

Document Title

512Kx72 DLW(Double Late Write) RAM

Revision History

<u>Rev.No.</u>	<u>History</u>	<u>Draft</u>	<u>Date</u>	<u>Remark</u>
0.0	1. Initial document.		Aug. 29. 2001	Preliminary
0.1	1. Device name change from Double Late Write SigmaRAM to Double Late Write RAM		Dec. 17. 2001	Preliminary

The attached data sheets are prepared and approved by SAMSUNG Electronics. SAMSUNG Electronics CO., LTD. reserve the right to change the specifications. SAMSUNG Electronics will evaluate and reply to your requests and questions on the parameters of this device. If you have any questions, please contact the SAMSUNG branch office near your office, call or contact Headquarters.

K7Z327285M

512Kx72 (DLW) Double Late Write RAM

32Mb NtRAM(Flow Through / Pipelined) , Double Late Write RAM x72 Ordering Information

Org.	Part Number	Mode	VDD	Speed FT ; Access Time(ns) Pipelined ; Cycle Time(MHz)	PKG	Temp
2Mx18	K7M321825M-Q(H/F)C65/75/85	FlowThrough	3.3	6.5/7.5/8.5ns	Q:100TQFP H:119BGA F:165FBGA	C (Commercial Temperature Range)
	K7N321801M-Q(H/F)C25/22/20/16/15/13	Pipelined	3.3	250/225/200/167/150/133MHz		
	K7N321845M-Q(H/F)C25/22/20/16/15/13	Pipelined	2.5	250/225/200/167/150/133MHz		
1Mx36	K7M323625M-Q(H/F)C65/75/85	FlowThrough	3.3	6.5/7.5/8.5ns	H : 209BGA	
	K7N323601M-Q(H/F)C25/22/20/16/15/13	Pipelined	3.3	250/225/200/167/150/133MHz		
	K7N323645M-Q(H/F)C25/22/20/16/15/13	Pipelined	2.5	250/225/200/167/150/133MHz		
512Kx72	K7N327245M-HC25/22/20/16/15/13	Pipelined (Normal Type)	2.5	250/225/200/167/150/133MHz	H : 209BGA	
	K7Z327285M-HC27/25	Pipelined (Sigma Type)	1.8	275/250MHz		

K7Z327285M

512Kx72 (DLW) Double Late Write RAM

512Kx72-Bit DLW(Double Late Write) RAM

FEATURES

- Double Late Write mode , Pipelined Read mode.
- Compatible with Double Late Write Sigma RAM™ x72.
- 1.8V+150/-100 mV Power Supply.
- 1.8V I/O supply.
- Byte Writable Function.
- Single READ/WRITE control pin.
- Self-Timed Write Cycle.
- Complement echo clock outputs
- Selectable impedance output buffer(ZQ)
- 2 User programmable chip enable inputs for easy depth expansion.(EP2, EP3)
- Supports linear burst mode only.
- Slow Down Function.
- IEEE 1149.1 JTAG Compatible Boundary Scan
- 209 bump, 14mm x 22mm, 1mm bump pitch BGA package
- 209BGA(11x19 Ball Grid Array Package).

GENERAL DESCRIPTION

The K7Z327285M is 37,748,736-bits Synchronous Static SRAMs. The double late write RAM utilizes all the bandwidth in any combination of operating cycles.

Address, data inputs, and all control signals except EP2, EP3, and $\overline{SD}$ are synchronized to input clock.

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.

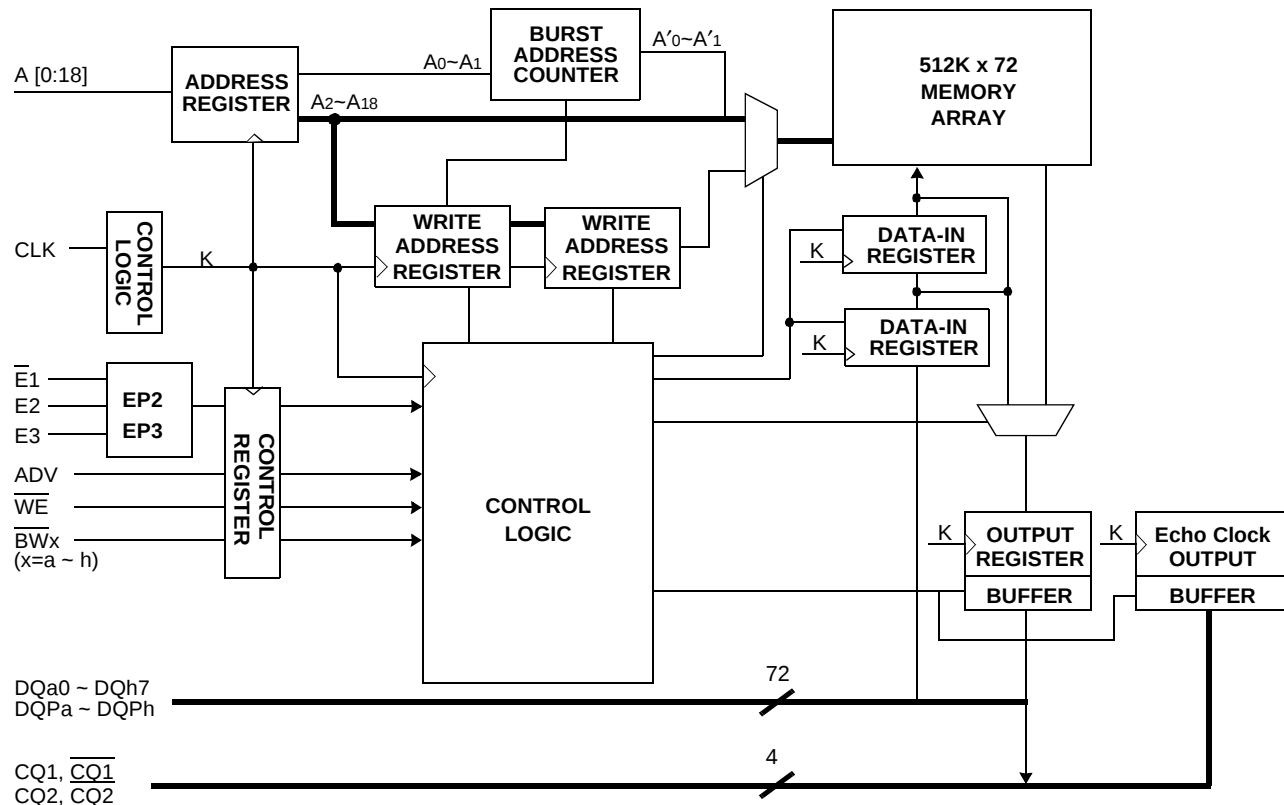
For read cycles, the SRAM output data is temporarily stored by an edge triggered output register and then released to the output buffers at the next rising edge of clock.

The K7Z327285M are implemented with SAMSUNG's high performance CMOS technology and is available in 209BGA packages. Multiple power and ground pins minimize ground bounce.

