

Document Title

64Kx36-Bit Synchronous Pipelined Burst SRAM, 3.3V Power
Datasheets for 100TQFP

Revision History

<u>Rev. No.</u>	<u>History</u>	<u>Draft Date</u>	<u>Remark</u>
Rev. 0.0	Initial draft	Nov. 17. 1996	Preliminary
Rev. 1.0	Final spec release	May. 01. 1997	Final
Rev. 1.1	Change -10/-11 tps from 2.0ns to 2.5ns	Jun. 11. 1997	Final

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64Kx36-Bit Synchronous Pipelined Burst SRAM**FEATURES**

- Synchronous Operation.
- 2 Stage Pipelined operation with 4 Burst.
- On-Chip Address Counter.
- Self-Timed Write Cycle.
- On-Chip Address and Control Registers.
- $V_{DD} = 3.3V - 5\% / +10\%$ Power Supply
- 5V Tolerant Inputs Except I/O Pins.
- Byte Writable Function.
- Global Write Enable Controls a full bus-width write.
- Power Down State via ZZ Signal.
- LBO Pin allows a choice of either a interleaved burst or a linear burst.
- Three Chip Enables for simple depth expansion with No Data Contention ; 2 cycle Enable, 1 cycle Disable.
- Asynchronous Output Enable Control.
- ADSP, ADSC, ADV Burst Control Pins.
- TTL-Level Three-State Output.
- 100-TQFP-1420A

GENERAL DESCRIPTION

The KM736V689/L is a 2,359,296-bit Synchronous Static Random Access Memory designed for high performance second level cache of Pentium and Power PC based System.

It is organized as 64K words of 36bits and integrates address and control registers, a 2-bit burst address counter and added some new functions for high performance cache RAM applications; $\overline{GW}$, $\overline{BW}$, $\overline{LBO}$, $\overline{ZZ}$. Write cycles are internally self-timed and synchronous.

Full bus-width write is done by $\overline{GW}$, and each byte write is performed by the combination of $\overline{WEx}$ and $\overline{BW}$ when $\overline{GW}$ is high. And with $\overline{CS}_1$ high, ADSP is blocked to control signals.

Burst cycle can be initiated with either the address status processor (ADSP) or address status cache controller (ADSC) inputs. Subsequent burst addresses are generated internally in the system's burst sequence and are controlled by the burst address advance (ADV) input.

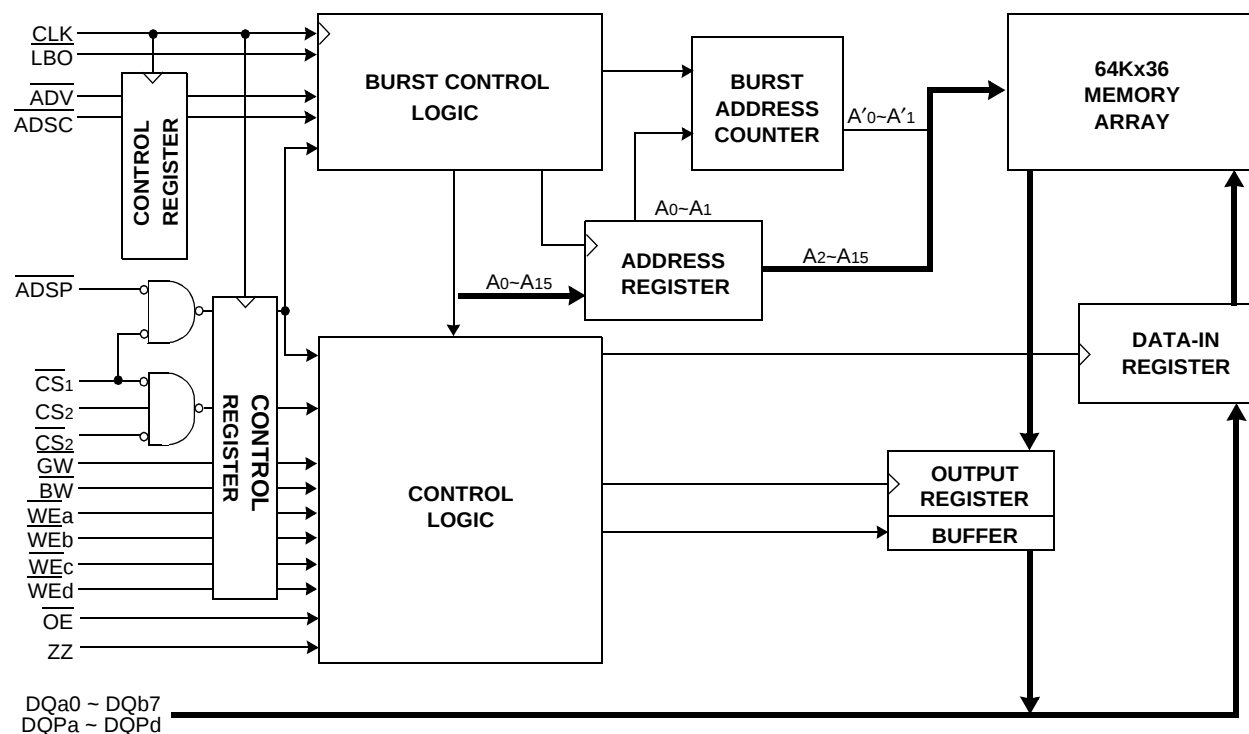
$\overline{LBO}$ pin is DC operated and determines burst sequence (linear or interleaved).

$\overline{ZZ}$ pin controls Power Down State and reduces Stand-by current regardless of CLK.

