

4M-WORD BY 72-BIT SYNCHRONOUS DYNAMIC RAM MODULE
UNBUFFERED TYPE**Description**

The MC-454AC726 is a 4,194,304 words by 72 bits synchronous dynamic RAM module on which 18 pieces of 16M

★ SDRAM : μ PD4516821A (Revision P) 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

- 4,194,304 words by 72 bits organization (ECC Type)
- Clock frequency and clock access time

Family	/CAS latency	Clock frequency (MAX.)	Clock access time (MAX.)	Power consumption (MAX.)	
				Active	Standby
MC-454AC726-A80	CL = 3	125 MHz	6 ns	4,795 mW	129.6 mW (CMOS level input)
	CL = 2	100 MHz	6 ns	4,309 mW	
MC-454AC726-A10	CL = 3	100 MHz	6 ns	4,633 mW	
	CL = 2	77 MHz	8 ns	4,309 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
- Dual internal banks controlled by BA0 (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 I/Os have $10\ \Omega \pm 10\%$ of series resistor
- Single 3.3 V ± 0.3 V power supply
- LVTTTL compatible
- 2,048 refresh cycles / 32 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.

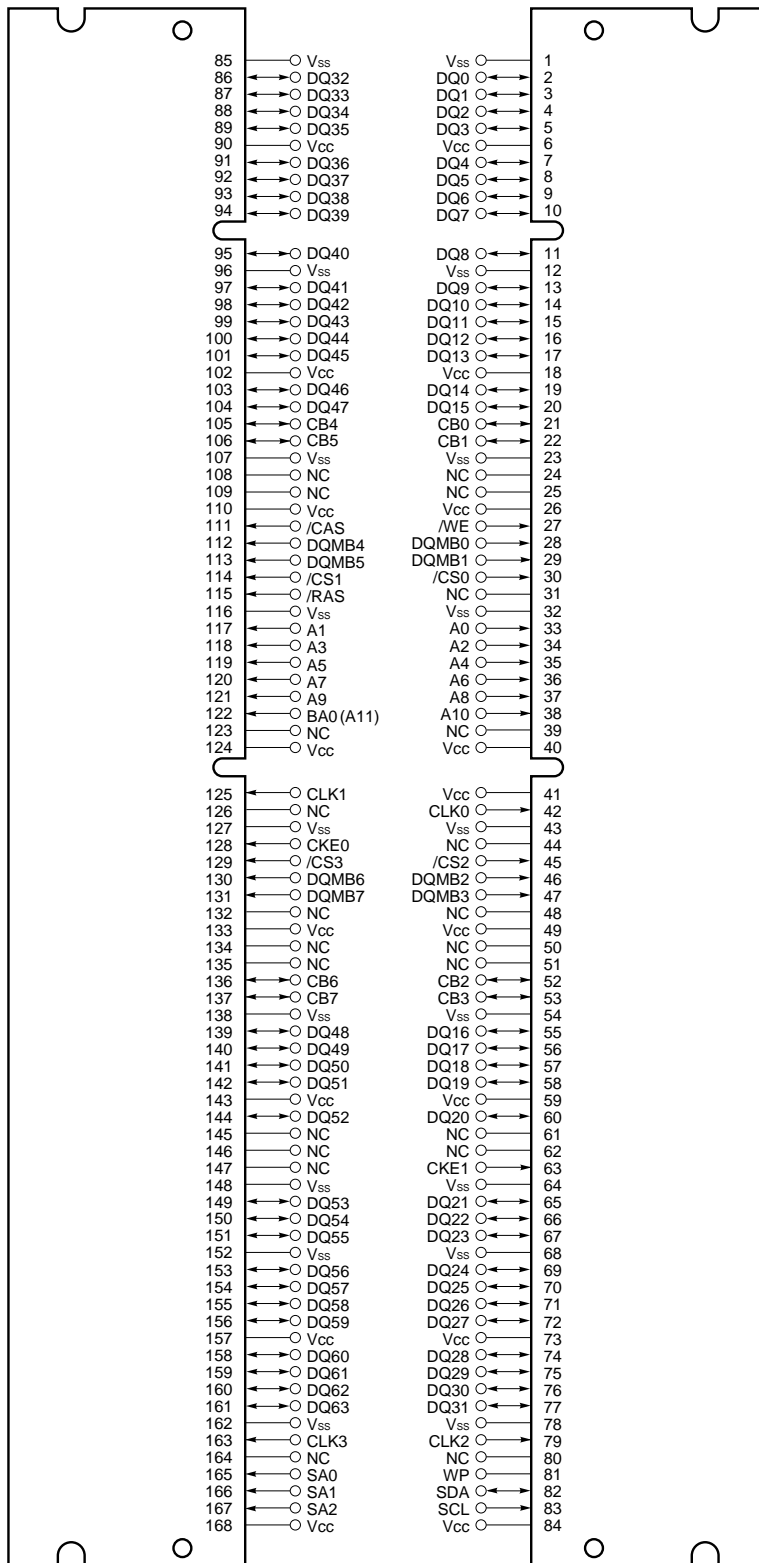
Ordering Information

Part number	Clock frequency MHz (MAX.)	Package	Mounted devices
MC-454AC726F-A80	125 MHz	168-pin Dual In-line Memory Module (Socket Type)	18 pieces of μ PD4516821AG5 (Revision P) (400 mil TSOP (II))
MC-454AC726F-A10	100 MHz	Edge connector : Gold plated 31.75 mm (1.25 inch) height	[Double side]

Pin Configuration

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

[MC-454AC726F]

