

# 32Mb M-die LW SRAM Specification

**119BGA with Pb & Pb-Free**  
**(RoHS compliant)**

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**Document Title**

**1Mx36 & 2Mx18 Synchronous Pipelined SRAM**

**Revision History**

<b><u>Rev. No.</u></b>	<b><u>History</u></b>	<b><u>Draft Date</u></b>	<b><u>Remark</u></b>
Rev. 0.0	- Initial Document	Apr. 2002	Advance
Rev. 0.1	- Recommended DC operating conditions are changed Max VDIF-CLK : VDDQ+0.3 -> VDDQ+0.6  - AC Characteristics are changed TAVKH / TDVKH / TWWKH / TSVKH : 0.4 / 0.4 / 0.4 -> 0.3 / 0.3 / 0.3 TKHAX / TKHDX / TKHWX / TKHSX : 0.5 / 0.6 / 0.7 -> 0.5 / 0.5 / 0.5 TKHAX / TKHDX / TKHWX / TKHSX : 1.6 / 1.7 / 2.0 -> 1.5 / 1.6 / 2.0	Feb. 2003	Advance
Rev. 0.2	- PACKAGE PIN CONFIGURATION are changed Numbering each SA pins.	Feb. 2003	Advance
Rev. 0.3	- AC Characteristics are changed TKHQV (-33) : 0.5 -> 0.6	Mar. 2003	Advance
Rev. 0.4	- PIN CAPACITANCE is changed Add Clock Pin capacitance	May 2003	Advance
Rev. 1.0	- Fill the thermal Data - Remove 333MHz Bin	Sep. 2004	Final
Rev. 1.1	- JTAG DC operating conditions are changed Change VIH, VIL, VOH, VOL	Oct. 2004	Final
Rev. 1.2	- Add Pb free.	Oct. 2005	Final
Rev. 1.3	- Modify package dimensions	Dec. 2005	Final

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# K7P323688M K7P321888M

# 1Mx36 & 2Mx18 SRAM

## 1Mx36 & 2Mx18 Synchronous Pipelined SRAM

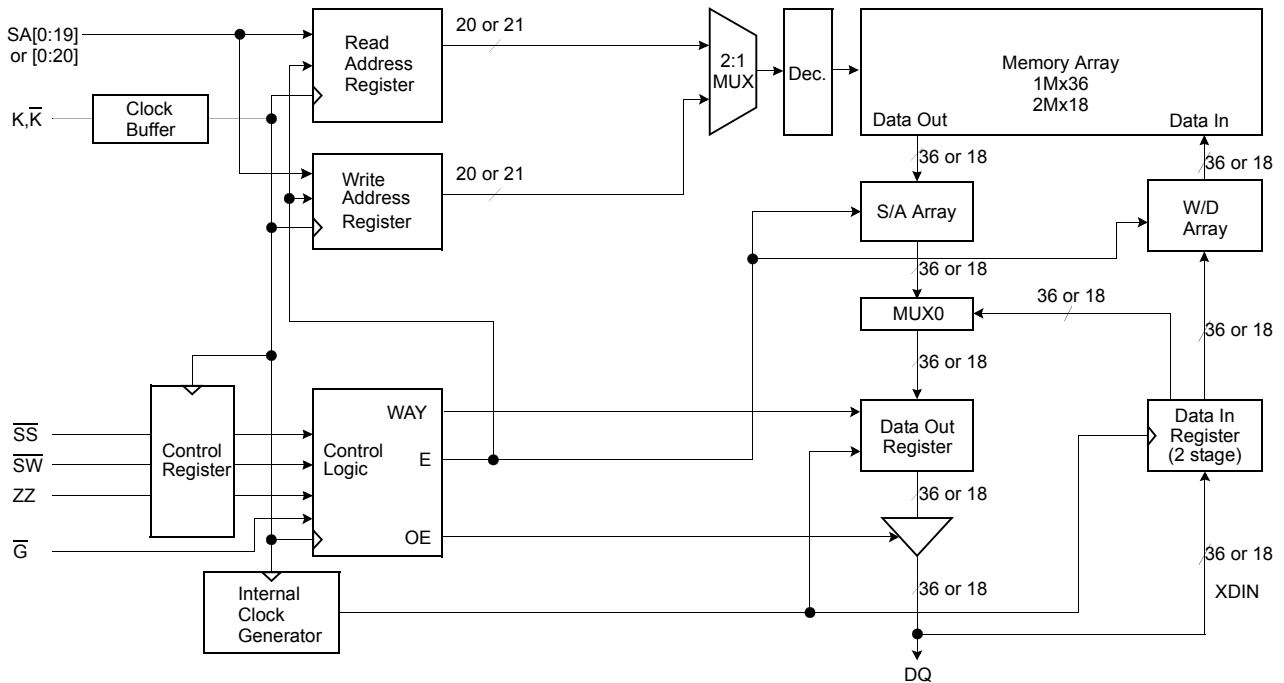
### FEATURES

- 1Mx36 or 2Mx18 Organizations.
- 1.8V V<sub>DD</sub>/1.5V or 1.8V V<sub>DDQ</sub>.
- HSTL Input and Output Levels.
- Differential, HSTL Clock Inputs K,  $\bar{K}$ .
- Synchronous Read and Write Operation
- Registered Input and Registered Output
- Internal Pipeline Latches to Support Late Write.
- Byte Write Capability(four byte write selects, one for each 9bits)
- Synchronous or Asynchronous Output Enable.
- Power Down Mode via ZZ Signal.
- Programmable Impedance Output Drivers.
- JTAG Boundary Scan (subset of IEEE std. 1149.1).
- 119(7x17) Flip Chip Ball Grid Array Package(14mmx22mm).

Org.	Part Number	Maximum Frequency	Access Time
1Mx36	K7P323688M-H(G)C30	300MHz	1.7
	K7P323688M-H(G)C25	250MHz	2.0
2Mx18	K7P321888M-H(G)C30	300MHz	1.7
	K7P321888M-H(G)C25	250MHz	2.0

\* G : Lead free package

### FUNCTIONAL BLOCK DIAGRAM



### PIN DESCRIPTION

Pin Name	Pin Description	Pin Name	Pin Description
K, $\bar{K}$	Differential Clocks	ZZ	Asynchronous Power Down
SAn	Synchronous Address Input	ZQ	Output Driver Impedance Control
DQn	Bi-directional Data Bus	TCK	JTAG Test Clock
$\bar{SS}$	Synchronous Select	TMS	JTAG Test Mode Select
$\bar{SW}$	Synchronous Global Write Enable	TDI	JTAG Test Data Input
$\bar{SWa}$	Synchronous Byte a Write Enable	TDO	JTAG Test Data Output
$\bar{SWb}$	Synchronous Byte b Write Enable	VREF	HSTL Input Reference Voltage
$\bar{SWc}$	Synchronous Byte c Write Enable	VDD	Power Supply
$\bar{SWd}$	Synchronous Byte d Write Enable	VDDQ	Output Power Supply
M1, M2	Read Protocol Mode Pins (M1=Vss, M2=VDDQ)	Vss	GND
$\bar{G}$	Asynchronous Output Enable	NC	No Connection

