

# OKI Semiconductor

## MSC23B1321D-xxBS2/DS2

1,048,576-word x 32-bit DYNAMIC RAM MODULE : FAST PAGE MODE TYPE

### DESCRIPTION

The MSC23B1321D-xxBS2/DS2 is a fully decoded, 1,048,576-word x 32-bit CMOS dynamic random access memory module composed of two 16Mb DRAMs in SOJ packages mounted with four decoupling capacitors on a 72-pin glass epoxy single-inline package. This module supports any application where high density and large capacity of storage memory are required.

### FEATURES

- 1,048,576-word x 32-bit organization
- 72-pin socket insertable module
  - MSC23B1321D-xxBS2 : Gold tab
  - MSC23B1321D-xxDS2 : Solder tab
- Single +5V supply  $\pm 10\%$  tolerance
- Input : TTL compatible
- Output : TTL compatible, 3-state
- Refresh : 1024cycles/16ms
- /CAS before /RAS refresh, hidden refresh, /RAS only refresh capability
- Fast page mode capability

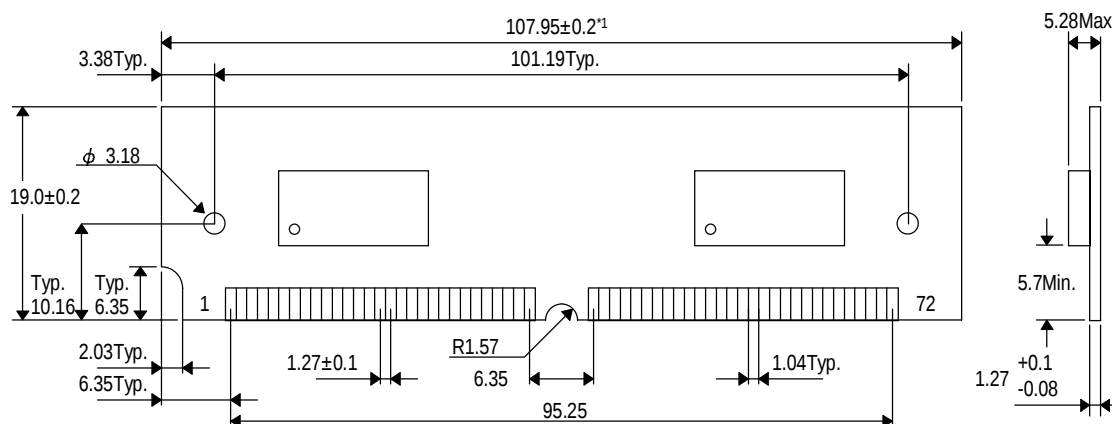
### PRODUCT FAMILY

| Family                | Access Time (Max.) |                 |                  | Cycle Time (Min.) | Power Dissipation |               |
|-----------------------|--------------------|-----------------|------------------|-------------------|-------------------|---------------|
|                       | t <sub>RAC</sub>   | t <sub>AA</sub> | t <sub>CAC</sub> |                   | Operating(Max.)   | Standby(Max.) |
| MSC23B1321D-60BS2/DS2 | 60ns               | 30ns            | 15ns             | 110ns             | 1375mW            | 11mW          |
| MSC23B1321D-70BS2/DS2 | 70ns               | 35ns            | 20ns             | 130ns             | 1265mW            |               |

# MODULE OUTLINE

MSC23B1321D-xxBS2/DS2

(Unit : mm)



\*1 The common size difference of the board width 12.5mm of its height is specified as  $\pm 0.2$ .  
The value above 12.5mm is specified as  $\pm 0.5$ .

