

SDRAM MODULE

Preliminary KMM378S1620CT

KMM378S1620CT

16Mx72 SDRAM DIMM with PLL & Register based on 16Mx4, 4Banks, 4K Ref. 3.3V Synch. DRAMs

GENERAL DESCRIPTION

The Samsung KMM378S1620CT is a 16M bit x 72 Synchronous Dynamic RAM high density memory module. The Samsung KMM378S1620CT consists of eighteen CMOS 16M x 4 bit Synchronous DRAMs in TSOP-II 400mil packages, two 20 bits Drive ICs for input control signal and one PLL in 24-pin TSOP package mounted on a 200-pin glass-epoxy substrate. Two 0.1uF decoupling capacitors are mounted on the printed circuit board for each SDRAM. The KMM378S1620CT is a Dual In-line Memory Module and is intended for mounting into 200-pin edge connector sockets.

Synchronous design allows precise cycle control with the use of system clock. I/O transactions are possible on every clock cycle. Range of operating frequencies, programmable latencies allows the same device to be useful for a variety of high bandwidth, high performance memory system applications.

FEATURE

- Performance range

Part No..	Max Freq. (Speed)
KMM378S1620CT-G8	125MHz (8ns @ CL=3)
KMM378S1620CT-GH	100MHz (10ns @ CL=2)
KMM378S1620CT-GL	100MHz (10ns @ CL=3)
KMM378S1620CT-G0	100MHz (10ns @ CL=3)

- Burst Mode Operation
- Auto & Self Refresh Capability (4096 cycles / 64ms)
- LVTTL compatible inputs and outputs
- Single 3.3V $\pm$ 0.3V power supply
- MRS cycle with address key programs
Latency (Access from column address)
Burst Length (1, 2, 4, 8 & Full page)
Data Scramble (Sequential & Interleave)
- All inputs are sampled at the positive going edge of the system clock
- PCB : Height(1,250mil), double sided component

PIN CONFIGURATIONS (Front Side / Back Side)

Pin	Front	Pin	Front	Pin	Front	Pin	Front	Pin	Back	Pin	Back	Pin	Back	Pin	Back
1	VDD	26	VDDQ	51	VSS	76	DQ16	101	NC	126	DQ53	151	CLK0	176	VDD(Q)
2	NC	27	DQ51	52	RAS	77	VSS	102	NC	127	DQ52	152	VDD	177	NC
3	NC	28	DQ50	53	VSS	78	NC	103	VSS	128	VDDQ	153	NC	178	VSS
4	*IN	29	VSS	54	*A12/CS2	79	NC	104	REGE	129	DQ47	154	CS0	179	VSS
5	*OUT	30	DQ49	55	A11	80	VDDQ	105	RFU	130	DQ46	155	VSS	180	NC
6	NC	31	DQ48	56	VDD	81	DQ15	106	RFU	131	VSS	156	BA1	181	NC
7	NC	32	VDDQ	57	A0	82	DQ14	107	NC	132	DQ45	157	A10(AP)	182	VDDQ
8	VSS	33	DQ43	58	A1	83	VSS	108	DQ71	133	DQ44	158	VDD	183	DQ11
9	DQ67	34	DQ42	59	VSS	84	DQ13	109	DQ70	134	VDDQ	159	A2	184	DQ10
10	DQ66	35	VSS	60	DQ35	85	DQ12	110	VSS	135	DQ39	160	A3	185	VSS
11	VDDQ	36	DQ41	61	DQ34	86	VDDQ	111	DQ69	136	DQ38	161	VSS	186	DQ9
12	DQ65	37	DQ40	62	VDDQ	87	DQ7	112	DQ68	137	VSS	162	DQ31	187	DQ8
13	DQ64	38	VDDQ	63	DQ33	88	DQ6	113	VDDQ	138	DQ37	163	DQ30	188	VDDQ
14	VSS	39	A4	64	DQ32	89	VSS	114	NC	139	DQ36	164	VDDQ	189	DQ3
15	DQ63	40	A5	65	VSS	90	DQ5	115	VSS	140	VDD	165	DQ29	190	DQ2
16	DQ62	41	VSS	66	DQ27	91	DQ4	116	NC	141	A6	166	DQ28	191	VSS
17	NC	42	A8	67	DQ26	92	VDDQ	117	DQ59	142	A7	167	VSS	192	DQ1
18	DQ61	43	A9	68	VDDQ	93	NC	118	DQ58	143	VSS	168	DQ23	193	DQ0
19	DQ60	44	VDD	69	DQ25	94	NC	119	VSS	144	BA0(A13)	169	DQ22	194	SDA
20	VDDQ	45	NC	70	DQ24	95	NC	120	DQ57	145	NC	170	VDDQ	195	SA0
21	NC	46	CKE0	71	VSS	96	NC	121	DQ56	146	VDD	171	DQ21	196	SA1
22	NC	47	VSS	72	DQ19	97	NC	122	VDDQ	147	DQM	172	DQ20	197	SA2
23	VSS	48	CAS	73	DQ18	98	SCL	123	DQ55	148	WE	173	VSS	198	VDD
24	NC	49	NC	74	VDDQ	99	NC	124	DQ54	149	VSS	174	NC	199	NC
25	NC	50	VDD	75	DQ17	100	VSS	125	VSS	150	NC	175	NC	200	NC