**K7P323688M**  
**K7P321888M**

**1Mx36 & 2Mx18 SRAM**

**PACKAGE PIN CONFIGURATIONS(TOP VIEW)**

**K7P323688MK7P321888M(1Mx36)**

	1	2	3	4	5	6	7
<b>A</b>	V <sub>DDQ</sub>	SA <sub>13</sub>	SA <sub>10</sub>	NC	SA <sub>7</sub>	SA <sub>4</sub>	V <sub>DDQ</sub>
<b>B</b>	NC	SA <sub>18</sub>	SA <sub>9</sub>	SA <sub>19</sub>	SA <sub>8</sub>	SA <sub>17</sub>	NC
<b>C</b>	NC	SA <sub>12</sub>	SA <sub>11</sub>	V <sub>DD</sub>	SA <sub>6</sub>	SA <sub>5</sub>	NC
<b>D</b>	DQ <sub>C8</sub>	DQ <sub>C9</sub>	V <sub>SS</sub>	ZQ	V <sub>SS</sub>	DQ <sub>b9</sub>	DQ <sub>b8</sub>
<b>E</b>	DQ <sub>C6</sub>	DQ <sub>C7</sub>	V <sub>SS</sub>	$\overline{SS}$	V <sub>SS</sub>	DQ <sub>b7</sub>	DQ <sub>b6</sub>
<b>F</b>	V <sub>DDQ</sub>	DQ <sub>C5</sub>	V <sub>SS</sub>	$\overline{G}$	V <sub>SS</sub>	DQ <sub>b5</sub>	V <sub>DDQ</sub>
<b>G</b>	DQ <sub>C3</sub>	DQ <sub>C4</sub>	$\overline{SWc}$	NC	$\overline{SWb}$	DQ <sub>b4</sub>	DQ <sub>b3</sub>
<b>H</b>	DQ <sub>C1</sub>	DQ <sub>C2</sub>	V <sub>SS</sub>	NC	V <sub>SS</sub>	DQ <sub>b2</sub>	DQ <sub>b1</sub>
<b>J</b>	V <sub>DDQ</sub>	V <sub>DD</sub>	V <sub>REF</sub>	V <sub>DD</sub>	V <sub>REF</sub>	V <sub>DD</sub>	V <sub>DDQ</sub>
<b>K</b>	DQ <sub>d1</sub>	DQ <sub>d2</sub>	V <sub>SS</sub>	K	V <sub>SS</sub>	DQ <sub>a2</sub>	DQ <sub>a1</sub>
<b>L</b>	DQ <sub>d3</sub>	DQ <sub>d4</sub>	$\overline{SWd}$	$\overline{K}$	$\overline{SWa}$	DQ <sub>a4</sub>	DQ <sub>a3</sub>
<b>M</b>	V <sub>DDQ</sub>	DQ <sub>d5</sub>	V <sub>SS</sub>	$\overline{SW}$	V <sub>SS</sub>	DQ <sub>a5</sub>	V <sub>DDQ</sub>
<b>N</b>	DQ <sub>d6</sub>	DQ <sub>d7</sub>	V <sub>SS</sub>	SA <sub>0</sub>	V <sub>SS</sub>	DQ <sub>a7</sub>	DQ <sub>a6</sub>
<b>P</b>	DQ <sub>d8</sub>	DQ <sub>d9</sub>	V <sub>SS</sub>	SA <sub>1</sub>	V <sub>SS</sub>	DQ <sub>a9</sub>	DQ <sub>a8</sub>
<b>R</b>	NC	SA <sub>15</sub>	M <sub>1</sub>	V <sub>DD</sub>	M <sub>2</sub>	SA <sub>2</sub>	NC
<b>T</b>	NC	NC	SA <sub>14</sub>	SA <sub>16</sub>	SA <sub>3</sub>	NC	ZZ
<b>U</b>	V <sub>DDQ</sub>	TMS	TDI	TCK	TDO	NC	V <sub>DDQ</sub>

**K7P321888M(2Mx18)**

	1	2	3	4	5	6	7
<b>A</b>	V <sub>DDQ</sub>	SA <sub>13</sub>	SA <sub>10</sub>	NC	SA <sub>7</sub>	SA <sub>4</sub>	V <sub>DDQ</sub>
<b>B</b>	NC	SA <sub>19</sub>	SA <sub>9</sub>	SA <sub>20</sub>	SA <sub>8</sub>	SA <sub>17</sub>	NC
<b>C</b>	NC	SA <sub>12</sub>	SA <sub>11</sub>	V <sub>DD</sub>	SA <sub>6</sub>	SA <sub>5</sub>	NC
<b>D</b>	DQ <sub>b1</sub>	NC	V <sub>SS</sub>	ZQ	V <sub>SS</sub>	DQ <sub>a9</sub>	NC
<b>E</b>	NC	DQ <sub>b2</sub>	V <sub>SS</sub>	$\overline{SS}$	V <sub>SS</sub>	NC	DQ <sub>a8</sub>
<b>F</b>	V <sub>DDQ</sub>	NC	V <sub>SS</sub>	$\overline{G}$	V <sub>SS</sub>	DQ <sub>a7</sub>	V <sub>DDQ</sub>
<b>G</b>	NC	DQ <sub>b3</sub>	$\overline{SWb}$	NC	NC	NC	DQ <sub>a6</sub>
<b>H</b>	DQ <sub>b4</sub>	NC	V <sub>SS</sub>	NC	V <sub>SS</sub>	DQ <sub>a5</sub>	NC
<b>J</b>	V <sub>DDQ</sub>	V <sub>DD</sub>	V <sub>REF</sub>	V <sub>DD</sub>	V <sub>REF</sub>	V <sub>DD</sub>	V <sub>DDQ</sub>
<b>K</b>	NC	DQ <sub>b5</sub>	V <sub>SS</sub>	K	V <sub>SS</sub>	NC	DQ <sub>a4</sub>
<b>L</b>	DQ <sub>b6</sub>	NC	NC	$\overline{K}$	$\overline{SWa}$	DQ <sub>a3</sub>	NC
<b>M</b>	V <sub>DDQ</sub>	DQ <sub>b7</sub>	V <sub>SS</sub>	$\overline{SW}$	V <sub>SS</sub>	NC	V <sub>DDQ</sub>
<b>N</b>	DQ <sub>b8</sub>	NC	V <sub>SS</sub>	SA <sub>0</sub>	V <sub>SS</sub>	DQ <sub>a2</sub>	NC
<b>P</b>	NC	DQ <sub>b9</sub>	V <sub>SS</sub>	SA <sub>1</sub>	V <sub>SS</sub>	NC	DQ <sub>a1</sub>
<b>R</b>	NC	SA <sub>15</sub>	M <sub>1</sub>	V <sub>DD</sub>	M <sub>2</sub>	SA <sub>2</sub>	NC
<b>T</b>	NC	SA <sub>18</sub>	SA <sub>14</sub>	NC	SA <sub>3</sub>	SA <sub>16</sub>	ZZ
<b>U</b>	V <sub>DDQ</sub>	TMS	TDI	TCK	TDO	NC	V <sub>DDQ</sub>

## FUNCTION DESCRIPTION

The K7P323688M and K7P321888M are 37,748,736 bit Synchronous Pipeline Mode SRAM. It is organized as 1,048,576 words of 36 bits(or 2,097,152 words of 18 bits)and is implemented in SAMSUNG's advanced CMOS technology.

