

32K x 36 Fast CMOS Synchronous Static RAM with Linear Burst Counter and Output Register

Features

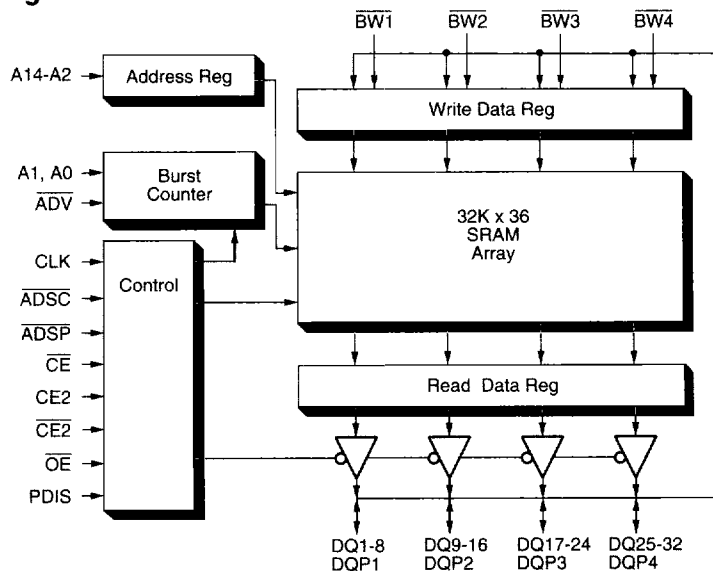
- Interfaces directly with the Motorola 680x0 and PowerPC™ microprocessors (100, 80, 66, 60, 50 MHz)
- High-speed access times
 - Clock to data valid times: 4.5, 5, 6, 7, 8 ns
 - Cycle times: 8, 10, 13, 15 ns
- High-density 32K x 36 architecture
- Output register for pipelined designs
- Choice of 5V or 3V ($\pm 10\%$) output Vcc for output level compatibility
- High-output drive: 30 pF at rated T_A
- Asynchronous output enable
- Self-timed write cycle
- Individual byte write controls
- Internal interleaved burst read / write address counter
- Internal registers for address, data, controls
- Packages: 100-pin TQFP - TQ

Description

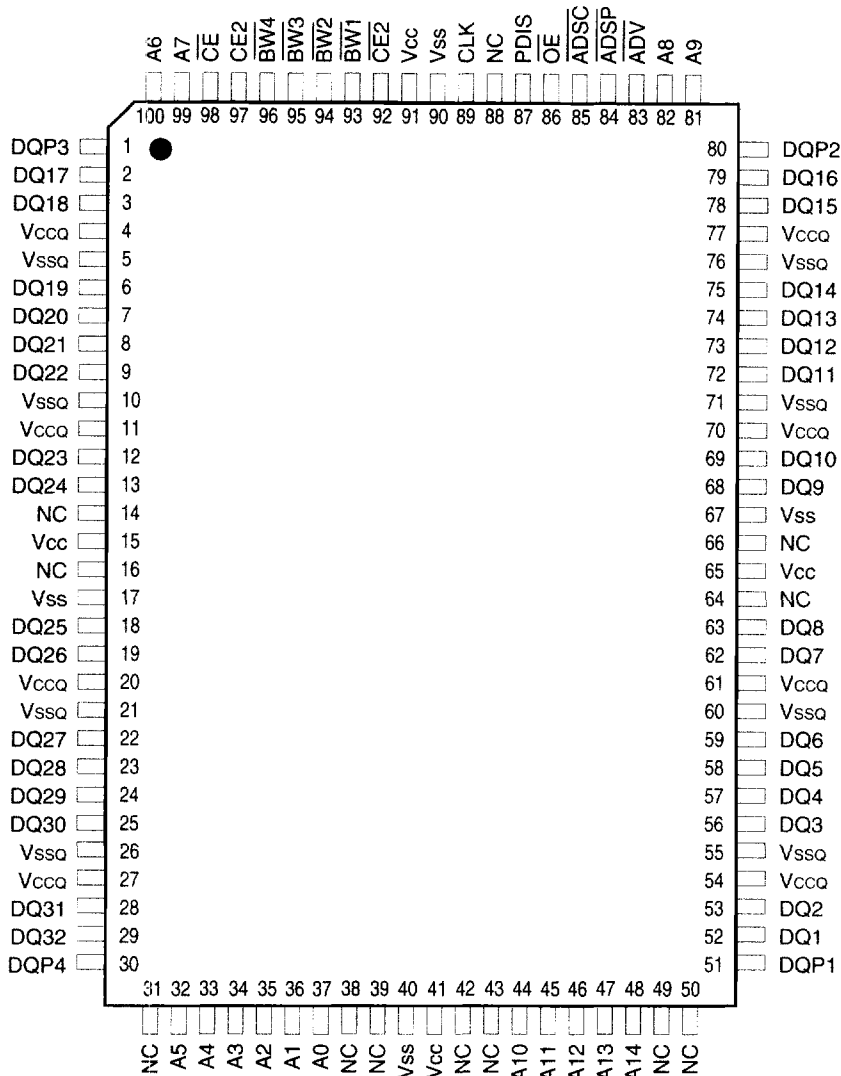
The PDM44066 is a 1,179,648 bit synchronous random access memory organized as 32,768 x 36 bits. It has burst mode capability and interface controls designed to provide high-performance in second level cache designs for Motorola 680x0 and PowerPC microprocessors. Addresses, write data and all control signals except output enable are controlled through positive edge-triggered registers. Write cycles are self-timed and are also initiated by the rising edge of the clock. Controls are provided to allow burst reads and writes of up to four words in length. A 2-bit burst address counter controls the two least-significant bits of the address during burst reads and writes. The burst address counter uses the 2-bit counting scheme required by the Motorola 680x0 and PowerPC microprocessors. Individual write strobes provide byte write for the four 9-bit bytes of data. An asynchronous output enable simplifies interface to high-speed buses. Separate output Vcc pins provide user-controlled 5V or 3.3V TTL-compatible output levels.

