SDRAM Unbuffered SODIMM

144pin Unbuffered SODIMM based on 256Mb E-die
64-bit Non ECC

Revision 1.5

May 2004

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Revision History

Revision 1.1 (Sepember, 2003)

- Corrected typo.

Revision 1.2 (February, 2004)

- Corrected typo.

Revision 1.3 (March. 2004)

- Corrected package dimension.

Revision 1.4 (March. 2004)

- Modified DC Characteristics Notes.

Revision 1.5 (May. 2004)

- Added Note 5. sentense of tRDL parameter

144Pin Unbuffered SODIMM based on 256Mb E-die(x8, x16)

Ordering Information

Part Number	Density	Organization	Component Composition	Component Package	Height
M464S1654ETS-C(L)7A	128MB	16M x 64	16Mx16(K4S561632E) * 4EA	54-TSOP(II)	1,000mil
M464S3254ETS-C(L)7A	256MB	32M x 64	16Mx16(K4S561632E) * 8EA		1,250mil
M464S6453EN0-C(L)7A	512MB	64M x 64	32Mx 8 (K4S560832E)*16EA	54-sTSOP(II)	1,250mil

Operating Frequencies

	7A	
	@CL3	@CL2
Maximum Clock Frequency	133MHz(7.5ns)	100MHz(10ns)
CL-tRCD-tRP(clock)	3 - 3 - 3	2 - 2 - 2

Feature

- Burst mode operation
- Auto & self refresh capability (8192 Cycles/64ms)
- LVTTL compatible inputs and outputs
- Single 3.3V ± 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
- Serial presence detect with EEPROM

PIN CONFIGURATIONS (Front side/back side)

Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back
1	VSS	2	VSS	51	DQ14	52	DQ46	95	DQ21	96	DQ53
3	DQ0	4	DQ32	53	DQ15	54	DQ47	97	DQ22	98	DQ54
5	DQ1	6	DQ33	55	VSS	56	VSS	99	DQ23	100	DQ55
7	DQ2	8	DQ34	57	NC	58	NC	101	VDD	102	VDD
9	DQ3	10	DQ35	59	NC	60	NC	103	A6	104	A7
11	VDD	12	VDD					105	A8	106	BA0
13	DQ4	14	DQ36		**Voltage Key**			107	VSS	108	VSS
15	DQ5	16	DQ37					109	A9	110	BA1
17	DQ6	18	DQ38	61	**CLK0	62	**CKE0	111	A10/AP	112	A11
19	DQ7	20	DQ39	63	VDD	64	VDD	113	VDD	114	VDD
21	VSS	22	VSS	65	$\overline{RAS}$	66	$\overline{CAS}$	115	DQM2	116	DQM6
23	DQM0	24	DQM4	67	$\overline{WE}$	68	**CKE1	117	DQM3	118	DQM7
25	DQM1	26	DQM5	69	**$\overline{CS0}$	70	A12	119	VSS	120	VSS
27	VDD	28	VDD	71	**$\overline{CS1}$	72	*A13	121	DQ24	122	DQ56
29	A0	30	A3	73	DU	74	**CLK1	123	DQ25	124	DQ57
31	A1	32	A4	75	VSS	76	VSS	125	DQ26	126	DQ58
33	A2	34	A5	77	NC	78	NC	127	DQ27	128	DQ59
35	VSS	36	VSS	79	NC	80	NC	129	VDD	130	VDD
37	DQ8	38	DQ40	81	VDD	82	VDD	131	DQ28	132	DQ60
39	DQ9	40	DQ41	83	DQ16	84	DQ48	133	DQ29	134	DQ61
41	DQ10	42	DQ42	85	DQ17	86	DQ49	135	DQ30	136	DQ62
43	DQ11	44	DQ43	87	DQ18	88	DQ50	137	DQ31	138	DQ63
45	VDD	46	VDD	89	DQ19	90	DQ51	139	VSS	140	VSS
47	DQ12	48	DQ44	91	VSS	92	VSS	141	SDA	142	SCL
49	DQ13	50	DQ45	93	DQ20	94	DQ52	143	VDD	144	VDD

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.

Pin Description

Pin Name	Function	Pin Name	Function
A0 ~ A12	Address input (Multiplexed)	$\overline{WE}$	Write enable
BA0 ~ BA1	Select bank	DQM0 ~ 7	DQM
DQ0 ~ DQ63	Data input/output	V_{DD}	Power supply (3.3V)
CLK0 ~ CLK1	Clock input	V_{SS}	Ground
CKE0 ~ CKE1	Clock enable input	SDA	Serial data I/O
$\overline{CS0}$ ~ $\overline{CS1}$	Chip select input	SCL	Serial clock
$\overline{RAS}$	Row address strobe	DU	Don't use
$\overline{CAS}$	Column address strobe	NC	No connection

