



# Am2168/Am2169

4096 X 4 Static R/W Random-Access Memory

## DISTINCTIVE CHARACTERISTICS

- High speed — access times as fast as 40 ns
- Fully static storage and interface circuitry
- No clocks or timing signals required
- Automatic power down when deselected (Am2168)
- Power dissipation
  - Am2168: 660 mW active, 165 mW standby
  - Am2169: 660 mW
- Standard 20-pin, .300 inch dual-in-line package
- Standard 20-pin rectangular ceramic leadless chip carrier
- High output drive
  - Up to seven standard TTL loads or six Schottky TTL loads
- TTL-compatible interface levels

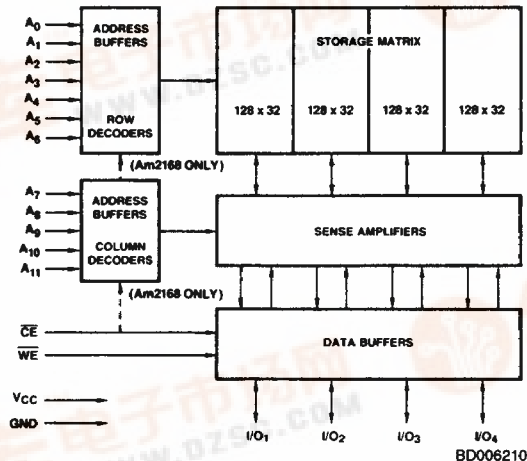
## GENERAL DESCRIPTION

The Am2168 and Am2169 are high-performance, static, N-channel, read/write, random-access memories organized as 4096 words of 4 bits. Operation is from a single 5 V supply, and all input/output levels are identical to standard TTL specifications. The Am2168 and Am2169 are the same except that the Am2168 offers an automatic Chip Enable (CE) power-down feature.

The Am2168 remains in a low-power standby mode as long as  $\overline{CE}$  remains HIGH, thus reducing its power requirements from 660 mW to 165 mW maximum.

The data read out is not destructive and has the same polarity as the input data. The device is packaged in either a .300 slim DIP or 20-pin leadless chip carrier. The outputs of similar devices can be OR-tied and easy selection obtained by use of the  $\overline{CE}$ .

## BLOCK DIAGRAM

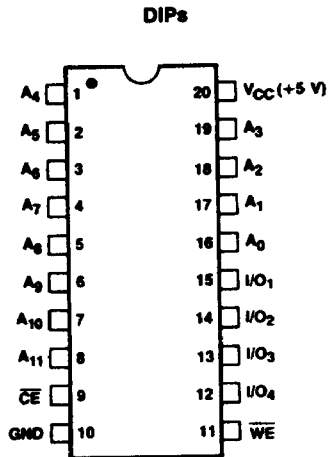


## PRODUCT SELECTOR GUIDE

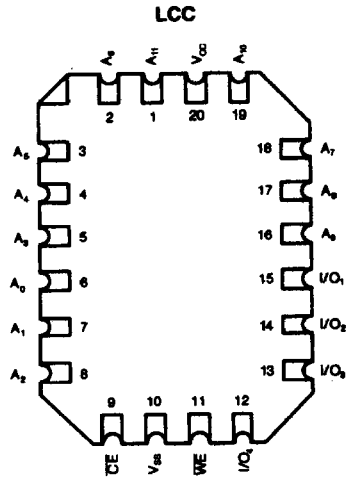
| Part Number              | Am2168-35              | Am2168-45 | Am2169-40 | Am2168-55 | Am2169-50 | Am2168-70 | Am2169-70 |
|--------------------------|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Maximum Access Time (ns) | 35                     | 45        | 40        | 55        | 50        | 70        | 70        |
| 0 to +70°C               | I <sub>CC</sub> (mA)   | 120       | 120       | 120       | 120       | 120       | 120       |
|                          | I <sub>SB</sub> * (mA) | 30        | 30        | N/A       | 30        | N/A       | N/A       |
| -55 to +125°C            | I <sub>CC</sub> (mA)   | N/A       | 160       | N/A       | 160       | 160       | 160       |
|                          | I <sub>SB</sub> * (mA) | N/A       | 30        | N/A       | 30        | N/A       | N/A       |

