PARADIGM®

32K x 9 Fast CMOS Synchronous Static RAM with Linear Burst Counter

Features

☐ Interfaces directly with the MC68040™ processor (66.6, 60 50, 40 and 33.3 MHz)

☐ High speed access times
  - Clock to data valid times:
    9, 10, 12, 14 ns
  - Cycle times:
    15, 16.6, 20, 25 ns

☐ High density 32K x 9 architecture

☐ Choice of 5V or 3.3V ±10% output Vcc
  for output level compatibility

☐ Self-timed write cycle

☐ Internal linear burst read/write address counter

☐ Internal input registers
  (address, data, and control)

☐ Packages:
  44-pin PLCC

Description

The PDM44659 is a high-performance synchronous CMOS static RAM organized as 32,768 x 9 bits. This product which is produced in Paradigm's proprietary CMOS technology integrates a high-speed SRAM array, input registers (address, data, and control), and a clock input to achieve synchronous read and write access. The PDM44659 was designed with specific control inputs and features to support high-performance secondary cache designs for the MC68040 architecture.

The PDM44659 internal self-timed write logic and input data and address registers eliminate the need for external write pulse generation and permit simplified self-timed write cycles triggered by the rising edge of the clock.

The internal linear burst address counter accepts the first cycle address from the processor, then cycles through the adjacent four locations using the MC68040 burst refill sequence on appropriate rising edges of the system clock.

The PDM44659 is available in a 44-pin plastic leaded chip carrier (PLCC). Multiple power and ground pins minimize effects induced by output noise. Separate power pins are provided for DQ0-DQ8 to allow user-controlled output levels of 5V or 3.3V.
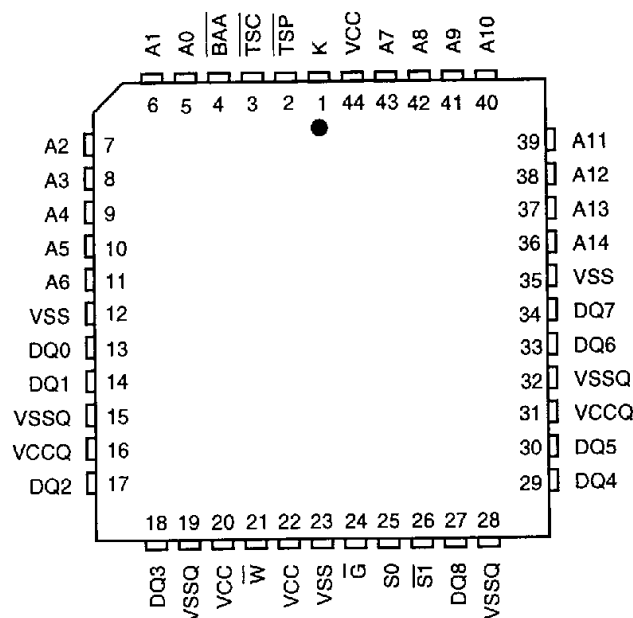
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Functional Block Diagram
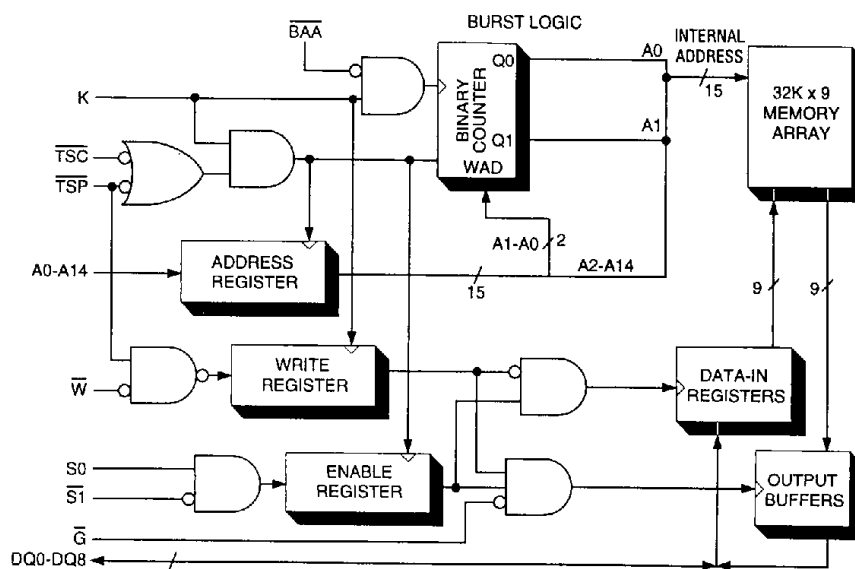
*MC68040 is a trademark of Motorola, Inc.

