

## MSC2333B-xxYS16/DS16

524,288-Word by 32-Bit DRAM Module: Fast Page Mode

### DESCRIPTION

The OKI MSC2333B-xxYS16/DS16 is a fully decoded 524,288-word x 32-bit CMOS Dynamic Random Access Memory Module composed of sixteen 1-Mb DRAMs in SOJ (MSM514256B) packages mounted with eight 0.2  $\mu$ F 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.

### FEATURES

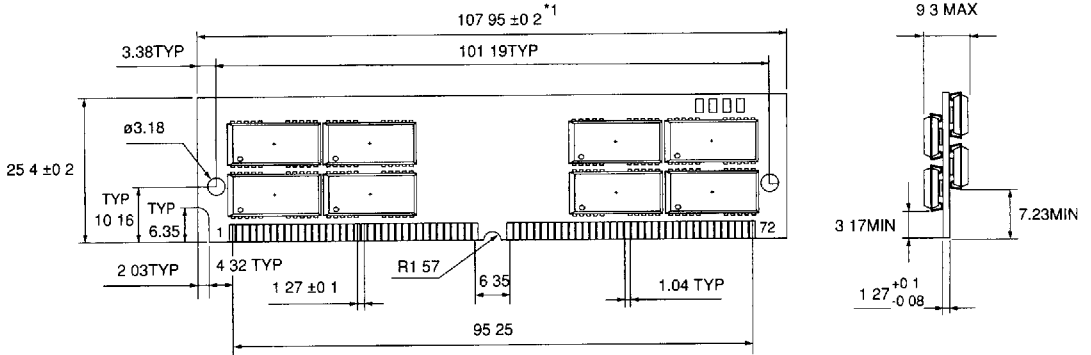
- 512 K x 32-bit organization
- 72-pin socket insertable module
  - MSC2333B-xxYS16: Gold tab
  - MSC2333B-xxDS16: Solder tab
- Single +5 V supply  $\pm 10\%$  tolerance
- Access times: 60, 70, 80, 100 ns
- Input: TTL compatible
- Output: TTL compatible, three-state
- Refresh: 512 cycles/8 ms
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh,  $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  hidden refresh,  $\overline{\text{RAS}}$ -only refresh capability

### Family Organization

Part Number	Access Time			Cycle Time (Min)	Power Dissipation (Max)	
	$t_{\text{RAC}}$	$t_{\text{AA}}$	$t_{\text{CAC}}$		Operating	Standby
MSC2333B-60YS16/DS16	60 ns	30 ns	15 ns	120 ns	4180 mW	88 mW (MOS level)
MSC2333B-70YS16/DS16	70 ns	35 ns	20 ns	130 ns	3740 mW	
MSC2333B-80YS16/DS16	80 ns	40 ns	20 ns	150 ns	3300 mW	
MSC2333B-10YS16/DS16	100 ns	50 ns	25 ns	190 ns	2860 mW	