Am2168

## CONNECTION DIAGRAMS Top View



CD008450

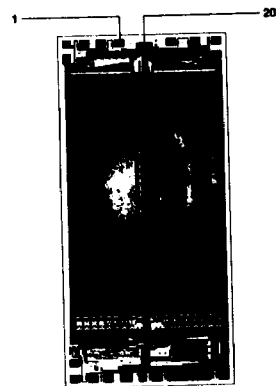


CD008262

Note: Pin 1 is marked for orientation.

## METALLIZATION AND PAD LAYOUT

| Address Designators |                 |
|---------------------|-----------------|
| External            | Internal        |
| A <sub>0</sub>      | A <sub>0</sub>  |
| A <sub>1</sub>      | A <sub>1</sub>  |
| A <sub>2</sub>      | A <sub>2</sub>  |
| A <sub>3</sub>      | A <sub>3</sub>  |
| A <sub>4</sub>      | A <sub>4</sub>  |
| A <sub>5</sub>      | A <sub>5</sub>  |
| A <sub>6</sub>      | A <sub>6</sub>  |
| A <sub>7</sub>      | A <sub>7</sub>  |
| A <sub>8</sub>      | A <sub>8</sub>  |
| A <sub>9</sub>      | A <sub>11</sub> |
| A <sub>10</sub>     | A <sub>10</sub> |
| A <sub>11</sub>     | A <sub>9</sub>  |



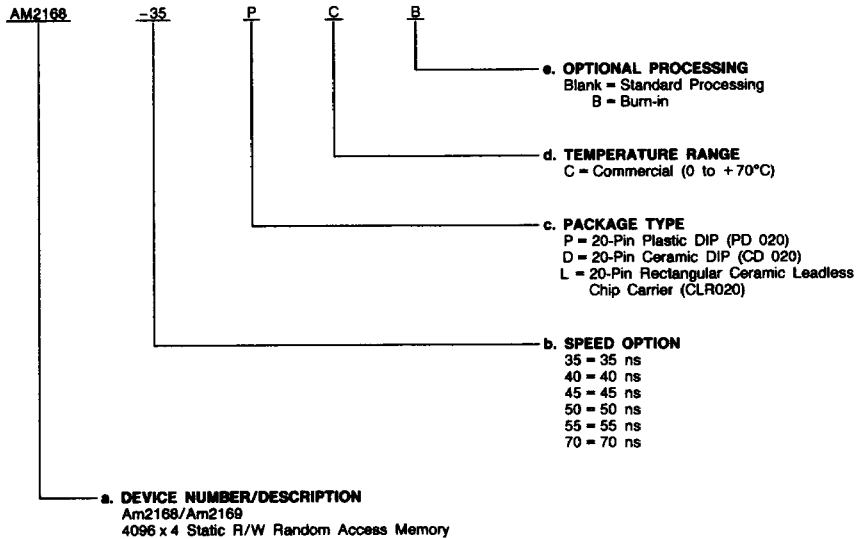
Die Size: 0.123" x 0.252"

## ORDERING INFORMATION

### Standard Products

AMD standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of:

- a. Device Number
- b. Speed Option (if applicable)
- c. Package Type
- d. Temperature Range
- e. Optional Processing



| Valid Combinations |                              |
|--------------------|------------------------------|
| AM2168-35          | PC, PCB, DC,<br>DCB, LC, LCB |
| AM2169-40          |                              |
| AM2168-45          | PC, PCB, DC, DCB             |
| AM2168-55          |                              |
| AM2169-50          |                              |
| AM2168-70          |                              |
| AM2169-70          |                              |

