

# MEMORY

## Unbuffered

# 16 M × 64 BIT

# SYNCHRONOUS DYNAMIC RAM DIMM

## MB8516S064AG-100/-84/-67/-100L/-84L/-67L

168-pin, 4 Clock, 2-bank, based on 8 M × 8 Bit SDRAMs with SPD

### DESCRIPTION

The Fujitsu MB8516S064AG is a fully decoded, CMOS Synchronous Dynamic Random Access Memory (SDRAM) Module consisting of sixteen MB81164842A devices which organized as four banks of 8 M × 8 bits and a 2K-bit serial EEPROM on a 168-pin glass-epoxy substrate.

The MB8516S064AG features a fully synchronous operation referenced to a positive edge clock whereby all operations are synchronized at a clock input which enables high performance and simple user interface coexistence.

The MB8516S064AG is optimized for those applications requiring high speed, high performance and large memory storage, and high density memory organizations.

This module is ideally suited for workstations, PCs, laser printers, and other applications where a simple interface is needed.

### PRODUCT LINE & FEATURES

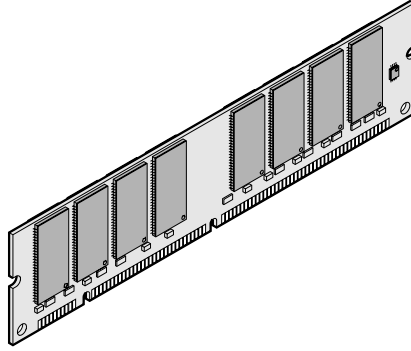
Parameter		MB8516S064AG -100/100L	MB8516S064AG -84/84L	MB8516S064AG -67/67L
Clock Frequency		100 MHz max.	84 MHz max.	67 MHz max.
Burst Mode Cycle Time		10 ns max. (CL = 3) 15 ns max. (CL = 2)	12 ns max. (CL = 3) 17 ns max. (CL = 2)	15 ns max. (CL = 3) 20 ns max. (CL = 2)
R <sub>AS</sub> Access Time		54 ns max.	56 ns max.	60 ns max.
C <sub>AS</sub> Access Time		24 ns max.	26 ns max.	30 ns max.
Output Valid from Clock		8.5 ns max. (CL = 3) 9 ns max. (CL = 2)	8.5 ns max. (CL = 3) 10 ns max. (CL = 2)	9 ns max. (CL = 3) 10 ns max. (CL = 2)
Power Dissipation	Burst Mode	4896 mW max.	4320 mW max.	3456 mW max.
	Power Down Mode	172.8 mW max. (std. power) 57.6 mW max. (low. power)		

- Unbuffered 168-pin DIMM Socket Type (Lead pitch: 1.27 mm)
- Conformed to JEDEC Standard (4 CLK)
- Organization: 16,777,216 words × 64 bits
- Memory: MB81164842A (8 M × 8, 4-bank) × 16 pcs.
- 3.3 V ±0.3 V Supply Voltage
- All input/output LVTTTL compatible
- 4096 Refresh Cycle every 65.6 ms
- Auto and Self Refresh
- CKE Power Down Mode
- DQM Byte Masking (Read/Write)
- Serial Presence Detect (SPD) with Serial EEPROM: JEDEC Standard SPD Format
- Module size: 1.0" (height) × 5.25" (length) × 0.157" (thickness)

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ PACKAGE

168-pin plastic DIMM (socket type)



(MDS-168P-P22)

### Package and Ordering Information

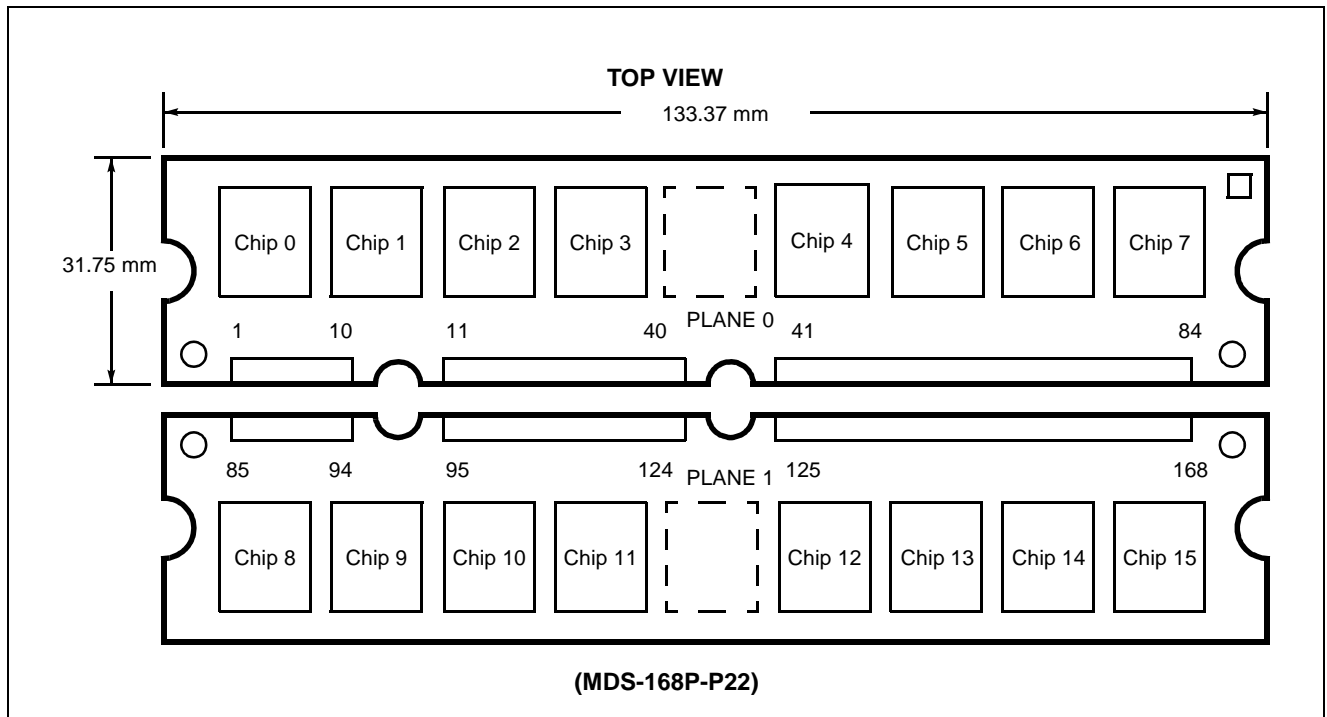
– 168-pin DIMM, order as MB8516S064AG-xxDG (DG = Gold Pad)

