72Mb NtRAM™ Specification

100TQFP/165FBGA with Pb/Pb-Free

(RoHS compliant)

Document Title

2Mx36 & 4Mx18-Bit Pipelined N*t*RAM™

Revision History

Rev. No.	History	Draft Date	Remark
0.0	1. Initial document.	Sep. 30. 2002	Advance
0.1	1. Delete the speed bins (FT : 7.5ns, 8.5ns / PP : 200MHz)	Oct. 8. 2002	Preliminary
0.2	1. Change to the New JTAG scan order.	Feb. 25, 2003	Preliminary
0.3	1. Add the comment about Vdd/Vddq wide by note on page 13.	Mar. 10, 2003	Preliminary
0.4	1. Delete the 119 BGA package type.	Aug. 18, 2004	Preliminary
0.5	1. Delete the 1.8V and 3.3V Vdd voltage level (Change the part number to K7N6436(18)45M from K7N6436(18)31M)	Oct. 20, 2004	Preliminary
0.6	1. Add the overshoot timing	Feb. 16, 2006	Final
1.0	1. Change ordering information	Apr. 03, 2006	Final
1.1	1. Add the current in the DC Elecrical Characteristics	Feb. 27, 2007	Final
1.2	1. change standby current value	Mar. 25, 2008	Final
1.3	1. Correct typo	Sep. 03, 2008	Final

72Mb NtRAM (Pipelined) Ordering Information

Org.	VDD (V)	Speed (ns)	Access Time (ns)	Part Number	RoHS Avail.
4Mx18	2.5	4.0	2.6	K7N641845M-P(Q,E,F)[1]C(I)[2]25	√
	2.5	6.0	3.5	K7N641845M-P(Q,E,F)[1]C(I)[2]16	√
2Mx36	2.5	4.0	2.6	K7N643645M-P(Q,E,F)[1]C(I)[2]25	√
	2.5	6.0	3.5	K7N643645M-P(Q,E,F)[1]C(I)[2]16	√

Note 1. P(Q,E,F) [Package type] : 100TQFP ; P-Pb Free, Q-Pb, 165FBGA ; E-Pb Free, F-Pb
2. C(I) [Operating Temperature] : C-Commercial, I-Industrial

2Mx36 & 4Mx18-Bit Pipelined NtRAM™

FEATURES

- 2.5V ±5% Power Supply.
- Byte Writable Function.
- Enable clock and suspend operation.
- Single $\overline{\text{R}}$EAD/WRITE control pin.
- Self-Timed Write Cycle.
- Three Chip Enable for simple depth expansion with no data contention .
- A interleaved burst or a linear burst mode.
- Asynchronous output enable control.
- Power Down mode.
- TTL-Level Three-State Outputs.
- 100-TQFP-1420A.
- 165FBGA(11x15 ball aray) with body size of 15mmx17mm.

FAST ACCESS TIMES

PARAMETER	Symbol	-25	-16	Unit
Cycle Time	tCYC	4.0	6.0	ns
Clock Access Time	tCD	2.6	3.5	ns
Output Enable Access Time	tOE	2.6	3.5	ns

GENERAL DESCRIPTION

The K7N643645M and K7N641845M are 75,497,472-bits Synchronous Static SRAMs.

The NtRAM™, or No Turnaround Random Access Memory utilizes all the bandwidth in any combination of operating cycles.

Address, data inputs, and all control signals except output enable and linear burst order are synchronized to input clock.

Burst order control must be tied "High or Low".

Asynchronous inputs include the sleep mode enable(ZZ).

Output Enable controls the outputs at any given time.

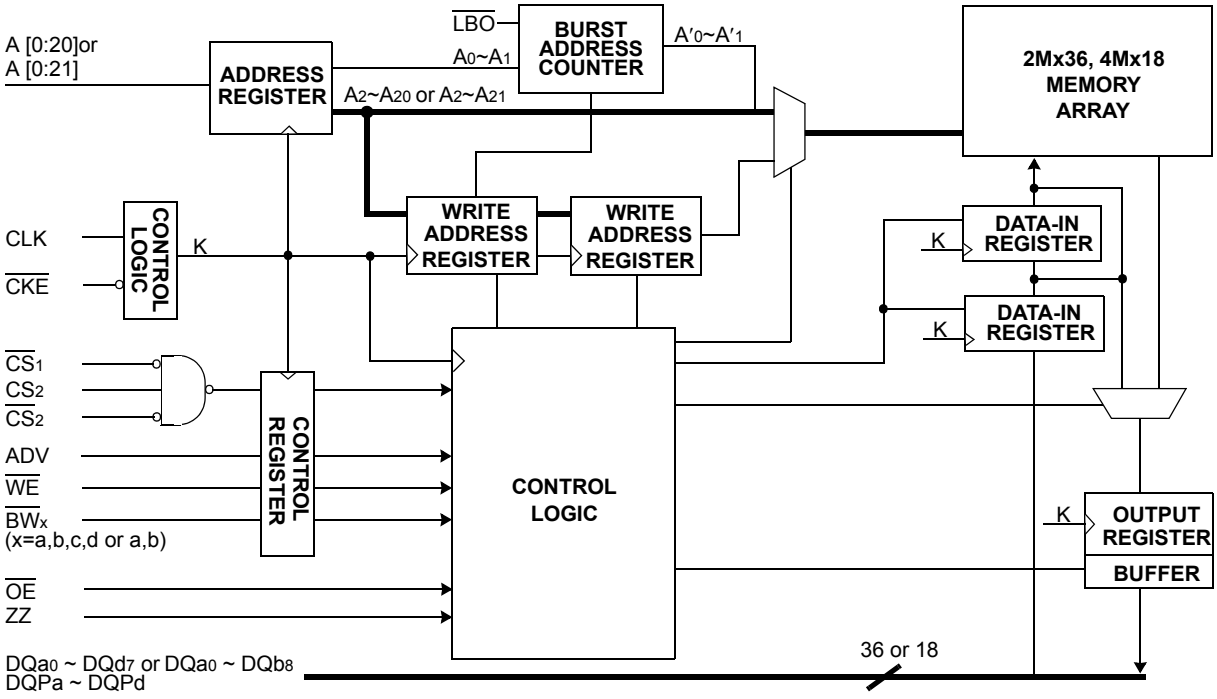
Write cycles are internally self-timed and initiated by the rising edge of the clock input. This feature eliminates complex off-chip write pulse generation

and provides increased timing flexibility for incoming signals.

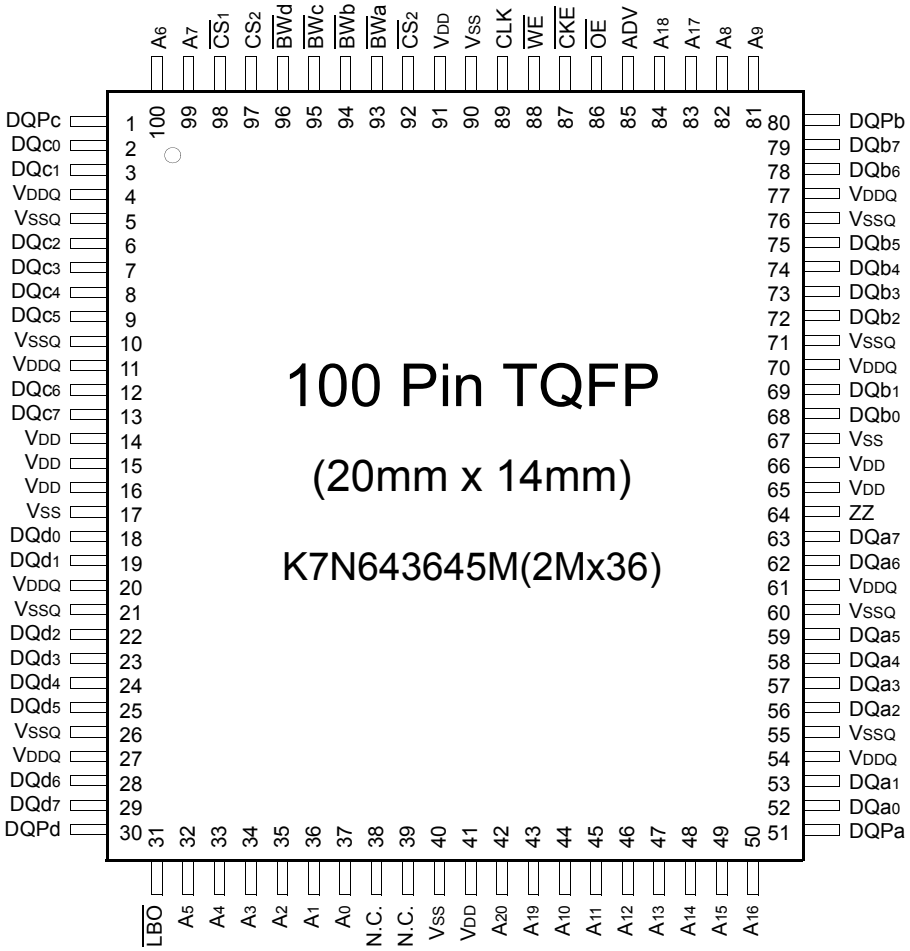
For read cycles, pipelined SRAM output data is temporarily stored by an edge triggered output register and then released to the output buffers at the next rising edge of clock.

The K7N643645M and K7N641845M are implemented with SAMSUNG′s high performance CMOS technology and is available in 100pin TQFP and 165FBGA packages. Multiple power and ground pins minimize ground bounce.

