

1GB DDR SDRAM MODULE

(128Mx72 ((64Mx72)*2)based on 64Mx4 DDR SDRAM)

Registered 184pin DIMM
72-bit ECC/Parity

Revision 0.1

Dec. 2001

Revision History**Revision 0.0 (August. 2000)**

- 1.First release for internal usage.

Revision 0.1 (Dec. 2001)

- Add derating values for the specifications if the single-ended clock skew rate is less than 1.0V/ns in page 47.
- Revised "Absolute maximum rating" table in page 38.
 - . Changed "Voltage on VDDQ supply relative to VSS" value from -0.5~3.6V to -1~3.6V
 - . Changed "power dissipation" value from 1.0W to 1.5W.
- Revised AC parameter table

	From						To					
	DDR266A		DDR266B		DDR200		DDR266A		DDR266B		DDR200	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
tHZ	tACmin -400ps	tACmax -400ps	tACmin -400ps	tACmax -400ps	tACmin -400ps	tACmax -400ps	-0.75	+0.75	-0.75	+0.75	-0.8	+0.8
tLZ	tACmin -400ps	tACmax -400ps	tACmin -400ps	tACmax -400ps	tACmin -400ps	tACmax -400ps	-0.75	+0.75	-0.75	+0.75	-0.8	+0.8
tWPST (tCK)	0.25		0.25		0.25		0.4	0.6	0.4	0.6	0.4	0.6
tPDEX	10ns		10ns		10ns		7.5ns		7.5ns		10ns	

- Deleted typical current in IDD spec. table
- Included address and control input setup/hold time(tIS/tIH) at slow slew rate in DDR200/266 AC specification
- Deleted Exit self refresh to write command(tXSW) in DDR200/266 AC specification
- Rename tXSA(exit self refresh to bank active command) to tXSNR(exit self refresh to non read command) at DDR200/266
- Rename tXSR(exit self refresh to read command) to tXSRD at DDR200/266
- Rename tWPREH(DQS in hold time) to tWPRE at DDR200/266
- Rename tREF(Refresh interval time) to tREFI at DDR200/266
- Changed tWR value from 2tCK to 15ns.
- Rename tCDLR(Write data out to Read command) to tWTR
- Added tDAL(tWR+tRP)

M383L2828CT1

184pin Registered DDR SDRAM MODULE

M383L2828CT1 DDR SDRAM 184pin DIMM 128Mx72 DDR SDRAM 184pin DIMM based on Stacked 64Mx4, 4bank, 8K refresh with SPD

GENERAL DESCRIPTION

The Samsung M383L2828CT1 is 128M bit x 72 Double Data Rate SDRAM high density memory modules. The Samsung M383L2828CT1 consists of thirty-six CMOS 64M x 4 bit with 4banks Double Data Rate SDRAMs in 66pin TSOP-II(400mil) packages, mounted on a 184pin glass-epoxy substrate. Four 0.1uF decoupling capacitors are mounted on the printed circuit board in parallel for each DDR SDRAM. The M383L2828CT1 is Dual In-line Memory Modules and intend-ed for mounting into 184pin edge connector sockets.

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 allow the same device to be useful for a variety of high bandwidth, high performance memory system applications.

FEATURE

- Performance range

Part No.	Max Freq.	Interface
M383L2828CT1-C(L)A2	133MHz(7.5ns@CL=2)	SSTL_2
M383L2828CT1-C(L)B0	133MHz(7.5ns@CL=2.5)	
M383L2828CT1-C(L)A0	100MHz(10ns@CL=2)	

- Power supply : Vdd: 2.5V $\pm$ 0.2V, Vddq: 2.5V $\pm$ 0.2V
- Double-data-rate architecture; two data transfers per clock cycle
- Bidirectional data strobe(DQS)
- Differential clock inputs(CK and $\overline{\text{CK}}$)
- 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, 7.8us refresh interval(8K/64ms refresh)
- Serial presence detect with EEPROM
- PCB : **Height 1700 mil**, double sided component

PIN CONFIGURATIONS (Front side/back side)

Pin	Front	Pin	Front	Pin	Front	Pin	Back	Pin	Back	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	DQS9	128	VDDQ	158	/CS1
6	DQ2	37	A4	67	DQS5	98	DQ6	129	DQS12	159	DQS14
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	/RESET	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	DQS10	138	/CK0	168	VDD
16	*CK1	47	DQS8	77	VDDQ	108	VDD	139	VSS	169	DQS15
17	*/CK1	48	A0	78	DQS6	109	DQ14	140	DQS17	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	DQS16
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	DQS11	149	DQS13	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