### Valid Combinations

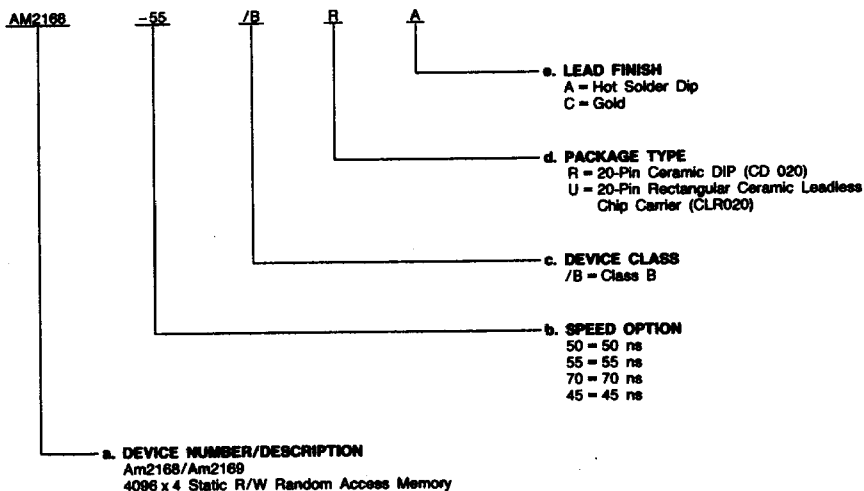
Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations, to check on newly released combinations, and to obtain additional data on AMD's standard military grade products.

## MILITARY ORDERING INFORMATION

### APL Products

AMD products for Aerospace and Defense applications are available in several packages and operating ranges. APL (Approved Products List) products are fully compliant with MIL-STD-883C requirements. The order number (Valid Combination) is formed by a combination of:

- a. Device Number
- b. Speed Option (if applicable)
- c. Device Class
- d. Package Type
- e. Lead Finish



| Valid Combinations |            |
|--------------------|------------|
| AM2168-45          | /BRA, /BUA |
| AM2168-55          |            |
| AM2168-50          |            |
| AM2168-70          |            |
| AM2169-70          |            |
| AM2168-45          |            |
| AM2168-55          |            |
| AM2169-50          |            |
| AM2168-70          |            |
| AM2169-70          |            |

### Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check for newly released valid combinations.

### Group A Tests

Group A tests consist of Subgroups 1, 2, 3, 7, 8, 9, 10, 11.

## PIN DESCRIPTION

### A<sub>0</sub> - A<sub>11</sub> Address Inputs (Inputs)

The address input lines select the RAM location to be read or written.

### CE Chip Enable (Input, Active LOW)

The Chip Enable selects the memory device.

### WE Write Enable (Input, Active LOW)

When Write Enable is LOW and Chip Enable is also LOW, data is written into the location specified on the address pins.

### I/O<sub>1</sub> - I/O<sub>4</sub> Data In/Out Bus (Bidirectional Active HIGH)

These I/O lines provide the path for data to be read from or written to the selected memory location.

### V<sub>CC</sub> Power Supply

### V<sub>SS</sub> Ground

## ABSOLUTE MAXIMUM RATINGS\*

|                                        |                  |
|----------------------------------------|------------------|
| Supply Voltage .....                   | -0.5 V to +7.0 V |
| All Signal Voltages .....              | -3.5 V to +7.0 V |
| DC Output Current .....                | 20 mA            |
| Power Dissipation                      |                  |
| Cerdip & Leadless Packages .....       | 1.2 W            |
| Plastic Packages .....                 | 0.7 W            |
| Ambient Temperature with Power Applied |                  |
| Cerdip & Leadless Packages .....       | -55 to +125°C    |
| Plastic Packages .....                 | -10 to +85°C     |
| Storage Temperature                    |                  |
| Cerdip & Leadless Packages .....       | -65 to +150°C    |
| Plastic Packages .....                 | -55 to +150°C    |

Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

\*Maximum ratings are for system design reference; parameters given may not be 100% tested.