Single differential HSTL level K clocks are used to initiate read/write operation and all internal operations are self-timed. At the rising edge of K clock, all Addresses, Write Enables, Synchronous Select and Data Ins are registered internally. Data outs are updated from output registers at the next rising edge of K clock. An internal write data buffer allows write data to follow one cycle after addresses and controls. The package is 119(7x17) Ball Grid Array with balls on a 1.27mm pitch.

## Read Operation

During read operations, addresses and controls are registered during the first rising edge of K clock and then the internal array is read between first rising and falling edges of K clock. Data outputs are updated from output registers off the falling edge of K clock.

During consecutive read operations where the address is the same, the data output must be held constant without any glitches. This characteristic is because the SRAM will be read by devices that will operate slower than the SRAM frequency and will require multiple SRAM cycles to perform a single read operation.

## Write Operation(Late Write)

During write operations, addresses and controls are registered at the first rising edge of K clock and data inputs are registered at the following rising edge of K clock. Write addresses and data inputs are stored in the data in registers until the next write operation, and only at the next write operation are data inputs fully written into SRAM array. Byte write operation is supported using SW[a:d] and the timing of SW[a:d] is the same as the SW signal.

## Bypass Read Operation

Bypass read operation occurs when the last write operation is followed by a read operation where write and read addresses are identical. For this case, data outputs are from the data in registers instead of SRAM array. Bypass read operation occurs on a byte to byte basis. If only one byte is written during a write operation but a read operation is required on the same address, a partial bypass read operation occurs since the new byte data is from the data in registers while the remaining bytes are from SRAM array.

## Sleep Mode

Sleep mode is a low power mode initiated by bringing the asynchronous ZZ pin high. During sleep mode, all other inputs are ignored and outputs are brought to a High-Impedance state. Sleep mode current and output High-Z are guaranteed after the specified sleep mode enable time. During sleep mode the memory array data content is preserved. Sleep mode must not be initiated until after all pending operations have completed, since any pending operation will not be guaranteed once sleep mode is initiated. Normal operations can be resumed by bringing the ZZ pin low, but only after the specified sleep mode recovery time.

## Mode Control

There are two mode control select pins (M1 and M2) used to set the proper read protocol. This SRAM supports single clock pipelined operating mode. For proper specified device operation, M1 must be connected to Vss and M2 must be connected to VDDQ. These mode pins must be set at power-up and must not change during device operation.

## Programmable Impedance Output Driver

The data output driver impedance is adjusted by an external resistor, RQ, connected between ZQ pin and Vss, and is equal to RQ/5. For example, 250Ω resistor will give an output impedance of 50Ω. Output driver impedance tolerance is 15% by test(10% by design) and is periodically readjusted to reflect the changes in supply voltage and temperature. Impedance updates occur early in cycles that do not activate the outputs, such as deselect cycles. They may also occur in cycles initiated with G high. In all cases impedance updates are transparent to the user and do not produce access time "push-outs" or other anomalous behavior in the SRAM. Impedance updates occur no more often than every 32 clock cycles. Clock cycles are counted whether the SRAM is selected or not and proceed regardless of the type of cycle being executed. Therefore, the user can be assured that after 33 continuous read cycles have occurred, an impedance update will occur the next time G are high at a rising edge of the K clock. There are no power up requirements for the SRAM. However, to guarantee optimum output driver impedance after power up, the SRAM needs 1024 non-read cycles. The output buffers can also be programmed in a minimum impedance configuration by connecting ZQ to Vss or VDDQ.

## Power-Up/Power-Down Supply Voltage Sequencing

The following power-up supply voltage application is recommended: Vss, VDD, VDDQ, VREF, then VIN. VDD and VDDQ can be applied simultaneously, as long as VDDQ does not exceed VDD by more than 0.5V during power-up. The following power-down supply voltage removal sequence is recommended: VIN, VREF, VDDQ, VDD, Vss. VDD and VDDQ can be removed simultaneously, as long as VDDQ does not exceed VDD by more than 0.5V during power-down.

**TRUTH TABLE**

K	ZZ	$\bar{G}$	$\bar{SS}$	$\bar{SW}$	$\bar{SWa}$	$\bar{SWb}$	$\bar{SWc}$	$\bar{SWd}$	DQa	DQb	DQc	DQd	Operation
X	H	X	X	X	X	X	X	X	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Power Down Mode. No Operation
X	L	H	X	X	X	X	X	X	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Output Disabled.
↑	L	L	H	X	X	X	X	X	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Output Disabled. No Operation
↑	L	L	L	H	X	X	X	X	DOUT	DOUT	DOUT	DOUT	Read Cycle
↑	L	X	L	L	H	H	H	H	Hi-Z	Hi-Z	Hi-Z	Hi-Z	No Bytes Written
↑	L	X	L	L	L	H	H	H	DIN	Hi-Z	Hi-Z	Hi-Z	Write first byte
↑	L	X	L	L	H	L	H	H	Hi-Z	DIN	Hi-Z	Hi-Z	Write second byte
↑	L	X	L	L	H	H	L	H	Hi-Z	Hi-Z	DIN	Hi-Z	Write third byte
↑	L	X	L	L	H	H	H	L	Hi-Z	Hi-Z	Hi-Z	DIN	Write fourth byte
↑	L	X	L	L	L	L	L	L	DIN	DIN	DIN	DIN	Write all bytes

NOTE : K &  $\bar{K}$  are complementary

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Value	Unit
Core Supply Voltage Relative to Vss	VDD	-0.5 to 2.3	V
Output Supply Voltage Relative to Vss	VDDQ	-0.5 to 2.3	V
Voltage on any pin Relative to Vss	VIN	-0.5 to VDDQ+0.5 (2.3V MAX)	V
Output Short-Circuit Current(per I/O)	IOUT	25	mA
Operating Temperature	TOPR	0 to 70	°C
Storage Temperature	TSTR	-55 to 125	°C

NOTE : Power Dissipation Capability will be dependent upon package characteristics and use environment. See enclosed thermal impedance data. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**RECOMMENDED DC OPERATING CONDITIONS**

Parameter	Symbol	Min	Typ	Max	Unit	Note
Core Power Supply Voltage	VDD	1.7	1.8	1.9	V	
Output Power Supply Voltage	VDDQ	1.4	1.8	1.9	V	
Input High Level	V <sub>IH</sub>	VREF+0.1	-	VDDQ+0.3	V	1, 2
Input Low Level	V <sub>IL</sub>	-0.3	-	VREF-0.1	V	1, 3
Input Reference Voltage	VREF	0.7	0.9	0.95	V	
Clock Input Signal Voltage	V <sub>IN-CLK</sub>	-0.3	-	VDDQ+0.3	V	
Clock Input Differential Voltage	V <sub>DIF-CLK</sub>	0.1	-	VDDQ+0.6	V	
Clock Input Common Mode Voltage	V <sub>CM-CLK</sub>	0.7	0.9	0.95	V	

NOTE : 1. These are DC test criteria. DC design criteria is VREF±50mV. The AC V<sub>IH</sub>/V<sub>IL</sub> levels are defined separately for measuring timing parameters.