Pin Assignment

Pin Names

Pin	In/Out	Description	Pin	In/Out	Description
A0-A14	I	Address Inputs	TSC	I	Transfer Start Cache Controller
K	I	Clock	DQ0-DQ8	I/O	Data Input/Output
W	I	Write Enable	VCC		+5V Power Supply
G	I	Output Enable	VCCQ		Output Buffer Power Supply
S0, S1	I	Chip Selects	VSS		Ground
BAA	I	Burst Address Advance	VSSQ		Output Buffer Ground
TSP	I	Transfer Start Processor			

All registers are positive-edge triggered. The state of W determines whether the next cycle will be a read or write cycle. The state of W is sampled at each clock rising edge. If sampled active (low), a write cycle begins; if sampled inactive (high), a read cycle begins. Read and write cycles begin at the current address, which is the base address loaded by TSP or TSC and modified by BAA. TSP overrides W. If TSP is active, W is internally forced inactive. Therefore, the first cycle following TSP is always a read cycle. The TSC or TSP signals control the duration of the burst and the start of the next burst. When TSP is sampled low, any ongoing burst is interrupted and a read (independent of W and TSC) is performed using the new external address. When TSC is sampled low (and TSP is sampled high), any ongoing burst is interrupted and a read or write (dependent on W) is performed using the new external address. chip selects (S0, S1) are sampled only when a new base address is loaded. After the first cycle of the burst, W determines whether the next cycle is a read or write cycle, and BAA controls the advance of the address counter. When BAA is sampled low, the internal address is advanced prior to the operation. When BAA is sampled high, the internal address is not advanced, thus inserting a wait state into the burst sequence accesses. Upon completion of a burst, the address will wrap around to its initial state. See **BURST SEQUENCE FIGURE.**

Synchronous Truth Table (See Notes 1, 2, 3, and 4)

| S	TSP	TSC	BAA	W	K	Address Used	Operation
F	L	X	X	X	L-H	N/A	Deselected
F	X	L	X	X	L-H	N/A	Deselected
T	L	X	X	X	L-H	External Address	Read Cycle, Begin Burst
T	H	L	X	L	L-H	External Address	Write Cycle, Begin Burst
T	H	L	X	H	L-H	External Address	Read Cycle, Begin Burst
X	H	H	L	L	L-H	Next Address	Write Cycle, Continue Burst
X	H	H	L	H	L-H	Next Address	Read Cycle, Continue Burst
X	H	H	H	L	L-H	Current Address	Write Cycle, Suspend Burst
X	H	H	H	H	L-H	Current Address	Read Cycle, Suspend Burst

NOTE: 1. X means Don't Care.
2. All inputs except must meet setup and hold times for the low-to-high transition of clock (K).
3. S represents S0 and $\overline{S1}$. T implies $\overline{S1}$ = L and S0 = H; F implies $\overline{S1}$ = H or S0 = L.
4. Wait states are inserted by suspending burst.

Asynchronous Truth Table (See Notes 1 and 2)

Operation	$\overline{G}$	I/O Status
Read	L	Data Out (DQ0-DQ8)
Read	H	High-Z
Write	X	High-Z -- Data In (DQ0-DQ8)
Deselected	X	High-Z

NOTE: 1. X means Don't Care.
2. For a write operation following a read operation, $\overline{G}$ must be high before the input data required setup time and held high through the input data hold time.

