

M312L6420DT0

184pin 1U Registered DDR SDRAM MODULE

512MB DDR SDRAM MODULE

(64Mx72 based on 64Mx4 DDR SDRAM)

Registered 184pin DIMM
72-bit ECC/Parity

Revision 0.0

Jan. 2002

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Revision History

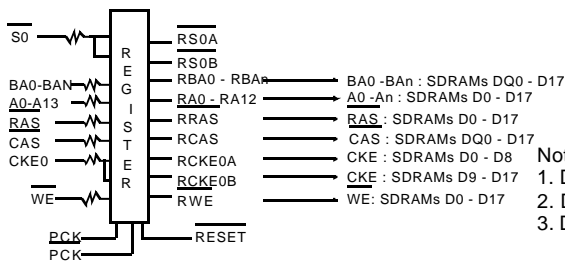
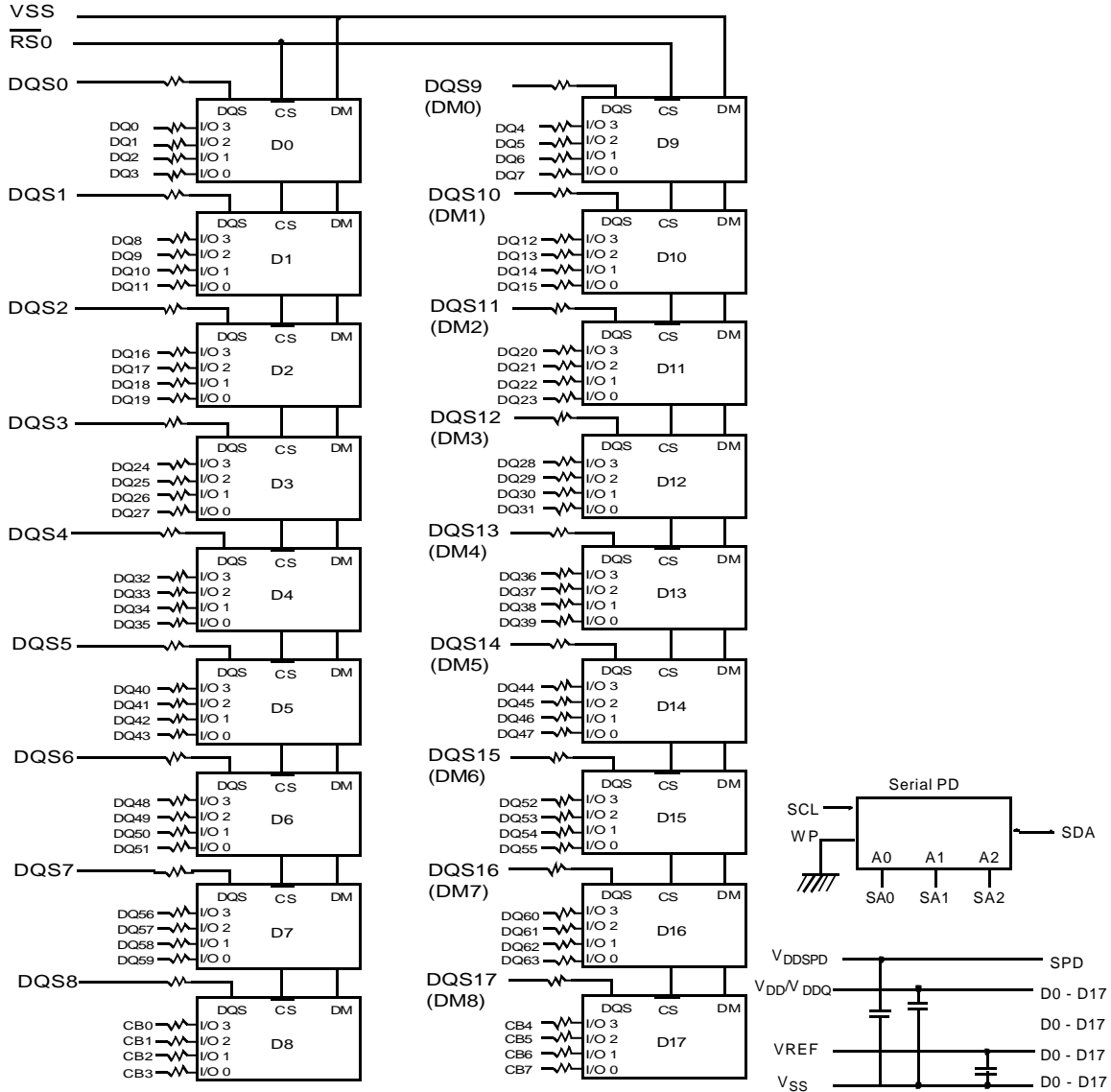
Revision 0 (Jan. 2002)

1. First release for internal usage

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Functional Block Diagram



CK0, CK0 → PLL*
 * Wire per Clock Loading table/wiring Diagrams

Notes:

1. DQ-to-I/O wiring is shown as recommended but may be changed.
2. DQ/DQS/DM/CKE/CS relationships must be maintained as shown.
3. DQ, DQS, DM/DQS resistors: 22 Ohms.