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Functional Block Diagram



Pin Assignment



Pinout

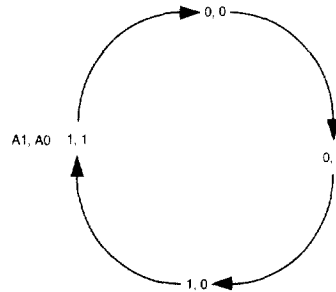
| Name | I/O | Description | Name | I/O | Description |
|-----------|-----|----------------------------------|------------------|-----|--------------------------------------|
| A14-A2 | I | Address Inputs A14-A2 | CE, CE2, CE2 | I | Chip Enables |
| A1, A0 | I | Address Inputs A1 & A0 | BW1-BW4 | I | Byte Write Enables |
| DQ1-DQ32 | I/O | Read/Write Data | OE | I | Output Enable |
| DQP1-DQP4 | I/O | Read/Write Data | CLK | I | Clock |
| PDIS | I | Parity Disable (disables DQP1-4) | V _{CC} | — | Array Power (+5V) |
| ADV | I | Burst Counter Advance | V _{CCQ} | — | Output Power for DQ's (+3.3V or +5V) |
| ADSC | I | Controller Address Status | V _{SS} | — | Array Ground |
| ADSP | I | Processor Address Status | V _{SSQ} | — | Output Ground for DQ's |

Asynchronous Truth Table

| Operation | OE | I/O Status |
|------------|----|-----------------------|
| Read | L | Data Out |
| Read | H | High-Z |
| Write | X | High-Z: Write Data In |
| Deselected | X | High-Z |

- NOTE: 1. L = Low, H = High, X = Don't Care.
 2. For a write operation following a read operation, OE 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 ADSP or ADSC. 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.

Synchronous Truth Table (See Notes 1 through 4)

| CE, CE2, CE2 | ADSP | ADSC | ADV | BW1-BW4 | CLK | Address | Operation |
|-----------------|------|------|-----|---------|-----|----------|-----------------------------|
| HXX, XLX or XXH | X | L | X | X | ↑ | N/A | Deselected |
| LHL | L | X | X | X | ↑ | External | Read Cycle, Begin Burst |
| LHL | H | L | X | L | ↑ | External | Write Cycle, Begin Burst |
| LHL | H | L | X | H | ↑ | External | Read Cycle, Begin Burst |
| X | H | H | L | L | ↑ | Next | Write Cycle, Continue Burst |
| X | H | H | L | H | ↑ | Next | Read Cycle, Continue Burst |
| X | H | H | H | L | ↑ | Current | Write Cycle, Suspend Burst |
| X | H | H | H | H | ↑ | Current | Read Cycle, Suspend Burst |
| HXX | X | H | L | L | ↑ | Next | Write Cycle, Continue Burst |
| HXX | X | H | L | H | ↑ | Next | Read Cycle, Continue Burst |
| HXX | X | H | H | L | ↑ | Current | Write Cycle, Suspend Burst |
| HXX | X | H | H | H | ↑ | Current | Read Cycle, Suspend Burst |

- NOTE: 1. L = Low, H = High, X = Don't Care, ↑ = Low-to-High transition.
 2. All inputs except OE must meet setup and hold times relative low-to-high transition of clock, CLK.
 3. Wait states are inserted by suspending burst.
 4. ADSP is gated by CE. Both ADSP and CE must be valid for ADSP to load the address register and force a read.

