NEC

MOS INTEGRATED CIRCUIT

MC-4516CD646

16M-WORD BY 64-BIT SYNCHRONOUS DYNAMIC RAM MODULE UNBUFFERED TYPE

Description

The MC-4516CD646 is a 16,777,216 words by 64 bits synchronous dynamic RAM module on which 16 pieces of 64M SDRAM : μPD4564841 (Revision E) are assembled.

This module provides high density and large quantities of memory in a small space without utilizing the surface-mounting technology on the printed circuit board.

Decoupling capacitors are mounted on power supply line for noise reduction.

Features

- 16,777,216 words by 64 bits organization
- Clock frequency and clock access time

Family	/CAS latency	Clock frequency (MAX.)	Clock access time (MAX.)	Power consumption (MAX.)	
				Active	Standby
MC-4516CD646-A80	CL = 3	125 MHz	6 ns	4,608 mW	28.8 mW (CMOS level input)
	CL = 2	100 MHz	6 ns	4,464 mW	
MC-4516CD646-A10	CL = 3	100 MHz	6 ns	4,608 mW	
	CL = 2	77 MHz	7 ns	4,464 mW	

- Fully Synchronous Dynamic RAM, with all signals referenced to a positive clock edge
- Pulsed interface
- Possible to assert random column address in every cycle
- Quad internal banks controlled by BA0 and BA1 (Bank Select)
- Programmable burst-length : 1, 2, 4, 8 and full page
- Programmable wrap sequence (sequential / interleave)
- Programmable /CAS latency (2, 3)
- Automatic precharge and controlled precharge
- CBR (Auto) refresh and self refresh
- All DQs have 10 Ω ±10 % of series resistor
- Single 3.3 V ± 0.3 V power supply
- LVTTL compatible
- 4,096 refresh cycles/64 ms
- Burst termination by Burst Stop command and Precharge command
- 168-pin dual in-line memory module (Pin pitch = 1.27 mm)
- Unbuffered type
- Serial PD

The information in this document is subject to change without notice.

Document No. M13047EJ4V0DS00 (4th edition)
Date Published May 1998 NS CP(K)
Printed in Japan

The mark ★ shows major revised points.