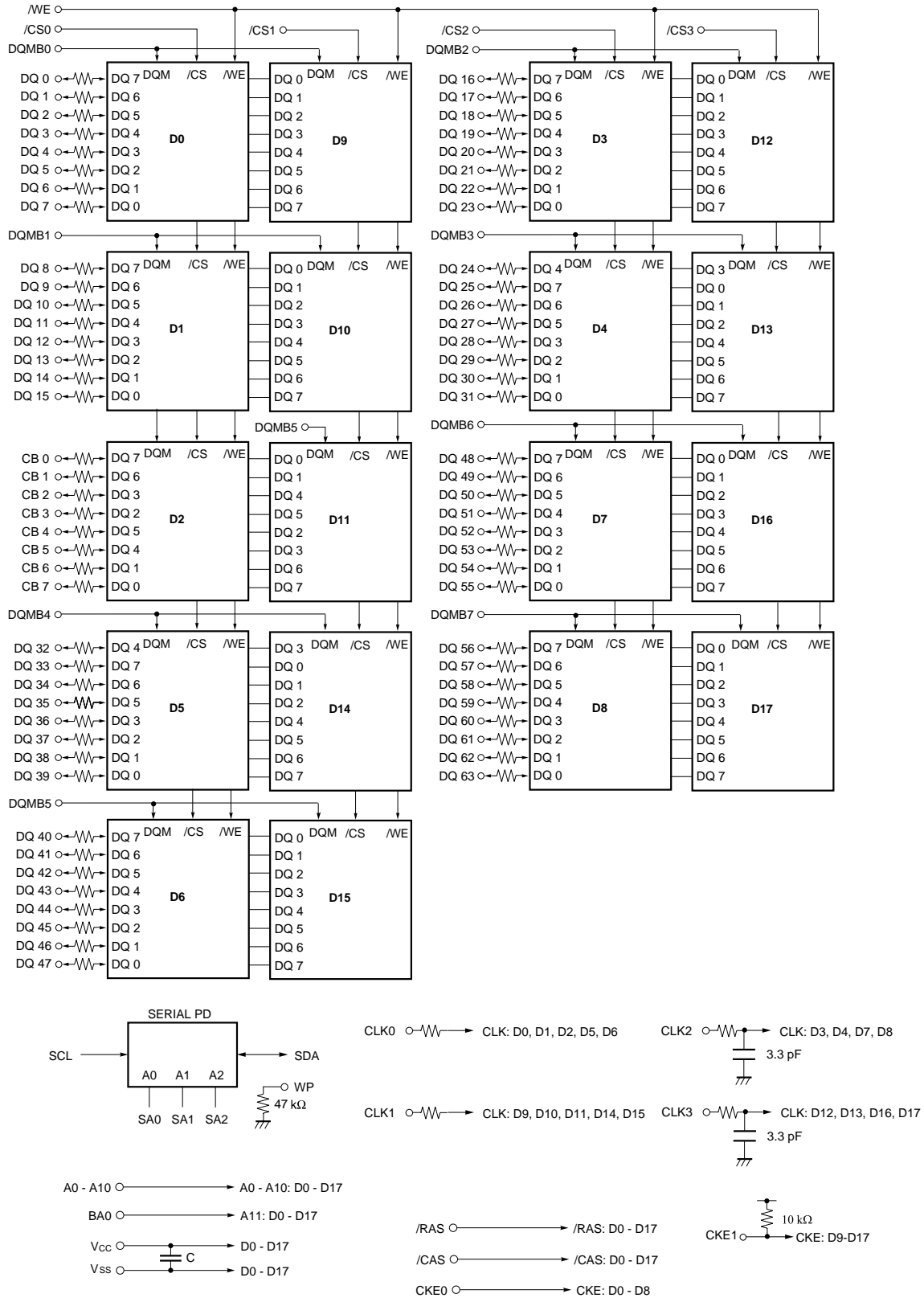


/XXX indicates active low signal.

- A0 - A10 : Address Inputs
[Row : A0 - A10, Column : A0 - A8]
- BA0 (A11) : SDRAM Bank Select
- DQ0 - DQ63,
- CB0 - CB7 : 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
- Vcc : Power Supply
- Vss : 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 WP.
 2. WP is not used yet. It is connected to ground.
 3. D0 – D17 : μPD4516821A (1M word × 8 bits × 2 banks)

Electrical Specifications

- All voltages are referenced to V_{SS} (GND).
- After power up, wait more than 100 μ s 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}		-1.0 to +4.6	V
Voltage on input pin relative to GND	V _T		-1.0 to +4.6	V
Short circuit output current	I _O		50	mA
Power dissipation	P _D		18	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 - A10, BA0 (A11), /RAS, /CAS, /WE	63		102	pF
	C _{I2}	CLK0 - CLK3	24		40	
	C _{I3}	CKE0, CKE1	34		56	
	C _{I4}	/CS0 - /CS3	17		33	
	C _{I5}	DQMB0 - DQMB7	10		22	
Data input/output capacitance	C _{I/O}	DQ0 - DQ63, CB0 - CB7	11		19	pF

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DC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

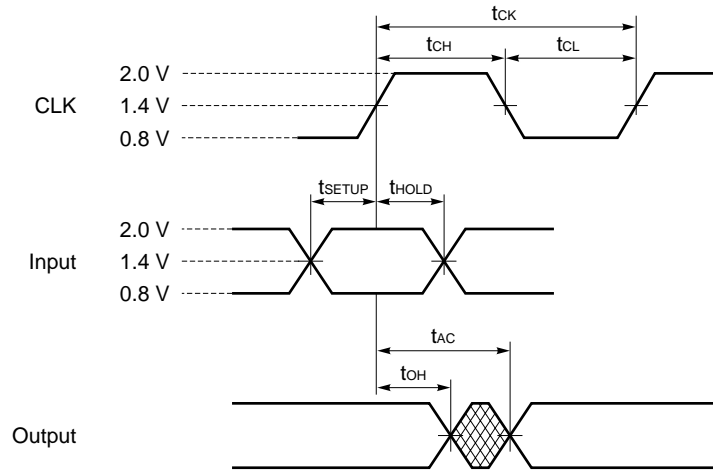
Parameter	Symbol	Test condition	Grade	MIN.	MAX.	Unit	Notes
Operating current	I _{CC1}	Burst length = 1 t _{RC} ≥ t _{RC(MIN.)} , I _O = 0 mA	/CAS latency = 2	-A80	1,197	mA	1