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Absolute Maximum Rate

| Parameter | Symbol | Value | Unit |
|---|-------------------|------------|------|
| Voltage on any pin relative to V_{SS} | V_{IN}, V_{OUT} | -0.5 ~ 3.6 | V |
| Voltage on V_{DD} & V_{DDQ} supply relative to V_{SS} | V_{DD}, V_{DDQ} | -1.0 ~ 3.6 | V |
| Storage temperature | T_{STG} | -55 ~ +150 | °C |
| Power dissipation | P_D | 27 | W |
| Short circuit current | I_{OS} | 50 | mA |

Note : Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded.
Functional operation should be restricted to recommended operating condition.
Exposure to higher than recommended voltage for extended periods of time could affect device reliability.

POWER & DC OPERATING CONDITIONS (SSTL_2 In/Out)

Recommended operating conditions(Voltage referenced to $V_{SS}=0V$, $T_A=0$ to $70^{\circ}C$)

| Parameter | Symbol | Min | Max | Unit | Note |
|---|--------------|------------------|------------------|------|------|
| Supply voltage(for device with a nominal V_{DD} of 2.5V) | V_{DD} | 2.3 | 2.7 | | |
| I/O Supply voltage | V_{DDQ} | 2.3 | 2.7 | V | |
| I/O Reference voltage | V_{REF} | $V_{DDQ}/2-50mV$ | $V_{DDQ}/2+50mV$ | V | 1 |
| I/O Termination voltage(system) | V_{TT} | $V_{REF}-0.04$ | $V_{REF}+0.04$ | V | 2 |
| Input logic high voltage | $V_{IH}(DC)$ | $V_{REF}+0.15$ | $V_{DDQ}+0.3$ | V | 4 |
| Input logic low voltage | $V_{IL}(DC)$ | -0.3 | $V_{REF}-0.15$ | V | 4 |
| Input Voltage Level, CK and \overline{CK} inputs | $V_{IN}(DC)$ | -0.3 | $V_{DDQ}+0.3$ | V | |
| Input Differential Voltage, CK and \overline{CK} inputs | $V_{ID}(DC)$ | 0.3 | $V_{DDQ}+0.6$ | V | 3 |
| Input crossing point voltage, CK and \overline{CK} inputs | $V_{IX}(DC)$ | 1.15 | 1.35 | V | 5 |
| Input leakage current | I_I | -2 | 2 | uA | |
| Output leakage current | I_{OZ} | -5 | 5 | uA | |
| Output High Current(Normal strength driver) ; $V_{OUT} = V_{TT} + 0.84V$ | I_{OH} | -16.8 | | mA | |
| Output High Current(Normal strength driver) ; $V_{OUT} = V_{TT} - 0.84V$ | I_{OL} | 16.8 | | mA | |
| Output High Current(Half strength driver) ; $V_{OUT} = V_{TT} + 0.45V$ | I_{OH} | -9 | | mA | |
| Output High Current(Half strength driver) ; $V_{OUT} = V_{TT} - 0.45V$ | I_{OL} | 9 | | mA | |

- Notes**
- Includes $\pm 25mV$ margin for DC offset on V_{REF} , and a combined total of $\pm 50mV$ margin for all AC noise and DC offset on V_{REF} , bandwidth limited to 20MHz. The DRAM must accommodate DRAM current spikes on V_{REF} and internal DRAM noise coupled TO V_{REF} , both of which may result in V_{REF} noise. V_{REF} should be de-coupled with an inductance of $\leq 3nH$.
 - V_{TT} is not applied directly to the device. V_{TT} is a system supply for signal termination resistors, is expected to be set equal to V_{REF} , and must track variations in the DC level of V_{REF}
 - V_{ID} is the magnitude of the difference between the input level on CK and the input level on \overline{CK} .
 - These parameters should be tested at the pin on actual components and may be checked at either the pin or the pad in simulation. The AC and DC input specifications are relative to a V_{REF} envelop that has been bandwidth limited to 200MHZ.
 - The value of V_{IX} is expected to equal $0.5 \cdot V_{DDQ}$ of the transmitting device and must track variations in the dc level of the same.
 - These characteristics obey the SSTL-2 class II standards.