Note :1. "*" ; These pins are not used in this synchronous DRAM module. Here these pins are equal to No Connection.
2. In LVTTL interface, VDDQ=VDD and VSSQ=VSS

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PIN NAMES

Pin Name	Function
A0~A11	Address Input (multiplexed)
BA0, BA1	SDRAM Bank Select
DQ0 ~ DQ71	Data Inputs / Outputs
CLK0	Clock Input
CKE0	Clock Enable Input
$\overline{CS}$ 0	Chip Select Input
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
$\overline{WE}$	Write Enable
DQM	DQ Mask Enable
REGE	Buffer Enable
*IN, *OUT	Unbuffered Physical Detect Input/Output (separate)
**SA0 ~ SA2	Address input for EEPROM
**SDA	Serial Data I/O for PD
**SCL	Clock Input for PD
VDD	Power Supply
VDDQ	Power supply for Data Input/Output
VSS	Ground
RFU	Reserved Future Use
NC	No Connection

* These pins are not used in this module.

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

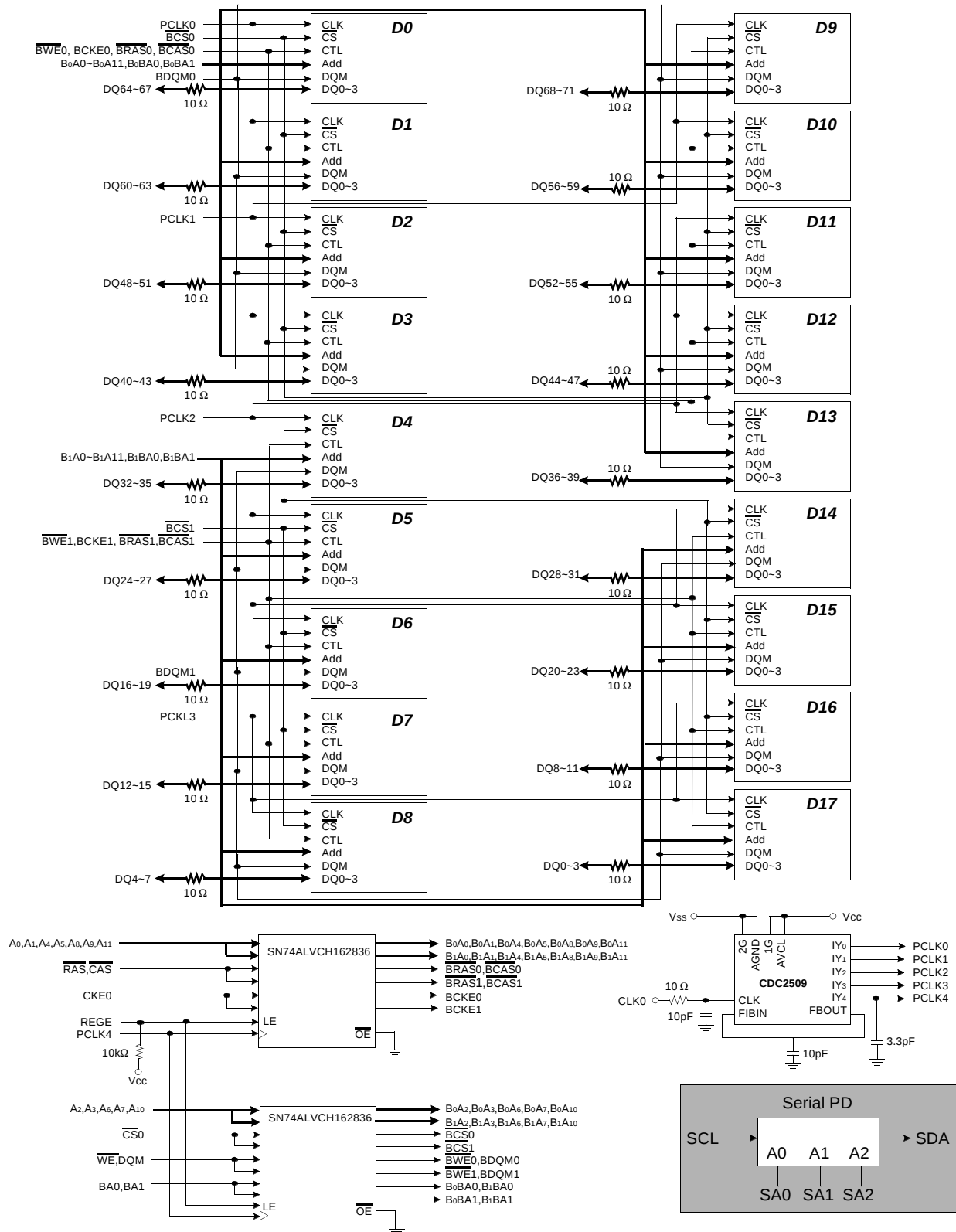
INPUT FUNCTION DESCRIPTION

CLK	Clock input
$\overline{CS}$	Disables or enables device operation by masking or enabling all inputs except CLK, CKE and DQM
CKE	Masks system clock to freeze operation from the next clock cycle. CKE should be enabled at least one cycle prior to new command. Disables input buffers for power down standby.
Address	Row & column address are multiplexed on the same pins. Row address:RA0~RA11, Column address:CA0~CA9
BA0,BA1	Selects bank to be activated during row address latch time and selects bank for read/write during column address latch time.
$\overline{RAS}$	Latches row address on the positive edge of the CLK with $\overline{RAS}$ low. Enables row access & precharge.
$\overline{CAS}$	Latches column address on the positive edge of the CLK with $\overline{RAS}$ low. Enables column access.
$\overline{WE}$	Enables write operation and row precharge. Latches data in starting from $\overline{CAS}$, $\overline{WE}$ active.
DQM	Makes data output Hi-Z, tSHZ after the clock and masks the output. Blocks data input when DQM active
DQ	Data inputs/outputs are multiplexed on the same pins.
REGE	The device operates in the transparent mode when REGE is low. When REGE is high, the device operates in the registered mode. In registered mode, the Address and control inputs are latched if CLK is held at a high or low logic level. the inputs are stored in the latch/flip-flop on the rising edge of CLK. REGE is tied to Vcc through 10K ohm Resistor on PCB. So if REGE of module is floating, this module will be operated as registered mode.

