



**DDR SDRAM Module 128Mbyte (16Mx72bit), based on 16Mx8, 4Banks**  
**4K Ref., 184Pin-DIMM with Unbuffered ECC Part No. HDD16M72D9W**

## GENERAL DESCRIPTION

The HDD16M72D9W is a 64M x 72 bit Double Data Rate(DDR) Synchronous Dynamic RAM high-density memory module. The module consists of nine CMOS 16M x 8 bit with 4banks DDR SDRAMs in 66pin TSOP-II 400mil packages and 2K EEPROM in 8-pin TSSOP package on a 184-pin glass-epoxy. Four 0.1uF decoupling capacitors are mounted on the printed circuit board in parallel for each DDR SDRAM. The HDD16M72D9W is a DIMM(Dual in line Memory Module) .Synchronous design allows precise cycle control with the use of system clock. Data I/O transactions are possible on both edges of DQS. Range of operating frequencies, programmable latencies and burst lengths allows the same device to be useful for a variety of high bandwidth, high performance memory system applications. All module components may be powered from a single 2.5V DC power supply and all inputs and outputs are SSTL\_2 compatible.

## FEATURES

- Part Identification
  - HDD16M72D9W – 10A : 100MHz (CL=2)
  - HDD16M72D9W – 13A : 133MHz (CL=2)
  - HDD16M72D9W – 13B : 133MHz (CL=2.5)
- Power supply :  $V_{DD}: 2.5V \pm 0.2V$ ,  $V_{DDQ}: 2.5V \pm 0.2V$
- Double-data-rate architecture; two data transfers per clock cycle
- Bidirectional data strobe(DQS)
- Differential clock inputs(CK and CK)
- DLL aligns DQ and DQS transition with CK transition
- Programmable Read latency 2, 2.5 (clock)
- Programmable Burst length (2, 4, 8)
- Programmable Burst type (sequential & interleave)
- Edge aligned data output, center aligned data input
- Auto & Self refresh, 15.6us refresh interval (4K/64ms refresh)
- Serial presence detect with EEPROM
- PCB : Height 1200 mil, double sided component