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ PIN ASSIGNMENTS

Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name
1	V <sub>SS</sub>	29	DQMB <sub>1</sub>	57	DQ <sub>18</sub>	85	V <sub>SS</sub>	113	DQMB <sub>5</sub>	141	DQ <sub>50</sub>
2	DQ <sub>0</sub>	30	$\overline{CS}_0$	58	DQ <sub>19</sub>	86	DQ <sub>32</sub>	114	CS <sub>1</sub>	142	DQ <sub>51</sub>
3	DQ <sub>1</sub>	31	N.C.	59	V <sub>CC</sub>	87	DQ <sub>33</sub>	115	RAS	143	V <sub>CC</sub>
4	DQ <sub>2</sub>	32	V <sub>SS</sub>	60	DQ <sub>20</sub>	88	DQ <sub>34</sub>	116	V <sub>SS</sub>	144	DQ <sub>52</sub>
5	DQ <sub>3</sub>	33	A <sub>0</sub>	61	N.C.	89	DQ <sub>35</sub>	117	A <sub>1</sub>	145	N.C.
6	V <sub>CC</sub>	34	A <sub>2</sub>	62	N.C.	90	V <sub>CC</sub>	118	A <sub>3</sub>	146	N.C.
7	DQ <sub>4</sub>	35	A <sub>4</sub>	63	CKE <sub>1</sub>	91	DQ <sub>36</sub>	119	A <sub>5</sub>	147	N.C.
8	DQ <sub>5</sub>	36	A <sub>6</sub>	64	V <sub>SS</sub>	92	DQ <sub>37</sub>	120	A <sub>7</sub>	148	V <sub>SS</sub>
9	DQ <sub>6</sub>	37	A <sub>8</sub>	65	DQ <sub>21</sub>	93	DQ <sub>38</sub>	121	A <sub>9</sub>	149	DQ <sub>53</sub>
10	DQ <sub>7</sub>	38	A <sub>10</sub>	66	DQ <sub>22</sub>	94	DQ <sub>39</sub>	122	BA <sub>0</sub>	150	DQ <sub>54</sub>
11	DQ <sub>8</sub>	39	BA <sub>1</sub>	67	DQ <sub>23</sub>	95	DQ <sub>40</sub>	123	A <sub>11</sub>	151	DQ <sub>55</sub>
12	V <sub>SS</sub>	40	V <sub>CC</sub>	68	V <sub>SS</sub>	96	V <sub>SS</sub>	124	V <sub>CC</sub>	152	V <sub>SS</sub>
13	DQ <sub>9</sub>	41	V <sub>CC</sub>	69	DQ <sub>24</sub>	97	DQ <sub>41</sub>	125	CLK <sub>1</sub>	153	DQ <sub>56</sub>
14	DQ <sub>10</sub>	42	CLK <sub>0</sub>	70	DQ <sub>25</sub>	98	DQ <sub>42</sub>	126	N.C.	154	DQ <sub>57</sub>
15	DQ <sub>11</sub>	43	V <sub>SS</sub>	71	DQ <sub>26</sub>	99	DQ <sub>43</sub>	127	V <sub>SS</sub>	155	DQ <sub>58</sub>
16	DQ <sub>12</sub>	44	N.C.	72	DQ <sub>27</sub>	100	DQ <sub>44</sub>	128	CKE <sub>0</sub>	156	DQ <sub>59</sub>
17	DQ <sub>13</sub>	45	$\overline{CS}_2$	73	V <sub>CC</sub>	101	DQ <sub>45</sub>	129	CS <sub>3</sub>	157	V <sub>CC</sub>
18	V <sub>CC</sub>	46	DQMB <sub>2</sub>	74	DQ <sub>28</sub>	102	V <sub>CC</sub>	130	DQMB <sub>6</sub>	158	DQ <sub>60</sub>
19	DQ <sub>14</sub>	47	DQMB <sub>3</sub>	75	DQ <sub>29</sub>	103	DQ <sub>46</sub>	131	DQMB <sub>7</sub>	159	DQ <sub>61</sub>
20	DQ <sub>15</sub>	48	N.C.	76	DQ <sub>30</sub>	104	DQ <sub>47</sub>	132	N.C.	160	DQ <sub>62</sub>
21	N.C.	49	V <sub>CC</sub>	77	DQ <sub>31</sub>	105	N.C.	133	V <sub>CC</sub>	161	DQ <sub>63</sub>
22	N.C.	50	N.C.	78	V <sub>SS</sub>	106	N.C.	134	N.C.	162	V <sub>SS</sub>
23	V <sub>SS</sub>	51	N.C.	79	CLK <sub>2</sub>	107	V <sub>SS</sub>	135	N.C.	163	CLK <sub>3</sub>
24	N.C.	52	N.C.	80	N.C.	108	N.C.	136	N.C.	164	N.C.
25	N.C.	53	N.C.	81	N.C.	109	N.C.	137	N.C.	165	SA <sub>0</sub>
26	V <sub>CC</sub>	54	V <sub>SS</sub>	82	SDA	110	V <sub>CC</sub>	138	V <sub>SS</sub>	166	SA <sub>1</sub>
27	$\overline{WE}$	55	DQ <sub>16</sub>	83	SCL	111	$\overline{CAS}$	139	DQ <sub>48</sub>	167	SA <sub>2</sub>
28	DQMB <sub>0</sub>	56	DQ <sub>17</sub>	84	V <sub>CC</sub>	112	DQMB <sub>4</sub>	140	DQ <sub>49</sub>	168	V <sub>CC</sub>

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L



## ■ PIN DESCRIPTIONS

Symbol	I/O	Function	Symbol	I/O	Function
$A_0$ to $A_{11}$ , $BA_0$ , $BA_1$	I	Address Input	$DQ_0$ to $DQ_{63}$	I/O	Data Input/Data Output
$\overline{RAS}$	I	Row Address Strobe	$V_{CC}$	—	Power Supply (+3.3 V)
$\overline{CAS}$	I	Column Address Strobe	$V_{SS}$	—	Ground (0 V)
$\overline{WE}$	I	Write Enable	N.C.	—	No Connection
$DQMB_0$ to $DQMB_7$	I	Data (DQ) Mask	$SA_0$ to $SA_2$	I	Serial PD Address Input
$CLK_0$ to $CLK_3$	I	Clock Input	SCL	I	Serial PD Clock
$CKE_0$ , $CKE_1$	I	Clock Enable	SDA	I/O	Serial PD Address/Data Input/Output
$\overline{CS}_0$ to $\overline{CS}_3$	I	Chip Select			