Burst Mode Operation

This is a synchronous part. All activities are initiated by the positive, low-to-high edge of the clock (CLK). This part can perform burst reads and writes with burst lengths of up to four words. The four word burst is created by using a burst counter to drive the two least-significant bits of the internal RAM address. The burst counter is loaded at the start of the burst and is incremented for each word of the burst. The burst counter uses a binary sequence compatible with the cache line burst reload sequence of PowerPC microprocessors. This sequence is given in the Burst Sequence Table.

Burst transfers are initiated by the \overline{ADSC} or \overline{ADSP} signals. When the \overline{ADSP} and \overline{CE} signals are sampled low, a read cycle is started (independent of $\overline{BW1}$, $\overline{BW2}$, $\overline{BW3}$, or $\overline{BW4}$ and \overline{ADSC}), and prior burst activity is terminated. \overline{ADSP} is gated by \overline{CE} , so both must be active for \overline{ADSP} to load the address register and to initiate a read cycle. The address and the chip enable input (\overline{CE}) are sampled by the same edge that samples \overline{ADSP} . Read data is valid at the output after the specified delay from the clock edge.

When \overline{ADSC} is sampled low and \overline{ADSP} is sampled high, a read or write cycle is started depending on the state of $\overline{BW1}$, $\overline{BW2}$, $\overline{BW3}$, or $\overline{BW4}$. If $\overline{BW1}$, $\overline{BW2}$, $\overline{BW3}$, and $\overline{BW4}$ are all sampled high, a read cycle is started, as described above. If $\overline{BW1}$, $\overline{BW2}$, $\overline{BW3}$, or $\overline{BW4}$ is sampled low, a write cycle is begun. The address, write data, and the chip enable inputs (\overline{CE} , $\overline{CE2}$ and $\overline{CE2}$) are sampled by the same edge that samples \overline{ADSC} and $\overline{BW1}$ – $\overline{BW4}$. The \overline{ADV} line is held high for this clock edge to maintain the correct address for the internal write operation which will follow this second clock edge.

After the first cycle of the write burst, the state of $\overline{BW1}$ – $\overline{BW4}$ determines whether the next cycle is a read or write cycle, and \overline{ADV} controls the advance of the address counter. The \overline{ADV} signal advances the address counter. This increments the address to the next available RAM address. You write the next word in the burst by taking \overline{ADV} low and presenting the write data at the positive edge of the clock. If \overline{ADV} is sampled low, the burst counter advances and the write data (which is sampled by the same clock) is written into the internal RAM during the time following the clock edge.

This part has an output register. Output read data is available one cycle after the address register and burst counter are loaded or the burst counter is incremented.

Absolute Maximum Ratings ⁽¹⁾

| Symbol | Rating | Com'l. | Ind. | Unit |
|-------------------|--------------------------------------------------|--------------|--------------|------|
| V _{TERM} | Terminal Voltage with Respect to V _{SS} | -0.5 to +7.0 | -0.5 to +7.0 | V |
| T _{BIAS} | Temperature Under Bias | -55 to +125 | -65 to +135 | °C |
| T _{STG} | Storage Temperature | -55 to +125 | -65 to +150 | °C |
| P _T | Power Dissipation | 1.5 | 1.5 | W |
| I _{OUT} | DC Output Current | 50 | 50 | mA |
| T _J | Maximum Junction Temperature ⁽²⁾ | 125 | 125 | °C |

NOTE: 1. 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.

2. Appropriate thermal calculations should be performed in all cases and specifically for those where the chosen package has a large thermal resistance (e.g., TSOP). The calculation should be of the form: $T_j = T_a + P * \theta_{ja}$ where T_a is the ambient temperature, P is average operating power and θ_{ja} the thermal resistance of the package. For this product, use the following θ_{ja} value:

TQFP: 50° C/W

Recommended DC Operating Conditions

| Symbol | Description | Min. | Typ. | Max. | Unit | |
|------------------|---------------------|------|------|------|------|---|
| V _{CC} | Supply Voltage | 4.75 | 5.0 | 5.25 | V | |
| V _{CCQ} | | 5V | 4.5 | 5.0 | 5.5 | V |
| | | 3.3V | 3.0 | 3.3 | 3.6 | V |
| V _{SS} | Supply Voltage | 0 | 0 | 0 | V | |
| Industrial | Ambient Temperature | -40 | 25 | 85 | °C | |
| Commercial | Ambient Temperature | 0 | 25 | 70 | °C | |