LOGIC BLOCK DIAGRAM



PIN CONFIGURATION(TOP VIEW)



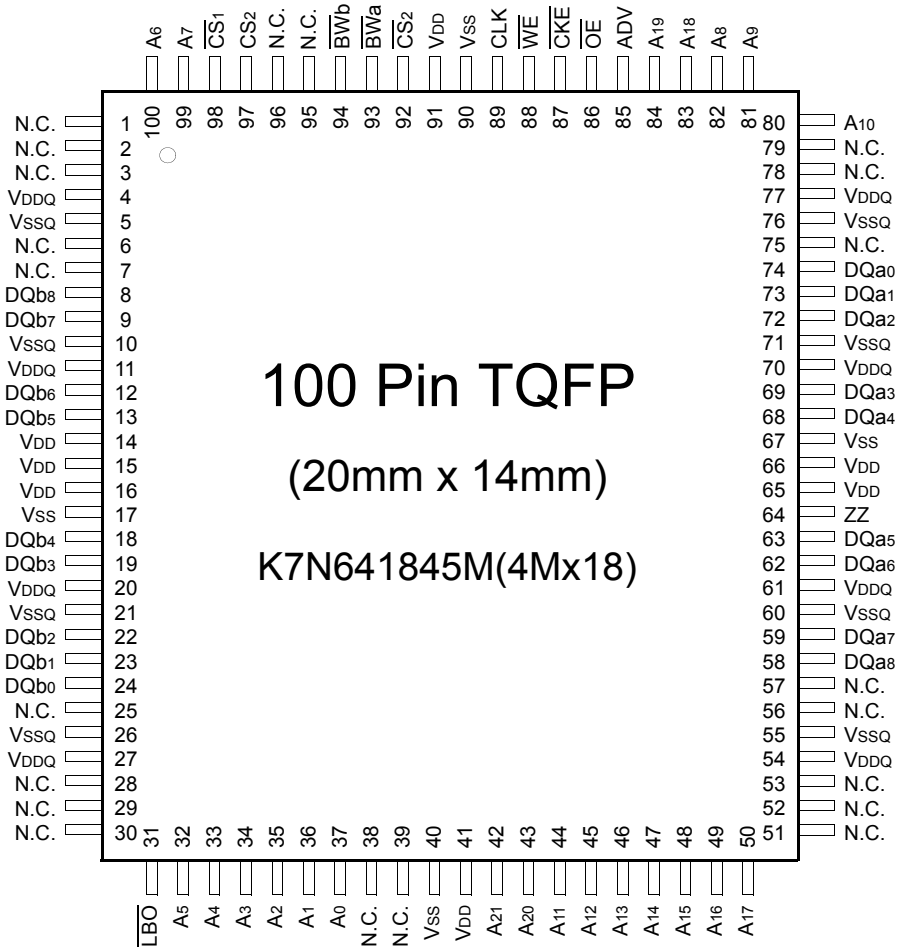
PIN NAME

SYMBOL	PIN NAME	TQFP PIN NO.	SYMBOL	PIN NAME	TQFP PIN NO.
A_0 - A_{20}	Address Inputs	32,33,34,35,36,37,42, 43,44,45,46,47,48,49, 50,81,82,83,84,99, 100	V_{DD}	Power Supply(2.5V)	14,15,16,41,65,66,91
			V_{SS}	Ground	17,40,67,90
			N.C.	No Connect	38,39
$\overline{ADV}$	Address Advance/Load	85			
$\overline{WE}$	Read/Write Control Input	88	DQa_0~a_7	Data Inputs/Outputs	52,53,56,57,58,59,62,63
$\overline{CLK}$	Clock	89	DQb_0~b_7	Data Inputs/Outputs	68,69,72,73,74,75,78,79
$\overline{CKE}$	Clock Enable	87	DQc_0~c_7	Data Inputs/Outputs	2,3,6,7,8,9,12,13
$\overline{CS_1}$	Chip Select	98	DQd_0~d_7	Data Inputs/Outputs	18,19,22,23,24,25,28,29
CS_2	Chip Select	97	DQPa~P_d	Data Inputs/Outputs	51,80,1,30
$\overline{CS_2}$	Chip Select	92			
$\overline{BW}$x(x=a,b,c,d)	Byte Write Inputs	93,94,95,96	V_{DDQ}	Output Power Supply (2.5V)	4,11,20,27,54,61,70,77
$\overline{OE}$	Output Enable	86			
$\overline{ZZ}$	Power Sleep Mode	64	V_{SSQ}	Output Ground	5,10,21,26,55,60,71,76
$\overline{LBO}$	Burst Mode Control	31			

Note : 1. A_0 and A_1 are the two least significant bits(LSB) of the address field and set the internal burst counter if burst is desired.

SAMSUNG ELECTRONICS

PIN CONFIGURATION(TOP VIEW)



PIN NAME

SYMBOL	PIN NAME	TQFP PIN NO.	SYMBOL	PIN NAME	TQFP PIN NO.
A_0 - A_{21}	Address Inputs	32,33,34,35,36,37,42, 43,44,45,46,47,48,49, 50,80,81,82,83,84,99, 100	V_{DD}	Power Supply(2.5V)	14,15,16,41,65,66,91
			V_{SS}	Ground	17,40,67,90
			N.C.	No Connect	1,2,3,6,7,25,28,29,30, 38,39,51,52,53,56,57, 75,78,79,95,96
ADV	Address Advance/Load	85			
$\overline{WE}$	Read/Write Control Input	88			
$\overline{CLK}$	Clock	89			
$\overline{CKE}$	Clock Enable	87	DQa_{0}~a_8	Data Inputs/Outputs	58,59,62,63,68,69,72,73,74
$\overline{CS_1}$	Chip Select	98	DQb_{0}~b_8	Data Inputs/Outputs	8,9,12,13,18,19,22,23,24
CS_2	Chip Select	97			
$\overline{CS_2}$	Chip Select	92			
$\overline{BW}$x(x=a,b)	Byte Write Inputs	93,94	V_{DDQ}	Output Power Supply (2.5V)	4,11,20,27,54,61,70,77
$\overline{OE}$	Output Enable	86			
$\overline{ZZ}$	Power Sleep Mode	64	V_{SSQ}	Output Ground	5,10,21,26,55,60,71,76
$\overline{LBO}$	Burst Mode Control	31			

NOTE : A_0 and A_1 are the two least significant bits(LSB) of the address field and set the internal burst counter if burst is desired.

SAMSUNG ELECTRONICS

165-PIN FBGA PACKAGE CONFIGURATIONS(TOP VIEW)

K7N643645M(2Mx36)

	1	2	3	4	5	6	7	8	9	10	11
A	NC**	A	$\overline{CS}$1	$\overline{BW}$c	$\overline{BW}$b	$\overline{CS}$2	$\overline{CKE}$	ADV	A	A	NC
B	NC	A	CS2	$\overline{BW}$d	$\overline{BW}$a	CLK	$\overline{WE}$	$\overline{OE}$	A	A	NC**
C	DQPc	NC	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	DQPb
D	DQc	DQc	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQb	DQb
E	DQc	DQc	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQb	DQb
F	DQc	DQc	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQb	DQb
G	DQc	DQc	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQb	DQb
H	NC	V_{DD}	NC	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	NC	NC	ZZ
J	DQd	DQd	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	DQa
K	DQd	DQd	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	DQa
L	DQd	DQd	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	DQa
M	DQd	DQd	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	DQa
N	DQPd	NC	V_{DDQ}	V_{SS}	NC	NC	NC	V_{SS}	V_{DDQ}	NC	DQPa
P	NC	A	A	A	TDI	A_1*	TDO	A	A	A	NC
R	$\overline{LBO}$	A	A	A	TMS	A_0*	TCK	A	A	A	A

Note : * A_0 and A_1 are the two least significant bits(LSB) of the address field and set the internal burst counter if burst is desired.

** Checked NoConnect(NC) pins are resered for higher density address, i.e. 11B for 128Mb and 1A for 256Mb.

PIN NAME

SYMBOL	PIN NAME	SYMBOL	PIN NAME
A	Address Inputs	V_{DD}	Power Supply
		V_{SS}	Ground
A_0,A_1	Burst Address Inputs		
$\overline{ADV}$	Address Advance/Load	N.C.	No Connect
$\overline{WE}$	Read/Write Control Input		
$\overline{CLK}$	Clock	DQa	Data Inputs/Outputs
$\overline{CKE}$	Clock Enable	DQb	Data Inputs/Outputs
$\overline{CS}_1$	Chip Select	DQc	Data Inputs/Outputs
CS_2	Chip Select	DQd	Data Inputs/Outputs
$\overline{CS}_2$	Chip Select	DQPa~Pd	Data Inputs/Outputs
$\overline{BW}$x	Byte Write Inputs		
(x=a,b,c,d)		V_{DDQ}	Output Power Supply
$\overline{OE}$	Output Enable		
$\overline{ZZ}$	Power Sleep Mode		
$\overline{LBO}$	Burst Mode Control		
TCK	JTAG Test Clock		
TMS	JTAG Test Mode Select		
TDI	JTAG Test Data Input		
TDO	JTAG Test Data Output		

165-PIN FBGA PACKAGE CONFIGURATIONS(TOP VIEW)

K7N641845M(4Mx18)

	1	2	3	4	5	6	7	8	9	10	11
A	NC**	A	$\overline{CS}$1	$\overline{BW}$b	NC	$\overline{CS}$2	$\overline{CKE}$	ADV	A	A	A
B	NC	A	CS2	NC	$\overline{BW}$a	CLK	$\overline{WE}$	$\overline{OE}$	A	A	NC**
C	NC	NC	V_{DDQ}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DDQ}	NC	DQPa
D	NC	DQb	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQa
E	NC	DQb	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQa
F	NC	DQb	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQa
G	NC	DQb	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	NC	DQa
H	NC	V_{DD}	NC	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	NC	NC	ZZ
J	DQb	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	NC
K	DQb	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	NC
L	DQb	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	NC
M	DQb	NC	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DDQ}	DQa	NC
N	DQPb	NC	V_{DDQ}	V_{SS}	NC	NC	NC	V_{SS}	V_{DDQ}	NC	NC
P	NC	A	A	A	TDI	A_1*	TDO	A	A	A	NC
R	$\overline{LBO}$	A	A	A	TMS	A_0*	TCK	A	A	A	A

Note : * A_0 and A_1 are the two least significant bits(LSB) of the address field and set the internal burst counter if burst is desired.

