

# OKI Semiconductor

## MSM5118165D/DSL

**1,048,576-Word × 16-Bit DYNAMIC RAM : FAST PAGE MODE TYPE WITH EDO**

### DESCRIPTION

The MSM5118165D/DSL is a 1,048,576-word × 16-bit dynamic RAM fabricated in Oki's silicon-gate CMOS technology. The MSM5118165D/DSL achieves high integration, high-speed operation, and low-power consumption because Oki manufactures the device in a quadruple-layer polysilicon/double-layer metal CMOS process. The MSM5118165D/DSL is available in a 42-pin plastic SOJ or 50/44-pin plastic TSOP. The MSM5118165DSL (the self-refresh version) is specially designed for lower-power applications.

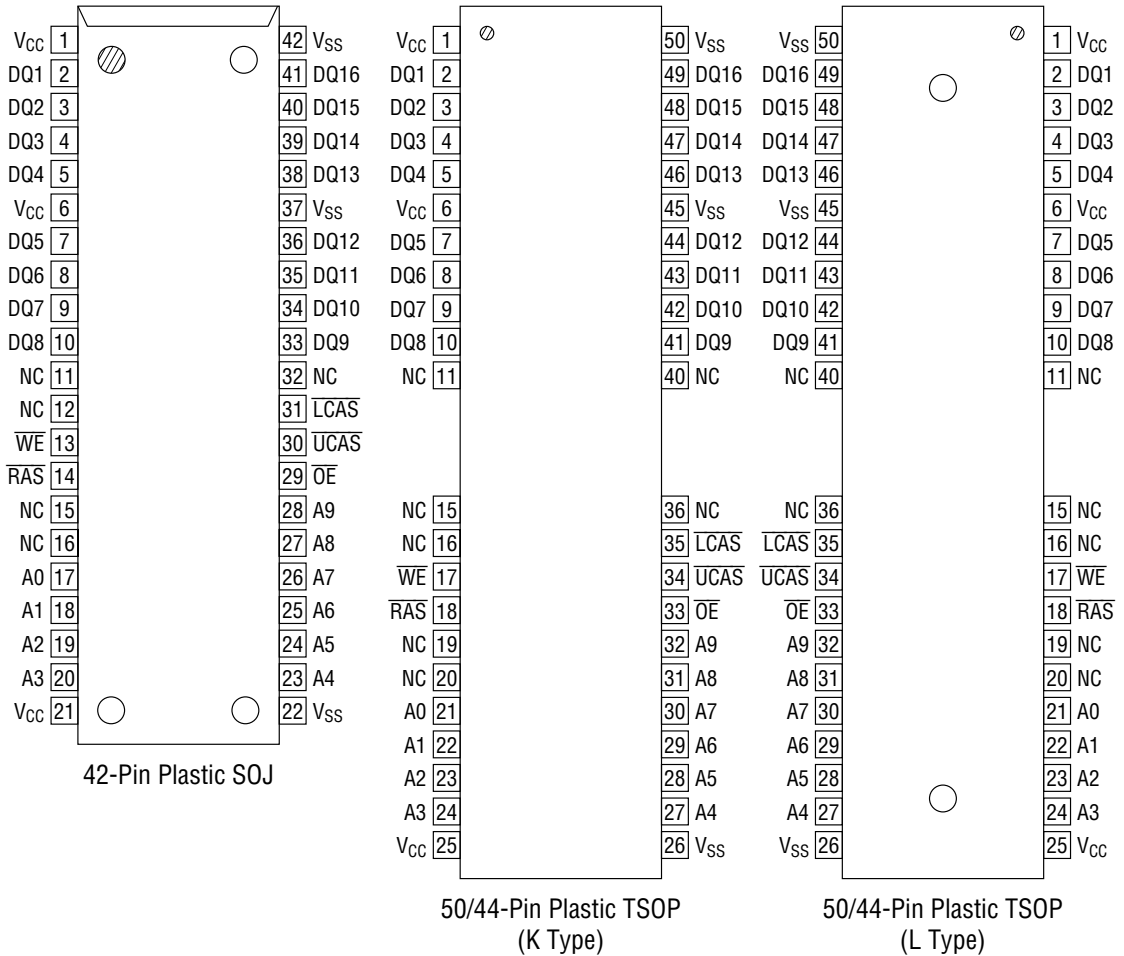
### FEATURES

- 1,048,576-word × 16-bit configuration
  - Single 5 V power supply, ±10% tolerance
  - Input : TTL compatible, low input capacitance
  - Output : TTL compatible, 3-state
  - Refresh : 1024 cycles/16 ms, 1024 cycles/128 ms (SL version)
  - Fast page mode with EDO, read modify write capability
  - $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh, hidden refresh,  $\overline{\text{RAS}}$ -only refresh capability
  - $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  self-refresh capability (SL version)
  - Package options:
    - 42-pin 400 mil plastic SOJ (SOJ42-P-400-1.27) (Product : MSM5118165D/DSL-xxJS)
    - 50/44-pin 400 mil plastic TSOP (TSOPII50/44-P-400-0.80-K) (Product : MSM5118165D/DSL-xxTS-K)
    - (TSOPII50/44-P-400-0.80-L) (Product : MSM5118165D/DSL-xxTS-L)
- xx indicates speed rank.

### PRODUCT FAMILY

| Family             | Access Time (Max.) |                 |                  |                  | Cycle Time (Min.) | Power Dissipation |                                |
|--------------------|--------------------|-----------------|------------------|------------------|-------------------|-------------------|--------------------------------|
|                    | t <sub>RAC</sub>   | t <sub>AA</sub> | t <sub>CAC</sub> | t <sub>OEA</sub> |                   | Operating (Max.)  | Standby (Max.)                 |
| MSM5118165D/DSL-50 | 50 ns              | 25 ns           | 13 ns            | 13 ns            | 84 ns             | 743 mW            | 5.5 mW/<br>1.1 mW (SL version) |
| MSM5118165D/DSL-60 | 60 ns              | 30 ns           | 15 ns            | 15 ns            | 104 ns            | 688 mW            |                                |
| MSM5118165D/DSL-70 | 70 ns              | 35 ns           | 20 ns            | 20 ns            | 124 ns            | 633 mW            |                                |

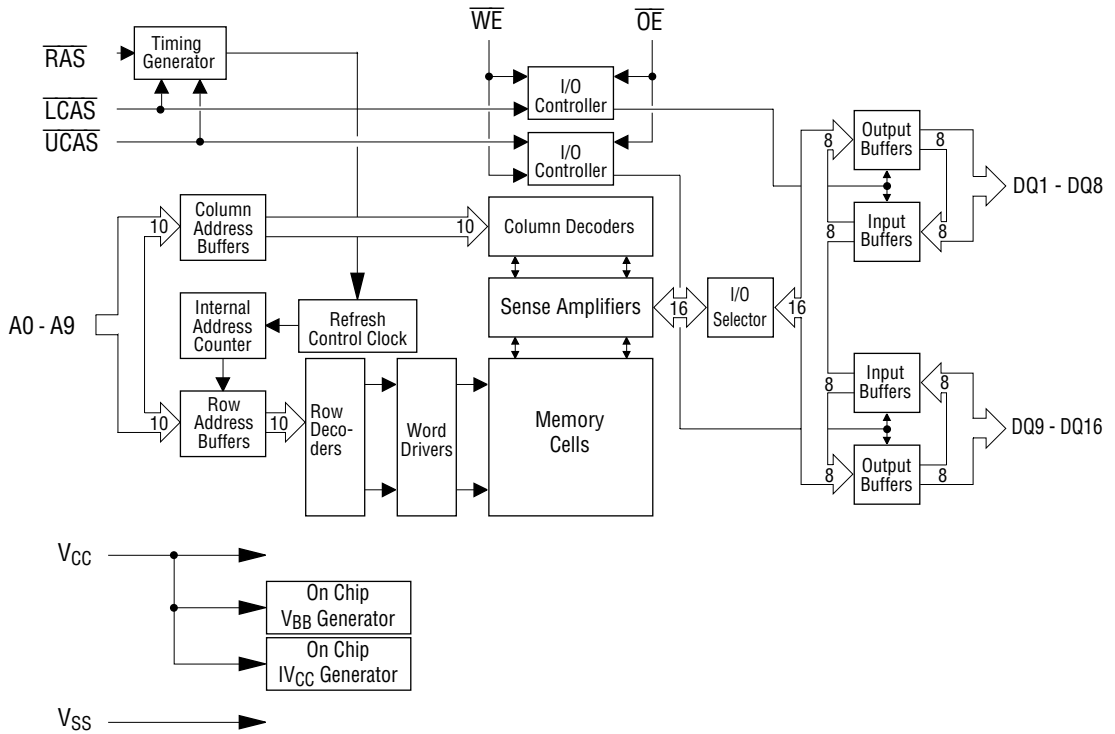
**PIN CONFIGURATION (TOP VIEW)**



| Pin Name                 | Function                         |
|--------------------------|----------------------------------|
| A0 - A9                  | Address Input                    |
| $\overline{\text{RAS}}$  | Row Address Strobe               |
| $\overline{\text{LCAS}}$ | Lower Byte Column Address Strobe |
| $\overline{\text{UCAS}}$ | Upper Byte Column Address Strobe |
| DQ1 - DQ16               | Data Input/Data Output           |
| $\overline{\text{OE}}$   | Output Enable                    |
| $\overline{\text{WE}}$   | Write Enable                     |
| V <sub>CC</sub>          | Power Supply (5 V)               |
| V <sub>SS</sub>          | Ground (0 V)                     |
| NC                       | No Connection                    |

Note : The same power supply voltage must be provided to every V<sub>CC</sub> pin, and the same GND voltage level must be provided to every V<sub>SS</sub> pin.