DC Electrical Characteristics (V_{CC} = 5.0V ± 5%, All Temperature Ranges)

| Symbol | Description | Test Conditions | Min. | Max. | Unit |
|-----------------|----------------------------------|-------------------------------------------------------------------------------|------|------------------|------|
| I _{LJ} | Input Leakage Current | V _{CC} = MAX., V _{IN} = V _{SS} to V _{CC} | — | 1 | μA |
| I _{LO} | Output Leakage Current | V _{CC} = MAX., V _{OUT} = V _{SS} to V _{CC} | — | 1 | μA |
| V _{OL} | Output Low Voltage | V _{CC} = Min., I _{OL} = 8 mA | 0 | 0.4 | V |
| V _{OH} | Output High Voltage | V _{CC} = Min., I _{OH} = -4 mA | 2.4 | V _{CCQ} | V |
| V _{IH} | Input HIGH Voltage | | 2.2 | 6 | V |
| V _{IL} | Input LOW Voltage ⁽¹⁾ | | -0.5 | 0.8 | V |

NOTE: 1. Undershoots to -1.5 for 10 ns are allowed once per cycle.

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Power Supply Characteristics

| Symbol | Description | Test Conditions | -4.5 | -5 ns | -6 ns | -7 ns | -8 ns | Unit |
|------------------|----------------------------------------|---------------------------------------------------------------------------------------------------|------|-------|-------|-------|-------|------|
| I _{CC1} | Active Supply Current: Outputs Open | V _{CC} = Max., Inputs @ 0.0V or 3.0V f = 1/t _{CYC} on Rclk & Wclk | 390 | 380 | 370 | 360 | 360 | mA |
| I _{SB} | Standby Current: Outputs Open | V _{CC} = Max., Inputs @ 0.0V or 3.0V f = 1/t _{CYC} , CE = V _{IH} | 135 | 130 | 125 | 120 | 120 | mA |

SHADED AREA = PRELIMINARY DATA

NOTE: All values are maximum guaranteed values

Capacitance (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 Capacitance | V _{OUT} = 0V | 8 | pF |

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

AC Test Conditions

| | |
|-------------------------------|---------------------|
| Input pulse levels | V_{SS} to 3.0V |
| Input rise and fall times | 3 ns |
| Input timing reference levels | 1.5V |
| Output reference levels | 1.5V |
| Output Load | See Figures 1 and 2 |

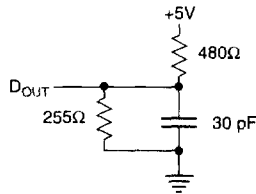


Figure 1. Output Load Equivalent

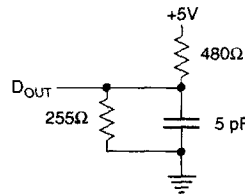


Figure 2. Output Load Equivalent
(for t_{LZCE} , t_{HZCE} , t_{LZWE} , t_{HZWE} , t_{LZOE} , t_{HZOE})

