DATA SHEET

ELPIDA

MOS INTEGRATED CIRCUIT
MC-4516CA726

16M-WORD BY 72-BIT SYNCHRONOUS DYNAMIC RAM MODULE UNBUFFERED TYPE

Description

The MC-4516CA726EF, MC-4516CA726PF and MC-4516CA726XF are 16,777,216 words by 72 bits synchronous dynamic RAM module on which 9 pieces of 128M SDRAM: μPD45128841 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 72 bits organization (ECC Type)
- Clock frequency and access time from CLK

Part number	/CAS latency	Clock frequency (MAX.)	Access time from CLK (MAX.)
MC-4516CA726EF-A80	CL = 3	125 MHz	6 ns
	CL = 2	100 MHz	6 ns
MC-4516CA726EF-A10	CL = 3	100 MHz	6 ns
	CL = 2	77 MHz	7 ns
MC-4516CA726PF-A80	CL = 3	125 MHz	6 ns
	CL = 2	100 MHz	6 ns
MC-4516CA726PF-A10	CL = 3	100 MHz	6 ns
	CL = 2	77 MHz	7 ns
MC-4516CA726XF-A80	CL = 3	125 MHz	6 ns
	CL = 2	100 MHz	6 ns
MC-4516CA726XF-A10	CL = 3	100 MHz	6 ns
	CL = 2	77 MHz	7 ns

- 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

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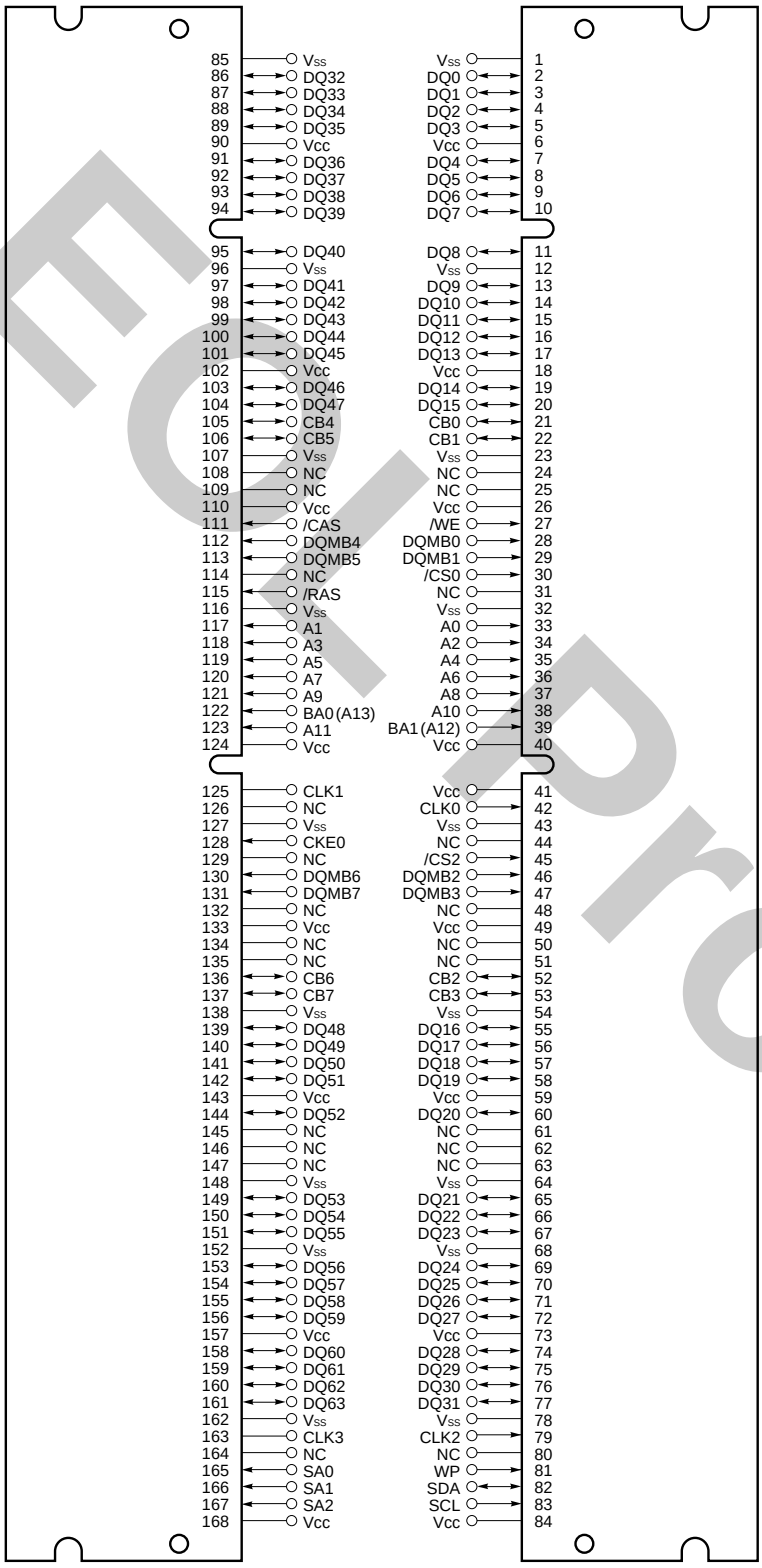
- LVTTL compatible
- 4,096 refresh cycles/64 ms
- Burst termination by Burst Stop command and Precharge command
- 168-pin dual in-line memory module (Pin pitch = 1.27 mm)
- Unbuffered type
- Serial PD