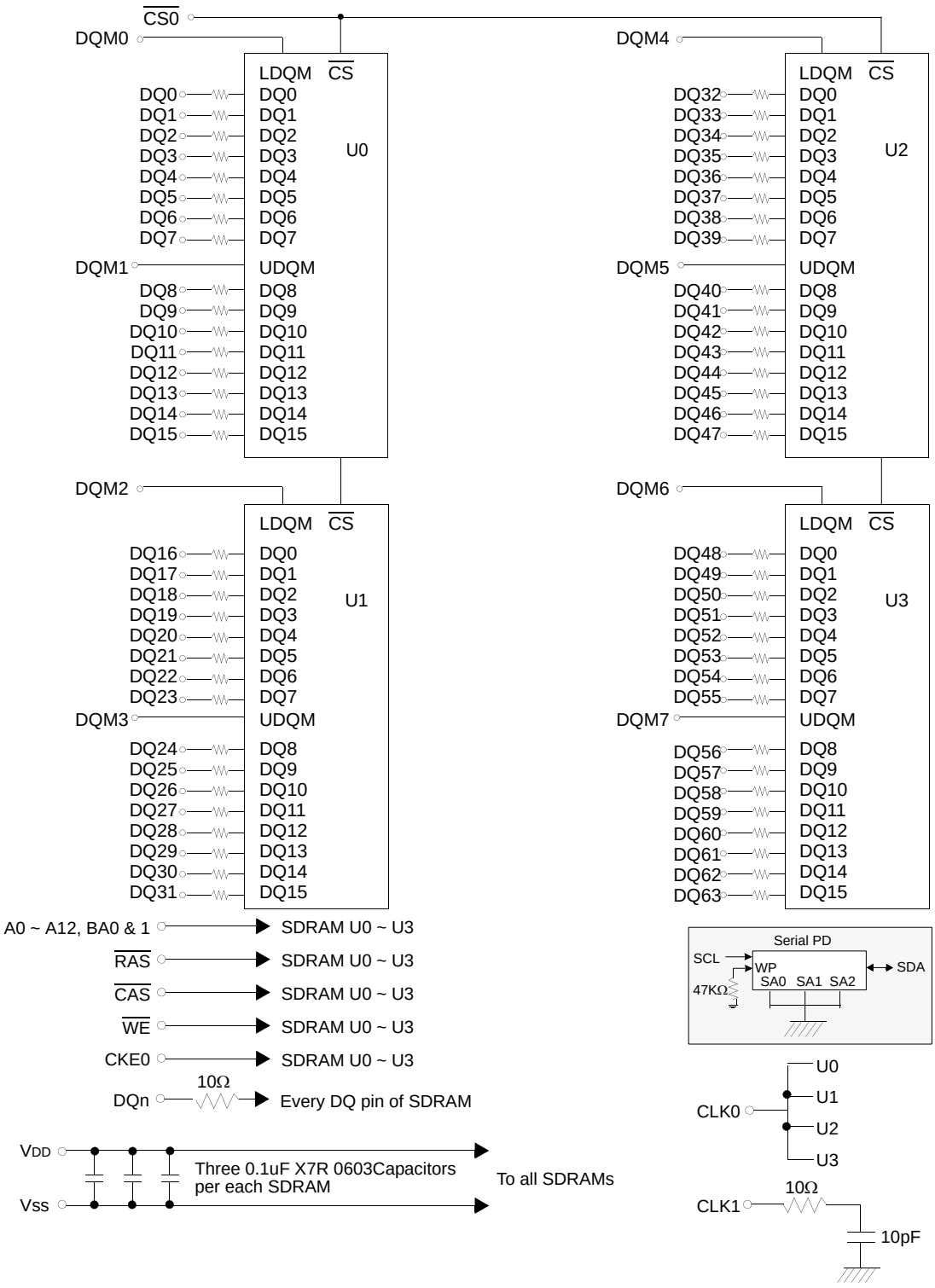
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PIN CONFIGURATION DESCRIPTION

Pin	Name	Input Function
CLK	*System clock*	Active on the positive going edge to sample all inputs.
$\overline{CS}$	*Chip select*	Disables or enables device operation by masking or enabling all inputs except CLK, CKE and DQM
CKE	*Clock enable*	Masks system clock to freeze operation from the next clock cycle. CKE should be enabled at least one cycle prior to new command. Disable input buffers for power down in standby. CKE should be enabled 1CLK+t_{SS} prior to valid command.
A0 ~ A12	*Address*	Row/column addresses are multiplexed on the same pins. Row address : RA0 ~ RA12 Column address : (x8 : CA0 ~ CA9), (x16 : CA0 ~ CA8)
BA0 ~ BA1	*Bank select address*	Selects bank to be activated during row address latch time. Selects bank for read/write during column address latch time.
$\overline{RAS}$	*Row address strobe*	Latches row addresses on the positive going edge of the CLK with $\overline{RAS}$ low. Enables row access & precharge.
$\overline{CAS}$	*Column address strobe*	Latches column addresses on the positive going edge of the CLK with $\overline{CAS}$ low. Enables column access.
$\overline{WE}$	*Write enable*	Enables write operation and row precharge. Latches data in starting from $\overline{CAS}$, $\overline{WE}$ active.
DQM0 ~ 7	*Data input/output mask*	Makes data output Hi-Z, t_{SHZ} after the clock and masks the output. Blocks data input when DQM active. (Byte masking)
$DQ_{0 \sim 63}$	*Data input/output*	Data inputs/outputs are multiplexed on the same pins.
V_{DD}/V_{SS}	*Power supply/ground*	Power and ground for the input buffers and the core logic.