AC Electrical Characteristics

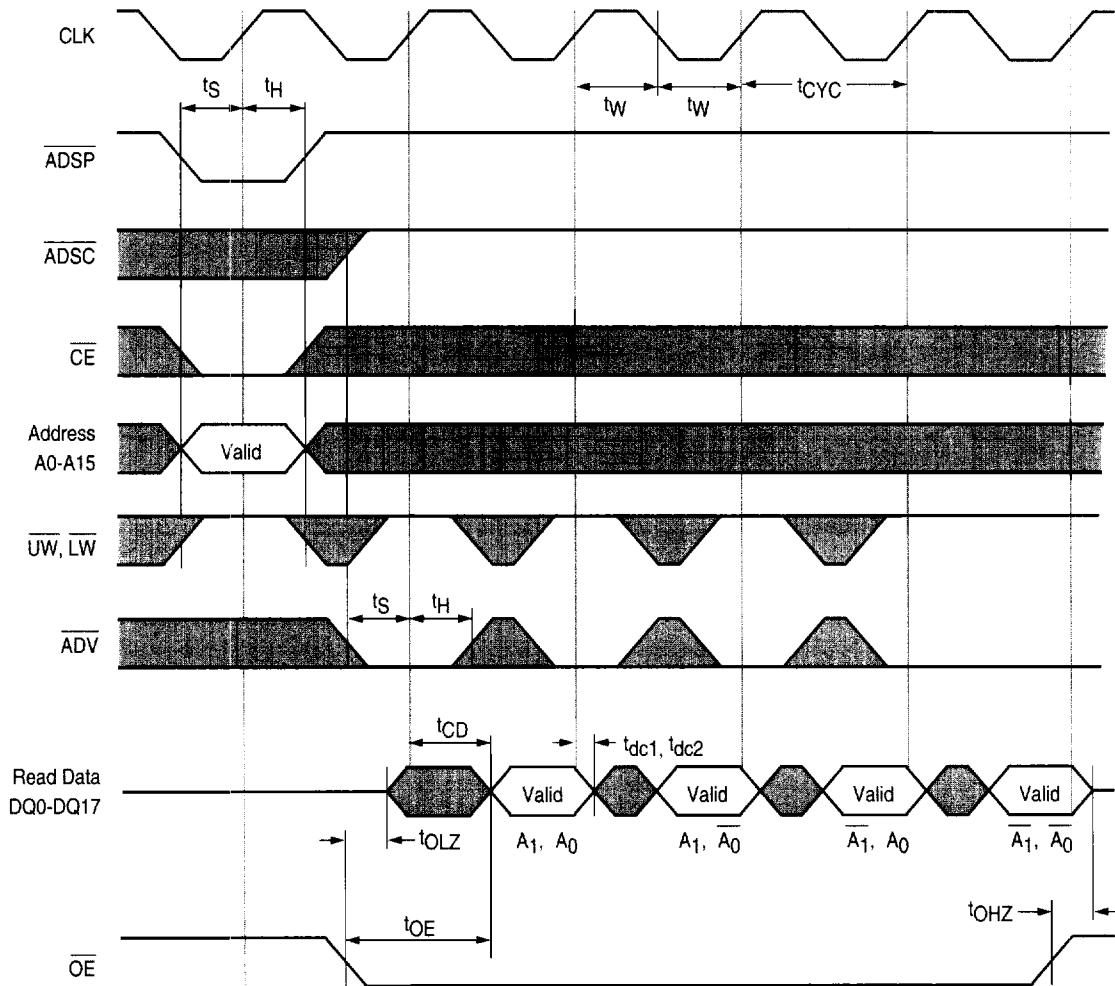
| Parameter | Symbol | -4.5 | -5 | -6 | -7 | -8 | Type | Units |
|-------------------------------------------------|-----------|------|-----|-----|-----|-----|------|-------|
| Clock cycle time | t_{CYC} | 8 | 10 | 13 | 15 | 15 | Min. | ns |
| Clock to data valid (std. load) | t_{CD} | 4.5 | 5 | 6 | 7 | 8 | Max. | ns |
| Clock to data valid (0 pF load) | t_{CD0} | 4 | 4 | 5 | 6 | 7 | Min. | ns |
| Output enable | t_{OE} | 4.5 | 5 | 5 | 5 | 5 | Max. | ns |
| Clock to data low-Z | t_{dc1} | 2 | 3 | 3 | 3 | 3 | Min. | ns |
| Clock to data hold time | t_{dc2} | 2 | 3 | 3 | 3 | 3 | Min. | ns |
| Output enable to output low-Z ⁽¹⁾ | t_{OLZ} | 0 | 0 | 0 | 0 | 0 | Min. | ns |
| Output enable to output high-Z ^(1,5) | t_{OHZ} | 2 | 2 | 2 | 2 | 2 | Min. | ns |
| | | 3 | 4 | 5 | 5 | 5 | Max. | ns |
| Clock to data high-Z ^(1,5) | t_{CHZ} | 4 | 5 | 6 | 6 | 6 | Max. | ns |
| Clock high/low | t_W | 3 | 4 | 4.5 | 5 | 5 | Min. | ns |
| Setup time ⁽⁶⁾ | t_S | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | Min. | ns |
| Hold time ⁽⁶⁾ | t_H | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | Min. | ns |

SHADED AREA = PRELIMINARY DATA

NOTES:

1. Values characterized and guaranteed by design, not currently tested.
2. A read cycle is defined by $BW1$, $BW2$, $BW3$ and $BW4$ high or $ADSP$ low for the setup and hold times. A write cycle is defined by $BW1$, $BW2$, $BW3$ or $BW4$ low and $ADSP$ high for the setup and hold times.
3. All read and write cycle timings are referenced from CLK or OE .
4. OE is a "don't care" when $BW1$, $BW2$, $BW3$ or $BW4$ is sampled low.
5. Transition is measured ± 500 mV from steady-state voltage with load of Figure 1b. This parameter is sampled rather than 100% tested. At any given voltage and temperature, t_{CHZ} max is less than t_{dc1} min for a given device and from device to device.
6. This is a synchronous device. All addresses must meet the specified setup and hold times for ALL rising edges of CLK whenever $ADSP$ or $ADSC$ is low, and the chip is enabled. Chip enable must be valid at each rising edge of clock for the device (when $ADSP$ or $ADSC$ is low) to remain enabled.
7. This device has an output data register. Read data is available one clock cycle after the address register and burst counter have been loaded or the burst counter has been incremented.