## OPERATING RANGES (Note 4)

|                                             |                 |
|---------------------------------------------|-----------------|
| Commercial (C) Devices                      |                 |
| Ambient Temperature (T <sub>A</sub> ) ..... | 0 to +70°C      |
| Supply Voltage (V <sub>CC</sub> ) .....     | 4.5 V to +5.5 V |
| Military (M) Devices                        |                 |
| Ambient Temperature (T <sub>A</sub> ) ..... | -55 to +125°C   |
| Supply Voltage (V <sub>CC</sub> ) .....     | +4.5 to +5.5 V  |

Operating ranges define those limits between which the functionality of the device is guaranteed.

**DC CHARACTERISTICS** over operating ranges unless otherwise specified (for APL Products, Group A, Subgroups 1, 2, 3 are tested unless otherwise noted) (Note 4)

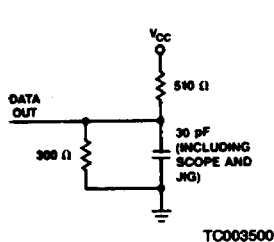
| Parameter Symbol | Parameter Description                         | Test Conditions                                                                                       |                         | Am2168-35, -45, & -40 |      | Am2168-55 & -70<br>Am2169-50 & -70 |      | Unit |
|------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------|-----------------------|------|------------------------------------|------|------|
|                  |                                               |                                                                                                       |                         | Min.                  | Max. | Min.                               | Max. |      |
| I <sub>OH</sub>  | Output HIGH Current                           | V <sub>OH</sub> = 2.4 V                                                                               | V <sub>CC</sub> = 4.5 V | -4                    |      | -4                                 |      | mA   |
| I <sub>OL</sub>  | Output LOW Current                            | V <sub>OL</sub> = 0.4 V                                                                               | COM'L                   | 8                     |      | 8                                  |      | mA   |
|                  |                                               |                                                                                                       | MIL                     | 8                     |      | 8                                  |      |      |
| V <sub>IH</sub>  | Input HIGH Voltage                            |                                                                                                       |                         | 2.2                   | 6.0  | 2.2                                | 6.0  | V    |
| V <sub>IL</sub>  | Input LOW Voltage                             | Note 3                                                                                                |                         | -0.5                  | 0.8  | -0.5                               | 0.8  | V    |
| I <sub>Ix</sub>  | Input Load Current                            | GND ≤ V <sub>I</sub> ≤ V <sub>CC</sub>                                                                |                         | -10                   | 10   | -10                                | 10   | μA   |
| I <sub>OZ</sub>  | Output Leakage Current                        | GND ≤ V <sub>O</sub> ≤ V <sub>CC</sub><br>Output Disabled                                             |                         | -50                   | 50   | -50                                | 50   | μA   |
| C <sub>I</sub>   | Input Capacitance                             | Test Frequency = 1.0 MHz<br>T <sub>A</sub> = 25°C, All Pins at 0 V, V <sub>CC</sub> = 5 V<br>(Note 5) |                         |                       | 5    |                                    | 5    | pF   |
| C <sub>I/O</sub> | Input/Output Capacitance                      |                                                                                                       |                         |                       | 7    |                                    | 7    |      |
| I <sub>CC</sub>  | V <sub>CC</sub> Operating Supply Current      | Max. V <sub>CC</sub> , CE ≤ V <sub>IL</sub><br>Output Open                                            | COM'L                   |                       | 120  |                                    | 120  | mA   |
|                  |                                               |                                                                                                       | MIL                     |                       | N/A  |                                    | 160  |      |
| I <sub>SB</sub>  | Automatic CE Power Down Current (Am2168 Only) | Max. V <sub>CC</sub> , (CE ≥ V <sub>IH</sub> )                                                        | COM'L                   |                       | 30   |                                    | 30   | mA   |
|                  |                                               |                                                                                                       | MIL                     |                       | N/A  |                                    | 30   |      |