Burst Sequence
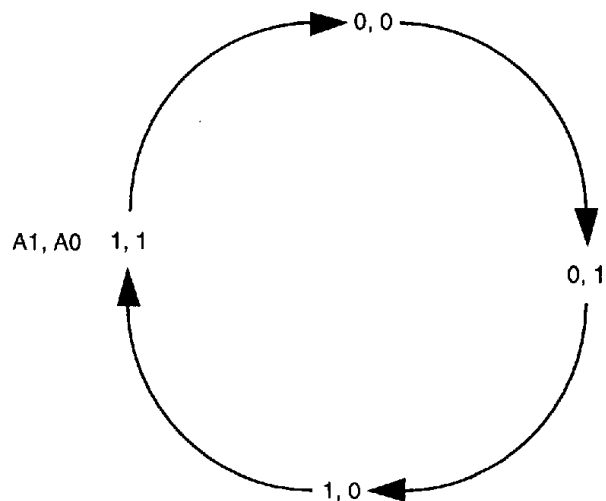
Base address provided with $\overline{TSP}$ or $\overline{TSC}$. The external two values for A1 and A0 provides the starting point for the burst sequence graph. The burst logic advances A1 and A0 as shown above.

6

Absolute Maximum Ratings [1]

Symbol	Rating	Value	Unit
V_{CC}	Power Supply Voltage	–0.5 to +7.0	V
V_{CCQ}	Output Power Supply Voltage	–0.5 to V_{CC}	V
V_{IN}, V_{OUT}	Voltage Relative to V_{SS}	–0.5 to V_{CC} + 0.5	V
I_{OUT}	Output Current (per I/O)	±20	mA
P_D	Power Dissipation (T_A = 70°C, V_{CC} = 5V, t_{KHKH} = 20 ns	1.2	W
T_{BIAS}	Temperature Under Bias	–10 to +85	°C
T_A	Operating Temperature	0 to +70	°C
T_{STG}	Storage Temperature	–55 to +125	°C

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 operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended DC Operating Conditions

Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage		4.75	5.0	5.25	V
V_{CCQ}	Output Supply Voltage	5V TTL	4.5	5.0	5.5	V
		3.3V TTL	3.00	3.3	3.60	V
VSS	Reference Voltage		0	0	0	V
Commercial	Ambient Temperature Range		0	25	70	°C

DC Electrical Characteristics (V_{CC} = 5.0V ±5%)

Symbol	Parameter	Test Conditions	PDM44659S		PDM44659L		Unit
			Min.	Max.	Min.	Max.	
I_{LI}	Input Leakage Current	V_{CC} = MAX., V_{IN} = GND to V_{CC}	–5	5	–2	2	µA
I_{LO}	Output Leakage Current	V_{CC} = MAX., V_{OUT} = GND to V_{CC} $\overline{S1}$ = V_{IH} or S0 = V_{IL}	–5	5	–2	2	µA
V_{OL}	Output Low Voltage	I_{OL}= 8 mA, V_{CC} = Min.	—	0.4	—	0.4	V
		I_{OL} = 10 mA, V_{CC} = Min.	—	0.5	—	0.5	V
V_{OH}	Output High Voltage	I_{OH} = –4 mA, V_{CC} = Min.	2.4	V_{CCQ}	2.4	V_{CCQ}	V

NOTE: 1. V_{IL}(min) = –3.0V for pulse width less than 20 ns.

Power Supply Characteristics

Symbol	Parameter	Power	-9	-10	-12	-14	Unit
I_{CC}	Dynamic Operating Current $\overline{S1} = V_{IL}$, $S0 = V_{IH}$	S	240	220	200	180	mA
	V_{CC} = Max., Outputs Open $f = f_{MAX} = 1/t_{RC}$	L	230	210	190	170	mA
I_{SB}	Standby Current (TTL Level) $\overline{S1} \geq V_{IH}$ or $S0 \leq V_{IL}$	S	90	80	70	60	mA
	V_{CC} = Max., Outputs Open $f = f_{MAX} = 1/t_{RC}$	L	80	70	60	50	mA

NOTES: All Values are maximum guaranteed values.

Capacitance[1] (T_A = +25°C, f = 1.0 MHz)

Symbol	Parameter	Conditions	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	6	pF
C_{OUT}	Output Leakage Current	V_{OUT} = 0V	8	pF

NOTE:1. This parameter is determined by device characterization but is not production tested.

