

# OKI Semiconductor

## MSC23232C/CL-xxBS16/DS16

2,097,152-Word × 32-Bit DRAM MODULE : FAST PAGE MODE TYPE

### DESCRIPTION

The OKI MSC23232C/CL-xxBS16/DS16 is a fully decoded 2,097,152-word × 32-bit CMOS Dynamic Random Access Memory Module composed of sixteen 4-Mb DRAMs (1M × 4) in SOJ packages mounted with sixteen decoupling capacitors on a 72-pin glass epoxy single-inline package. This module is generally used for non-parity memory expansion applications such as fax machines, printers and personal computers. The low-power version (CL) offers reduced power consumption for mobile computing applications like laptops and palmtops.

### FEATURES

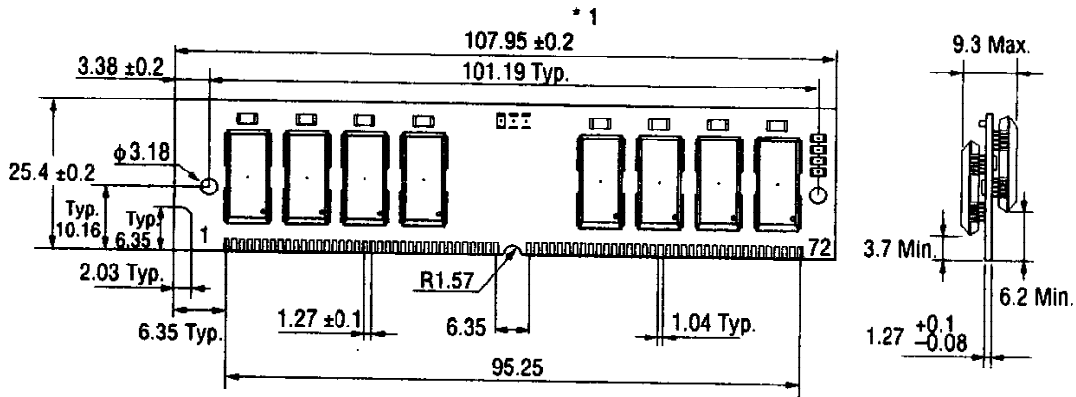
- 2-Meg × 32-bit organization
- 72-Pin Socket Insertable Module  
MSC23232C/CL-xxBS16 : Gold tab  
MSC23232C/CL-xxDS16 : Solder tab
- Single 5 V supply ±10% tolerance
- Access times : 60, 70, 80 ns
- Input : TTL compatible
- Output : TTL compatible, 3-state
- Refresh : 1024 cycles/16 ms (128 ms : L-version)
- CAS before RAS refresh, CAS before RAS hidden refresh, RAS-only refresh capability
- Multi-bit test mode 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.)
MSC23232C/CL-60BS16/DS16	60 ns	30 ns	15 ns	110 ns	4620 mW	88 mW/ 17.6 mW (L-version)
MSC23232C/CL-70BS16/DS16	70 ns	35 ns	20 ns	130 ns	4180 mW	
MSC23232C/CL-80BS16/DS16	80 ns	40 ns	20 ns	150 ns	3740 mW	