				-A10	1,197		
			/CAS latency = 3	-A80	1,287		
				-A10	1,287		
Precharge standby current in power down mode	I _{CC2P}	CKE ≤ V _{IL(MAX.)} , t _{CK} = 15 ns			54	mA	
	I _{CC2PS}	CKE ≤ V _{IL(MAX.)} , t _{CK} = ∞			36		
Precharge standby current in non power down mode	I _{CC2N}	CKE ≥ V _{IH(MIN.)} , t _{CK} = 15 ns, /CS ≥ V _{IH(MIN.)} , Input signals are changed one time during 30 ns.			450	mA	
	I _{CC2NS}	CKE ≥ V _{IH(MIN.)} , t _{CK} = ∞ Input signals are stable.			108		
Active standby current in power down mode	I _{CC3P}	CKE ≤ V _{IL(MAX.)} , t _{CK} = 15 ns			54	mA	
	I _{CC3PS}	CKE ≤ V _{IL(MAX.)} , t _{CK} = ∞			36		
Active standby current in non power down mode	I _{CC3N}	CKE ≥ V _{IH(MIN.)} , t _{CK} = 15 ns, /CS ≥ V _{IH(MIN.)} , Input signals are changed one time during 30 ns.			504	mA	
	I _{CC3NS}	CKE ≥ V _{IH(MIN.)} , t _{CK} = ∞ Input signals are stable.			216		
Operating current (Burst mode)	I _{CC4}	t _{CK} ≥ t _{CK(MIN.)} I _O = 0 mA	/CAS latency = 2	-A80	1,197	mA	2
				-A10	1,017		
			/CAS latency = 3	-A80	1,332		
				-A10	1,152		
Refresh current	I _{CC5}	t _{RC} ≥ t _{RC(MIN.)}			1,062	mA	3
Self refresh current	I _{CC6}	CKE ≤ 0.2 V			18	mA	
Input leakage current	I _{I(L)}	V _I = 0 to 3.6 V, All other pins not under test = 0 V		-18	+18	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	