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DDR SDRAM IDD spec table

| Symbol | A2(DDR266@CL=2) | B0(DDR266@CL=2.5) | A0(DDR200@CL=2) | Unit | Note |
|--------|-----------------|-------------------|-----------------|------|----------|
| IDD0 | 1890 | 1890 | 1820 | mA | |
| IDD1 | 2130 | 2130 | 2060 | mA | |
| IDD2P | 1120 | 1120 | 1120 | mA | |
| IDD2F | 1240 | 1240 | 1220 | mA | |
| IDD2Q | 1320 | 1320 | 1280 | mA | |
| IDD3P | 1360 | 1360 | 1330 | mA | |
| IDD3N | 1520 | 1520 | 1460 | mA | |
| IDD4R | 2370 | 2370 | 2200 | mA | |
| IDD4W | 2260 | 2260 | 2040 | mA | |
| IDD5 | 2550 | 2550 | 2410 | mA | |
| IDD6 | 1130 | 1130 | 1130 | mA | |
| IDD6 | Low Power | 1115 | 1115 | mA | Optional |
| IDD7A | 3780 | 3780 | 3240 | mA | |

* Module IDD was calculated on the basis of component IDD and can be differently measured according to DQ loading cap.

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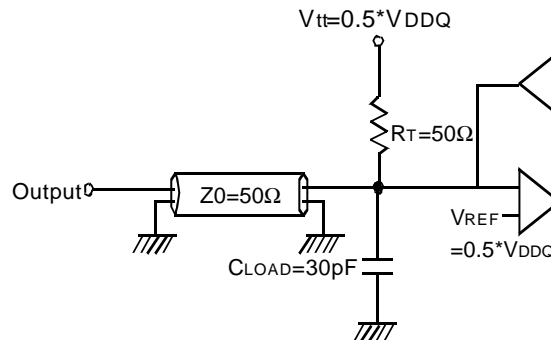
AC Operating Conditions

| Parameter/Condition | Symbol | Min | Max | Unit | Note |
|--|----------------------|---------------------------|---------------------------|------|------|
| Input High (Logic 1) Voltage, DQ, DQS and DM signals | V _{IH} (AC) | V _{REF} + 0.31 | | V | 3 |
| Input Low (Logic 0) Voltage, DQ, DQS and DM signals. | V _{IL} (AC) | | V _{REF} - 0.31 | V | 3 |
| Input Differential Voltage, CK and CK inputs | V _{ID} (AC) | 0.7 | V _{DDQ} +0.6 | V | 1 |
| Input Crossing Point Voltage, CK and CK inputs | V _{IX} (AC) | 0.5*V _{DDQ} -0.2 | 0.5*V _{DDQ} +0.2 | V | 2 |

- Note 1. V_{ID} is the magnitude of the difference between the input level on CK and the input on \overline{CK} .
 2. The value of V_{IX} is expected to equal 0.5*V_{DDQ} of the transmitting device and must track variations in the DC level of the same.
 3. These parameters should be tested at the pin on actual components and may be checked at either the pin or the pad in simulation. the AC and DC input specificatims are refation to a Vref envelope that has been bandwidth limited 20MHz.

AC OPERATING TEST CONDITIONS (V_{DD}=2.5V, V_{DDQ}=2.5V, T_A= 0 to 70°C)

| Parameter | Value | Unit | Note |
|---|---|------|------|
| Input reference voltage for Clock | 0.5 * V _{DDQ} | V | |
| Input signal maximum peak swing | 1.5 | V | |
| Input Levels(V _{IH} /V _{IL}) | V _{REF} +0.31/V _{REF} -0.31 | V | |
| Input timing measurement reference level | V _{REF} | V | |
| Output timing measurement reference level | V _{tt} | V | |
| Output load condition | See Load Circuit | | |



Output Load Circuit (SSTL_2)

Input/Output CAPACITANCE (V_{DD}=2.5, V_{DDQ}=2.5V, T_A= 25°C, f=1MHz)

| Parameter | Symbol | Min | Max | Unit |
|--|-------------------|-----|-----|------|
| Input capacitance(A0 ~ A12, BA0 ~ BA1, \overline{RAS} , \overline{CAS} , \overline{WE}) | C _{IN1} | - | 12 | pF |
| Input capacitance(CKE0) | C _{IN2} | - | 12 | pF |
| Input capacitance(\overline{CS} 0) | C _{IN3} | - | 11 | pF |
| Input capacitance(CLK0, /CLK0) | C _{IN4} | - | 12 | pF |
| Input capacitance(DM0~DM 8) | C _{IN5} | - | 16 | pF |
| Data & DQS input/output capacitance(DQ0~DQ63) | C _{OUT1} | - | 16 | pF |
| Data input/output capacitance(CB0~CB7) | C _{OUT2} | - | 16 | pF |