**PIN CONFIGURATION**

**MSC23232C/CL-xxBS16/DS16**



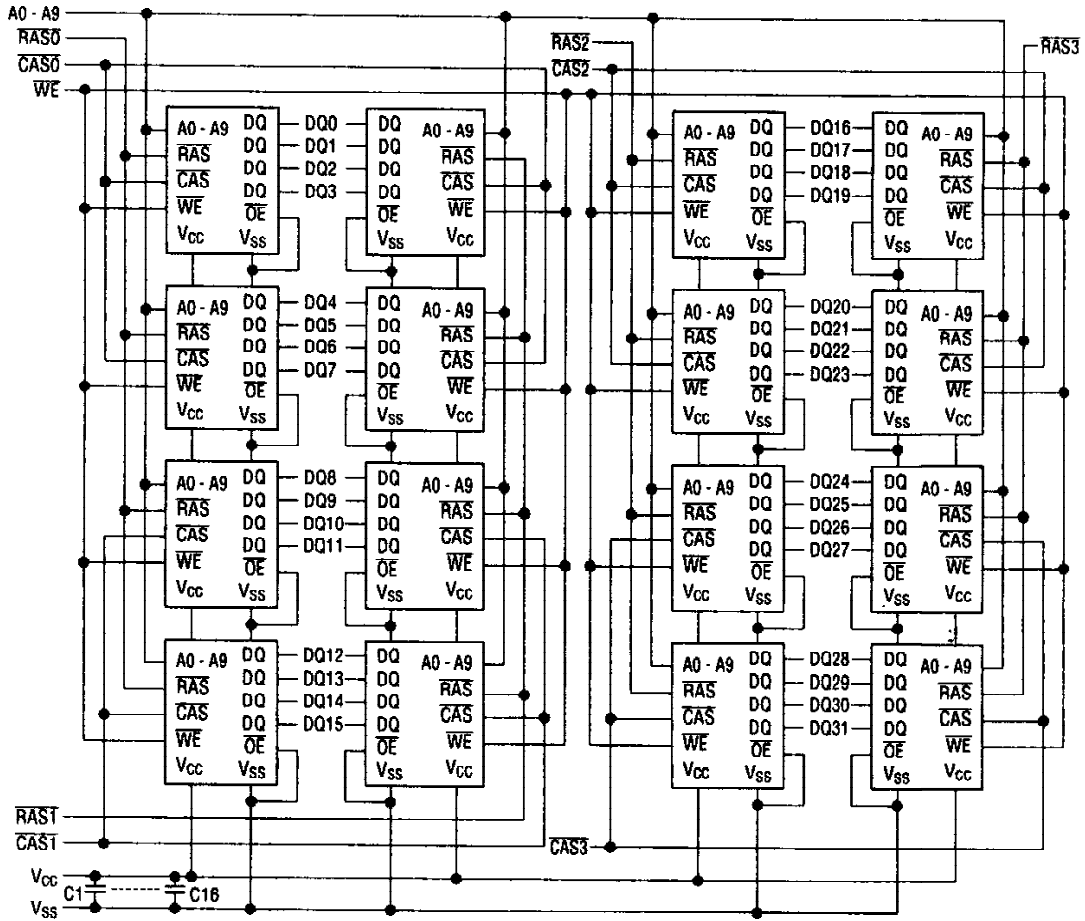
\*1 The common size difference of the board width 12.5 mm of its height is specified as ±0.2. The value above 12.5 mm is specified as ±0.5.

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
1	V <sub>SS</sub>	16	A4	31	A8	46	NC	61	DQ13
2	DQ0	17	A5	32	A9	47	$\overline{WE}$	62	DQ30
3	DQ16	18	A6	33	$\overline{RAS3}$	48	NC	63	DQ14
4	DQ1	19	NC	34	$\overline{RAS2}$	49	DQ8	64	DQ31
5	DQ17	20	DQ4	35	NC	50	DQ24	65	DQ15
6	DQ2	21	DQ20	36	NC	51	DQ9	66	NC
7	DQ18	22	DQ5	37	NC	52	DQ25	67	PD1
8	DQ3	23	DQ21	38	NC	53	DQ10	68	PD2
9	DQ19	24	DQ6	39	V <sub>SS</sub>	54	DQ26	69	PD3
10	V <sub>CC</sub>	25	DQ22	40	$\overline{CAS0}$	55	DQ11	70	PD4
11	NC	26	DQ7	41	$\overline{CAS2}$	56	DQ27	71	NC
12	A0	27	DQ23	42	$\overline{CAS3}$	57	DQ12	72	V <sub>SS</sub>
13	A1	28	A7	43	$\overline{CAS1}$	58	DQ28		
14	A2	29	NC	44	$\overline{RAS0}$	59	V <sub>CC</sub>		
15	A3	30	V <sub>CC</sub>	45	$\overline{RAS1}$	60	DQ29		