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- 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

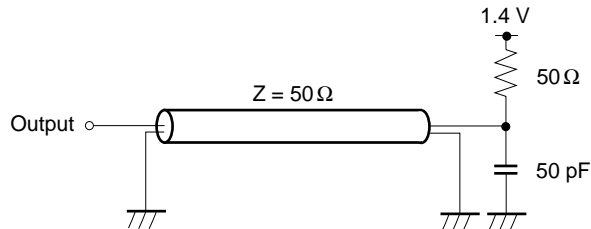
- AC measurements assume $t_r = 1$ ns.
- Reference level for measuring timing of input signals is 1.4 V. Transition times are measured between V_{IH} and V_{IL} .
- If t_r is longer than 1 ns, reference level for measuring timing of input signals is $V_{IH(MIN)}$ and $V_{IL(MAX)}$.
- An access time is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



Synchronous Characteristics

Parameter		Symbol	-A 80		-A 10		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		8	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	8	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, /CS2, /RAS, /CAS, /WE, DQMB0 - DQMB7) setup time	t _{CMS}	2		2		ns	
	Command (/CS0, /CS2, /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 (Auto precharge)	/CAS latency = 3	t _{DAL3}	1CLK+20	1CLK+20		ns	
	/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}		32		32	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	0BH	0	0	0	0	1	0	1	1	11 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 bank
6	Data width	48H	0	1	0	0	1	0	0	0	72 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	8 ns
		(-A10)	A0H	1	0	1	0	0	0	0	10 ns
10	CL = 3 Access time	(-A80)	60H	0	1	1	0	0	0	0	6 ns
		(-A10)	60H	0	1	1	0	0	0	0	6 ns
11	DIMM configuration type	02H	0	0	0	0	0	0	1	0	ECC
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	08H	0	0	0	0	1	0	0	0	×8
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	02H	0	0	0	0	0	0	1	0	2 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	10 ns
		(-A10)	D0H	1	1	0	1	0	0	0	13 ns
24	CL = 2 Access time	(-A80)	60H	0	1	1	0	0	0	0	6 ns
		(-A10)	80H	1	0	0	0	0	0	0	8 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	20 ns
		(-A10)	14H	0	0	0	1	0	1	0	20 ns
28	t _{RRD} (MIN.)	(-A80)	10H	0	0	0	1	0	0	0	16 ns
		(-A10)	14H	0	0	0	1	0	1	0	20 ns
29	t _{RCD} (MIN.)	(-A80)	14H	0	0	0	1	0	1	0	20 ns
		(-A10)	14H	0	0	0	1	0	1	0	20 ns
30	t _{RAS} (MIN.)	(-A80)	30H	0	0	1	1	0	0	0	48 ns
		(-A10)	32H	0	0	1	1	0	0	1	50 ns
31	Module bank density	04H	0	0	0	0	0	1	0	0	16M bytes

(2/2)