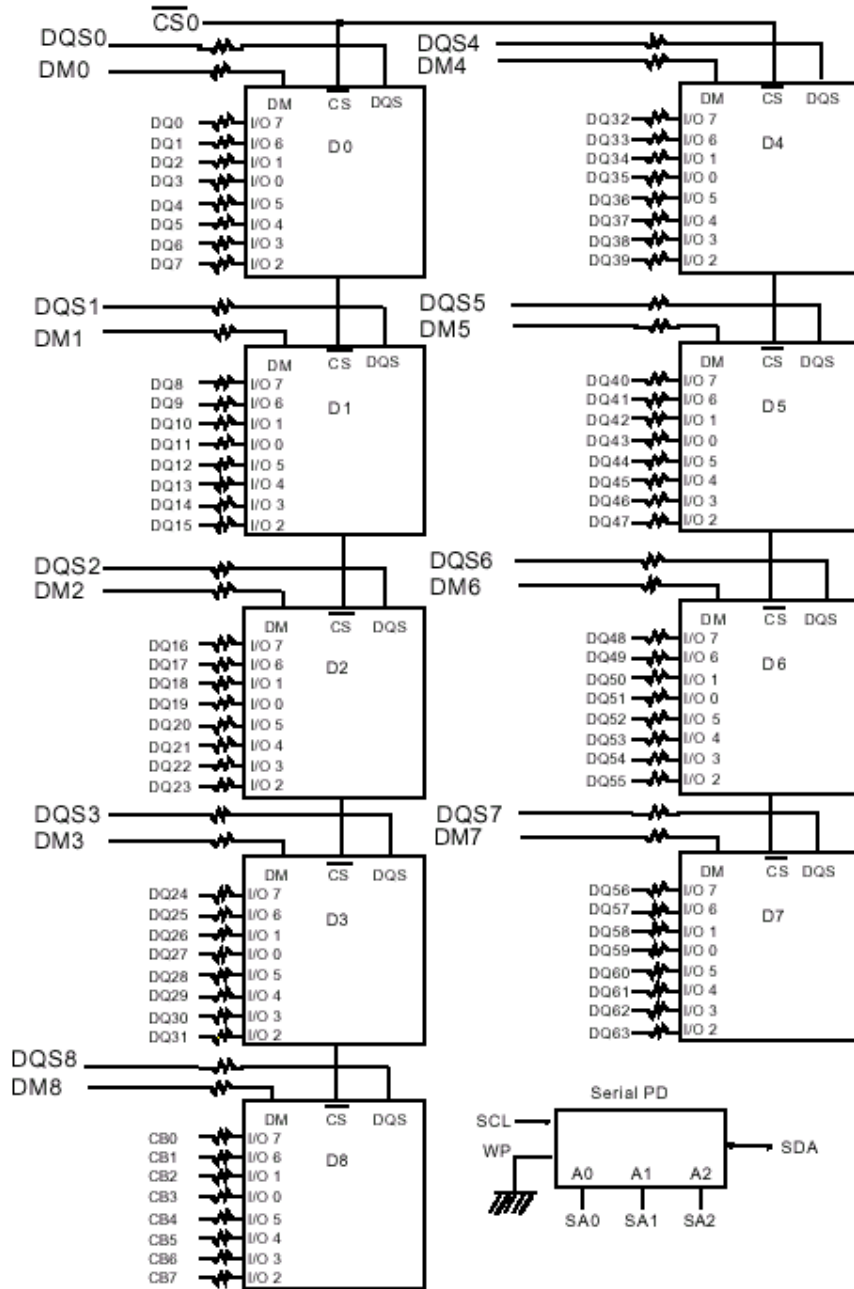
## PIN ASSIGNMENT

PIN	Front	PIN	Back	PIN	Frontl	PIN	Back	PIN	Front	PIN	Back
1	VREF	32	A5	62	VDDQ	93	VSS	124	VSS	154	/RAS
2	DQ0	33	DQ24	63	/WE	94	DQ4	125	A6	155	DQ45
3	VSS	34	VSS	64	DQ41	95	DQ5	126	DQ28	156	VDDQ
4	DQ1	35	DQ25	65	/CAS	96	VDDQ	127	DQ29	157	/CS0
5	DQS0	36	DQS3	66	VSS	97	DM0	128	VDDQ	158	* /CS1
6	DQ2	37	A4	67	DQS5	98	DQ6	129	DM3	159	DM5
7	VDD	38	VDD	68	DQ42	99	DQ7	130	A3	160	VSS
8	DQ3	39	DQ26	69	DQ43	100	VSS	131	DQ30	161	DQ46
9	NC	40	DQ27	70	VDD	101	NC	132	VSS	162	DQ47
10	NC	41	A2	71	* /CS2	102	NC	133	DQ31	163	* /CS3
11	VSS	42	VSS	72	DQ48	103	NC	134	CB4	164	VDDQ
12	DQ8	43	A1	73	DQ49	104	VDDQ	135	CB5	165	DQ52
13	DQ9	44	CB0	74	VSS	105	DQ12	136	VDDQ	166	DQ53
14	DQS1	45	CB1	75	* CK2	106	DQ13	137	CK0	167	*A13
15	VDDQ	46	VDD	76	* /CK2	107	DM1	138	/CK0	168	VDD
16	* CK1	47	DQS8	77	VDDQ	108	VDD	139	VSS	169	DM6
17	* /CK1	48	A0	78	DQS6	109	DQ14	140	DM8	170	DQ54
18	VSS	49	CB2	79	DQ50	110	DQ15	141	A10	171	DQ55
19	DQ10	50	VSS	80	DQ51	111	CKE1	142	CB6	172	VDDQ
20	DQ11	51	CB3	81	VSS	112	VDDQ	143	VDDQ	173	NC
21	CKE0	52	BA1	82	VDDID	113	* BA2	144	CB7	174	DQ60
22	VDDQ	KEY		83	DQ56	114	DQ20	KEY		175	DQ61
23	DQ16	53	DQ32	84	DQ57	115	*A12	145	VSS	176	VSS
24	DQ17	54	VDDQ	85	VDD	116	VSS	146	DQ36	177	DM7
25	DQS2	55	DQ33	86	DQS7	117	DQ21	147	DQ37	178	DQ62
26	VSS	56	DQS4	87	DQ58	118	A11	148	VDD	179	DQ63
27	A9	57	DQ34	88	DQ59	119	DM2	149	DM4	180	VDDQ
28	DQ18	58	VSS	89	VSS	120	VDD	150	DQ38	181	SA0
29	A7	59	BA0	90	NC	121	DQ22	151	DQ39	182	SA1
30	VDDQ	60	DQ35	91	SDA	122	A8	152	VSS	183	SA2
31	DQ19	61	DQ40	92	SCL	123	DQ23	153	DQ44	184	VDDSPD