**BLOCK DIAGRAM**



**FUNCTION TABLE**

| Input Pin |      |      |    |    | DQ Pin           |                  | Function Mode    |
|-----------|------|------|----|----|------------------|------------------|------------------|
| RAS       | LCAS | UCAS | WE | OE | DQ1 - DQ8        | DQ9 - DQ16       |                  |
| H         | *    | *    | *  | *  | High-Z           | High-Z           | Standby          |
| L         | H    | H    | *  | *  | High-Z           | High-Z           | Refresh          |
| L         | L    | H    | H  | L  | D <sub>OUT</sub> | High-Z           | Lower Byte Read  |
| L         | H    | L    | H  | L  | High-Z           | D <sub>OUT</sub> | Upper Byte Read  |
| L         | L    | L    | H  | L  | D <sub>OUT</sub> | D <sub>OUT</sub> | Word Read        |
| L         | L    | H    | L  | H  | D <sub>IN</sub>  | Don't Care       | Lower Byte Write |
| L         | H    | L    | L  | H  | Don't Care       | D <sub>IN</sub>  | Upper Byte Write |
| L         | L    | L    | L  | H  | D <sub>IN</sub>  | D <sub>IN</sub>  | Word Write       |
| L         | L    | L    | H  | H  | High-Z           | High-Z           | —                |

\*: "H" or "L"

## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings

| Parameter                                       | Symbol            | Rating                 | Unit |
|---|-------------------|------------------------|------|
| Voltage on Any Pin Relative to $V_{SS}$         | $V_{IN}, V_{OUT}$ | -0.5 to $V_{CC} + 0.5$ | V    |
| Voltage on $V_{CC}$ Supply Relative to $V_{SS}$ | $V_{CC}$          | -0.5 to 7              | V    |
| Short Circuit Output Current                    | $I_{OS}$          | 50                     | mA   |
| Power Dissipation                               | $P_D^*$           | 1                      | W    |
| Operating Temperature                           | $T_{opr}$         | 0 to 70                | °C   |
| Storage Temperature                             | $T_{stg}$         | -55 to 150             | °C   |

\*:  $T_a = 25^\circ\text{C}$

### Recommended Operating Conditions

( $T_a = 0^\circ\text{C}$  to  $70^\circ\text{C}$ )

| Parameter            | Symbol   | Min.        | Typ. | Max.                | Unit |
|----------------------|----------|-------------|------|---------------------|------|
| Power Supply Voltage | $V_{CC}$ | 4.5         | 5.0  | 5.5                 | V    |
|                      | $V_{SS}$ | 0           | 0    | 0                   | V    |
| Input High Voltage   | $V_{IH}$ | 2.4         | —    | $V_{CC} + 0.5^{*1}$ | V    |
| Input Low Voltage    | $V_{IL}$ | $-0.5^{*2}$ | —    | 0.8                 | V    |

Notes : \*1. The input voltage is  $V_{CC} + 2.0\text{V}$  when the pulse width is less than 20 ns (the pulse width is with respect to the point at which  $V_{CC}$  is applied).

\*2. The input voltage is  $V_{SS} - 2.0\text{V}$  when the pulse width is less than 20 ns (the pulse width is with respect to the point at which  $V_{SS}$  is applied).

### Capacitance

( $V_{CC} = 5\text{V} \pm 10\%$ ,  $T_a = 25^\circ\text{C}$ ,  $f = 1\text{MHz}$ )

| Parameter  | Symbol    | Typ. | Max. | Unit |
|--|-----------|------|------|------|
| Input Capacitance (A0 - A9)  | $C_{IN1}$ | —    | 5    | pF   |
| Input Capacitance<br>( $\overline{\text{RAS}}$ , $\overline{\text{LCAS}}$ , $\overline{\text{UCAS}}$ , $\overline{\text{WE}}$ , $\overline{\text{OE}}$ ) | $C_{IN2}$ | —    | 7    | pF   |
| Output Capacitance (DQ1 - DQ16)  | $C_{I/O}$ | —    | 7    | pF   |

DC Characteristics

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C)

| Parameter   | Symbol            | Condition  | MSM5118165 D/DSL-50 |                 | MSM5118165 D/DSL-60       |      | MSM5118165 D/DSL-70 |      | Unit | Note    |
|---|-------------------|--|---------------------|-----------------|---------------------------|------|---------------------|------|------|---------|
|   |                   |  | Min.                | Max.            | Min.                      | Max. | Min.                | Max. |      |         |
|   |                   |  | Output High Voltage | V <sub>OH</sub> | I <sub>OH</sub> = -5.0 mA | 2.4  | V <sub>CC</sub>     | 2.4  |      |         |
| Output Low Voltage  | V <sub>OL</sub>   | I <sub>OL</sub> = 4.2 mA   | 0                   | 0.4             | 0                         | 0.4  | 0                   | 0.4  | V    |         |
| Input Leakage Current   | I <sub>LI</sub>   | 0 V ≤ V <sub>I</sub> ≤ 6.5 V;<br>All other pins not under test = 0 V   | -10                 | 10              | -10                       | 10   | -10                 | 10   | μA   |         |
| Output Leakage Current  | I <sub>LO</sub>   | DQ disable<br>0 V ≤ V <sub>O</sub> ≤ V <sub>CC</sub>   | -10                 | 10              | -10                       | 10   | -10                 | 10   | μA   |         |
| Average Power Supply Current (Operating)  | I <sub>CC1</sub>  | $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ cycling,<br>t <sub>RC</sub> = Min.                             | —                   | 135             | —                         | 125  | —                   | 115  | mA   | 1, 2    |
| Power Supply Current (Standby)  | I <sub>CC2</sub>  | $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ = V <sub>IH</sub>  | —                   | 2               | —                         | 2    | —                   | 2    | mA   | 1       |
|   |                   | $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$<br>≥ V <sub>CC</sub> - 0.2 V                                   | —                   | 1               | —                         | 1    | —                   | 1    | μA   | 1, 5    |
|   |                   |  | —                   | 200             | —                         | 200  | —                   | 200  | μA   |         |
| Average Power Supply Current ( $\overline{\text{RAS}}$ -only Refresh)                               | I <sub>CC3</sub>  | $\overline{\text{RAS}}$ cycling,<br>$\overline{\text{CAS}}$ = V <sub>IH</sub> ,<br>t <sub>RC</sub> = Min.        | —                   | 135             | —                         | 125  | —                   | 115  | mA   | 1, 2    |
| Power Supply Current (Standby)  | I <sub>CC5</sub>  | $\overline{\text{RAS}}$ = V <sub>IH</sub> ,<br>$\overline{\text{CAS}}$ = V <sub>IL</sub> ,<br>DQ = enable        | —                   | 5               | —                         | 5    | —                   | 5    | mA   | 1       |
| Average Power Supply Current ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Refresh)      | I <sub>CC6</sub>  | $\overline{\text{RAS}}$ cycling,<br>$\overline{\text{CAS}}$ before $\overline{\text{RAS}}$                       | —                   | 135             | —                         | 125  | —                   | 115  | mA   | 1, 2    |
| Average Power Supply Current (Fast Page Mode)   | I <sub>CC7</sub>  | $\overline{\text{RAS}}$ = V <sub>IL</sub> ,<br>$\overline{\text{CAS}}$ cycling,<br>t <sub>HPC</sub> = Min.       | —                   | 135             | —                         | 125  | —                   | 115  | mA   | 1, 3    |
| Average Power Supply Current (Battery Backup)   | I <sub>CC10</sub> | t <sub>RC</sub> = 125 μs,<br>$\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ ,<br>t <sub>RAS</sub> ≤ 1 μs | —                   | 300             | —                         | 300  | —                   | 300  | μA   | 1, 4, 5 |
| Average Power Supply Current ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh) | I <sub>CC8</sub>  | $\overline{\text{RAS}}$ ≤ 0.2 V,<br>$\overline{\text{CAS}}$ ≤ 0.2 V  | —                   | 300             | —                         | 300  | —                   | 300  | μA   | 1, 5    |

- Notes :
1. I<sub>CC</sub> Max. is specified as I<sub>CC</sub> for output open condition.
  2. The address can be changed once or less while  $\overline{\text{RAS}}$  = V<sub>IL</sub>.
  3. The address can be changed once or less while  $\overline{\text{CAS}}$  = V<sub>IH</sub>.
  4. V<sub>CC</sub> - 0.2 V ≤ V<sub>IH</sub> ≤ V<sub>CC</sub> + 0.5 V, -0.5 V ≤ V<sub>IL</sub> ≤ 0.2 V.
  5. SL version.