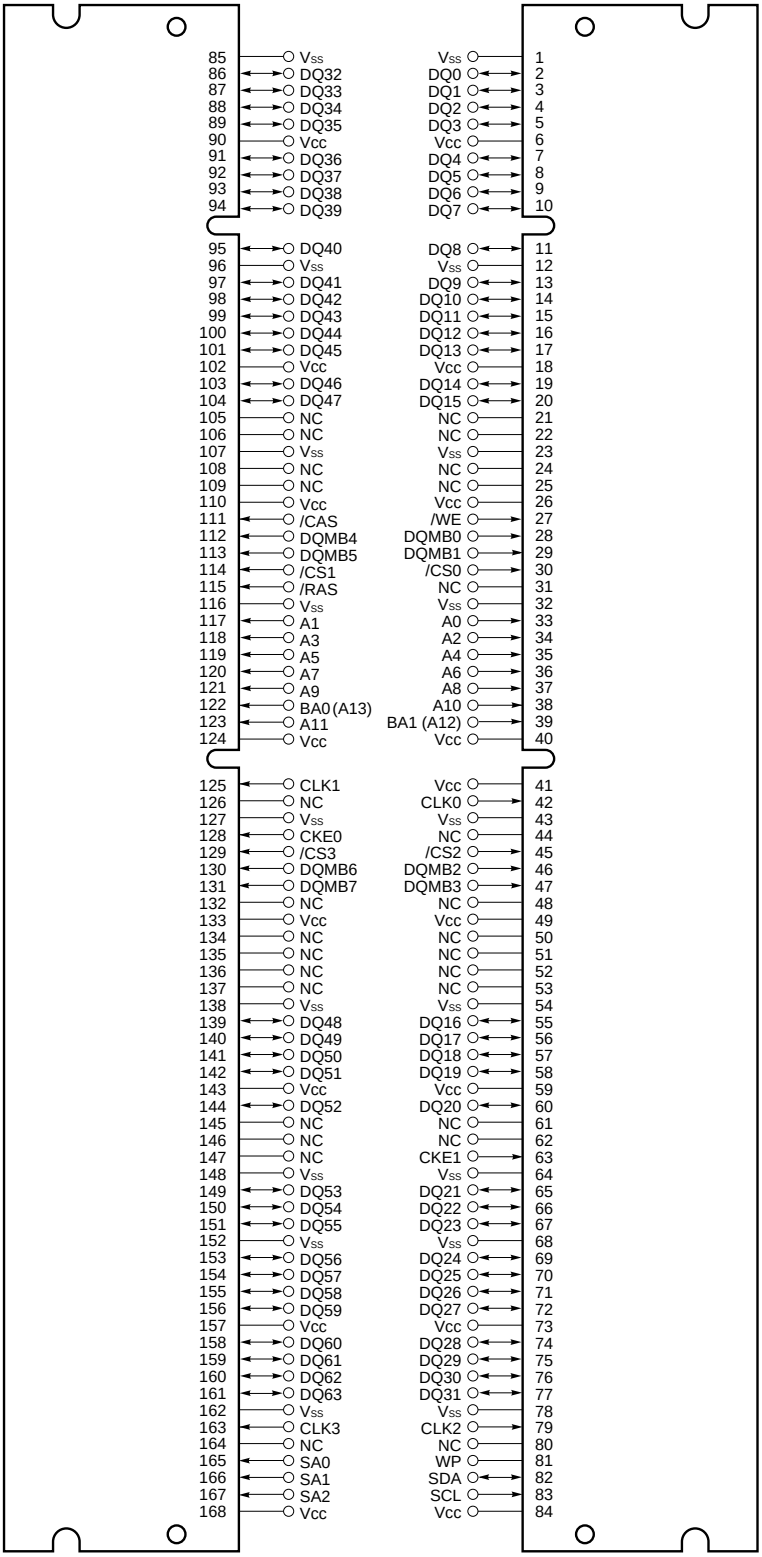
Ordering Information

Part number	Clock frequency MHz (MAX.)	Package	Mounted devices
MC-4516CD646F-A80	125 MHz	168-pin Dual In-line Memory Module (Socket Type) Edge connector : Gold plated 34.93 mm (1.375 inch) height	16 pieces of μPD4564841G5 (Revision E) (400 mil TSOP (II)) [Double side]
MC-4516CD646F-A10	100 MHz		

Pin Configuration

168-pin Dual In-line Memory Module Socket Type (Edge connector: Gold plated)

[MC-4516CD646F]