**Presence Detect Pins**

Pin No.	Pin Name	MSC23232C/CL-60BS16/DS16	MSC23232C/CL-70BS16/DS16	MSC23232C/CL-80BS16/DS16
67	PD1	NC	NC	NC
68	PD2	NC	NC	NC
69	PD3	NC	V <sub>SS</sub>	NC
70	PD4	NC	NC	V <sub>SS</sub>

**BLOCK DIAGRAM**



**ELECTRICAL CHARACTERISTICS****Absolute Maximum Ratings**

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 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>	16	W
Operating Temperature	T <sub>opr</sub>	0 to 70	°C
Storage Temperature	T <sub>stg</sub>	-40 to 125	°C

Note: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Recommended Operating Conditions**(T<sub>a</sub> = 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**(T<sub>a</sub> = 25°C, f = 1 MHz)

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 - A9)	C <sub>IN1</sub>	—	109	pF
Input Capacitance ( $\overline{WE}$ )	C <sub>IN2</sub>	—	125	pF
Input Capacitance ( $\overline{RAS0}$ - $\overline{RAS3}$ )	C <sub>IN3</sub>	—	35	pF
Input Capacitance ( $\overline{CAS0}$ - $\overline{CAS3}$ )	C <sub>IN4</sub>	—	35	pF
I/O Capacitance (DQ0 - DQ31)	C <sub>DQ</sub>	—	20	pF

Note : Capacitance measured with Boonton Meter.

## DC Characteristics

 $(V_{CC} = 5 V \pm 10\%, T_a = 0^\circ C \text{ to } 70^\circ C)$ 

Parameter	Symbol	Condition	MSC23232C/CL -60BS16/DS16		MSC23232C/CL -70BS16/DS16		MSC23232C/CL -80BS16/DS16		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.		
			Input Leakage Current	$I_{LI}$	$0 V \leq V_I \leq 6.5 V$ ; All other pins not under test = $0 V$	-160	160	-160		
Output Leakage Current	$I_{LO}$	$D_{OUT}$ disable $0 V \leq V_O \leq 5.5 V$	-20	20	-20	20	-20	20	$\mu A$	
Output High Voltage	$V_{OH}$	$I_{OH} = -5.0 \text{ mA}$	2.4	$V_{CC}$	2.4	$V_{CC}$	2.4	$V_{CC}$	V	
Output Low Voltage	$V_{OL}$	$I_{OL} = 4.2 \text{ mA}$	0	0.4	0	0.4	0	0.4	V	
Average Power Supply Current (Operating)	$I_{CC1}$	$\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = \text{Min.}$	—	840	—	760	—	680	mA	1, 2
Power Supply Current (Standby)	$I_{CC2}$	$\overline{RAS}$ , $\overline{CAS} = V_{IH}$	—	32	—	32	—	32	mA	1
		$\overline{RAS}$ , $\overline{CAS}$ $\geq V_{CC} - 0.2 V$	—	16	—	16	—	16	mA	1
			—	3.2	—	3.2	—	3.2	mA	1, 5
Average Power Supply Current ( $\overline{RAS}$ -only Refresh)	$I_{CC3}$	$\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$ , $t_{RC} = \text{Min.}$	—	840	—	760	—	680	mA	1, 2
Average Power Supply Current ( $\overline{CAS}$ before $\overline{RAS}$ Refresh)	$I_{CC6}$	$\overline{RAS}$ cycling, $\overline{CAS}$ before $\overline{RAS}$ , $t_{RC} = \text{Min.}$	—	840	—	760	—	680	mA	1, 2
Average Power Supply Current (Fast Page Mode)	$I_{CC7}$	$\overline{RAS} = V_{IL}$ , $\overline{CAS}$ cycling, $t_{PC} = \text{Min.}$	—	680	—	600	—	520	mA	1, 3
Average Power Supply Current (Battery Backup)	$I_{CC10}$	$t_{RC} = 125 \mu s$ , $\overline{CAS}$ before $\overline{RAS}$ cycling	—	4.8	—	4.8	—	4.8	mA	1, 2 4, 5