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ SERIAL-PD INFORMATION

Byte	Function Described		Hex Value		
			-100/ 100L	-84/ 84L	-67/ 67L
0	Defines Number of Bytes Written into Serial Memory at Module Manufacture	128 Byte	80h	80h	80h
1	Total Number of Bytes of SPD Memory Device	256 Byte	08h	08h	08h
2	Fundamental Memory Type	SDRAM	04h	04h	04h
3	Number of Row Addresses	12	0Ch	0Ch	0Ch
4	Number of Column Addresses	9	09h	09h	09h
5	Number of Module Banks	2 bank	02h	02h	02h
6	Data Width	64 bit	40h	40h	40h
7	Data Width (Continuation)	+0	00h	00h	00h
8	Interface Type	LVTTL	01h	01h	01h
9	SDRAM Cycle Time (Highest CAS Latency)	10/12/15 ns	A0h	C0h	F0h
10	SDRAM Access from Clock (Highest CAS Latency)	8.5/8.5/9 ns	85h	85h	90h
11	DIMM Configuration Type	Non-Parity	00h	00h	00h
12	Refresh Rate/Type	Self, Normal	80h	80h	80h
13	Primary SDRAM Width	×8	08h	08h	08h
14	Error Checking SDRAM Width	0	00h	00h	00h
15	Minimum Clock Delay for Back to Back Random Column Addresses	1 Cycle	01h	01h	01h
16	Burst Lengths Supported	1, 2, 4, 8, Page	8Fh	8Fh	8Fh
17	Number of Banks on Each SDRAM Device	4 bank	04h	04h	04h
18	CAS Latency	2, 3	06h	06h	06h
19	CS Latency	0	01h	01h	01h
20	Write Latency	0	01h	01h	01h
21	SDRAM Module Attributes	UN-buffer	00h	00h	00h
22	SDRAM Device Attributes	*1	06h	06h	06h
23	SDRAM Cycle Time (2nd. Highest CAS Latency)	15/17/20 ns	F0h	20h	FFh
24	SDRAM Access from Clock (2nd. Highest CAS Latency)	9/9/10 ns	90h	90h	A0h
25	SDRAM Cycle Time (3rd. Highest CAS Latency)	No Support	00h	00h	00h
26	SDRAM Access from Clock (3rd. Highest CAS Latency)	No Support	00h	00h	00h
27	Minimum Row Precharge Time (t <sub>RP</sub> )	30/35/40 ns	1Eh	23h	28h
28	Row Activate to Row Activate Min. (t <sub>RRD</sub> )	30/30/30 ns	1Eh	1Eh	1Eh
29	RAS to CAS Delay Min. (t <sub>RCD</sub> )	30/30/30 ns	1Eh	1Eh	1Eh
30	Minimum RAS Pulse Width	60/65/70 ns	3Ch	41h	46h
31	Module Bank Density	64 MByte	10h	10h	10h
32 to 61	Unused Storage Locations	—	00h	00h	00h
62	SPD Data Revision Code	1	01h	01h	01h
63	Checksum for Byte 0 to 62	*2	5Ah	C4h	E8h
64 to 98	Manufacturer's Information: Unused Storage	—	00h	00h	00h
99 to 127	Vendor Specific Data: Unused Storage	—	00h	00h	00h
128+	Unused Storage Locations	—	—	—	—

**Note:** Any write operation must NOT be executed into the addresses of Byte 0 to Byte 127. Some or all data stored into Byte 0 to Byte 127 may be broken.

\*1. Byte 22: SDRAM Device Attributes

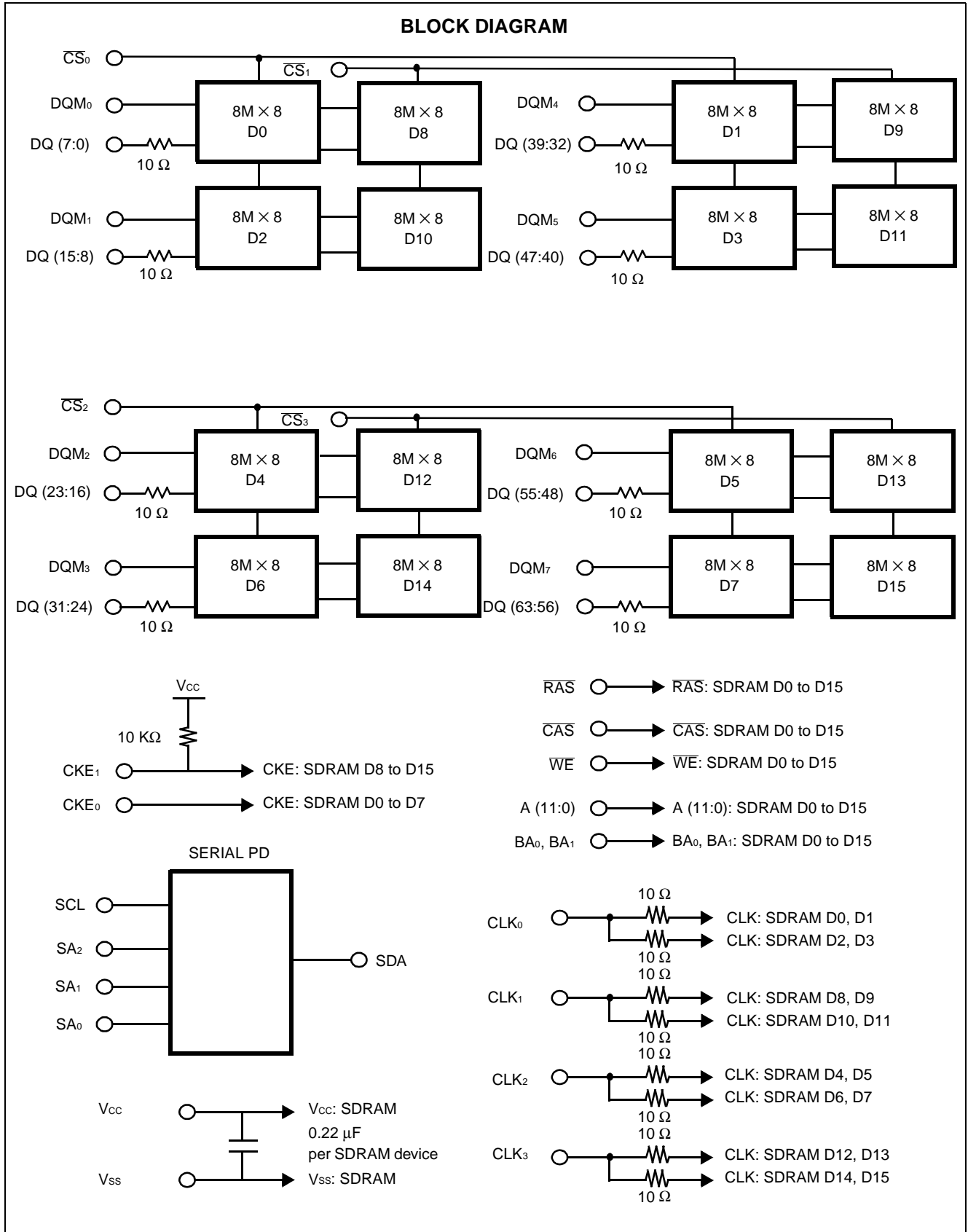
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
TBD	TBD	Upper V <sub>CC</sub> tolerance	Lower V <sub>CC</sub> tolerance	Supports Write 1 /Read Burst	Supports Precharge All	Supports Auto-precharge	Supports Early RAS Precharge
0	0	0	0	0	1	1	0

\*2. Byte 63: Checksum for Bytes 0 to 62

This byte is the checksum for bytes 0 through 62. This byte contains the value of the low 8-bits of the arithmetic sum of bytes 0 through 62.

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ BLOCK DIAGRAM



# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ ABSOLUTE MAXIMUM RATINGS (See WARNING)

Parameter	Symbol	Value		Unit
		Min.	Max.	
Supply Voltage*	$V_{CC}$	-0.5	+4.6	V
Input Voltage*	$V_{IN}$	-0.5	+4.6	V
Output Voltage*	$V_{OUT}$	-0.5	+4.6	V
Storage Temperature	$T_{STG}$	-55	+125	°C
Power Dissipation	$P_D$	—	16.0	W
Output Current (D.C.)	$I_{OUT}$	-50	+50	mA

\* : Voltages referenced to  $V_{SS}$  (= 0 V)

**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

## ■ RECOMMENDED OPERATING CONDITIONS

Parameter	Notes	Symbol	Value			Unit
			Min.	Typ.	Max.	
Supply Voltage	*1	$V_{CC}$	3.0	3.3	3.6	V
		$V_{SS}$	0	0	0	V
Input High Voltage, All Inputs	*1, 2	$V_{IH}$	2.0	—	$V_{CC}+0.5$	V
Input Low Voltage, All Inputs	*1, 3	$V_{IL}$	-0.5	—	0.8	V
Ambient Temperature		$T_A$	0	—	+70	°C

\*1. Voltages referenced to  $V_{SS}$  (= 0 V)

\*2. Overshoot limit:  $V_{IH}$  (max.) =  $V_{CC} + 1.5$  V with a pulsewidth  $\leq 5$  ns.