- V<sub>IH</sub> (Max)DC=VDDQ+0.3, V<sub>IH</sub> (Max)AC=2.6V (2.1V for DQs) (pulse width ≤ 20% of cycle time).
- V<sub>IL</sub> (Min)DC=-0.3V, V<sub>IL</sub> (Min)AC=-1.0V (-0.5V for DQs) (pulse width ≤ 20% of cycle time).

**PIN CAPACITANCE**

Parameter	Symbol	Test Condition	Min	Max	Unit
Input Capacitance	C <sub>IN</sub>	V <sub>IN</sub> =0V	-	4	pF
Data Output Capacitance	C <sub>OUT</sub>	V <sub>OUT</sub> =0V	-	5	pF
Clock Capacitance	C <sub>CLK</sub>	V <sub>CLK</sub> =0V	-	5	pF

**NOTE** : Periodically sampled and not 100% tested.(TA=25°C, f=1MHz)

**DC CHARACTERISTICS**

Parameter	Symbol	Min	Max	Unit	Note
Average Power Supply Operating Current-x36 (V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub> , ZZ & SS=V <sub>IL</sub> )	I <sub>DD30</sub> I <sub>DD25</sub>	-	620 550	mA	1, 2
Average Power Supply Operating Current-x18 (V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub> , ZZ & SS=V <sub>IL</sub> )	I <sub>DD30</sub> I <sub>DD25</sub>	-	570 500	mA	1, 2
Power Supply Standby Current (V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub> , ZZ=V <sub>IH</sub> )	I <sub>SBZZ</sub>	-	70	mA	1
Active Standby Power Supply Current (V <sub>IN</sub> =V <sub>IH</sub> or V <sub>IL</sub> , SS=V <sub>IH</sub> , ZZ=V <sub>IL</sub> )	I <sub>SBSS</sub>	-	200	mA	1
Input Leakage Current (V <sub>IN</sub> =V <sub>SS</sub> or V <sub>DDQ</sub> )	I <sub>LI</sub>	-1	1	μA	
Output Leakage Current (V <sub>OUT</sub> =V <sub>SS</sub> or V <sub>DDQ</sub> , DQ in High-Z)	I <sub>LO</sub>	-1	1	μA	
Output High Voltage(Programmable Impedance Mode)	V <sub>OH1</sub>	V <sub>DDQ</sub> /2	V <sub>DDQ</sub>	V	3,5
Output Low Voltage(Programmable Impedance Mode)	V <sub>OL1</sub>	V <sub>SS</sub>	V <sub>DDQ</sub> /2	V	4,5
Output High Voltage(I <sub>OH</sub> =-0.1mA)	V <sub>OH2</sub>	V <sub>DDQ</sub> -0.2	V <sub>DDQ</sub>	V	6
Output Low Voltage(I <sub>OL</sub> =0.1mA)	V <sub>OL2</sub>	V <sub>SS</sub>	0.2	V	6
Output High Voltage(I <sub>OH</sub> =-6mA)	V <sub>OH3</sub>	V <sub>DDQ</sub> -0.4	V <sub>DDQ</sub>	V	6
Output Low Voltage(I <sub>OL</sub> =6mA)	V <sub>OL3</sub>	V <sub>SS</sub>	0.4	V	6

**NOTE** :1. Minimum cycle. I<sub>OUT</sub>=0mA.  
 2. 50% read cycles.  
 3. |I<sub>OH</sub>|=(V<sub>DDQ</sub>/2)/(R<sub>Q</sub>/5)±15% @V<sub>OH</sub>=V<sub>DDQ</sub>/2 for 175Ω ≤ R<sub>Q</sub> ≤ 350Ω.  
 4. |I<sub>OL</sub>|=(V<sub>DDQ</sub>/2)/(R<sub>Q</sub>/5)±15% @V<sub>OL</sub>=V<sub>DDQ</sub>/2 for 175Ω ≤ R<sub>Q</sub> ≤ 350Ω.  
 5. Programmable Impedance Output Buffer Mode. The ZQ pin is connected to V<sub>SS</sub> through R<sub>Q</sub>.  
 6. Minimum Impedance Output Buffer Mode. The ZQ pin is connected to V<sub>SS</sub> or V<sub>DDQ</sub>.

# K7P323688M K7P321888M

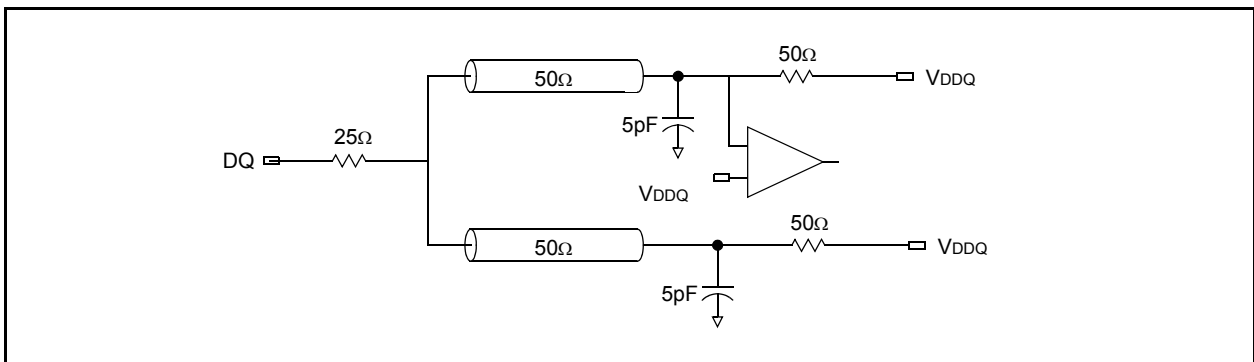
## 1Mx36 & 2Mx18 SRAM

### AC TEST CONDITIONS (TA=0 to 70°C, RQ=250Ω)

Parameter	Symbol	Value	Unit	Note
Core Power Supply Voltage	V <sub>DD</sub>	1.7~1.9	V	
Output Power Supply Voltage	V <sub>DDQ</sub>	1.8	V	1
Input High/Low Level	V <sub>IH</sub> /V <sub>IL</sub>	V <sub>DDQ</sub> /2 ± 0.5	V	1
Input Reference Level	V <sub>REF</sub>	V <sub>DDQ</sub> /2	V	1
Input Rise/Fall Time	T <sub>R</sub> /T <sub>F</sub>	0.5/0.5	ns	
Input and Out Timing Reference Level		V <sub>DDQ</sub> /2	V	1
Clock Input Timing Reference Level		Cross Point	V	

NOTE : 1. V<sub>DDQ</sub> should never be higher than V<sub>DD</sub>.