FAST ACCESS TIMES

PARAMETER	Symbol	-27	-25	Unit
Cycle Time	tcyc	3.6	4.0	ns
Clock Access Time	tcd	2.0	2.1	ns

LOGIC BLOCK DIAGRAM



K7Z327285M

512Kx72 (DLW) Double Late Write RAM

209BGA PACKAGE PIN CONFIGURATIONS (TOP VIEW)

512Kx72 Common I/O-Top View

	1	2	3	4	5	6	7	8	9	10	11
A	DQg	DQg	A	E2	A	ADV	A	E3	A	DQb	DQb
B	DQg	DQg	$\overline{BW}c$	$\overline{BW}g$	NC	$\overline{WE}$	A	$\overline{BW}b$	$\overline{BW}f$	DQb	DQb
C	DQg	DQg	$\overline{BW}h$	$\overline{BW}d$	NC(128M)	$\overline{E1}$	NC	$\overline{BWe}$	$\overline{BWa}$	DQb	DQb
D	DQg	DQg	Vss	NC	NC	MCL	NC	NC	Vss	DQb	DQb
E	DQPg	DQPc	VDDQ	VDDQ	VDD	VDD	VDD	VDDQ	VDDQ	DQPf	DQPb
F	DQc	DQc	Vss	Vss	Vss	ZQ	Vss	Vss	Vss	DQf	DQf
G	DQc	DQc	VDDQ	VDDQ	VDD	EP2	VDD	VDDQ	VDDQ	DQf	DQf
H	DQc	DQc	Vss	Vss	Vss	EP3	Vss	Vss	Vss	DQf	DQf
J	DQc	DQc	VDDQ	VDDQ	VDD	MCH	VDD	VDDQ	VDDQ	DQf	DQf
K	CQ2	$\overline{CQ2}$	CK	NC	Vss	MCL	Vss	NC	NC	$\overline{CQ1}$	CQ1
L	DQh	DQh	VDDQ	VDDQ	VDD	MCH	VDD	VDDQ	VDDQ	DQa	DQa
M	DQh	DQh	Vss	Vss	Vss	MCL	Vss	Vss	Vss	DQa	DQa
N	DQh	DQh	VDDQ	VDDQ	VDD	$\overline{SD}$	VDD	VDDQ	VDDQ	DQa	DQa
P	DQh	DQh	Vss	Vss	Vss	MCL	Vss	Vss	Vss	DQa	DQa
R	DQPd	DQPh	VDDQ	VDDQ	VDD	VDD	VDD	VDDQ	VDDQ	DQPa	DQPe
T	DQd	DQd	Vss	NC	NC	MCL	NC	NC	Vss	DQe	DQe
U	DQd	DQd	NC	A	NC(64M)	A	A	A	NC	DQe	DQe
V	DQd	DQd	A	A	A	A1	A	A	A	DQe	DQe
W	DQd	DQd	TMS	TDI	A	A0	A	TDO	TCK	DQe	DQe

Pin Description Table

Pin Name	Description	Type	Comments
A	Address	Input	-
ADV	Advance	Input	Active High
$\overline{BW_x}(x=a \sim h)$	Byte Write Enable	Input	Active Low
CK	Clock	Input	Active High
DQ	Data I/O	Input/Output	-
CQ	Echo Clock Outputs	Output	Active High
$\overline{CQ}$	Echo Clock Outputs	Output	Active Low
$\overline{E1}$	Chip Enable	Input	Active Low
E2 & E3	Chip Enable	Input	Programmable Active High or Low
EP2 & EP3	Chip Enable Program Pin	Input	-
$\overline{SD}$	Slow Down Input	Input	Active Low
TCK	Test Clock	Input	Active High
TDI	Test Data In	Input	-
TDO	Test Data Out	Output	-
TMS	Test Mode Select	Input	-
MCH	Must Connect High	Input	Active High
MCL	Must Connect Low	Input	Active Low
NC	No Connect	-	Not connected to die
$\overline{WE}$	Write	Input	Active Low
V _{DD}	Core Power Supply	Input	1.8V
V _{DDQ}	Output Driver Power Supply	Input	1.8V
V _{SS}	Ground	Input	-
ZQ	Output Impedance Control	Input	Low = Low Impedance(High Drive) High = High Impedance(Low Drive)

FUNCTION DESCRIPTION

The K7Z327285M is Double Late Write RAM designed to sustain 100% bus bandwidth by eliminating turnaround cycle when there is transition from Read to Write, or vice versa.

Because a Double Late Write RAM is a synchronous device, address, data Inputs, and read/write control inputs are captured on the rising edge of the input clock. EP2, EP3 and $\overline{SD}$ are asynchronous control input.

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, all three chip enables ($\overline{E1}$, $\overline{E2}$, $\overline{E3}$) are active, the write enable input signals $\overline{WE}$ are driven high, and $\overline{ADV}$ driven low. The internal array is read between the first rising edge of the clock 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.

Write operation occurs when $\overline{WE}$ is driven low at the rising edge of the clock. $\overline{BWx[h:a]}$ can be used for byte write operation. The Double Late Write RAM uses a double-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 $\overline{ADV}$ High for the burst access as shown below. The starting point of the burst sequence is provided by the external address. The burst address counter wraps around to its initial state upon completion.

Double Late Write RAM supports linear burst sequence only.

BURST SEQUENCE TABLE (Linear Burst Order)

	A[1:0]	A[1:0]	A[1:0]	A[1:0]
1st address	00	01	10	11
2nd address	01	10	11	00
3rd address	10	11	00	01
4th address	11	00	01	10

Slow Down Function

$\overline{SD}$ is helpful to prevent bus contention in read operation after write operation, especially high frequency application.

When $\overline{SD}$ is Low, the SRAM is operated in a slow down mode. In a slow down mode, the enable/disable timings of output data become slower, which are defined as t_{KHQV} , t_{KHQZ} , t_{KHQX} , t_{KHQX1} , t_{KHCH} and t_{KLCL} .

The valid data window in slow down mode is same with normal operation mode, so it will be helpful in read operation after write operation.

When $\overline{SD}$ is High, the SRAM returns to normal operation mode.

The state of $\overline{SD}$ must be fixed before operation, and it can not be changed during operation.