## PIN CONFIGURATION

### MSC2333B-xxYS16/DS16



\*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

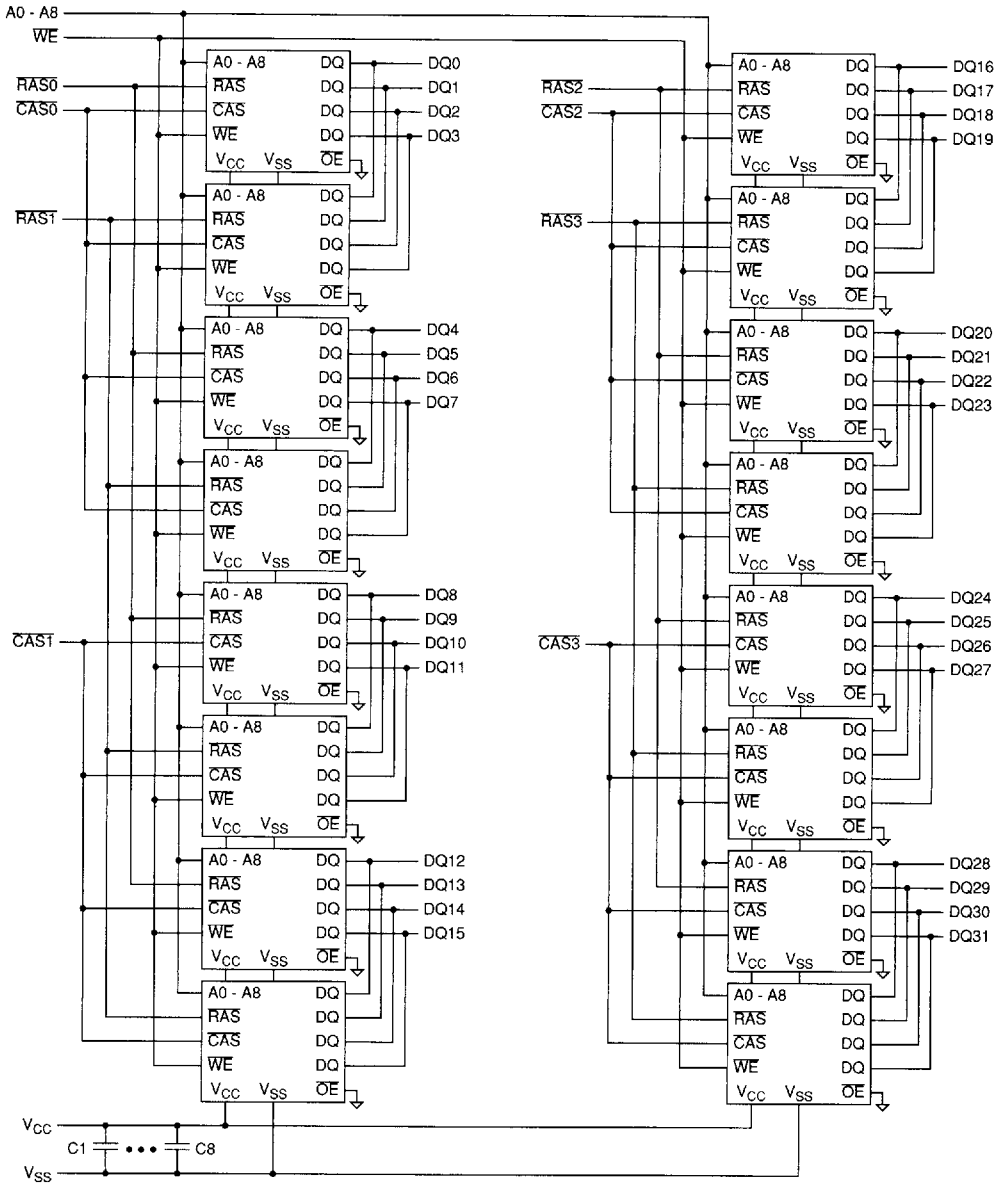
Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name	Pin Number	Pin Name
1	V <sub>SS</sub>	16	A4	31	A8	46	N C	61	DQ13
2	DQ0	17	A5	32	N C	47	WE	62	DQ30
3	DQ16	18	A6	33	RAS3	48	N C	63	DQ14
4	DQ1	19	N C	34	RAS2	49	DQ8	64	DQ31
5	DQ17	20	DQ4	35	N C	50	DQ24	65	DQ15
6	DQ2	21	DQ20	36	N C	51	DQ9	66	N C
7	DQ18	22	DQ5	37	N C	52	DQ25	67	PD0
8	DQ3	23	DQ21	38	N C	53	DQ10	68	PD1
9	DQ19	24	DQ6	39	V <sub>SS</sub>	54	DQ26	69	PD2
10	V <sub>CC</sub>	25	DQ22	40	CAS0	55	DQ11	70	PD3
11	N C	26	DQ7	41	CAS2	56	DQ27	71	N C
12	A0	27	DQ23	42	CAS3	57	DQ12	72	V <sub>SS</sub>
13	A1	28	A7	43	CAS1	58	DQ28		
14	A2	29	N.C	44	RAS0	59	V <sub>CC</sub>		
15	A3	30	V <sub>CC</sub>	45	RAS1	60	DQ29		

### Presence Detect Pins

Pin Number	Pin Name	60 ns	70 ns	80 ns	100 ns
67	PD0	N C	N C	N C	N C
68	PD1	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>
69	PD2	N.C.	V <sub>SS</sub>	N C	V <sub>SS</sub>
70	PD3	N C	N C	V <sub>SS</sub>	V <sub>SS</sub>