128MB, 16Mx64 Module (M464S1654ETS) (Populated as 1 bank of x16 SDRAM Module)

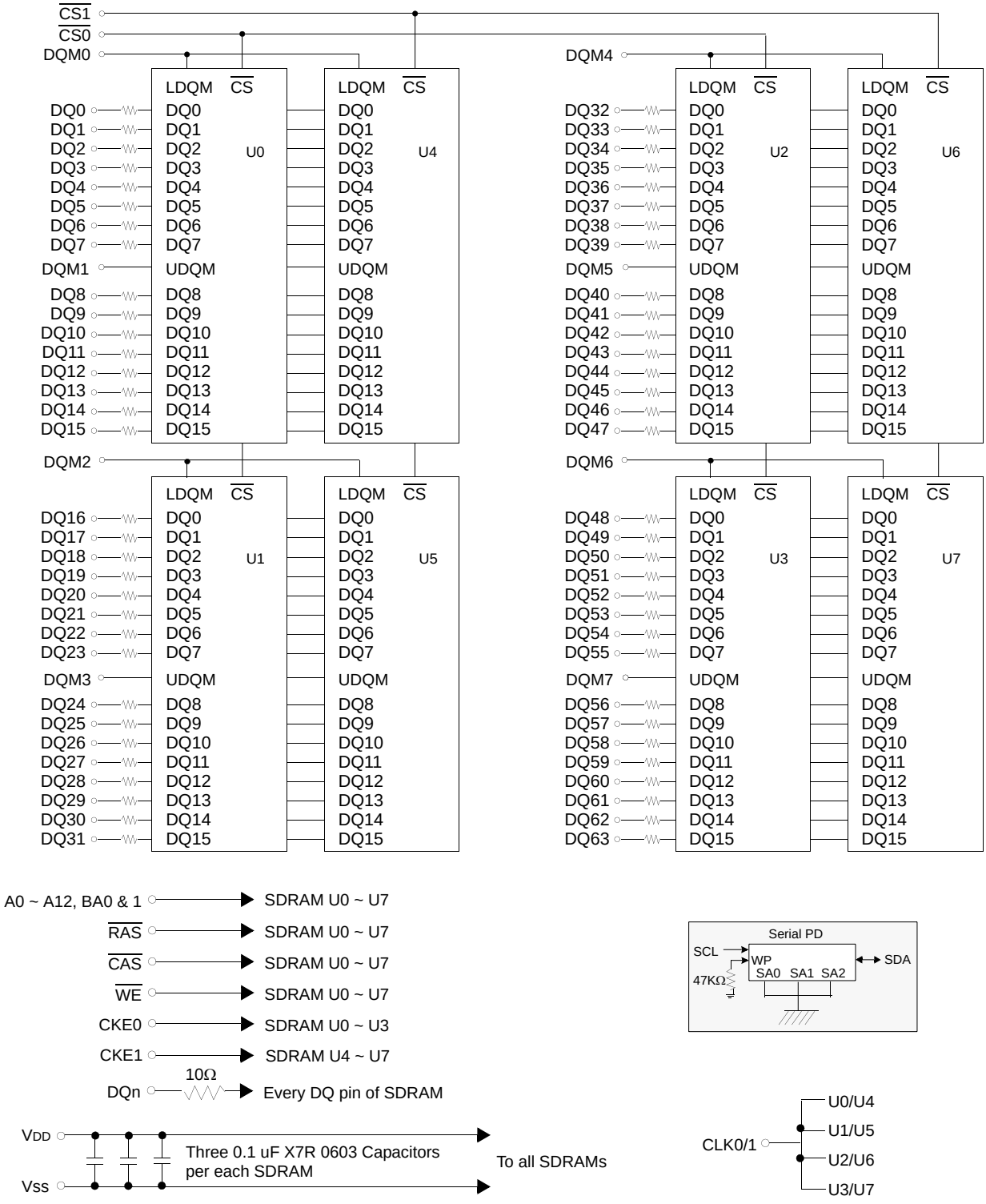
FUNCTIONAL BLOCK DIAGRAM



SAMSUNG ELECTRONICS

256MB, 32Mx64 Module (M366S3254ETS) (Populated as 2 bank of x16 SDRAM Module)