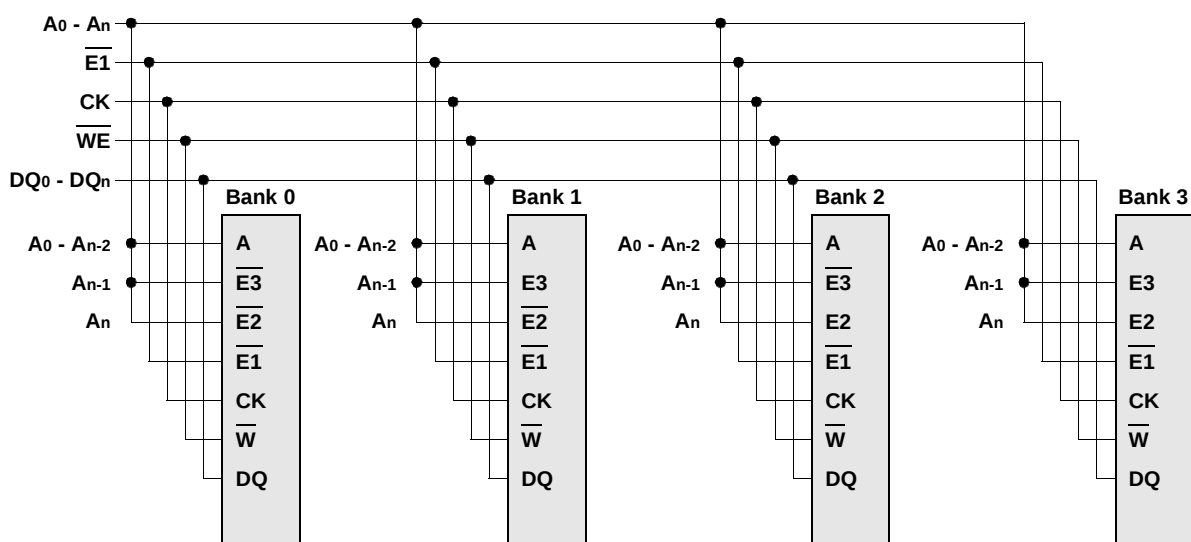
Programmable Enables

Double Late Write RAM features two user programmable chip enable inputs, E2 and E3. The sense of the inputs, whether they function as active low or active high inputs, is determined by the state of the programming inputs, EP2 and EP3. For example, if EP2 is held at V_{DD}, E2 functions as an active high enable. If EP2 is held to V_{SS}, E2 functions as an active low chip enable input.

Programmability of E2 and E3 allows four banks of depth expansion to be accomplished with no additional logic. By programming the enable inputs of four Double Late Write RAMs in binary sequence (00, 01, 10, 11) and driving the enable inputs with two address inputs. Four Double Late Write RAM can be made to look like one larger RAM to the system.

Deselection of the RAM via $\overline{E1}$ does not deactivate the Echo Clocks.

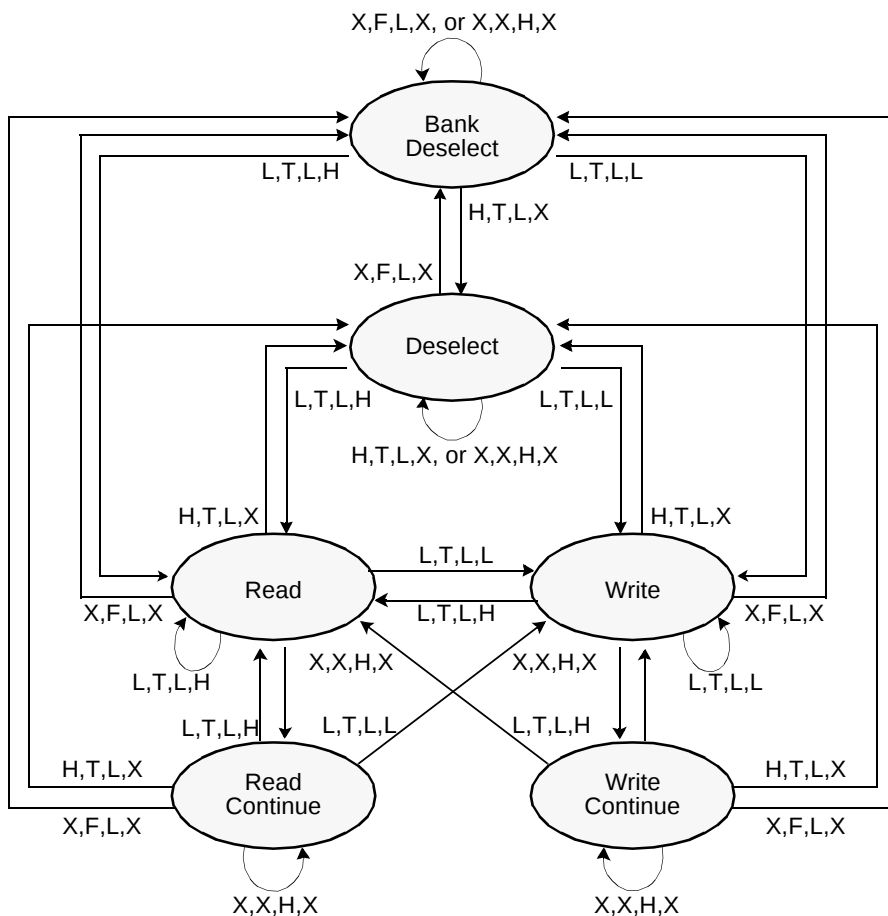
Example Four Bank Depth Expansion Schematic



Bank Enable Truth Table

	EP2	EP3	E2	E3
Bank 0	V _{SS}	V _{SS}	Active Low	Active Low
Bank 1	V _{SS}	V _{DD}	Active Low	Active High
Bank 2	V _{DD}	V _{SS}	Active High	Active Low
Bank 3	V _{DD}	V _{DD}	Active High	Active High

STATE DIAGRAM FOR Double Late Write RAM

**Notes:**

1. The notation "X,X,X,X" controlling the state transitions above indicate the states of inputs $\overline{E1}$, $\overline{E}$, $\overline{ADV}$, and $\overline{WE}$ respectively.
2. If ($E2=EP2$ and $E3=EP3$) then $E="T"$ else $E="F"$.
3. "H"=input "high"; "L"=input "low"; "X"=input "don't care"; "T"=input "true"; "F"=input "false".

TRUTH TABLES

Previous Cycle	Input Type	$\overline{E1}$ (tn)	E (tn)	ADV (tn)	$\overline{WE}$ (tn)	$\overline{BWx}$ (tn)	Current Operation	Address	DQ/CQ (tn)	DQ/CQ (tn+1)	Notes
N/A	D	H	T	L	X	X	Deselect Cycle	None	*	Hi-Z/CQ	4
Deselect	C	X	X	H	X	X	Deselect Cycle, Continue	Next	Hi-Z/CQ	Hi-Z/CQ	4
N/A	D	X	F	L	X	X	Bank Deselect Cycle	None	*	Hi-Z	4, 5
Bank Deselect	C	X	X	H	X	X	Bank Deselect Cycle, Continue	Next	Hi-Z	Hi-Z	4, 5
N/A	R	L	T	L	H	X	Read Cycle, Begin Burst	External	*	Q/CQ	2
Read	C	X	X	H	X	X	Read Cycle, Continue Burst	Next	Q/CQ	Q/CQ	
N/A	W	L	T	L	L	X	Write Cycle, Begin Burst	External	*	D/CQ	2, 3
N/A	W	L	T	L	L	F	Non-Write Cycle, Begin Burst	External	*	*	2, 3
Write	C	X	X	H	X	T	Write Cycle, Continue Burst	Next	D/CQ	D/CQ	3
Write	C	X	X	H	X	F	Non-Write Cycle, Continue Burst	Next	*	D/CQ	3, 4, 5

Note:

1. X=Don't Care, H=High, L=Low.
2. E=T(True) if E2=active and E3=active; E=F(False) if E2=inactive or E3=inactive.
3. "*" indicates that the DQ input requirement / output state and CQ output state are determined by the previous operation.
4. $\overline{BWx}$ = F(False) if all Byte Write Enable pins are high. $\overline{BWx}$ = T(True) if any one Byte Write Enable pin is low.
5. DQs are tri-state in response to Bank Deselect, Deselect, and Write commands.
6. Deassertion of $\overline{E1}$ does not deactivate the echo clock outputs(CQ1, CQ1 , CQ2, CQ2).