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AC Timing Parameters & Specifications (These AC characteristics were tested on the Component)

| Parameter | Symbol | -TCA2 (DDR266A) | | -TCB0 (DDR266B) | | -TCA0 (DDR200) | | Unit | Note | |
|---|---------|--------------------|-------|--------------------|-------|-------------------|------|------|------|---|
| | | Min | Max | Min | Max | Min | Max | | | |
| Row cycle time | tRC | 65 | | 65 | | 70 | | ns | | |
| Refresh row cycle time | tRFC | 75 | | 75 | | 80 | | ns | | |
| Row active time | tRAS | 45 | 120K | 45 | 120K | 48 | 120K | ns | | |
| RAS to CAS delay | tRCD | 20 | | 20 | | 20 | | ns | | |
| Row precharge time | tRP | 20 | | 20 | | 20 | | ns | | |
| Row active to Row active delay | tRRD | 15 | | 15 | | 15 | | ns | | |
| Write recovery time | tWR | 15 | | 15 | | 15 | | ns | | |
| Last data in to Read command | tWTR | 1 | | 1 | | 1 | | tCK | | |
| Col. address to Col. address delay | tCCD | 1 | | 1 | | 1 | | tCK | | |
| Clock cycle time | CL=2.0 | tCK | 7.5 | 12 | 10 | 12 | 10 | 12 | ns | 5 |
| | CL=2.5 | | 7.5 | 12 | 7.5 | 12 | | | ns | 5 |
| Clock high level width | tCH | 0.45 | 0.55 | 0.45 | 0.55 | 0.45 | 0.55 | tCK | | |
| Clock low level width | tCL | 0.45 | 0.55 | 0.45 | 0.55 | 0.45 | 0.55 | tCK | | |
| DQS-out access time from CK/CK | tDQSCK | -0.75 | +0.75 | -0.75 | +0.75 | -0.8 | +0.8 | ns | | |
| Output data access time from CK/CK | tAC | -0.75 | +0.75 | -0.75 | +0.75 | -0.8 | +0.8 | ns | | |
| Data strobe edge to output data edge | tDQSQ | - | 0.5 | - | 0.5 | - | 0.6 | ns | 5 | |
| Read Preamble | tRPRE | 0.9 | 1.1 | 0.9 | 1.1 | 0.9 | 1.1 | tCK | | |
| Read Postamble | tRPST | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | tCK | | |
| CK to valid DQS-in | tDQSS | 0.75 | 1.25 | 0.75 | 1.25 | 0.75 | 1.25 | tCK | | |
| DQS-in setup time | tWPRES | 0 | | 0 | | 0 | | ns | 2 | |
| DQS-in hold time | tWPRE | 0.25 | | 0.25 | | 0.25 | | tCK | | |
| DQS falling edge to CK rising-setup time | tDSS | 0.2 | | 0.2 | | 0.2 | | tCK | | |
| DQS falling edge from CK rising-hold time | tDSH | 0.2 | | 0.2 | | 0.2 | | tCK | | |
| DQS-in high level width | tDQSH | 0.35 | | 0.35 | | 0.35 | | tCK | | |
| DQS-in low level width | tDQSL | 0.35 | | 0.35 | | 0.35 | | tCK | | |
| DQS-in cycle time | tDSC | 0.9 | 1.1 | 0.9 | 1.1 | 0.9 | 1.1 | tCK | | |
| Address and Control Input setup time(fast) | tIS | 0.9 | | 0.9 | | 1.1 | | ns | 6 | |
| Address and Control Input hold time(fast) | tIH | 0.9 | | 0.9 | | 1.1 | | ns | 6 | |
| Address and Control Input setup time(slow) | tIS | 1.0 | | 1.0 | | 1.1 | | ns | 6 | |
| Address and Control Input hold time(slow) | tIH | 1.0 | | 1.0 | | 1.1 | | ns | 6 | |
| Data-out high impedance time from CK/CK | tHZ | -0.75 | +0.75 | -0.75 | +0.75 | -0.8 | +0.8 | ns | | |
| Data-out low impedance time from CK/CK | tLZ | -0.75 | +0.75 | -0.75 | +0.75 | -0.8 | +0.8 | ns | | |
| Input Slew Rate(for input only pins) | tSL(I) | 0.5 | | 0.5 | | 0.5 | | V/ns | 6 | |
| Input Slew Rate(for I/O pins) | tSL(IO) | 0.5 | | 0.5 | | 0.5 | | V/ns | 7 | |
| Output Slew Rate(x4,x8) | tSL(O) | 1.0 | 4.5 | 1.0 | 4.5 | 1.0 | 4.5 | V/ns | 10 | |
| Output Slew Rate Matching Ratio(rise to fall) | tSLMR | 0.67 | 1.5 | 0.67 | 1.5 | 0.67 | 1.5 | | | |