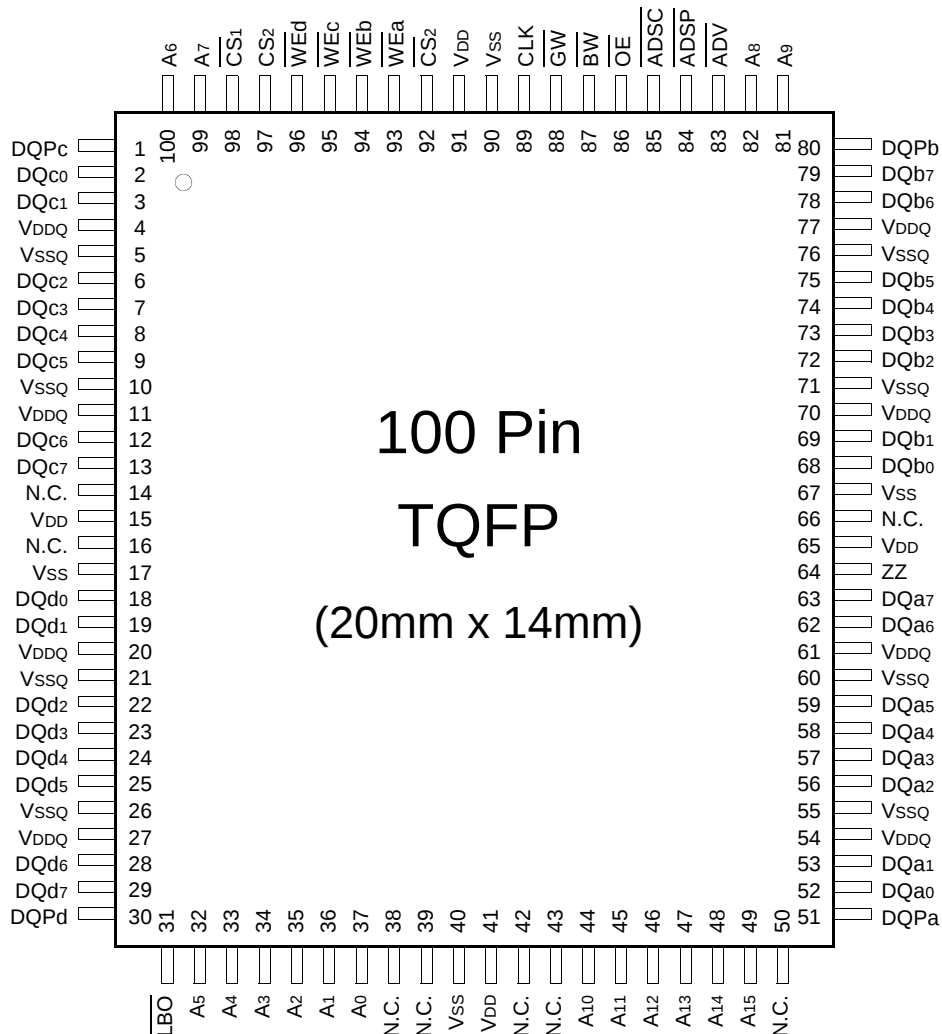
The KM736V689/L is fabricated using SAMSUNG's high performance CMOS technology and is available in a 100pin TQFP package. Multiple power and ground pins are utilized to minimize ground bounce.

FAST ACCESS TIMES

Parameter	Symbol	-7	-8	-10	-11	Unit
Cycle Time	t_{CYC}	7.5	8.6	10	11	ns
Clock Access Time	t_{CD}	4.5	5.0	5.0	6.0	ns
Output Enable Access Time	t_{OE}	4.5	5.0	5.0	6.0	ns

LOGIC BLOCK DIAGRAM

PIN CONFIGURATION(TOP VIEW)



PIN NAME

SYMBOL	PIN NAME	TQFP PIN NO.	SYMBOL	PIN NAME	TQFP PIN NO.
A0-A15	Address Inputs	32,33,34,35,36,37,44,45,46,47,48,49,81,82,99,100	VDD	Power Supply(+3.3V)	15,41,65,91
			VSS	Ground	17,40,67,90
			N.C.	No Connect	14,16,38,39,42,43,50,66
ADV	Burst Address Advance	83	DQa0~a7	Data Inputs/Outputs	52,53,56,57,58,59,62,63
ADSP	Address Status Processor	84	DQb0~b7		68,69,72,73,74,75,78,79
ADSC	Address Status Controller	85	DQc0~c7		2,3,6,7,8,9,12,13
CLK	Clock	89	DQd0~d7		18,19,22,23,24,25,28,29
CS1	Chip Select	98	DQPa~Pd		51,80,1,30
CS2	Chip Select	97	VDDQ	Output Power Supply (+3.3V)	4,11,20,27,54,61,70,77
CS2	Chip Select	92	VSSQ	Output Ground	5,10,21,26,55,60,71,76
WEx	Byte Write Inputs	93,94,95,96			
OE	Output Enable	86			
GW	Global Write Enable	88			
BW	Byte Write Enable	87			
ZZ	Power Down Input	64			
LBO	Burst Mode Control	31			

FUNCTION DESCRIPTION

The KM736V689/L is a synchronous SRAM designed to support the burst address accessing sequence of the P6 and Power PC based microprocessor. All inputs (with the exception of $\overline{OE}$, LBO and ZZ) are sampled on rising clock edges. The start and duration of the burst access is controlled by $\overline{ADSC}$, $\overline{ADSP}$ and $\overline{ADV}$ and chip select pins.

The accesses are enabled with the chip select signals and output enabled signals. Wait states are inserted into the access with $\overline{ADV}$.

When ZZ is pulled high, the SRAM will enter a Power Down State. 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. ZZ pin is pulled down internally.

Read cycles are initiated with $\overline{ADSP}$ (regardless of $\overline{WEx}$ and $\overline{ADSC}$) using the new external address clocked into the on-chip address register whenever $\overline{ADSP}$ is sampled low, the chip selects are sampled active, and the output buffer is enabled with $\overline{OE}$. In read operation the data of cell array accessed by the current address, registered in the Data-out registers by the positive edge of CLK, are carried to the Data-out buffer by the next positive edge of CLK. The data, registered in the Data-out buffer, are projected to the output pins. $\overline{ADV}$ is ignored on the clock edge that samples $\overline{ADSP}$ asserted, but is sampled on the subsequent clock edges. The address increases internally for the next access of the burst when $\overline{WEx}$ are sampled High and $\overline{ADV}$ is sampled low. And $\overline{ADSP}$ is blocked to control signals by disabling $\overline{CS1}$.

All byte write is done by $\overline{GW}$ (regardless of $\overline{BW}$ and $\overline{WEx}$), and each byte write is performed by the combination of $\overline{BW}$ and $\overline{WEx}$ when $\overline{GW}$ is high.

Write cycles are performed by disabling the output buffers with $\overline{OE}$ and asserting $\overline{WEx}$. $\overline{WEx}$ are ignored on the clock edge that samples $\overline{ADSP}$ low, but are sampled on the subsequent clock edges. The output buffers are disabled when $\overline{WEx}$ are sampled Low (regardless of $\overline{OE}$). Data is clocked into the data input register when $\overline{WEx}$ sampled Low. The address increases internally to the next address of burst, if both $\overline{WEx}$ and $\overline{ADV}$ are sampled Low. Individual byte write cycles are performed by any one or more byte write enable signals ($\overline{WEa}$, $\overline{WEb}$, $\overline{WEc}$ or $\overline{WEd}$) sampled low. The $\overline{WEa}$ control $\overline{DQa0} \sim \overline{DQa7}$ and $\overline{DQPa}$, $\overline{WEb}$ controls $\overline{DQb0} \sim \overline{DQb7}$ and $\overline{DQPb}$, $\overline{WEc}$ controls $\overline{DQc0} \sim \overline{DQc7}$ and $\overline{DQPc}$, and $\overline{WEd}$ control $\overline{DQd0} \sim \overline{DQd7}$ and $\overline{DQPd}$. Read or write cycle may also be initiated with $\overline{ADSC}$, instead of $\overline{ADSP}$. The differences between cycles initiated with $\overline{ADSC}$ and $\overline{ADSP}$ as are follows;

$\overline{ADSP}$ must be sampled high when $\overline{ADSC}$ is sampled low to initiate a cycle with $\overline{ADSC}$.
 $\overline{WEx}$ are sampled on the same clock edge that sampled $\overline{ADSC}$ low (and $\overline{ADSP}$ high).