AC Test Conditions

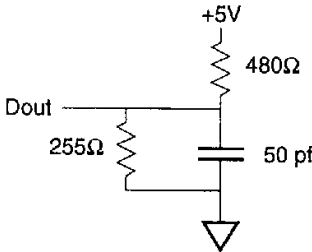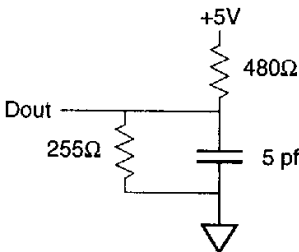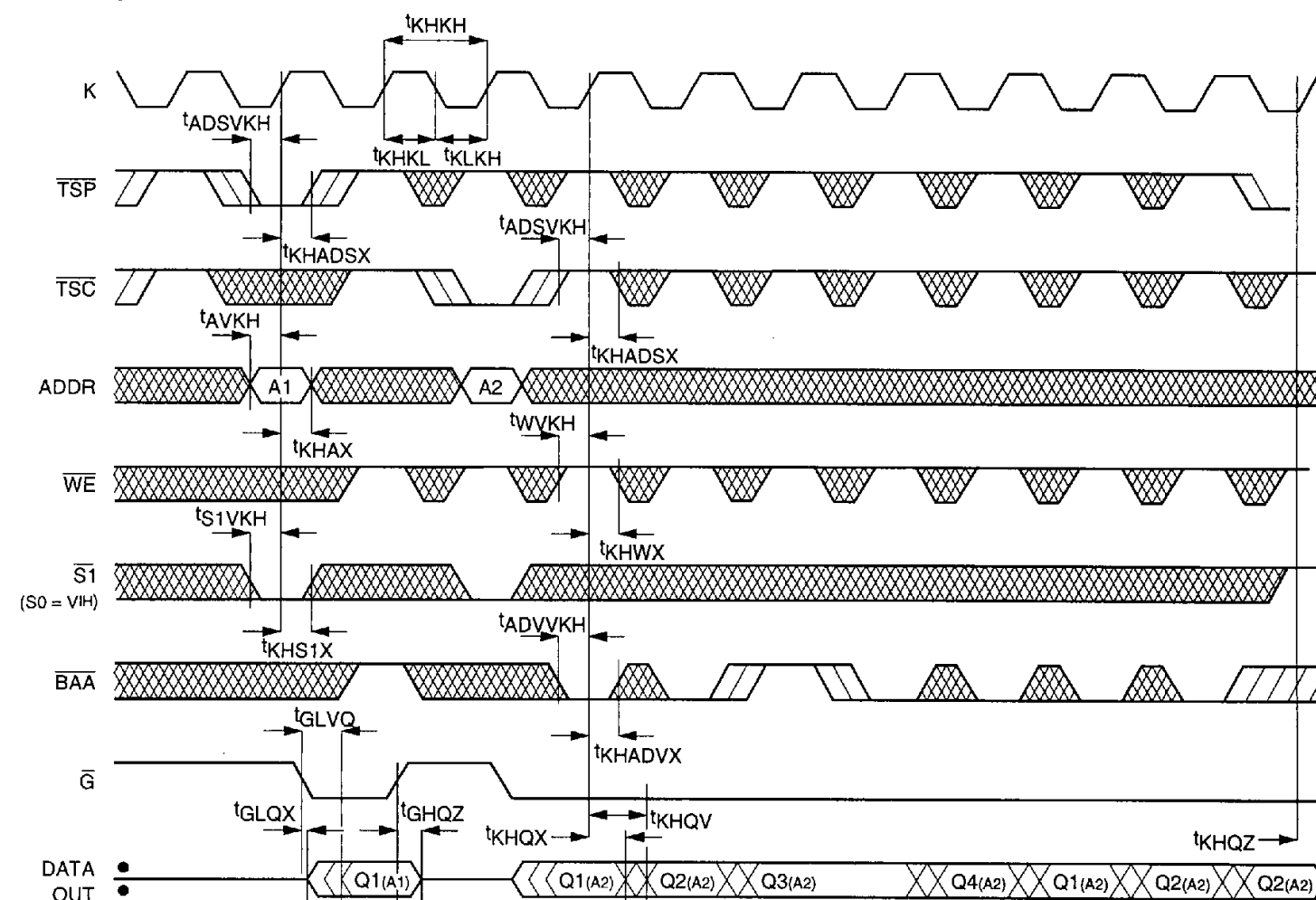|	
Input Pulse Levels	GND to 3.0V
Input rise and fall times	5 ns
Input timing reference levels	1.5V
Output reference levels	1.5V
Output load	See figures 1 and 2