AC Characteristics (1/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

| Parameter  | Symbol             | MSM5118165<br>D/DSL-50 |         | MSM5118165<br>D/DSL-60 |         | MSM5118165<br>D/DSL-70 |         | Unit | Note    |
|--|--------------------|------------------------|---------|------------------------|---------|------------------------|---------|------|---------|
|  |                    | Min.                   | Max.    | Min.                   | Max.    | Min.                   | Max.    |      |         |
| Random Read or Write Cycle Time  | t <sub>RC</sub>    | 84                     | —       | 104                    | —       | 124                    | —       | ns   |         |
| Read Modify Write Cycle Time   | t <sub>RWC</sub>   | 110                    | —       | 135                    | —       | 160                    | —       | ns   |         |
| Fast Page Mode Cycle Time  | t <sub>HPC</sub>   | 20                     | —       | 25                     | —       | 30                     | —       | ns   |         |
| Fast Page Mode Read Modify Write Cycle Time                                | t <sub>HPRWC</sub> | 58                     | —       | 68                     | —       | 78                     | —       | ns   |         |
| Access Time from $\overline{\text{RAS}}$                                   | t <sub>RAC</sub>   | —                      | 50      | —                      | 60      | —                      | 70      | ns   | 4, 5, 6 |
| Access Time from $\overline{\text{CAS}}$                                   | t <sub>CAC</sub>   | —                      | 13      | —                      | 15      | —                      | 20      | ns   | 4, 5    |
| Access Time from Column Address  | t <sub>AA</sub>    | —                      | 25      | —                      | 30      | —                      | 35      | ns   | 4, 6    |
| Access Time from $\overline{\text{CAS}}$ Precharge                         | t <sub>CPA</sub>   | —                      | 30      | —                      | 35      | —                      | 40      | ns   | 4, 13   |
| Access Time from $\overline{\text{OE}}$                                    | t <sub>OEA</sub>   | —                      | 13      | —                      | 15      | —                      | 20      | ns   | 4       |
| Output Low Impedance Time from $\overline{\text{CAS}}$                     | t <sub>CLZ</sub>   | 0                      | —       | 0                      | —       | 0                      | —       | ns   | 4       |
| Data Output Hold After $\overline{\text{CAS}}$ Low                         | t <sub>DOH</sub>   | 5                      | —       | 5                      | —       | 5                      | —       | ns   |         |
| $\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time          | t <sub>CEZ</sub>   | 0                      | 13      | 0                      | 15      | 0                      | 20      | ns   | 7, 8    |
| $\overline{\text{RAS}}$ to Data Output Buffer Turn-off Delay Time          | t <sub>REZ</sub>   | 0                      | 13      | 0                      | 15      | 0                      | 20      | ns   | 7, 8    |
| $\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time           | t <sub>OEZ</sub>   | 0                      | 13      | 0                      | 15      | 0                      | 20      | ns   | 7       |
| $\overline{\text{WE}}$ to Data Output Buffer Turn-off Delay Time           | t <sub>WEZ</sub>   | 0                      | 13      | 0                      | 15      | 0                      | 20      | ns   | 7       |
| Transition Time  | t <sub>T</sub>     | 1                      | 50      | 1                      | 50      | 1                      | 50      | ns   | 3       |
| Refresh Period   | t <sub>REF</sub>   | —                      | 16      | —                      | 16      | —                      | 16      | ms   |         |
| Refresh Period (SL version)  | t <sub>REF</sub>   | —                      | 128     | —                      | 128     | —                      | 128     | ms   | 16      |
| $\overline{\text{RAS}}$ Precharge Time                                     | t <sub>RP</sub>    | 30                     | —       | 40                     | —       | 50                     | —       | ns   |         |
| $\overline{\text{RAS}}$ Pulse Width  | t <sub>RAS</sub>   | 50                     | 10,000  | 60                     | 10,000  | 70                     | 10,000  | ns   |         |
| $\overline{\text{RAS}}$ Pulse Width (Fast Page Mode with EDO)              | t <sub>RASP</sub>  | 50                     | 100,000 | 60                     | 100,000 | 70                     | 100,000 | ns   |         |
| $\overline{\text{RAS}}$ Hold Time  | t <sub>RSH</sub>   | 7                      | —       | 10                     | —       | 13                     | —       | ns   |         |
| $\overline{\text{RAS}}$ Hold Time referenced to $\overline{\text{OE}}$     | t <sub>ROH</sub>   | 7                      | —       | 10                     | —       | 13                     | —       | ns   |         |
| $\overline{\text{CAS}}$ Precharge Time (Fast Page Mode with EDO)           | t <sub>CP</sub>    | 7                      | —       | 10                     | —       | 10                     | —       | ns   | 15      |
| $\overline{\text{CAS}}$ Pulse Width  | t <sub>CAS</sub>   | 7                      | 10,000  | 10                     | 10,000  | 13                     | 10,000  | ns   |         |
| $\overline{\text{CAS}}$ Hold Time  | t <sub>CSH</sub>   | 35                     | —       | 40                     | —       | 45                     | —       | ns   |         |
| $\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time          | t <sub>CRP</sub>   | 5                      | —       | 5                      | —       | 5                      | —       | ns   | 13      |
| $\overline{\text{RAS}}$ Hold Time from $\overline{\text{CAS}}$ Precharge   | t <sub>RHCP</sub>  | 30                     | —       | 35                     | —       | 40                     | —       | ns   | 13      |
| $\overline{\text{OE}}$ Hold Time from $\overline{\text{CAS}}$ (DQ Disable) | t <sub>CHO</sub>   | 5                      | —       | 5                      | —       | 5                      | —       | ns   |         |
| $\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time              | t <sub>RCD</sub>   | 11                     | 37      | 14                     | 45      | 14                     | 50      | ns   | 5       |
| $\overline{\text{RAS}}$ to Column Address Delay Time                       | t <sub>RAD</sub>   | 9                      | 25      | 12                     | 30      | 12                     | 35      | ns   | 6       |
| Row Address Set-up Time  | t <sub>ASR</sub>   | 0                      | —       | 0                      | —       | 0                      | —       | ns   |         |
| Row Address Hold Time  | t <sub>RAH</sub>   | 7                      | —       | 10                     | —       | 10                     | —       | ns   |         |
| Column Address Set-up Time   | t <sub>ASC</sub>   | 0                      | —       | 0                      | —       | 0                      | —       | ns   | 12      |
| Column Address Hold Time   | t <sub>CAH</sub>   | 7                      | —       | 10                     | —       | 13                     | —       | ns   | 12      |
| Column Address to $\overline{\text{RAS}}$ Lead Time                        | t <sub>RAL</sub>   | 25                     | —       | 30                     | —       | 35                     | —       | ns   |         |