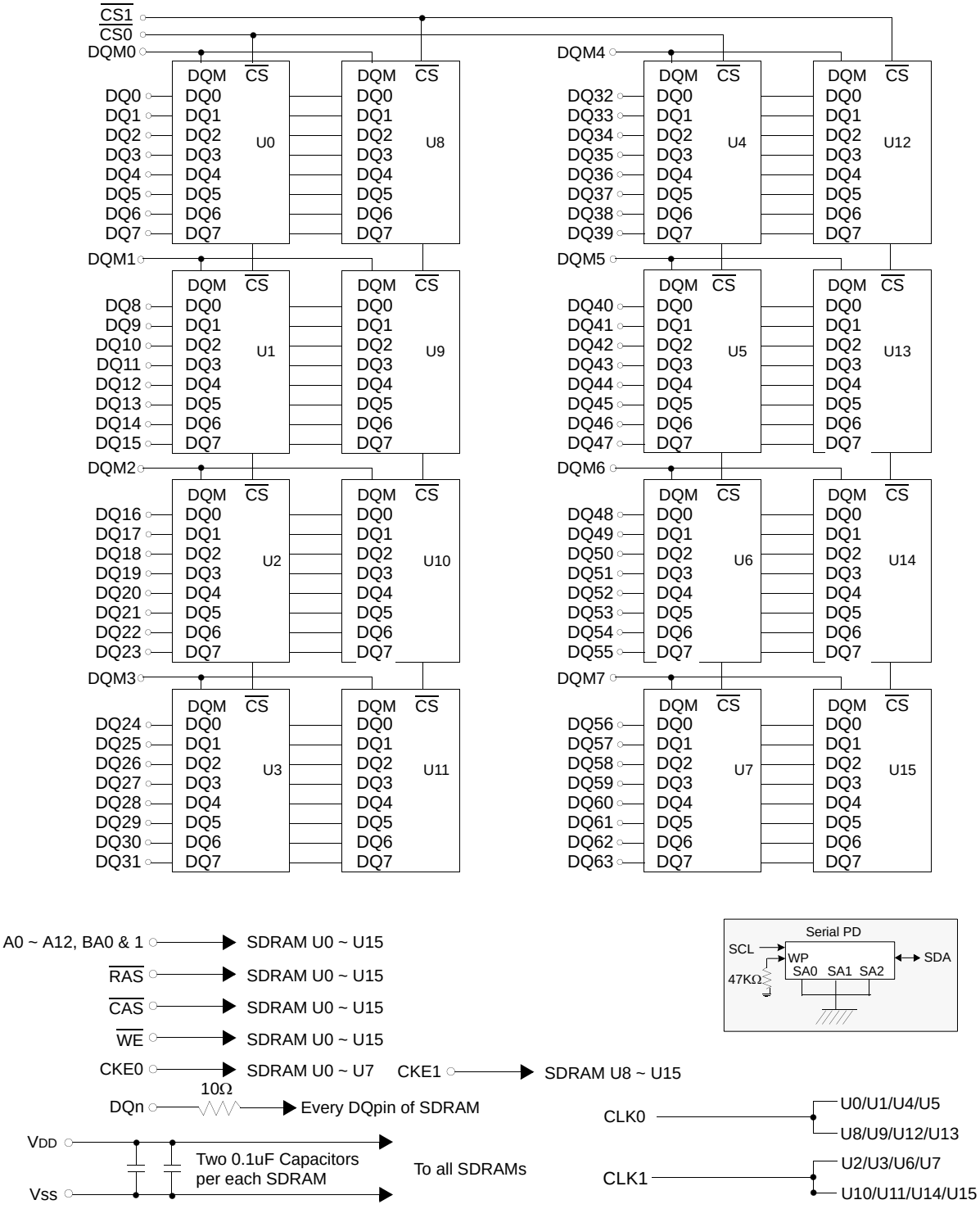
FUNCTIONAL BLOCK DIAGRAM



SAMSUNG ELECTRONICS

512MB, 64Mx64 Module (M366S6453EN0) (Populated as 2 bank of x8 SDRAM Module)

FUNCTIONAL BLOCK DIAGRAM



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	1.0 * # of component	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 V_{SS} = 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	I_{LI}	-10	-	10	uA	3

Notes : 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.

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

Parameter	Symbol	M464S1654ETS		M464S3254ETS		M464S6453EN0		Unit
		Min	Max	Min	Max	Min	Max	
Input capacitance (A_0 ~ A_{12}, BA0 ~ BA1)	C_{IN1}	15	25	25	45	45	90	pF
Input capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$)	C_{IN2}	15	25	25	45	45	90	pF
Input capacitance (CKE0 ~ CKE1)	C_{IN3}	15	25	15	25	25	45	pF
Input capacitance (CLK0 ~ CLK1)	C_{IN4}	15	21	15	21	15	21	pF
Input capacitance ($\overline{CS0}$ ~ $\overline{CS1}$)	C_{IN5}	15	25	15	25	15	25	pF
Input capacitance (DQM0 ~ DQM7)	C_{IN6}	10	12	10	12	10	15	pF
Data input/output capacitance (DQ0 ~ DQ63)	C_{OUT}	10	12	10	12	13	18	pF

DC CHARACTERISTICS

M464S1654ETS (16M x 64, 128MB Module)

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

Parameter	Symbol	Test Condition		Version	Unit	Note
				7A		
Operating current (One bank active)	I_{CC1}	Burst length = 1 $t_{RC} \geq t_{RC}$(min) I_O = 0 mA		360	mA	1
Precharge standby current in power-down mode	I_{CC2P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		8	mA	
	I_{CC2PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		8		
Precharge standby current in non power-down mode	I_{CC2N}	CKE ≥ V_{IH}(min), $\overline{CS} \geq V_{IH}$(min), t_{CC} = 10ns Input signals are changed one time during 20ns		80	mA	
	I_{CC2NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		40		
Active standby current in power-down mode	I_{CC3P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		25	mA	
	I_{CC3PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		25		
Active standby current in non power-down mode (One bank active)	I_{CC3N}	CKE ≥ V_{IH}(min), $\overline{CS} \geq V_{IH}$(min), t_{CC} = 10ns Input signals are changed one time during 20ns		100	mA	
	I_{CC3NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		100	mA	
Operating current (Burst mode)	I_{CC4}	I_O = 0 mA Page burst 4Banks activated t_{CCD} = 2CLKs		520	mA	1
Refresh current	I_{CC5}	$t_{RC} \geq t_{RC}$(min)		720	mA	2
Self refresh current	I_{CC6}	CKE ≤ 0.2V	C	12	mA	
			L	6	mA	

