

## 256M (8Mx32bit) Hynix SDRAM Memory

**Document Title**

**256Mbit (8M x32) Synchronous DRAM**

**Revision History**

| Revision No. | History       | Draft Date | Remark      |
|--------------|---------------|------------|-------------|
| 0.1          | Initial Draft | Sep. 2009  | Preliminary |
| 1.0          | Release       | Oct. 2009  |             |

## DESCRIPTION

The Hynix H57V2622GMR Synchronous DRAM (Dual Die) ideally suited for the consumer memory applications which requires large memory density and high bandwidth uses Hynix's 128Mb SDR monolithic die and has similar functionality.

Synchronous DRAM is a type of DRAM which operates in synchronization with input clock. The Hynix Synchronous DRAM latch each control signal at the rising edge of a basic input clock (CLK) and input/output data in synchronization with the input clock (CLK). The address lines are multiplexed with the Data Input/ Output signals on a multiplexed x32 Input/ Output bus. All the commands are latched in synchronization with the rising edge of CLK.

The Synchronous DRAM provides for programmable read or write Burst length of Programmable burst lengths: 1, 2, 4, 8 locations or full page. An AUTO PRECHARGE function may be enabled to provide a self-timed row precharge that is initiated at the end of the burst access. The Synchronous DRAM uses an internal pipelined architecture to achieve high-speed operation. This architecture is compatible with the 2n rule of prefetch architectures, but it also allows the column address to be changed on every clock cycle to achieve a high-speed, fully random access. Precharging one bank while accessing one of the other three banks will hide the precharge cycles and provide seamless, high-speed, random-access operation.

Read and write accesses to the Hynix Synchronous DRAM are burst oriented; accesses start at a selected location and continue for a programmed number of locations in a programmed sequence. Accesses begin with the registration of an ACTIVE command, which is then followed by a READ or WRITE command. The address bits registered coincident with the ACTIVE command are used to select the bank and the row to be accessed. The address bits registered coincident with the READ or WRITE command are used to select the bank and the starting column location for the burst access.

A burst of Read or Write cycles in progress can be terminated by a burst terminate command or can be interrupted and replaced by a new burst Read or Write command on any cycle (This pipelined design is not restricted by a 2N rule).

All inputs are LVTTTL compatible. Devices will have a VDD and VDDQ supply of 3.3V (nominal).

## 256Mb Synchronous DRAM(8M x 32) FEATURES

- Standard SDRAM Protocol
- Uses 2pcs of 128Mb Monolithic Die
- Power Supply Voltage : VDD = 3.3V, VDDQ = 3.3V
- All device pins are compatible with LVTTL interface
- 4096 Refresh cycles / 64ms
- Programmable CAS latency of 2 or 3
- Programmable Burst Length and Burst Type
- Operating Temp.
  - Commercial Temp. : 0°C ~ 70°C, Industrial Temp. : -40°C ~ 85°C
- [This product is in compliance with the directive pertaining of RoHS.](#)