Echo clock outputs are tri-stated in response to Bank Deselect Commands only.

WRITE TRUTH TABLE

$\overline{WE}$	$\overline{Bwa}$	$\overline{Bwb}$	$\overline{Bwc}$	$\overline{Bwd}$	$\overline{Bwe}$	$\overline{Bwf}$	$\overline{BWg}$	$\overline{BWh}$	OPERATION
H	X	X	X	X	X	X	X	X	READ
L	L	H	H	H	H	H	H	H	WRITE BYTE a
L	H	L	H	H	H	H	H	H	WRITE BYTE b
L	H	H	L	H	H	H	H	H	WRITE BYTE c
L	H	H	H	L	H	H	H	H	WRITE BYTE d
L	H	H	H	H	L	H	H	H	WRITE BYTE e
L	H	H	H	H	H	L	H	H	WRITE BYTE f
L	H	H	H	H	H	H	L	H	WRITE BYTE g
L	H	H	H	H	H	H	H	L	WRITE BYTE h
L	L	L	L	L	L	L	L	L	WRITE ALL BYTES
L	H	H	H	H	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(↑).

ABSOLUTE MAXIMUM RATINGS*

PARAMETER	SYMBOL	RATING	UNIT
Voltage on V _{DD} Supply Relative to V _{SS}	V _{DD}	-0.3 to 2.5	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 ≤ T_A ≤ 70°C)

PARAMETER	SYMBOL	MIN	Typ.	MAX	UNIT
Supply Voltage	V _{DD}	1.7	1.8	1.95	V
	V _{DDQ}	1.7	1.8	1.95	V
Ground	V _{SS}	0	0	0	V

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

Selectable Impedance Output Driver DC ELECTRICAL CHARACTERISTICS

The KZ327285M is supplied with selectable (high or low) impedance output buffers.

ZQ=V_{DDQ}

PARAMETER	SYMBOL	TEST CONDITION	MIN	MAX	UNIT
Low Drive Output Low Voltage	V _{OLL}	I _{OL} =4.0mA	-	0.4	V
Low Drive Output High Voltage	V _{OHL}	I _{OH} =-4.0mA	V _{DDQ} - 0.4	-	V

ZQ=0V

PARAMETER	SYMBOL	TEST CONDITION	MIN	MAX	UNIT
High Drive Output Low Voltage	V _{OLH}	I _{OL} = 8.0mA	-	0.4	V
High Drive Output High Voltage	V _{OHH}	I _{OH} =-8.0mA	V _{DDQ} - 0.4	-	V

***Note :** The ZQ level supplied with selectable impedance allows selection between high drive strength (ZQ=Low) and low drive strength (ZQ=High).

CAPACITANCE*(T_A=25°C, f=1MHz)

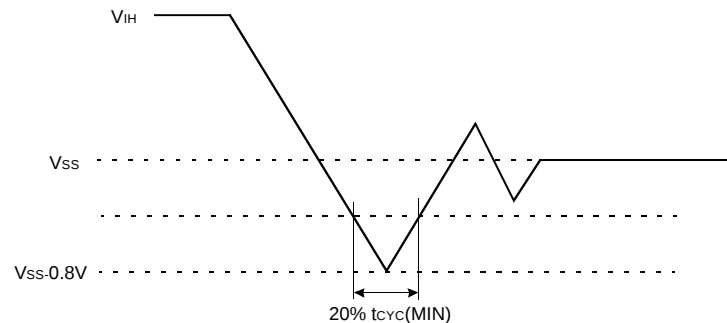
PARAMETER	SYMBOL	TEST CONDITION	MIN	MAX	UNIT
Input Capacitance	C _{IN}	V _{IN} =0V	-	5	pF
Output Capacitance	C _{OUT}	V _{OUT} =0V	-	7	pF

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

DC ELECTRICAL CHARACTERISTICS($V_{DD}=1.8V + 150/-100mV$, $T_A=0^{\circ}C$ to $+70^{\circ}C$)

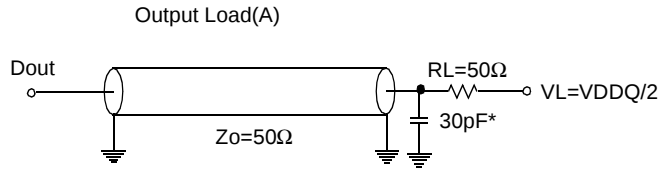
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT	NOTES
Input Leakage Current	I_{IL}	$V_{DD}=Max$; $V_{IN}=V_{SS}$ to V_{DD}	-2	+2	μA	
Output Leakage Current	I_{OL}	Output Disabled,	-2	+2	μA	
Operating Current	I_{CC}	$V_{DD}=Max$, $I_{OUT}=0mA$ Cycle Time $\geq t_{CYC}$ Min	-27	-	TBD	1,2
			-25	-	TBD	
Standby Current	I_{SB1}	E2 or E3 False, $I_{OUT}=0mA$, $f=Max$ All Inputs $\leq V_{IL}$ or $\geq V_{IH}$	-	TBD	mA	
	I_{SB2}	$\overline{E1} \geq V_{IH}$, $I_{OUT}=0mA$, $f=Max$, All Inputs $\leq V_{IL}$ or $\geq V_{IH}$	-	TBD	mA	
	I_{SB3}	Device deselected, $I_{OUT}=0mA$, $f=0$, All Inputs=fixed ($V_{DD}-0.2V$ or $0.2V$)	-	TBD	mA	
Input Low Voltage	V_{IL}		-0.3	$0.3 \cdot V_{DDQ}$	V	3
Input Low Voltage for EP2,EP3, $\overline{SD}$	V_{IL1}		-0.3	0.3	V	
Input High Voltage	V_{IH}		$0.7 \cdot V_{DDQ}$	$V_{DD}+0.3$	V	3
Input High Voltage for EP2,EP3, $\overline{SD}$	V_{IH1}		$V_{DD} - 0.3$	$V_{DD}+0.3$	V	

- 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. $V_{IH}=V_{DDQ}+0.3V$
 4. The EP2, EP3 pins must not be changed during operation.