### AC TEST OUTPUT LOAD

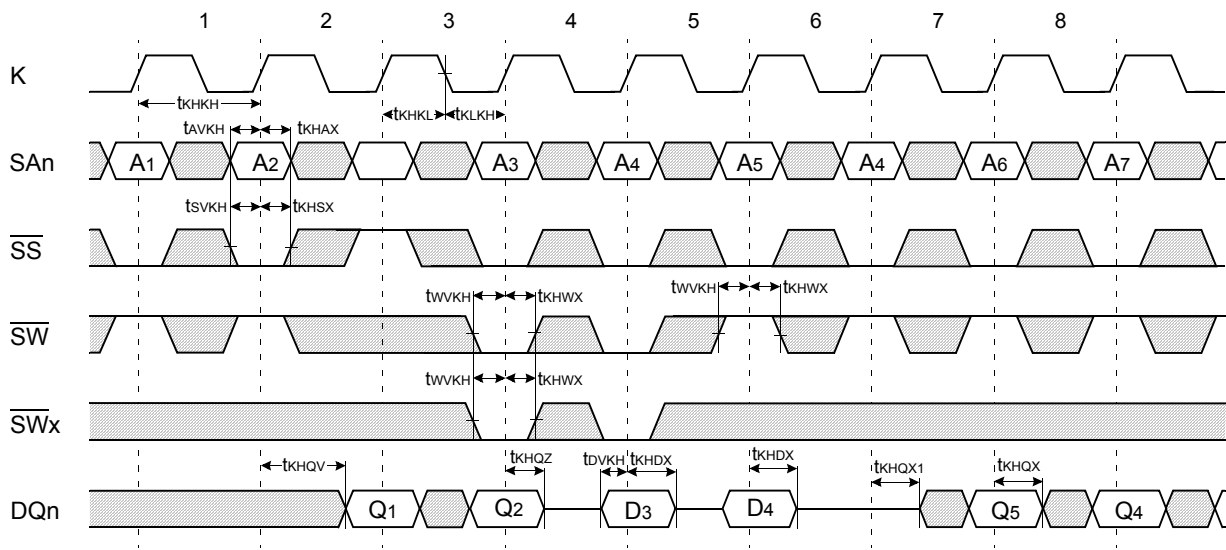


### AC CHARACTERISTICS

Parameter	Symbol	-30		-25		Unit	Note
		Min	Max	Min	Max		
Clock Cycle Time	t <sub>KHKH</sub>	3.3	-	4.0	-	ns	
Clock High Pulse Width	t <sub>KHKL</sub>	1.3	-	1.6	-	ns	
Clock Low Pulse Width	t <sub>KLKH</sub>	1.3	-	1.6	-	ns	
Clock High to Output Valid	t <sub>KHQV</sub>	-	1.6	-	2.0	ns	
Clock High to Output Hold	t <sub>KHQX</sub>	0.5	-	0.5	-	ns	
Address Setup Time	t <sub>AVKH</sub>	0.3	-	0.3	-	ns	
Address Hold Time	t <sub>KHAX</sub>	0.5	-	0.5	-	ns	
Write Data Setup Time	t <sub>DVKH</sub>	0.3	-	0.3	-	ns	
Write Data Hold Time	t <sub>KHDX</sub>	0.5	-	0.5	-	ns	
$\overline{SW}$ , $\overline{SW}[a:d]$ Setup Time	t <sub>WVKH</sub>	0.3	-	0.3	-	ns	
$\overline{SW}$ , $\overline{SW}[a:d]$ Hold Time	t <sub>KHWX</sub>	0.5	-	0.5	-	ns	
$\overline{SS}$ Setup Time	t <sub>SVKH</sub>	0.3	-	0.3	-	ns	
$\overline{SS}$ Hold Time	t <sub>KHSX</sub>	0.5	-	0.5	-	ns	
Clock High to Output Hi-Z	t <sub>KHQZ</sub>	-	1.7	-	2.0	ns	
Clock High to Output Low-Z	t <sub>KHQX1</sub>	0.5	-	0.5	-	ns	
$\overline{G}$ High to Output High-Z	t <sub>GHQZ</sub>	-	1.7	-	2.0	ns	
$\overline{G}$ Low to Output Low-Z	t <sub>GLQX</sub>	0.5	-	0.5	-	ns	
$\overline{G}$ Low to Output Valid	t <sub>GLQV</sub>	-	1.7	-	2.0	ns	
ZZ High to Power Down(Sleep Time)	t <sub>ZZE</sub>	-	15	-	15	ns	
ZZ Low to Recovery(Wake-up Time)	t <sub>ZZR</sub>	-	20	-	20	ns	



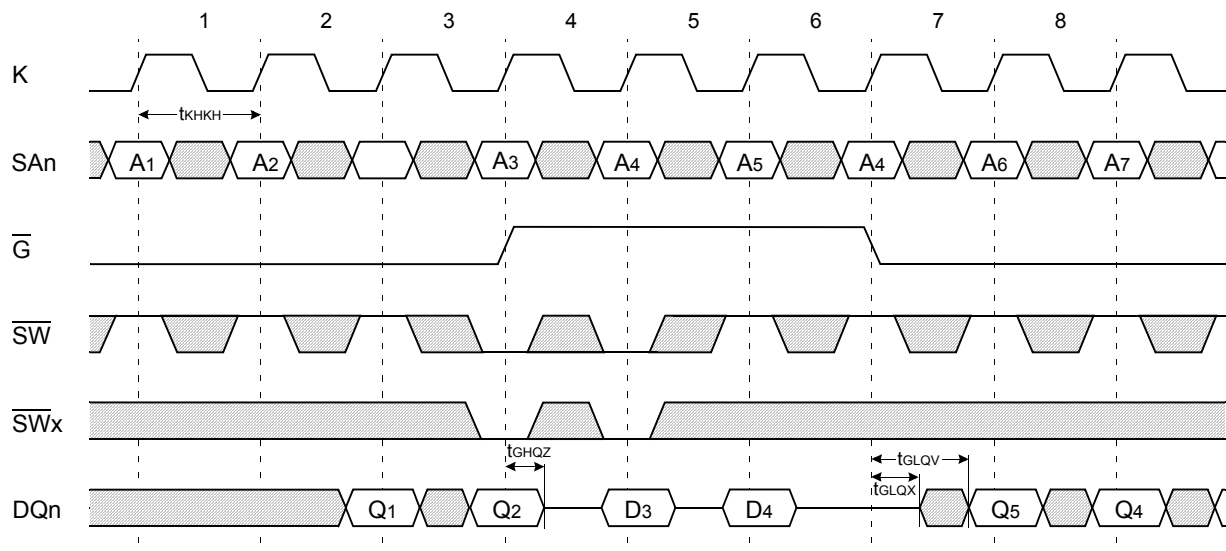
**TIMING WAVEFORMS OF NORMAL ACTIVE CYCLES ( $\overline{SS}$  Controlled,  $\overline{G}$ =Low)**



**NOTE**

1. D<sub>3</sub> is the input data written in memory location A<sub>3</sub>.
2. Q<sub>4</sub> is the output data read from the write data buffer(not from the cell array), as a result of address A<sub>4</sub> being a match from the last write cycle address.