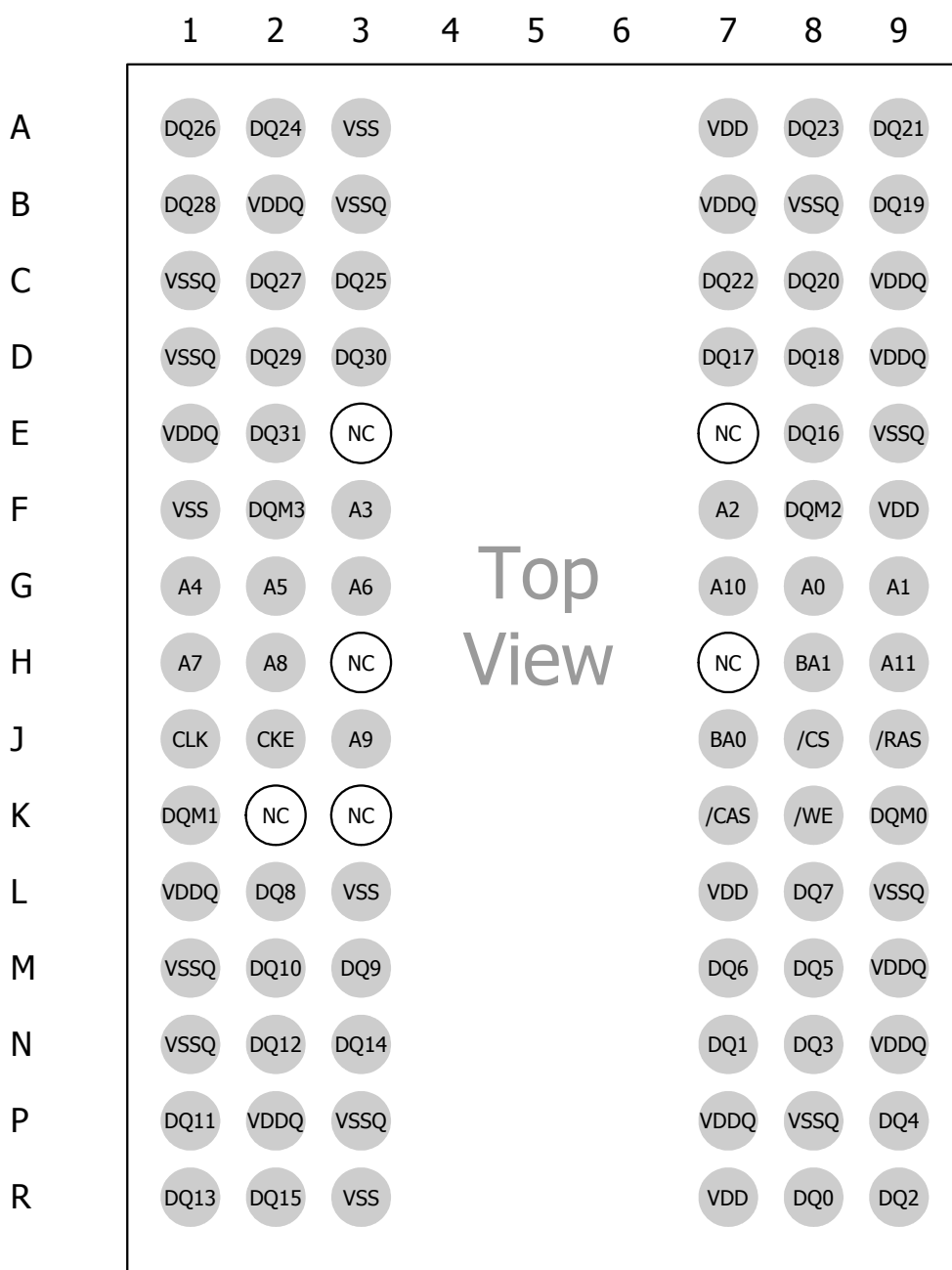
## ORDERING INFORMATION

| Part Number     | Clock Frequency | CAS Latency | Voltage | Organization               | Interface |
|-----------------|-----------------|-------------|---------|----------------------------|-----------|
| H57V2622GMR-60X | 166MHz          | 3           | 3.3V    | 4Banks x 2Mbits x16 x 2Die | LVTTL     |
| H57V2622GMR-75X | 133MHz          | 3           |         |                            |           |
| H57V2622GMR-60X | 166MHz          | 3           |         |                            |           |
| H57V2622GMR-75X | 133MHz          | 3           |         |                            |           |

Note :

1. H57V2622GMR-XXC : Normal power, Commercial Temp. (0~70°C)
2. H57V2622GMR-XXI : Normal power, Industrial Temp. (-40~85°C)
3. H57V2622GMR-XXL : Low power, Commercial Temp. (0~70°C)
4. H57V2622GMR-XXJ : Low power, Industrial Temp. (-40~85°C)