\*3. Undershoot limit:  $V_{IL}$  (min.) =  $-1.5$  V with a pulsewidth  $\leq 5$  ns.

**WARNING:** Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges.

Always use semiconductor devices within the recommended operating conditions. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representative beforehand.

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ CAPACITANCE

( $V_{CC} = +3.3\text{ V}$ ,  $f = 1\text{ MHz}$ ,  $T_A = +25^\circ\text{C}$ )

Parameter		Symbol	Value		Unit
			Min.	Max.	
Input Capacitance	A <sub>0</sub> to A <sub>11</sub> , BA <sub>0</sub> , BA <sub>1</sub>	C <sub>IN1</sub>	—	83	pF
	RAS, CAS, WE	C <sub>IN2</sub>	—	77	pF
	$\overline{\text{CS}}_0$ , $\overline{\text{CS}}_2$	C <sub>IN3</sub>	—	24	pF
	CKE <sub>0</sub>	C <sub>IN4</sub>	—	43	pF
	CLK <sub>0</sub> to CLK <sub>3</sub>	C <sub>IN5</sub>	—	40	pF
	DQMB <sub>0</sub> to DQMB <sub>7</sub>	C <sub>IN6</sub>	—	19	pF
	SCL	C <sub>SCL</sub>	—	6	pF
	SA <sub>0</sub> , SA <sub>1</sub> , SA <sub>2</sub>	C <sub>SA</sub>	—	8	pF
Input/Output Capacitance	SDA	C <sub>SDA</sub>	—	7	pF
	DQ <sub>0</sub> to DQ <sub>63</sub>	C <sub>DQ</sub>	—	21	pF



# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ DC CHARACTERISTICS

(At recommended operating conditions unless otherwise noted.)

Parameter	Notes	Symbol	Condition	Value			Unit	
				Min.	Max.			
					Std. ver.	Low ver.		
Operating Current (Average Power Supply Current)	-100/100L	I <sub>CC1S</sub>	No Burst; t <sub>CK</sub> = min t <sub>RC</sub> = min One Bank Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	800		mA	
	-84/84L				760		mA	
	-67/67L				720		mA	
	*1	-100/100L	I <sub>CC1D</sub>	No Burst; t <sub>CK</sub> = min t <sub>RC</sub> = min Two Banks Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	1280		mA
		-84/84L				1200		mA
		-67/67L				1120		mA
Precharge Standby Current (Power Supply Current)	*1	I <sub>CC2P</sub>	CKE = V <sub>IL</sub> , t <sub>CK</sub> = min All Banks Idle 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	48	16	mA	
		I <sub>CC2PS</sub>	CKE = V <sub>IL</sub> , CLK = V <sub>IL</sub> All Banks Idle 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	32	8	mA	
		I <sub>CC2N</sub>	CKE = V <sub>IH</sub> , t <sub>CK</sub> = min All Banks Idle 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	320		mA	
		I <sub>CC2NS</sub>	CKE = V <sub>IH</sub> , CLK = V <sub>IL</sub> All Banks Idle 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	80		mA	
Active Standby Current (Power Supply Current)	*1	I <sub>CC3P</sub>	CKE = V <sub>IL</sub> , t <sub>CK</sub> = min Any Bank Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	200	184	mA	
		I <sub>CC3PS</sub>	CKE = V <sub>IL</sub> , CLK = V <sub>IL</sub> Any Bank Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	72	56	mA	
		I <sub>CC3N</sub>	CKE = V <sub>IH</sub> , t <sub>CK</sub> = min Any Bank Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	360		mA	
		I <sub>CC3NS</sub>	CKE = V <sub>IH</sub> , CLK = V <sub>IL</sub> Any Bank Active 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	120		mA	
Burst Mode Current (Average Power Supply Current)	*1	I <sub>CC4</sub>	t <sub>CK</sub> = min 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	1360		mA	
				—	1200		mA	
				—	960		mA	
Auto-refresh Current (Average Power Supply Current)	*1	I <sub>CC5</sub>	Auto Refresh t <sub>CK</sub> = min t <sub>RC</sub> = min 0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>	—	1600		mA	
				—	1480		mA	
				—	1360		mA	

(Continued)

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

(Continued)

Parameter	Notes	Symbol	Condition	Value			Unit
				Min.	Max.		
					Std. ver.	Low ver.	
Self-refresh Current (Average Power Supply Current)		$I_{CC6}$	$CKE = V_{IL}, 0 V \leq V_{IN} \leq V_{CC}$	—	32	8	mA
Input Leakage Current (All Inputs)		$I_{I(L)}$	$0 V \leq V_{IN} \leq V_{CC}$ All other pins not under test = 0 V	−80	80		$\mu A$
Output Leakage Current		$I_{O(L)}$	Output is disabled (Hi-Z) $0 V \leq V_{IN} \leq V_{CC}$	−20	20		$\mu A$
LVTTL Output High Voltage	*2	$V_{OH}$	$I_{OH} = -2.0 \text{ mA}$	2.4	—		V
LVTTL Output Low Voltage	*2	$V_{OL}$	$I_{OL} = +2.0 \text{ mA}$	—	0.4		V

- Notes:**
- \*1.  $I_{CC}$  depends on the output termination, load conditions, clock cycle rate and signal clock rate. The specified values are obtained with the output open and no termination register.
  - \*2. Voltages referenced to  $V_{SS}$  (= 0 V)
  - \*3. An initial pause (DESL on NOP) of 200  $\mu s$  is required after power-on followed by a minimum of eight Auto-refresh cycles.
  - \*4. Values except  $I_{CC2P}$  and  $I_{CC2PS}$  are for when one side of the double-sided module is in standby mode ( $I_{CC2N}$  /  $I_{CC2NS}$ ) and other side has two banks active in burst mode.
  - \*5. DC characteristics is the Serial PD standby state ( $V_{IN} = GND$  or  $V_{CC}$ ).

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

## ■ AC CHARACTERISTICS

### (1) BASE CHARACTERISTICS

(At recommended operating conditions unless otherwise noted.)