## AC Characteristics (2/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

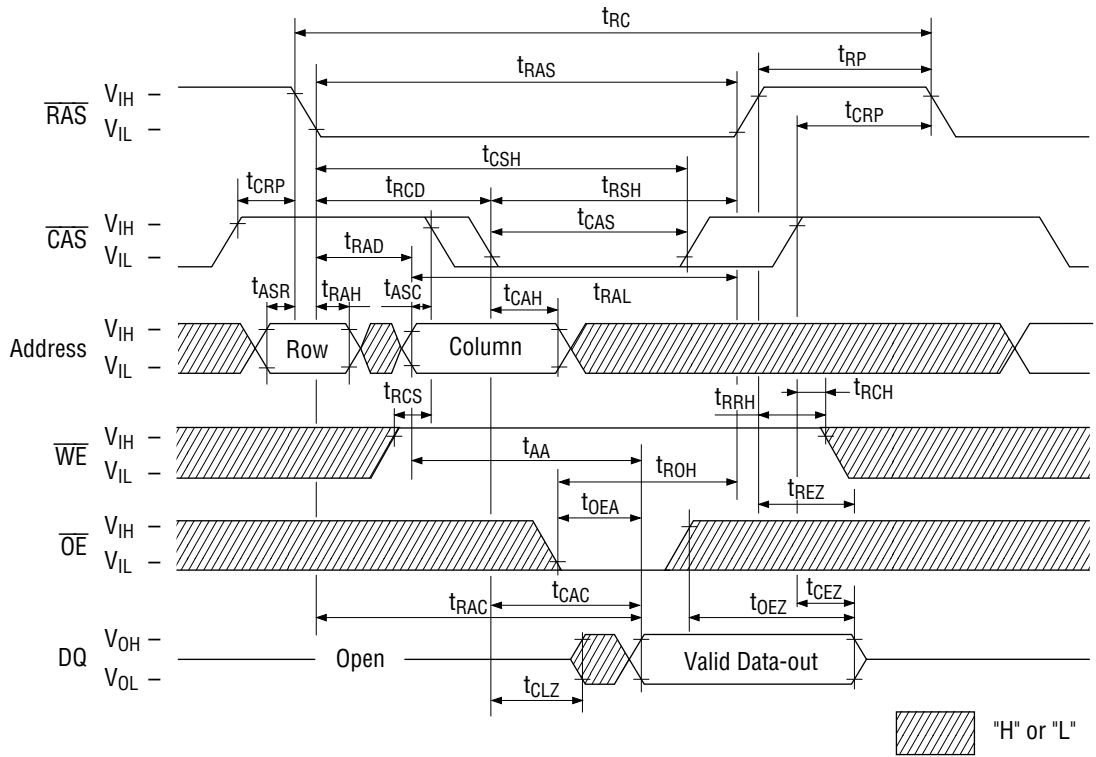
| Parameter   | Symbol            | MSM5118165<br>D/DSL-50 |      | MSM5118165<br>D/DSL-60 |      | MSM5118165<br>D/DSL-70 |      | Unit | Note   |
|---|-------------------|------------------------|------|------------------------|------|------------------------|------|------|--------|
|   |                   | Min.                   | Max. | Min.                   | Max. | Min.                   | Max. |      |        |
| Read Command Set-up Time  | t <sub>RCS</sub>  | 0                      | —    | 0                      | —    | 0                      | —    | ns   | 12     |
| Read Command Hold Time  | t <sub>RCH</sub>  | 0                      | —    | 0                      | —    | 0                      | —    | ns   | 9, 12  |
| Read Command Hold Time referenced to $\overline{\text{RAS}}$  | t <sub>RRH</sub>  | 0                      | —    | 0                      | —    | 0                      | —    | ns   | 9      |
| Write Command Set-up Time   | t <sub>WCS</sub>  | 0                      | —    | 0                      | —    | 0                      | —    | ns   | 10, 12 |
| Write Command Hold Time   | t <sub>WCH</sub>  | 7                      | —    | 10                     | —    | 13                     | —    | ns   | 12     |
| Write Command Pulse Width   | t <sub>WP</sub>   | 7                      | —    | 10                     | —    | 10                     | —    | ns   |        |
| $\overline{\text{WE}}$ Pulse Width (DQ Disable)   | t <sub>WPE</sub>  | 7                      | —    | 10                     | —    | 10                     | —    | ns   |        |
| $\overline{\text{OE}}$ Command Hold Time  | t <sub>OEH</sub>  | 7                      | —    | 10                     | —    | 13                     | —    | ns   |        |
| $\overline{\text{OE}}$ Precharge Time   | t <sub>OEP</sub>  | 7                      | —    | 10                     | —    | 10                     | —    | ns   |        |
| $\overline{\text{OE}}$ Command Hold Time  | t <sub>OCH</sub>  | 7                      | —    | 10                     | —    | 10                     | —    | ns   |        |
| Write Command to $\overline{\text{RAS}}$ Lead Time  | t <sub>RWL</sub>  | 7                      | —    | 10                     | —    | 13                     | —    | ns   |        |
| Write Command to $\overline{\text{CAS}}$ Lead Time  | t <sub>CWL</sub>  | 7                      | —    | 10                     | —    | 13                     | —    | ns   | 14     |
| Data-in Set-up Time   | t <sub>DS</sub>   | 0                      | —    | 0                      | —    | 0                      | —    | ns   | 11, 12 |
| Data-in Hold Time   | t <sub>DH</sub>   | 7                      | —    | 10                     | —    | 13                     | —    | ns   | 11, 12 |
| $\overline{\text{OE}}$ to Data-in Delay Time  | t <sub>OED</sub>  | 13                     | —    | 15                     | —    | 20                     | —    | ns   |        |
| $\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time  | t <sub>CWD</sub>  | 30                     | —    | 34                     | —    | 44                     | —    | ns   | 10     |
| Column Address to $\overline{\text{WE}}$ Delay Time   | t <sub>AWD</sub>  | 42                     | —    | 49                     | —    | 59                     | —    | ns   | 10     |
| $\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time  | t <sub>RWD</sub>  | 67                     | —    | 79                     | —    | 94                     | —    | ns   | 10     |
| $\overline{\text{CAS}}$ Precharge $\overline{\text{WE}}$ Delay Time   | t <sub>CPWD</sub> | 47                     | —    | 54                     | —    | 64                     | —    | ns   | 10     |
| $\overline{\text{CAS}}$ Active Delay Time from $\overline{\text{RAS}}$ Precharge  | t <sub>RPC</sub>  | 5                      | —    | 5                      | —    | 5                      | —    | ns   | 12     |
| $\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Set-up Time ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ ) | t <sub>CSR</sub>  | 5                      | —    | 5                      | —    | 5                      | —    | ns   | 12     |
| $\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Hold Time ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ )   | t <sub>CHR</sub>  | 10                     | —    | 10                     | —    | 10                     | —    | ns   | 13     |
| $\overline{\text{RAS}}$ Pulse Width<br>( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)             | t <sub>RASS</sub> | 100                    | —    | 100                    | —    | 100                    | —    | μs   | 16     |
| $\overline{\text{RAS}}$ Precharge Time<br>( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)          | t <sub>RPS</sub>  | 90                     | —    | 110                    | —    | 130                    | —    | ns   | 16     |
| $\overline{\text{CAS}}$ Hold Time<br>( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Self-Refresh)               | t <sub>CHS</sub>  | -50                    | —    | -50                    | —    | -50                    | —    | ns   | 16     |

- Notes:
1. A start-up delay of 200  $\mu$ s is required after power-up, followed by a minimum of eight initialization cycles ( $\overline{\text{RAS}}$ -only refresh or  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh) before proper device operation is achieved.
  2. The AC characteristics assume  $t_T = 2$  ns.
  3.  $V_{IH}$  (Min.) and  $V_{IL}$  (Max.) are reference levels for measuring input timing signals. Transition times ( $t_T$ ) are measured between  $V_{IH}$  and  $V_{IL}$ .
  4. This parameter is measured with a load circuit equivalent to 2 TTL loads and 100 pF.
  5. Operation within the  $t_{RCD}$  (Max.) limit ensures that  $t_{RAC}$  (Max.) can be met.  $t_{RCD}$  (Max.) is specified as a reference point only. If  $t_{RCD}$  is greater than the specified  $t_{RCD}$  (Max.) limit, then the access time is controlled by  $t_{CAC}$ .
  6. Operation within the  $t_{RAD}$  (Max.) limit ensures that  $t_{RAC}$  (Max.) can be met.  $t_{RAD}$  (Max.) is specified as a reference point only. If  $t_{RAD}$  is greater than the specified  $t_{RAD}$  (Max.) limit, then the access time is controlled by  $t_{AA}$ .
  7.  $t_{CEZ}$  (Max.),  $t_{REZ}$  (Max.),  $t_{WEZ}$  (Max.) and  $t_{OEZ}$  (Max.) define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
  8.  $t_{CEZ}$  and  $t_{REZ}$  must be satisfied for open circuit condition.
  9.  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.
  10.  $t_{WCS}$ ,  $t_{CWD}$ ,  $t_{RWD}$ ,  $t_{AWD}$  and  $t_{CPWD}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $t_{WCS} \geq t_{WCS}$  (Min.), then the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If  $t_{CWD} \geq t_{CWD}$  (Min.),  $t_{RWD} \geq t_{RWD}$  (Min.),  $t_{AWD} \geq t_{AWD}$  (Min.) and  $t_{CPWD} \geq t_{CPWD}$  (Min.), then the cycle is a read modify write cycle and data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, then the condition of the data out (at access time) is indeterminate.
  11. These parameters are referenced to the  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ , leading edges in an early write cycle, and to the  $\overline{\text{WE}}$  leading edge in an  $\overline{\text{OE}}$  control write cycle, or a read modify write cycle.
  12. These parameters are determined by the falling edge of either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is earlier.
  13. These parameters are determined by the rising edge of either  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is later.
  14.  $t_{CWL}$  should be satisfied by both  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$ .
  15.  $t_{CP}$  is determined by the time both  $\overline{\text{UCAS}}$  and  $\overline{\text{LCAS}}$  are high.
  16. Only SL version.