## BALL CONFIGURATION

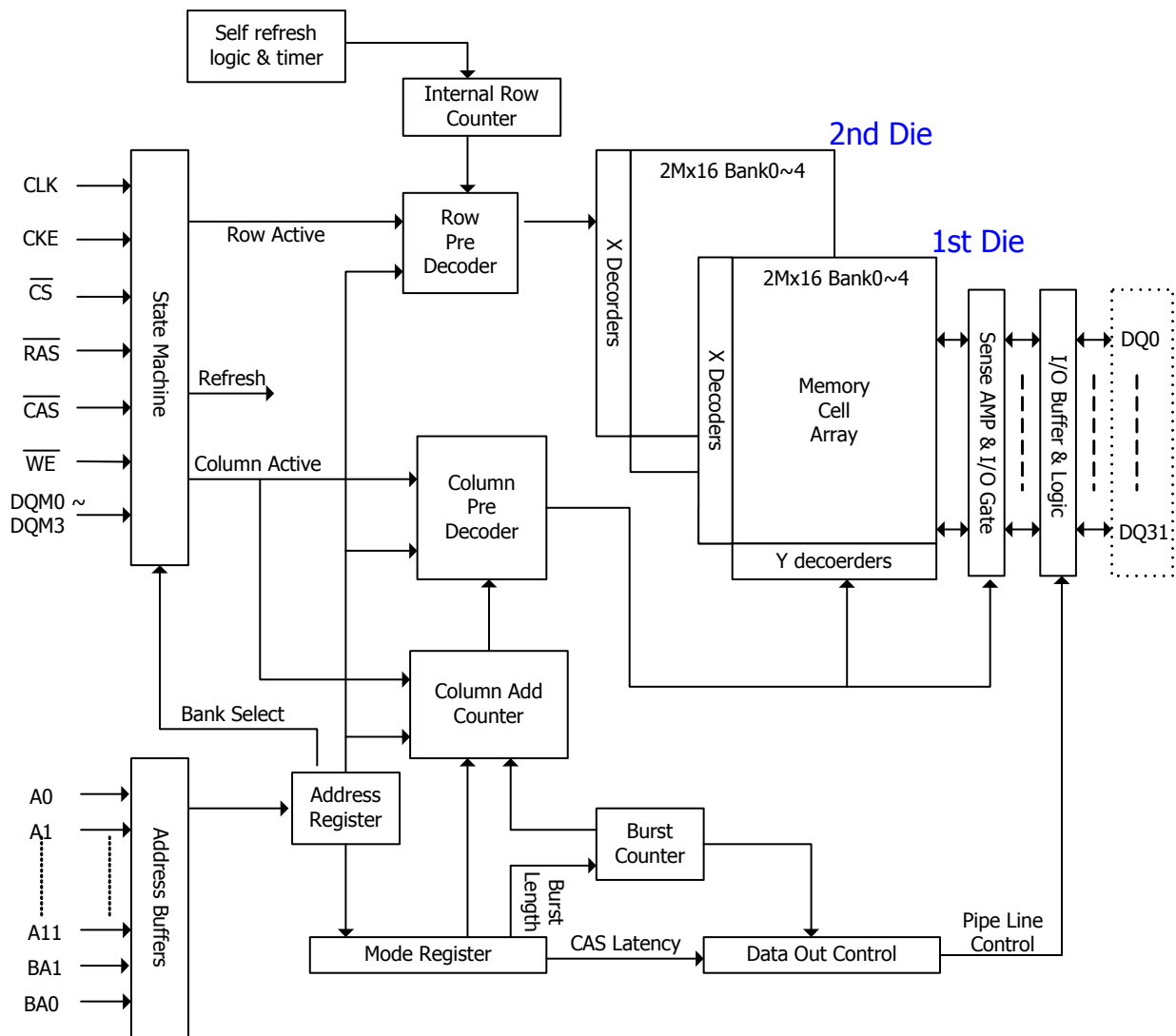


## BALL DESCRIPTIONS

| SYMBOL                                                | TYPE   | DESCRIPTION                                                                                                                                         |
|-------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| CLK                                                   | INPUT  | Clock :<br>The system clock input. All other inputs are registered to the SDRAM on the rising edge of CLK                                           |
| CKE                                                   | INPUT  | Clock Enable:<br>Controls internal clock signal and when deactivated, the SDRAM will be one of the states among power down, suspend or self refresh |
| $\overline{CS}$                                       | INPUT  | Chip Select:<br>Enables or disables all inputs except CLK, CKE and DQM                                                                              |
| BA0, BA1                                              | INPUT  | Bank Address:<br>Selects bank to be activated during $\overline{RAS}$ activity<br>Selects bank to be read/written during $\overline{CAS}$ activity  |
| A0 ~ A11                                              | INPUT  | Row Address: RA0 ~ RA11, Column Address: CA0 ~ CA8<br>Auto-precharge flag: A10                                                                      |
| $\overline{RAS}$ , $\overline{CAS}$ , $\overline{WE}$ | INPUT  | Command Inputs:<br>$\overline{RAS}$ , $\overline{CAS}$ and $\overline{WE}$ define the operation<br>Refer function truth table for details           |
| DQM0 ~ DQM3                                           | I/O    | Data Mask:<br>Controls output buffers in read mode and masks input data in write mode                                                               |
| DQ0 ~ DQ31                                            | I/O    | Data Input / Output:<br>Multiplexed data input / output pin                                                                                         |
| VDD / VSS                                             | SUPPLY | Power supply                                                                                                                                        |
| VDDQ / VSSQ                                           | SUPPLY | I/O Power supply                                                                                                                                    |
| NC                                                    | -      | No connection : These pads should be left unconnected                                                                                               |

## FUNCTIONAL BLOCK DIAGRAM

2Mbit x 4banks x 16 I/O x 2 Die Synchronous DRAM



## ABSOLUTE MAXIMUM RATING

| Parameter                              | Symbol    | Rating     | Unit     |
|----------------------------------------|-----------|------------|----------|
| Ambient Temperature (Commercial Temp.) | TA        | 0 ~ 70     | °C       |
| Ambient Temperature (Industrial Temp.) |           | -40 ~ 85   | °C       |
| Storage Temperature                    | TSTG      | -55 ~ 125  | °C       |
| Voltage on Any Pin relative to VSS     | VIN, VOUT | -1.0 ~ 4.6 | V        |
| Voltage on VDD supply relative to VSS  | VDD, VDDQ | -1.0 ~ 4.6 | V        |
| Short Circuit Output Current           | IOS       | 50         | mA       |
| Power Dissipation                      | PD        | 1          | W        |
| Soldering Temperature · Time           | TSOLDER   | 260 · 10   | °C · Sec |

## DC OPERATING CONDITION (Commercial : TA = 0~70℃, Industrial : TA = -40~85℃)

| Parameter            | Symbol    | Min  | Max        | Unit | Note |
|----------------------|-----------|------|------------|------|------|
| Power Supply Voltage | VDD, VDDQ | 3.0  | 3.6        | V    | 1    |
| Input High Voltage   | VIH       | 2.0  | VDDQ + 0.3 | V    | 1, 2 |
| Input Low Voltage    | VIL       | -0.3 | 0.8        | V    | 1, 3 |

### Note:

1. All voltages are referenced to VSS = 0V.
2. VIH(Max) is acceptable VDDQ + 2V for a pulse width with <= 3ns of duration.
3. VIL(min) is acceptable -2.0V for a pulse width with <= 3ns of duration.

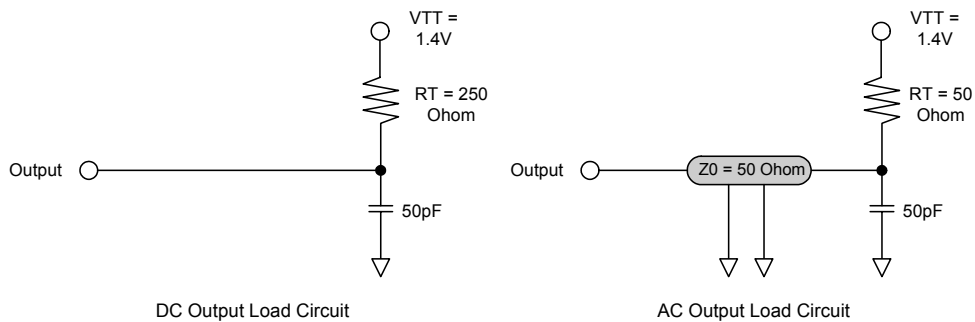
## AC OPERATING TEST CONDITION

(Commercial : TA = 0~70℃, Industrial : TA = -40~85℃, VDD=3.3±0.3V / VSS=0V)

| Parameter                                           | Symbol    | Value      | Unit | Note |
|-----------------------------------------------------|-----------|------------|------|------|
| AC Input High / Low Level Voltage                   | VIH / VIL | 2.4 / 0.4  | V    |      |
| Input Timing Measurement Reference Level Voltage    | Vtrip     | 0.5 x VDDQ | V    |      |
| Input Rise / Fall Time                              | tR / tF   | 1          | ns   |      |
| Output Timing Measurement Reference Level Voltage   | Voutref   | 0.5 x VDDQ | V    |      |
| Output Load Capacitance for Access Time Measurement | CL        | 50         | pF   | 1    |