Addresses are generated 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. The burst sequence is determined by the state of the LBO pin. When this pin is Low, linear burst sequence is selected. When this pin is High, Interleaved burst sequence is selected.

BURST SEQUENCE TABLE

(Interleaved Burst)

$\overline{\text{LBO PIN}}$	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 ↓ Fourth 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
		1	1	1	0	0	1	0	0

(Linear Burst)

$\overline{\text{LBO}}$ 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 ↓ Fourth 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
		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.

TRUTH TABLES

SYNCHRONOUS TRUTH TABLE

$\overline{\text{CS}}_1$	$\overline{\text{CS}}_2$	$\overline{\text{CS}}_2$	$\overline{\text{ADSP}}$	$\overline{\text{ADSC}}$	$\overline{\text{ADV}}$	$\overline{\text{WRITE}}$	CLK	Address Accessed	Operation
H	X	X	X	L	X	X	↑	N/A	Not Selected
L	L	X	L	X	X	X	↑	N/A	Not Selected
L	X	H	L	X	X	X	↑	N/A	Not Selected
L	L	X	X	L	X	X	↑	N/A	Not Selected
L	X	H	X	L	X	X	↑	N/A	Not Selected
L	H	L	L	X	X	X	↑	External Address	Begin Burst Read Cycle
L	H	L	H	L	X	L	↑	External Address	Begin Burst Write Cycle
L	H	L	H	L	X	H	↑	External Address	Begin Burst Read Cycle
X	X	X	H	H	L	H	↑	Next Address	Continue Burst Read Cycle
H	X	X	X	H	L	H	↑	Next Address	Continue Burst Read Cycle
X	X	X	H	H	L	L	↑	Next Address	Continue Burst Write Cycle
H	X	X	X	H	L	L	↑	Next Address	Continue Burst Write Cycle
X	X	X	H	H	H	H	↑	Current Address	Suspend Burst Read Cycle
H	X	X	X	H	H	H	↑	Current Address	Suspend Burst Read Cycle
X	X	X	H	H	H	L	↑	Current Address	Suspend Burst Write Cycle
H	X	X	X	H	H	L	↑	Current Address	Suspend Burst Write Cycle

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

2. The rising edge of clock is symbolized by ↑.

3. $\overline{\text{WRITE}} = \text{L}$ means Write operation in WRITE TRUTH TABLE. $\overline{\text{WRITE}} = \text{H}$ means Read operation in WRITE TRUTH TABLE.4. Operation finally depends on status of asynchronous input pins($\overline{\text{ZZ}}$ and $\overline{\text{OE}}$).

WRITE TRUTH TABLE

$\overline{\text{GW}}$	$\overline{\text{BW}}$	$\overline{\text{WEa}}$	$\overline{\text{WEb}}$	$\overline{\text{WEc}}$	$\overline{\text{WEd}}$	Operation
H	H	X	X	X	X	READ
H	L	H	H	H	H	READ
H	L	L	H	H	H	WRITE BYTE a
H	L	H	L	H	H	WRITE BYTE b
H	L	H	H	L	L	WRITE BYTE c and d
H	L	L	L	L	L	WRITE ALL BYTES
L	X	X	X	X	X	WRITE ALL BYTES

NOTE : 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

(See Notes 1 and 2):

Operation	$\overline{\text{ZZ}}$	$\overline{\text{OE}}$	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

NOTE

1. X means "Don't Care".

2. $\overline{\text{ZZ}}$ pin is pulled down internally3. For write cycles that following read cycles, the output buffers must be disabled with $\overline{\text{OE}}$, otherwise data bus contention will occur.

4. Sleep Mode means power down state of which stand-by current does not depend on cycle time.

5. Deselected means power down state of which stand-by current depends on cycle time.

PASS-THROUGH TRUTH TABLE

Previous Cycle		Present Cycle				Next Cycle
Operation	WRITE	Operation	CS ₁	WRITE	OE	
Write Cycle, All bytes Address=An-1, Data=Dn-1	All L	Initiate Read Cycle Address=An Data=Qn-1 for all bytes	L	H	L	Read Cycle Data=Qn
Write Cycle, All bytes Address=An-1, Data=Dn-1	All L	No new cycle Data=Qn-1 for all bytes	H	H	L	No carryover from previous cycle
Write Cycle, All bytes Address=An-1, Data=Dn-1	All L	No new cycle Data=High-Z	H	H	H	No carryover from previous cycle
Write Cycle, One byte Address=An-1, Data=Dn-1	One L	Initiate Read Cycle Address=An Data=Qn-1 for one byte	L	H	L	Read Cycle Data=Qn
Write Cycle, One byte Address=An-1, Data=Dn-1	One L	No new cycle Data=Qn-1 for one byte	H	H	L	No carryover from previous cycle

NOTE : 1. This operation makes written data immediately available at output during a read cycle preceded by a write cycle.

ABSOLUTE MAXIMUM RATINGS*

Parameter	Symbol	Rating	Unit
Voltage on V _{DD} Supply Relative to V _{SS}	V _{DD}	-0.3 to 4.6	V
Voltage on V _{DDQ} Supply Relative to V _{SS}	V _{DDQ}	V _{DD}	V
Voltage on Input Pin Relative to V _{SS}	V _{IN}	-0.3 to 6.0	V
Voltage on I/O Pin Relative to V _{SS}	V _{IO}	-0.3 to V _{DDQ} +0.5	V
Power Dissipation	P _D	1.2	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}	3.13	3.3	3.6	V
	V _{DDQ}	3.13	3.3	3.6	V
Ground	V _{SS}	0	0	0	V

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.