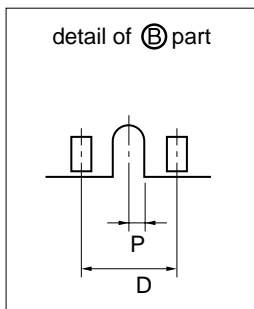
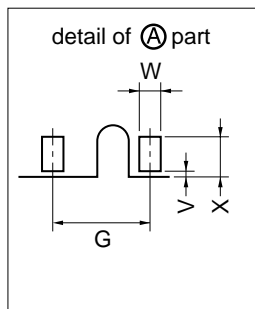
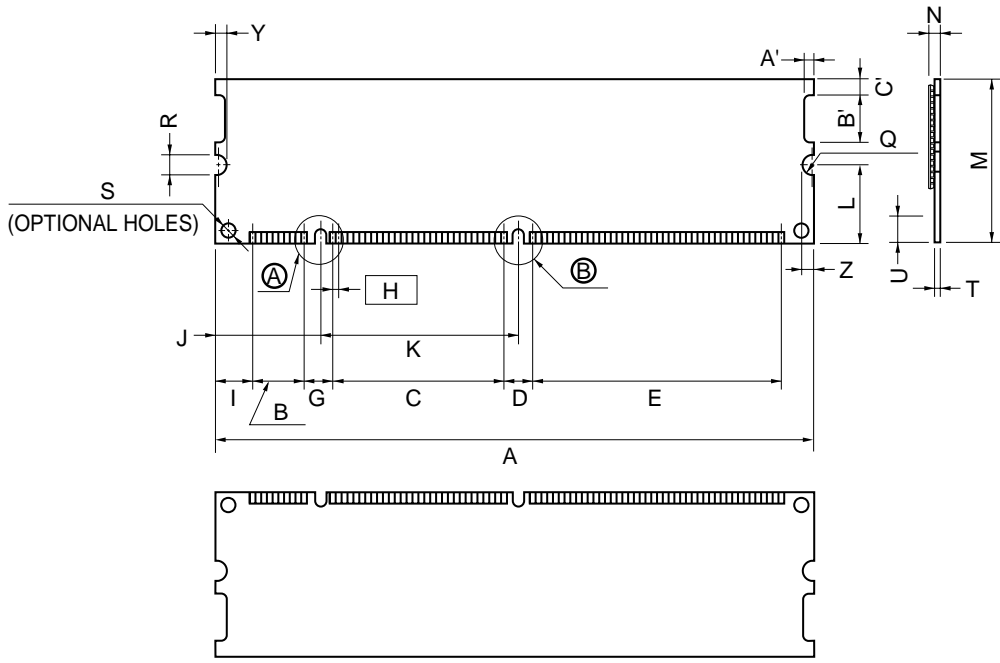
Byte No.	Function Described	Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
32	Command and address signal input setup time	20H	0	0	1	0	0	0	0	0	2 ns
33	Command and address signal input hold time	10H	0	0	0	1	0	0	0	0	1 ns
34	Data signal input setup time	20H	0	0	1	0	0	0	0	0	2 ns
35	Data signal 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) E3H	1	1	1	0	0	0	1	1	
		(-A10) 59H	0	1	0	1	1	0	0	1	
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	INCHES
A	133.35±0.13	5.250±0.006
A'	2.26	0.089
B	11.43	0.450
B'	6.35	0.250
C	36.83	1.450
C'	3.175	0.125
D	6.35	0.250
E	54.61	2.150
G	6.35	0.250
H	1.27 (T.P.)	0.050 (T.P.)
I	8.89	0.350
J	24.495	0.964
K	42.18	1.661
L	17.78	0.700
M	31.75	1.250
N	4.00 MAX.	0.158 MAX.
P	1.0	0.039
Q	R2.0	R0.079
R	4.0±0.1	0.157 ^{+0.005} _{-0.004}
S	φ3.0	φ0.118
T	1.27±0.1	0.05±0.004
U	4.0 MIN.	0.157 MIN.
V	0.2±0.15	0.00787±0.00590
W	1.0±0.05	0.039 ^{+0.003} _{-0.002}
X	2.54 MIN.	0.100±0.004
Y	3.0 MIN.	0.118 MIN.
Z	3.0 MIN.	0.118 MIN.

[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 immediately 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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NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.