### Note:

1. See Next Page



## CAPACITANCE (Commercial : TA = 0~70℃, Industrial : TA = -40~85℃, f=1MHz)

| Parameter                       | Pin                                                                                                                          | Symbol | Min | Max | Unit |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------|--------|-----|-----|------|
| Input capacitance               | CLK                                                                                                                          | CI1    | 4.0 | 8.0 | pF   |
|                                 | A0 ~ A11, BA0, BA1, CKE, $\overline{\text{CS}}$ , $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ | CI2    | 4.0 | 8.0 | pF   |
|                                 | DQM0 ~ DQM3                                                                                                                  | CI3    | 4.0 | 8.0 | pF   |
| Data input / output capacitance | DQ0 ~ DQ31                                                                                                                   | CI/O   | 3.5 | 6.5 | pF   |

## DC CHARACTERISTICS I (Commercial : TA = 0~70℃, Industrial : TA = -40~85℃)

| Parameter              | Symbol | Min | Max | Unit | Note       |
|------------------------|--------|-----|-----|------|------------|
| Input Leakage Current  | ILI    | -1  | 1   | uA   | 1          |
| Output Leakage Current | ILO    | -1  | 1   | uA   | 2          |
| Output High Voltage    | VOH    | 2.4 | -   | V    | IOH = -4mA |
| Output Low Voltage     | VOL    | -   | 0.4 | V    | IOL = +4mA |

### Note:

- VIN = 0 to 3.6V, All other balls are not tested under VIN = 0V
- DOUT is disabled, VOUT = 0 to 3.6

**DC CHARACTERISTICS II** (Commercial : TA = 0~70℃, Industrial : TA = -40~85℃)

| Parameter                                           | Symbol | Test Condition                                                                                                                                    |           | Speed |     | Unit | Note |
|-----------------------------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------|-----|------|------|
|                                                     |        |                                                                                                                                                   |           | 166   | 133 |      |      |
| Operating Current                                   | IDD1   | Burst length=1, One bank active<br>tRC ≥ tRC(min), IOL=0mA                                                                                        |           | 160   | 140 | mA   | 1    |
| Precharge Standby Current<br>in Power Down Mode     | IDD2P  | CKE ≤ VIL(max), tCK = 15ns                                                                                                                        | Normal    | 2.0   |     | mA   | 3    |
|                                                     |        |                                                                                                                                                   | Low Power | 1.6   |     | mA   |      |
|                                                     | IDD2PS | CKE ≤ VIL(max), tCK = ∞                                                                                                                           | Normal    | 2.0   |     | mA   | 3    |
|                                                     |        |                                                                                                                                                   | Low Power | 1.6   |     | mA   |      |
| Precharge Standby Current<br>in Non Power Down Mode | IDD2N  | CKE ≥ VIH(min), $\overline{CS}$ ≥ VIH(min), tCK = 15ns<br>Input signals are changed one time during 2clks.<br>All other pins ≥ VDD-0.2V or ≤ 0.2V |           | 18    |     | mA   |      |
|                                                     | IDD2NS | CKE ≥ VIH(min), tCK = ∞<br>Input signals are stable.                                                                                              |           | 15    |     |      |      |
| Active Standby Current<br>in Power Down Mode        | IDD3P  | CKE ≤ VIL(max), tCK = 15ns                                                                                                                        |           | 8     |     | mA   |      |
|                                                     | IDD3PS | CKE ≤ VIL(max), tCK = ∞                                                                                                                           |           | 8     |     |      |      |
| Active Standby Current in Non Power Down Mode       | IDD3N  | CKE ≥ VIH(min), $\overline{CS}$ ≥ VIH(min), tCK = 15ns<br>Input signals are changed one time during 2clks.<br>All other pins ≥ VDD-0.2V or ≤ 0.2V |           | 40    |     | mA   |      |
|                                                     | IDD3NS | CKE ≥ VIH(min), tCK = ∞<br>Input signals are stable.                                                                                              |           | 35    |     |      |      |
| Burst Mode Operating Current                        | IDD4   | tCK ≥ tCK(min), IOL=0mA<br>All banks active                                                                                                       |           | 200   | 200 | mA   | 1    |
| Auto Refresh Current                                | IDD5   | tRC ≥ tRC(min), All banks active                                                                                                                  |           | 400   | 380 | mA   | 2    |
| Self Refresh Current                                | IDD6   | CKE ≤ 0.2V                                                                                                                                        | Normal    | 4     |     | mA   | 3    |
|                                                     |        |                                                                                                                                                   | Low Power | 1.6   |     |      |      |

**Note:**

1. IDD1 and IDD4 depend on output loading and cycle rates. Specified values are measured with the output open.
2. Min. of  $t_{RC}$  (Refresh RAS cycle time) is shown at AC CHARACTERISTICS II
3. H57V2622GMR-XXC : Normal, H57V2622GMR-XXL : Low Power