Notes : 1. Measured with outputs open.
2. Refresh period is 64ms.
3. Unless otherwise noted, input swing level is CMOS(V_{IH}/V_{IL}=V_{DDQ}/V_{SSQ})

DC CHARACTERISTICS

M464S3254ETS (32M x 64, 256MB Module)

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

Parameter	Symbol	Test Condition		Version 7A	Unit	Note
Operating current (One bank active)	I_{CC1}	Burst length = 1 $t_{RC} \geq t_{RC}$(min) I_O = 0 mA		460	mA	1
Precharge standby current in power-down mode	I_{CC2P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		16	mA	
	I_{CC2PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		16		
Precharge standby current in non power-down mode	I_{CC2N}	CKE ≥ V_{IH}(min), $\overline{CS}$ ≥ V_{IH}(min), t_{CC} = 10ns Input signals are changed one time during 20ns		160	mA	
	I_{CC2NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		80		
Active standby current in power-down mode	I_{CC3P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		50	mA	
	I_{CC3PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		50		
Active standby current in non power-down mode (One bank active)	I_{CC3N}	CKE ≥ V_{IH}(min), $\overline{CS}$ ≥ V_{IH}(min), t_{CC} = 10ns Input signals are changed one time during 20ns		200	mA	
	I_{CC3NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		200	mA	
Operating current (Burst mode)	I_{CC4}	I_O = 0 mA Page burst 4Banks activated t_{CCD} = 2CLKs		620	mA	1
Refresh current	I_{CC5}	$t_{RC} \geq t_{RC}$(min)		820	mA	2
Self refresh current	I_{CC6}	CKE ≤ 0.2V	C	24	mA	
			L	12	mA	

Notes : 1. Measured with outputs open.
2. Refresh period is 64ms.
3. Unless otherwise noted, input swing level is CMOS(V_{IH}/V_{IL}=V_{DDQ}/V_{SSQ})

DC CHARACTERISTICS

M464S6453EN0 (64M x 64, 512MB Module)

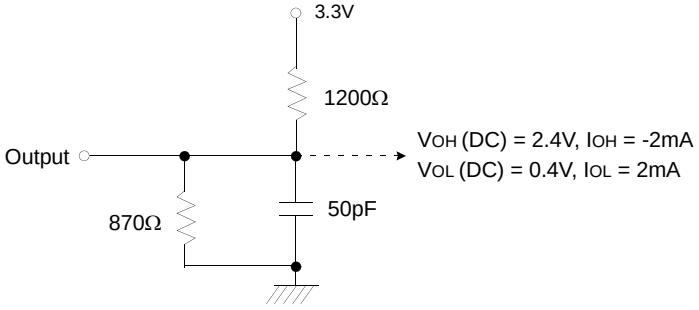
(Recommended operating condition unless otherwise noted, T_A = 0 to 70°C)

Parameter	Symbol	Test Condition		Version 7A	Unit	Note
Operating current (One bank active)	I_{CC1}	Burst length = 1 $t_{RC} \geq t_{RC}$(min) I_O = 0 mA		840	mA	1
Precharge standby current in power-down mode	I_{CC2P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		32	mA	
	I_{CC2PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		32		
Precharge standby current in non power-down mode	I_{CC2N}	CKE ≥ V_{IH}(min), $\overline{CS}$ ≥ V_{IH}(min), t_{CC} = 10ns Input signals are changed one time during 20ns		320	mA	
	I_{CC2NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		160		
Active standby current in power-down mode	I_{CC3P}	CKE ≤ V_{IL}(max), t_{CC} = 10ns		100	mA	
	I_{CC3PS}	CKE & CLK ≤ V_{IL}(max), t_{CC} =∞		100		
Active standby current in non power-down mode (One bank active)	I_{CC3N}	CKE ≥ V_{IH}(min), $\overline{CS}$ ≥ V_{IH}(min), t_{CC} = 10ns Input signals are changed one time during 20ns		400	mA	
	I_{CC3NS}	CKE ≥ V_{IH}(min), CLK ≤ V_{IL}(max), t_{CC} =∞ Input signals are stable		400	mA	
Operating current (Burst mode)	I_{CC4}	I_O = 0 mA Page burst 4Banks activated t_{CCD} = 2CLKs		1,000	mA	1
Refresh current	I_{CC5}	$t_{RC} \geq t_{RC}$(min)		1,000	mA	2
Self refresh current	I_{CC6}	CKE ≤ 0.2V	C	48	mA	
			L	48	mA	