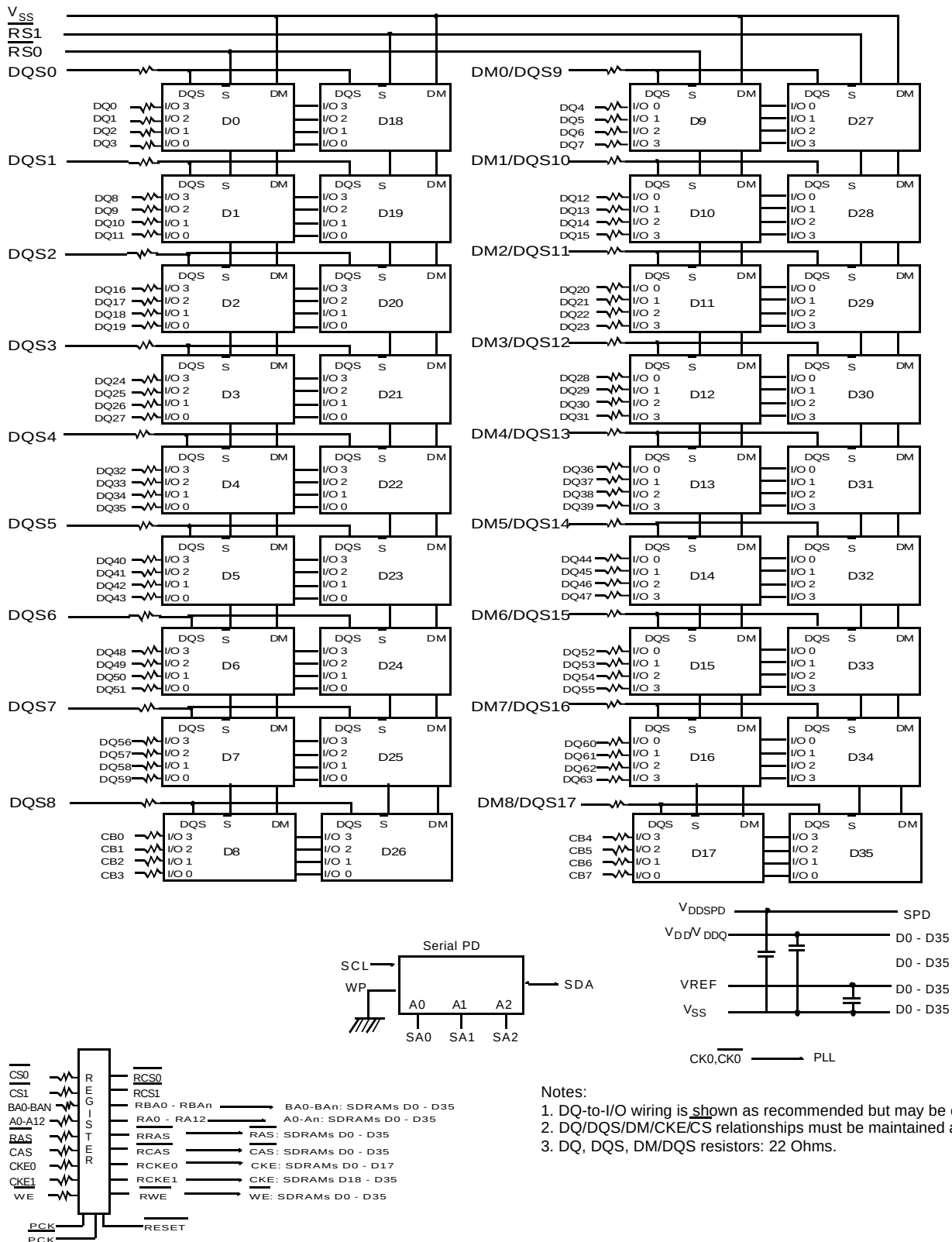
PIN DESCRIPTION

Pin Name	Function
A0 ~ A12	Address input (Multiplexed)
BA0 ~ BA1	Bank Select Address
DQ0 ~ DQ63	Data input/output
CB0 ~ CB7	Check bit(Data-in/data-out)
DQS0 ~ DQS17	Data Strobe input/output
CK0,CK0	Clock input
CKE0,CKE1	Clock enable input
CS0,CS1	Chip select input
RAS	Row address strobe
CAS	Column address strobe
WE	Write enable
VDD	Power supply (2.5V)
VDDQ	Power Supply for DQS(2.5V)
VSS	Ground
VREF	Power supply for reference
VDDSPD	Serial EEPROM Power Supply (2.3V to 3.6V)
SDA	Serial data I/O
SCL	Serial clock
SA0 ~ 2	Address in EEPROM
VDDID	VDD identification flag
RESET	Reset enable
NC	No connection

* These pins are not used in this module.