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FUNCTIONAL BLOCK DIAGRAM



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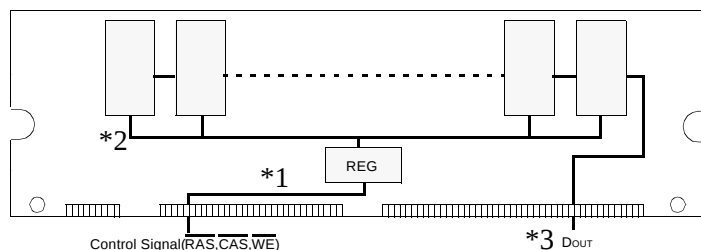
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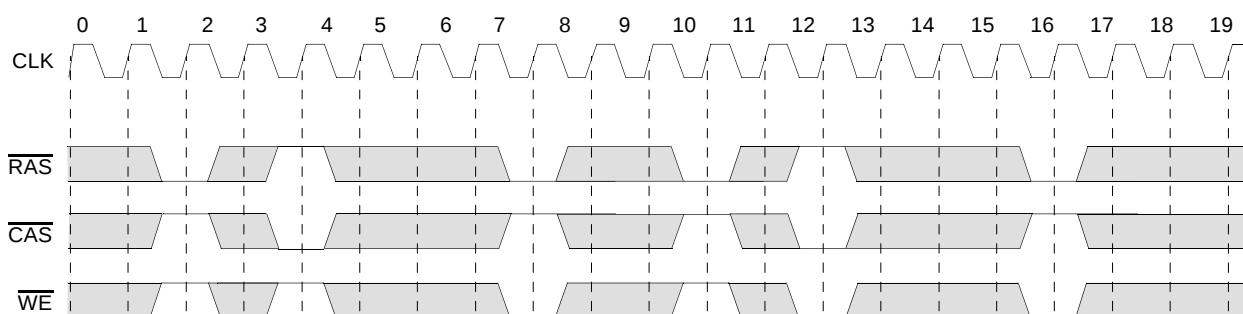
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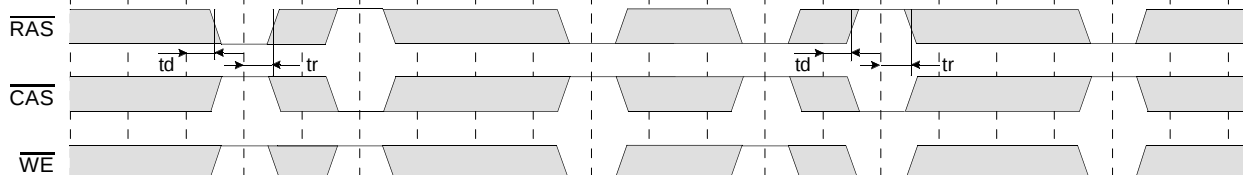
STANDARD TIMING DIAGRAM WITH PLL & REGISTER(CL=2,BL=4)



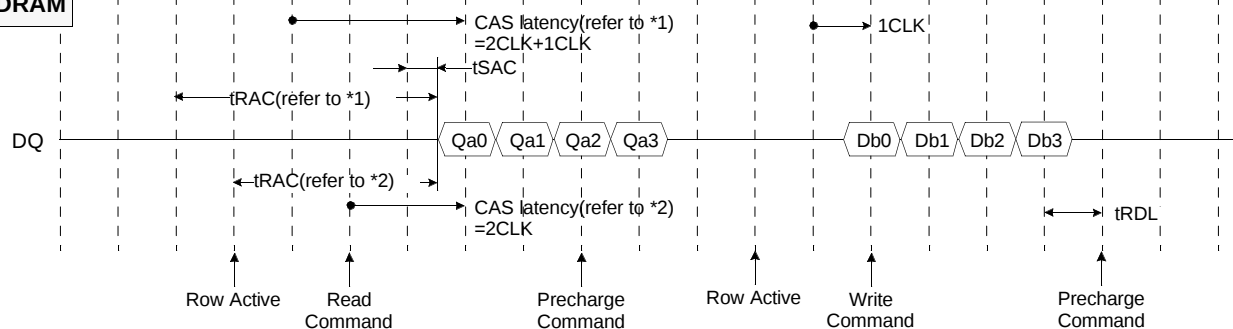
*1. Register Input



*2. Register Output



*3. SDRAM



t_d , t_r = Delay of Register (SN74ALVCH162836 of TI)

Note : 1. In case of module timing, command cycles delayed 1CLK with respect to external input timing at the address and input signal because of the buffering in register (SN74ALVCH162836). Therefore, Input/Output signals of read/write function should be issued 1CLK earlier as compared to Unbuffered DIMMs.

2. D_{IN} is to be issued 1clock after write command in external timing because D_{IN} is issued directly to module.

□ : Don't Care

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ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on any pin relative to Vss	V _{IN} , V _{OUT}	-1.0 ~ 4.6	V
Voltage on V _{DD} supply relative to Vss	V _{DD} , V _{DDQ}	-1.0 ~ 4.6	V
Storage temperature	T _{STG}	-55 ~ +150	°C
Power dissipation	P _D	18	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.