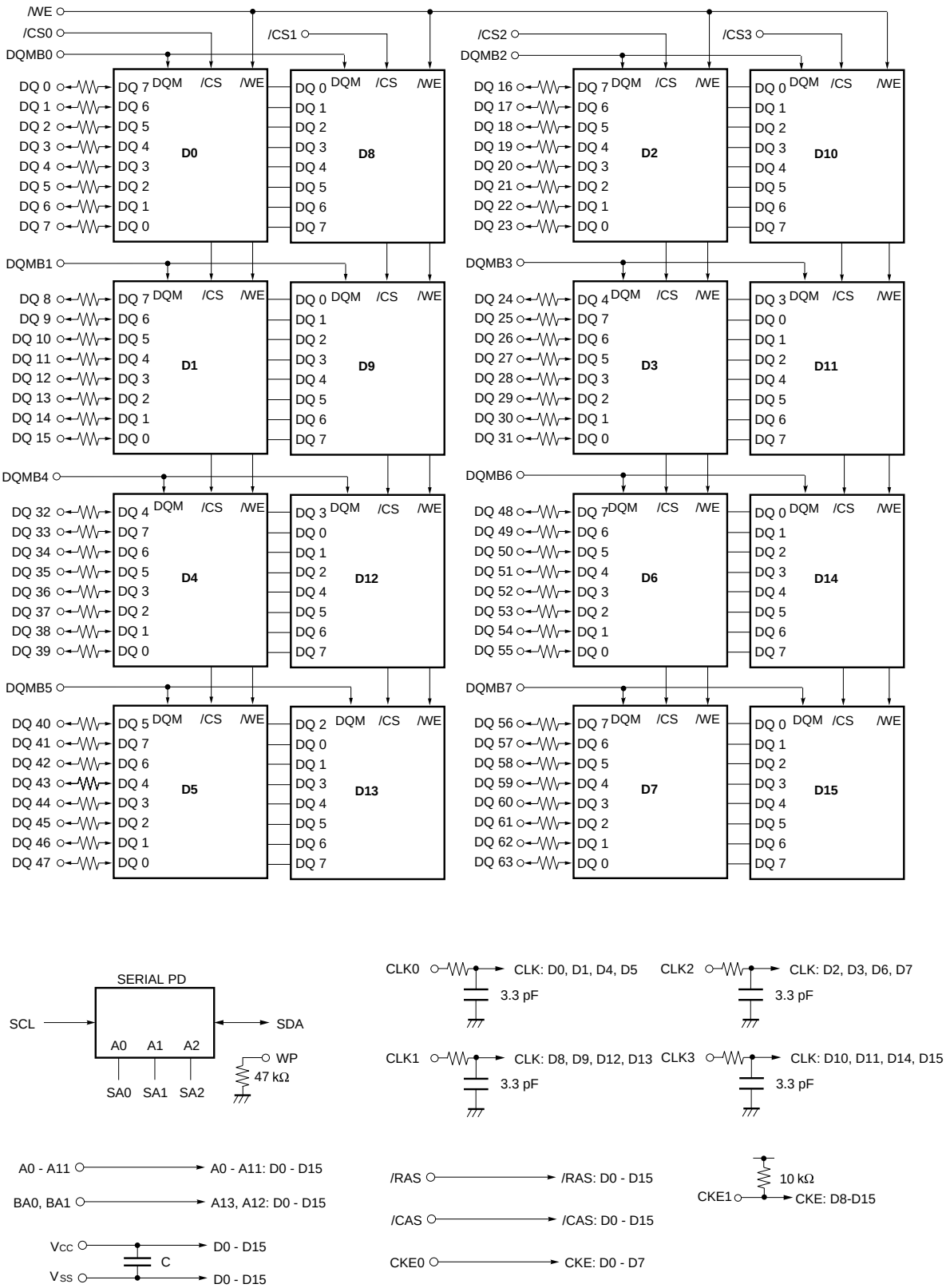


/XXX indicates active low signal.

A0 - A11	: Address Inputs
[Row : A0 - A11, Column : A0 - A8]	
BA0 (A13), BA1 (A12)	: SDRAM Bank Select
DQ0 - DQ63	: Data Inputs/Outputs
CLK0 - CLK3	: Clock Input
CKE0, CKE1	: Clock Enable Input
/CS0 - /CS3	: Chip Select Input
/RAS	: Row Address Strobe
/CAS	: Column Address Strobe
/WE	: Write Enable
DQMB0 - DQMB7	: DQ Mask Enable
SA0 - SA2	: Address Input for EEPROM
SDA	: Serial Data I/O for PD
SCL	: Clock Input for PD
V_{CC}	: Power Supply
V_{SS}	: Ground
WP	: Write Protect [Note]
NC	: No Connection

Note WP is not used yet. It is connected to ground.

Block Diagram



Remarks 1. The value of all resistors is 10 Ω except CKE1 and WP.

2. WP is not used yet. It is connected to ground.

3. D0 - D15 : μPD4564841 (2M words × 8 bits × 4 banks)

Electrical Specifications

- All voltages are referenced to V_{SS} (GND).
- After power up, wait more than 100 μs and then, execute power on sequence and auto refresh before proper device operation is achieved.

Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Voltage on power supply pin relative to GND	V_{CC}		–0.5 to +4.6	V
Voltage on input pin relative to GND	V_T		–0.5 to +4.6	V
Short circuit output current	I_O		50	mA
Power dissipation	P_D		16	W
Operating ambient temperature	T_A		0 to +70	°C
Storage temperature	T_{stg}		–55 to +125	°C

Caution Exposing the device to stress above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{CC}		3.0	3.3	3.6	V
High level input voltage	V_{IH}		2.0		V_{CC} + 0.3	V
Low level input voltage	V_{IL}		–0.3		+0.8	V
Operating ambient temperature	T_A		0		70	°C

Capacitance (T_A = 25 °C, f = 1 MHz)

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{I1}	A0 - A11, BA0 (A13), BA1 (A12), /RAS, /CAS, /WE	58		94	pF
	C_{I2}	CLK0 - CLK3	24		40	
	C_{I3}	CKE0, CKE1	32		52	
	C_{I4}	/CS0 - /CS3	17		29	
	C_{I5}	DQMB0 - DQMB7	10		17	
Data input/output capacitance	$C_{I/O}$	DQ0 - DQ63	11		19	pF