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| Parameter | Symbol | -TCA2 (DDR266A) | | -TCB0 (DDR266B) | | -TCA0 (DDR200) | | Unit | Note |
|---|--------|-----------------------------|------|-----------------------------|------|-----------------------------|-----|------|-------|
| | | Min | Max | Min | Max | Min | Max | | |
| Mode register set cycle time | tMRD | 15 | | 15 | | 16 | | ns | |
| DQ & DM setup time to DQS | tDS | 0.5 | | 0.5 | | 0.6 | | ns | 7,8,9 |
| DQ & DM hold time to DQS | tDH | 0.5 | | 0.5 | | 0.6 | | ns | 7,8,9 |
| Control & Address input pulse width | tIPW | 2.2 | | 2.2 | | 2.5 | | ns | |
| DQ & DM input pulse width | tDIPW | 1.75 | | 1.75 | | 2 | | ns | |
| Power down exit time | tPDEX | 7.5 | | 7.5 | | 10 | | ns | |
| Exit self refresh to non-Read command | tXSNR | 75 | | 75 | | 80 | | ns | 4 |
| Exit self refresh to read command | tXSRD | 200 | | 200 | | 200 | | tCK | |
| Refresh interval time | tREFI | 7.8 | | 7.8 | | 7.8 | | us | 1 |
| Output DQS valid window | tQH | tHP -tQHS | - | tHP -tQHS | - | tHP -tQHS | - | ns | 5 |
| Clock half period | tHP | tCLmin or tCHmin | - | tCLmin or tCHmin | - | tCLmin or tCHmin | - | ns | |
| Data hold skew factor | tQHS | | 0.75 | | 0.75 | | 0.8 | ns | |
| DQS write postamble time | tWPST | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | tCK | 3 |
| Active to Read with Auto precharge command | tRAP | 20 | | 20 | | 20 | | | |
| Autoprecharge write recovery + Precharge time | tDAL | (tWR/tCK) + (tRP/tCK) | | (tWR/tCK) + (tRP/tCK) | | (tWR/tCK) + (tRP/tCK) | | tCK | 11 |

1. Maximum burst refresh cycle : 8
2. The specific requirement is that DQS be valid(High or Low) on or before this CK edge. The case shown(DQS going from High_Z to logic Low) applies when no writes were previously in progress on the bus. If a previous write was in progress, DQS could be High at this time, depending on tDQSS.
3. The maximum limit for this parameter is not a device limit. The device will operate with a great value for this parameter, but system performance (bus turnaround) will degrade accordingly.
4. A write command can be applied with tRCD satisfied after this command.
5. For registered DIMMs, tCL and tCH are ≥ 45% of the period including both the half period jitter (tJIT(HP)) of the PLL and the half period jitter due to crosstalk (tJIT(crosstalk)) on the DIMM.
6. Input Setup/Hold Slew Rate Derating

| Input Setup/Hold Slew Rate | ΔtIS | ΔtIH |
|----------------------------|------|------|
| (V/ns) | (ps) | (ps) |
| 0.5 | 0 | 0 |
| 0.4 | +50 | +50 |
| 0.3 | +100 | +100 |

This derating table is used to increase t_{IS}/t_{IH} in the case where the input slew rate is below 0.5V/ns. Input setup/hold slew rate based on the lesser of AC-AC slew rate and DC-DC slew rate.

7. I/O Setup/Hold Slew Rate Derating

| I/O Setup/Hold Slew Rate | ΔtDS | ΔtDH |
|--------------------------|------|------|
| (V/ns) | (ps) | (ps) |
| 0.5 | 0 | 0 |
| 0.4 | +75 | +75 |
| 0.3 | +150 | +150 |

This derating table is used to increase t_{DS}/t_{DH} in the case where the I/O slew rate is below 0.5V/ns. I/O setup/hold slew rate based on the lesser of AC-AC slew rate and DC-DC slew rate.