**BLOCK DIAGRAM**

**4**



## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings <sup>[1]</sup>

Parameter	Symbol	Value	Unit
Voltage on any pin relative to V <sub>SS</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-1.0 ~ +7.0	V
Voltage V <sub>CC</sub> supply relative to V <sub>SS</sub>	V <sub>CC</sub>	-1.0 ~ +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 ~ +70	°C
Storage temperature	T <sub>STG</sub>	-40 ~ +125	°C

1. 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 ~ +70°C)

Parameter	Symbol	Rated Value			Unit
		Min	Typ	Max	
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) <sup>[1]</sup>

Parameter	Symbol	Typ	Max	Unit
Input capacitance (A0 ~ A8)	C <sub>IN1</sub>	-	130	pF
Input capacitance (WE)	C <sub>IN2</sub>	-	132	pF
Input capacitance (RAS0 ~ RAS3)	C <sub>IN3</sub>	-	48	pF
Input capacitance (CAS0 ~ CAS3)	C <sub>IN4</sub>	-	48	pF
I/O capacitance (DQ0 ~ DQ31)	C <sub>DQ</sub>	-	24	pF

1. Capacitance measured with Boonton Meter

**DC Characteristics ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $T_a = 0^\circ\text{C} \sim +70^\circ\text{C}$ )**

Parameter	Symbol	Condition	60 ns		70 ns		80 ns		100 ns		Unit	Note	
			Min	Max	Min	Max	Min	Max	Min	Max			
Input leakage current	$I_{LI}$	$0\text{ V} \leq V_I \leq 6.5\text{ V}$ , All other pins not under test = 0 V	-160	160	-160	160	-160	160	-160	160	$\mu\text{A}$		
Output leakage current	$I_{LO}$	$D_{OUT}$ disable $0\text{ V} \leq V_O \leq 5.5\text{ V}$	-20	20	-20	20	-20	20	-20	20	$\mu\text{A}$		
Output high voltage	$V_{OH}$	$I_{OH} = -5.0\text{ mA}$	2.4	$V_{CC}$	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	0	0.4	V		
Average power supply current (Operating)	$I_{CC1}$	RAS, CAS cycling, $t_{RC} = \text{min}$	-	760	-	680	-	600	-	520	mA	[1] [2]	
Power supply current (Standby)	$I_{CC2}$	RAS = $V_{IH}$ , CAS = $V_{IH}$ , $D_{OUT} = \text{Hi-Z}$	TTL	-	32	-	32	-	32	-	32	mA	
			MOS	-	16	-	16	-	16	-	16	mA	
Average power supply current (RAS-only refresh)	$I_{CC3}$	RAS cycling, CAS = $V_{IH}$ , $t_{RC} = \text{min}$ .	-	760	-	680	-	600	-	520	mA	[1] [2]	
Average power supply current (CAS-before-RAS refresh)	$I_{CC6}$	RAS cycling, CCAS-before-RAS, $t_{RC} = \text{min}$	-	760	-	680	-	600	-	520	mA	[1]	
Average power supply current (Fast Page Mode)	$I_{CC7}$	RAS = $V_{IL}$ , CAS cycling, $t_{PC} = \text{min}$	-	680	-	600	-	520	-	480	mA	[1] [3]	

- 1  $I_{CC}$  depends on output loading and cycle rates. Specified values are obtained with the output open.
- 2 Address can be changed once or less while RAS =  $V_{IL}$
- 3 Address can be changed once or less while CAS =  $V_{IH}$

**4**

**AC Characteristics ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $T_a = 0^\circ\text{C} \sim +70^\circ\text{C}$ ) [1] [2] [3]**