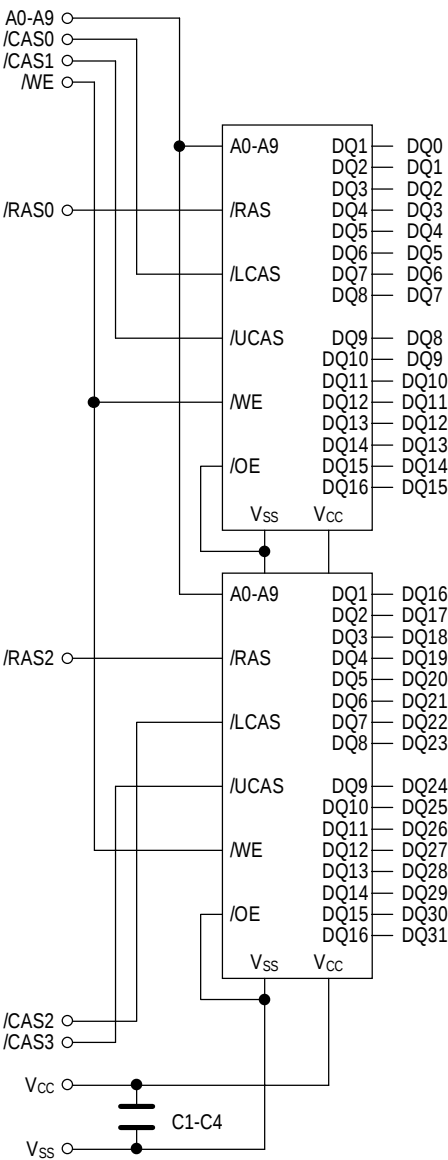
## PIN CONFIGURATION

| Pin No. | Pin Name        | Pin No. | Pin Name        | Pin No. | Pin Name        | Pin No. | Pin Name        |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 1       | V <sub>SS</sub> | 19      | NC              | 37      | NC              | 55      | DQ11            |
| 2       | DQ0             | 20      | DQ4             | 38      | NC              | 56      | DQ27            |
| 3       | DQ16            | 21      | DQ20            | 39      | V <sub>SS</sub> | 57      | DQ12            |
| 4       | DQ1             | 22      | DQ5             | 40      | /CAS0           | 58      | DQ28            |
| 5       | DQ17            | 23      | DQ21            | 41      | /CAS2           | 59      | V <sub>CC</sub> |
| 6       | DQ2             | 24      | DQ6             | 42      | /CAS3           | 60      | DQ29            |
| 7       | DQ18            | 25      | DQ22            | 43      | /CAS1           | 61      | DQ13            |
| 8       | DQ3             | 26      | DQ7             | 44      | /RAS0           | 62      | DQ30            |
| 9       | DQ19            | 27      | DQ23            | 45      | NC              | 63      | DQ14            |
| 10      | V <sub>CC</sub> | 28      | A7              | 46      | NC              | 64      | DQ31            |
| 11      | NC              | 29      | NC              | 47      | /WE             | 65      | DQ15            |
| 12      | A0              | 30      | V <sub>CC</sub> | 48      | NC              | 66      | NC              |
| 13      | A1              | 31      | A8              | 49      | DQ8             | 67      | PD1             |
| 14      | A2              | 32      | A9              | 50      | DQ24            | 68      | PD2             |
| 15      | A3              | 33      | NC              | 51      | DQ9             | 69      | PD3             |
| 16      | A4              | 34      | /RAS2           | 52      | DQ25            | 70      | PD4             |
| 17      | A5              | 35      | NC              | 53      | DQ10            | 71      | NC              |
| 18      | A6              | 36      | NC              | 54      | DQ26            | 72      | V <sub>SS</sub> |

## Presence Detect Pins

| Pin No. | Pin Name | MSC23B1321D<br>-60BS2/DS2 | MSC23B1321D<br>-70BS2/DS2 |
|---------|----------|---------------------------|---------------------------|
| 67      | PD1      | V <sub>SS</sub>           | V <sub>SS</sub>           |
| 68      | PD2      | V <sub>SS</sub>           | V <sub>SS</sub>           |
| 69      | PD3      | NC                        | V <sub>SS</sub>           |
| 70      | PD4      | NC                        | NC                        |

BLOCK DIAGRAM



## ELECTRICAL CHARACTERISTICS

## Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                                                     | Symbol                             | Rating       | Unit |
|---------------------------------------------------------------|------------------------------------|--------------|------|
| Voltage on Any Pin Relative to V <sub>SS</sub>                | V <sub>IN</sub> , V <sub>OUT</sub> | -1.0 to +7.0 | V    |
| Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub> | V <sub>CC</sub>                    | -1.0 to +7.0 | V    |
| Short Circuit Output Current                                  | I <sub>OS</sub>                    | 50           | mA   |
| Power Dissipation                                             | P <sub>D</sub>                     | 2            | W    |
| Operating Temperature                                         | T <sub>OPR</sub>                   | 0 to +70     | °C   |
| Storage Temperature                                           | T <sub>STG</sub>                   | -40 to +125  | °C   |