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Functional Block Diagram



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	54	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.

DDR SDRAM I_{DD} spec table

Symbol		A2(DDR266@CL=2)	B0(DDR266@CL=2.5)	A0(DDR200@CL=2)	Unit	Notes
IDD0		3560	3560	3260	mA	
IDD1		4170	4170	3660	mA	
IDD2P		1180	1180	1180	mA	
IDD2F		1700	1700	1660	mA	
IDD2Q		1980	1980	1900	mA	
IDD3P		2210	2210	2050	mA	
IDD3N		2850	2850	2570	mA	
IDD4R		4170	4170	3700	mA	
IDD4W		4450	4450	3820	mA	
IDD5		5000	5000	4610	mA	
IDD6		1220	1220	1220	mA	
IDD6	Low Power	1160	1160	1160	mA	Optional
IDD7A		6750	6750	5920	mA	

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

For the I_{DD} spec of a DDR SDRAM Module with 2 rows, SAMSUNG defines the test condition of each row as below:

Test (condition)	
1 row (Active)	2 row (Stand by)
IDD0	IDD3N
IDD1	IDD3N
IDD2P	IDD2P
IDD2F	IDD2F
IDD2Q	IDD2Q
IDD3P	IDD3P
IDD3N	IDD3N
IDD4R	IDD3N
IDD4W	IDD3N
IDD5	IDD3N
IDD6	IDD6
IDD7	IDD3N

AC Operating Conditions

Parameter/Condition	Symbol	Min	Max	Unit	Note
Input High (Logic 1) Voltage, DQ, DQS and DM signals	VIH(AC)	VREF + 0.31		V	3
Input Low (Logic 0) Voltage, DQ, DQS and DM signals.	VIL(AC)		VREF - 0.31	V	3
Input Differential Voltage, CK and CK inputs	VID(AC)	0.7	VDDQ+0.6	V	1
Input Crossing Point Voltage, CK and CK inputs	VIX(AC)	0.5*VDDQ-0.2	0.5*VDDQ+0.2	V	2

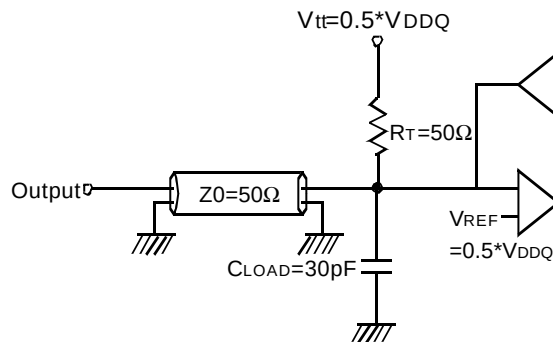
Note 1. VID is the magnitude of the difference between the input level on CK and the input on $\overline{\text{CK}}$.

2. 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.

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	$0.5 \cdot V_{DDQ}$	V	
Input signal maximum peak swing	1.5	V	
Input Levels(VIH/VIL)	$V_{REF}+0.31/V_{REF}-0.31$	V	
Input timing measurement reference level	VREF	V	
Output timing measurement reference level	Vtt	V	
Output load condition	See Load Circuit		



Output Load Circuit (SSTL_2)

Input/Output CAPACITANCE ($V_{DD}=2.5$, $V_{DDQ}=2.5V$, $T_A=25^\circ\text{C}$, $f=1\text{MHz}$)

Parameter	Symbol	Min	Max	Unit
Input capacitance(A0 ~ A12, BA0 ~ BA1, $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$)	CIN1	6	8	pF
Input capacitance(CKE0, CKE1)	CIN2	5	7	pF
Input capacitance($\overline{\text{CS0}}$, $\overline{\text{CS1}}$)	CIN3	5	7	pF
Input capacitance(CLK0, /CLK0)	CIN4	8	10	pF
Input capacitance(DM0~DM8)	CIN5	12	14	pF
Data & DQS input/output capacitance(DQ0~DQ63)	COUT1	12	14	pF
Data input/output capacitance(CB0~CB7)	COUT2	12	14	pF

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 ouput 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		