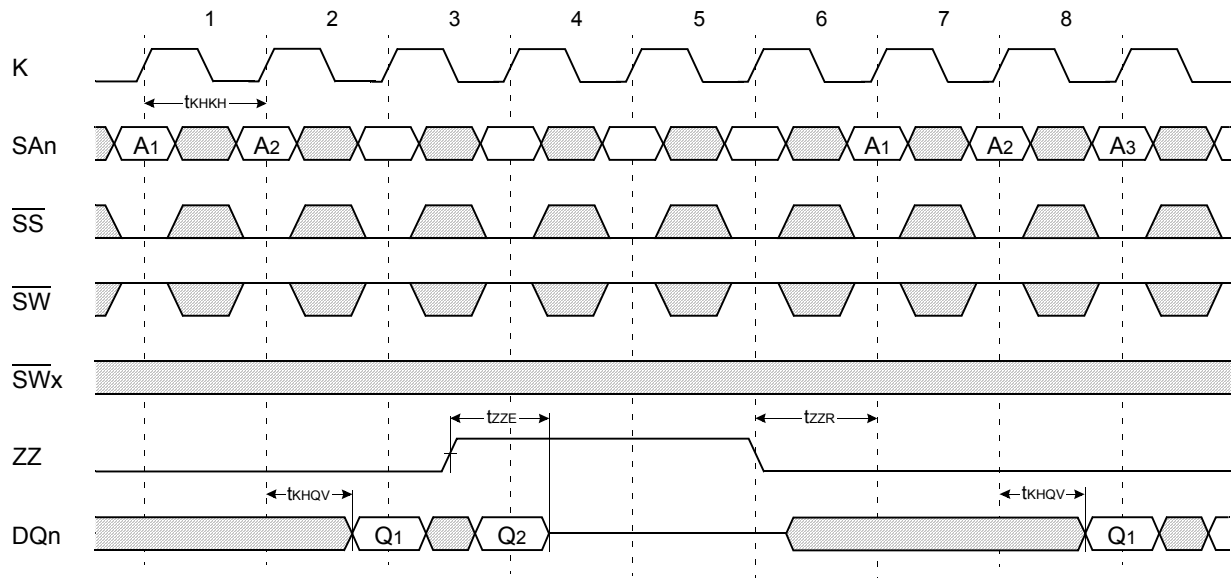
**TIMING WAVEFORMS OF NORMAL ACTIVE CYCLES ( $\overline{G}$  Controlled,  $\overline{SS}$ =Low)**



**NOTE**

1. D<sub>3</sub> is the input data written in memory location A<sub>3</sub>.
2. Q<sub>4</sub> is the output data read from the write data buffer(not from the cell array), as a result of address A<sub>4</sub> being a match from the last write cycle address.

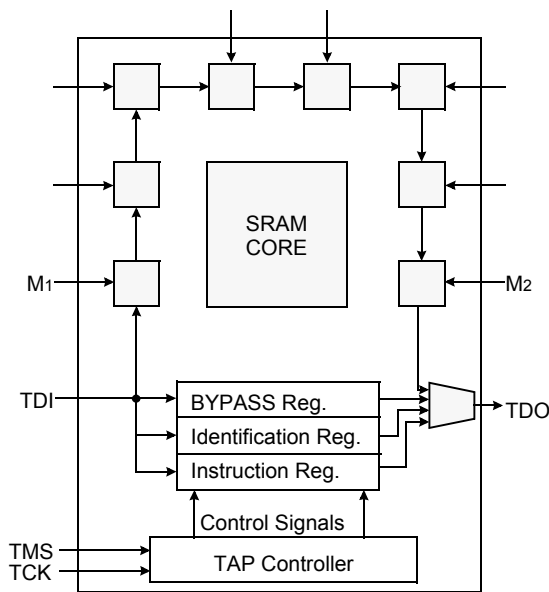
**TIMING WAVEFORMS OF STANDBY CYCLES**



**IEEE 1149.1 TEST ACCESS PORT AND BOUNDARY SCAN-JTAG**

The SRAM provides a limited set of IEEE standard 1149.1 JTAG functions. This is to test the connectivity during manufacturing between SRAM, printed circuit board and other components. Internal data is not driven out of SRAM under JTAG control. In conformance with IEEE 1149.1, the SRAM contains a TAP controller, Instruction Register, Bypass Register and ID register. The TAP controller has a standard 16-state machine that resets internally upon power-up, therefore, TRST signal is not required. It is possible to use this device without utilizing the TAP. To disable the TAP controller without interfacing with normal operation of the SRAM, TCK must be tied to V<sub>ss</sub> to preclude mid level input. TMS and TDI are designed so an undriven input will produce a response identical to the application of a logic 1, and therefore can be left unconnected. But they may also be tied to V<sub>DD</sub> through a resistor. TDO should be left unconnected.

**JTAG Block Diagram**



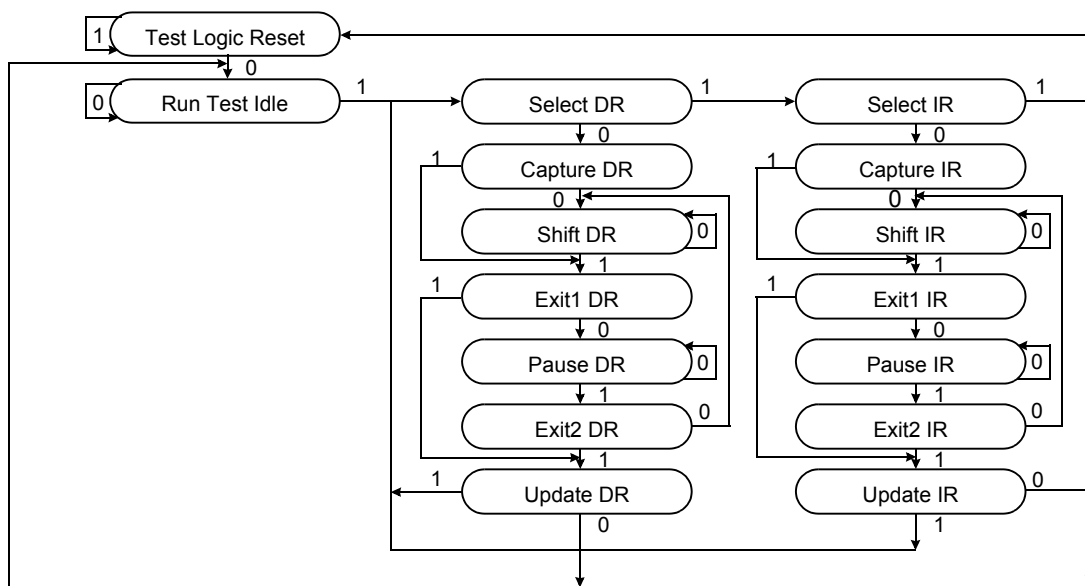
**JTAG Instruction Coding**

IR2	IR1	IR0	Instruction	TDO Output	Notes
0	0	0	SAMPLE-Z	Boundary Scan Register	1
0	0	1	IDCODE	Identification Register	2
0	1	0	SAMPLE-Z	Boundary Scan Register	1
0	1	1	BYPASS	Bypass Register	3
1	0	0	SAMPLE	Boundary Scan Register	4
1	0	1	PRIVATE		5
1	1	0	BYPASS	Bypass Register	3
1	1	1	BYPASS	Bypass Register	3