DC OPERATING CONDITIONS AND CHARACTERISTICS

Recommended operating conditions (Voltage referenced to Vss = 0V, T_A = 0 to 70°C)

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	V _{DD}	3.0	3.3	3.6	V	
Input high voltage	V _{IH}	2.0	3.0	V _{DDQ} + 0.3	V	1
Input low voltage	V _{IL}	-0.3	0	0.8	V	2
Output high voltage	V _{OH}	2.4	-	-	V	I _{OH} = -2mA
Output low voltage	V _{OL}	-	-	0.4	V	I _{OL} = 2mA
Input leakage current (Inputs)	I _{IL}	-2	-	2	µA	3
Input leakage current (I/O pins)	I _{IL}	-1.5	-	1.5	µA	3,4

Note : 1. V_{IH} (max) = 5.6V AC. The overshoot voltage duration is ≤ 3ns.
2. V_{IL} (min) = -2.0V AC. The undershoot voltage duration is ≤ 3ns.
3. Any input 0V ≤ V_{IN} ≤ V_{DDQ}.
Input leakage currents include HI-Z output leakage for all bi-directional buffers with Tri-State outputs.
4. Dout is disabled, 0V ≤ V_{OUT} ≤ V_{DDQ}.

CAPACITANCE (V_{DD} = 3.3V, T_A = 23°C, f = 1MHz, V_{REF} = 1.4V ± 200 mV)

Parameter	Symbol	Min	Max	Unit
Input capacitance (A ₀ ~ A ₁₁ , $\overline{\text{CS0}}$)	C _{IN1}	-	22	pF
Input capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, CKE ₀)	C _{IN2}	-	22	pF
Input capacitance (CLK ₀)	C _{IN3}	-	14	pF
Input capacitance (BA ₀ , BA ₁)	C _{IN4}	-	22	pF
Input capacitance (DQM)	C _{IN5}	-	22	pF
Data input/output capacitance (DQ ₀ ~ DQ ₇₁)	C _{OUT}	-	16.5	pF

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DC CHARACTERISTICS

(Recommended operating condition unless otherwise noted, T_A = 0 to 70°C)

Parameter	Symbol	Test Condition	CAS Latency	Version				Unit	Note
				-8	-H	-L	-10		
Operating Current (One Bank Active)	Icc1	Burst Length =1 trc ≥ trc(min) IoL = 0 mA		1,550	1,460	1,460	1,370	mA	1
Precharge Standby Current in power-down mode	Icc2P	CKE ≤ VIL(max), tcc = 15ns		20				mA	
	Icc2PS	CKE & CLK ≤ VIL(max), tcc = ∞		20					
Precharge Standby Current in non power-down mode	Icc2N	CKE ≥ VIH(min), $\overline{CS} \geq V_{IH}(\min)$, tcc = 15ns Input signals are changed one time during 30ns		218				mA	
	Icc2NS	CKE ≥ VIH(min), CLK ≤ VIL(max), tcc = ∞ Input signals are stable		110					
Active Standby Current in power-down mode	Icc3P	CKE ≤ VIL(max), tcc = 15ns		38				mA	
	Icc3PS	CKE & CLK ≤ VIL(max), tcc = ∞		38					
Active Standby Current in non power-down mode (One Bank Active)	Icc3N	CKE ≥ VIH(min), $\overline{CS} \geq V_{IH}(\min)$, tcc = 15ns Input signals are changed one time during 30ns		360				mA	
	Icc3NS	CKE ≥ VIH(min), CLK ≤ VIL(max), tcc = ∞ Input signals are stable		180				mA	
Operating Current (Burst Mode)	Icc4	IoL = 0 mA Page Burst tccd = 2CLKs	3	1,910	1,550	1,550	1,550	mA	1
			2	1,550	1,550	1,460	1,460		
Refresh Current	Icc5	trc ≥ trc(min)		2,250			1,980	mA	2
Self Refresh Current	Icc6	CKE ≤ 0.2V		20				mA	3

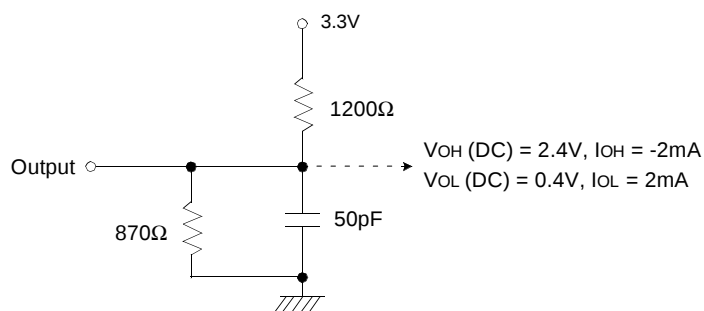
Note : 1. Measured with outputs open.
2. Refresh period is 64ms.
3. Measured with 1 PLL & 2 Drive ICs.