DC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

Parameter	Symbol	Test condition		Grade	MIN.	MAX.	Unit	Notes
Operating current	I_{CC1}	Burst length = 1 $t_{RC} \geq t_{RC(MIN.)}$, I_O = 0 mA	/CAS latency = 2	-A80		840	mA	1
				-A10		760		
			/CAS latency = 3	-A80		880		
				-A10		800		
Precharge standby current in power down mode	$I_{CC2}P$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = 15 ns				16	mA	
	$I_{CC2}PS$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = ∞				8		
Precharge standby current in non power down mode	$I_{CC2}N$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = 15 ns, /CS ≥ $V_{IH(MIN.)}$, Input signals are changed one time during 30 ns.				320	mA	
	$I_{CC2}NS$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = ∞ Input signals are stable.				96		
Active standby current in power down mode	$I_{CC3}P$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = 15 ns				80	mA	
	$I_{CC3}PS$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = ∞				64		
Active standby current in non power down mode	$I_{CC3}N$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = 15 ns, /CS ≥ $V_{IH(MIN.)}$, Input signals are changed one time during 30 ns.				400	mA	
	$I_{CC3}NS$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = ∞ Input signals are stable.				160		
Operating current (Burst mode)	I_{CC4}	$t_{CK} \geq t_{CK(MIN.)}$ I_O = 0 mA	/CAS latency = 2	-A80		1,040	mA	2
				-A10		840		
			/CAS latency = 3	-A80		1,200		
				-A10		1,040		
Refresh current	I_{CC5}	$t_{RC} \geq t_{RC(MIN.)}$	/CAS latency = 2	-A80		1,240	mA	3
				-A10		1,240		
			/CAS latency = 3	-A80		1,280		
				-A10		1,280		
Self refresh current	I_{CC6}	CKE ≤ 0.2 V				16	mA	
Input leakage current	$I_{I(L)}$	V_I = 0 to 3.6 V, All other pins not under test = 0 V			– 16	+ 16	μA	
Input leakage current (CKE1)					– 500	+500		
Output leakage current	$I_{O(L)}$	D_{OUT} is disabled, V_O = 0 to 3.6 V			– 3	+ 3	μA	
High level output voltage	V_{OH}	I_O = – 4.0 mA			2.4		V	
Low level output voltage	V_{OL}	I_O = + 4.0 mA				0.4	V	

Notes 1. I_{CC1} depends on output loading and cycle rates. Specified values are obtained with the output open. In addition to this, I_{CC1} is measured on condition that addresses are changed only one time during $t_{CK (MIN.)}$.

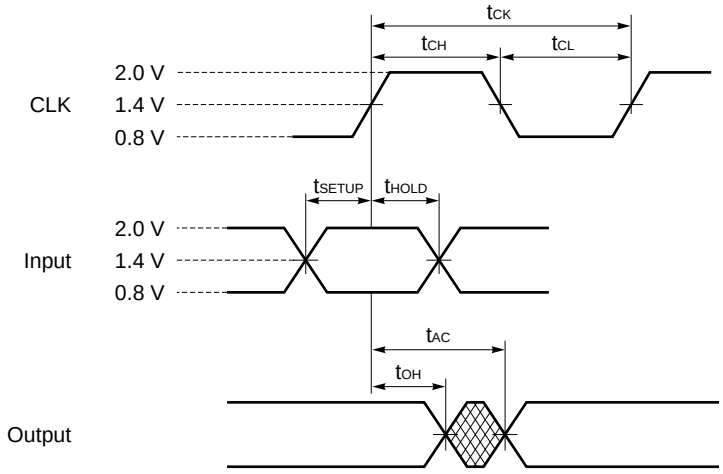
2. I_{CC4} depends on output loading and cycle rates. Specified values are obtained with the output open. In addition to this, I_{CC4} is measured on condition that addresses are changed only one time during $t_{CK (MIN.)}$.