ADSP Read Timing Diagram

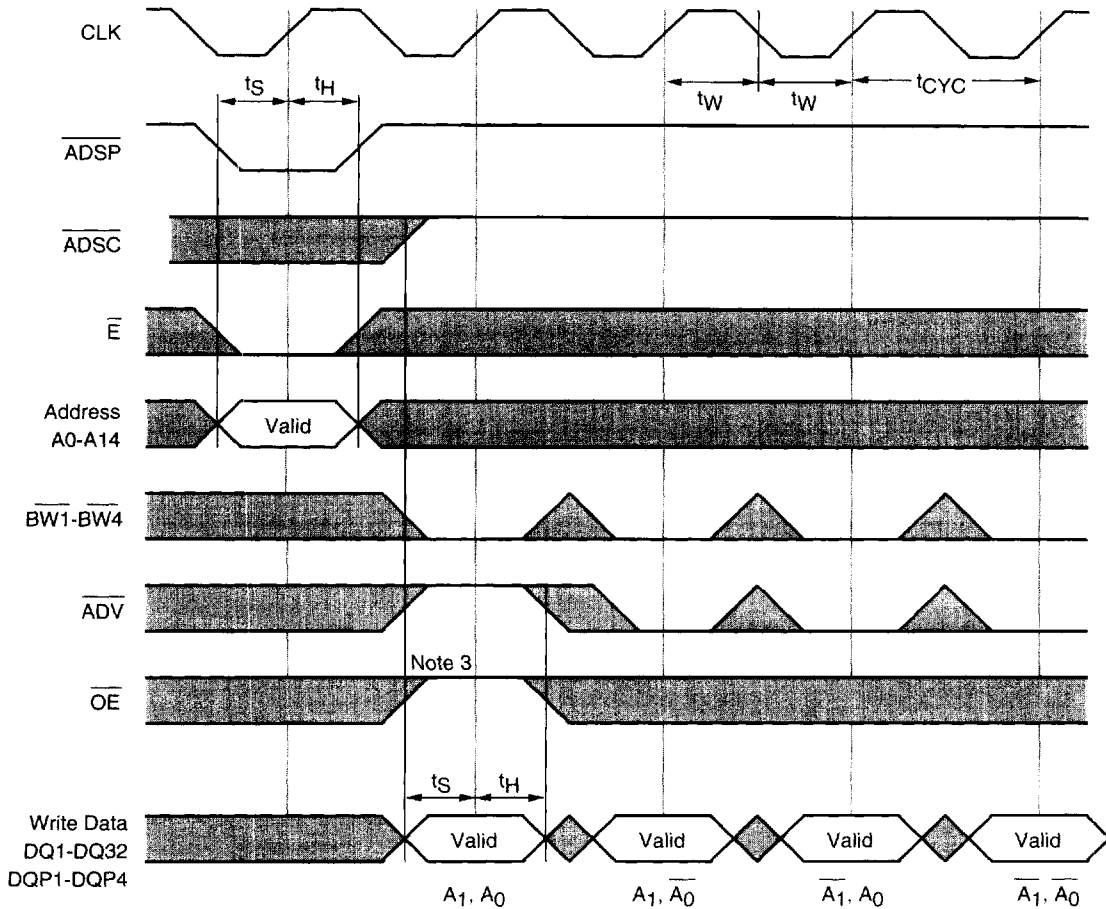


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NOTE:

1. \overline{E} is low when $\overline{CE} = \text{low}$, $CE2 = \text{high}$ and $\overline{CE2} = \text{low}$. \overline{E} is high otherwise.