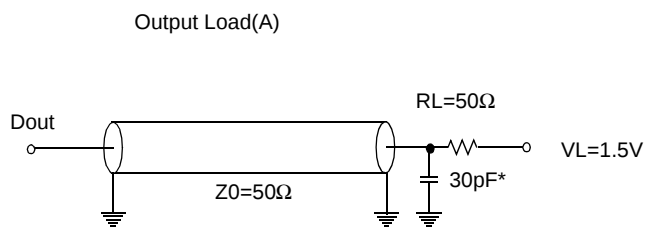
DC ELECTRICAL CHARACTERISTICS($T_A=0$ to 70°C , $V_{DD}=3.3\text{V}\pm 5\%$)

Parameter	Symbol	Test Conditions	Min	Max	Unit
Input Leakage Current(except ZZ)	I_{IL}	$V_{DD}=V_{SS}$ to V_{DD} ; $V_{IN}=V_{SS}$ to V_{DD}	-2	+2	μA
Output Leakage Current	I_{OL}	Output Disabled, $V_{OUT}=V_{SS}$ to V_{DDQ}	-2	+2	μA
Operating Current	I_{CC}	Device Selected, $I_{OUT}=0\text{mA}$, $ZZ\leq V_{IL}$, All Inputs= V_{IL} or V_{IH} Cycle Time $\geq t_{CYC}$ min	-7	-	395
			-8	-	360
			-10	-	320
			-11	-	320
Standby Current	I_{SB}	Device deselected, $I_{OUT}=0\text{mA}$, $ZZ\leq V_{IL}$, $f = \text{Max}$, All Inputs $\leq 0.2\text{V}$ or $\geq V_{DD}-0.2\text{V}$	-7	-	100
			-8	-	90
			-10	-	80
			-11	-	80
	I_{SB1}	Device deselected, $I_{OUT}=0\text{mA}$, $ZZ\leq 0.2\text{V}$, $f = 0$, All Inputs=fixed ($V_{DD}-0.2\text{V}$ or 0.2V)		-	10
			L-Ver	-	5.0
	I_{SB2}	Device deselected, $I_{OUT}=0\text{mA}$, $ZZ\geq V_{DD}-0.2\text{V}$, $f = \text{Max}$, All Inputs $\leq V_{IL}$ or $\geq V_{IH}$		-	10
			L-Ver	-	1.0
Output Low Voltage	V_{OL}	$I_{OL} = 8.0\text{mA}$	-	0.4	V
Output High Voltage	V_{OH}	$I_{OH} = -4.0\text{mA}$	2.4	-	V
Input Low Voltage	V_{IL}		-0.5*	0.8	V
Input High Voltage	V_{IH}		2.0	5.5**	V

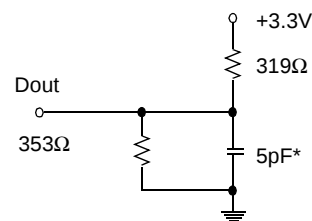
* $V_{IL}(\text{Min})=-3.0(\text{Pulse Width}\leq 20\text{ns})$ ** In Case of I/O Pins, the Max. $V_{IH}=V_{DDQ}+0.5\text{V}$ **TEST CONDITIONS**

(TA=0 to 70°C, VDD=3.3V-5%/+10%, unless otherwise specified)

Parameter	Value
Input Pulse Level	0 to 3V
Input Rise and Fall Time(Measured at 0.3V and 2.7V)	2ns
Input and Output Timing Reference Levels	1.5V
Output Load	See Fig. 1



* Capacitive Load consists of all components of the test environment.

Output Load(B),(3.3V I/O)
(for t_{LZC} , t_{LZOE} , t_{HZOE} & t_{HZC})

* Including Scope and Jig Capacitance

Fig. 1

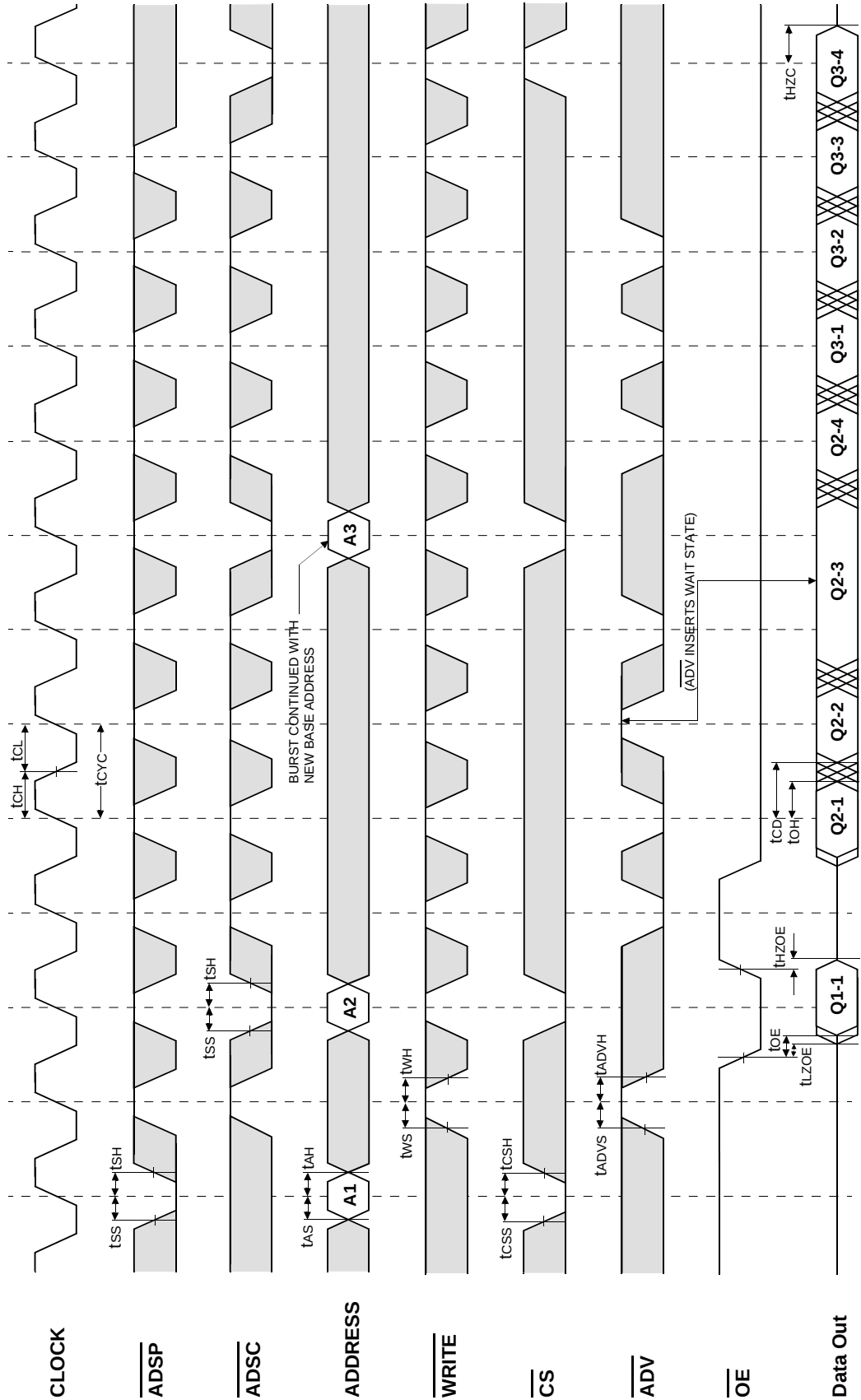
AC TIMING CHARACTERISTICS

(V_{DD}=3.3V-5%/+10%, T_A=0 to 70°C)