**NOTE :**

1. Places DQs in Hi-Z in order to sample all input data regardless of other SRAM inputs.
2. TDI is sampled as an input to the first ID register to allow for the serial shift of the external TDI data.
3. Bypass register is initiated to V<sub>ss</sub> when BYPASS instruction is invoked. The Bypass Register also holds serially loaded TDI when exiting the Shift DR states.
4. SAMPLE instruction does not places DQs in Hi-Z.
5. PRIVATE is reserved for the exclusive use of SAMSUNG. This instruction should not be used.

**TAP Controller State Diagram**



**SCAN REGISTER DEFINITION**

Part	Instruction Register	Bypass Register	ID Register	Boundary Scan
1Mx36	3 bits	1 bits	32 bits	70 bits
2Mx18	3 bits	1 bits	32 bits	51 bits

**ID REGISTER DEFINITION**

Part	Revision Number (31:28)	Part Configuration (27:18)	Vendor Definition (17:12)	Samsung JEDEC Code (11: 1)	Start Bit(0)
1Mx36	0000	01000 00100	XXXXXX	00001001110	1
2Mx18	0000	01001 00011	XXXXXX	00001001110	1

**BOUNDARY SCAN EXIT ORDER(x36)**

36	3B	SA	SA	5B	35
37	2B	SA	SA	6B	34
38	3A	SA	SA	5A	33
39	3C	SA	SA	5C	32
40	2C	SA	SA	6C	31
41	2A	SA	SA	6A	30
42	2D	DQc9	DQb9	6D	29
43	1D	DQc8	DQb8	7D	28
44	2E	DQc7	DQb7	6E	27
45	1E	DQc6	DQb6	7E	26
46	2F	DQc5	DQb5	6F	25
47	2G	DQc4	DQb4	6G	24
48	1G	DQc3	DQb3	7G	23
49	2H	DQc2	DQb2	6H	22
50	1H	DQc1	DQb1	7H	21
51	3G	$\overline{SWc}$	$\overline{SWb}$	5G	20
52	4D	ZQ	$\overline{G}$	4F	19
53	4E	$\overline{SS}$	K	4K	18
54	4B	SA	$\overline{K}$	4L	17
55	4H	$\overline{NC}^{*1}$	$\overline{SWa}$	5L	16
56	4M	$\overline{SW}$	DQa1	7K	15
57	3L	$\overline{SWd}$	DQa2	6K	14
58	1K	DQd1	DQa3	7L	13
59	2K	DQd2	DQa4	6L	12
60	1L	DQd3	DQa5	6M	11
61	2L	DQd4	DQa6	7N	10
62	2M	DQd5	DQa7	6N	9
63	1N	DQd6	DQa8	7P	8
64	2N	DQd7	DQa9	6P	7
65	1P	DQd8	ZZ	7T	6
66	2P	DQd9	SA	5T	5
67	3T	SA	SA	6R	4
68	2R	SA	SA	4T	3
69	4N	SA	SA	4P	2
70	3R	M1	M2	5R	1

**BOUNDARY SCAN EXIT ORDER(x18)**

26	3B	SA	SA	5B	25
27	2B	SA	SA	6B	24
28	3A	SA	SA	5A	23
29	3C	SA	SA	5C	22
30	2C	SA	SA	6C	21
31	2A	SA	SA	6A	20
			DQa9	6D	19
32	1D	DQb1			
33	2E	DQb2			
			DQa8	7E	18
			DQa7	6F	17
34	2G	DQb3			
			DQa6	7G	16
			DQa5	6H	15
35	1H	DQb4			
36	3G	$\overline{SWb}$			
37	4D	ZQ	$\overline{G}$	4F	14
38	4E	$\overline{SS}$	K	4K	13
39	4B	SA	$\overline{K}$	4L	12
40	4H	$\overline{NC}^{*1}$	$\overline{SWa}$	5L	11
41	4M	$\overline{SW}$	DQa4	7K	10
42	2K	DQb5	DQa3	6L	9
43	1L	DQb6			
44	2M	DQb7	DQa2	6N	8
45	1N	DQb8	DQa1	7P	7
			ZZ	7T	6
46	2P	DQb9	SA	5T	5
47	3T	SA	SA	6R	4
48	2R	SA			
49	4N	SA	SA	4P	3
50	2T	SA	SA	6T	2
51	3R	M1	M2	5R	1

NOTE :1. Pin 4H is no connection pin to internal chip and the scanned data is "0".

**JTAG DC OPERATING CONDITIONS**

Parameter	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	V <sub>DD</sub>	1.7	1.8	1.9	V	
Input High Level	V <sub>IH</sub>	0.65 V <sub>DD</sub>	-	V <sub>DD</sub> +0.3	V	
Input Low Level	V <sub>IL</sub>	-0.3	-	0.35 V <sub>DD</sub>	V	
Output High Voltage(I <sub>OH</sub> =-2mA)	V <sub>OH</sub>	V <sub>DD</sub> - 0.45	-	V <sub>DD</sub>	V	
Output Low Voltage(I <sub>OL</sub> =2mA)	V <sub>OL</sub>	V <sub>SS</sub>	-	0.45	V	