No.	Parameter	Notes	Symbol	MB8516S064AG -100/100L		MB8516S064AG -84/84L		MB8516S064AG -67/67L		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
1	Clock Period	CL = 3	t <sub>CK</sub>	10	—	12	—	15	—	ns
		CL = 2		15	—	17	—	20	—	ns
2	Clock High Time		t <sub>CH</sub>	3.5	—	4	—	4	—	ns
3	Clock Low Time		t <sub>CL</sub>	3.5	—	4	—	4	—	ns
4	Input Setup Time		t <sub>SI</sub>	3	—	3	—	3	—	ns
5	Input Hold Time		t <sub>HI</sub>	1	—	1	—	1	—	ns
6	Output Valid from Clock (t <sub>CLK</sub> = min)	*1, *2 CL = 3	t <sub>AC</sub>	—	8.5	—	8.5	—	9	ns
		CL = 2		—	9	—	10	—	10	
7	Output in Low-Z		t <sub>LZ</sub>	3	—	3	—	3	—	ns
8	Output in High-Z	*3 CL = 3	t <sub>HZ</sub>	3	8.5	3	8.5	3	9	ns
		CL = 2		3	9	3	10	3	10	ns
9	Output Hold Time		t <sub>OH</sub>	3	—	3	—	3	—	ns
10	Time between Refresh		t <sub>REF</sub>	—	65.6	—	65.6	—	65.6	ms
11	Transition Time		t <sub>T</sub>	0.5	2	0.5	2	0.5	2	ns
12	Power Down Exit Time		t <sub>PDE</sub>	3	—	4	—	5	—	ns

### (2) BASE VALUES FOR CLOCK COUNT/LATENCY

No.	Parameter	Notes	Symbol	MB8516S064AG -100/100L		MB8516S064AG -84/84L		MB8516S064AG -67/67L		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
1	RAS Cycle Time	*4	t <sub>RC</sub>	90	—	100	—	110	—	ns
2	RAS Access Time	*5	t <sub>RAC</sub>	—	54	—	56	—	60	ns
3	CAS Access Time	*6, *9	t <sub>CAC</sub>	—	24	—	26	—	30	ns
4	RAS Precharge Time		t <sub>RP</sub>	30	—	35	—	40	—	ns
5	RAS Active Time		t <sub>RAS</sub>	60	100000	65	100000	70	100000	ns
6	RAS to CAS Delay Time	*7	t <sub>RCD</sub>	30	—	30	—	30	—	ns
7	Write Recovery Time		t <sub>WR</sub>	10	—	12	—	15	—	ns
8	Write to Precharge Read Delay Time		t <sub>RWL</sub>	10	—	12	—	15	—	ns
9	RAS to RAS Bank Active Delay Time		t <sub>RRD</sub>	20	—	20	—	20	—	ns

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## (3) CLOCK COUNT FORMULA (\*8)

$$\text{Clock} \geq \frac{\text{Base Value}}{\text{Clock Period}} \quad (\text{Round off a whole number})$$

## (4) LATENCY (The latency values on these parameters are fixed regardless of clock period.)

No.	Parameter	Symbol	MB8516S064AG -100/100L	MB8516S064AG -84/84L	MB8516S064AG -67/67L	Unit	
1	CKE to Clock Disable	I <sub>CKE</sub>	1	1	1	Cycle	
2	DQM to Output in High-Z	I <sub>DQZ</sub>	2	2	2	Cycle	
3	DQM to Input Data Delay	I <sub>DQD</sub>	0	0	0	Cycle	
4	Last Output to Write Command Delay	I <sub>OWD</sub>	2	2	2	Cycle	
5	Write Command to Input Data Delay	I <sub>DWD</sub>	0	0	0	Cycle	
6	Precharge to Output in High-Z Delay	CL = 3	I <sub>ROH</sub>	3	3	3	Cycle
		CL = 2		2	2	2	Cycle
7	Burst Stop Command to Output in High-Z Delay	CL = 3	I <sub>BSH</sub>	3	3	3	Cycle
		CL = 2		2	2	2	Cycle
8	Mode Register Access to Bank Active (min)	I <sub>MRD</sub>	2	2	2	Cycle	
9	$\overline{\text{CAS}}$ to $\overline{\text{CAS}}$ Delay (min)	I <sub>CCD</sub>	1	1	1	Cycle	
10	$\overline{\text{CAS}}$ Bank Delay (min)	I <sub>CBD</sub>	1	1	1	Cycle	
11	Write to Precharge Read Delay	CL = 3	I <sub>RWL</sub>	1	1	1	Cycle
		CL = 2		1	1	1	Cycle

**Notes:** \*1. Assumes t<sub>RCD</sub> and t<sub>CAC</sub> are satisfied.

\*2. t<sub>CAC</sub> also specifies the access time at burst mode except for first access.

\*3. Specified where output buffer is no longer driven.

\*4. Actual clock count of t<sub>RC</sub> (I<sub>RC</sub>) will be sum of clock count of t<sub>RAS</sub> (I<sub>RAS</sub>) and t<sub>RP</sub> (I<sub>RP</sub>).

\*5. t<sub>RAC</sub> is a reference value. Maximum value is obtained from the sum of t<sub>RCD</sub> (min) and t<sub>CAC</sub> (max).

\*6. Assumes t<sub>RAC</sub> and t<sub>CAC</sub> are satisfied.

\*7. Operation within the t<sub>RCD</sub> (min) ensures that t<sub>RAC</sub> can be met; if t<sub>RCD</sub> is greater than the specified t<sub>RCD</sub> (min), access time is determined by t<sub>CAC</sub> and t<sub>CAC</sub>.

\*8. All base values are measured from the clock edge at the command input to the clock edge for the next command input.

All clock counts are calculated by a simple formula:

clock count equals base value divided by clock period (round off to a whole number).

\*9. The I<sub>CAC</sub> (CAS latency: CL) is programmed by the mode register.

\*10. An initial pause (DESL on NOP) of 200 μs is required after power-up followed by a minimum of eight Auto-refresh cycles.

\*11. 1.4 V or V<sub>REF</sub> is the reference level for measuring timing of signals.

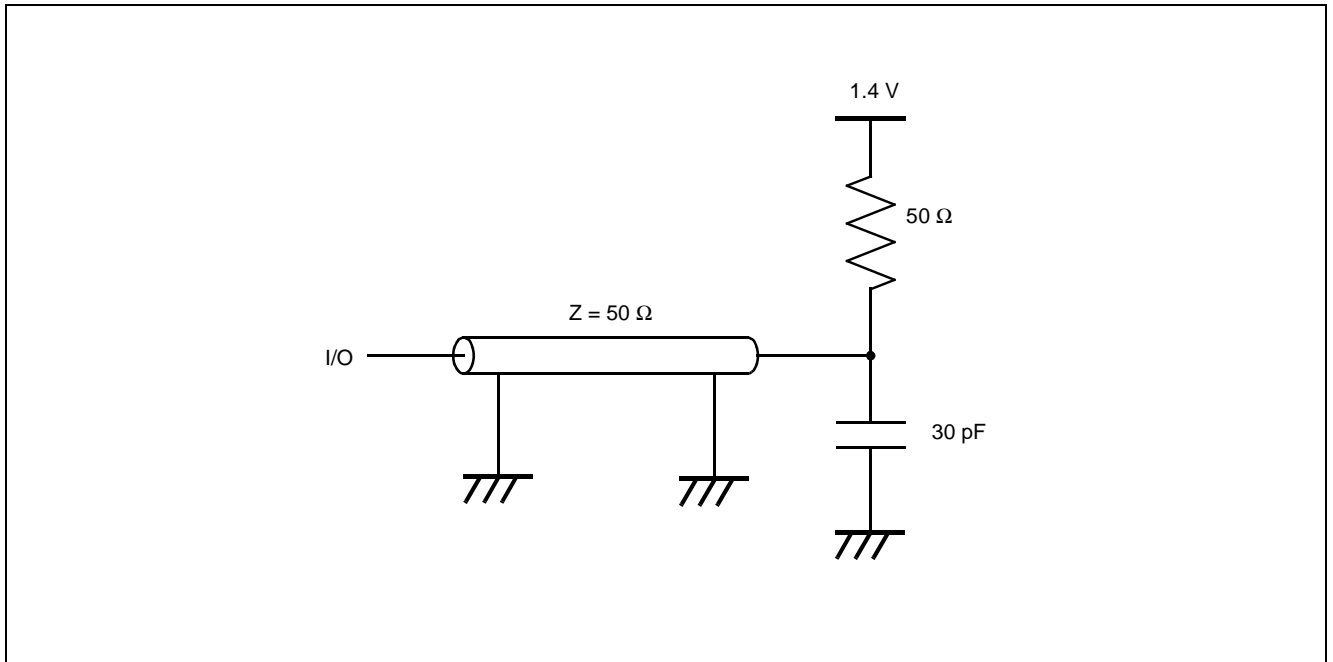
Transition times are measured between V<sub>IH</sub> (min) and V<sub>IL</sub> (max).