## Recommended Operating Conditions

(Ta = 0°C to +70°C)

| Parameter            | Symbol          | Min. | Typ. | Max. | Unit |
|----------------------|-----------------|------|------|------|------|
| Power Supply Voltage | V <sub>CC</sub> | 4.5  | 5.0  | 5.5  | V    |
|                      | V <sub>SS</sub> | 0    | 0    | 0    | V    |
| Input High Voltage   | V <sub>IH</sub> | 2.4  | -    | 6.5  | V    |
| Input Low Voltage    | V <sub>IL</sub> | -1.0 | -    | 0.8  | V    |

## Capacitance

(V<sub>CC</sub> = 5V ± 10%, Ta = 25°C, f = 1 MHz)

| Parameter                        | Symbol           | Typ. | Max. | Unit |
|----------------------------------|------------------|------|------|------|
| Input Capacitance (A0 - A9)      | C <sub>IN1</sub> | -    | 16   | pF   |
| Input Capacitance (/WE)          | C <sub>IN2</sub> | -    | 20   | pF   |
| Input Capacitance (/RAS0, /RAS2) | C <sub>IN3</sub> | -    | 13   | pF   |
| Input Capacitance (/CAS0- /CAS3) | C <sub>IN4</sub> | -    | 13   | pF   |
| I/O Capacitance (DQ0 - DQ31)     | C <sub>DQ</sub>  | -    | 13   | pF   |

Note: Capacitance measured with Boonton Meter.

## DC Characteristics

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

| Parameter                                                  | Symbol           | Condition                                                             | MSC23B1321D<br>-60BS2/DS2 |                 | MSC23B1321D<br>-70BS2/DS2 |                 | Unit | Note |
|------------------------------------------------------------|------------------|-----------------------------------------------------------------------|---------------------------|-----------------|---------------------------|-----------------|------|------|
|                                                            |                  |                                                                       | Min.                      | Max.            | Min.                      | Max.            |      |      |
| Input Leakage Current                                      | I <sub>LI</sub>  | 0V ≤ V <sub>IN</sub> ≤ 6.5V:<br>All other pins not<br>under test = 0V | -20                       | 20              | -20                       | 20              | μA   |      |
| Output Leakage Current                                     | I <sub>LO</sub>  | Data out is disable<br>0V ≤ V <sub>OUT</sub> ≤ 5.5V                   | -10                       | 10              | -10                       | 10              | μA   |      |
| Output High Voltage                                        | V <sub>OH</sub>  | I <sub>OH</sub> = -5.0mA                                              | 2.4                       | V <sub>CC</sub> | 2.4                       | V <sub>CC</sub> | V    |      |
| Output Low Voltage                                         | V <sub>OL</sub>  | I <sub>OL</sub> = 4.2mA                                               | 0                         | 0.4             | 0                         | 0.4             | V    |      |
| Average Power Supply Current<br>(Operating)                | I <sub>CC1</sub> | /RAS cycling,<br>/CAS cycling,<br>t <sub>RC</sub> = min.              | -                         | 250             | -                         | 230             | mA   | 1, 2 |
| Power supply current<br>(Standby)                          | I <sub>CC2</sub> | /RAS = V <sub>IH</sub> TTL                                            | -                         | 4               | -                         | 4               | mA   | 1    |
|                                                            |                  | /CAS = V <sub>IH</sub> MOS                                            | -                         | 2               | -                         | 2               | mA   | 1    |
| Average Power Supply Current<br>(/RAS only refresh)        | I <sub>CC3</sub> | /RAS cycling,<br>/CAS = V <sub>IH</sub> ,<br>t <sub>RC</sub> = min.   | -                         | 250             | -                         | 230             | mA   | 1, 2 |
| Average Power Supply Current<br>(/CAS before /RAS refresh) | I <sub>CC6</sub> | t <sub>RC</sub> = min.                                                | -                         | 250             | -                         | 230             | mA   | 1, 2 |
| Average Power Supply Current<br>(Fast Page Mode)           | I <sub>CC7</sub> | /RAS = V <sub>IL</sub> ,<br>/CAS cycling,<br>t <sub>PC</sub> = min.   | -                         | 250             | -                         | 230             | mA   | 1, 3 |