** Checked NoConnect(NC) pins are resered for higher density address, i.e. 11B for 128Mb and 1A for 256Mb.

PIN NAME

SYMBOL	PIN NAME	SYMBOL	PIN NAME
A	Address Inputs	V_{DD}	Power Supply
		V_{SS}	Ground
A_0,A_1	Burst Address Inputs		
$\overline{ADV}$	Address Advance/Load	N.C.	No Connect
$\overline{WE}$	Read/Write Control Input		
$\overline{CLK}$	Clock		
$\overline{CKE}$	Clock Enable	DQa	Data Inputs/Outputs
$\overline{CS}_1$	Chip Select	DQb	Data Inputs/Outputs
CS_2	Chip Select	DQPa, Pb	Data Inputs/Outputs
$\overline{CS}_2$	Chip Select		
$\overline{BW}$x (x=a,b)	Byte Write Inputs	V_{DDQ}	Output Power Supply
$\overline{OE}$	Output Enable		
$\overline{ZZ}$	Power Sleep Mode		
$\overline{LBO}$	Burst Mode Control		
TCK	JTAG Test Clock		
TMS	JTAG Test Mode Select		
TDI	JTAG Test Data Input		
TDO	JTAG Test Data Output		

FUNCTION DESCRIPTION

The K7N643645M and K7N641845M are N*t*RAM™ designed to sustain 100% bus bandwidth by eliminating turnaround cycle when there is transition from Read to Write, or vice versa.
All inputs (with the exception of $\overline{OE}$, $\overline{LBO}$ and ZZ) are synchronized to rising clock edges.

All read, write and deselect cycles are initiated by the ADV input. Subsequent burst addresses can be internally generated by the burst advance pin (ADV). ADV should be driven to Low once the device has been deselected in order to load a new address for next operation.

Clock Enable($\overline{CKE}$) pin allows the operation of the chip to be suspended as long as necessary. When $\overline{CKE}$ is high, all synchronous inputs are ignored and the internal device registers will hold their previous values.

N*t*RAM™ latches external address and initiates a cycle, when $\overline{CKE}$, ADV are driven to low and all three chip enables($\overline{CS_1}$, CS_2, $\overline{CS_2}$) are active .
Output Enable($\overline{OE}$) can be used to disable the output at any given time.

Read operation is initiated when at the rising edge of the clock, the address presented to the address inputs are latched in the address register, $\overline{CKE}$ is driven low, all three chip enables($\overline{CS_1}$, CS_2, $\overline{CS_2}$) are active, the write enable input signals $\overline{WE}$ are driven high, and ADV driven low.The internal array is read between the first rising edge and the second rising edge of the clock and the data is latched in the output register. At the second clock edge the data is driven out of the SRAM. Also during read operation $\overline{OE}$ must be driven low for the device to drive out the requested data.

Write operation occurs when $\overline{WE}$ is driven low at the rising edge of the clock. $\overline{BW}$[d:a] can be used for byte write operation. The pipe-lined N*t*RAM™ uses a late-late write cycle to utilize 100% of the bandwidth.
At the first rising edge of the clock, $\overline{WE}$ and address are registered, and the data associated with that address is required two cycle later.

Subsequent addresses are generated by ADV High for the burst access as shown below. The starting point of the burst seguence is provided by the external address. The burst address counter wraps around to its initial state upon completion.
The burst sequence is determined by the state of the $\overline{LBO}$ pin. When this pin is low, linear burst sequence is selected.
And when this pin is high, Interleaved burst sequence is selected.

During normal operation, ZZ must be driven low. When ZZ is driven high, the SRAM will enter a Power Sleep Mode after 2 cycles. At this time, internal state of the SRAM is preserved. When ZZ returns to low, the SRAM normally operates after 2 cycles of wake up time.

BURST SEQUENCE TABLE

(Interleaved Burst, $\overline{LBO}$=High)

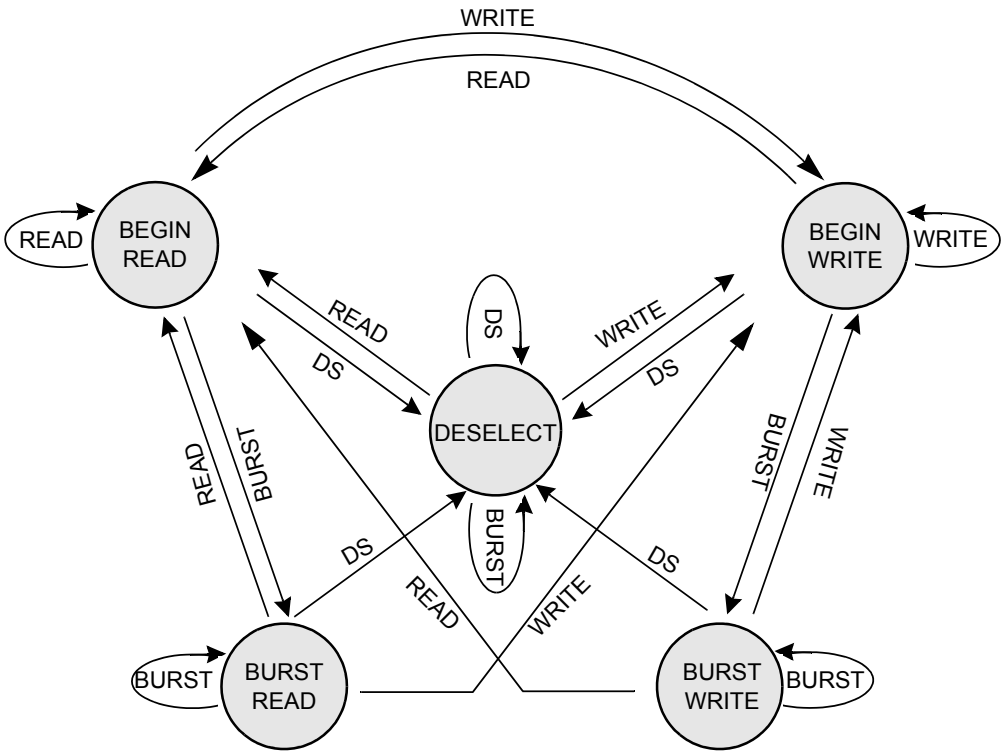
$\overline{LBO}$ PIN	HIGH	Case 1		Case 2		Case 3		Case 4	
		A_1	A_0	A_1	A_0	A_1	A_0	A_1	A_0
First Address		0	0	0	1	1	0	1	1
↓		0	1	0	0	1	1	1	0
↓		1	0	1	1	0	0	0	1
Fourth Address		1	1	1	0	0	1	0	0

(Linear Burst, $\overline{LBO}$=Low)

$\overline{LBO}$ PIN	LOW	Case 1		Case 2		Case 3		Case 4	
		A_1	A_0	A_1	A_0	A_1	A_0	A_1	A_0
First Address		0	0	0	1	1	0	1	1
↓		0	1	1	0	1	1	0	0
↓		1	0	1	1	0	0	0	1
Fourth Address		1	1	0	0	0	1	1	0

Note : 1. $\overline{LBO}$ pin must be tied to High or Low, and Floating State must not be allowed.

STATE DIAGRAM FOR NtRAM™



COMMAND	ACTION
DS	DESELECT
READ	BEGIN READ
WRITE	BEGIN WRITE
BURST	BEGIN READ BEGIN WRITE CONTINUE DESELECT

Notes : 1. An IGNORE CLOCK EDGE cycle is not shown is the above diagram. This is because CKE HIGH only blocks the clock(CLK) input and does not change the state of the device.
2. States change on the rising edge of the clock(CLK)

TRUTH TABLES

SYNCHRONOUS TRUTH TABLE

$\overline{CS_1}$	CS_2	$\overline{CS_2}$	ADV	$\overline{WE}$	$\overline{BWx}$	$\overline{OE}$	$\overline{CKE}$	CLK	ADDRESS ACCESSED	OPERATION
H	X	X	L	X	X	X	L	↑	N/A	Not Selected
X	L	X	L	X	X	X	L	↑	N/A	Not Selected
X	X	H	L	X	X	X	L	↑	N/A	Not Selected
X	X	X	H	X	X	X	L	↑	N/A	Not Selected Continue
L	H	L	L	H	X	L	L	↑	External Address	Begin Burst Read Cycle
X	X	X	H	X	X	L	L	↑	Next Address	Continue Burst Read Cycle
L	H	L	L	H	X	H	L	↑	External Address	NOP/Dummy Read
X	X	X	H	X	X	H	L	↑	Next Address	Dummy Read
L	H	L	L	L	L	X	L	↑	External Address	Begin Burst Write Cycle
X	X	X	H	X	L	X	L	↑	Next Address	Continue Burst Write Cycle
L	H	L	L	L	H	X	L	↑	N/A	NOP/Write Abort
X	X	X	H	X	H	X	L	↑	Next Address	Write Abort
X	X	X	X	X	X	X	H	↑	Current Address	Ignore Clock

Notes : 1. X means "Don't Care".

2. The rising edge of clock is symbolized by (↑).
3. A continue deselect cycle can only be enterd if a deselect cycle is executed first.
4. $\overline{WRITE}$ = L means Write operation in WRITE TRUTH TABLE.
   $\overline{WRITE}$ = H means Read operation in WRITE TRUTH TABLE.
5. Operation finally depends on status of asynchronous input pins(ZZ and $\overline{OE}$).

WRITE TRUTH TABLE(x36)

$\overline{WE}$	$\overline{BWa}$	$\overline{BWb}$	$\overline{BWc}$	$\overline{BWd}$	OPERATION
H	X	X	X	X	READ
L	L	H	H	H	WRITE BYTE a
L	H	L	H	H	WRITE BYTE b
L	H	H	L	H	WRITE BYTE c
L	H	H	H	L	WRITE BYTE d
L	L	L	L	L	WRITE ALL BYTEs
L	H	H	H	H	WRITE ABORT/NOP

Notes : 1. X means "Don't Care".