3. I_{CC5} is measured on condition that addresses are changed only one time during $t_{CK (MIN.)}$.

AC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

AC Characteristics Test Conditions

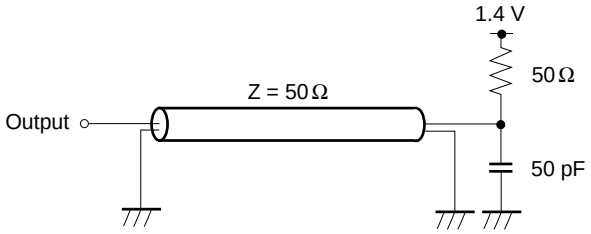
- AC measurements assume t_T = 1 ns.
- Reference level for measuring timing of input signals is 1.4 V. Transition times are measured between V_{IH} and V_{IL}.
- If t_T is longer than 1 ns, reference level for measuring timing of input signals is $V_{IH\ (MIN.)}$ and $V_{IL\ (MAX.)}$.
- An access time is measured at 1.4 V.



Synchronous Characteristics

Parameter		Symbol	-A80		-A10		Unit	Note
			MIN.	MAX.	MIN.	MAX.		
Clock cycle time	/CAS latency = 3	t_{CK3}	8	(125 MHz)	10	(100 MHz)	ns	
	/CAS latency = 2	t_{CK2}	10	(100 MHz)	13	(77 MHz)	ns	
Access time from CLK	/CAS latency = 3	t_{AC3}		6		6	ns	1
	/CAS latency = 2	t_{AC2}		6		7	ns	1
CLK high level width		t_{CH}	3		3		ns	
CLK low level width		t_{CL}	3		3		ns	
Data-out hold time		t_{OH}	3		3		ns	1
Data-out low-impedance time		t_{LZ}	0		0		ns	
Data-out high-impedance time	/CAS latency = 3	t_{HZ3}	3	6	3	6	ns	
	/CAS latency = 2	t_{HZ2}	3	6	3	7	ns	
Data-in setup time		t_{DS}	2		2		ns	
Data-in hold time		t_{DH}	1		1		ns	
Address setup time		t_{AS}	2		2		ns	
Address hold time		t_{AH}	1		1		ns	
CKE setup time		t_{CKS}	2		2		ns	
CKE hold time		t_{CKH}	1		1		ns	
CKE setup time (Power down exit)		t_{CKSP}	2		2		ns	
Command (/CS0 - /CS3, /RAS, /CAS, /WE, DQMB0 - DQMB7) setup time		t_{CMS}	2		2		ns	
Command (/CS0 - /CS3, /RAS, /CAS, /WE, DQMB0 - DQMB7) hold time		t_{CMH}	1		1		ns	

Note 1. Output load



Remark These specifications are applied to the monolithic device.

Asynchronous Characteristics

Parameter		Symbol	-A80		-A10		Unit	Note
			MIN.	MAX.	MIN.	MAX.		
REF to REF/ACT command period		t_{RC}	70		70		ns	
ACT to PRE command period		t_{RAS}	48	120,000	50	120,000	ns	
PRE to ACT command period		t_{RP}	20		20		ns	
Delay time ACT to READ/WRITE command		t_{RCD}	20		20		ns	
ACT(0) to ACT(1) command period		t_{RRD}	16		20		ns	
Data-in to PRE command period		t_{DPL}	8		10		ns	
Data-in to ACT(REF) command period	/CAS latency = 3	t_{DAL3}	1CLK+20		1CLK+20		ns	
(Auto precharge)	/CAS latency = 2	t_{DAL2}	1CLK+20		1CLK+20		ns	
Mode register set cycle time		t_{RSC}	2		2		CLK	
Transition time		t_T	0.5	30	1	30	ns	
Refresh time		t_{REF}		64		64	ms	

Serial PD (1/2)