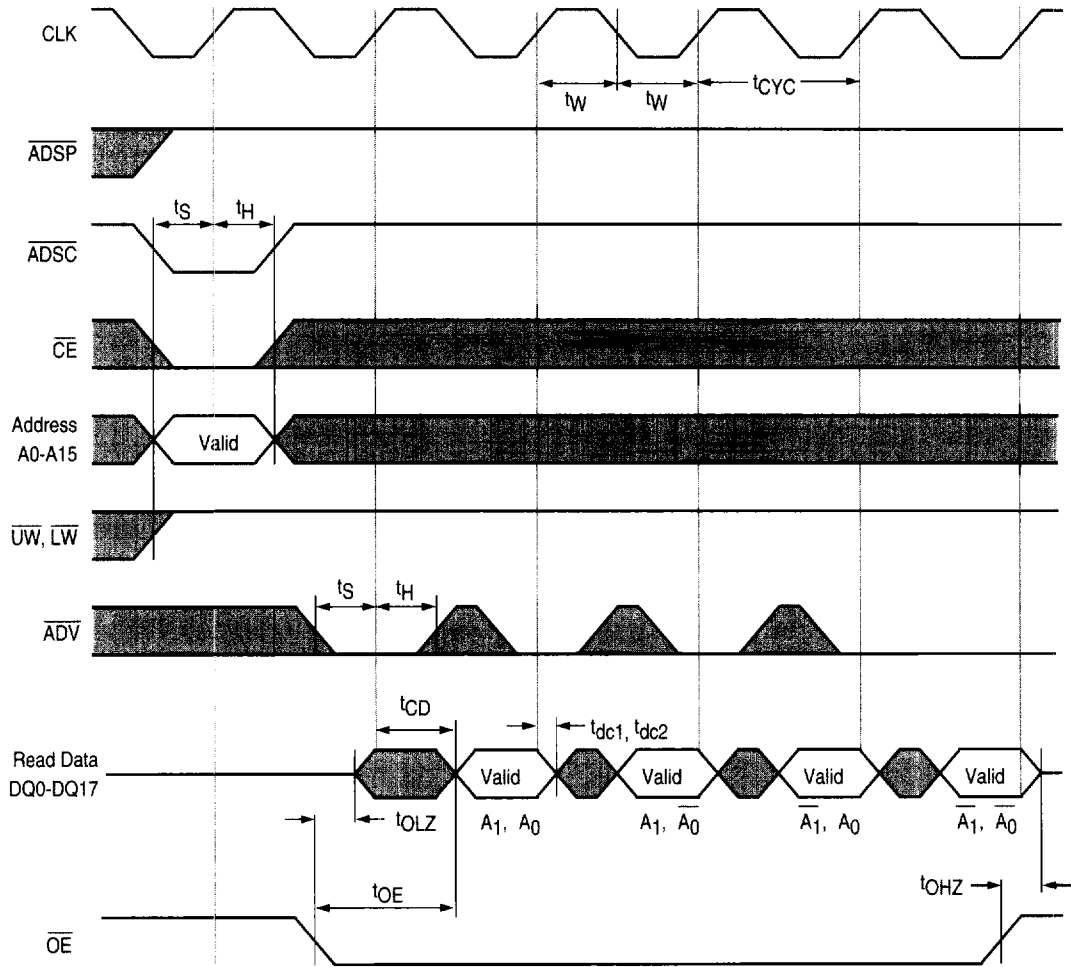
ADSP Write Timing Diagram



NOTES:

1. \bar{E} is low when $\bar{CE} = \text{low}$, $CE2 = \text{high}$ and $\bar{CE}2 = \text{low}$. \bar{E} is high otherwise.
2. $\bar{BW}1-\bar{BW}4$ are ignored for the first cycle when \bar{ADSP} initiates the burst. \bar{ADSP} active loads a new address into the address counter and forces the first cycle to be a read cycle.
3. \bar{OE} is high before data in setup.