**TEST CONDITIONS**($T_A=0$ to $70^{\circ}C$, $V_{DD}=1.8V + 150/-100mV$, unless otherwise specified)

PARAMETER	VALUE
Input Pulse Level	0 to 1.8V
Input Rise and Fall Time(Measured at 20% to 80%)	2.0V/ns
Input and Output Timing Reference Levels	0.9V
Output Load	See Fig. 1

AC Test Load Diagram



* Including Scope and Jig Capacitance

Fig. 1

AC TIMING CHARACTERISTICS when /SD=VDD ($V_{DD}=1.8\text{V} + 150/-100\text{mV}$, $T_A=0$ to 70°C)

PARAMETER	SYMBOL	-27		-25		UNIT
		MIN	MAX	MIN	MAX	
Cycle Time	t_{KHK}	3.6	-	4.0	-	ns
Clock High to Output Valid	t_{KHQV}	-	2.0	-	2.1	ns
Clock High to Output High-Z	t_{KHQZ}	0.5	2.0	0.5	2.1	ns
Output Hold from Clock High	t_{KHQX}	0.5	-	0.5	-	ns
Clock High to Output Low-Z	t_{KHQX1}	0.5	-	0.5	-	ns
Clock High to CQ High	t_{KHCH}	0.5	1.9	0.5	2.0	ns
Clock Low to CQ Low	t_{KLCL}	0.5	2.0	0.5	2.3	ns
Output Hold from CQ High	t_{CHQX}	-0.4	-	-0.5	-	ns
CQ High to Output Low-Z	t_{CHQX1}	-0.4	-	-0.5	-	ns
CQ High to Output Valid	t_{CHQV}	-	0.4	-	0.5	ns
Clock High to CQ Low-Z	t_{KHXC1}	0.5	-	0.5	-	ns
Clock High to CQ High-Z	t_{KHCZ}	0.5	1.9	0.5	2.0	ns
Clock High Pulse Width	t_{HKHL}	1.4	-	1.5	-	ns
Clock Low Pulse Width	t_{KLKH}	1.4	-	1.5	-	ns
Address Setup to Clock High	t_{AVKH}	0.7	-	0.8	-	ns
Chip Enable Setup to Clock High	t_{EVKH}	0.7	-	0.8	-	ns
Write Setup to Clock High($\overline{WE}$, $\overline{BWx}$)	t_{WVKH}	0.7	-	0.8	-	ns
Data Setup to Clock High	t_{DVKH}	0.7	-	0.8	-	ns
Address Advance Setup to Clock High	t_{advVKH}	0.7	-	0.8	-	ns
Address Hold from Clock High	t_{KHAX}	0.4	-	0.5	-	ns
Chip Enable Hold from Clock High	t_{KHEx}	0.4	-	0.5	-	ns
Write Hold from Clock High($\overline{WE}$, $\overline{BWx}$)	t_{KHwx}	0.4	-	0.5	-	ns
Data Hold from Clock High	t_{KHDX}	0.4	-	0.5	-	ns
Address Advance Hold from Clock High	t_{KHadvx}	0.4	-	0.5	-	ns

- 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 $\overline{E1}$ 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_{KHQX1} is more than t_{KHQZ} .
The specs as shown do not imply bus contention because t_{KHQX1} is a Min. parameter that is worst case at totally different test conditions ($0^\circ\text{C}, 1.95\text{V}$) than t_{KHQZ} , which is a Max. parameter(worst case at $70^\circ\text{C}, 1.7\text{V}$)
It is not possible for two SRAMs on the same board to be at such different voltage and temperature.

AC TIMING CHARACTERISTICS when /SD=VSS (V_{DD}=1.8V + 150/-100mV, T_A=0 to 70°C)

PARAMETER	SYMBOL	-27		-25		UNIT
		MIN	MAX	MIN	MAX	
Cycle Time	t _{KHKH}	3.6	-	4.0	-	ns
Clock High to Output Valid	t _{KHQV}	-	2.9	-	3.0	ns
Clock High to Output High-Z	t _{KHQZ}	1.4	2.9	1.4	3.0	ns
Output Hold from Clock High	t _{KHQX}	1.4	-	1.4	-	ns
Clock High to Output Low-Z	t _{KHQX1}	1.4	-	1.4	-	ns
Clock High to CQ High	t _{KHCH}	1.4	2.8	1.4	2.9	ns
Clock Low to CQ Low	t _{KLCL}	1.4	2.9	1.4	3.2	ns
Output Hold from CQ High	t _{CHQX}	-0.4	-	-0.5	-	ns
CQ High to Output Low-Z	t _{CHQX1}	-0.4	-	-0.5	-	ns
CQ High to Output Valid	t _{CHQV}	-	0.4	-	0.5	ns
Clock High to CQ Low-Z	t _{KHCX1}	1.4	-	1.4	-	ns
Clock High to CQ High-Z	t _{KHCZ}	1.4	2.8	1.4	2.9	ns
Clock High Pulse Width	t _{KHKL}	1.4	-	1.5	-	ns
Clock Low Pulse Width	t _{KLKH}	1.4	-	1.5	-	ns
Address Setup to Clock High	t _{AVKH}	0.7	-	0.8	-	ns
Chip Enable Setup to Clock High	t _{EVKH}	0.7	-	0.8	-	ns
Write Setup to Clock High(W, $\overline{BW}$ x)	t _{WVKH}	0.7	-	0.8	-	ns
Data Setup to Clock High	t _{DVKH}	0.7	-	0.8	-	ns
Address Advance Setup to Clock High	t _{advVKH}	0.7	-	0.8	-	ns
Address Hold from Clock High	t _{KHAX}	0.4	-	0.5	-	ns
Chip Enable Hold from Clock High	t _{KHEX}	0.4	-	0.5	-	ns
Write Hold from Clock High(W, $\overline{BW}$ x)	t _{KHWX}	0.4	-	0.5	-	ns
Data Hold from Clock High	t _{KHDX}	0.4	-	0.5	-	ns
Address Advance Hold from Clock High	t _{KHadvX}	0.4	-	0.5	-	ns

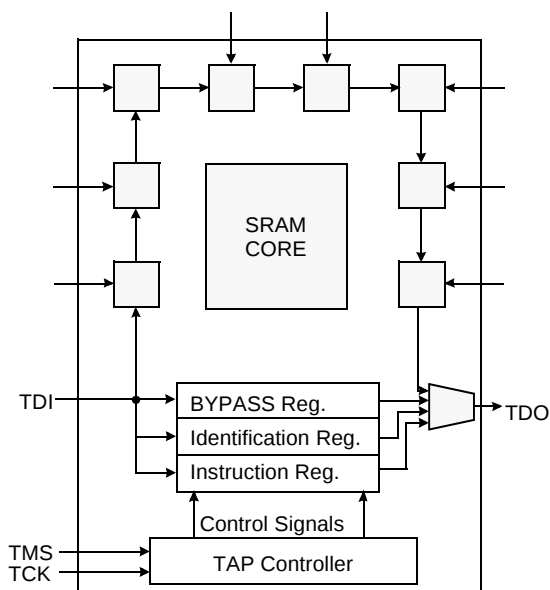
Notes :

1. All address inputs must meet the specified setup and hold times for all rising clock(CLK) edges when ADV is sampled low and $\overline{E1}$ 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 W low having been registered into the device at ADV Low. A Read cycle is defined by $\overline{W}$ High with ADV Low. Both cases must meet setup and hold times.
4. To avoid bus contention, At a given voltage and temperature t_{KHQX1} is more than t_{KHQZ}.
The specs as shown do not imply bus contention because t_{KHQX1} is a Min. parameter that is worst case at totally different test conditions (0°C, 1.95V) than t_{KHQZ}, which is a Max. parameter(worst case at 70°C, 1.7V)
It is not possible for two SRAMs on the same board to be at such different voltage and temperature.

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 Vss 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 VDD through a resistor. TDO should be left unconnected.