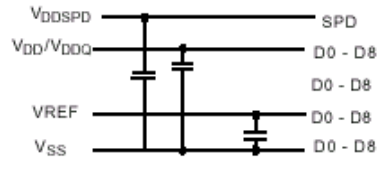
\*These pins should be NC in the system which does not support SPD

PIN	PIN DESCRIPTION	PIN	PIN DESCRIPTION
A0~A11	Address input	VDD	Power supply(2.5V)
BA0~BA1	Bank Select Address	VDDQ	Power supply for DQs(2.5V)
DQ0~DQ63	Data input/output	VREF	Power supply for reference
CB0~CB7	Check bit(Data input/output)	VSPD	Serial EEPROM Power supply(3.3)
DQS0~DQS7	Data Strobe input/output	VSS	Ground
DM0~DM7	Data-in Mask	SA0~SA2	Address in EEPROM
CK0~CK2,/CK0~/CK2	Clock input	SDA	Serial data I/O
CKE0	Clock enable input	SCL	Serial clock
/CS0	Chip Select input	WP	Write protection
/RAS	Row Address strobe	VDDIN	VDD identification flag
/CAS	Column Address strobe	NC	No connection

FUNCTIONAL BLOCK DIAGRAM



- BA0 - BA1 → BA0-BA1: SDRAMs D0 - D8
- A0 - A13 → A0-A13: SDRAMs D0 - D8
- RAS → RAS: SDRAMs D0 - D8
- CAS → CAS: SDRAMs D0 - D8
- CKE0 → CKE: SDRAMs D0 - D8
- WE → WE: SDRAMs D0 - D8



- 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.