Byte No.	Function Described		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
0	Defines the number of bytes written into serial PD memory		80H	1	0	0	0	0	0	0	0	128 bytes
1	Total number of bytes of serial PD memory		08H	0	0	0	0	1	0	0	0	256 bytes
2	Fundamental memory type		04H	0	0	0	0	0	1	0	0	SDRAM
3	Number of rows		0CH	0	0	0	0	1	1	0	0	12 rows
4	Number of columns		09H	0	0	0	0	1	0	0	1	9 columns
5	Number of banks		02H	0	0	0	0	0	0	1	0	2 banks
6	Data width		40H	0	1	0	0	0	0	0	0	64 bits
7	Data width (continued)		00H	0	0	0	0	0	0	0	0	0
8	Voltage interface		01H	0	0	0	0	0	0	0	1	LVTTL
9	CL = 3 Cycle time	(-A80)	80H	1	0	0	0	0	0	0	0	8 ns
		(-A10)	A0H	1	0	1	0	0	0	0	0	10 ns
10	CL = 3 Access time	(-A80)	60H	0	1	1	0	0	0	0	0	6 ns
		(-A10)	60H	0	1	1	0	0	0	0	0	6 ns
11	DIMM configuration type		00H	0	0	0	0	0	0	0	0	None
12	Refresh rate/type		80H	1	0	0	0	0	0	0	0	Normal
13	SDRAM width		08H	0	0	0	0	1	0	0	0	×8
14	Error checking SDRAM width		00H	0	0	0	0	0	0	0	0	None
15	Minimum clock delay		01H	0	0	0	0	0	0	0	1	1 clock
16	Burst length supported		8FH	1	0	0	0	1	1	1	1	1, 2, 4, 8, F
17	Number of banks on each SDRAM		04H	0	0	0	0	0	1	0	0	4 banks
18	/CAS latency supported		06H	0	0	0	0	0	1	1	0	2, 3
19	/CS latency supported		01H	0	0	0	0	0	0	0	1	0
20	/WE latency supported		01H	0	0	0	0	0	0	0	1	0
21	SDRAM module attributes		00H	0	0	0	0	0	0	0	0	
22	SDRAM device attributes : General		0EH	0	0	0	0	1	1	1	0	
23	CL = 2 Cycle time	(-A80)	A0H	1	0	1	0	0	0	0	0	10 ns
		(-A10)	D0H	1	1	0	1	0	0	0	0	13 ns
24	CL = 2 Access time	(-A80)	60H	0	1	1	0	0	0	0	0	6 ns
		(-A10)	70H	0	1	1	1	0	0	0	0	7 ns
25-26			00H	0	0	0	0	0	0	0	0	
27	$t_{RP(MIN.)}$	(-A80)	14H	0	0	0	1	0	1	0	0	20 ns
		(-A10)	14H	0	0	0	1	0	1	0	0	20 ns
28	$t_{RRD(MIN.)}$	(-A80)	10H	0	0	0	1	0	0	0	0	16 ns
		(-A10)	14H	0	0	0	1	0	1	0	0	20 ns
29	$t_{RCD(MIN.)}$	(-A80)	14H	0	0	0	1	0	1	0	0	20 ns
		(-A10)	14H	0	0	0	1	0	1	0	0	20 ns
30	$t_{RAS(MIN.)}$	(-A80)	30H	0	0	1	1	0	0	0	0	48 ns
		(-A10)	32H	0	0	1	1	0	0	1	0	50 ns
31	Module bank density		10H	0	0	0	1	0	0	0	0	64M bytes

(2/2)