ADSC Read Timing Diagram

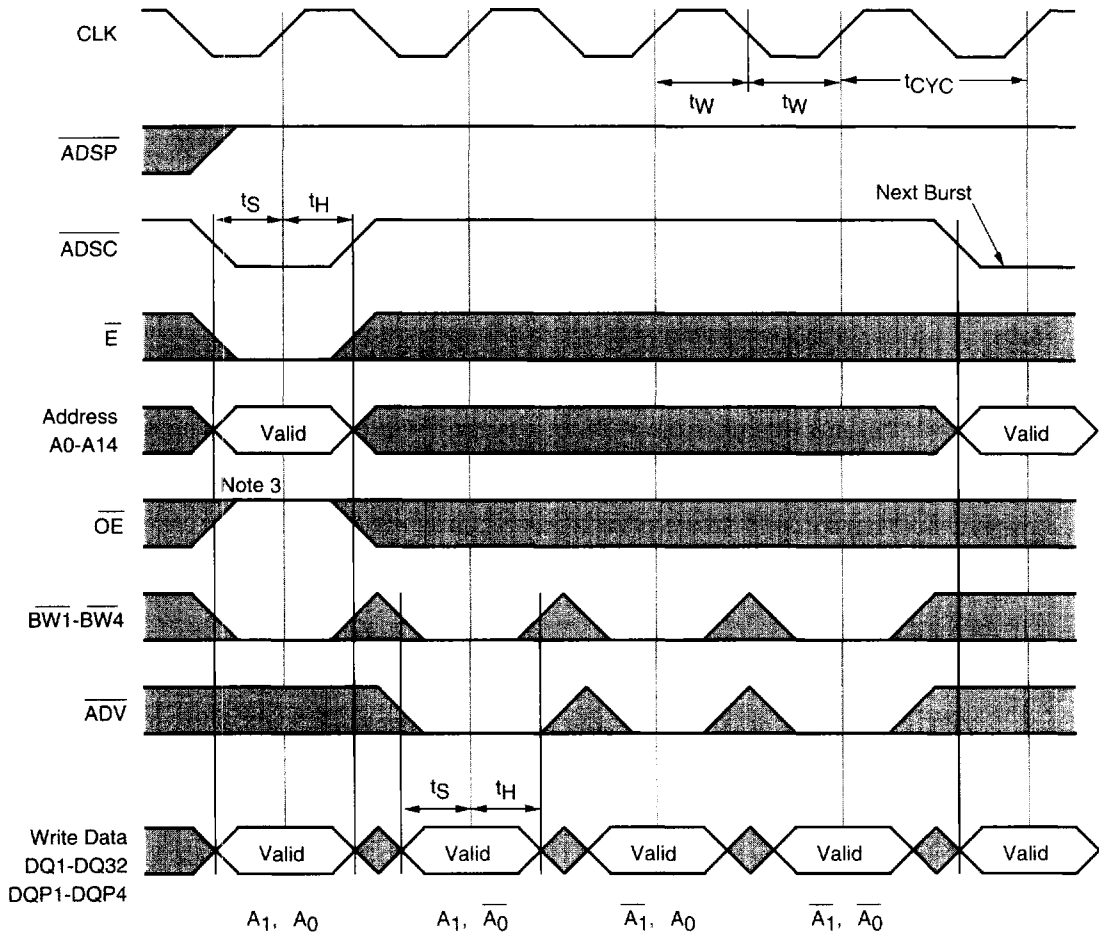


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NOTES:

1. \bar{E} is low when $\bar{CE} = \text{low}$, $CE2 = \text{high}$ and $\bar{CE}2 = \text{low}$. \bar{E} is high otherwise.

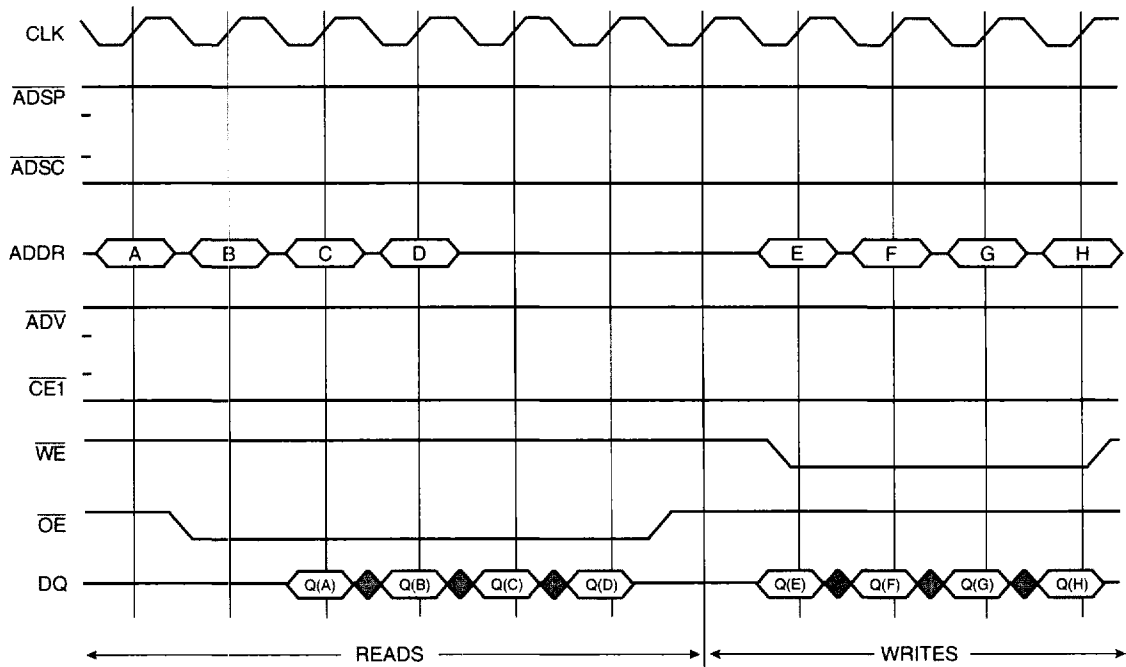
ADSC Write Timing Diagram



NOTES:

- \bar{E} is low when $\bar{CE} = \text{low}$, $CE2 = \text{high}$ and $\bar{CE}2 = \text{low}$. \bar{E} is high otherwise.
- $\bar{BW}1-\bar{BW}4$ are ignored for the first cycle when \bar{ADSP} initiates the burst. \bar{ADSP} active loads a new address into the address counter and forces the first cycle to be a read cycle.
- \bar{OE} is high before data in setup.

Sequential Non-burst Read and Write Timing Diagram



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NOTES:

1. $\overline{ADSP} = \text{high}$, $\overline{ADSC} = \text{low}$, $\overline{ADV} = \text{high}$, $\overline{CE1} = \text{low}$.
2. $H \geq V_{IH}$, $L \leq V_{IL}$.

Ordering Information