Parameter	Symbol	-7		-8		-10		-11		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Cycle Time	t _{CYC}	7.5	-	8.6	-	10	-	11	-	ns
Clock Access Time	t _{CD}	-	4.5	-	5.0	-	5.0	-	6.0	ns
Output Enable to Data Valid	t _{OE}	-	4.5	-	5.0	-	5.0	-	6.0	ns
Clock High to Output Low-Z	t _{LZC}	0	-	0	-	0	-	0	-	ns
Output Hold from Clock High	t _{OH}	1.5	-	1.5	-	1.5	-	1.5	-	ns
Output Enable Low to Output Low-Z	t _{LZOE}	0	-	0	-	0	-	0	-	ns
Output Enable High to Output High-Z	t _{HZOE}	-	4.0	-	4.0	-	4.0	-	4.0	ns
Clock High to Output High-Z	t _{HZC}	1.5	5.0	1.5	5.0	1.5	5.0	1.5	5.0	ns
Clock High Pulse Width	t _{CH}	3.0	-	3.5	-	4.0	-	4.0	-	ns
Clock Low Pulse Width	t _{CL}	3.0	-	3.5	-	4.0	-	4.0	-	ns
Address Setup to Clock High	t _{AS}	2.0	-	2.0	-	2.0	-	2.0	-	ns
Address Status Setup to Clock High	t _{SS}	2.0	-	2.0	-	2.0	-	2.0	-	ns
Data Setup to Clock High	t _{DS}	2.0	-	2.0	-	2.5	-	2.5	-	ns
Write Setup to Clock High ($\overline{GW}$, $\overline{BW}$, $\overline{WEx}$)	t _{WS}	2.0	-	2.0	-	2.0	-	2.0	-	ns
Address Advance Setup to Clock High	t _{ADVS}	2.0	-	2.0	-	2.0	-	2.0	-	ns
Chip Select Setup to Clock High	t _{CSS}	2.0	-	2.0	-	2.0	-	2.0	-	ns
Address Hold from Clock High	t _{AH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
Address Status Hold from Clock High	t _{SH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
Data Hold from Clock High	t _{DH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
Write Hold from Clock High ($\overline{GW}$, $\overline{BW}$, $\overline{WEx}$)	t _{WH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
Address Advance Hold from Clock High	t _{ADVH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
Chip Select Hold from Clock High	t _{CSH}	0.5	-	0.5	-	0.5	-	0.5	-	ns
ZZ High to Power Down	t _{PDS}	2	-	2	-	2	-	2	-	cycle
ZZ Low to Power Up	t _{PUS}	2	-	2	-	2	-	2	-	cycle

NOTE : 1. All address inputs must meet the specified setup and hold times for all rising clock edges whenever $\overline{ADSC}$ and/or $\overline{ADSP}$ 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. Both chip selects must be active whenever $\overline{ADSC}$ or $\overline{ADSP}$ is sampled low in order for the this device to remain enabled.
 3. $\overline{ADSC}$ or $\overline{ADSP}$ must not be asserted for at least 2 Clock after leaving ZZ state.