- Notes: 1. Specified values are obtained with the output open.  
 2. Address can be changed once or less while  $\overline{RAS} = V_{IL}$ .  
 3. Address can be changed once or less while  $\overline{CAS} = V_{IH}$ .  
 4.  $V_{CC} - 0.2 V \leq V_{IH} \leq 6.5 V$ ,  $-1.0 V \leq V_{IL} \leq 0.2 V$ .  
 5. L-version.

## AC Characteristics (1/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1,2,3,9,10

Parameter	Symbol	MSC23232C/CL -60BS16/DS16		MSC23232C/CL -70BS16/DS16		MSC23232C/CL -80BS16/DS16		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
		Random Read or Write Cycle Time	t <sub>RC</sub>	110	—	130	—		
Fast Page Mode Cycle Time	t <sub>PC</sub>	40	—	45	—	50	—	ns	
Access Time from RAS	t <sub>RAC</sub>	—	60	—	70	—	80	ns	4, 5, 6
Access Time from CAS	t <sub>CAC</sub>	—	15	—	20	—	20	ns	4, 5
Access Time from Column Address	t <sub>AA</sub>	—	30	—	35	—	40	ns	4, 6
Access Time from CAS Precharge	t <sub>CPA</sub>	—	35	—	40	—	45	ns	4
Output Low Impedance Time from CAS	t <sub>CLZ</sub>	0	—	0	—	0	—	ns	4
Output Buffer Turn-off Delay Time	t <sub>OFF</sub>	0	15	0	20	0	20	ns	7
Transition Time	t <sub>T</sub>	3	50	3	50	3	50	ns	3
Refresh Period	t <sub>REF</sub>	—	16	—	16	—	16	ms	
Refresh Period (L-version)	t <sub>REF</sub>	—	128	—	128	—	128	ms	
RAS Precharge Time	t <sub>RP</sub>	40	—	50	—	60	—	ns	
RAS Pulse Width	t <sub>RAS</sub>	60	10K	70	10K	80	10K	ns	
RAS Pulse Width (Fast Page Mode)	t <sub>RASP</sub>	60	100K	70	100K	80	100K	ns	
RAS Hold Time	t <sub>RSH</sub>	15	—	20	—	20	—	ns	
CAS Precharge Time	t <sub>CP</sub>	10	—	10	—	10	—	ns	
CAS Pulse Width	t <sub>CAS</sub>	15	10K	20	10K	20	10K	ns	
CAS Hold Time	t <sub>CSH</sub>	60	—	70	—	80	—	ns	
CAS to RAS Precharge Time	t <sub>CRP</sub>	5	—	5	—	5	—	ns	
RAS to CAS Delay Time	t <sub>RCd</sub>	20	45	20	50	20	60	ns	5
RAS to Column Address Delay Time	t <sub>RAD</sub>	15	30	15	35	15	40	ns	6
Row Address Set-up Time	t <sub>ASR</sub>	0	—	0	—	0	—	ns	
Row Address Hold Time	t <sub>RAH</sub>	10	—	10	—	10	—	ns	
Column Address Set-up Time	t <sub>ASC</sub>	0	—	0	—	0	—	ns	
Column Address Hold Time	t <sub>CAH</sub>	15	—	15	—	15	—	ns	
Column Address Hold Time from RAS	t <sub>AR</sub>	50	—	55	—	60	—	ns	
Column Address to RAS Lead Time	t <sub>RAL</sub>	30	—	35	—	40	—	ns	