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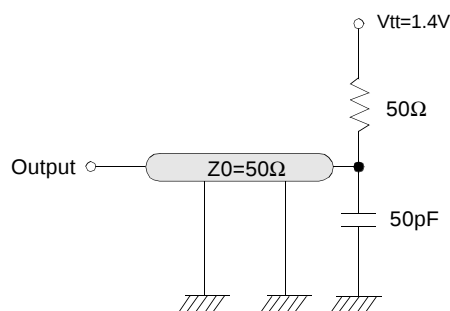
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AC OPERATING TEST CONDITIONS ($V_{DD} = 3.45V \pm 0.15V$, $T_A = 0$ to $70^\circ C$)

Parameter	Value	Unit
Input levels (V_{ih}/V_{il})	2.4 / 0.4	V
Input timing measurement reference level	1.4	V
Output timing measurement reference level	1.4	V
Output load condition	See Fig. 2	



(Fig. 1) DC Output Load Circuit



(Fig. 2) AC Output Load Circuit

OPERATING AC PARAMETER

(AC operating conditions unless otherwise noted)

Parameter		Symbol	Version				Unit	Note
			-8	-H	-L	-10		
Row active to row active delay		tRRD(min)	16	20	20	20	ns	1
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay		tRCD(min)	20	20	20	24	ns	1
Row precharge time		tRP(min)	20	20	20	24	ns	1
Row active time		tRAS(min)	48	50	50	50	ns	1
		tRAS(max)	100				us	
Row cycle time		tRC(min)	68	70	70	80	ns	1
Last data in to row precharge		tRDL(min)	8	10	10	12	ns	2
Last data in to new col. address delay		tCDL(min)	1				CLK	2
Last data in to burst stop		tBDL(min)	1				CLK	2
Col. address to col. address delay		tCCD(min)	1				CLK	3
Number of valid output data	CAS latency=3		2				ea	4
	CAS latency=2		1					

- Note :** 1. The minimum number of clock cycles is determined by dividing the minimum time required with clock cycle time and then rounding off to the next higher integer.
 2. Minimum delay is required to complete write.
 3. All parts allow every cycle column address change.
 4. In case of row precharge interrupt, auto precharge and read burst stop.

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AC CHARACTERISTICS (AC operating conditions unless otherwise noted)

Parameter		Symbol	-8		-H		-L		-10		Unit	Note
			Min	Max	Min	Max	Min	Max	Min	Max		
CLK cycle time	CAS Latency=3	tcc	8	1000	10	1000	10	1000	10	1000	ns	1
	CAS Latency=2		10		10		12		13			
CLK to valid output delay	CAS Latency=3	tsac		6		6		6		7	ns	1,2
	CAS Latency=2			6		6		7		7		
Output data hold time	CAS Latency=3	toH	3		3		3		3		ns	1,2
	CAS Latency=2		3		3		3		3			
CLK high pulse width		tCH	3		3		3		3.5		ns	3
CLK low pulse width		tCL	3		3		3		3.5		ns	3
Input setup time		tSS	2		2		2		2.5		ns	3
Input hold time		tSH	1		1		1		1		ns	3
CLK to output in Low-Z		tsLZ	1		1		1		1		ns	2
CLK to output in Hi-Z	CAS Latency=3	tSHZ		6		6		6		7	ns	1
	CAS Latency=2			6		6		7		7		

- Note :**
- Parameters depend on programmed CAS latency.
 - If clock rising time is longer than 1ns, $(tr/2-0.5)ns$ should be added to the parameter.
 - Assumed input rise and fall time (tr & tf)=1ns.
If tr & tf is longer than 1ns, transient time compensation should be considered,
i.e., $[(tr + tf)/2-1]ns$ should be added to the parameter.