- Notes: 1. Test conditions assume signal transition times of 5 ns or less, timing reference levels of 1.5 V, input pulse levels of 0 to 3.0 V and output loading of the specified I<sub>OL</sub>/I<sub>OH</sub> and 30 pF load capacitance. Output timing reference is 1.5 V.
2. The internal write time of the memory is defined by the overlap of CE LOW and WE LOW. Both signals must be LOW to initiate a write and either signal can terminate a write by going HIGH. The data input setup and hold timing should be referenced to the rising edge of the signal that terminates the write.
3. V<sub>IL</sub> voltages of less than -0.5 V on the I/O pins will cause the output current to exceed the maximum rating and thus should not exceed 30 seconds in duration.
4. For test and correlation purposes, ambient temperature is defined as the "Instant-on" case temperature.
5. At any given temperature and voltage condition, t<sub>HZ</sub> is less than t<sub>LZ</sub> and t<sub>WZ</sub> is less than t<sub>OW</sub> for all devices. Transition is measured at 1.5 V on the input to V<sub>OH</sub> - 500 mV and V<sub>OL</sub> + 500 mV on the outputs using the load shown in B. under Switching Test Circuits. C<sub>L</sub> = 5 pF.
6. Not 100% tested parameter; parameter guaranteed by characterization.

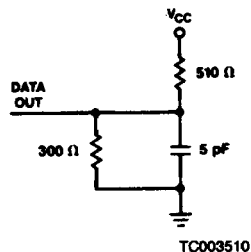
**SWITCHING CHARACTERISTICS** over operating ranges unless otherwise specified (for APL Products, Group A, Subgroups 9, 10, 11 are tested unless otherwise noted) (Note 1)

| No.         | Parameter Symbol | Parameter Description                                       | Am2168-35    |              | Am2168-45, Am2169-40 |      | Am2168-55, Am2169-50 |      | Am2168-70, Am2169-70 |      | Unit    |       |
|-------------|------------------|-------------------------------------------------------------|--------------|--------------|----------------------|------|----------------------|------|----------------------|------|---------|-------|
|             |                  |                                                             | Min.         | Max.         | Min.                 | Max. | Min.                 | Max. | Min.                 | Max. |         |       |
| READ CYCLE  |                  |                                                             |              |              |                      |      |                      |      |                      |      |         |       |
| 1           | t <sub>RC</sub>  | Address Valid to Address Do Not Care Time (Read Cycle Time) |              | 35           |                      | 40   |                      | 50   |                      | 70   | ns      |       |
| 2           | t <sub>AA</sub>  | Address Valid to Data Out Valid Delay (Address Access Time) |              |              | 35                   |      | 40                   |      | 50                   |      | 70 ns   |       |
| 3           | t <sub>ACS</sub> | Chip Enable LOW to Data Out Valid (Chip Enable Access Time) | Am2168       |              | 35                   |      | 45                   |      | 55                   |      | 70 ns   |       |
|             |                  |                                                             | Am2169       |              |                      |      | 20                   |      | 25                   |      | 30      |       |
| 4           | t <sub>LZ</sub>  | Chip Enable LOW to Data Out On                              | Am2168       | (Notes 4, 5) | 5                    |      | 5                    |      | 5                    |      |         |       |
|             |                  |                                                             | Am2169       |              |                      |      |                      | 2    |                      | 2    |         |       |
| 5           | t <sub>HZ</sub>  | Chip Enable HIGH to Data Out Off                            |              | (Notes 4, 5) | 0                    | 20   | 0                    | 20   | 0                    | 25   | 0 30 ns |       |
| 6           | t <sub>OH</sub>  | Output hold time from address change                        | COM'L        |              | 3                    |      | 3                    |      | 3                    |      | 3       |       |
|             |                  |                                                             | MIL          |              |                      |      | 1                    |      | 1                    |      | 1       |       |
| 7           | t <sub>PD</sub>  | Chip Enable HIGH to Power-Down Delay                        | Am2168       | (Note 5)     |                      | 35   |                      | 45   |                      | 55   |         | 70 ns |
| 8           | t <sub>PJ</sub>  | Chip Enable LOW to Power-Up Delay                           | Am2168       | (Note 5)     | 0                    |      | 0                    |      | 0                    |      | 0       | ns    |
| WRITE CYCLE |                  |                                                             |              |              |                      |      |                      |      |                      |      |         |       |
| 9           | t <sub>WC</sub>  | Address Valid to Address Do Not Care (Write Cycle Time)     |              | 35           |                      | 40   |                      | 50   |                      | 70   | ns      |       |
| 10          | t <sub>WP</sub>  | Write Enable LOW to Write Enable HIGH                       | (Note 2)     | 30           |                      | 35   |                      | 45   |                      | 65   | ns      |       |
| 11          | t <sub>WR</sub>  | Write Enable HIGH to Address Do Not Care                    |              | 0            |                      | 0    |                      | 0    |                      | 0    | ns      |       |
| 12          | t <sub>WZ</sub>  | Write Enable LOW to Output in Hi-Z                          | (Notes 4, 5) | 0            | 15                   | 0    | 15                   | 0    | 20                   | 0    | 25 ns   |       |
| 13          | t <sub>DW</sub>  | Data In Valid to Write Enable HIGH                          |              | 20           |                      | 20   |                      | 25   |                      | 35   | ns      |       |
| 14          | t <sub>DH</sub>  | Data Hold Time                                              |              | 5            |                      | 5    |                      | 5    |                      | 5    | ns      |       |
| 15          | t <sub>AS</sub>  | Address Valid to Write Enable LOW                           |              | 0            |                      | 0    |                      | 0    |                      | 0    | ns      |       |
| 16          | t <sub>OW</sub>  | Chip Enable LOW to Write Enable HIGH                        | (Note 2)     | 30           |                      | 35   |                      | 45   |                      | 65   | ns      |       |
| 17          | t <sub>OW</sub>  | Write Enable HIGH to Output in Low-Z                        | (Notes 4, 5) | 0            |                      | 0    |                      | 0    |                      | 0    | ns      |       |
| 18          | t <sub>AW</sub>  | Address Valid to End of Write                               |              | 30           |                      | 35   |                      | 45   |                      | 65   | ns      |       |