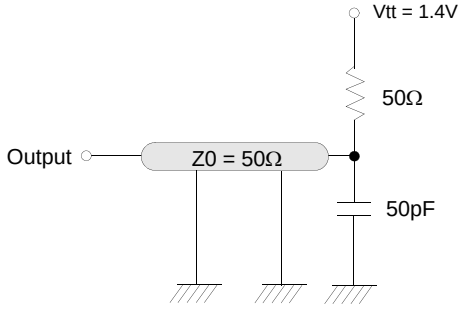
Notes : 1. Measured with outputs open.
2. Refresh period is 64ms.
3. Unless otherwise noted, input swing level is CMOS(V_{IH}/V_{IL}=V_{DDQ}/V_{SSQ})

AC OPERATING TEST CONDITIONS (V_{DD} = 3.3V ± 0.3V, T_A = 0 to 70°C)

Parameter	Value	Unit
AC input levels (Vih/Vil)	2.4/0.4	V
Input timing measurement reference level	1.4	V
Input rise and fall time	tr/tf = 1/1	ns
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
			7A		
Row active to row active delay		tRRD(min)	15	ns	1
$\overline{RAS}$ to $\overline{CAS}$ delay		tRCD(min)	20	ns	1
Row precharge time		tRP(min)	20	ns	1
Row active time		tRAS(min)	45	ns	1
		tRAS(max)	100	us	
Row cycle time		tRC(min)	65	ns	1
Last data in to row precharge		tRDL(min)	2	CLK	2,5
Last data in to Active delay		tDAL(min)	2 CLK + tRP	-	5
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		

Notes : 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.
5. In 100MHz and below 100MHz operating conditions, tRDL=1CLK and tDAL=1CLK + 20ns is also supported. SAMSUNG recommends tRDL=2CLK and tDAL=2CLK + tRP.

AC CHARACTERISTICS (AC operating conditions unless otherwise noted)

REFER TO THE INDIVIDUAL COMPONENET, NOT THE WHOLE MODULE.

Parameter		Symbol	7A		Unit	Note
			Min	Max		
CLK cycle time	CAS latency=3	tCC	7.5	1000	ns	1
	CAS latency=2		10			
CLK to valid output delay	CAS latency=3	tSAC		5.4	ns	1,2
	CAS latency=2			6		
Output data hold time	CAS latency=3	tOH	3		ns	2
	CAS latency=2		3			
CLK high pulse width		tCH	2.5		ns	3
CLK low pulse width		tCL	2.5		ns	3
Input setup time		tSS	1.5		ns	3
Input hold time		tSH	0.8		ns	3
CLK to output in Low-Z		tSLZ	1		ns	2
CLK to output in Hi-Z	CAS latency=3	tSHZ		5.4	ns	
	CAS latency=2			6		

Notes : 1. Parameters depend on programmed CAS latency.

2. If clock rising time is longer than 1ns, (tr/2-0.5)ns should be added to the parameter.

3. 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.

SIMPLIFIED TRUTH TABLE

(V=Valid, X=Don't care, H=Logic high, L=Logic low)

Command			CKEn-1	CKEn	$\overline{CS}$	$\overline{RAS}$	$\overline{CAS}$	$\overline{WE}$	DQM	$BA_{0,1}$	A_{10}/AP	A_0 ~ A_9, A_{11}, A_{12}	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
					H	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	4
	Auto precharge enable										H		4,5
Write & column address	Auto precharge disable		H	X	L	H	L	L	X	V	L	Column address	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	
	All 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	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					

Notes : 1. OP Code : Operand code
A_0 ~ A_{12} & BA_0 ~ BA_1 : Program keys. (@ MRS)

2. MRS can be issued only at all banks precharge state.
A new command can be issued after 2 clock cycles of MRS.

3. 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.

4. BA_0 ~ BA_1 : Bank select addresses.
If both BA_0 and BA_1 are "Low" at read, write, row active and precharge, bank A is selected.
If BA_0 is "High" and BA_1 is "Low" at read, write, row active and precharge, bank B is selected.
If BA_0 is "Low" and BA_1 is "High" at read, write, row active and precharge, bank C is selected.
If both BA_0 and BA_1 are "High" at read, write, row active and precharge, bank D is selected.
If A_{10}/AP is "High" at row precharge, BA_0 and BA_1 is ignored and all banks are selected.

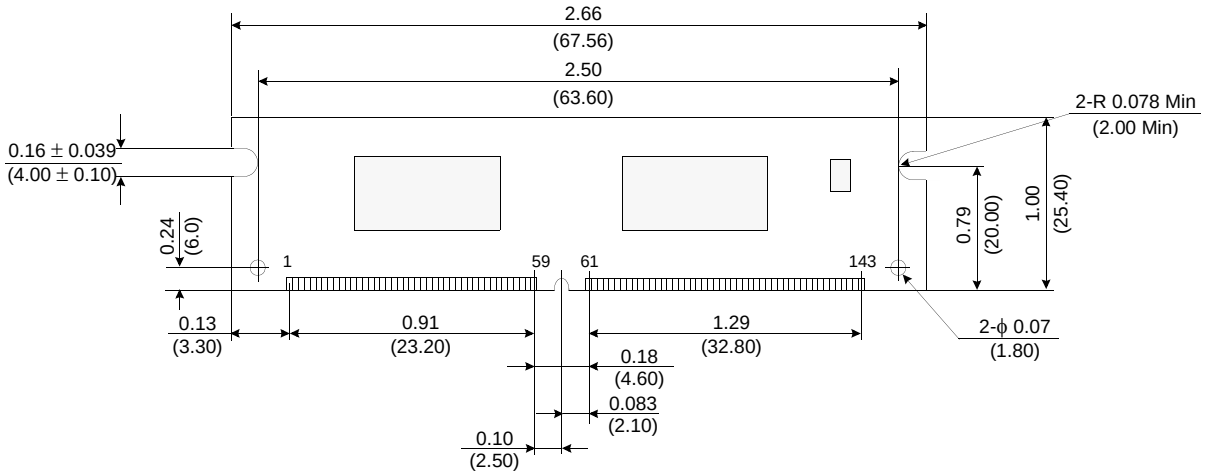
5. During burst read or write with auto precharge, new read/write command can not be issued.
Another bank read/write command can be issued after the end of burst.
New row active of the associated bank can be issued at t_{RP} after the end of burst.