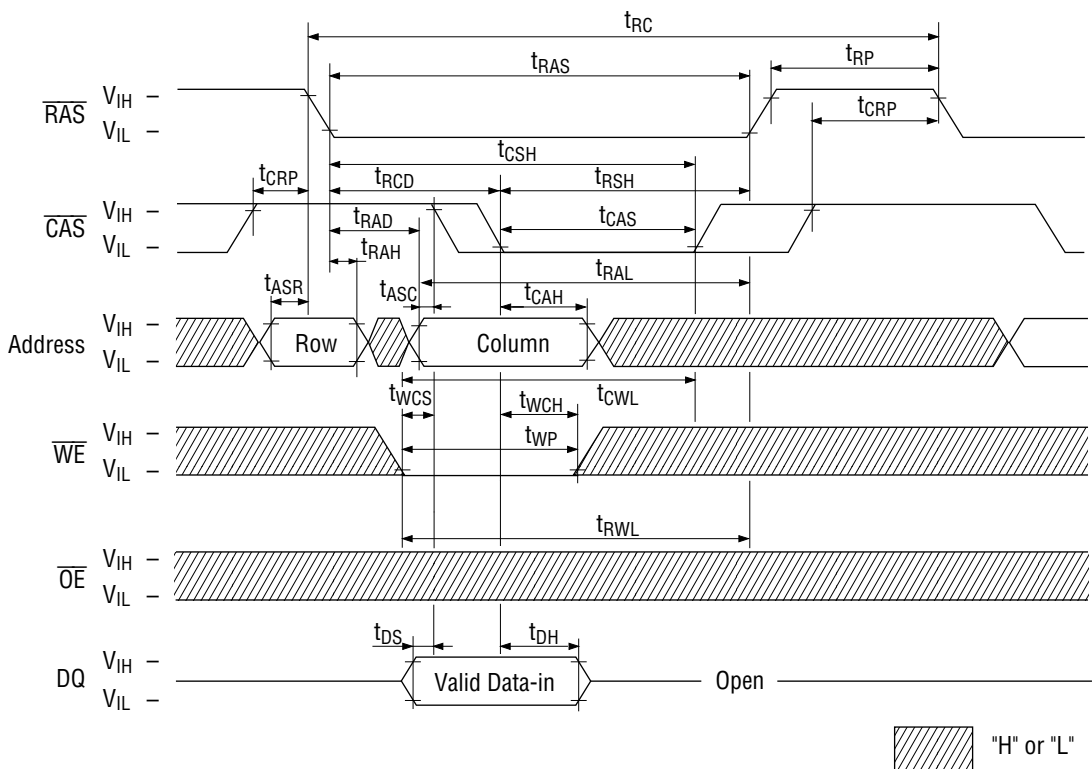


**TIMING WAVEFORM**

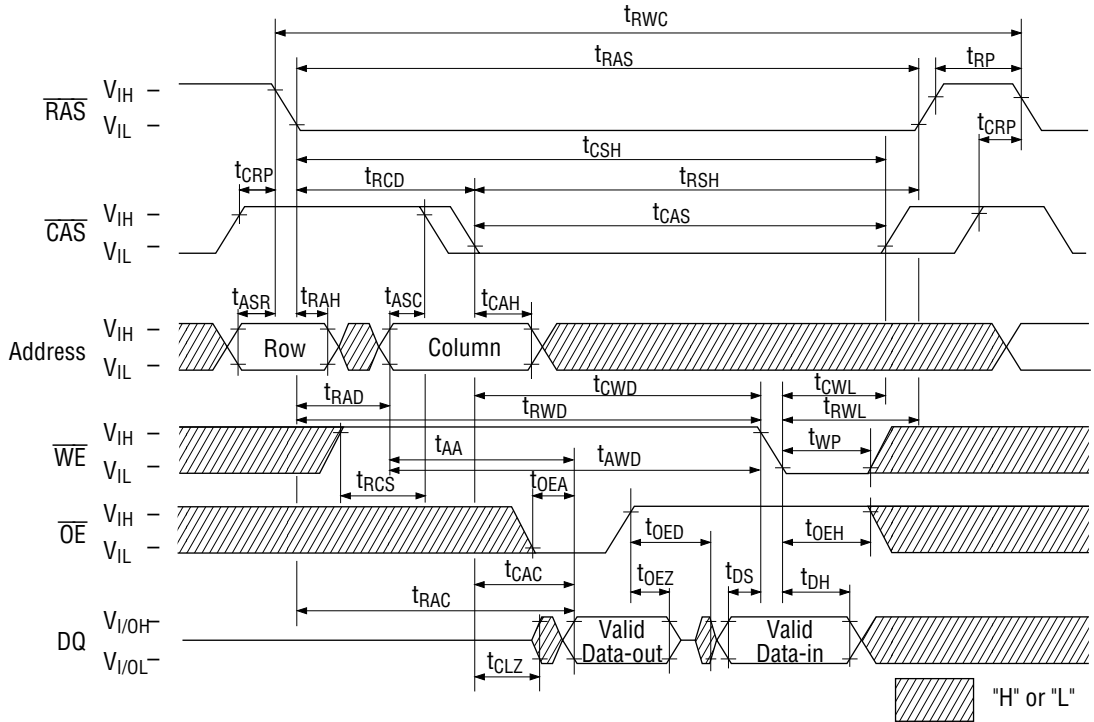
**Read Cycle**



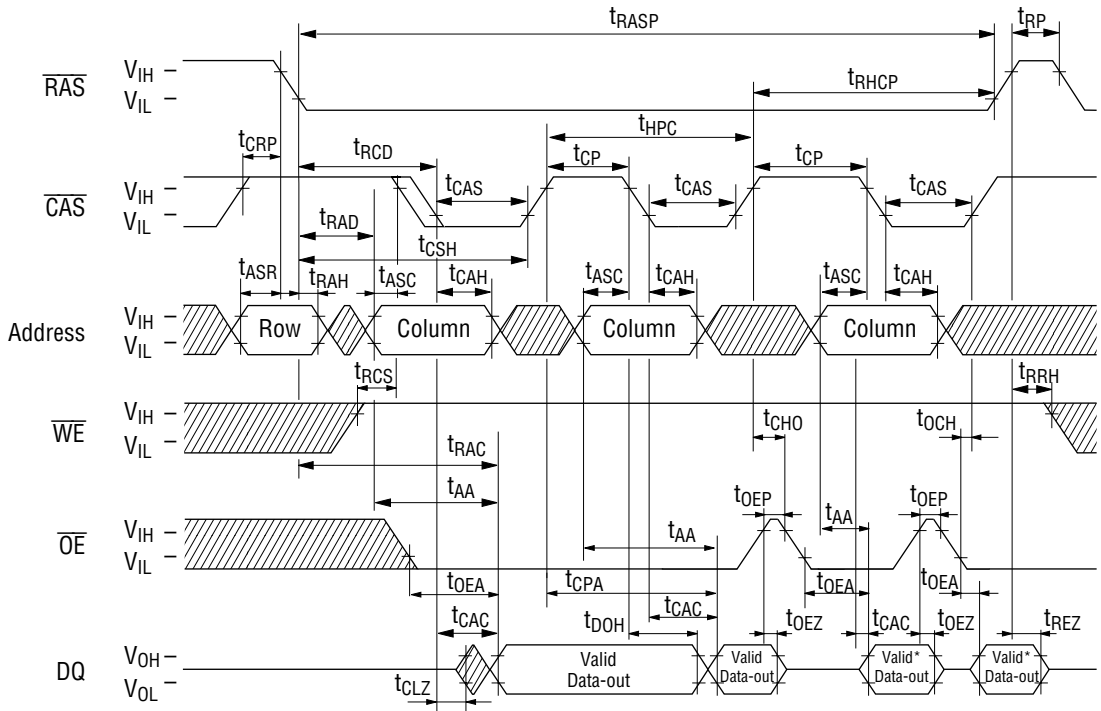
**Write Cycle (Early Write)**



Read Modify Write Cycle

