | 4bank | 04 |
| 18 | CAS# Latency | 3 | 04 |
| 19 | CS# Latency | 0 | 01 |
| 20 | Write Latency | 0 | 01 |
| 21 | SDRAM Module Attributes | unbuffered | 00 |
| 22 | SDRAM Device Attributes:General | Precharge All,Auto precharge Write1/Read Burst | 0E |
| 23 | SDRAM Cycle time(2nd highest CAS latency) Cycle time for CL=2 | N/A | 00 |
| 24 | SDRAM Access form Clock(2nd highest CAS latency) tAC for CL=2 | N/A | 00 |
| 25 | SDRAM Cycle time(3rd highest CAS latency) | N/A | 00 |
| 26 | SDRAM Access form Clock(3rd highest CAS latency) | N/A | 00 |
| 27 | Precharge to Active Minimum | 23ns(22.5ns) | 17 |
| 28 | Row Active to Row Active Min. | 15ns | 0F |
| 29 | RAS to CAS Delay Min | 23ns(22.5ns) | 17 |
| 30 | Active to Precharge Min | 45ns | 2D |

Preliminary
Spec.

MH16S72PHB-6

1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Serial Presence Detect Table II

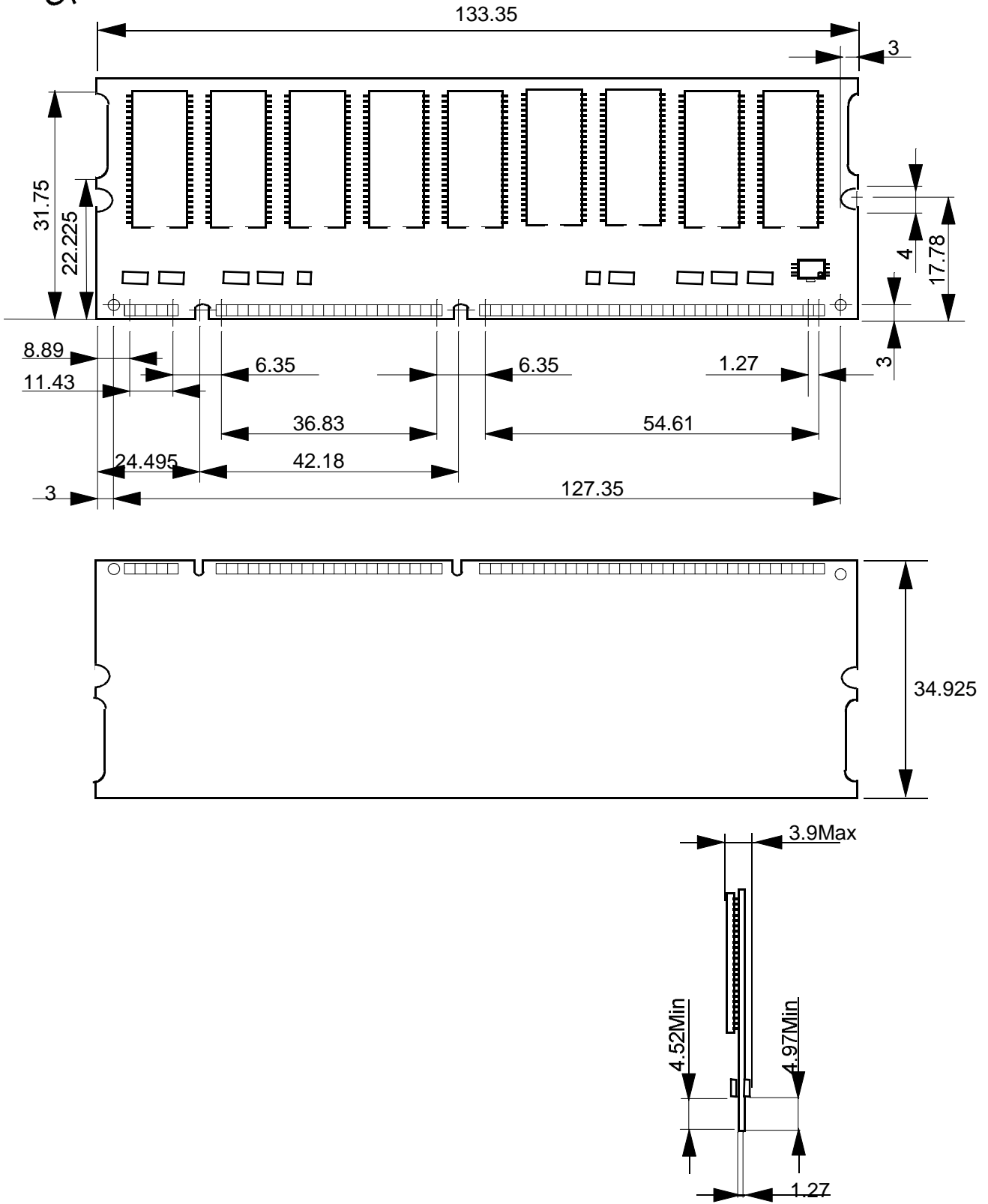
| | | | |
|--------|--|----------------|------------------------------------|
| 31 | Density of each bank on module | 128MByte | 20 |
| 32 | Command and Address signal input setup time | 1.5ns | 15 |
| 33 | Command and Address signal input hold time | 0.8ns | 08 |
| 34 | Data signal input setup time | 1.5ns | 15 |
| 35 | Data signal input hold time | 0.8ns | 08 |
| 36-61 | Superset Information (may be used in future) | option | 00 |
| 62 | SPD Revision | JEDEC2 | 02 |
| 63 | Checksum for bytes 0-62 | | B5 |
| 64-71 | Manufactures Jedec ID code per JEP-108E | MITSUBISHI | 1CFFFFFFFFFFFFFF |
| 72 | Manufacturing location | Miyoshi,Japan | 01 |
| | | Tajima,Japan | 02 |
| | | NC,USA | 03 |
| | | Germany | 04 |
| 73-90 | Manufactures Part Number | MH16S72PHB-6 | 4D4831365337325048422D362020202020 |
| 91-92 | Revision Code | PCB revision | rrrr |
| 93-94 | Manufacturing date | year/week code | yyww |
| 95-98 | Assembly Serial Number | serial number | ssssssss |
| 99-125 | Manufacture Specific Data | option | 00 |
| 126 | Intell specification frequency | | 64 |
| 127 | Intel specification CAS# Latency support | CL=3,AP,CK0,2 | AD |
| 128+ | Unused storage locations | open | 00 |

Preliminary
Spec.

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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM



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1,207,959,552-BIT (16,777,216-WORD BY 72-BIT) Synchronous DYNAMIC RAM

Keep safety first in your circuit designs!

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