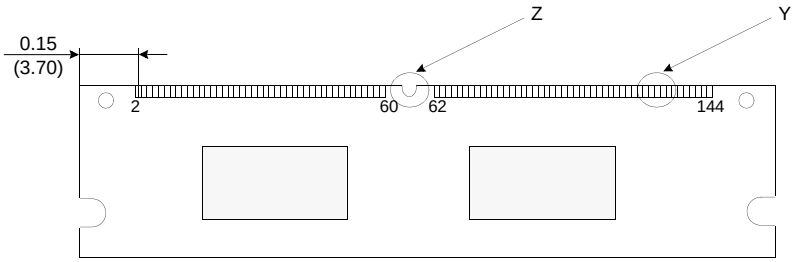
6. Burst stop command is valid at every burst length.

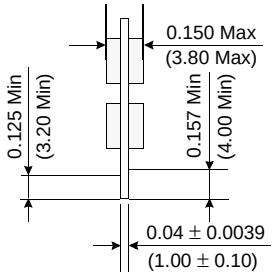
7. DQM sampled at positive going edge of a CLK and masks the data-in at the very CLK (Write DQM latency is 0), but makes Hi-Z state the data-out of 2 CLK cycles after. (Read DQM latency is 2)

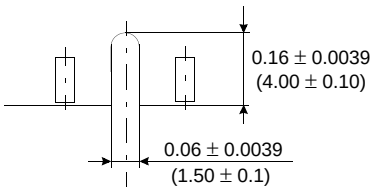
PACKAGE DIMENSIONS : 16Mx64 (M464S1654ETS)

Units : Inches (Millimeters)

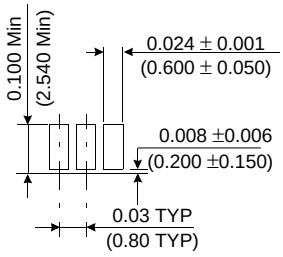








Detail Z



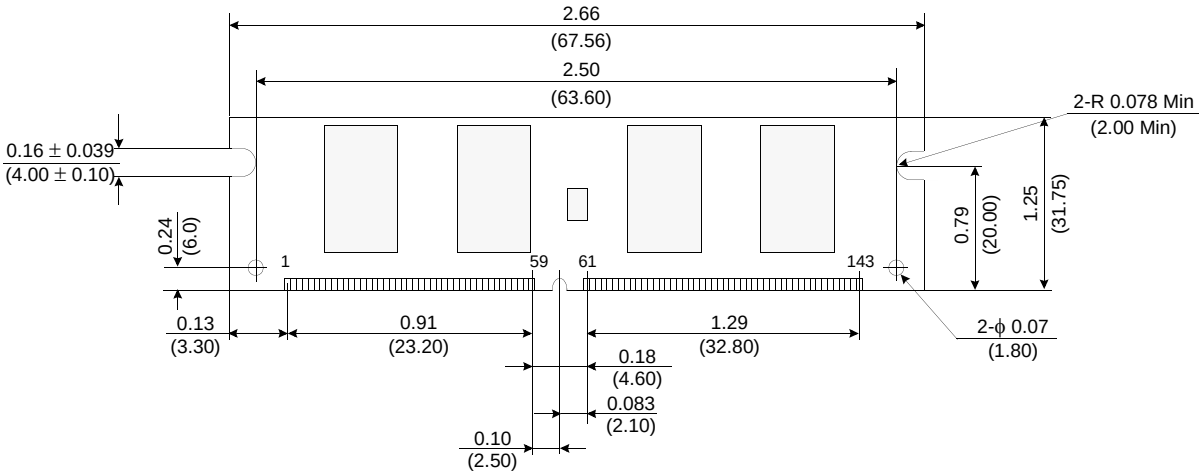
Detail Y

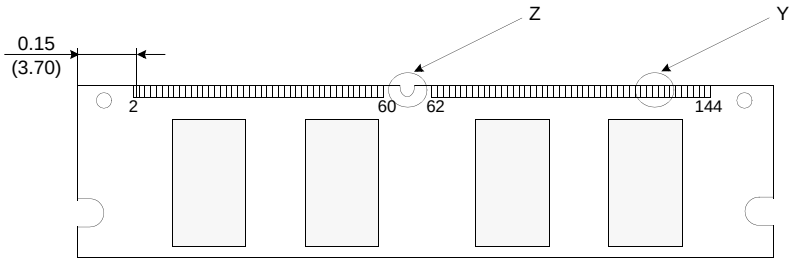
Tolerances : ± 0.006(.15) unless otherwise specified