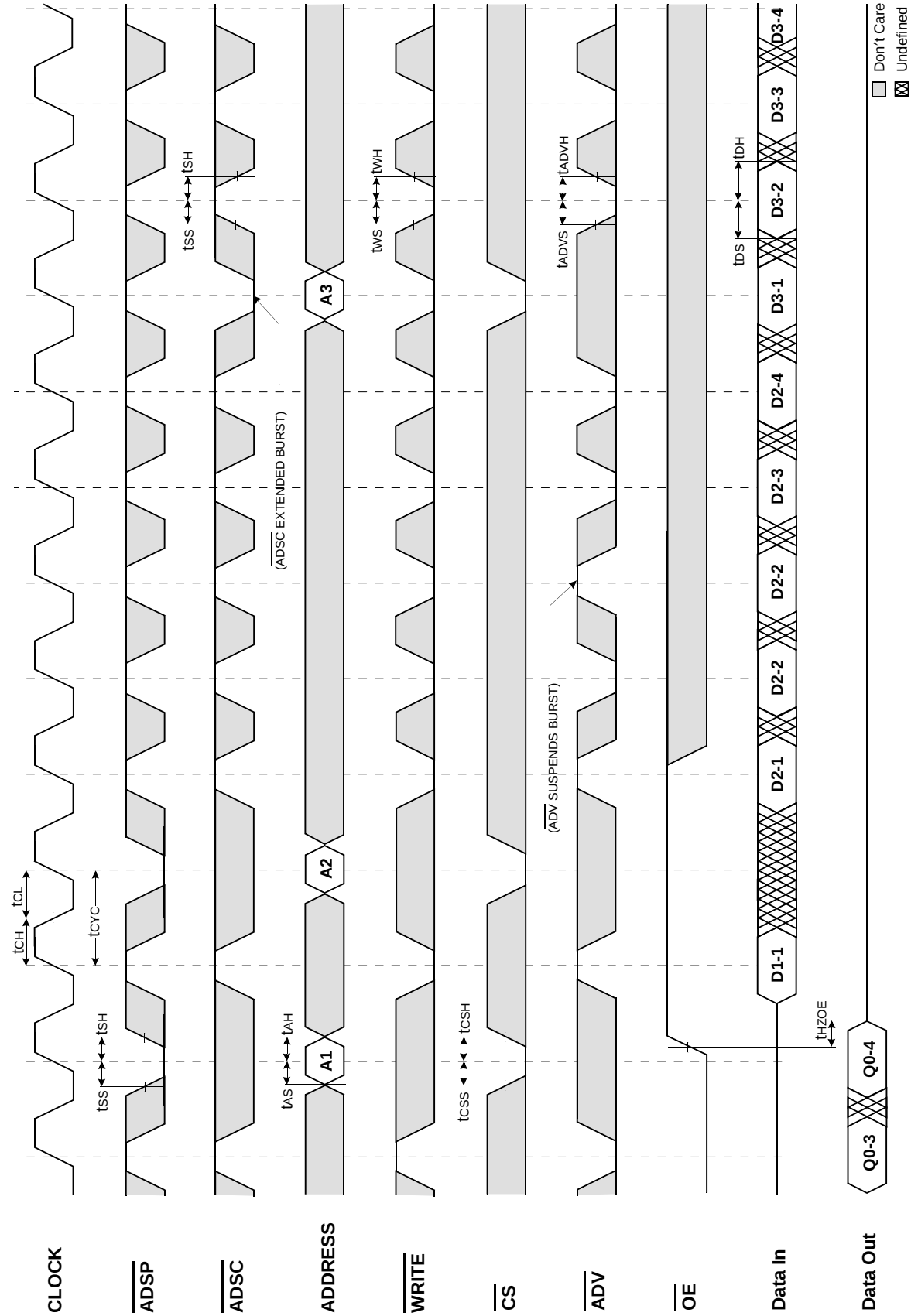
TIMING WAVEFORM OF READ CYCLE



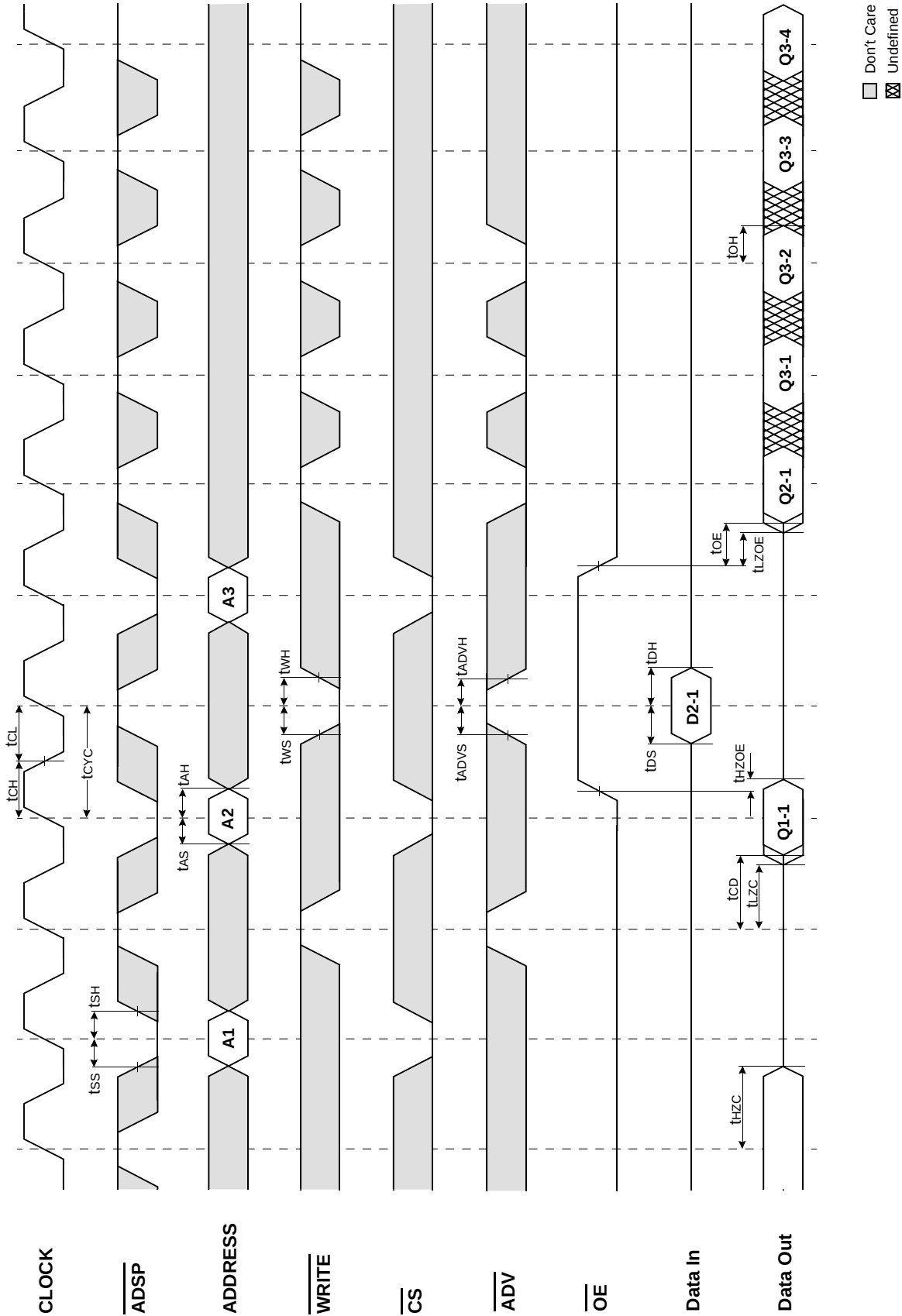
NOTES : $\overline{\text{WRITE}} = \text{L}$ means $\overline{\text{GW}} = \text{L}$, or $\overline{\text{GW}} = \text{H}$, $\overline{\text{BW}} = \text{L}$, $\overline{\text{WE}} = \text{L}$
 $\overline{\text{CS}} = \text{L}$ means $\overline{\text{CS}}_1 = \text{L}$, $\overline{\text{CS}}_2 = \text{H}$ and $\overline{\text{CS}}_2 = \text{L}$
 $\overline{\text{CS}} = \text{H}$ means $\overline{\text{CS}}_1 = \text{H}$, or $\overline{\text{CS}}_1 = \text{L}$ and $\overline{\text{CS}}_2 = \text{H}$, or $\overline{\text{CS}}_1 = \text{L}$, and $\overline{\text{CS}}_2 = \text{L}$