\*12. AC characteristics assume t<sub>T</sub> = 1 ns and 30 pF of capacitive load.

\*Source: See MB81164842A Data Sheet for details on the electricals.

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## ■ AC OPERATING TEST CONDITION (Example of AC Test Load Circuit)



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## ■ SERIAL PRESENCE DETECT (SPD) FUNCTION

### 1. PIN DESCRIPTIONS

#### SCL (Serial Clock)

SCL input is used to clock all data input/output of SPD

#### SDA (Serial Data)

SDA is a common pin used for all data input/output of SPD. The SDA pull-up resistor is required due to the open-drain output.

#### SA<sub>0</sub>, SA<sub>1</sub>, SA<sub>2</sub> (Address)

Address inputs are used to set the least significant three bits of the eight bits slave address. The address inputs must be fixed to select a particular module and the fixed address of each module must be different each other.

### 2. SPD OPERATIONS

#### CLOCK and DATA CONVENTION

Data states on the SDA can change only during SCL = Low. SDA state changes during SCL = High are indicated start and stop conditions. Refer to Fig. 1 below.

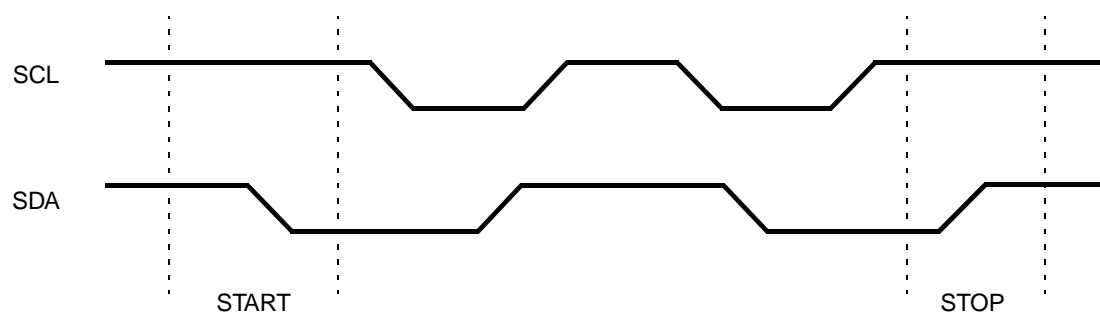
#### START CONDITION

All commands are preceded by a start condition, which is a transition of SDA state from High to Low when SCL = High. SPD will not respond to any command until this condition has been met.

#### STOP CONDITION

All read or write operation must be terminated by a stop condition, which is a transition of SDA state from Low to High when SCL = High. The stop condition is also used to make the SPD into the state of standby power mode after a read sequence.

Fig. 1 – START AND STOP CONDITIONS



START = High to Low transition of SDA state when SCL is High

STOP = Low to High transition of SDA state when SCL is High

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## ACKNOWLEDGE

Acknowledge is a software convention used to indicate successful data transfer. The transmitting device, either master or slave, will release the bus after transmitting eight bits. During the ninth clock cycle the receiver will put the SDA line to Low in order to acknowledge that it received the eight bits of data.

The SPD will respond with an acknowledge when it received the start condition followed by slave address issued by master.

In the read operation, the SPD will transmit eight bits of data, release the SDA line and monitor the line for an acknowledge. If an acknowledge is detected and no stop condition is issued by master, the SPD will continue to transmit data. If an acknowledge is not detected, the SPD will terminated further data transmissions. The master must then issue a stop condition to return the SPD to the standby power mode.

In the write operation, upon receipt of eight bits of data the SPD will respond with an acknowledge, and await the next eight bits of data, again responding with an acknowledge until the stop condition is issued by master.

## SLAVE ADDRESS ADDRESSING

Following a start condition, the master must output the eight bits slave address. The most significant four bits of the slave address are device type identifier. For the SPD this is fixed as 1010[B]. Refer to the Fig. 2 below.

The next three significant bits are used to select a particular device. A system could have up to eight SPD devices—namely up to eight modules—on the bus. The eight addresses for eight SPD devices are defined by the state of the SA<sub>0</sub>, SA<sub>1</sub> and SA<sub>2</sub> inputs.

The last bit of the slave address defines the operation to be performed. When R/ $\bar{W}$  bit is “1”, a read operation is selected, when R/ $\bar{W}$  bit is “0”, a write operation is selected.

Following the start condition, the SPD monitors the SDA line comparing the slave address being transmitted with its slave address (device type and state of SA<sub>0</sub>, SA<sub>1</sub>, and SA<sub>2</sub> inputs). Upon a correct compare the SPD outputs an acknowledge on the SDA line. Depending on the state of the R/ $\bar{W}$  bit, the SPD will execute a read or write operation.

**Fig. 2 – SLAVE ADDRESS**

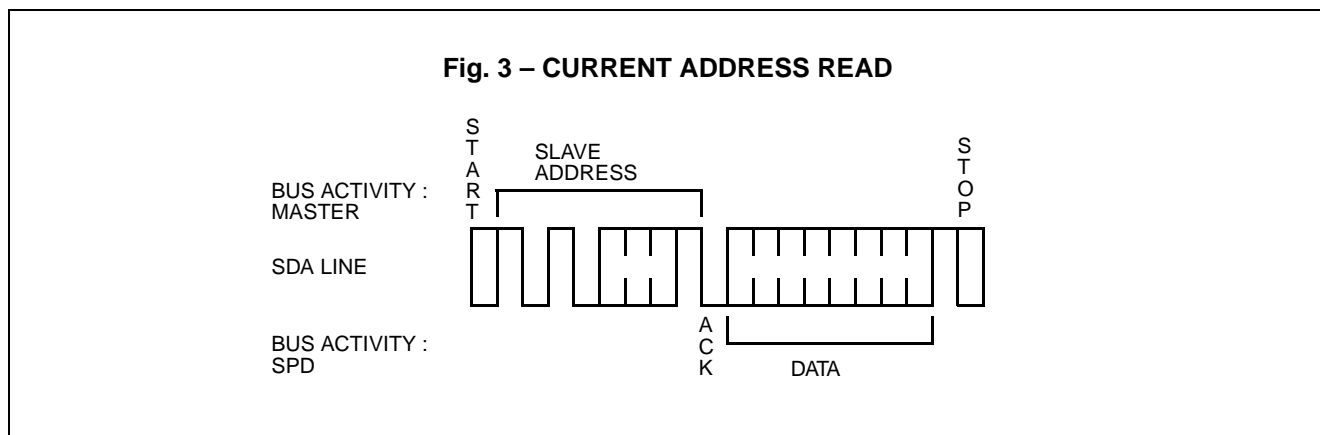
DEVICE TYPE IDENTIFIER				DEVICE ADDRESS			
1	0	1	0	SA <sub>2</sub>	SA <sub>1</sub>	SA <sub>0</sub>	R/ $\bar{W}$