JTAG Block Diagram



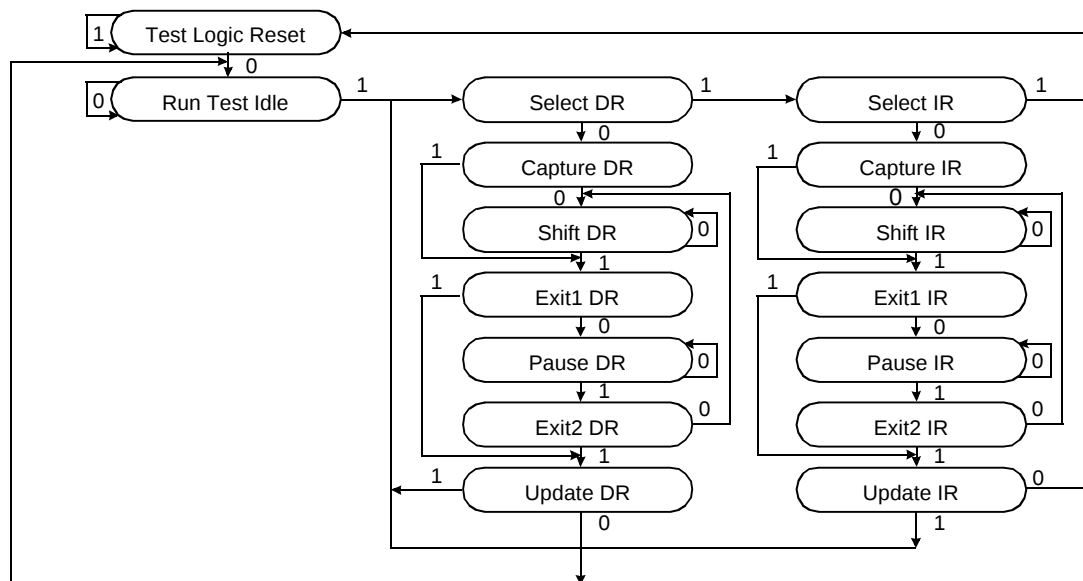
JTAG Instruction Coding

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 Vss 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



BOUNDARY SCAN ORDER INFORMATION

TBD

JTAG DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	V _{DD}	1.7	1.8	1.95	V	
Input High Level	V _{IH}	1.05	-	V _{DD} +0.3	V	1
Input Low Level	V _{IL}	-0.3	-	0.7	V	
Output High Voltage(I _{OH} =-2mA)	V _{OH}	1.5	-	V _{DD}	V	
Output Low Voltage(I _{OL} =2mA)	V _{OL}	V _{SS}	-	0.45	V	

*Note : 1. In Case of I/O Pins, the Max. V_{IH}=V_{DDQ}+0.3V

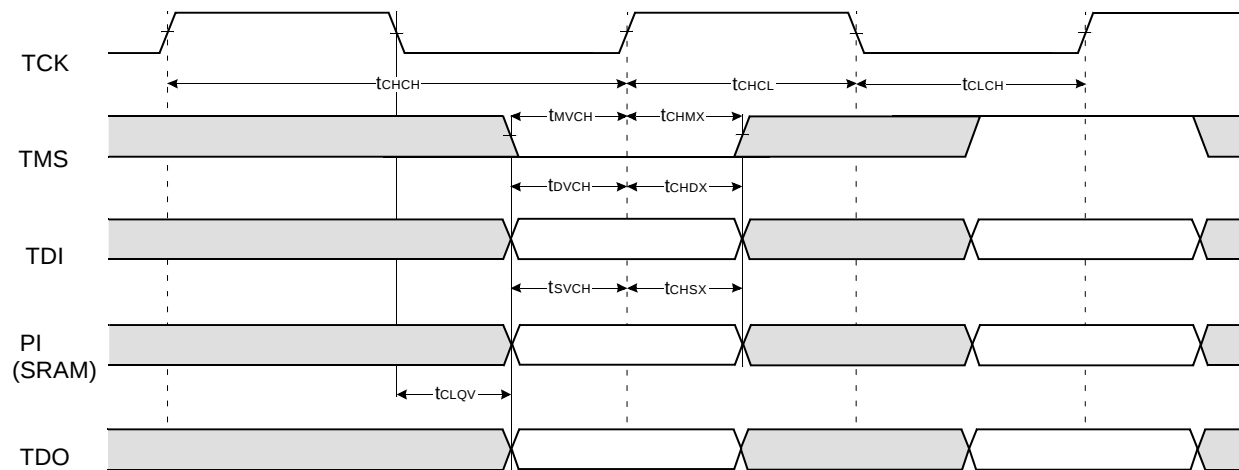
JTAG AC TEST CONDITIONS

Parameter	Symbol	Min	Unit	Note
Input High/Low Level	V _{IH} /V _{IL}	1.8/0.0	V	
Input Rise/Fall Time	TR/TF	1.0/1.0	ns	
Input and Output Timing Reference Level		0.9	V	