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FREQUENCY vs. AC PARAMETER RELATIONSHIP TABLE

KMM378S1620CT-8

(Unit : number of clock)

Frequency	CAS Latency	tRC	tRAS	tRP	tRRD	tRCD	tCCD	tCDL	tRDL
		68ns	48ns	20ns	16ns	20ns	8ns	8ns	8ns
125MHz (8.0ns)	3	9	6	3	2	3	1	1	1
100MHz (10.0ns)	3	7	5	2	2	2	1	1	1
83MHz (12.0ns)	2	6	4	2	2	2	1	1	1
75MHz (13.0ns)	2	6	4	2	2	2	1	1	1
66MHz (15.0ns)	2	5	4	2	2	2	1	1	1

KMM378S1620CT-H

(Unit : number of clock)

Frequency	CAS Latency	tRC	tRAS	tRP	tRRD	tRCD	tCCD	tCDL	tRDL
		70ns	50ns	20ns	20ns	20ns	10ns	10ns	10ns
100MHz (10.0ns)	2	7	5	2	2	2	1	1	1
83MHz (12.0ns)	2	6	5	2	2	2	1	1	1
75MHz (13.0ns)	2	6	4	2	2	2	1	1	1
66MHz (15.0ns)	2	5	4	2	2	2	1	1	1
60MHz (16.7ns)	2	5	3	2	2	2	1	1	1

KMM378S1620CT-L

(Unit : number of clock)

Frequency	CAS Latency	tRC	tRAS	tRP	tRRD	tRCD	tCCD	tCDL	tRDL
		70ns	50ns	20ns	20ns	20ns	10ns	10ns	10ns
100MHz (10.0ns)	3	7	5	2	2	2	1	1	1
83MHz (12.0ns)	2	6	5	2	2	2	1	1	1
75MHz (13.0ns)	2	6	4	2	2	2	1	1	1
66MHz (15.0ns)	2	5	4	2	2	2	1	1	1
60MHz (16.7ns)	2	5	3	2	2	2	1	1	1

KMM378S1620CT-10

(Unit : number of clock)

Frequency	CAS Latency	tRC	tRAS	tRP	tRRD	tRCD	tCCD	tCDL	tRDL
		80ns	50ns	24ns	20ns	24ns	10ns	10ns	12ns
100MHz (10.0ns)	3	8	5	3	2	3	1	1	2
83MHz (12.0ns)	3	7	5	2	2	2	1	1	1
75MHz (13.0ns)	2	7	4	2	2	2	1	1	1
66MHz (15.0ns)	2	6	4	2	2	2	1	1	1
60MHz (16.7ns)	2	5	3	2	2	2	1	1	1

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SIMPLIFIED TRUTH TABLE

COMMAND			CKEn-1	CKEn	$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	DQM	A13	A10/AP	A12 ~ A11, A9 ~ A0	Note
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									3
		Exit	L	H	L	H	H	H	X	X			3
													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~A8)	4
	Auto Precharge Enable										H		4, 5
Write & Column Address	Auto Precharge Disable		H	X	L	H	L	L	X	V	L	Column Address (A0~A8)	4
	Auto Precharge Enable										H		4, 5
Burst Stop			H	X	L	H	H	L	X	X			6
Precharge	Bank Selection		H	X	L	L	H	L	X	V	L	X	
	Both Banks									X	H		
Clock Suspend or Active Power Down		Entry	H	L	H	X	X	X	X	X			
					L	V	V	V					
		Exit	L	H	X	X	X	X	X				
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				
					L	V	V	V					
DQM			H	X					V	X			7
No Operation Command			H	X	H	X	X	X	X	X			
					L	H	H	H					