Figure 1. Output Load Equivalent

Figure 2. Output Load Equivalent
(for t_LZ, t_{CZ}, t_{OHZ}, t_{OLZ})

6

Read/Write Cycle Timing   (See Notes 1, 2, 3)

Parameter	Symbol	Alternate Symbol	-09 Min.	-09 Max.	-10 Min.	-10 Max.	-12 Min.	-12 Max.	-14 Min.	-14 Max.	Units
Cycle time	t_{KHKH}	t_{CYC}	15		16.6		20		25		ns
Clock access time, 50 pF load	t_{KHQV}	t_{CD}		9		10		12		14	ns
Clock access time, 0 pF load	t_{KHQVO}	t_{CDO}		7.5		8.5		10		12	ns
Output enable to output valid	t_{GLQV}	t_{OE}		5		5		6		7	ns
Clock High to output active	t_{KHQX}	t_{DC}	3		3		3		3		ns
Output enable to output active[4]	t_{GLQX}	t_{OLZ}	0		0		0		0		ns
Output disable to Q High Z[4]	t_{GHQZ}	t_{OHZ}	2	5	2	5	2	6	2	7	ns
Clock High to Q High Z[4]	t_{KHQZ}	t_{CZ}		6		6		7		8	ns
Clock High to Q Low Z[4]	t_{KHLZ}	t_{LZ}	3		3		3		3		ns
Clock High pulse width	t_{KHKL}	t_{CH}	4		5		6		7		ns
Clock Low pulse width	t_{KLKH}	t_{CL}	4		5		6		7		ns
Setup times for:[5] Address	t_{AVKH}	t_{AS}	2.5		2.5		3		3		ns
Address Status	t_{ADSVKH}	t_{SS}									
Data in	t_{DVKH}	t_{DS}									
Write	t_{WVKH}	t_{WS}									
Address Advance	t_{ADVVKH}										
Chip Select	t_{SOVKH}										
	t_{S1VKH}										
Hold times for:[5] Address	t_{KHAX}	t_{AH}	0.5		0.5		0.5		0.5		ns
Address Status	t_{KHADSX}	t_{SH}									
Data in	t_{KHDX}	t_{DH}									
Write	t_{KHWX}	t_{WH}									
Address Advance	t_{KHADVX}										
Chip Select	t_{KHSOX}										
	t_{KHS1X}										