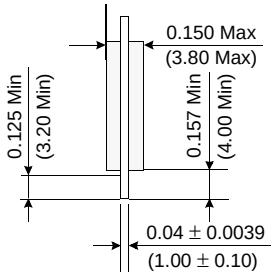
The used device is 16Mx16 SDRAM, TSOPII
SDRAM Part No. : K4S561632E

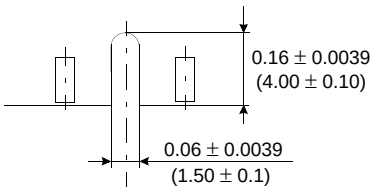
PACKAGE DIMENSIONS : 32Mx64 (M464S3254ETS)

Units : Inches (Millimeters)

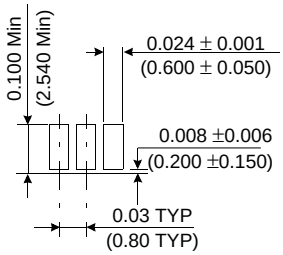








Detail Z



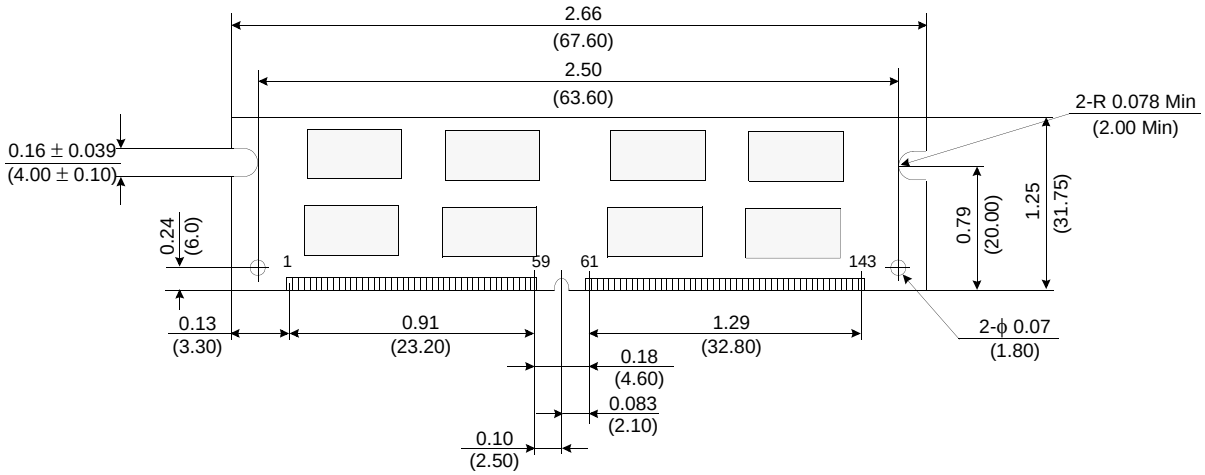
Detail Y

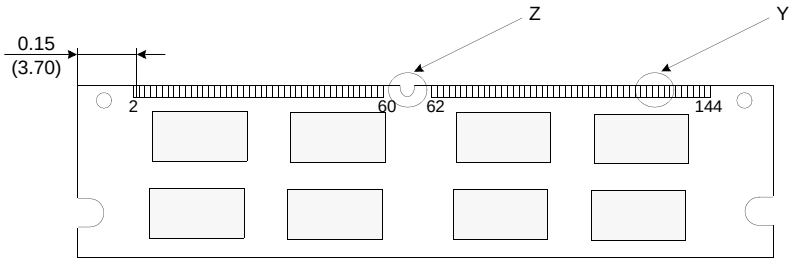
Tolerances : ±.006(.15) unless otherwise specified

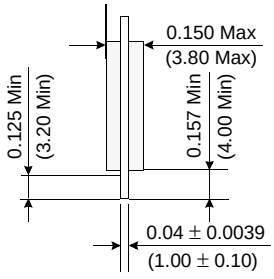
The used device is 16Mx16 SDRAM, TSOPII
SDRAM Part No. : K4S561632E

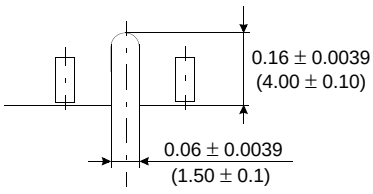
PACKAGE DIMENSIONS : 64Mx64 (M464S6453EN0)

Units : Inches (Millimeters)

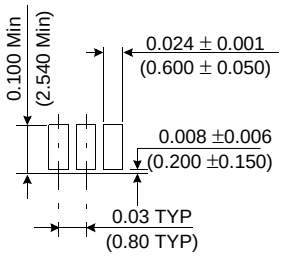








Detail Z



Detail Y

Tolerances : ±.006(.15) unless otherwise specified

The used device is 32Mx8 SDRAM, sTSOP
SDRAM Part No. : K4S560832E