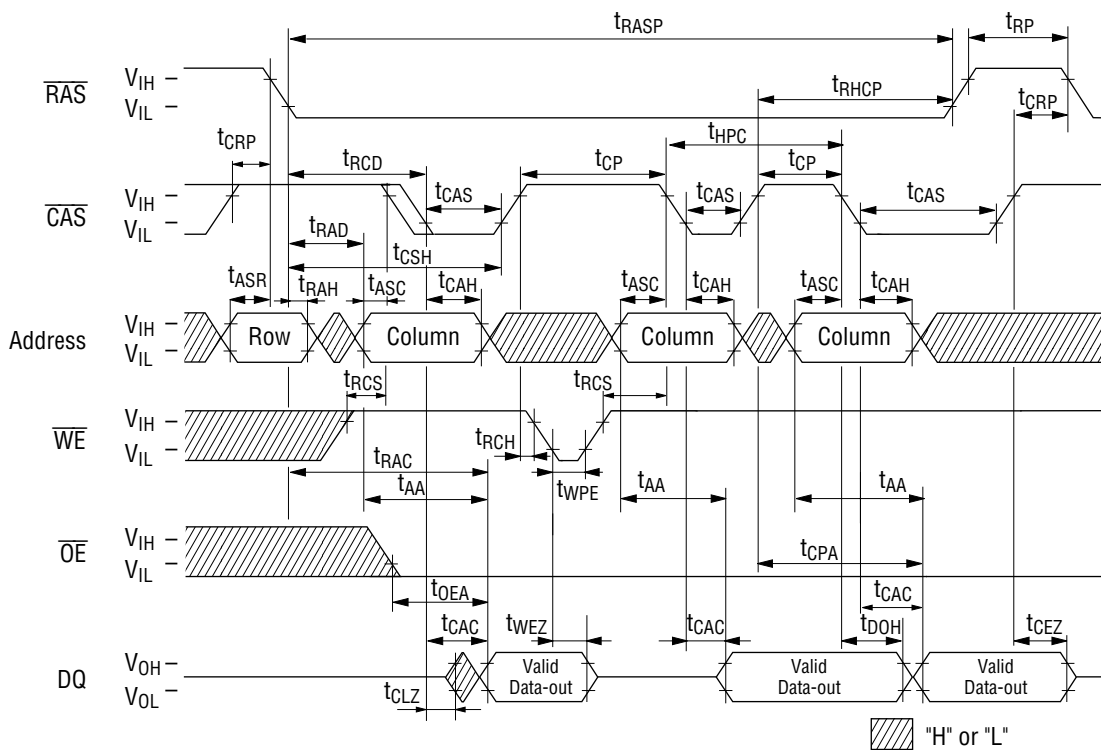


Fast Page Mode Read Cycle (Part-1)



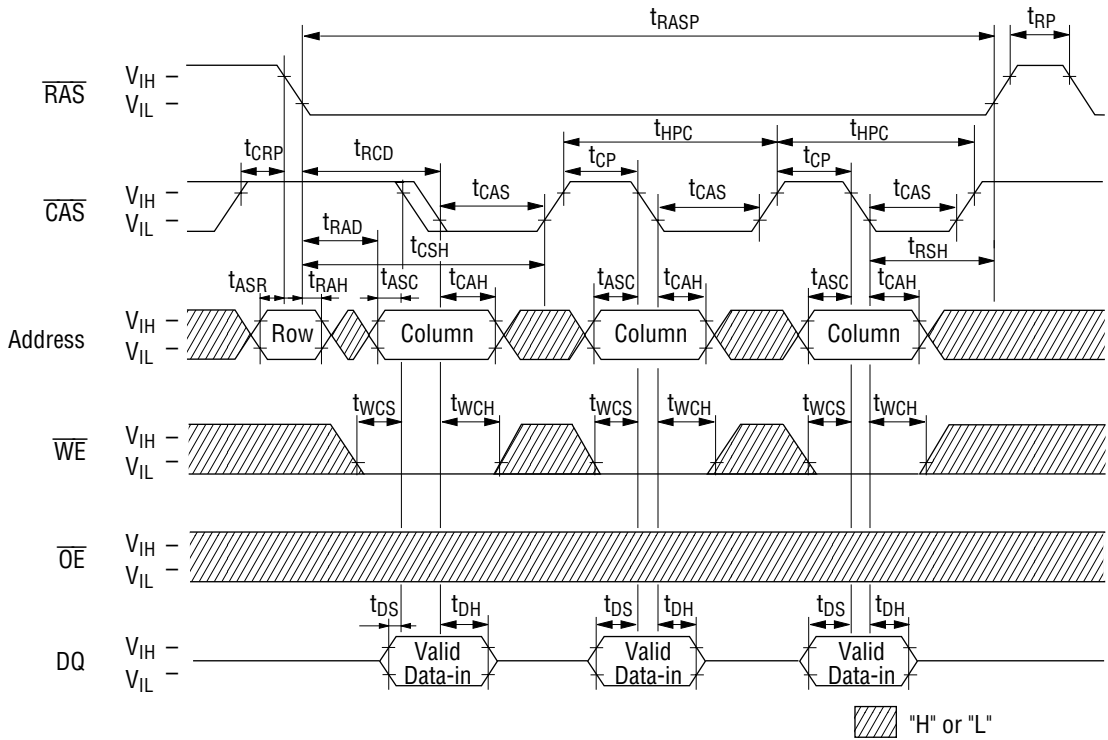
\* : Same Data, "H" or "L"

Fast Page Mode Read Cycle (Part-2)

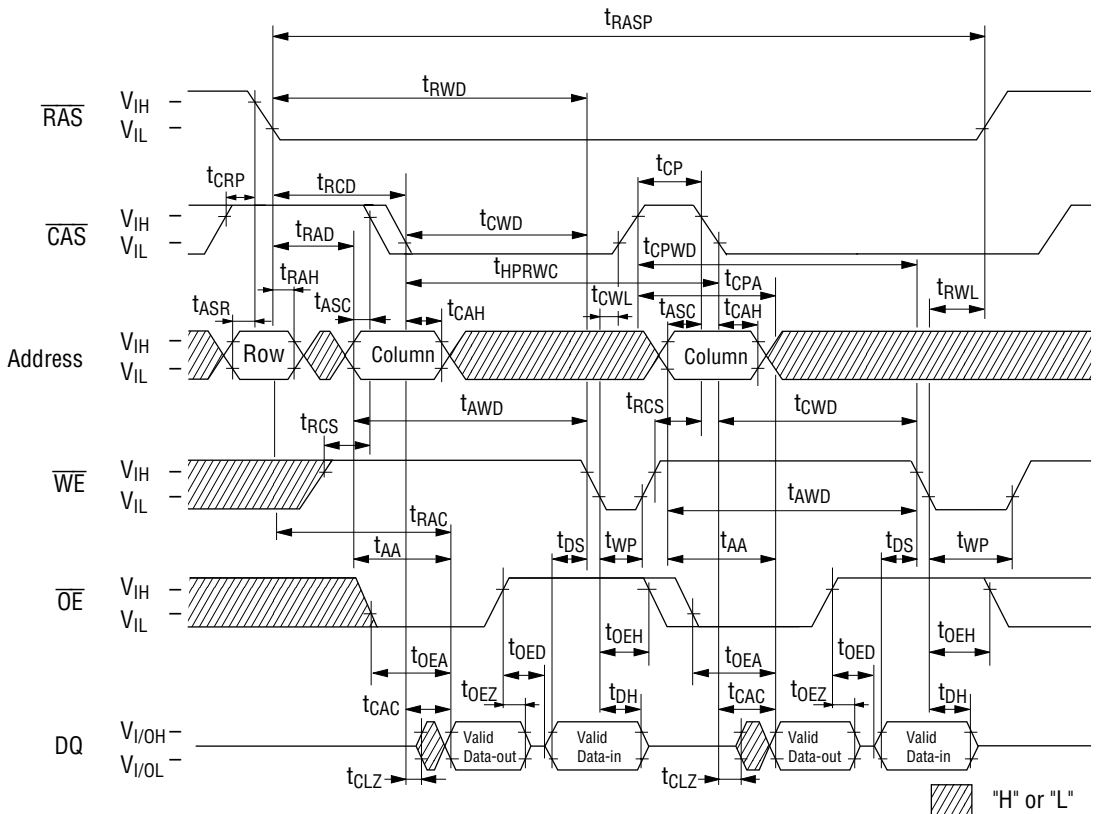


"H" or "L"