□ Don't Care
⊠ Undefined

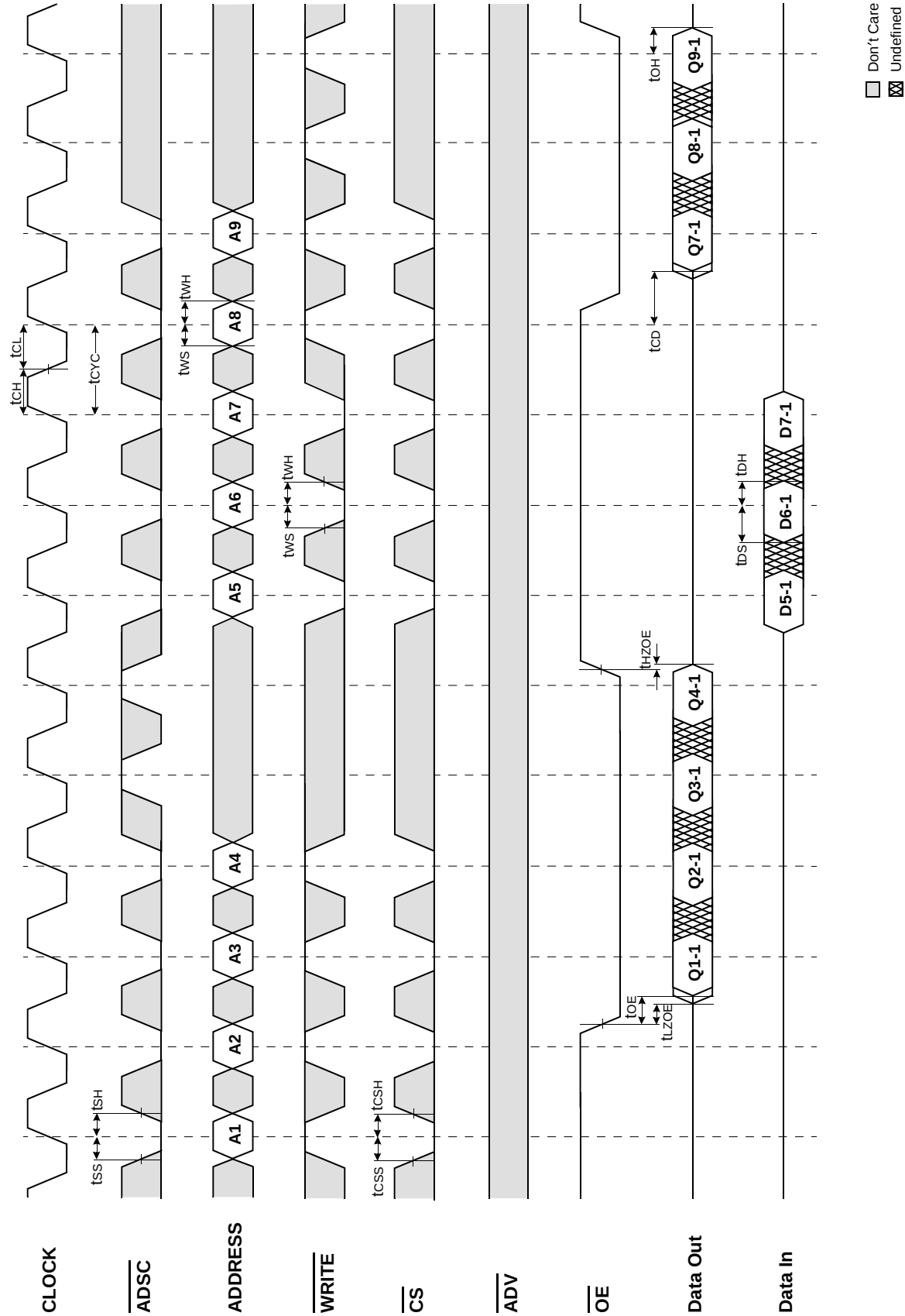
TIMING WAVEFORM OF WRTE CYCLE



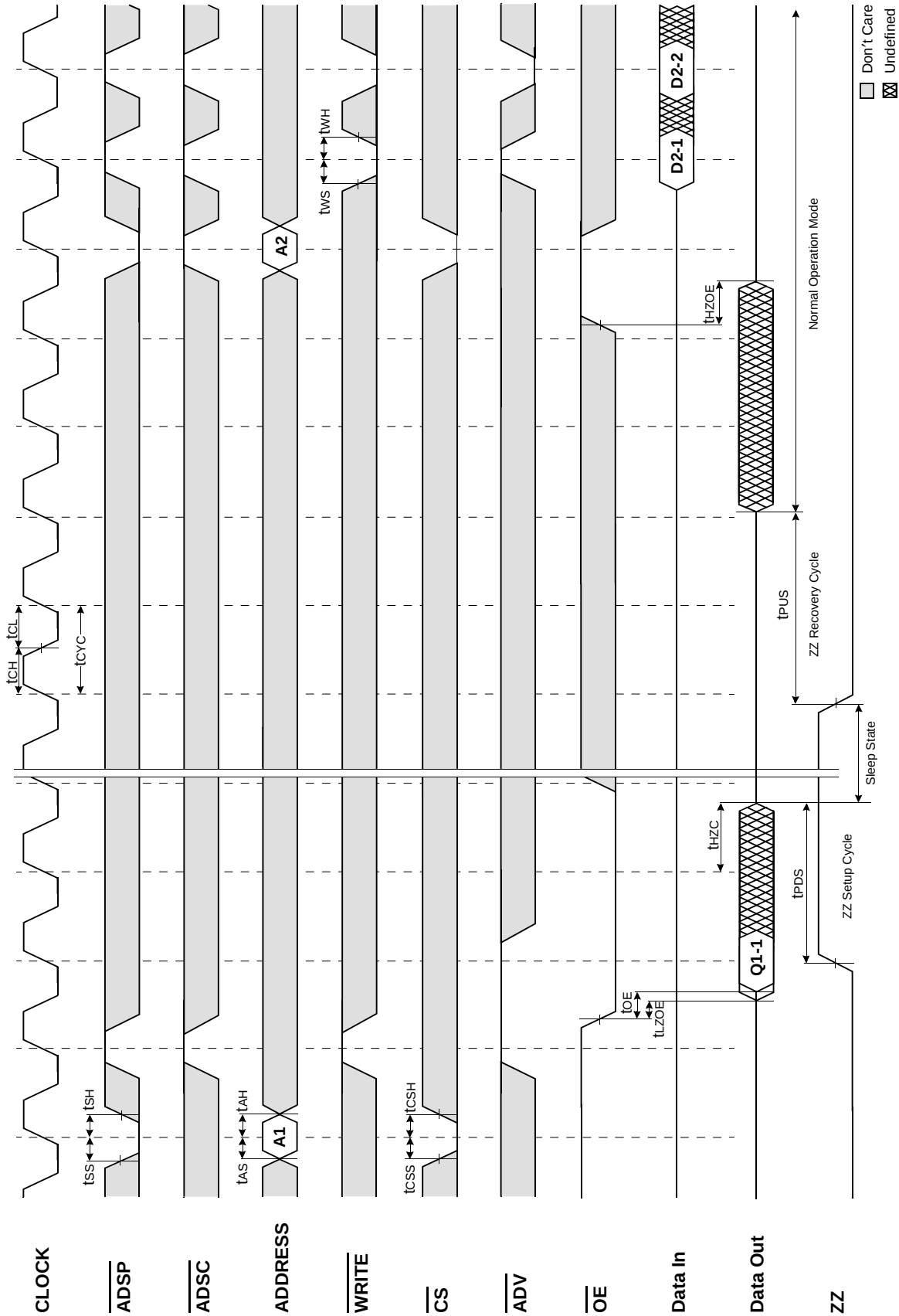
TIMING WAVEFORM OF COMBINATION READ/WRITE CYCLE