**NOTE** : 1. The input level of SRAM pin is to follow the SRAM DC specification.

**JTAG AC TEST CONDITIONS**

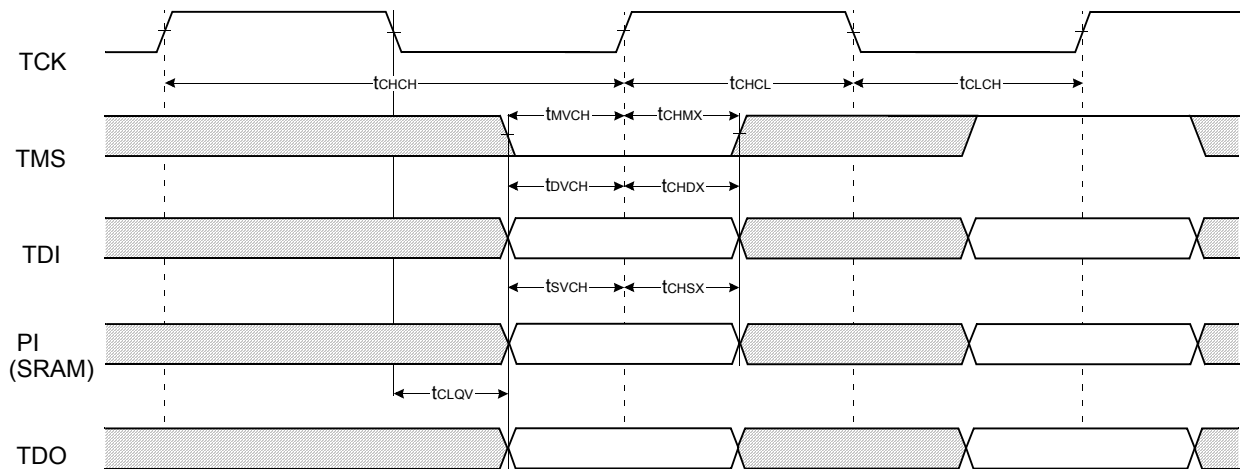
Parameter	Symbol	Min	Unit	Note
Input High/Low Level	V <sub>IH</sub> /V <sub>IL</sub>	1.8/0.0	V	
Input Rise/Fall Time	T <sub>R</sub> /T <sub>F</sub>	1.0/1.0	ns	
Input and Output Timing Reference Level		0.9	V	1

**NOTE** : 1. See SRAM AC test output load on page 7.

**JTAG AC Characteristics**

Parameter	Symbol	Min	Max	Unit	Note
TCK Cycle Time	t <sub>CHCH</sub>	50	-	ns	
TCK High Pulse Width	t <sub>CHCL</sub>	20	-	ns	
TCK Low Pulse Width	t <sub>CLCH</sub>	20	-	ns	
TMS Input Setup Time	t <sub>MVCH</sub>	5	-	ns	
TMS Input Hold Time	t <sub>CHMX</sub>	5	-	ns	
TDI Input Setup Time	t <sub>DVCH</sub>	5	-	ns	
TDI Input Hold Time	t <sub>CHDX</sub>	5	-	ns	
SRAM Input Setup Time	t <sub>SVCH</sub>	5	-	ns	
SRAM Input Hold Time	t <sub>CHSX</sub>	5	-	ns	
Clock Low to Output Valid	t <sub>CLQV</sub>	0	10	ns	

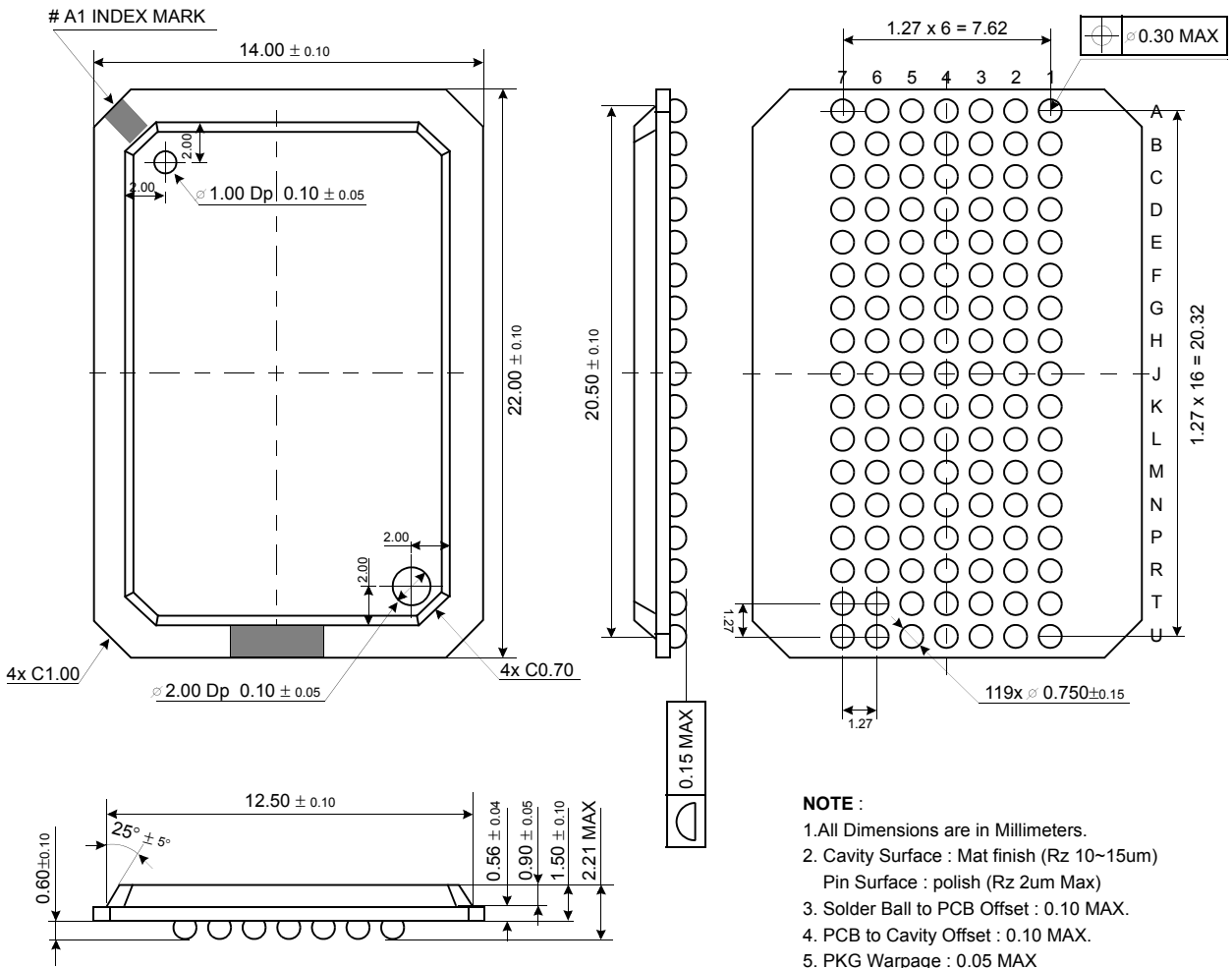
**JTAG TIMING DIAGRAM**



**K7P323688M**  
**K7P321888M**

**1Mx36 & 2Mx18 SRAM**

**119 BGA PACKAGE DIMENSIONS**



- NOTE :**
1. All Dimensions are in Millimeters.
  2. Cavity Surface : Mat finish (Rz 10~15um)  
Pin Surface : polish (Rz 2um Max)
  3. Solder Ball to PCB Offset : 0.10 MAX.
  4. PCB to Cavity Offset : 0.10 MAX.
  5. PKG Warpage : 0.05 MAX

**119 BGA PACKAGE THERMAL CHARACTERISTICS**

Parameter	Symbol	Thermal Resistance	Unit	Note
Junction to Ambient(at still air)	Theta_JA	20.0	°C/W	1.5W Heating
Junction to Case	Theta_JC	4.3	°C/W	
Junction to Board	Theta_JB	5.4	°C/W	1.5W Heating

NOTE : 1. Junction temperature can be calculated by :  $T_J = T_A + P_D \times \text{Theta\_JA}$ .