### SWITCHING TEST CIRCUITS



**A. Output Load**



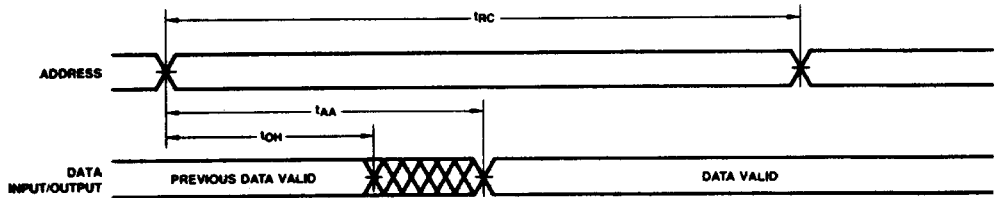
**B. Output Load for t<sub>HZ</sub>, t<sub>LZ</sub>, t<sub>OW</sub>, t<sub>WZ</sub>**

## SWITCHING WAVEFORMS

### KEY TO SWITCHING WAVEFORMS

| WAVEFORM                                                                          | INPUTS                           | OUTPUTS                                   |
|-----------------------------------------------------------------------------------|----------------------------------|-------------------------------------------|
|  | MUST BE STEADY                   | WILL BE STEADY                            |
|  | MAY CHANGE FROM H TO L           | WILL BE CHANGING FROM H TO L              |
|  | MAY CHANGE FROM L TO H           | WILL BE CHANGING FROM L TO H              |
|  | DON'T CARE; ANY CHANGE PERMITTED | CHANGING; STATE UNKNOWN                   |
|  | DOES NOT APPLY                   | CENTER LINE IS HIGH IMPEDANCE "OFF" STATE |