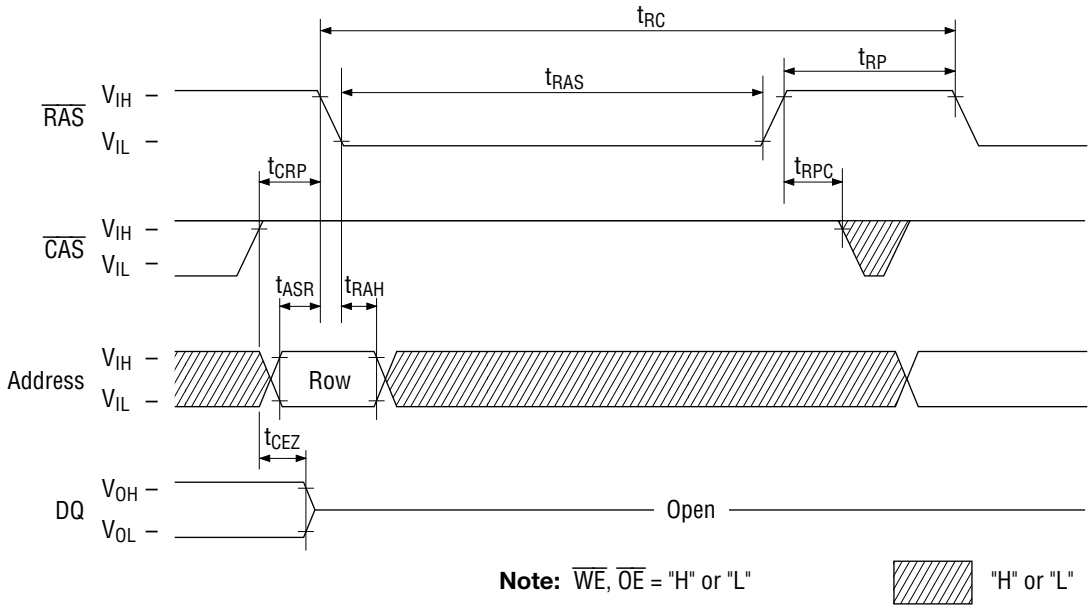
**Fast Page Mode Write Cycle (Early Write)**



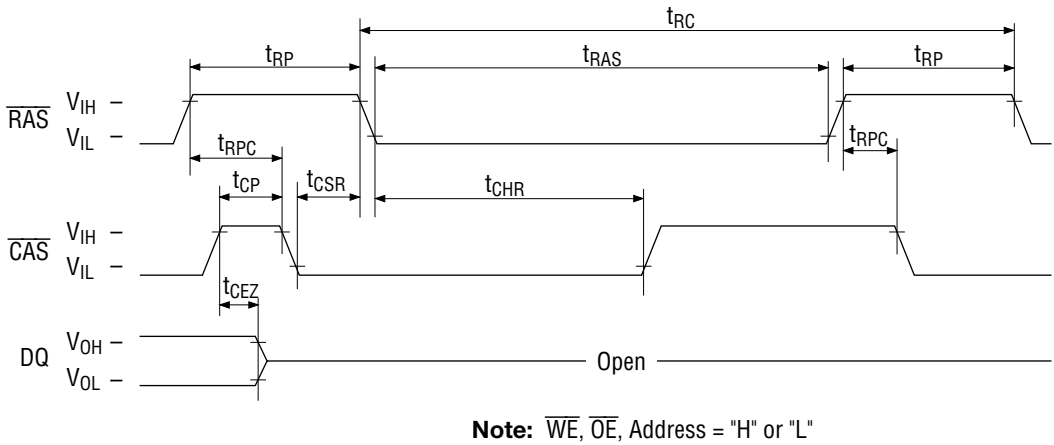
**Fast Page Mode Read Modify Write Cycle**