## AC CHARACTERISTICS I (AC operating conditions unless otherwise noted)

| Parameter                         |        | Symbol | 166 |      | 133 |      | Unit | Note |
|-----------------------------------|--------|--------|-----|------|-----|------|------|------|
|                                   |        |        | Min | Max  | Min | Max  |      |      |
| System Clock Cycle Time           | CL = 3 | tCK3   | 6.0 | 1000 | 7.5 | 1000 | ns   |      |
|                                   | CL = 2 | tCK2   | -   | -    | 10  | 1000 | ns   |      |
| Clock High Pulse Width            |        | tCHW   | 2.5 | -    | 2.5 | -    | ns   | 1    |
| Clock Low Pulse Width             |        | tCLW   | 2.5 | -    | 2.5 | -    | ns   | 1    |
| Access Time From Clock            | CL = 3 | tAC3   | -   | 5.4  | -   | 5.4  | ns   | 2    |
|                                   | CL = 2 | tAC2   | -   | -    | -   | 6    | ns   | 2    |
| Data-out Hold Time                |        | tOH    | 2.0 | -    | 2.5 | -    | ns   |      |
| Data-Input Setup Time             |        | tDS    | 1.5 | -    | 1.5 | -    | ns   | 1    |
| Data-Input Hold Time              |        | tDH    | 0.8 | -    | 0.8 | -    | ns   | 1    |
| Address Setup Time                |        | tAS    | 1.5 | -    | 1.5 | -    | ns   | 1    |
| Address Hold Time                 |        | tAH    | 0.8 | -    | 0.8 | -    | ns   | 1    |
| CKE Setup Time                    |        | tCKS   | 1.5 | -    | 1.5 | -    | ns   | 1    |
| CKE Hold Time                     |        | tCKH   | 0.8 | -    | 0.8 | -    | ns   | 1    |
| Command Setup Time                |        | tCS    | 1.5 | -    | 1.5 | -    | ns   | 1    |
| Command Hold Time                 |        | tCH    | 0.8 | -    | 0.8 | -    | ns   | 1    |
| CLK to Data Output in Low-Z Time  |        | tOLZ   | 1.0 | -    | 1.0 | -    | ns   |      |
| CLK to Data Output in High-Z Time | CL = 3 | tOHZ3  | 2.7 | 5.4  | 2.7 | 5.4  | ns   |      |
|                                   | CL = 2 | tOHZ2  | -   | -    | 3   | 6    | ns   |      |

### Note:

1. Assume  $t_R$  /  $t_F$  (input rise and fall time) is 1ns. If  $t_R$  &  $t_F > 1ns$ , then  $[(t_R+t_F)/2-1]ns$  should be added to the parameter.
2. Access time to be measured with input signals of 1V/ns edge rate, from 0.8V to 0.2V. If  $t_R > 1ns$ , then  $(t_R/2-0.5)ns$  should be added to the parameter.

## AC CHARACTERISTICS II (AC operating conditions unless otherwise noted)

| Parameter                       |              | Symbol             | 166 |      | 133 |      | Unit | Note |
|---------------------------------|--------------|--------------------|-----|------|-----|------|------|------|
|                                 |              |                    | Min | Max  | Min | Max  |      |      |
| RAS Cycle Time                  | Operation    | t <sub>RC</sub>    | 60  | -    | 63  | -    | ns   |      |
|                                 | Auto Refresh | t <sub>RRC</sub>   | 60  | -    | 63  | -    | ns   |      |
| RAS to CAS Delay                |              | t <sub>RCD</sub>   | 18  | -    | 20  | -    | ns   |      |
| RAS Active Time                 |              | t <sub>RAS</sub>   | 42  | 100K | 42  | 100K | ns   |      |
| RAS Precharge Time              |              | t <sub>RP</sub>    | 18  | -    | 20  | -    | ns   |      |
| RAS to RAS Bank Active Delay    |              | t <sub>RRD</sub>   | 12  | -    | 15  | -    | ns   |      |
| CAS to CAS Delay                |              | t <sub>CCD</sub>   | 1   | -    | 1   | -    | CLK  |      |
| Write Command to Data-In Delay  |              | t <sub>WTL</sub>   | 0   | -    | 0   | -    | CLK  |      |
| Data-in to Precharge Command    |              | t <sub>DPL</sub>   | 2   | -    | 2   | -    | CLK  |      |
| Data-In to Active Command       |              | t <sub>DAL</sub>   | 5   |      |     |      | CLK  |      |
| DQM to Data-Out Hi-Z            |              | t <sub>DQZ</sub>   | 2   | -    | 2   | -    | CLK  |      |
| DQM to Data-In Mask             |              | t <sub>DQM</sub>   | 0   | -    | 0   | -    | CLK  |      |
| MRS to New Command              |              | t <sub>MRD</sub>   | 2   | -    | 2   | -    | CLK  |      |
| Precharge to Data Output High-Z | CL = 3       | t <sub>PROZ3</sub> | 3   | -    | 3   | -    | CLK  |      |
|                                 | CL = 2       | t <sub>PROZ2</sub> | -   | -    | 2   | -    | CLK  |      |
| Power Down Exit Time            |              | t <sub>DPE</sub>   | 1   | -    | 1   | -    | CLK  |      |
| Self Refresh Exit Time          |              | t <sub>SRE</sub>   | 1   | -    | 1   | -    | CLK  | 1    |
| Refresh Time                    |              | t <sub>REF</sub>   | -   | 64   | -   | 64   | ms   |      |

### Note:

1. A new command can be given t<sub>RC</sub> after self refresh exit.

## BASIC FUNCTIONAL DESCRIPTION

### Mode Register

| BA1 | BA0 | A11 | A10 | A9      | A8 | A7 | A6          | A5 | A4 | A3 | A2           | A1 | A0 |
|-----|-----|-----|-----|---------|----|----|-------------|----|----|----|--------------|----|----|
| 0   | 0   | 0   | 0   | OP Code | 0  | 0  | CAS Latency |    |    | BT | Burst Length |    |    |

#### OP Code

| A9 | Write Mode                  |
|----|-----------------------------|
| 0  | Burst Read and Burst Write  |
| 1  | Burst Read and Single Write |

#### Burst Type

| A3 | Burst Type |
|----|------------|
| 0  | Sequential |
| 1  | Interleave |

#### CAS Latency

| A6 | A5 | A4 | CAS Latency |
|----|----|----|-------------|
| 0  | 0  | 0  | Reserved    |
| 0  | 0  | 1  | Reserved    |
| 0  | 1  | 0  | 2           |
| 0  | 1  | 1  | 3           |
| 1  | 0  | 0  | Reserved    |
| 1  | 0  | 1  | Reserved    |
| 1  | 1  | 0  | Reserved    |
| 1  | 1  | 1  | Reserved    |