2. All inputs in this table must meet setup and hold time around the rising edge of CLK(↑).

WRITE TRUTH TABLE(x18)

$\overline{WE}$	$\overline{BWa}$	$\overline{BWb}$	OPERATION
H	X	X	READ
L	L	H	WRITE BYTE a
L	H	L	WRITE BYTE b
L	L	L	WRITE ALL BYTEs
L	H	H	WRITE ABORT/NOP

Notes : 1. X means "Don't Care".

2. All inputs in this table must meet setup and hold time around the rising edge of CLK(↑).

ASYNCHRONOUS TRUTH TABLE

OPERATION	ZZ	$\overline{OE}$	I/O STATUS
Sleep Mode	H	X	High-Z
Read	L	L	DQ
	L	H	High-Z
Write	L	X	Din, High-Z
Deselected	L	X	High-Z

Notes

1. X means "Don't Care".
2. Sleep Mode means power Sleep Mode of which stand-by current does not depend on cycle time.
3. Deselected means power Sleep Mode of which stand-by current depends on cycle time.

ABSOLUTE MAXIMUM RATINGS*

PARAMETER	SYMBOL	RATING	UNIT
Voltage on V_{DD} Supply Relative to V_{SS}	V_{DD}	-0.3 to 3.6	V
Voltage on Any Other Pin Relative to V_{SS}	V_{IN}	-0.3 to V_{DD}+0.3	V
Power Dissipation	P_D	1.6	W
Storage Temperature	T_{STG}	-65 to 150	°C
Operating Temperature	T_{OPR}	0 to 70	°C
Storage Temperature Range Under Bias	T_{BIAS}	-10 to 85	°C

***Note** : 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.

OPERATING CONDITIONS($0°C \le T_A \le 70°C$)

PARAMETER	SYMBOL	MIN	Typ.	MAX	UNIT
Supply Voltage	V_{DD}	2.375	2.5	2.625	V
	V_{DDQ}	2.375	2.5	2.625	V
Ground	V_{SS}	0	0	0	V

***Note** : V_{DD} and V_{DDQ} must be supplied with identical vlotage levels.

CAPACITANCE*(T_A=25°C, f=1MHz)

PARAMETER	SYMBOL	TEST CONDITION	TYP	MAX	UNIT
Input Capacitance	C_{IN}	V_{IN}=0V	-	TBD	pF
Output Capacitance	C_{OUT}	V_{OUT}=0V	-	TBD	pF

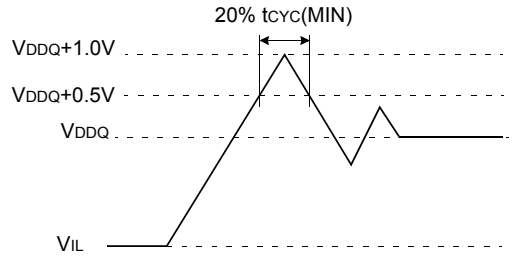
***Note** : Sampled not 100% tested.

DC ELECTRICAL CHARACTERISTICS(V_{DD}=2.5V ±5%, T_A=0°C to +70°C)

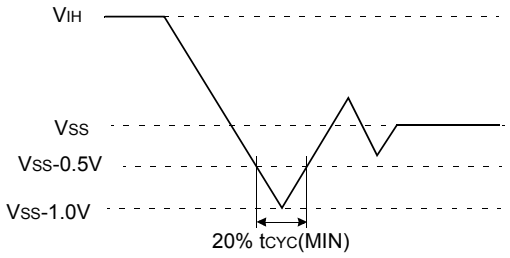
PARAMETER	SYMBOL	TEST CONDITIONS		MIN	MAX	UNIT	NOTES
Input Leakage Current(except ZZ)	I_{IL}	V_{DD}=Max ; V_{IN}=V_{SS} to V_{DD}		-2	+2	µA	
Output Leakage Current	I_{OL}	Output Disabled,		-2	+2	µA	
Operating Current	I_{CC}	V_{DD}=Max I_{OUT}=0mA Cycle Time ≥ t_{CYC} Min	-25	-	470	mA	1,2
			-16	-	350		
Standby Current	I_{SB}	Device deselected, I_{OUT}=0mA, ZZ≤V_{IL}, f=Max, All Inputs≤0.2V or ≥ V_{DD}-0.2V	-25	-	200	mA	
			-16	-	200		
	I_{SB1}	Device deselected, I_{OUT}=0mA, ZZ≤0.2V, f=0, All Inputs=fixed (V_{DD}-0.2V or 0.2V)		-	170	mA	
	I_{SB2}	Device deselected, I_{OUT}=0mA, ZZ≥V_{DD}-0.2V, f=Max, All Inputs≤V_{IL} or ≥V_{IH}		-	170	mA	
Output Low Voltage	V_{OL}	I_{OL}=1.0mA		-	0.4	V	
Output High Voltage	V_{OH}	I_{OH}=-1.0mA		2.0	-	V	
Input Low Voltage	V_{IL}			-0.3*	0.7	V	
Input High Voltage	V_{IH}			1.7	V_{DD}+0.3**	V	3

Notes : 1. Reference AC Operating Conditions and Characteristics for input and timing.
2. Data states are all zero.
3. In Case of I/O Pins, the Max. V_{IH}=V_{DDQ}+0.3V

Overshoot Timing



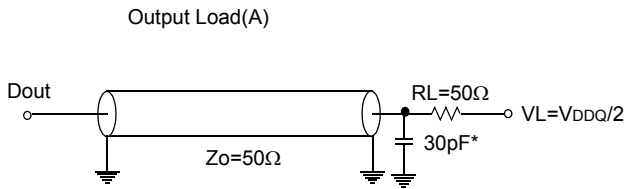
Undershoot Timing

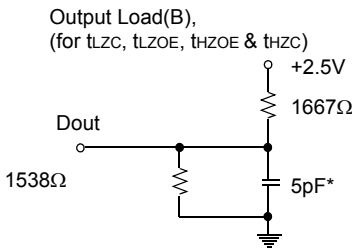


TEST CONDITIONS

(T_A=0 to 70°C, V_{DD}=2.5V ±5%, unless otherwise specified)

PARAMETER	VALUE
Input Pulse Level	0 to 2.5V
Input Rise and Fall Time(Measured at 20% to 80%)	1.0V/ns
Input and Output Timing Reference Levels	V_{DDQ}/2
Output Load	See Fig. 1





* Including Scope and Jig Capacitance

Fig. 1

SAMSUNG ELECTRONICS

AC TIMING CHARACTERISTICS

(V_{DD}=2.5V ±5%, T_A=0 to 70°C)

PARAMETER	SYMBOL	-25		-16		UNIT
		MIN	MAX	MIN	MAX	
Cycle Time	t_{CYC}	4.0	-	6.0	-	ns
Clock Access Time	t_{CD}	-	2.6	-	3.5	ns
Output Enable to Data Valid	t_{OE}	-	2.6	-	3.5	ns
Clock High to Output Low-Z	t_{LZC}	1.5	-	1.5	-	ns
Output Hold from Clock High	t_{OH}	1.5	-	1.5	-	ns
Output Enable Low to Output Low-Z	t_{LZOE}	0	-	0	-	ns
Output Enable High to Output High-Z	t_{HZOE}	-	2.6	-	3.0	ns
Clock High to Output High-Z	t_{HZC}	-	2.6	-	3.0	ns
Clock High Pulse Width	t_{CH}	1.7	-	2.2	-	ns
Clock Low Pulse Width	t_{CL}	1.7	-	2.2	-	ns
Address Setup to Clock High	t_{AS}	1.2	-	1.5	-	ns
$\overline{CKE}$ Setup to Clock High	t_{CES}	1.2	-	1.5	-	ns
Data Setup to Clock High	t_{DS}	1.2	-	1.5	-	ns
Write Setup to Clock High ($\overline{WE}$, $\overline{BW}$x)	t_{WS}	1.2	-	1.5	-	ns
Address Advance Setup to Clock High	t_{ADVS}	1.2	-	1.5	-	ns
Chip Select Setup to Clock High	t_{CSS}	1.2	-	1.5	-	ns
Address Hold from Clock High	t_{AH}	0.3	-	0.5	-	ns
$\overline{CKE}$ Hold from Clock High	t_{CEH}	0.3	-	0.5	-	ns
Data Hold from Clock High	t_{DH}	0.3	-	0.5	-	ns
Write Hold from Clock High ($\overline{WE}$, $\overline{BW}$x)	t_{WH}	0.3	-	0.5	-	ns
Address Advance Hold from Clock High	t_{ADVH}	0.3	-	0.5	-	ns
Chip Select Hold from Clock High	t_{CSH}	0.3	-	0.5	-	ns
ZZ High to Power Down	t_{PDS}	2	-	2	-	cycle
ZZ Low to Power Up	t_{PUS}	2	-	2	-	cycle

Notes : 1. All address inputs must meet the specified setup and hold times for all rising clock(CLK) edges when ADV is sampled low and $\overline{CS}$ is sampled low. All other synchronous inputs must meet the specified setup and hold times whenever this device is chip selected.

2. Chip selects must be valid at each rising edge of CLK(when ADV is Low) to remain enabled.

3. A write cycle is defined by $\overline{WE}$ low having been registered into the device at ADV Low, A Read cycle is defined by $\overline{WE}$ High with ADV Low, Both cases must meet setup and hold times.

4. To avoid bus contention, At a given voltage and temperature t_{LZC} is more than t_{HZC}. The specs as shown do not imply bus contention because t_{LZC} is a Min. parameter that is worst case at totally different test conditions (0°C,2.625V) than t_{HZC}, which is a Max. parameter(worst case at 70°C,2.375V) It is not possible for two SRAMs on the same board to be at such different voltage and temperature.