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8. I/O Setup/Hold Plateau Derating

| I/O Input Level | Δt_{DS} | Δt_{DH} |
|-----------------|-----------------|-----------------|
| (mV) | (ps) | (ps) |
| ± 280 | +50 | +50 |

This derating table is used to increase t_{DS}/t_{DH} in the case where the input level is flat below $V_{REF} \pm 310mV$ for a duration of up to 2ns.

9. I/O Delta Rise/Fall Rate(1/slew-rate) Derating

| Delta Rise/Fall Rate | Δt_{DS} | Δt_{DH} |
|----------------------|-----------------|-----------------|
| (ns/V) | (ps) | (ps) |
| 0 | 0 | 0 |
| ± 0.25 | +50 | +50 |
| ± 0.5 | +100 | +100 |

This derating table is used to increase t_{DS}/t_{DH} in the case where the DQ and DQS slew rates differ. The Delta Rise/Fall Rate is calated as $1/SlewRate1-1/SlewRate2$. For example, if slew rate 1 = 5V/ns and slew rate 2 =.4V/ns then the Delta Rise/Fall Rate =-0/5ns/V. Input S/H slew rate based on larger of AC-AC delta rise/fall rate and DC-DC delta rise/fall rate.

10. This parameter is fir system simulation purpose. It is guranteed by design.

11. For each of the terms, if not already an integer, round to the next highest integer. tCK is actual to the system clock cycle time.

<Reference>

The following table specifies derating values for the specifications listed if the single-ended clock skew rate is less than 1.0V/ns.

| CK slew rate (Single ended) | $\Delta t_{IH}/t_{IS}$ (ps) | $\Delta t_{DSS}/t_{DSH}$ (ps) | $\Delta t_{AC}/t_{DQSCK}$ (ps) | $\Delta t_{LZ}(\min)$ (ps) | $\Delta t_{HZ}(\max)$ (ps) |
|--------------------------------|--------------------------------|----------------------------------|-----------------------------------|-------------------------------|-------------------------------|
| 1.0V/ns | 0 | 0 | 0 | 0 | 0 |
| 0.75V/ns | +50 | +50 | +50 | -50 | +50 |
| 0.5V/ns | +100 | +100 | +100 | -100 | +100 |

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Command Truth Table

(V=Valid, X=Don't Care, H=Logic High, L=Logic Low)

| COMMAND | | CKEn-1 | CKEn | \overline{CS} | \overline{RAS} | \overline{CAS} | \overline{WE} | BA _{0,1} | A _{10/AP} | A _{11, A12} A _{9 ~ A0} | Note | |
|----------------------------------|------------------------|--------|------|-----------------|------------------|------------------|-----------------|-------------------|--------------------|---|------|---|
| Register | Extended MRS | H | X | L | L | L | L | OP CODE | | | 1, 2 | |
| Register | Mode Register Set | H | X | L | L | L | L | OP CODE | | | 1, 2 | |
| Refresh | Auto Refresh | | H | H | L | L | L | H | X | | 3 | |
| | Self Refresh | Entry | | L | | | | | | | | |
| | | Exit | L | H | L | H | H | H | X | | 3 | |
| | H | | X | X | X | 3 | | | | | | |
| Bank Active & Row Addr. | | H | X | L | L | H | H | V | Row Address | | | |
| Read & Column Address | Auto Precharge Disable | | H | X | L | H | L | H | L | Column Address A _{0~A9, A11} | 4 | |
| | Auto Precharge Enable | | | | | | | | H | | 4 | |
| Write & Column Address | Auto Precharge Disable | | H | X | L | H | L | L | L | Column Address A _{0~A9, A11} | 4 | |
| | Auto Precharge Enable | | | | | | | | H | | 4, 6 | |
| Burst Stop | | H | X | L | H | H | L | X | | | 7 | |
| Precharge | Bank Selection | | H | X | L | L | H | L | V | L | X | |
| | All Banks | | | | | | | | X | H | | 5 |
| Active Power Down | | Entry | H | L | H | X | X | X | X | | | |
| | | | | | L | V | V | V | | | | |
| | | | | | L | H | X | X | | | X | X |
| Precharge Power Down Mode | | Entry | H | L | H | X | X | X | X | | | |
| | | | | | L | H | H | H | | | | |
| | | | | | L | H | X | X | | | X | |
| | | | | | L | V | V | V | | | | |
| DM | | H | | X | | | | X | | | 8 | |
| No operation (NOP) : Not defined | | H | X | H | X | X | X | X | | | 9 | |
| | | | | L | H | H | H | | | 9 | | |