AC Characteristics (2/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1,2,3,9,10

Parameter	Symbol	MSC23232C/CL-60BS16/DS16		MSC23232C/CL-70BS16/DS16		MSC23232C/CL-80BS16/DS16		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
		Read Command Set-up Time	t <sub>RCS</sub>	0	—	0	—		
Read Command Hold Time	t <sub>RCH</sub>	0	—	0	—	0	—	ns	8
Read Command Hold Time referenced to RAS	t <sub>RRH</sub>	0	—	0	—	0	—	ns	8
Write Command Set-up Time	t <sub>WCS</sub>	0	—	0	—	0	—	ns	
Write Command Hold Time	t <sub>WCH</sub>	10	—	10	—	10	—	ns	
Write Command Hold Time from RAS	t <sub>WCR</sub>	45	—	50	—	60	—	ns	
Write Command Pulse Width	t <sub>WP</sub>	10	—	10	—	10	—	ns	
Write Command to RAS Lead Time	t <sub>RWL</sub>	15	—	20	—	20	—	ns	
Write Command to CAS Lead Time	t <sub>CWL</sub>	15	—	20	—	20	—	ns	
Data-in Set-up Time	t <sub>DS</sub>	0	—	0	—	0	—	ns	
Data-in Hold Time	t <sub>DH</sub>	15	—	15	—	15	—	ns	
Data-in Hold Time from RAS	t <sub>DHR</sub>	50	—	55	—	60	—	ns	
CAS Active Delay Time from RAS Precharge	t <sub>RPC</sub>	5	—	5	—	5	—	ns	
RAS to CAS Set-up Time (CAS before RAS)	t <sub>CSR</sub>	5	—	5	—	5	—	ns	
RAS to CAS Hold Time (CAS before RAS)	t <sub>CHR</sub>	10	—	10	—	10	—	ns	
CAS Precharge Time (Refresh Counter Test)	t <sub>CPT</sub>	30	—	35	—	40	—	ns	
WE to RAS Precharge Time (CAS before RAS)	t <sub>WRP</sub>	10	—	10	—	10	—	ns	
WE Hold Time from RAS (CAS before RAS)	t <sub>WRH</sub>	10	—	10	—	10	—	ns	
RAS to WE Set-up Time (Test Mode)	t <sub>WTS</sub>	10	—	10	—	10	—	ns	
RAS to WE Hold Time (Test Mode)	t <sub>WTH</sub>	10	—	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 ( $\overline{\text{RAS}}$ -only refresh or  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh) before proper device operation is achieved.  
When using the internal refresh counter, a minimum of eight  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  initialization cycles is required.
  2. AC measurement assume  $t_r = 5$  ns.
  3.  $V_{IH}$  (Min.) and  $V_{IL}$  (Max.) are reference levels for measuring input timing signals. Transition times are measured between  $V_{IH}$  and  $V_{IL}$ .
  4. 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, 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, access time is controlled by  $t_{AA}$ .
  7.  $t_{OFF}$  (Max.) defines the time at which the output achieves an open circuit condition and is not referenced to output voltage levels.
  8.  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a read cycle.
  9. The test mode is initiated by performing a  $\overline{\text{WE}}$  and  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh cycle. This mode is latched and remains in effect until the exit cycle is generated. The test mode specified in this data sheet is 2-bit parallel test function. CA0 is not used. In a read cycle, if all internal bits are equal, the DQ pin will indicate a high level. If any internal bits are not equal, the DQ pin will indicate a low level. The test mode is cleared and the memory device returned to its normal operating state by performing a RAS-only refresh cycle or a  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  refresh cycle.
  10. In a test mode read cycle, the access time parameters are delayed by 5 ns. The test mode parameters are obtained by adding 5 ns to the normal read cycle values.

**See ADDENDUM E for AC Timing Waveforms**