#### Burst Length

| A2 | A1 | A0 | Burst Length |          |
|----|----|----|--------------|----------|
|    |    |    | A3 = 0       | A3 = 1   |
| 0  | 0  | 0  | 1            | 1        |
| 0  | 0  | 1  | 2            | 2        |
| 0  | 1  | 0  | 4            | 4        |
| 0  | 1  | 1  | 8            | 8        |
| 1  | 0  | 0  | Reserved     | Reserved |
| 1  | 0  | 1  | Reserved     | Reserved |
| 1  | 1  | 0  | Reserved     | Reserved |
| 1  | 1  | 1  | Full page    | Reserved |

## COMMAND TRUTH TABLE

| Function                   | CKEn-1 | CKEn | $\overline{CS}$ | $\overline{RAS}$ | $\overline{CAS}$ | $\overline{WE}$ | DQM | ADDR                                | A10/AP | BA | Note |
|----------------------------|--------|------|-----------------|------------------|------------------|-----------------|-----|-------------------------------------|--------|----|------|
| Mode Register Set          | H      | X    | L               | L                | L                | L               | X   | Op Code                             |        |    |      |
| No Operation               | H      | X    | L               | H                | H                | H               | X   | X                                   |        |    |      |
| Device Deselect            | H      | X    | H               | X                | X                | X               | X   | X                                   |        |    |      |
| Bank Active                | H      | X    | L               | L                | H                | H               | X   | Row Address                         |        | V  |      |
| Read                       | H      | X    | L               | H                | L                | H               |     | Col-umn                             | L      | V  |      |
| Read with Autoprecharge    | H      | X    | L               | H                | L                | H               | X   | Col-umn                             | H      | V  |      |
| Write                      | H      | X    | L               | H                | L                | L               | X   | Col-umn                             | L      | V  |      |
| Write with Autoprecharge   | H      | X    | L               | H                | L                | L               | X   | Col-umn                             | H      | V  |      |
| Precharge All Banks        | H      | X    | L               | L                | H                | L               | X   | X                                   | H      | X  |      |
| Precharge selected Bank    | H      | X    | L               | L                | H                | L               | X   | X                                   | L      | V  |      |
| Burst stop                 | H      | X    | L               | H                | H                | L               | X   | X                                   |        |    |      |
| DQM                        | H      | X    | X               |                  |                  |                 | V   | X                                   |        |    | 2    |
| Auto Refresh               | H      | H    | L               | L                | L                | H               | X   | X                                   |        |    |      |
| Burst-Read Single-Write    | H      | X    | L               | L                | L                | H               | X   | A9 Pin High<br>(Other Pins OP code) |        |    |      |
| Self Refresh Entry         | H      | L    | L               | L                | L                | H               | X   | X                                   |        |    |      |
| Self Refresh Exit          | L      | H    | H               | X                | X                | X               | X   | X                                   |        |    | 1    |
|                            |        |      | L               | H                | H                | H               |     |                                     |        |    |      |
| Precharge Power Down Entry | H      | L    | H               | X                | X                | X               | X   | X                                   |        |    |      |
|                            |        |      | L               | H                | H                | H               |     |                                     |        |    |      |
| Precharge Power Down Exit  | L      | H    | H               | X                | X                | X               | X   | X                                   |        |    |      |
|                            |        |      | L               | H                | H                | H               |     |                                     |        |    |      |
| Clock Suspend Entry        | H      | L    | H               | X                | X                | X               | X   | X                                   |        |    |      |
|                            |        |      | L               | V                | V                | V               |     |                                     |        |    |      |
| Clock Suspend Exit         | L      | H    | X               |                  |                  |                 | X   | X                                   |        |    |      |

### Note :

- Exiting Self Refresh occurs by asynchronously bringing CKE from low to high.
- see to Next page (DQM TRUTH TABLE)

## DQM TRUTH TABLE

| Function                                    | CKEn-1 | CKEn | DQM0 | DQM1 | DQM2 | DQM3 |
|---------------------------------------------|--------|------|------|------|------|------|
| Data Write/Output enable                    | H      | X    | L    | L    | L    | L    |
| Data Mask/Output disable                    | H      | X    | H    | H    | H    | H    |
| DQ0 to DQ7 write enable / output enable     | H      | X    | L    | X    | X    | X    |
| DQ0 to DQ7 write inhibit / output disable   | H      | X    | H    | X    | X    | X    |
| DQ8 to DQ15 write enable / output enable    | H      | X    | X    | L    | X    | X    |
| DQ8 to DQ15 write inhibit / output disable  | H      | X    | X    | H    | X    | X    |
| DQ16 to DQ23 write enable / output enable   | H      | X    | X    | X    | L    | X    |
| DQ16 to DQ23 write inhibit / output disable | H      | X    | X    | X    | H    | X    |
| DQ24 to DQ31 write enable / output enable   | H      | X    | X    | X    | X    | L    |
| DQ24 to DQ31 write inhibit / output disable | H      | X    | X    | X    | X    | H    |

### Note

1. H: High Level, L: Low Level, X: Don't Care
2. Write DQM Latency is 0 CLK and Read DQM Latency is 2 CLK

## CURRENT STATE TRUTH TABLE (Sheet 1 of 4)

| Current State | Command                |                         |                         |                        |         |              | Action               | Notes                                           |
|---------------|------------------------|-------------------------|-------------------------|------------------------|---------|--------------|----------------------|-------------------------------------------------|
|               | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0/BA1 | Amax-A0      |                      |                                                 |
| idle          | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | Set the Mode Register                           |
|               | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | Start Auto or Self Refresh 5                    |
|               | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | No Operation                                    |
|               | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | Activate the specified bank and row             |
|               | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL 4                                       |
|               | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL 4                                       |
|               | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation 3                                  |
|               | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation or Power Down 3                    |
| Row Active    | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL 13                                      |
|               | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL 13                                      |
|               | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | Precharge 7                                     |
|               | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL 4                                       |
|               | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | Start Write : optional AP(A10=H) 6              |
|               | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | Start Read : optional AP(A10=H) 6               |
|               | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation                                    |
|               | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation                                    |
| Read          | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL 13                                      |
|               | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL 13                                      |
|               | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | Termination Burst: Start the Precharge          |
|               | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL 4                                       |
|               | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | Termination Burst: Start Write(optional AP) 8,9 |
|               | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | Termination Burst: Start Read(optional AP) 8    |
|               | L                      | H                       | H                       | H                      | X       | X            | No Operation         | Continue the Burst                              |
|               |                        |                         |                         |                        |         |              |                      |                                                 |