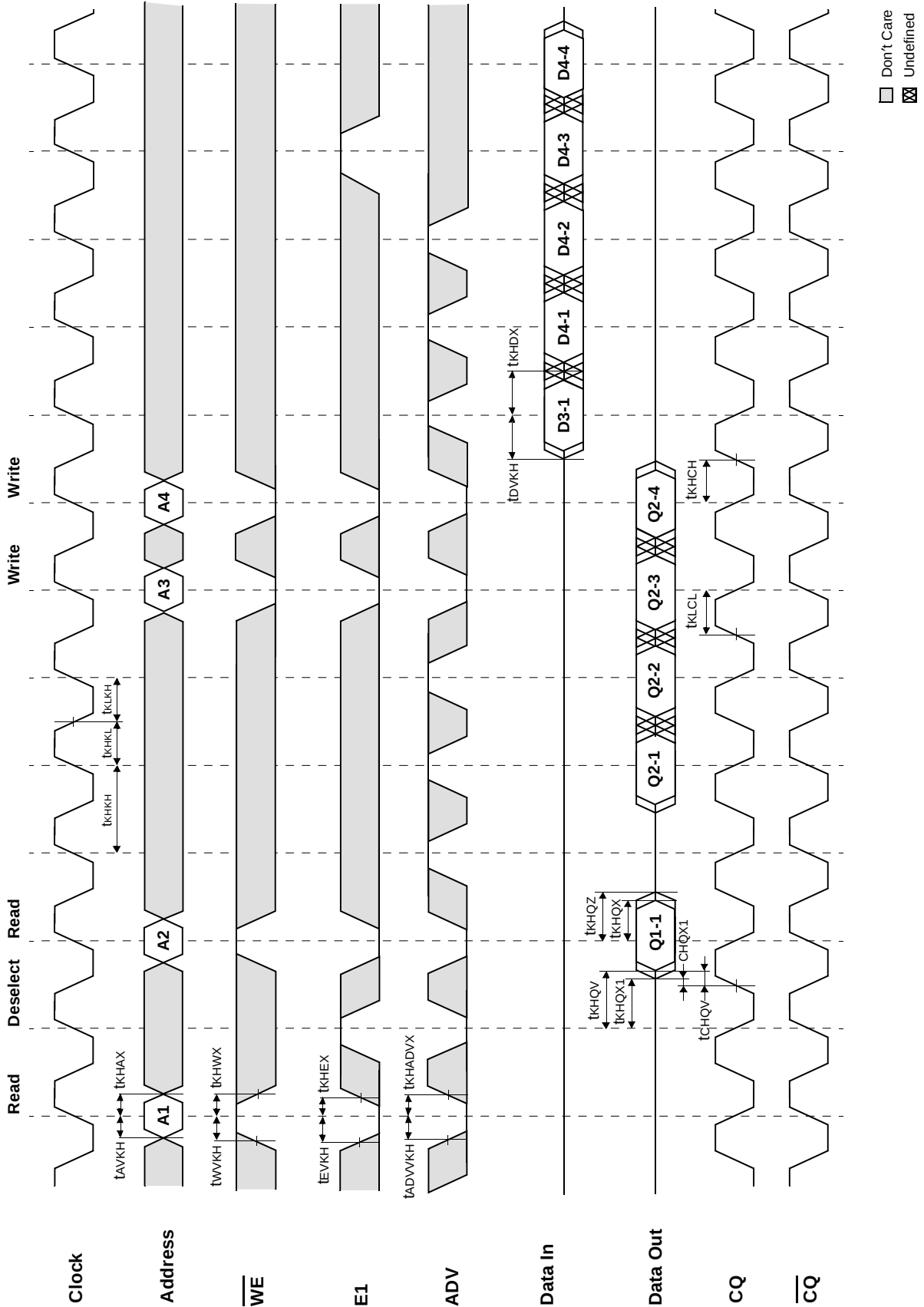
JTAG AC Characteristics

Parameter	Symbol	Min	Max	Unit	Note
TCK Cycle Time	t _{CHCH}	20	-	ns	
TCK High Pulse Width	t _{CHCL}	10	-	ns	
TCK Low Pulse Width	t _{CLCH}	10	-	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	