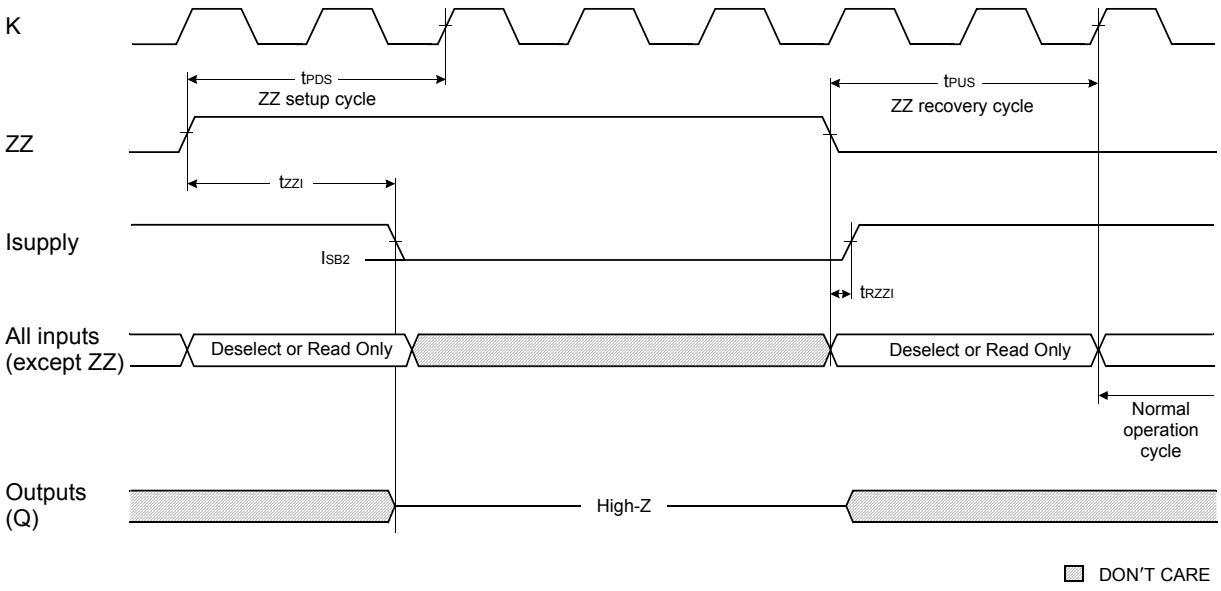
SLEEP MODE

SLEEP MODE is a low current, power-down mode in which the device is deselected and current is reduced to I_{SB2}. The duration of SLEEP MODE is dictated by the length of time the ZZ is in a High state.
After entering SLEEP MODE, all inputs except ZZ become disabled and all outputs go to High-Z
The ZZ pin is an asynchronous, active high input that causes the device to enter SLEEP MODE.
When the ZZ pin becomes a logic High, I_{SB2} is guaranteed after the time t_{ZZI} is met. Any operation pending when entering SLEEP MODE is not guaranteed to successful complete. Therefore, SLEEP MODE (READ or WRITE) must not be initiated until valid pending operations are completed. similarly, when exiting SLEEP MODE during t_{PUS}, only a DESELECT or READ cycle should be given while the SRAM is transitioning out of SLEEP MODE.

SLEEP MODE ELECTRICAL CHARACTERISTICS

DESCRIPTION	CONDITIONS	SYMBOL	MIN	MAX	UNITS
Current during SLEEP MODE	ZZ ≥ V_{IH}	I_{SB2}		170	mA
ZZ active to input ignored		t_{PDS}	2		cycle
ZZ inactive to input sampled		t_{PUS}	2		cycle
ZZ active to SLEEP current		t_{ZZI}		2	cycle
ZZ inactive to exit SLEEP current		t_{RZZI}	0		

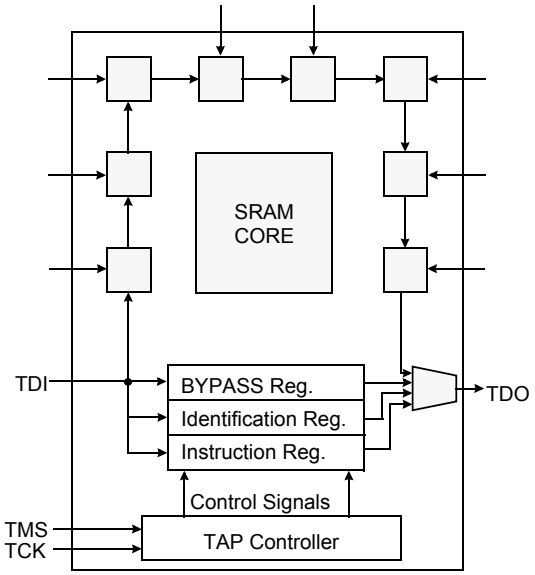
SLEEP MODE WAVEFORM



IEEE 1149.1 TEST ACCESS PORT AND BOUNDARY SCAN-JTAG

This part contains an IEEE standard 1149.1 Compatible Test Access Port(TAP). The package pads are monitored by the Serial Scan circuitry when in test mode. This is to support connectivity testing during manufacturing and system diagnostics. Internal data is not driven out of the 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_{SS} 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 may be left unconnected. But they may also be tied to V_{DD} through a resistor. TDO should be left unconnected.

JTAG Block Diagram



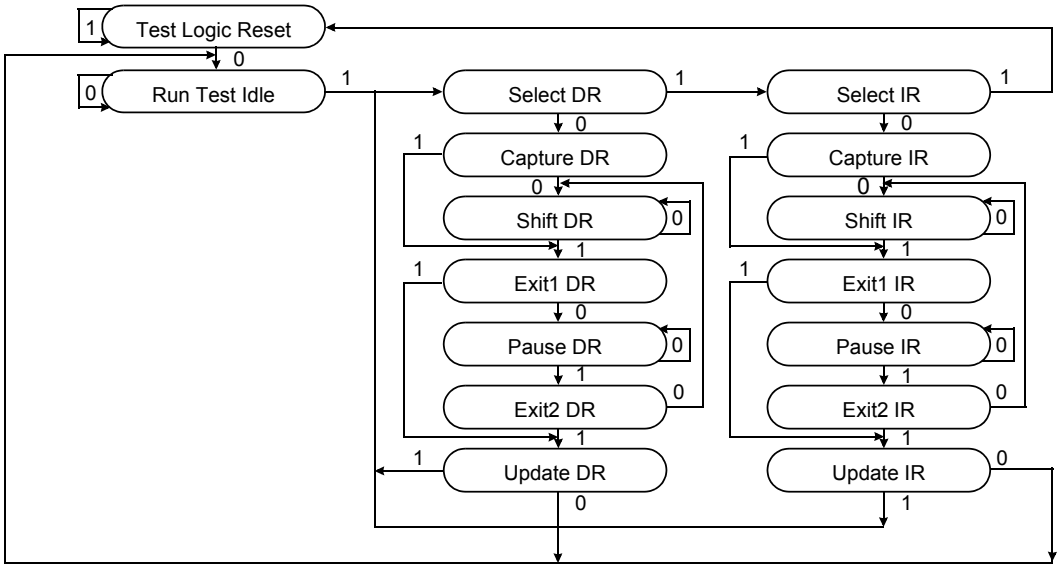
JTAG Instruction Coding

IR2	IR1	IR0	Instruction	TDO Output	Notes
0	0	0	EXTEST	Boundary Scan Register	1
0	0	1	IDCODE	Identification Register	3
0	1	0	SAMPLE-Z	Boundary Scan Register	2
0	1	1	BYPASS	Bypass Register	4
1	0	0	SAMPLE	Boundary Scan Register	5
1	0	1	RESERVED	Do Not Use	6
1	1	0	BYPASS	Bypass Register	4
1	1	1	BYPASS	Bypass Register	4

NOTE :

1. Places DQs in Hi-Z in order to sample all input data regardless of other SRAM inputs. This instruction is not IEEE 1149.1 compliant.
2. Places DQs in Hi-Z in order to sample all input data regardless of other SRAM inputs.
3. TDI is sampled as an input to the first ID register to allow for the serial shift of the external TDI data.
4. Bypass register is initiated to V_{SS} when BYPASS instruction is invoked. The Bypass Register also holds serially loaded TDI when exiting the Shift DR states.
5. SAMPLE instruction dose not places DQs in Hi-Z.
6. This instruction is reserved for future use.

TAP Controller State Diagram



SCAN INFORMATION (165 FBGA)

SCAN REGISTER DEFINITION

Part	Instruction Register	Bypass Register	ID Register	Boundary Scan
2Mx36	3 bits	1 bits	32 bits	89 bits
4Mx18	3 bits	1 bits	32 bits	89 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)
2Mx36	0000	01001 00100	XXXXXX	00001001110	1
4Mx18	0000	01010 00011	XXXXXX	00001001110	1

BOUNDARY SCAN EXIT ORDER

BIT	PIN ID	BIT	PIN ID
1	6N	40	8A
2	7N	41	8B
3	10N	42	7A
4	11P	43	7B
5	8P	44	6B
6	8R	45	6A
7	9R	46	5B
8	9P	47	5A
9	10P	48	4A
10	10R	49	4B
11	11R	50	3B
12	11H	51	3A
13	11N	52	2A
14	11M	53	2B
15	11L	54	2C
16	11K	55	1B
17	11J	56	1A
18	10M	57	1C
19	10L	58	1D
20	10K	59	1E
21	10J	60	1F
22	9H	61	1G
23	10H	62	2D
24	11G	63	2E
25	11F	64	2F
26	11E	65	2G
27	11D	66	1H
28	10G	67	3H
29	10F	68	1J
30	10E	69	1K
31	10D	70	1L
32	11C	71	1M
33	11A	72	2J
34	11B	73	2K
35	10A	74	2L
36	10B	75	2M
37	9A	76	1N
38	9B	77	2N
39	10C	78	1P

BIT	PIN ID	BIT	PIN ID
79	1R		
80	2R		
81	3P		
82	3R		
83	2P		
84	4R		
85	4P		
86	5N		
87	6P		
88	6R		
89	Internal		

Note: 1. NC and Vss pins included in the scan exit order are read as "X" (i.e. don't care).