## CURRENT STATE TRUTH TABLE (Sheet 2 of 4)

| Current State             | Command                |                         |                         |                        |         |              |                      | Action                                      | Notes |
|---------------------------|------------------------|-------------------------|-------------------------|------------------------|---------|--------------|----------------------|---------------------------------------------|-------|
|                           | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0/BA1 | Amax-A0      | Description          |                                             |       |
| Read                      | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | Continue the Burst                          |       |
| Write                     | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                     | 13    |
|                           | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                     | 13    |
|                           | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | Termination Burst: Start the Precharge      | 10    |
|                           | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                     | 4     |
|                           | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | Termination Burst: Start Write(optional AP) | 8     |
|                           | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | Termination Burst: Start Read(optional AP)  | 8,9   |
|                           | L                      | H                       | H                       | H                      | X       | X            | No Operation         | Continue the Burst                          |       |
|                           | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | Continue the Burst                          |       |
| Read with Auto Precharge  | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                     | 13    |
|                           | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                     | 13    |
|                           | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                     | 4,12  |
|                           | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                     | 4,12  |
|                           | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                     | 12    |
|                           | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                     | 12    |
|                           | L                      | H                       | H                       | H                      | X       | X            | No Operation         | Continue the Burst                          |       |
|                           | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | Continue the Burst                          |       |
| Write with Auto Precharge | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                     | 13    |
|                           | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                     | 13    |
|                           | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                     | 4,12  |
|                           | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                     | 4,12  |
|                           | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                     | 12    |
|                           | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                     | 12    |
|                           | L                      | H                       | H                       | H                      | X       | X            | No Operation         | Continue the Burst                          |       |
|                           | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | Continue the Burst                          |       |

# CURRENT STATE TRUTH TABLE (Sheet 3 of 4)

| Current State    | Command                |                         |                         |                        |         |              |                      | Action                                  | Notes   |
|------------------|------------------------|-------------------------|-------------------------|------------------------|---------|--------------|----------------------|-----------------------------------------|---------|
|                  | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0/BA1 | Amax-A0      | Description          |                                         |         |
| Precharging      | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                 | 13      |
|                  | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                 | 13      |
|                  | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | No Operation:<br>Bank(s) idle after tRP |         |
|                  | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation:<br>Bank(s) idle after tRP |         |
|                  | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation:<br>Bank(s) idle after tRP |         |
| Row Activating   | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                 | 13      |
|                  | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                 | 13      |
|                  | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                 | 4,12    |
|                  | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                 | 4,11,12 |
|                  | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation: Row Active after tRCD     |         |
|                  | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation: Row Active after tRCD     |         |
| Write Recovering | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                 | 13      |
|                  | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                 | 13      |
|                  | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                 | 4,13    |
|                  | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                 | 4,12    |
|                  | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | Start Write:<br>Optional AP(A10=H)      |         |
|                  | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | Start Read: Optional AP(A10=H)          | 9       |
|                  | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation:<br>Row Active after tDPL  |         |

## CURRENT STATE TRUTH TABLE (Sheet 4 of 4)

| Current State                        | Command                |                         |                         |                        |         |              |                      | Action                                     | Notes  |
|--------------------------------------|------------------------|-------------------------|-------------------------|------------------------|---------|--------------|----------------------|--------------------------------------------|--------|
|                                      | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0/BA1 | Amax-A0      | Description          |                                            |        |
| Write Recovering                     | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation:<br>Row Active after tDPL     |        |
| Write Recovering with Auto Precharge | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                    | 4,13   |
|                                      | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                    | 4,12   |
|                                      | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                    | 4,12   |
|                                      | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                    | 4,9,12 |
|                                      | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation:<br>Precharge after tDPL      |        |
|                                      | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation:<br>Precharge after tDPL      |        |
| Refreshing                           | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation:<br>idle after tRC            |        |
|                                      | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation:<br>idle after tRC            |        |
| Mode Register Accessing              | L                      | L                       | L                       | L                      | OP CODE |              | Mode Register Set    | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | L                       | H                      | X       | X            | Auto or Self Refresh | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | H                       | L                      | BA      | X            | Precharge            | ILLEGAL                                    | 13     |
|                                      | L                      | L                       | H                       | H                      | BA      | Row Add.     | Bank Activate        | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | L                       | L                      | BA      | Col Add. A10 | Write/WriteAP        | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | L                       | H                      | BA      | Col Add. A10 | Read/ReadAP          | ILLEGAL                                    | 13     |
|                                      | L                      | H                       | H                       | H                      | X       | X            | No Operation         | No Operation:<br>idle after 2 clock cycles |        |
|                                      | H                      | X                       | X                       | X                      | X       | X            | Device Deselect      | No Operation:<br>idle after 2 clock cycles |        |

**Note :**

1. H: Logic High, L: Logic Low, X: Don't care, BA: Bank Address, AP: Auto Precharge.
2. All entries assume that CKE was active during the preceding clock cycle.
3. If both banks are idle and CKE is inactive, then in power down cycle
4. Illegal to bank in specified states. Function may be legal in the bank indicated by Bank Address, depending on the state of that bank.
5. If both banks are idle and CKE is inactive, then Self Refresh mode.
6. Illegal if tRCD is not satisfied.
7. Illegal if tRAS is not satisfied.
8. Must satisfy burst interrupt condition.
9. Must satisfy bus contention, bus turn around, and/or write recovery requirements.
10. Must mask preceding data which don't satisfy tDPL.
11. Illegal if tRRD is not satisfied
12. Illegal for single bank, but legal for other banks in multi-bank devices.
13. Illegal for all banks.