Note : 1. OP Code : Operand Code. A_{0 ~ A12} & BA_{0 ~ BA1} : Program keys. (@EMRS/MRS)

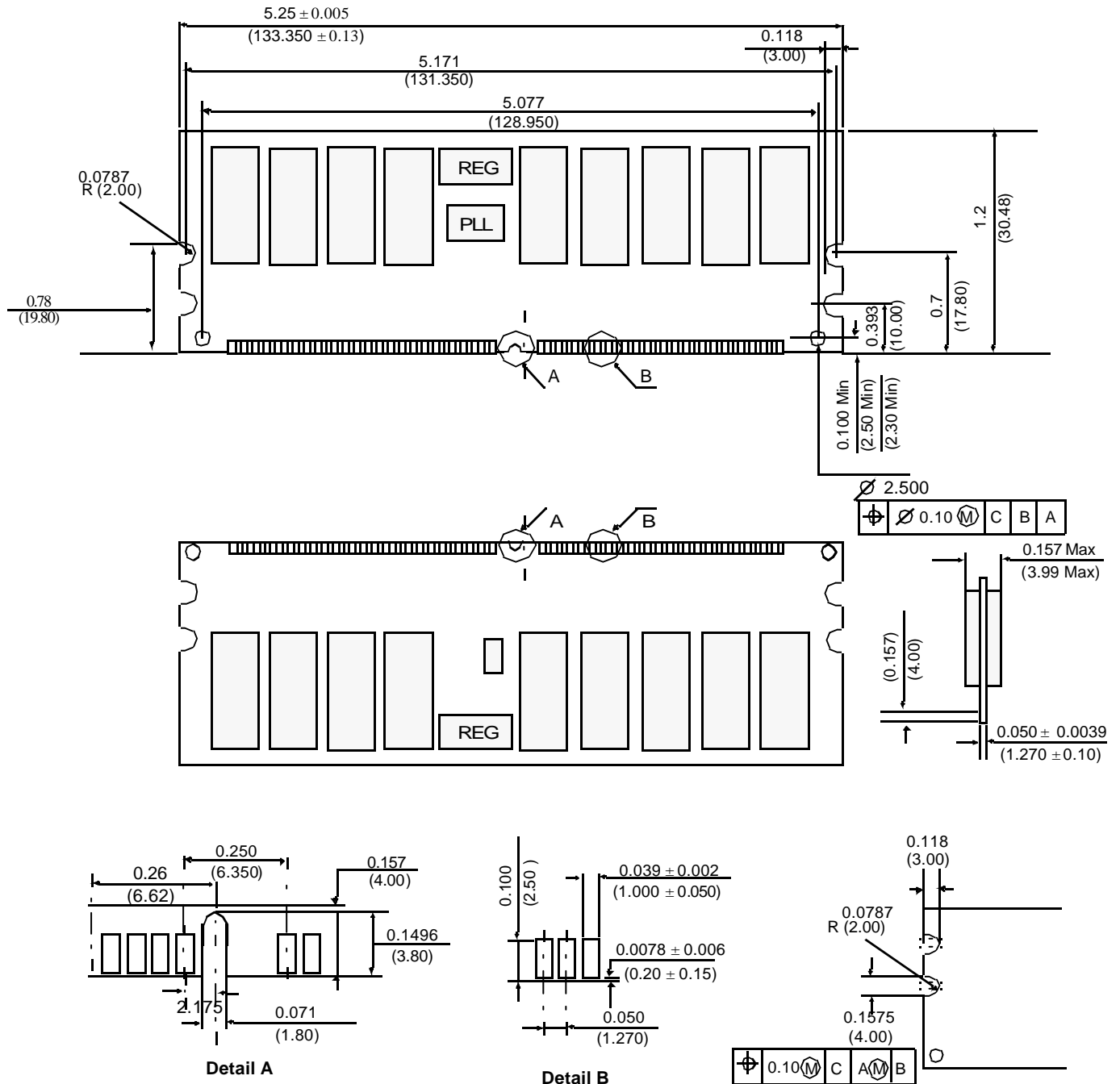
- EMRS/ MRS can be issued only at all banks precharge state.
A new command can be issued 2 clock cycles after EMRS or MRS.
- Auto refresh functions are same as the CBR refresh of DRAM.
The automatical precharge without row precharge command is meant by "Auto".
Auto/self refresh can be issued only at all banks precharge state.
- BA_{0 ~ BA1} : Bank select addresses.
If both BA₀ and BA₁ are "Low" at read, write, row active and precharge, bank A is selected.
If BA₀ is "High" and BA₁ is "Low" at read, write, row active and precharge, bank B is selected.
If BA₀ is "Low" and BA₁ is "High" at read, write, row active and precharge, bank C is selected.
If both BA₀ and BA₁ are "High" at read, write, row active and precharge, bank D is selected.
- If A_{10/AP} is "High" at row precharge, BA₀ and BA₁ are ignored and all banks are selected.
- During burst write with auto precharge, new read/write command can not be issued.
Another bank read/write command can be issued after the end of burst.
New row active of the associated bank can be issued at t_{RP} after the end of burst.
- Burst stop command is valid at every burst length.
- DM sampled at the rising and falling edges of the DQS and Data-in are masked at the both edges (Write DM latency is 0).
- This combination is not defined for any function, which means "No Operation(NOP)" in DDR SDRAM.