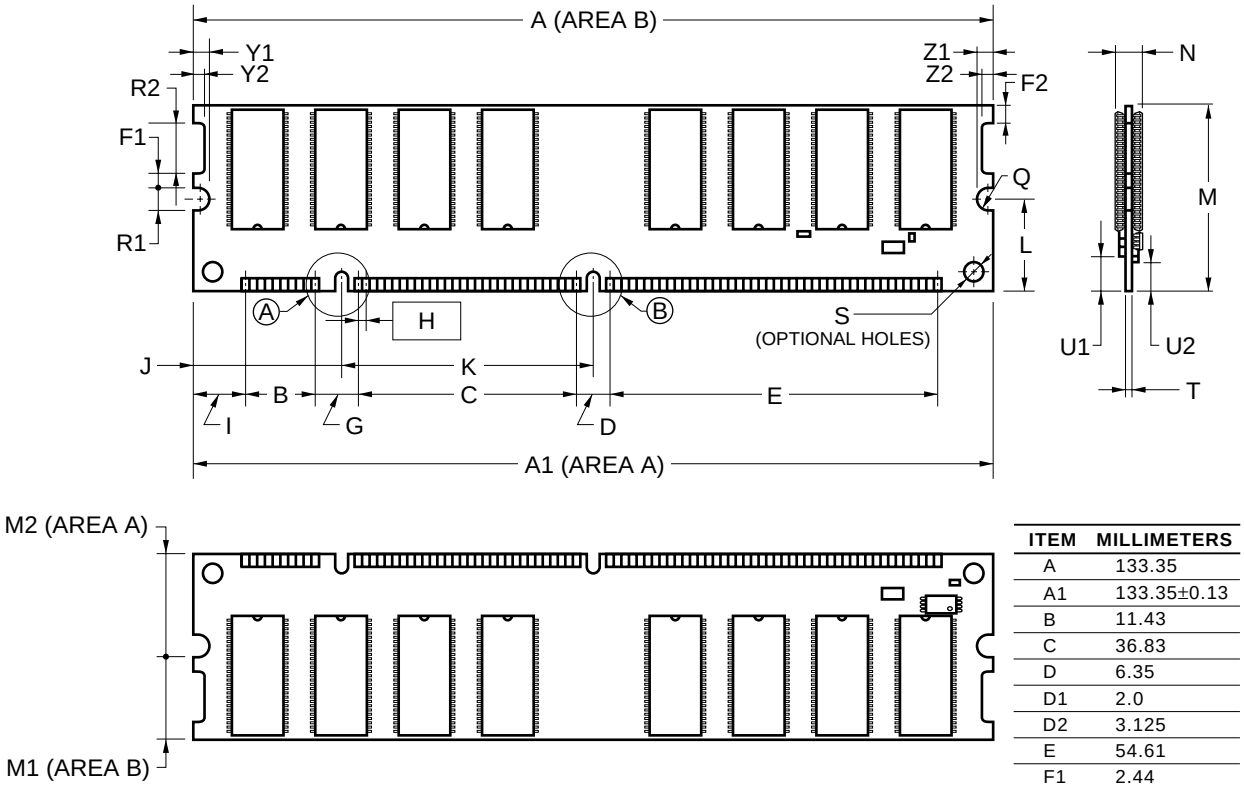
Byte No.	Function Described		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
32	Command and address signal input setup time		20H	0	0	1	0	0	0	0	0	2 ns
33	Command and address signal input hold time		10H	0	0	0	1	0	0	0	0	1 ns
34	Data signal input setup time		20H	0	0	1	0	0	0	0	0	2 ns
35	Data signal input hold time		10H	0	0	0	1	0	0	0	0	1 ns
36-61			00H	0	0	0	0	0	0	0	0	
62	SPD revision		12H	0	0	0	1	0	0	1	0	1.2
63	Checksum for bytes 0 - 62	(-A80)	E0H	1	1	1	0	0	0	0	0	
		(-A10)	46H	0	1	0	0	0	1	1	0	
64-71	Manufacture's JEDEC ID code											
72	Manufacturing location											
73-90	Manufacture's P/N											
91-92	Revision code											
93-94	Manufacturing date											
95-98	Assembly serial number											
99-125	Mfg specific											
126	Intel specification frequency		64H	0	1	1	0	0	1	0	0	100 MHz
127	Intel specification /CAS	(-A80)	FFH	1	1	1	1	1	1	1	1	
	latency support	(-A10)	FDH	1	1	1	1	1	1	0	1	

Timing Chart

Please refer to NEC Synchronous DRAM Data sheet.

★ **Package Drawing**

168 PIN DUAL IN-LINE MODULE (SOCKET TYPE)



ITEM	MILLIMETERS
A	133.35
A1	133.35±0.13
B	11.43
C	36.83
D	6.35
D1	2.0
D2	3.125
E	54.61
F1	2.44
F2	3.18
G	6.35
H	1.27 (T.P.)
I	8.89
J	24.495
K	42.18
L	17.78
M	34.93±0.13
M1	15.15
M2	19.78
N	4.0 MAX.
P	1.0
Q	R2.0
R1	4.0±0.10
R2	9.53
S	ϕ3.0
T	1.27±0.1
U1	4.0 MIN.
U2	4.0 MIN.
V	0.2±0.15
W	1.0±0.05
X	2.54±0.10
Y1	3.0 MIN.
Y2	2.26
Z1	3.0 MIN.
Z2	2.26

M168S-50A78

[MEMO]

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS device behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed imme-diately after power-on for devices having reset function.

[MEMO]

CAUTION FOR HANDLING MEMORY MODULES

When handling or inserting memory modules, be sure not to touch any components on the modules, such as the memory IC, chip capacitors and chip resistors. It is necessary to avoid undue mechanical stress on these components to prevent damaging them.

When re-packing memory modules, be sure the modules are NOT touching each other. Modules in contact with other modules may cause excessive mechanical stress, which may damage the modules.

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