Notes:
1. A read cycle is defined by $\overline{W}$ high or $\overline{TSP}$ low for the setup and hold times. A write cycle is defined by $\overline{W}$ low for the setup and hold times.
2. All read and write cycle timings are referenced from (K).
3. $\overline{G}$ is a "don't care" when $\overline{W}$ is low.
4. Transition is measured ±200 mV from steady-state voltage with load of Figure 2. This parameter is sampled and not 100% tested. At any given voltage and temperature, t_{GHQZ} max is less than t_{GLQX} min for a given device and from device to device.
5. This is a synchronous device. All synchronous inputs must meet the specified setup and hold times with stable logic levels for *ALL* rising edges of clock (K). Chip Select must be true ($\overline{S1}$ low and S0 high) at each rising edge of clock for the device (when $\overline{TSP}$ or $\overline{TSC}$ is low) to remain enabled.
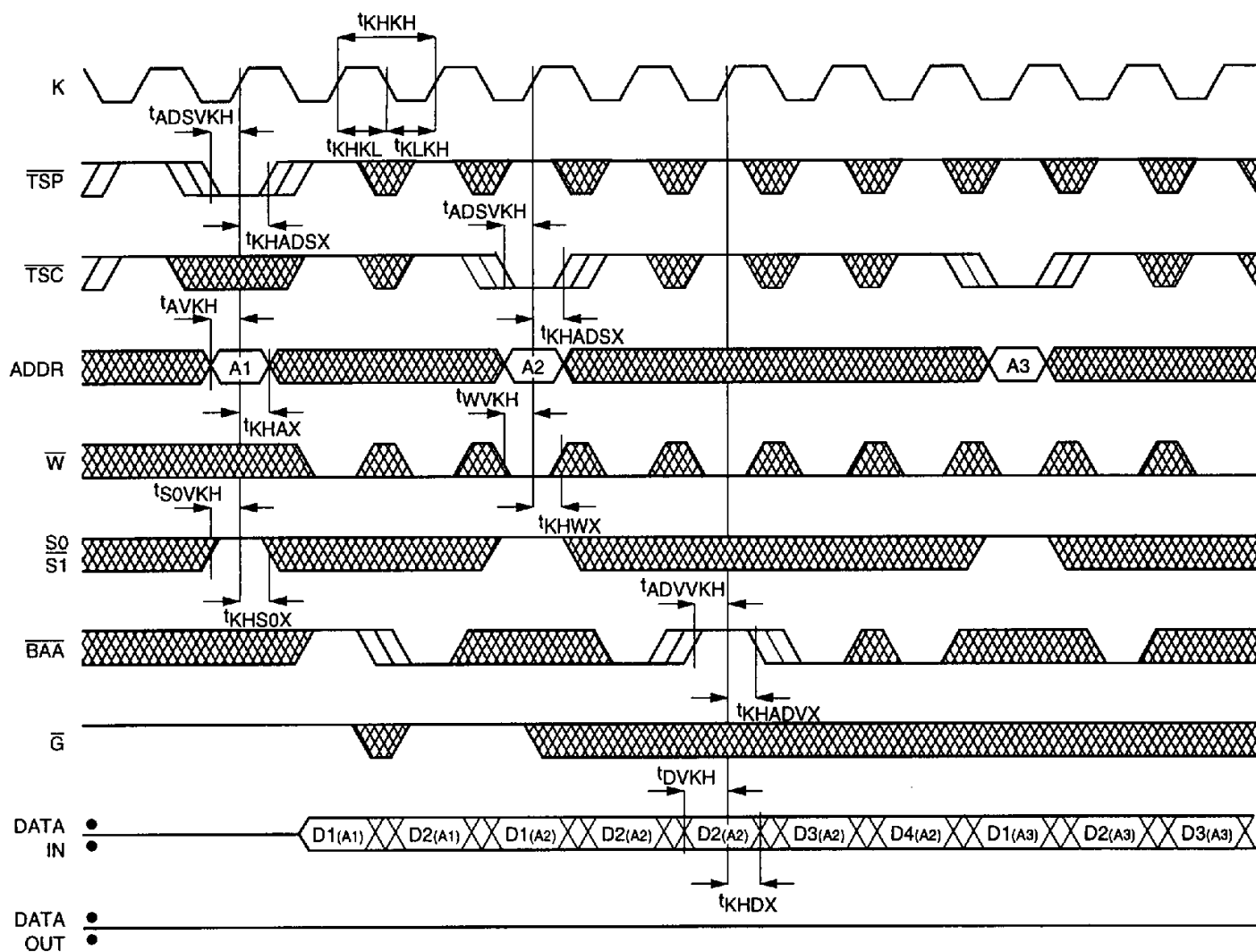
Read Cycle

K

^{t}KHKH

^{t}ADSVKH

^{t}KHKL ^{t}KLKH

$\overline{TSP}$

^{t}ADSVKH

^{t}KHADSX

$\overline{TSC}$

^{t}AVKH

^{t}KHADSX

ADDR A1 A2

^{t}KHAX

^{t}WVKH

$\overline{WE}$

^{t}S1VKH

^{t}KHWX

$\overline{S1}$
(S0 = V$_{IH}$)

^{t}KHS1X

^{t}ADVVKH

$\overline{BAA}$

^{t}GLVQ

^{t}KHADVX

$\overline{G}$

^{t}GLQX ^{t}GHQZ ^{t}KHQX ^{t}KHQV ^{t}KHQZ

DATA
OUT Q1(A1) Q1(A2) Q2(A2) Q3(A2) Q4(A2) Q1(A2) Q2(A2) Q2(A2)

NOTE:
Q1(A2) represents the first output data from the base address A2;
Q2(A2) represents the next output data in the burst sequence with A2 as the base address.

6

Write Cycle

Note: $\overline{W}$ is ignored for the first cycle when $\overline{TSP}$ initiates the burst. $\overline{TSP}$ active loads a new base address and forces the first cycle to be a read cycle.