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PACKAGE DIMENSIONS

Units : Inches (Millimeters)

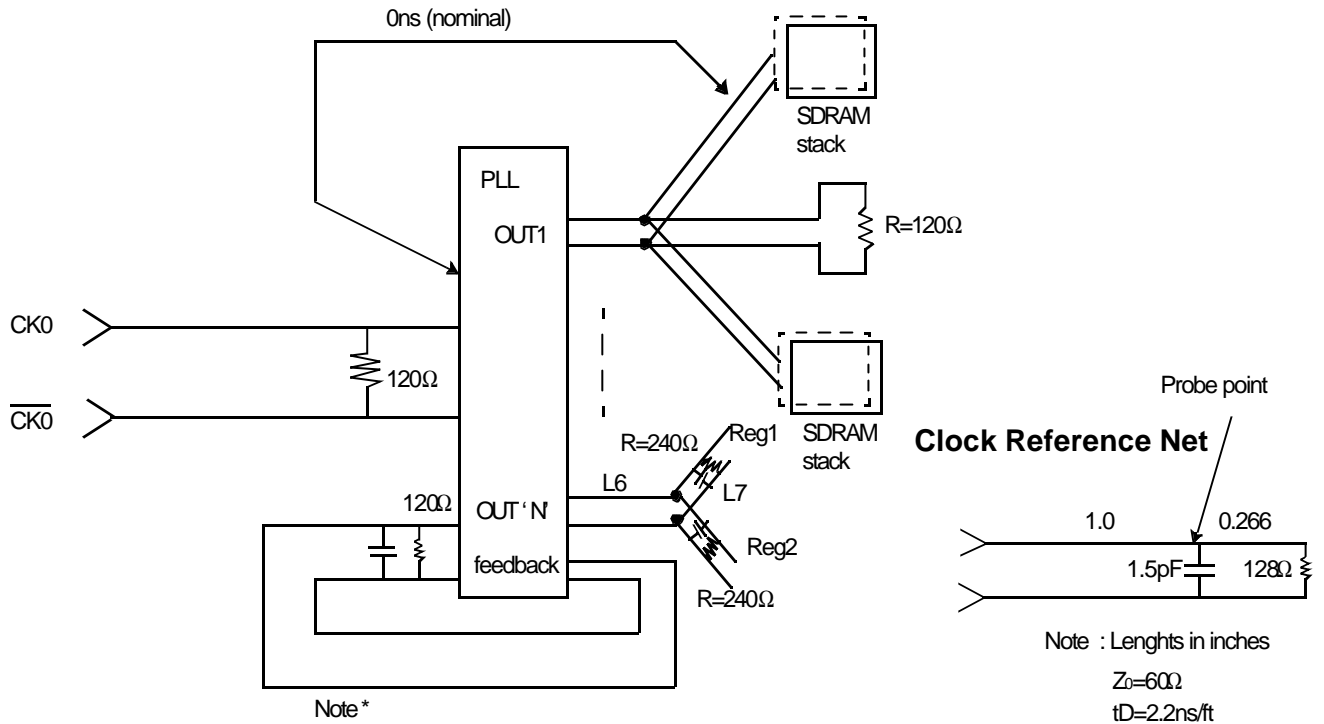


Tolerances : $\pm 0.005(.13)$ unless otherwise specified
 The used device is 64Mx4 SDRAM, TSOP
 SDRAM Part NO : K4H560438D

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184 Pin DDR Registered DIMM Clock Topolgy



Notes* :

1. The Clock delay from the input of the PLL clock to the input of any SDRAM or register will be set to 0ns(nominal).
2. Input,output, and feedback clock lines are terminated from line to leine as shown, and not from line to ground.
3. Only one PLL output is shown per output type. Any additional PLL outputs will be wired in a similar maner.
4. termination resistors for the PLL feedback path clocks are loacted after the pins of the PLL.