## PIN FUNCTION DESCRIPTION

Pin	Name	Input Function
CK, /CK	Clock	CK and /CK are differential clock inputs. All address and control input signals are sampled on the positive edge of CK and negative edge of CK. Output (read) data is referenced to both edges of CK. Internal clock signals are derived from CK/CK.
CKE	Clock Enable	CKE HIGH activates, and CKE LOW deactivates internal clock signals, and device input buffers and output drivers. Deactivating the clock provides PRECHARGE POWER-DOWN and SELF REFRESH operation (all banks idle), or ACTIVE POWER-DOWN(row ACTIVE in any bank). CKE is synchronous for all functions except for disabling outputs, which is achieved asynchronously. Input buffers, excluding CK, CK and CKE are disabled during power-down and self refresh modes, providing low standby power. CKE will recognizean LVCMOS LOW level prior to VREF being stable on power-up.
/CS	Chip Select	/CS enables(registered LOW) and disables(registered HIGH) the command decoder. All commands are masked when /CS is registered HIGH. /CS provides for external bank selection on systems with multiple banks. /CS is considered part of the command code.
A0 ~ A11	Address	Addresses are multiplexed on the same pins. Address : A0 ~ A11
BA0 ~ BA1	Bank select address	BA0 and BA1 define to which bank an ACTIVE, READ, WRITE or PRE-CHARGE command is being applied.
/RAS	Row address strobe	Latches row addresses on the positive going edge of the CLK with /RAS low. Enables row access & precharge.
/CAS	Columnaddress strobe	Latches column addresses on the positive going edge of the CLK with /CAS low. Enables column access.
/WE	Write enable	Enables write operation and row precharge. Latches data in starting from /CAS, /WE active.
DQS0 ~ 7	Data Strobe	Output with read data, input with write data. Edge-aligned with read data, centered in write data. Used to capture write data.
DM0~7	Input Data Mask	DM is an input mask signal for write data. Input data is masked when DM is sampled HIGH along with that input data during a WRITE access. DM is sampled on both edges of DQS. DM pins include dummy loading internally, to matches the DQ and DQS load-ing.
DQ0 ~ 63	Data input/output	Data inputs/outputs are multiplexed on the same pins.
WP	Write Protection	WP pin is connected to Vcc. When WP is "high", EEPROM Programming will be inhibited and the entire memory will be write-protected.
VDDQ	Supply	DQ Power Supply : +2.5V ± 0.2V.
VDD	Supply	Power Supply : +2.5V ± 0.2V (device specific).
VSS	Supply	DQ Ground.
VREF	Supply	SSTL_2 reference voltage.

## ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNTE
Voltage on any pin relative to V <sub>ss</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-0.5 ~ 3.6	V
Voltage on V <sub>DD</sub> supply relative to V <sub>ss</sub>	V <sub>DD</sub>	-1.0 ~ 3.6	V
Voltage on V <sub>DDQ</sub> supply relative to V <sub>ss</sub>	V <sub>DDQ</sub>	-0.5 ~ 3.6	V
Storage temperature	T <sub>STG</sub>	-55 ~ +150	°C
Power dissipation	P <sub>D</sub>	13.5	W
Short circuit current	I <sub>OS</sub>	50	mA

**Notes:** 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 &amp; DC OPERATING CONDITIONS

(Recommended operating conditions (Voltage referenced to V<sub>ss</sub> = 0V, T<sub>A</sub> = 0 to 70°C) )

PARAMETER	SYMBOL	MIN	MAX	UNIT	NOTE
Supply Voltage	V <sub>DD</sub>	2.3	2.7	V	
I/O Supply Voltage	V <sub>DDQ</sub>	2.3	2.7	V	
I/O Reference Voltage	V <sub>REF</sub>	V <sub>DDQ</sub> /2-50mV	V <sub>DDQ</sub> /2+50mV	V	1
I/O Termination Voltage(system)	V <sub>TT</sub>	V <sub>REF</sub> - 0.04	V <sub>REF</sub> + 0.04	V	2
Input High Voltage	V <sub>IH</sub> (DC)	V <sub>REF</sub> + 0.15	V <sub>REF</sub> + 0.3	V	
Input Low Voltage	V <sub>IL</sub> (DC)	-0.3	V <sub>REF</sub> - 0.15	V	
Input Voltage Level, CK and /CK inputs	V <sub>IN</sub> (DC)	-0.3	V <sub>DDQ</sub> + 0.3	V	
Input Differential Voltage, CK and /CK inputs	V <sub>ID</sub> (DC)	0.3	V <sub>DDQ</sub> + 0.6	V	
Input leakage current	I <sub>LI</sub>	-2	2	uA	3
Output leakage current	I <sub>OZ</sub>	-5	5	uA	
Output High current (V <sub>OUT</sub> = 1.95V)	I <sub>OH</sub>	-16.8		mA	
Output Low current (V <sub>OUT</sub> = 0.35V)	I <sub>OL</sub>	16.8		mA	
Output High Current(Half strength driver)	I <sub>OH</sub>	-9		mA	
Output High Current(Half strength driver)	I <sub>OL</sub>	9		mA	

**Notes**

1. Includes ± 25mV margin for DC offset on V<sub>REF</sub>, and a combined total of ± 50mV margin for all AC noise and DC offset on V<sub>REF</sub>, bandwidth limited to 20MHz. The DRAM must accommodate DRAM current spikes on V<sub>REF</sub> and internal DRAM noise coupled TO V<sub>REF</sub>, both of which may result in V<sub>REF</sub> noise. V<sub>REF</sub> should be de-coupled with an inductance of £ 3nH.