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## 3. READ OPERATIONS

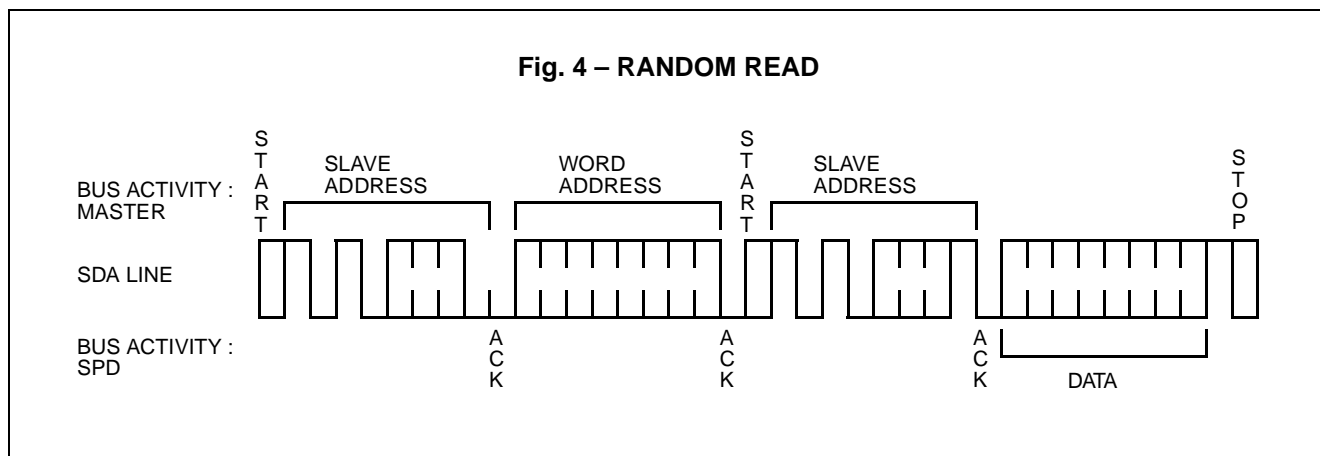
### CURRENT ADDRESS READ

Internally the SPD contains an address counter that maintains the address of the last data accessed, incremented by one. Therefore, if the last access (either a read or write operation) was to address(n), the next read operation would access data from address(n+1). Upon receipt of the slave address with the R/W bit = "1", the SPD issues an acknowledge and transmits the eight bits of data during the next eight clock cycles. The master terminates this transmission by issuing a stop condition, omitting the ninth clock cycle acknowledge. Refer to Fig. 3 for the sequence of address, acknowledge and data transfer.



### RANDOM READ

Random Read operations allow the master to access any memory location in a random manner. Prior to issuing the slave address with the R/W bit = "1", the master must first perform a "dummy" write operation on the SPD. The master issues the start condition, and the slave address followed by the word address. After the word address acknowledge, the master immediately reissues the start condition and the slave address with the R/W bit = "1". This will be followed by an acknowledge from the SPD and then by the eight bits of data. The master terminates this transmission by issuing a stop condition, omitting the ninth clock cycle acknowledge. Refer to Fig. 4 for the sequence of address, acknowledge and data transfer.



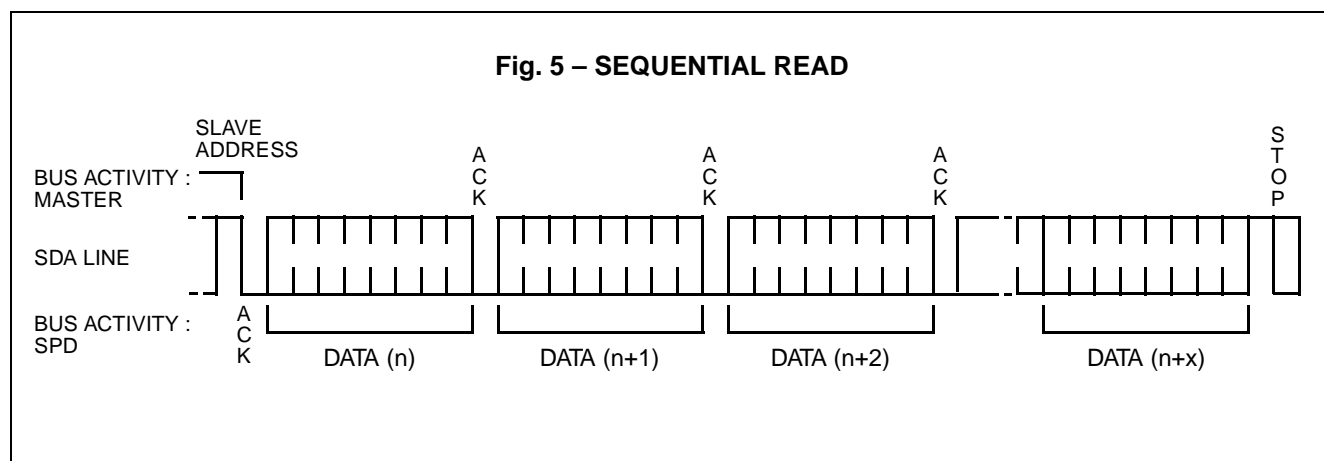


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## SEQUENTIAL READ

Sequential Read can be initiated as either a current address read or random read. The first data are transmitted as with the other read mode, however, the master now responds with an acknowledge, indicating it requires additional data. The SPD continues to output data for each acknowledge received. The master terminates this transmission by issuing a stop condition, omitting the ninth clock cycle acknowledge. Refer to Fig. 5 for the sequence of address, acknowledge and data transfer.

The data output is sequential, with the data from address(n) followed by the data from address(n+1). The address counter for read operations increments all address bits, allowing the entire memory contents to be serially read during one operation. At the end of the address space (address 255), the counter “rolls over” to address 0 and the SPD continues to output data for each acknowledge received.