CKE Enable(CKE) Truth TABLE (Sheet 1 of 2)

| Current State  | CKE            |               | Command                |                         |                         |                        |          |      | Action                                                           | Notes |
|----------------|----------------|---------------|------------------------|-------------------------|-------------------------|------------------------|----------|------|------------------------------------------------------------------|-------|
|                | Previous Cycle | Current Cycle | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0, BA1 | ADDR |                                                                  |       |
| Self Refresh   | H              | X             | X                      | X                       | X                       | X                      | X        | X    | INVALID                                                          | 1     |
|                | L              | H             | H                      | X                       | X                       | X                      | X        | X    | Exit Self Refresh with Device Deselect                           | 2     |
|                | L              | H             | L                      | H                       | H                       | H                      | X        | X    | Exit Self Refresh with No Operation                              | 2     |
|                | L              | H             | L                      | H                       | H                       | L                      | X        | X    | ILLEGAL                                                          | 2     |
|                | L              | H             | L                      | H                       | L                       | X                      | X        | X    | ILLEGAL                                                          | 2     |
|                | L              | H             | L                      | L                       | X                       | X                      | X        | X    | ILLEGAL                                                          | 2     |
|                | L              | L             | X                      | X                       | X                       | X                      | X        | X    | Maintain Self Refresh                                            |       |
| Power Down     | H              | X             | X                      | X                       | X                       | X                      | X        | X    | INVALID                                                          | 1     |
|                | L              | H             | H                      | X                       | X                       | X                      | X        | X    | Power Down mode exit, all banks idle                             | 2     |
|                |                |               | L                      | H                       | H                       | H                      | X        | X    |                                                                  |       |
|                | L              | H             | L                      | L                       | X                       | X                      | X        | X    | ILLEGAL                                                          | 2     |
|                |                |               |                        | X                       | L                       | X                      | X        | X    |                                                                  |       |
|                |                |               |                        | X                       | X                       | L                      | X        | X    |                                                                  |       |
|                | L              | L             | X                      | X                       | X                       | X                      | X        | X    | Maintain Power Down Mode                                         |       |
| All Banks Idle | H              | H             | H                      | X                       | X                       | X                      |          |      | Refer to the idle State section of the Current State Truth Table | 3     |
|                | H              | H             | L                      | H                       | X                       | X                      |          |      |                                                                  | 3     |
|                | H              | H             | L                      | L                       | H                       | X                      |          |      |                                                                  | 3     |
|                | H              | H             | L                      | L                       | L                       | H                      | X        | X    | Auto Refresh                                                     |       |
|                | H              | H             | L                      | L                       | L                       | L                      | OP CODE  |      | Mode Register Set                                                | 4     |
|                | H              | L             | H                      | X                       | X                       | X                      |          |      | Refer to the idle State section of the Current State Truth Table | 3     |
|                | H              | L             | L                      | H                       | X                       | X                      |          |      |                                                                  | 3     |
|                | H              | L             | L                      | L                       | H                       | X                      |          |      |                                                                  | 3     |
|                | H              | L             | L                      | L                       | L                       | H                      | X        | X    | Entry Self Refresh                                               | 4     |
|                | H              | L             | L                      | L                       | L                       | L                      | OP CODE  |      | Mode Register Set                                                |       |
|                | L              | X             | X                      | X                       | X                       | X                      | X        | X    | Power Down                                                       | 4     |

## CKE Enable(CKE) Truth TABLE (Sheet 2 of 2)

| Current State                     | CKE            |               | Command                |                         |                         |                        |          |      | Action                                               | Notes |
|-----------------------------------|----------------|---------------|------------------------|-------------------------|-------------------------|------------------------|----------|------|------------------------------------------------------|-------|
|                                   | Previous Cycle | Current Cycle | $\overline{\text{CS}}$ | $\overline{\text{RAS}}$ | $\overline{\text{CAS}}$ | $\overline{\text{WE}}$ | BA0, BA1 | ADDR |                                                      |       |
| Any State other than listed above | H              | H             | X                      | X                       | X                       | X                      | X        | X    | Refer to operations of the Current State Truth Table |       |
|                                   | H              | L             | X                      | X                       | X                       | X                      | X        | X    | Begin Clock Suspend next cycle                       |       |
|                                   | L              | H             | X                      | X                       | X                       | X                      | X        | X    | Exit Clock Suspend next cycle                        |       |
|                                   | L              | L             | X                      | X                       | X                       | X                      | X        | X    | Maintain Clock Suspend                               |       |

### Note :

- For the given current state CKE must be low in the previous cycle.
- When CKE has a low to high transition, the clock and other inputs are re-enabled asynchronously. When exiting power down mode, a NOP (or Device Deselect) command is required on the first positive edge of clock after CKE goes high.
- The address inputs depend on the command that is issued.
- The Precharge Power Down mode, the Self Refresh mode, and the Mode Register Set can only be entered from the all banks idle state.
- When CKE has a low to high transition, the clock and other inputs are re-enabled asynchronously.  
When exiting deep power down mode, a NOP (or Device Deselect) command is required on the first positive edge of clock after CKE goes high and is maintained for a minimum 200usec.

## PACKAGE INFORMATION

90 Ball FBGA, 8mm x 13mm x 1.1mm, 0.8mm pitch

Unit [mm]