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

- 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 tDQSS.
- 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 tRCD satisfied after this command.
- For registered DIMMs, tCL and tCH are $\geq 45\%$ 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.
- Input Setup/Hold Slew Rate Derating

Input Setup/Hold Slew Rate	Δt_{IS}	Δt_{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_{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	Δt_{DS}	Δt_{DH}
(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	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 $V_{REF} \pm 310\text{mV}$ 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 $1/\text{SlewRate1}-1/\text{SlewRate2}$. 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)	$\Delta t_{LZ}(\text{min})$ (ps)	$\Delta t_{HZ}(\text{max})$ (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

Command Truth Table

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

COMMAND			CKEn-1	CKEn	$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	BA0,1	A10/AP	A11, A12 A9 ~ 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								3
		Exit	L	H	L	H	H	H	X			3
												H
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	V	L	Column Address A0~A9, A11	4
	Auto Precharge Enable									H		4
Write & Column Address	Auto Precharge Disable		H	X	L	H	L	L	V	L	Column Address A0~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				
Precharge Power Down Mode		Entry	H	L	H	X	X	X	X			
					L	H	H	H				
		Exit	L	H	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. A₀ ~ A₁₂ & BA₀ ~ BA₁ : Program keys. (@EMRS/MRS)

2. EMRS/ MRS can be issued only at all banks precharge state.

A new command can be issued 2 clock cycles after EMRS or MRS.

3. 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.

4. 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.

5. If A₁₀/AP is "High" at row precharge, BA₀ and BA₁ are ignored and all banks are selected.

6. 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.

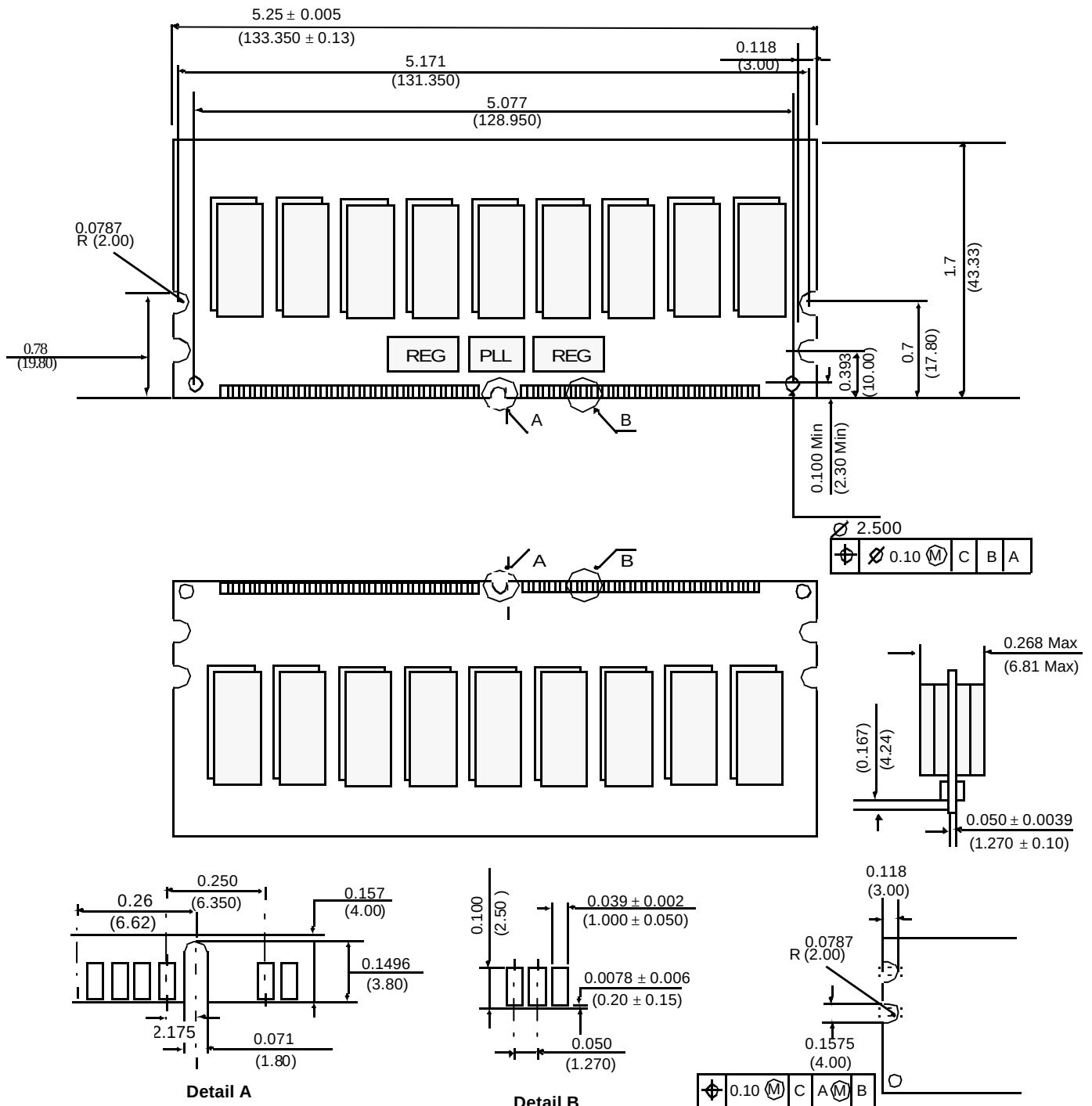
7. Burst stop command is valid at every burst length.