Parameter	Symbol	60 ns		70 ns		80 ns		100 ns		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max		
Random read or write cycle time	$t_{RC}$	120	-	130	-	150	-	190	-	ns	
Fast Page Mode cycle time	$t_{PC}$	40	-	45	-	50	-	55	-	ns	
Access time from RAS	$t_{RAC}$	-	60	-	70	-	80	-	100	ns	[4] [5] [6]
Access time for CAS	$t_{CAC}$	-	15	-	20	-	20	-	25	ns	[4] [5]
Access time from column address	$t_{AA}$	-	30	-	35	-	40	-	50	ns	[4] [6]
Access time from CAS precharge	$t_{CPA}$	-	35	-	40	-	45	-	50	ns	[4]
Output low impedance time from CAS	$t_{CLZ}$	0	-	0	-	0	-	0	-	ns	
Output buffer turn-off delay time	$t_{OFF}$	0	20	0	20	0	20	0	20	ns	[7]
Transition time	$t_T$	3	50	3	50	3	50	3	50	ns	[3]
Refresh period	$t_{REF}$	-	8	-	8	-	8	-	8	ms	
RAS precharge time	$t_{RP}$	50	-	50	-	60	-	80	-	ns	
RAS pulse width	$t_{RAS}$	60	10K	70	10K	80	10K	100	10K	ns	
RAS pulse width (Fast Page Mode)	$t_{RASP}$	60	100K	70	100K	80	100K	100	100K	ns	
RAS hold time	$t_{RSH}$	15	-	20	-	20	-	25	-	ns	
CAS precharge time (Fast Page Mode)	$t_{CP}$	10	-	10	-	10	-	10	-	ns	
CAS pulse width	$t_{CAS}$	15	10K	20	10K	20	10K	25	10K	ns	
CAS hold time	$t_{CSH}$	60	-	70	-	80	-	100	-	ns	
CAS to RAS precharge time	$t_{CRP}$	5	-	5	-	5	-	5	-	ns	
RAS to CAS delay time	$t_{RCD}$	20	45	20	50	20	60	25	75	ns	[5]
RAS to column address delay time	$t_{RAD}$	15	30	15	35	15	40	20	50	ns	[6]
Row address set-up time	$t_{ASR}$	0	-	0	-	0	-	0	-	ns	
Row address hold time	$t_{RAH}$	10	-	10	-	10	-	15	-	ns	
Column address set-up time	$t_{ASC}$	0	-	0	-	0	-	0	-	ns	
Column address hold time	$t_{CAH}$	15	-	15	-	15	-	20	-	ns	
Column address hold time from RAS	$t_{AR}$	50	-	55	-	60	-	75	-	ns	
Column address to RAS lead time	$t_{RAL}$	30	-	35	-	40	-	50	-	ns	
Read command set-up time	$t_{RCS}$	0	-	0	-	0	-	0	-	ns	
Read command hold time	$t_{RCH}$	0	-	0	-	0	-	0	-	ns	[8]
Read command hold time reference to RAS	$t_{RRH}$	0	-	0	-	0	-	0	-	ns	[8]
Write command set-up time	$t_{WCS}$	0	-	0	-	0	-	0	-	ns	
Write command hold time	$t_{WCH}$	10	-	15	-	15	-	20	-	ns	
Write command hold time from RAS	$t_{WCR}$	50	-	55	-	60	-	75	-	ns	
Write command pulse width	$t_{WCP}$	10	-	15	-	15	-	20	-	ns	
Write command to RAS lead time	$t_{RWL}$	15	-	20	-	20	-	25	-	ns	
Write command to CAS lead time	$t_{CWL}$	15	-	20	-	20	-	25	-	ns	
Data-in set-up time	$t_{DS}$	0	-	0	-	0	-	0	-	ns	
Data-in hold time	$t_{DH}$	15	-	15	-	15	-	20	-	ns	

**AC Characteristics ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $T_a = 0^\circ\text{C} \sim +70^\circ\text{C}$ ) [1] [2] [3] (Continued)**

Parameter	Symbol	60 ns		70 ns		80 ns		100 ns		Unit	Note
		Min	Max	Min	Max	Min	Max	Min	Max		
Data-in hold time from RAS	$t_{DHR}$	50	-	55	-	60	-	75	-	ns	
CAS active delay from RAS precharge	$t_{RPC}$	10	-	10	-	10	-	10	-	ns	
RAS to CAS set-up time (CAS-before-RAS)	$t_{CSR}$	10	-	10	-	10	-	10	-	ns	
RAS to CAS hold time (CAS-before-RAS)	$t_{CHR}$	30	-	30	-	30	-	30	-	ns	
CAS precharge time (Refresh counter test)	$t_{CPT}$	40	-	40	-	40	-	50	-	ns	

- 1 A start-up delay of 100  $\mu\text{s}$  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. When using the internal refresh counter, a minimum of eight CAS-before-RAS initialization cycles is required.
- 2 AC measurements assume  $t_T = 5\text{ ns}$ .
- 3  $V_{IH}(\text{min})$  and  $V_{IL}(\text{max})$  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 + 100 pF.
- 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, 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, access time is controlled by  $t_{AA}$ .
- 7  $t_{OFF}(\text{max})$  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.

**4**

**See ADDENDUM A for AC Timing Waveforms**