2. V<sub>TT</sub> is not applied directly to the device. V<sub>TT</sub> is a system supply for signal termination resistors, is expected to be set equal to V<sub>REF</sub>, and must track variations in the DC level of V<sub>REF</sub>.

3. V<sub>ID</sub> is the magnitude of the difference between the input level on CK and the input level on /CK.

4. 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<sub>REF</sub> envelop that has been bandwidth limited to 200MHZ.

5. The value of V<sub>IX</sub> is expected to equal 0.5\*V<sub>DDQ</sub> of the transmitting device and must track variations in the dc level of the same.

6. These characteristics obey the SSTL-2 class II standards.

**INPUT/OUTPUT Capacitance ( $V_{DD} = 2.5V$ ,  $V_{DDQ} = 2.5V$ ,  $T_A = 25^\circ C$ ,  $F = 1MHz$ )**

DESCRIPTION	SYMBOL	MIN	MAX	UNITS
Input Capacitance(A0 ~ A12, BA0 ~ BA1,RAS,CAS, WE )	$C_{IN1}$	49	57	pF
Input Capacitance(CKE0)	$C_{IN2}$	42	50	pF
Input Capacitance( CS0)	$C_{IN3}$	42	50	pF
Input Capacitance( CLK0, CLK1,CLK2 )	$C_{IN4}$	22	25	pF
Data & DQS input/output Capacitance(DQ0~DQ63)	$C_{OUT1}$	6	8	pF
Input Capacitance(DM0~DM8)	$C_{IN5}$	6	8	pF

**AC Operating Conditions**

PARAMETER/ Condition	STMBOL	MIN	MAX	UNIT	NOTE
Input High (Logic 1) Voltage, DQ, DQS and DM signals	$V_{IH}$ (AC)	$V_{REF} + 0.31$			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

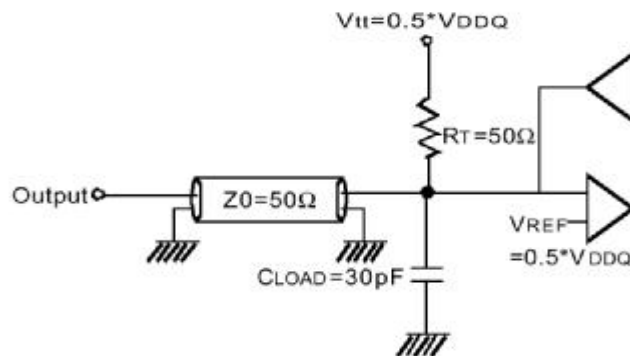
**Note 1.**  $V_{ID}$  is the magnitude of the difference between the input level on CK and the input on CK.

**Note 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.

**Note 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 specifacitims are refation to a  $V_{REF}$  envelope that has been bandwidth limited 20MHz.

**AC Operating TEST Conditions**

PARAMETER	VALUE	UNIT	NOTE
Input reference voltage for Clock	$0.5 * V_{DDQ}$	V	
Input signal maximum peak swing	1.5	V	
Input signal minimum slew rate	0.5	V/ns	
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	V	



Output Load Circuit (SSTL\_2)