- Notes: 1. I<sub>CC</sub> is dependent on output loading and cycles rates. Specified values are obtained with the output open.  
2. Address can be changed once or less while /RAS = V<sub>IL</sub>.  
3. Address can be changed once or less while /CAS = V<sub>IH</sub>.

## AC Characteristics (1/2)

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

| Parameter                                      | Symbol            | MSC23B1321D<br>-60BS2/DS2 |      | MSC23B1321D<br>-70BS2/DS2 |      | Unit | Note    |
|------------------------------------------------|-------------------|---------------------------|------|---------------------------|------|------|---------|
|                                                |                   | Min.                      | Max. | Min.                      | Max. |      |         |
| Random Read or Write Cycle Time                | t <sub>RC</sub>   | 110                       | -    | 130                       | -    | ns   |         |
| Fast Page Mode Cycle Time                      | t <sub>PC</sub>   | 40                        | -    | 45                        | -    | ns   |         |
| Access Time from /RAS                          | t <sub>RAC</sub>  | -                         | 60   | -                         | 70   | ns   | 4, 5, 6 |
| Access Time from /CAS                          | t <sub>CAC</sub>  | -                         | 15   | -                         | 20   | ns   | 4, 5    |
| Access Time from Column Address                | t <sub>AA</sub>   | -                         | 30   | -                         | 35   | ns   | 4, 6    |
| Access Time from /CAS Precharge                | t <sub>CPA</sub>  | -                         | 35   | -                         | 40   | ns   | 4       |
| Output Low Impedance Time from /CAS            | t <sub>CLZ</sub>  | 0                         | -    | 0                         | -    | ns   | 4       |
| /CAS to Data Output Buffer Turn-off Delay Time | t <sub>OFF</sub>  | 0                         | 15   | 0                         | 20   | ns   | 7       |
| Transition Time                                | t <sub>T</sub>    | 3                         | 50   | 3                         | 50   | ns   | 3       |
| Refresh Period                                 | t <sub>REF</sub>  | -                         | 16   | -                         | 16   | ms   |         |
| /RAS Precharge Time                            | t <sub>RP</sub>   | 40                        | -    | 50                        | -    | ns   |         |
| /RAS Pulse Width                               | t <sub>RAS</sub>  | 60                        | 10K  | 70                        | 10K  | ns   |         |
| /RAS Pulse Width (Fast Page Mode)              | t <sub>RASP</sub> | 60                        | 100K | 70                        | 100K | ns   |         |
| /RAS Hold Time                                 | t <sub>RSH</sub>  | 15                        | -    | 20                        | -    | ns   |         |
| /CAS Precharge Time (Fast Page Mode)           | t <sub>CP</sub>   | 10                        | -    | 10                        | -    | ns   |         |
| /CAS Pulse Width                               | t <sub>CAS</sub>  | 15                        | 10K  | 20                        | 10K  | ns   |         |
| /CAS Hold Time                                 | t <sub>CSH</sub>  | 60                        | -    | 70                        | -    | ns   |         |
| /CAS to /RAS Precharge Time                    | t <sub>CRP</sub>  | 5                         | -    | 5                         | -    | ns   |         |
| /RAS Hold Time from /CAS Precharge             | t <sub>RHCP</sub> | 35                        | -    | 40                        | -    | ns   |         |
| /RAS to /CAS Delay Time                        | t <sub>RCD</sub>  | 20                        | 45   | 20                        | 50   | ns   | 5       |
| /RAS to Column Address Delay Time              | t <sub>RAD</sub>  | 15                        | 30   | 15                        | 35   | ns   | 6       |
| Row Address Set-up Time                        | t <sub>ASR</sub>  | 0                         | -    | 0                         | -    | ns   |         |
| Row Address Hold Time                          | t <sub>RAH</sub>  | 10                        | -    | 10                        | -    | ns   |         |
| Column Address Set-up Time                     | t <sub>ASC</sub>  | 0                         | -    | 0                         | -    | ns   |         |
| Column Address Hold Time                       | t <sub>CAH</sub>  | 10                        | -    | 15                        | -    | ns   |         |
| Column Address to /RAS Lead Time               | t <sub>RAL</sub>  | 30                        | -    | 35                        | -    | ns   |         |
| Read Command Set-up Time                       | t <sub>RCS</sub>  | 0                         | -    | 0                         | -    | ns   |         |
| Read Command Hold Time                         | t <sub>RCH</sub>  | 0                         | -    | 0                         | -    | ns   | 8       |
| Read Command Hold Time referenced to /RAS      | t <sub>RRH</sub>  | 0                         | -    | 0                         | -    | ns   | 8       |