JTAG DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	V_{DD}	2.375	2.5	2.625	V	
Input High Level	V_{IH}	1.7	-	V_{DD}+0.3	V	
Input Low Level	V_{IL}	-0.3	-	0.7	V	
Output High Voltage	V_{OH}	2.0	-	-	V	
Output Low Voltage	V_{OL}	-	-	0.4	V	

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

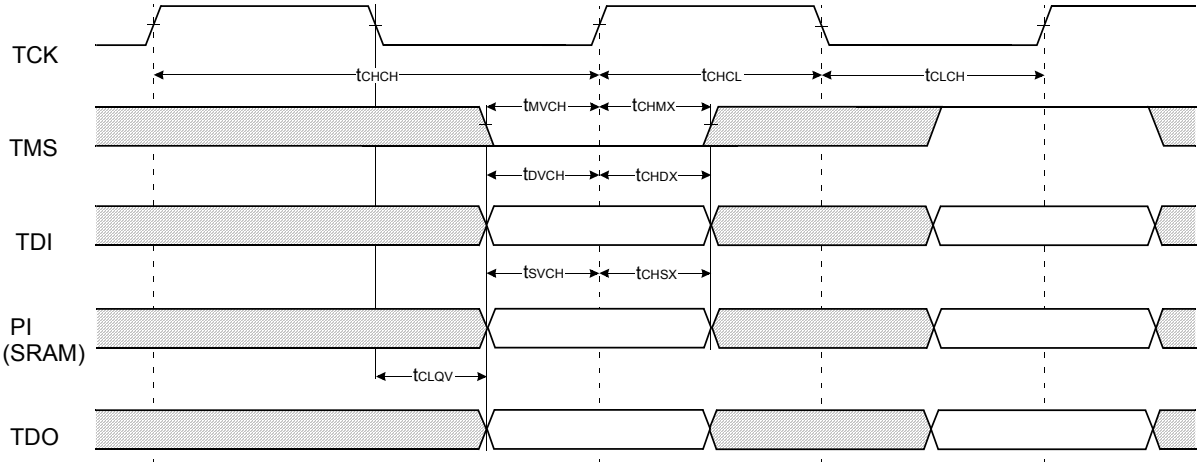
JTAG AC TEST CONDITIONS

Parameter	Symbol	Min	Unit	Note
Input High/Low Level	V_{IH}/V_{IL}	2.5/0	V	
Input Rise/Fall Time	TR/TF	1.0/1.0	ns	
Input and Output Timing Reference Level		$V_{DDQ}/2$	V	