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

PARAMETER	SYMBOL	DDR200		DDR266A		DDR266B		UNIT	NOTE
		-10A		-13A		-13B			
		MIN	MAX	MIN	MAX	MIN	MAX		
Row cycle time	$t_{RC}$	70		65		65		ns	1
Refresh row cycle time	$t_{RFC}$	80		75		75		ns	1,2
Row active time	$t_{RAS}$	48	120K	45	120K	45	120K	ns	1,2
/RAS to /CAS delay	$t_{RCD}$	20		20		20		ns	3
Row precharge time	$t_{RP}$	20		20		20		ns	3
Row active to Row active delay	$t_{RRD}$	15		15		15		ns	3
Write recovery time	$t_{WR}$	15		15		15		$t_{CK}$	3
Last data in to Read command	$t_{CDLR}$	1		1		1		$t_{CK}$	2
Col. address to Col. address delay	$t_{CCD}$	1		1		1		$t_{CK}$	
Clock cycle time	CL=2.0	10	12	7.5	12	10	12	ns	
	CL=2.5		12	7.5	12	7.5	12	ns	
Clock high level width	$t_{CH}$	0.45	0.55	0.45	0.55	0.45	0.55	$t_{CK}$	
Clock low level width	$t_{CL}$	0.45	0.55	0.45	0.55	0.45	0.55	$t_{CK}$	
DQS-out access time from CK/CK	$t_{DQSQ}$	-0.8	+0.8	-0.75	+0.75	-0.75	+0.75	ns	
Output data access time from CK/CK	$t_{AC}$	-0.8	+0.8	-0.75	+0.75	-0.75	+0.75	ns	
Data strobe edge to output data edge	$t_{DQSQ}$	-	+0.6	-	+0.5	-	+0.5	ns	
Read Preamble	$t_{RPRE}$	0.9	1.1	0.9	1.1	0.9	1.1	$t_{CK}$	
Read Postamble	$t_{RPST}$	0.4	0.6	0.4	0.6	0.4	0.6	$t_{CK}$	
Data out high impedance time from CK-/CK	$t_{HZQ}$	-0.8	+0.8	-0.75	+0.75	-0.75	+0.75	ns	2
CK to valid DQS-in	$t_{DQSS}$	0.75	1.25	0.75	1.25	0.75	1.25	$t_{CK}$	
DQS-in setup time	$t_{WPRES}$	0		0		0		ns	3
DQS-in hold time	$t_{WPREH}$	0.25		0.25		0.25		$t_{CK}$	
DQS-in falling edge to CK rising-setup time	$t_{DSS}$	0.2		0.2		0.2		$t_{CK}$	
DQS-in falling edge to CK rising hold time	$t_{DSH}$	0.2		0.2		0.2		$t_{CK}$	
DQS-in high level width	$t_{DQSH}$	0.35		0.35		0.35		$t_{CK}$	
DQS-in low level width	$t_{DQSL}$	0.35		0.35		0.35		$t_{CK}$	
DQS-in cycle time	$t_{DSC}$	0.9	1.1	0.9	1.1	0.9	1.1	$t_{CK}$	
Address and Control Input setup time	$t_{IS}$	1.1		0.9		0.9		ns	
Address and Control Input hold time	$t_{IH}$	1.1		0.9		0.9		ns	
Mode register set cycle time	$t_{MRD}$	16		15		15		ns	
DQ & DM setup time to DQS	$t_{DS}$	0.6		0.5		0.5		ns	
DQ & DM hold time to DQS	$t_{DH}$	0.6		0.5		0.5		ns	
DQ & DM input pulse width	$t_{DIPW}$	2		1.75		1.75		ns	
Power down exit time	$t_{PDEX}$	10		7.5		7.5		ns	
Exit self refresh to write command	$t_{XSW}$	116		95				ns	
Exit self refresh to bank active command	$t_{XSA}$	80		75		75		ns	
Exit self refresh to read command	$t_{XSR}$	200		200		200		Cycle	
Refresh interval time	$t_{REF}$	15.6		15.6		15.6		us	1
Output DQS valid window	$t_{QH}$	-	-	-	-	-	-	$t_{CK}$	
DQS write postamble time	$t_{WPST}$	0.4	0.6	0.4	0.6	0.4	0.6	$t_{CK}$	4

**Notes :**

- Maximum burst refresh cycle : 8
- 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  $t_{DQSS}$ .
- 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.
- A write command can be applied with  $t_{RCD}$  satisfied after this command.
- For registered DIMMs,  $t_{CL}$  and  $t_{CH}$  are  $\geq 45\%$  of the period including both the half period jitter ( $t_{JIT}(HP)$ ) of the PLL and the half jitter due to crosstalk ( $t_{JIT}(crosstalk)$ ) on the DIMM.