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

Note 1. OP Code : Operand Code

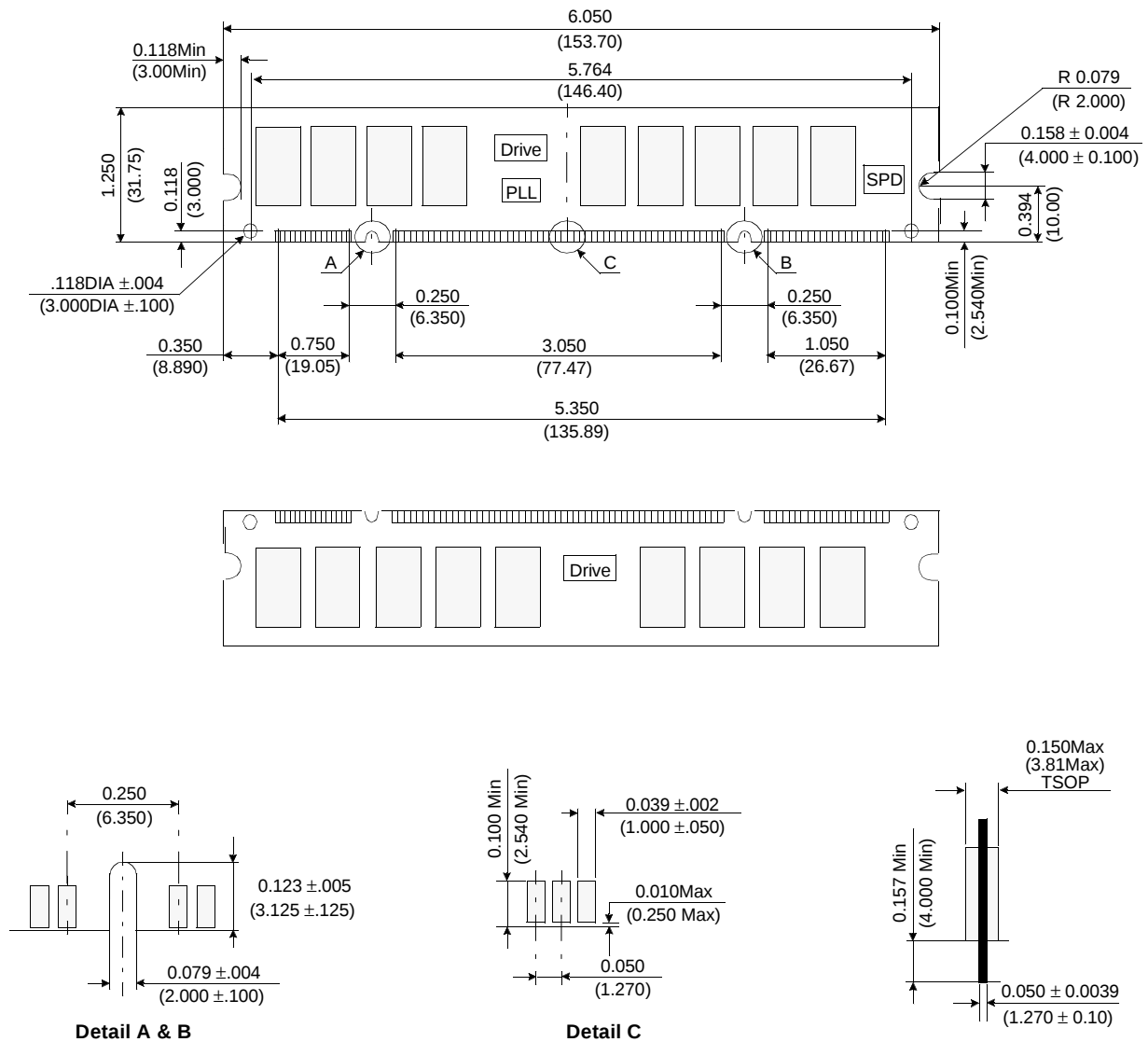
- A0 ~ A11 & BA0 ~ BA1 : Program keys. (@MRS)
- MRS can be issued only at all banks precharge state.
A new command can be issued after 2 clock cycles of MRS.
- Auto refresh functions are as same as CBR refresh of DRAM.
The automatical precharge without row precharge command is meant by "Auto".
Auto/self 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 both BA0 is "Low" and BA1 is "High" at read, write, row active and precharge, bank B is selected.
If both BA0 is "High" and BA1 is "Low" 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 is ignored and all banks are selected.
- During burst read or 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.
- DQM sampled at positive going edge of a CLK and masks the data-in at the very CLK (Write DQM latency is 0), but makes Hi-Z state the data-out of 2 CLK cycles after. (Read DQM latency is 2)

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PACKAGE DIMENSIONS

Units : Inches (millimeters)



Tolerances : ±.005(.13) unless otherwise specified

The used device is 16Mx4 SDRAM, TSOPII (Forward)

SDRAM Part No. : KM44S16030BT

PLL Part No. : TI CDC2509

Drive IC : TI SN74ALVCH162836