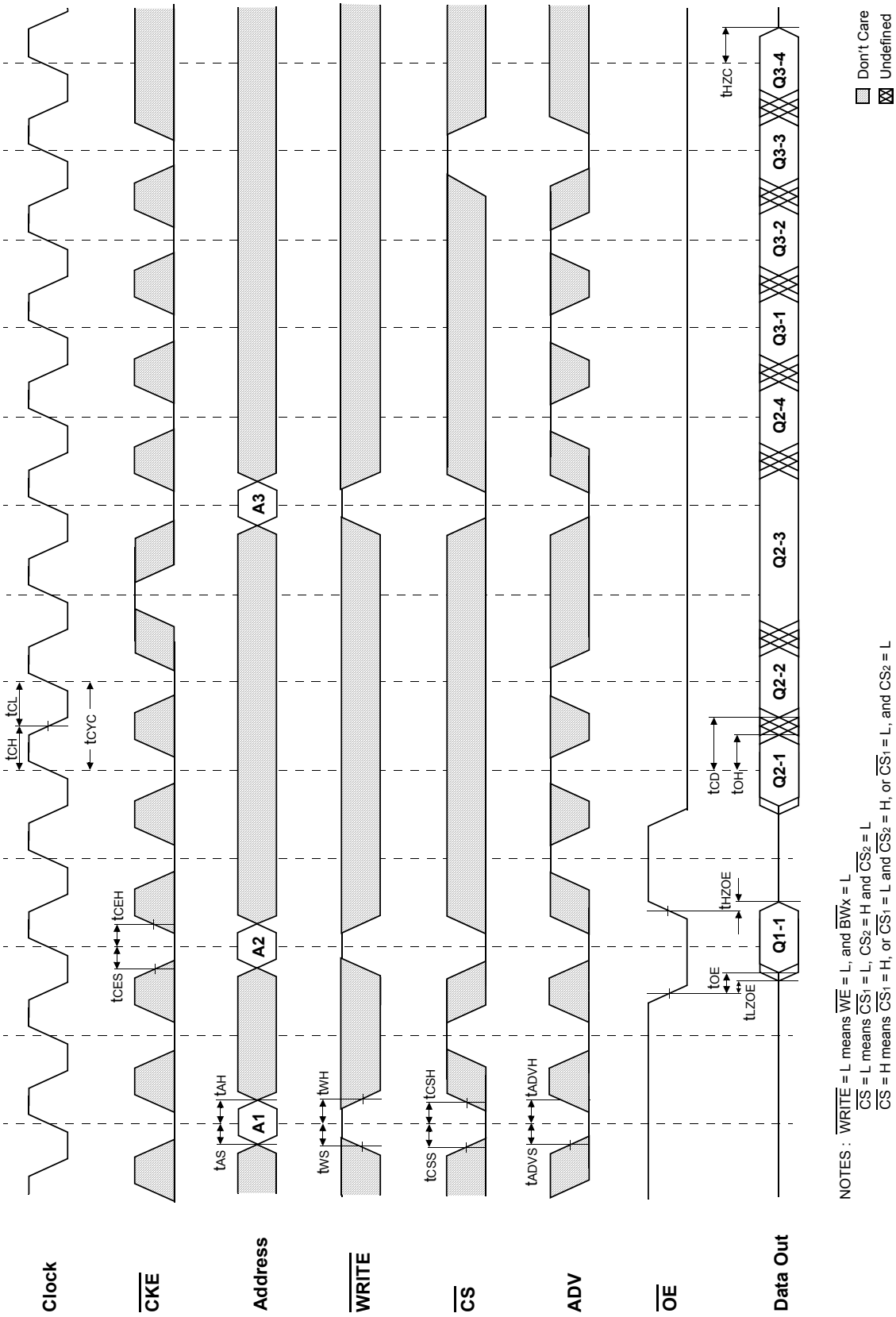
JTAG AC Characteristics

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

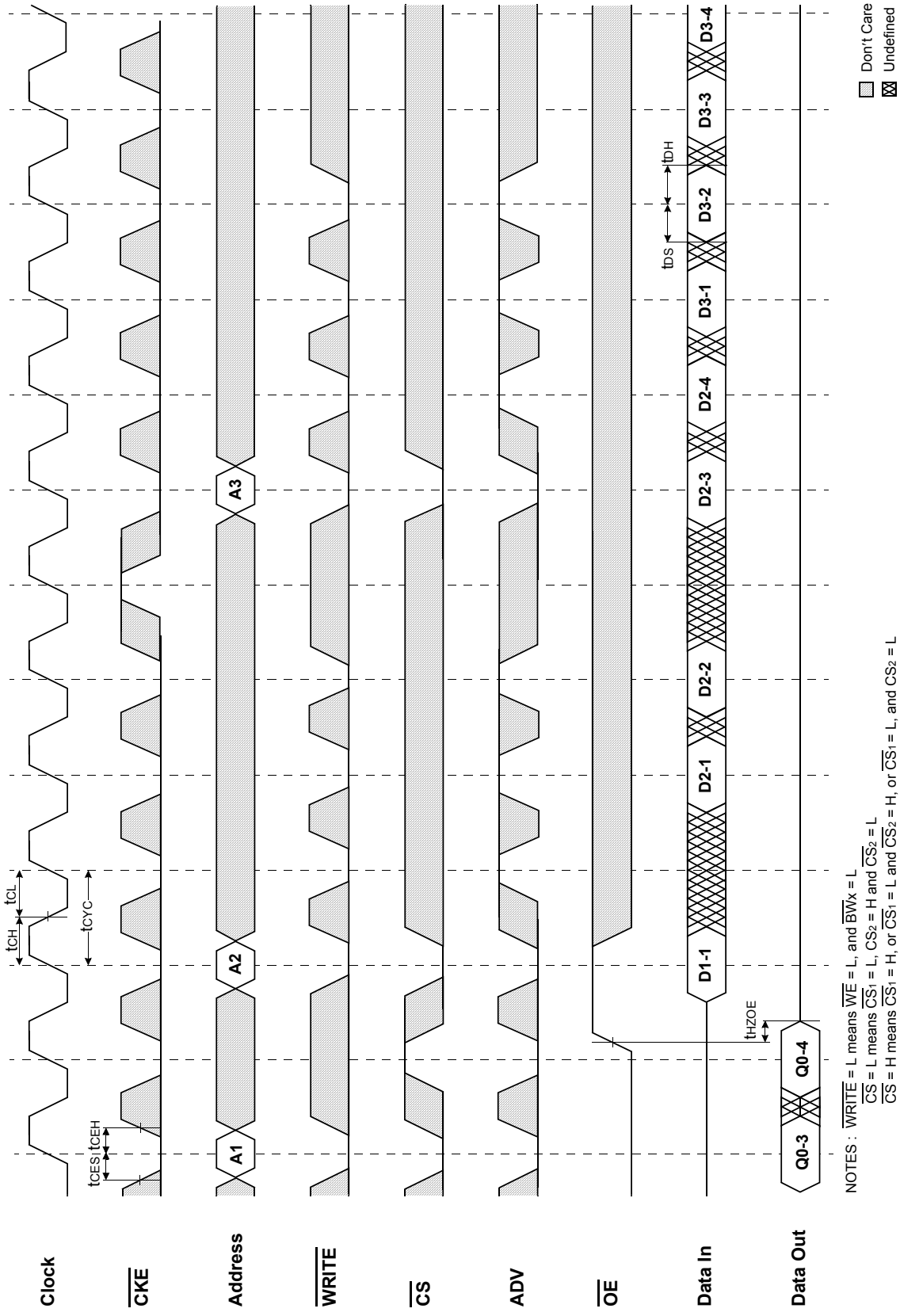
JTAG TIMING DIAGRAM



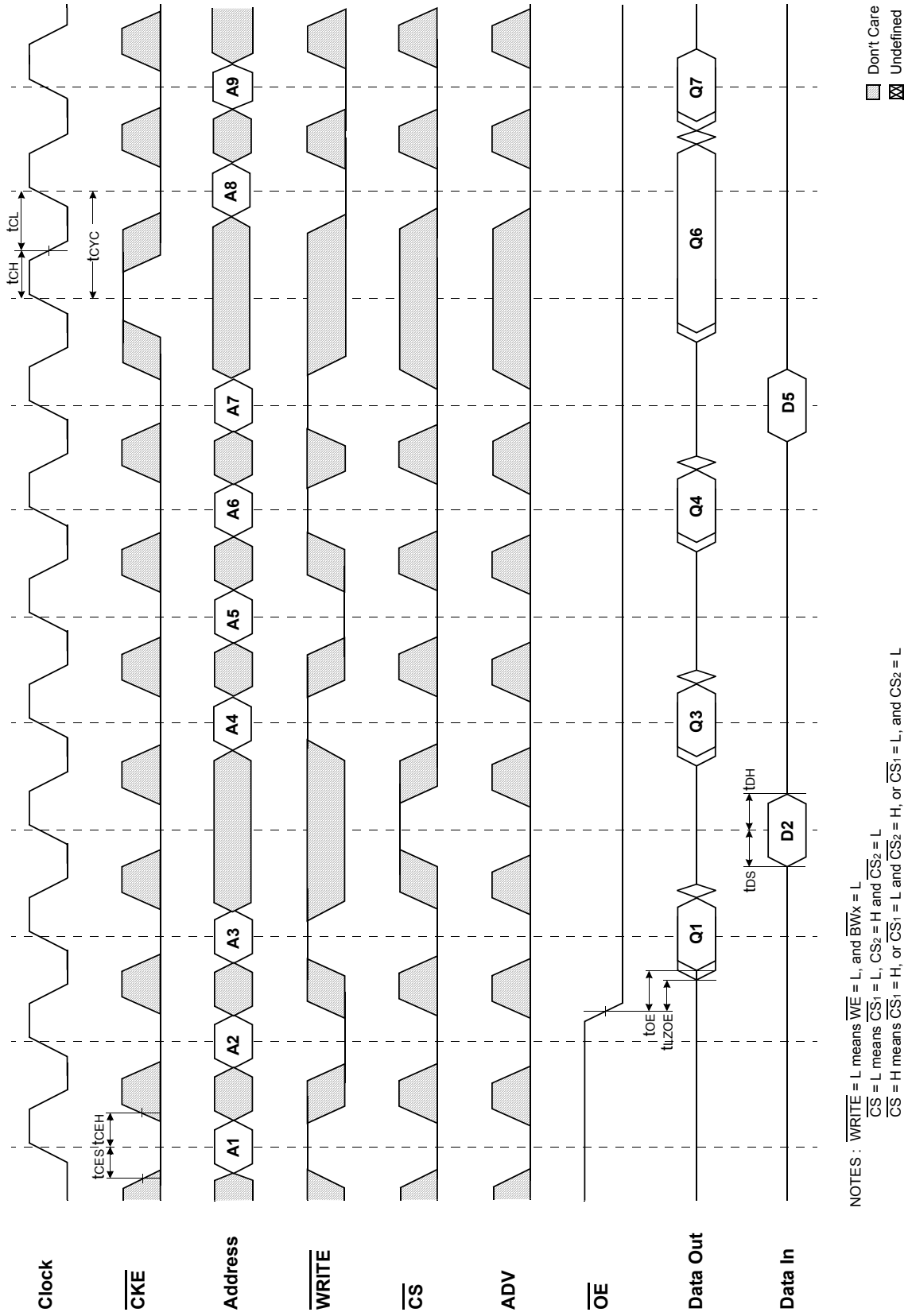
TIMING WAVEFORM OF READ CYCLE



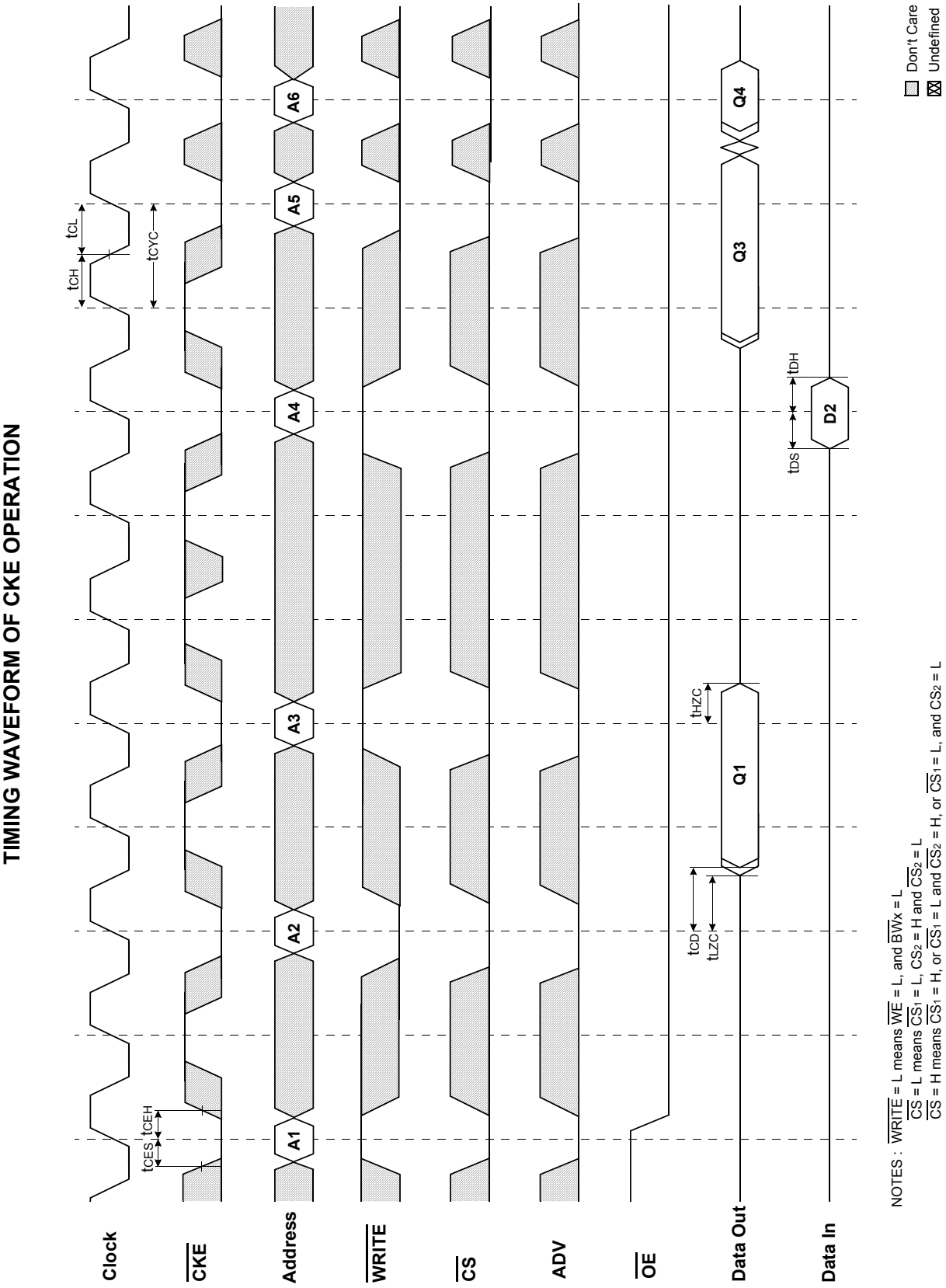
TIMING WAVEFORM OF WRTE CYCLE



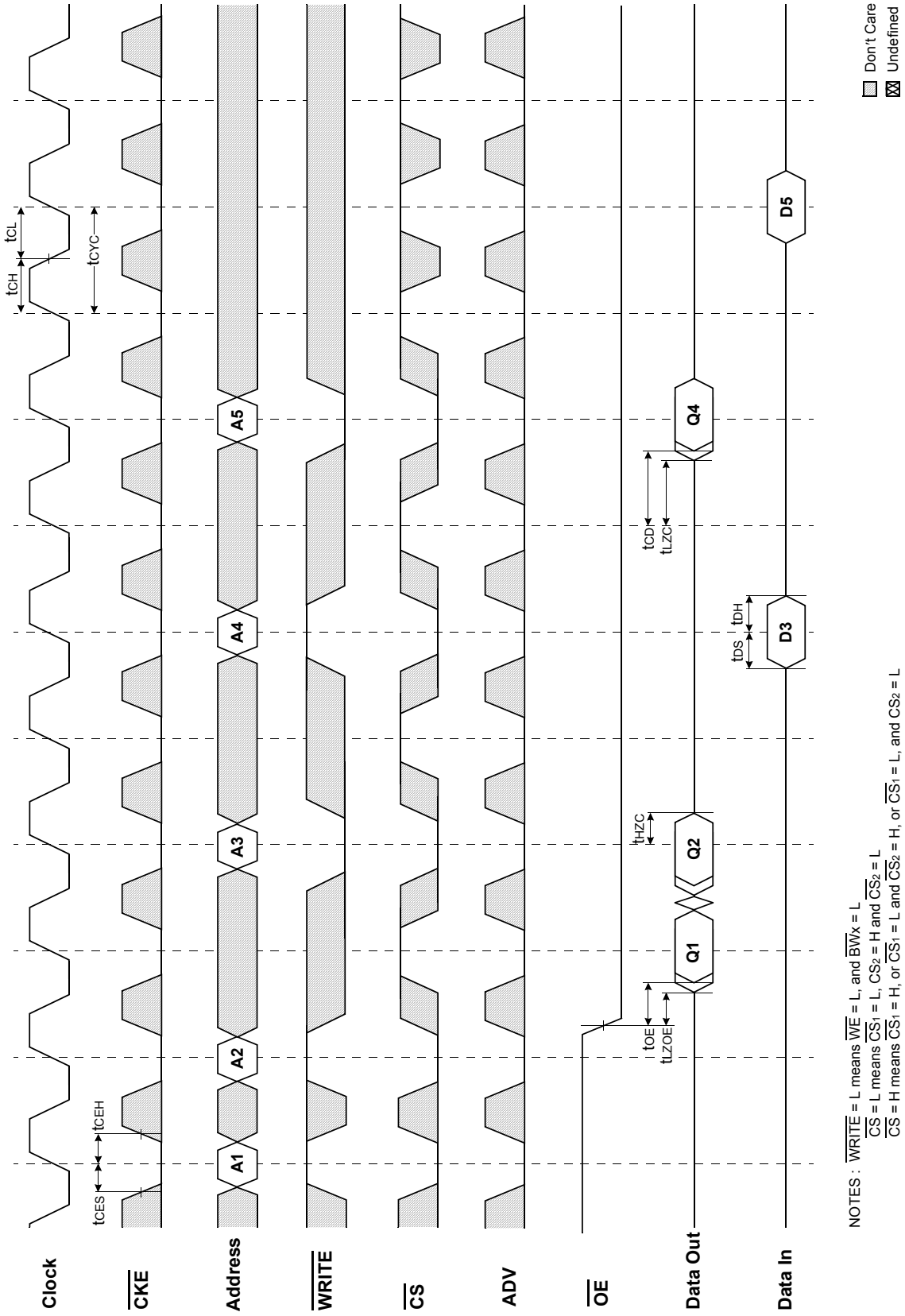
TIMING WAVEFORM OF SINGLE READ/WRITE



TIMING WAVEFORM OF $\overline{CKE}$ OPERATION



TIMING WAVEFORM OF $\overline{CS}$ OPERATION

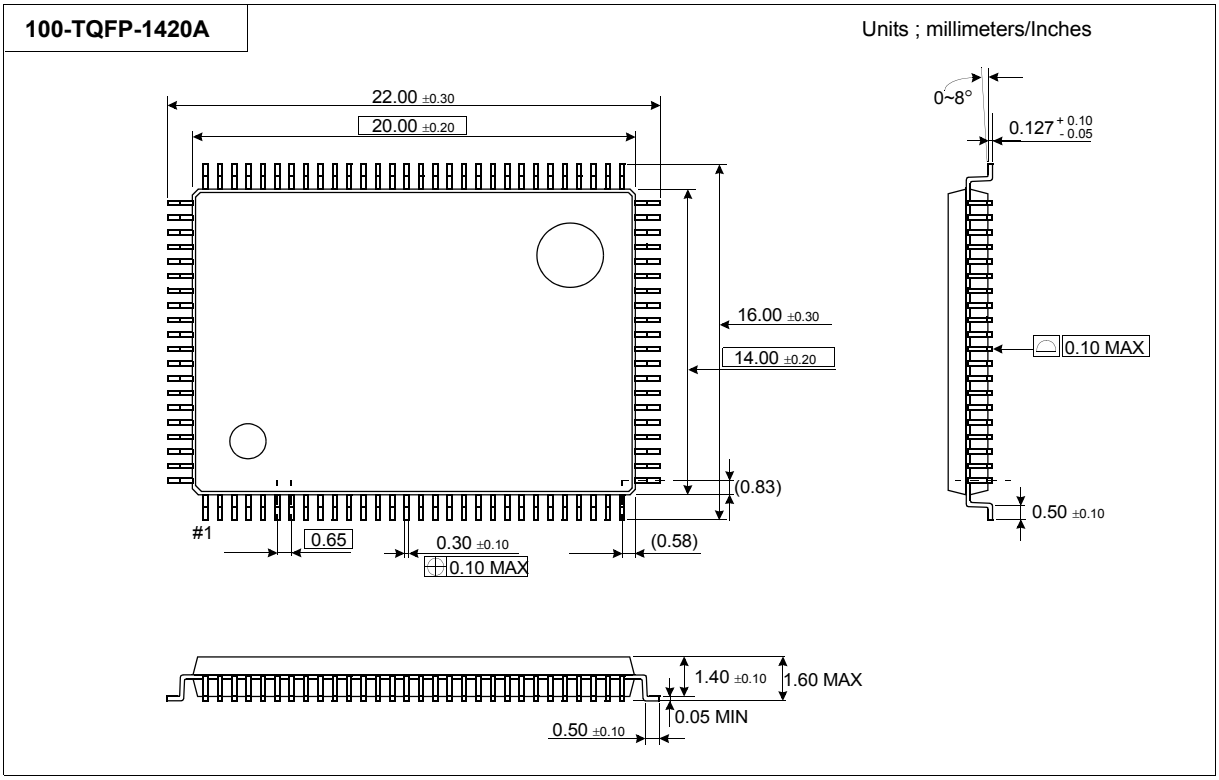


NOTES : $\overline{WRITE}$ = L means $\overline{WE}$ = L, and $\overline{BWx}$ = L