## 6. Input Setup/Hold Slew Rate Derating

Input Setup/Hold Slew Rate	$\Delta t_{IS}$	$\Delta t_{IH}$
(V/ns)	(ps)	(ps)
0.5	0	0
0.4	+50	+50
0.3	+100	+100

- This derating table is used to increase  $t_{DS}/t_{DH}$  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

Input Setup/Hold Slew Rate	$\Delta t_{IS}$	$\Delta t_{IH}$
(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.

## 8. I/O Setup/Hold Plateau Derating

I/O Input Level	$\Delta t_{DS}$	$\Delta t_{DH}$
(mV)	(ps)	(ps)
$\pm 280$	+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	$\Delta t_{DS}$	$\Delta t_{DH}$
(ns/V)	(ps)	(ps)
0	0	0
$\pm 0.25$	+50	+50
$\pm 0.5$	+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.

- This parameter is fir system simulation purpose. It is guaranteed by design.
- For each of the terms, if not already an integer, round to the next highest integer.  $t_{CK}$  is actual to the system clock cycle time.



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

COMMAND		CKE <sub>n-1</sub>	CKE <sub>n</sub>	/CS	/RAS	/CAS	/WE	DM	BA <sub>0,1</sub>	A10/AP	A11 A9~A0	NOTE	
Register	Extended MRS	H	X	L	L	L	L	X	OP code			1,2	
Register	Mode register set	H	X	L	L	L	L	X	OP code			1,2	
Refresh	Auto refresh		H	H	L	L	L	H	X	X		3	
	Self refresh	Entry		L						X		3	
		Exit	L	H	L	H	H	H	X	X		3	
	H		X	X	X	X		3					
Bank active & Row Addr.		H	X	L	L	H	H	X	V	Row address			
Read & column address	Auto precharge disable		H	X	L	H	L	H	X	V	L	Column Address (A0 ~ A9)	4
	Auto precharge enable										H		4
Write & column address	Auto precharge disable		H	X	L	H	L	H	X	V	L	Column Address (A0 ~ A9)	4
	Auto precharge enable										L		4,6
Burst Stop		H	X	L	H	H	L	X	X			7	
Precharge	Bank selection		H	X	L	L	H	L	X	V	L	X	
	All banks									X	H		5
Clock suspend or active power down	Entry	H	L	H	X	X	X	X	X				
				L	V	V	V						
Precharge power down mode	Entry	H	L	H	X	X	X	X	X				
				L	H	H	H						
	Exit	L	H	H	X	X	X	X	X				
				L	V	V	V						
DM		H	X					V	X		8		
No operation command		H	X	H	X	X	X	X	X				
				L	H	H	H						

**Note :**

- OP Code : Operand Code. A0 ~ A12 & BA0 ~ 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.
- BA0 ~ 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 A10/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 tRP 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.



## ORDERING INFORMATION

Part Number	Density	Org.	Package	Ref.	Vcc	MODE	MAX.frq
HDD16M72D9W-10A	128MByte	16M x 72	184PIN DIMM	4K	2.5V	DDR	100MHz/CL2
HDD16M72D9W-13A	128MByte	16M x 72	184PIN DIMM	4K	2.5V	DDR	133MHz/CL2
HDD16M72D9W-13B	128MByte	16M x 72	184PIN DIMM	4K	2.5V	DDR	133MHz/CL2.5