## AC Characteristics (2/2)

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

| Parameter                                      | Symbol           | MSC23B1321D<br>-60BS2/DS2 |      | MSC23B1321D<br>-70BS2/DS2 |      | Unit | Note |
|------------------------------------------------|------------------|---------------------------|------|---------------------------|------|------|------|
|                                                |                  | Min.                      | Max. | Min.                      | Max. |      |      |
| Write Command Set-up Time                      | t <sub>WCS</sub> | 0                         | -    | 0                         | -    | ns   |      |
| Write Command Hold Time                        | t <sub>WCH</sub> | 10                        | -    | 15                        | -    | ns   |      |
| Write Command Pulse Width                      | t <sub>WP</sub>  | 10                        | -    | 10                        | -    | ns   |      |
| Write Command to /RAS Lead Time                | t <sub>RWL</sub> | 15                        | -    | 20                        | -    | ns   |      |
| Write Command to /CAS Lead Time                | t <sub>CWL</sub> | 15                        | -    | 20                        | -    | ns   |      |
| Data-in Set-up Time                            | t <sub>DS</sub>  | 0                         | -    | 0                         | -    | ns   |      |
| Data-in Hold Time                              | t <sub>DH</sub>  | 10                        | -    | 15                        | -    | ns   |      |
| /CAS Active Delay Time from /RAS Precharge     | t <sub>RPC</sub> | 5                         | -    | 5                         | -    | ns   |      |
| /RAS to /CAS Set-up Time<br>(/CAS before /RAS) | t <sub>CSR</sub> | 10                        | -    | 10                        | -    | ns   |      |
| /RAS to /CAS Hold Time<br>(/CAS before /RAS)   | t <sub>CHR</sub> | 10                        | -    | 10                        | -    | ns   |      |

- Notes:
1. A start-up delay of 200 $\mu$ s is required after power-up, followed by a minimum of eight initialization cycles (/RAS only refresh or /CAS before /RAS refresh) before proper device operation is achieved.
  2. The AC characteristics assumes  $t_T = 5\text{ns}$ .
  3.  $V_{IH}(\text{Min.})$  and  $V_{IL}(\text{Max.})$  are reference levels for measuring input timing signals. Transition time ( $t_T$ ) are measured between  $V_{IH}$  and  $V_{IL}$ .
  4. This parameter is measured with a load circuit equivalent to 2TTL loads and 100pF.
  5. Operation within the  $t_{RCD}(\text{Max.})$  limit ensures that  $t_{RAC}(\text{Max.})$  can be met.  
 $t_{RCD}(\text{Max.})$  is specified as a reference point only. If  $t_{RCD}$  is greater than the specified  $t_{RCD}(\text{Max.})$  limit, then the access time is controlled by  $t_{CAC}$ .
  6. Operation within the  $t_{RAD}(\text{Max.})$  limit ensures that  $t_{RAC}(\text{Max.})$  can be met.  
 $t_{RAD}(\text{Max.})$  is specified as a reference point only. If  $t_{RAD}$  is greater than the specified  $t_{RAD}(\text{Max.})$  limit, then the access time is controlled by  $t_{AA}$ .
  7.  $t_{OFF}(\text{Max.})$  define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
  8.  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.