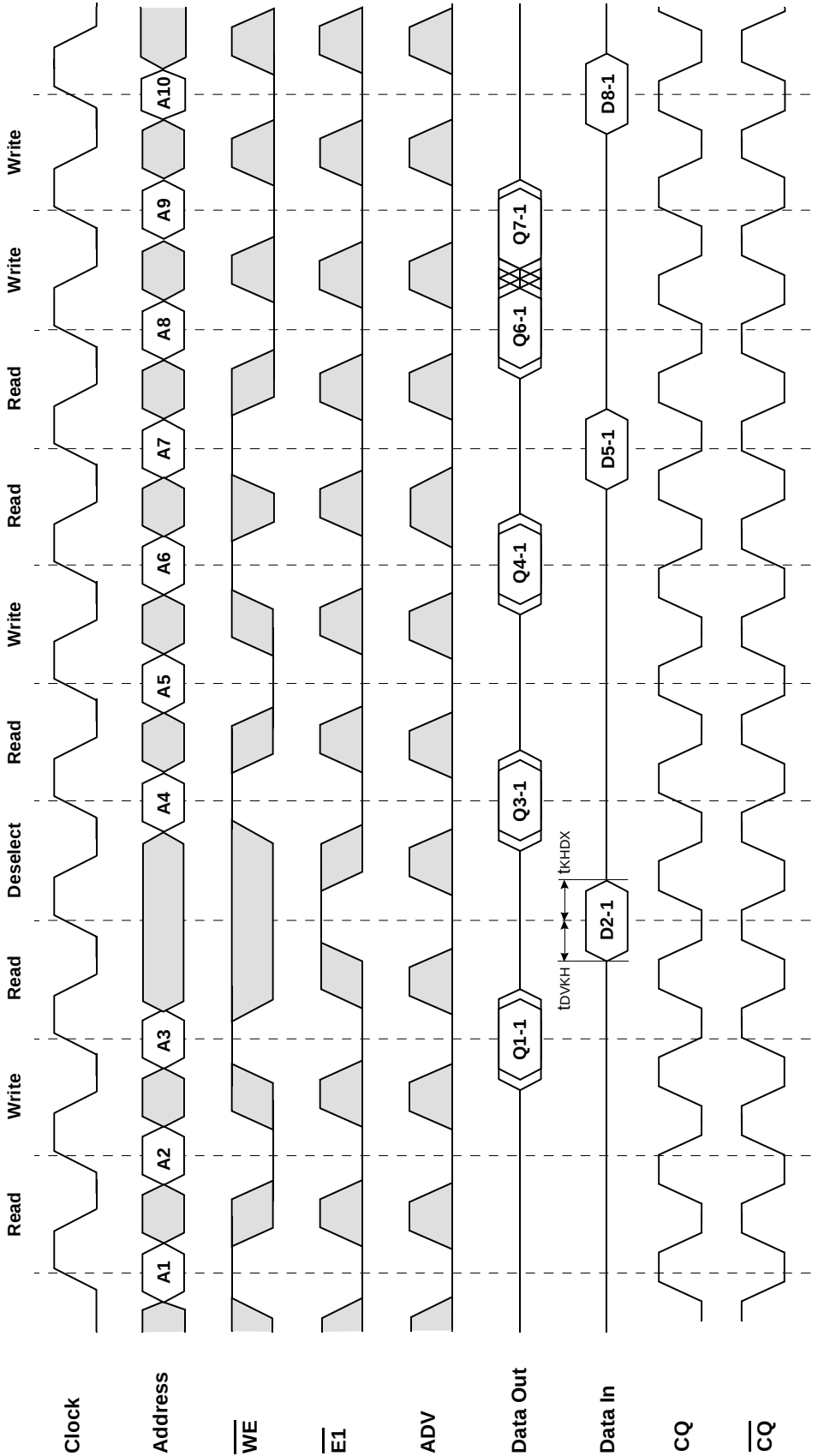
JTAG TIMING DIAGRAM



TIMING WAVEFORM OF READ/WRITE CYCLE with Continue operation

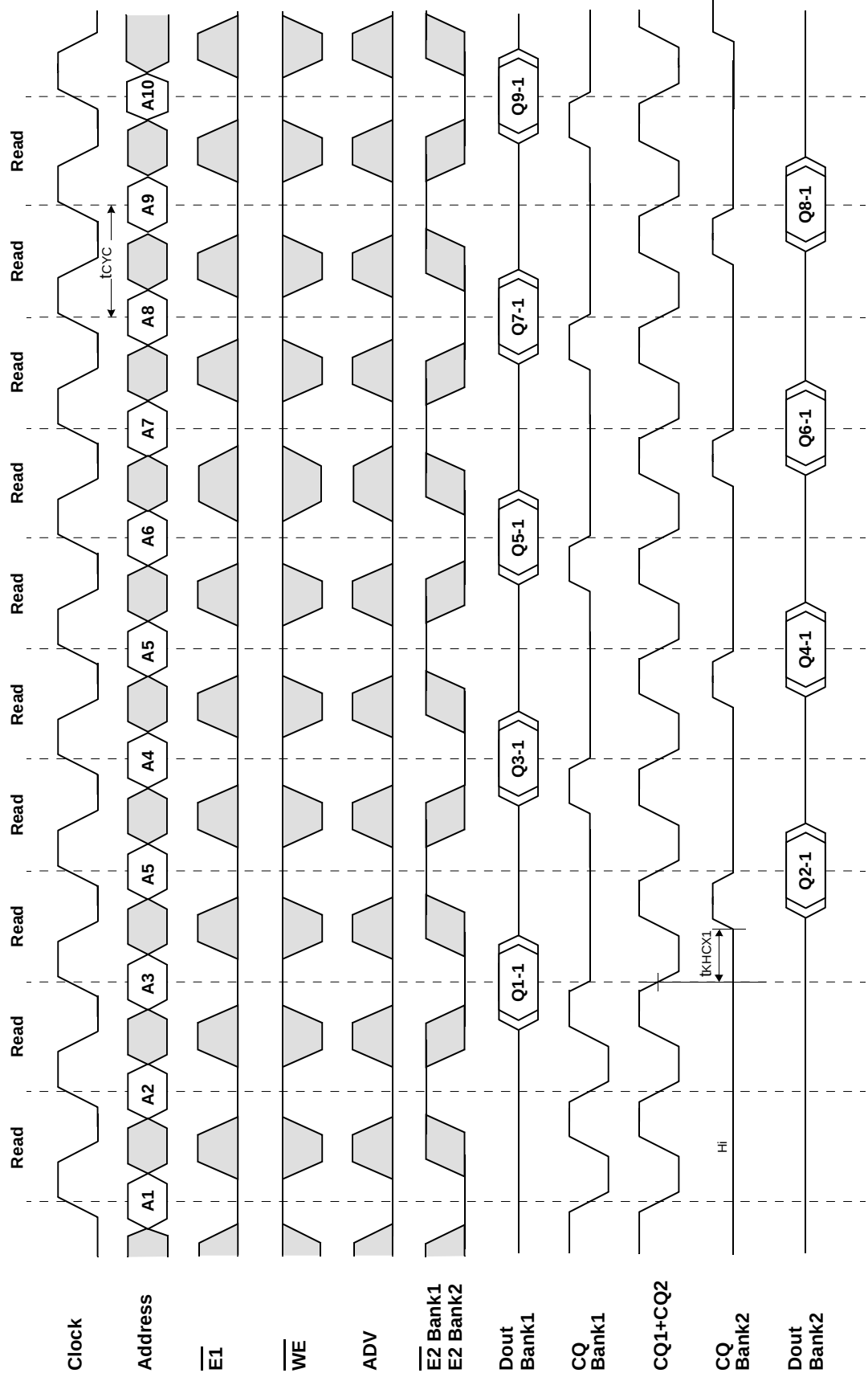


TIMING WAVEFORM OF SINGLE READ/WRITE



□ Don't Care
 ⊠ Undefined

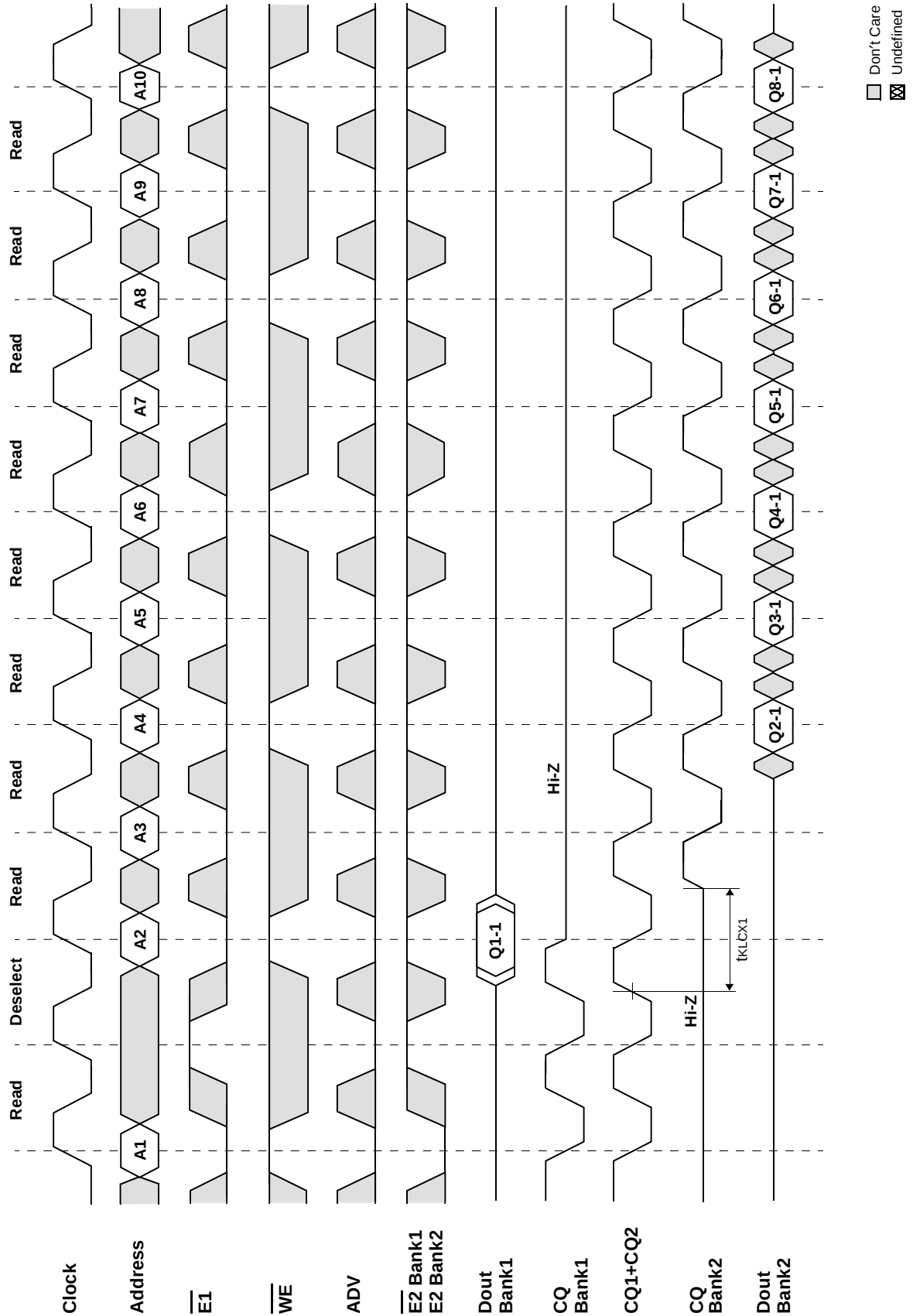
ECHO CLOCK CONTROL IN TWO BANKS



□ Don't Care
 ⊗ Undefined

NOTE: $\overline{E1}$ does not deselect the Echo Clock Outputs. Echo Clock Outputs are de-selected by E2 or E3 being sampled false.

BANK SWITCH WITH $\overline{E1}$ DESELECT



209 Bump BGA PACKAGE DIMENSIONS

14mm x 22mm Body, 1.0mm Bump Pitch, 11x19 Bump Array