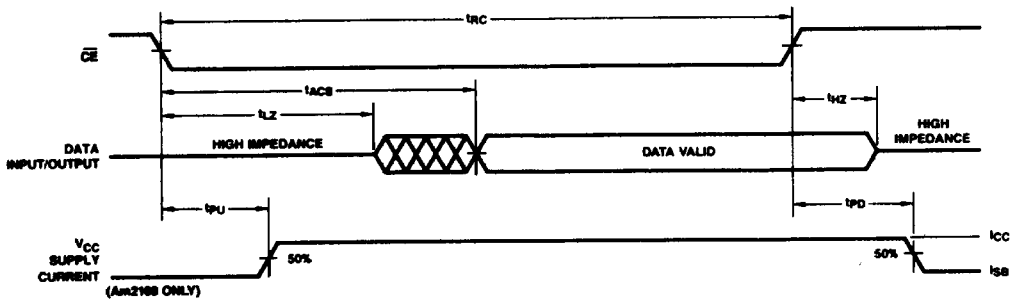
KS000010



WF021270

**Read Cycle No. 1 ( $\overline{WE}$  HIGH,  $\overline{CE}$  LOW)**

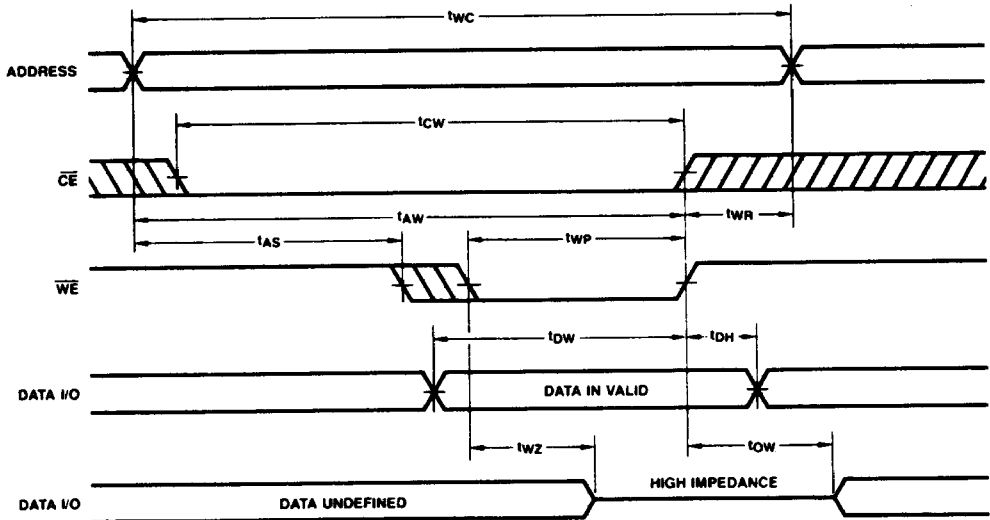
4



WF021280

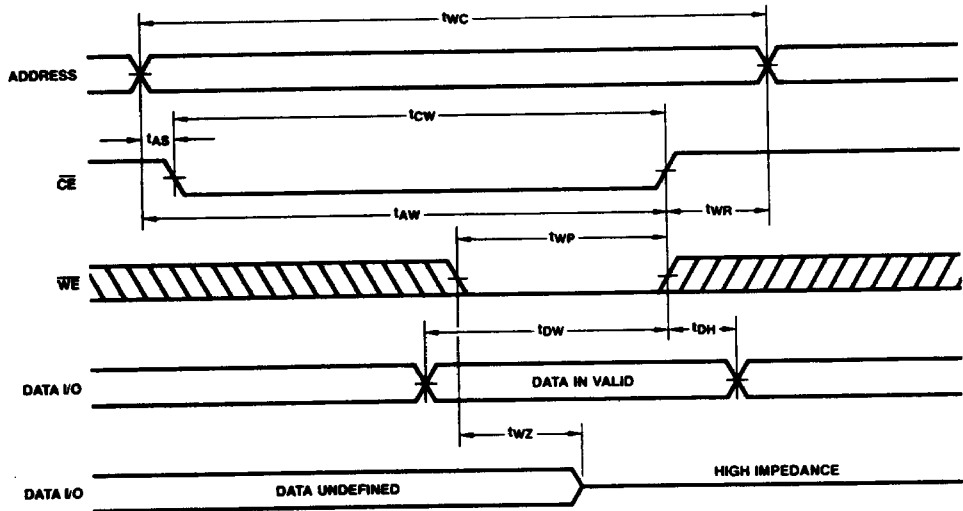
**Read Cycle No. 2 ( $\overline{WE}$  HIGH, Address Valid Prior to  $\overline{CE}$  Transition to LOW)**