## 4. DC CHARACTERISTICS

Parameter	Note	Symbol	Condition	Value		Unit
				Min.	Max.	
Input Leakage Current		$S_{ILI}$	$0 V \leq V_{IN} \leq V_{CC}$	-10	10	$\mu A$
Output Leakage Current		$S_{ILO}$	$0 V \leq V_{OUT} \leq V_{CC}$	-10	10	$\mu A$
Output Low Voltage	*1	$S_{VOL}$	$I_{OL} = 3.0 \text{ mA}$	—	0.4	V

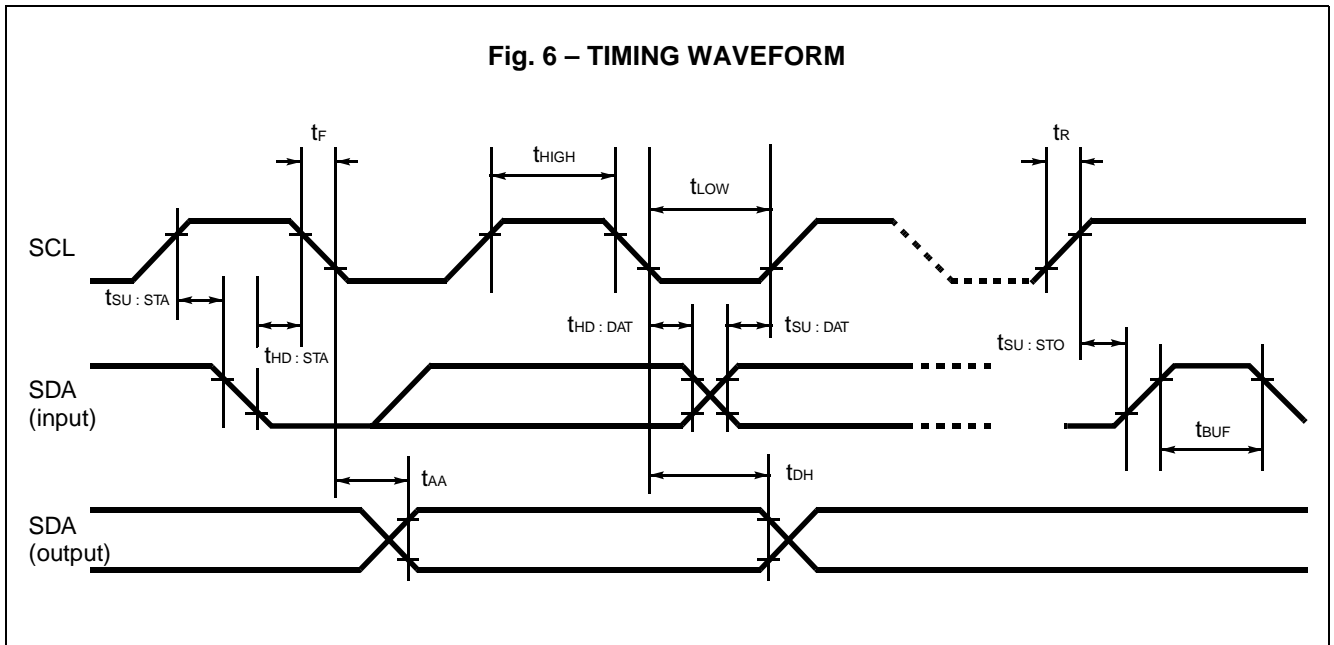
**Note:** \*1. Referenced to  $V_{SS}$ .

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## 5. AC CHARACTERISTICS

No.	Parameter	Symbol	Value		Unit
			Min.	Max.	
1	SCL Clock Frequency	$f_{SCL}$	—	100	KHz
2	Noise Suppression Time Constant at SCL, SDA Inputs	$T_I$	—	100	ns
3	SCL Low to SDA Data Out Valid	$t_{AA}$	—	3.5	$\mu$ s
4	Time the Bus Must Be Free Before a New Transmission Can Start	$t_{BUF}$	4.7	—	$\mu$ s
5	Start Condition Hold Time	$t_{HD:STA}$	4.0	—	$\mu$ s
6	Clock Low Period	$t_{LOW}$	4.7	—	$\mu$ s
7	Clock High Period	$t_{HIGH}$	4.0	—	$\mu$ s
8	Start Condition Setup Time	$t_{SU:STA}$	4.7	—	$\mu$ s
9	Data in Hold Time	$t_{HD:DAT}$	0	—	$\mu$ s
10	Data in Setup Time	$t_{SU:DAT}$	250	—	ns
11	SDA and SCL Rise Time	$t_r$	—	1	$\mu$ s
12	SDA and SCL Fall Time	$t_f$	—	300	ns
13	Stop Condition Setup Time	$t_{SU:STO}$	4.7	—	$\mu$ s
14	Data Out Hold Time	$t_{DH}$	100	—	ns
15	Write Cycle Time	$t_{WR}$	—	15	ms

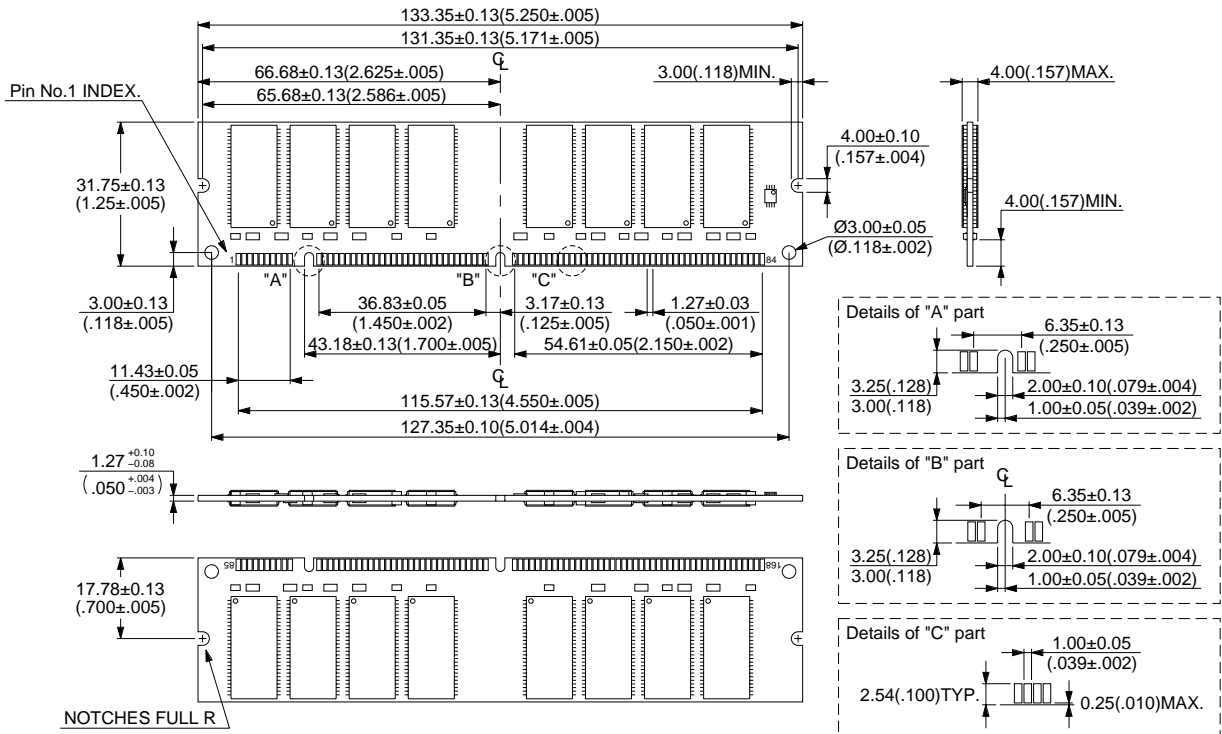
Fig. 6 – TIMING WAVEFORM



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## PACKAGE DIMENSION

168-pin plastic DIMM (socket type)  
(MDS-168P-P22)



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Dimensions in mm (inches)

# MB8516S064AG-100/-84/-67/-100L/-84L/-67L

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