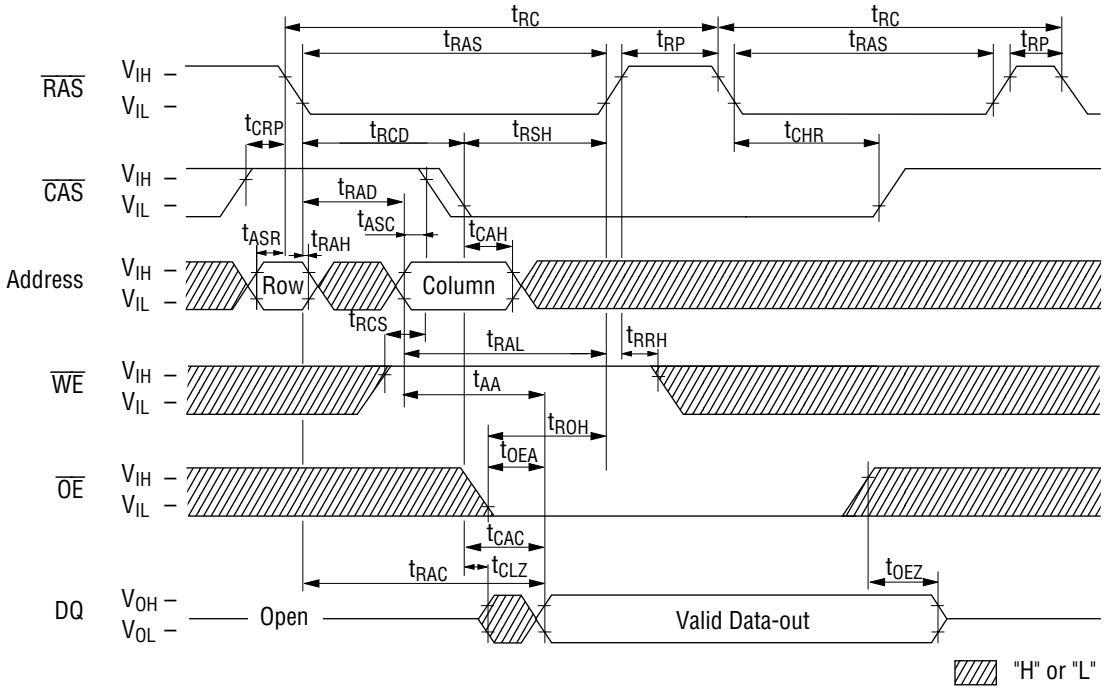
**RAS-Only Refresh Cycle**



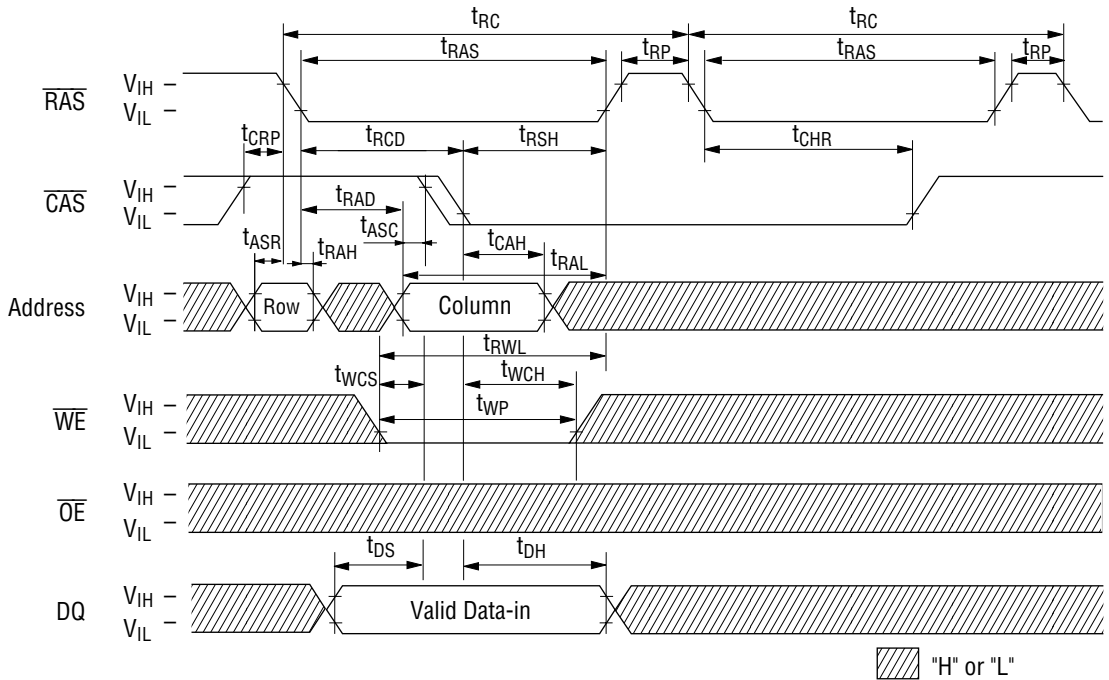
**CAS before RAS Refresh Cycle**



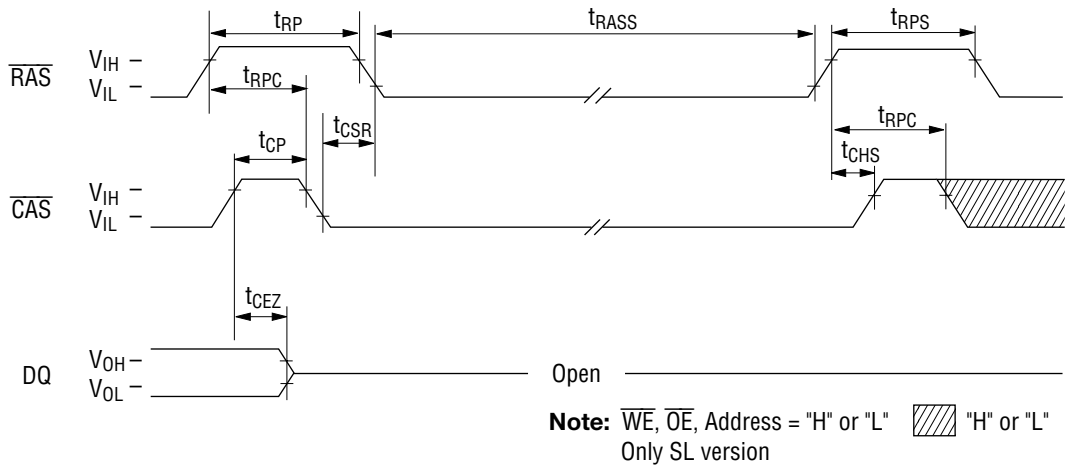
**Hidden Refresh Read Cycle**



**Hidden Refresh Write Cycle**

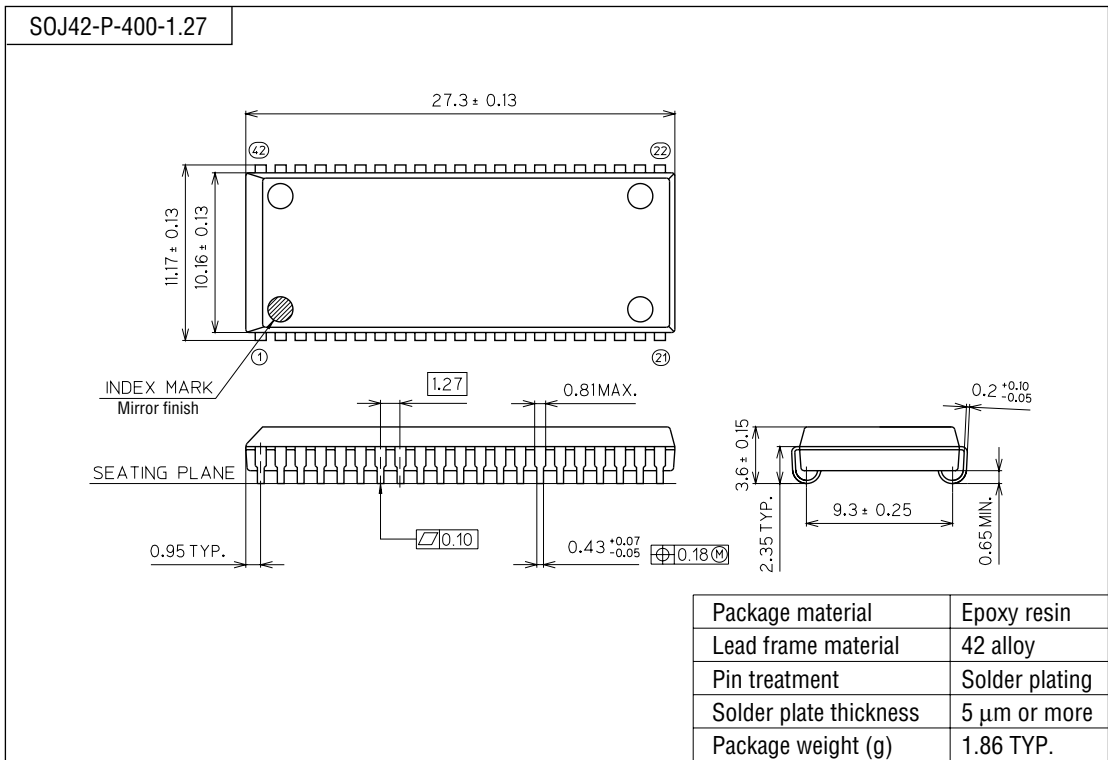


**$\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Self-Refresh Cycle**



**PACKAGE DIMENSIONS**

(Unit : mm)

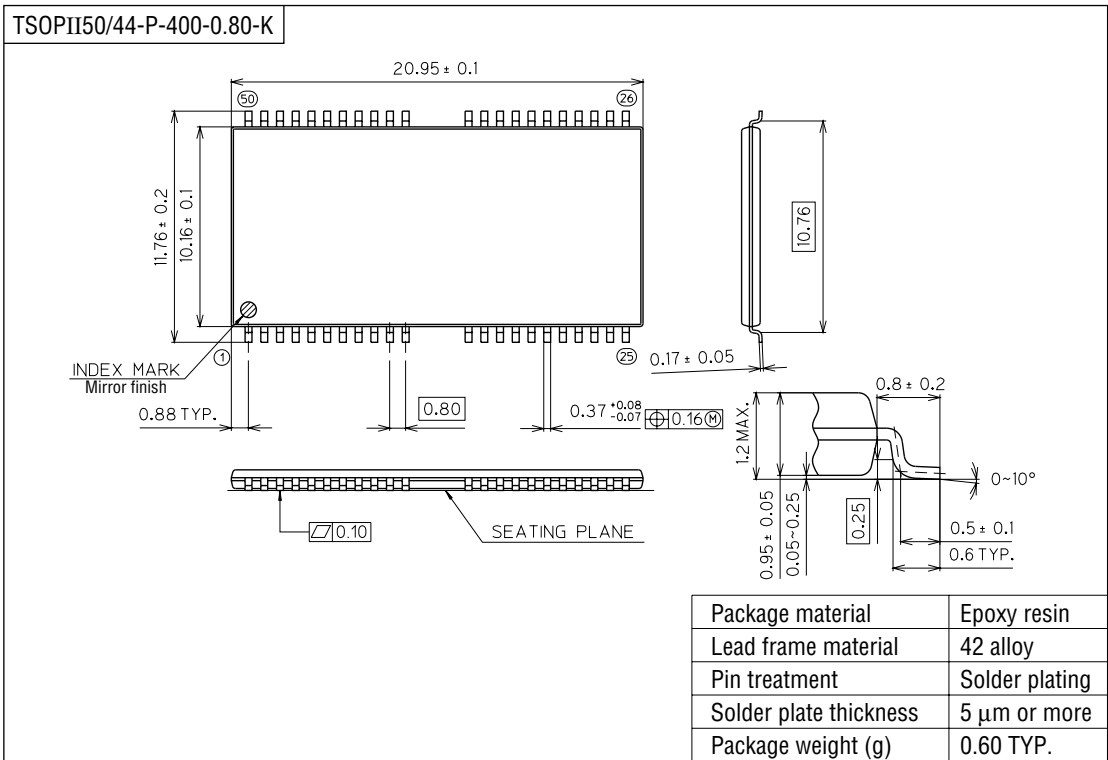


**Notes for Mounting the Surface Mount Type Package**

The SOP, QFP, TSOP, SOJ, QFJ (PLCC), SHP and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact Oki's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).



(Unit : mm)



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2. The outline of action and examples for application circuits described herein have been chosen as an explanation for the standard action and performance of the product. When planning to use the product, please ensure that the external conditions are reflected in the actual circuit, assembly, and program designs.
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