## SWITCHING WAVEFORMS (Cont'd.)



WF021970

### Write Cycle No. 1 ( $\overline{WE}$ Controlled)



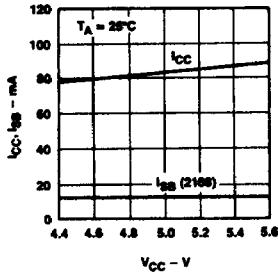
WF021300

### Write Cycle No. 2 ( $\overline{CE}$ Controlled)

Note: If  $\overline{CE}$  goes HIGH simultaneously with  $\overline{WE}$  HIGH, the output remains in a high-impedance state.

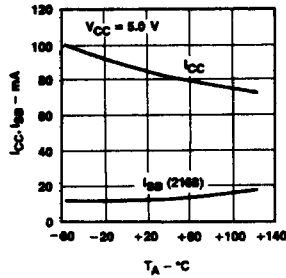
## TYPICAL PERFORMANCE CURVES

Supply Current  
versus Supply Voltage



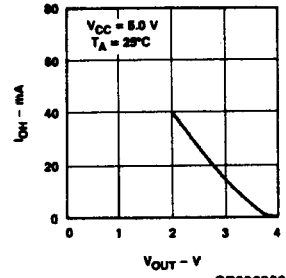
OP001980

Supply Current  
versus Ambient Temperature



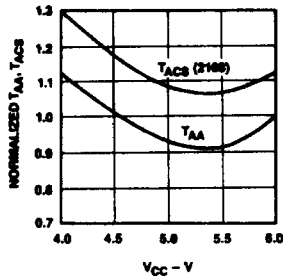
OP001990

Output Source Current  
versus Output Voltage



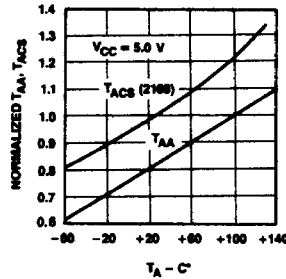
OP002000

Normalized Access Time  
versus Supply Voltage



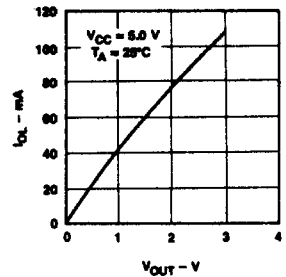
OP002010

Normalized Access Time  
versus Ambient Temperature



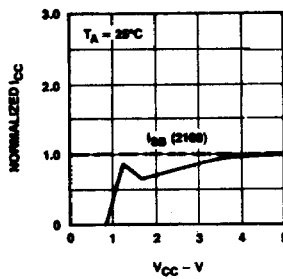
OP002020

Output Sink Current  
versus Output Voltage



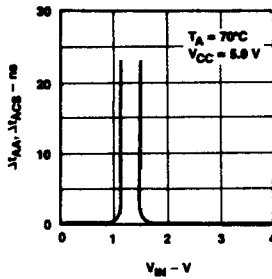
OP002030

Typical Power-On Current  
versus Power Supply



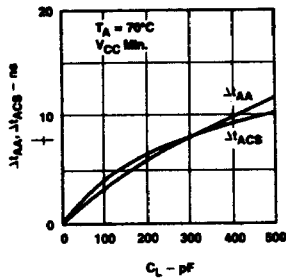
OP002040

Access Time Change  
versus Input Voltage



OP002050

Access Time Change  
versus Output Loading



OP002060