$\overline{CS}$ = L means $\overline{CS_1}$ = L, CS_2 = H and $\overline{CS_2}$ = L
$\overline{CS}$ = H means $\overline{CS_1}$ = H, or $\overline{CS_1}$ = L and $\overline{CS_2}$ = H, or $\overline{CS_1}$ = L, and CS_2 = L

PACKAGE DIMENSIONS

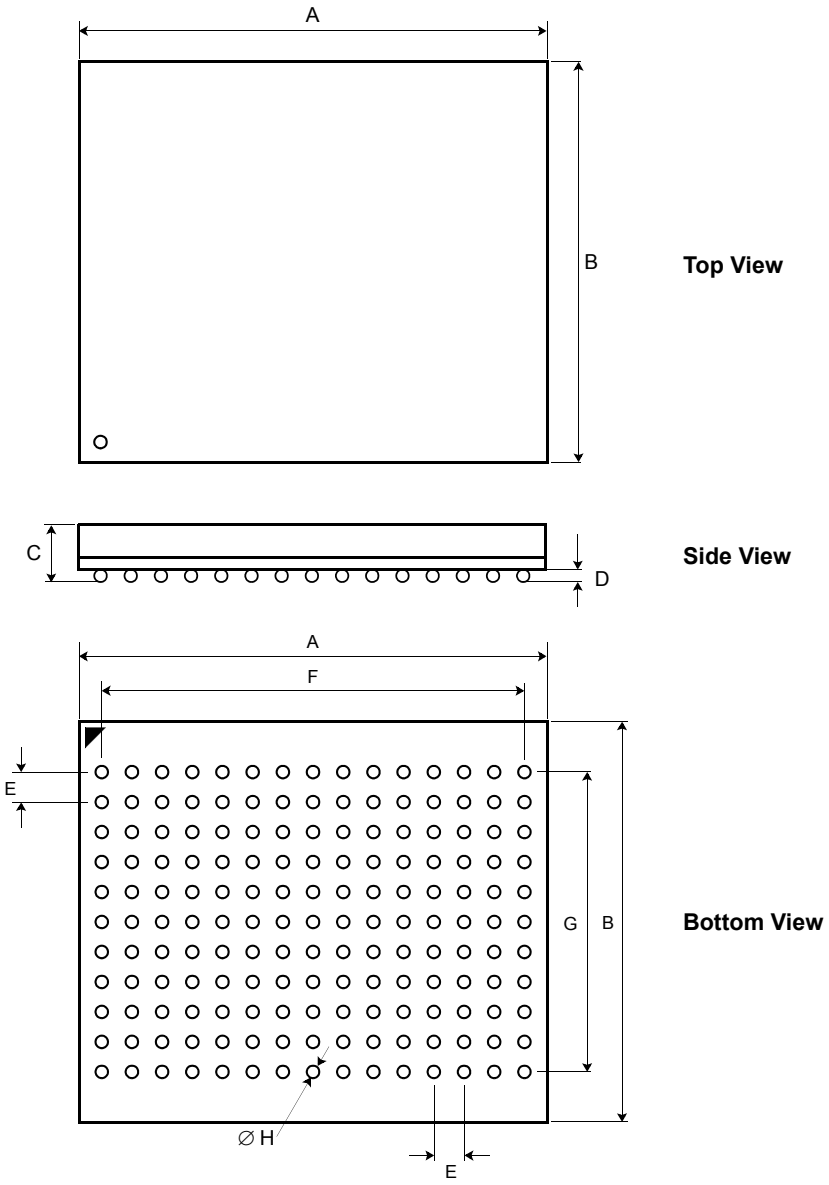
100-TQFP-1420A

Units ; millimeters/Inches



165 FBGA PACKAGE DIMENSIONS

15mm x 17mm Body, 1.0mm Bump Pitch, 11x15 Ball Array



Symbol	Value	Units	Note	Symbol	Value	Units	Note
A	17 ± 0.1	mm		**E**	1.0	mm	
B	15 ± 0.1	mm		**F**	14.0	mm	
C	1.3 ± 0.1	mm		**G**	10.0	mm	
D	0.35 ± 0.05	mm		**H**	0.50 ± 0.05	mm	