TIMING WAVEFORM OF SINGLE READ/WRITE CYCLE



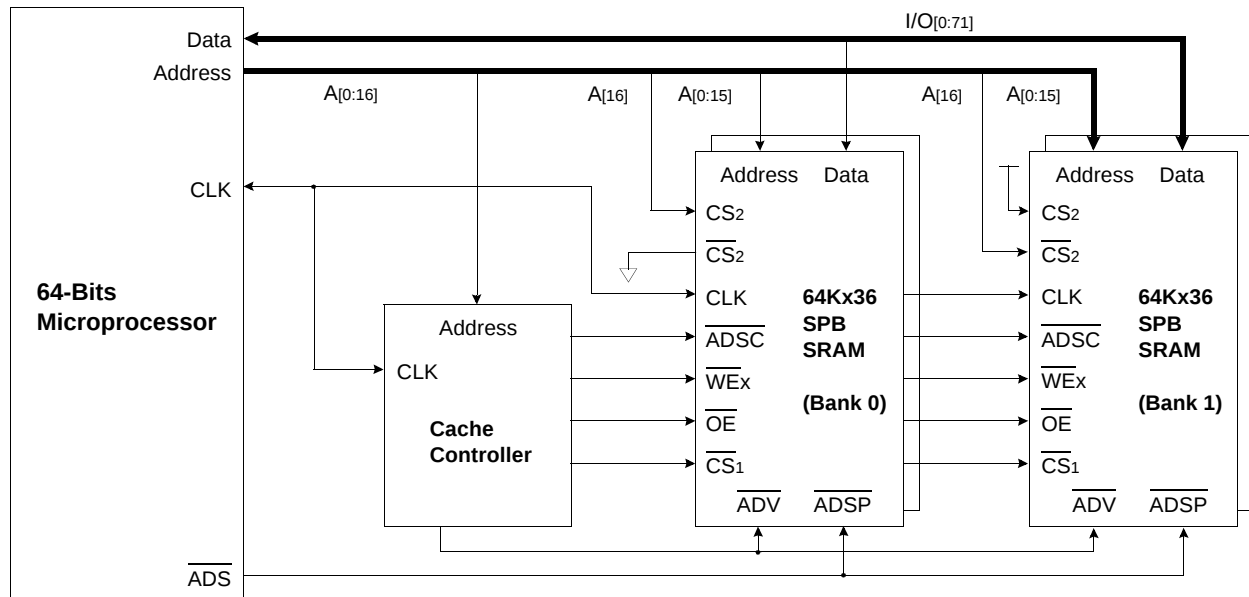
TIMING WAVEFORM OF POWER DOWN CYCLE



APPLICATION INFORMATION

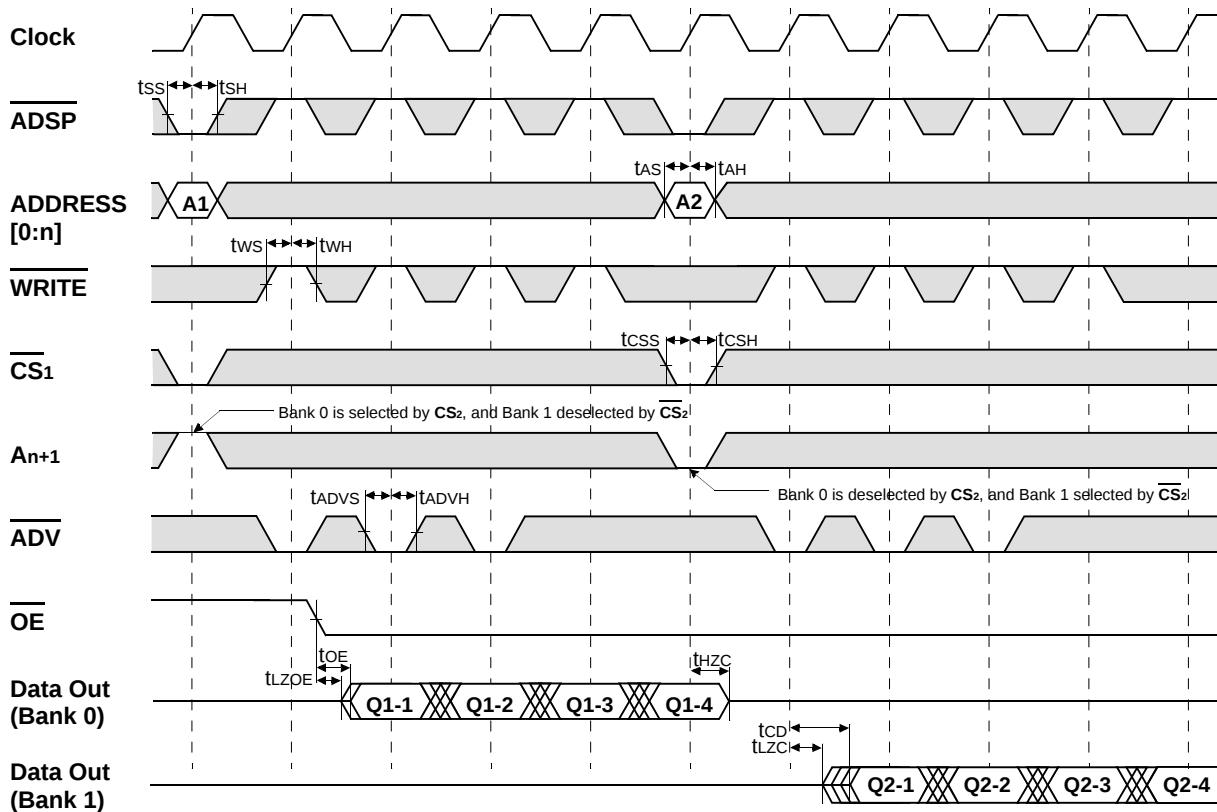
DEPTH EXPANSION

The Samsung 64Kx36 Synchronous Pipelined Burst SRAM has two additional chip selects for simple depth expansion. This permits easy secondary cache upgrades from 64K depth to 128K depth without extra logic.



* Please refer to attached timing diagram 2

INTERLEAVE READ TIMING (Refer to non-interleave write timing for interleave write timing)



*NOTES n = 14 32K depth, 15 64K depth, 16 128K depth, 17 256K depth

□ Don't Care ⊗ Undefined

100-TQFP-1420A