8. 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).

9. This combination is not defined for any function, which means "No Operation(NOP)" in DDR SDRAM.

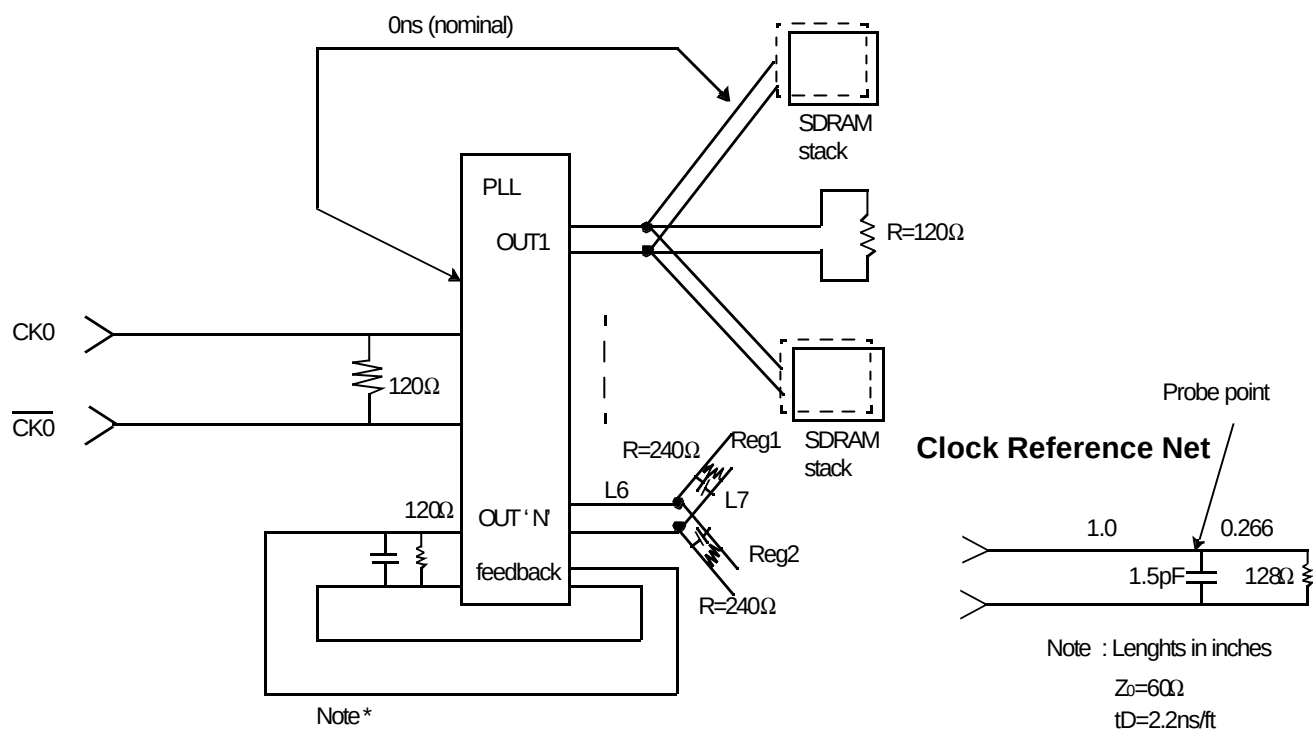
PACKAGE DIMENSIONS

Units : Inches (Millimeters)



Tolerances : ± 0.005 (.13) unless otherwise specified
 The used device is 64Mx4 SDRAM, 66TSOPII
 SDRAM Part NO : K4H510638C

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 line 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.