Combined Read/Write Cycle
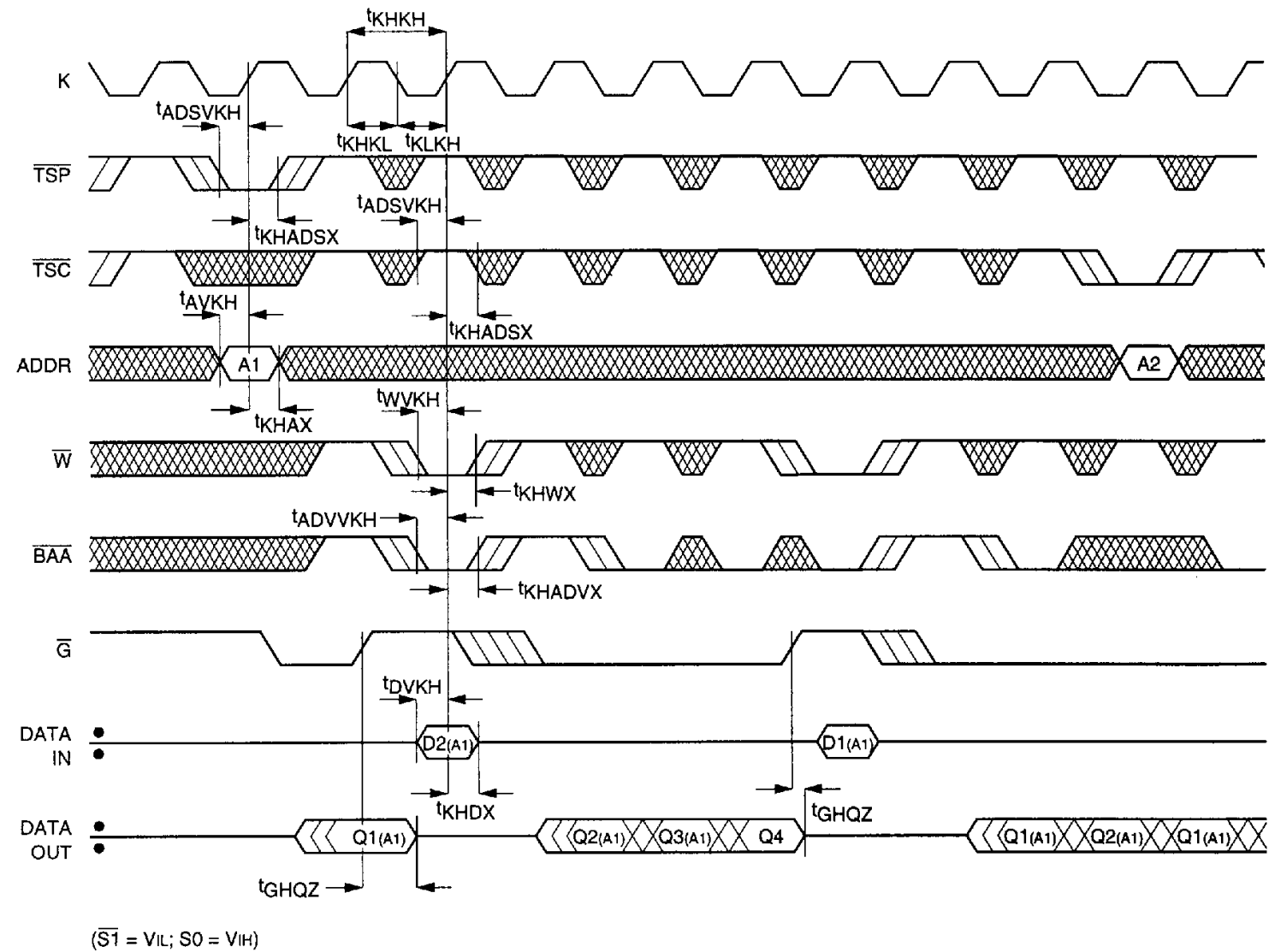
$(\overline{S1} = V_{IL}; S0 = V_{IH})$

Note: $\overline{W}$ is ignored for the first cycle when $\overline{TSP}$ initiates the burst. $\overline{TSP}$ active loads a new base address and forces the first cycle to be a read cycle.

Ordering Information

PDM   XXXXX   A   XX   A   A
     Device Type   Power   Speed   Package   Process / Temperature Range

Blank   Commercial (0° to +70°C)

J   44-Pin PLCC

9
10
12
14

S   Standard Power
L   Low Power

44659   32K x 9 Synchronous Static RAM w/Burst Counter

Chip	Package Type
PDM44659	44-pin Plastic LCC