Ordering Information

Part number	Clock frequency MHz (MAX.)	Package	Mounted devices
MC-4516CA726EF-A80	125 MHz	168-pin Dual In-line Memory Module (Socket Type) Edge connector : Gold plated 34.93 mm height	9 pieces of μPD45128841G5 (Rev. E) (10.16 mm (400) TSOP (II))
MC-4516CA726EF-A10	100 MHz		
MC-4516CA726PF-A80	125 MHz		9 pieces of μPD45128841G5 (Rev. P) (10.16 mm (400) TSOP (II))
MC-4516CA726PF-A10	100 MHz		
MC-4516CA726XF-A80	125 MHz		9 pieces of μPD45128841G5 (Rev. X) (10.16 mm (400) TSOP (II))
MC-4516CA726XF-A10	100 MHz		

Pin Configuration

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



/xxx indicates active low signal.

A0 - A11	: Address Inputs
[Row: A0 - A11, Column: A0 - A9]	
BA0 (A13),	
BA1 (A12)	: SDRAM Bank Select
DQ0 - DQ63,	
CB0 - CB7	: Data Inputs/Outputs
CLK0 - CLK3	: Clock Input
CKE0	: Clock Enable Input
/CS0, /CS2	: 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
NC	: No Connection

Block Diagram

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

2. D0 - D8: μPD45128841 (4M 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 CBR (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		9	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	26		66	pF
	C_{I2}	CLK0, CLK2	20		40	
	C_{I3}	CKE0	30		56	
	C_{I4}	/CS0, /CS2	15		33	
	C_{I5}	DQMB0 - DQMB7	3		17	
Data input/output capacitance	$C_{I/O}$	DQ0 - DQ63, CB0 - CB7	4		13	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		900	mA	1
				-A10		900		
			/CAS latency = 3	-A80		900		
				-A10		900		
Precharge standby current in power down mode	$I_{CC2}P$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = 15 ns				9	mA	
	$I_{CC2}PS$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = ∞				9		
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.				180	mA	
	$I_{CC2}NS$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = ∞ Input signals are stable.				72		
Active standby current in power down mode	$I_{CC3}P$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = 15 ns				45	mA	
	$I_{CC3}PS$	CKE ≤ $V_{IL(MAX.)}$, t_{CK} = ∞				36		
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.				270	mA	
	$I_{CC3}NS$	CKE ≥ $V_{IH(MIN.)}$, t_{CK} = ∞ Input signals are stable.				180		
Operating current (Burst mode)	I_{CC4}	$t_{CK} \geq t_{CK(MIN.)}$ I_O = 0 mA	/CAS latency = 2	-A80		1,080	mA	2
				-A10		855		
			/CAS latency = 3	-A80		1,305		
				-A10		1,125		
CBR (Auto) refresh current	I_{CC5}	$t_{RC} \geq t_{RC(MIN.)}$	/CAS latency = 2	-A80		2,070	mA	3
				-A10		2,070		
			/CAS latency = 3	-A80		2,070		
				-A10		2,070		
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			−9	+9	μA	
Output leakage current	$I_{O(L)}$	D_{OUT} is disabled, V_O = 0 to 3.6 V			−1.5	+1.5	μA	
High level output voltage	V_{OH}	I_O = −4 mA			2.4		V	
Low level output voltage	V_{OL}	I_O = +4 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 $t_{CK (MIN.)}$.

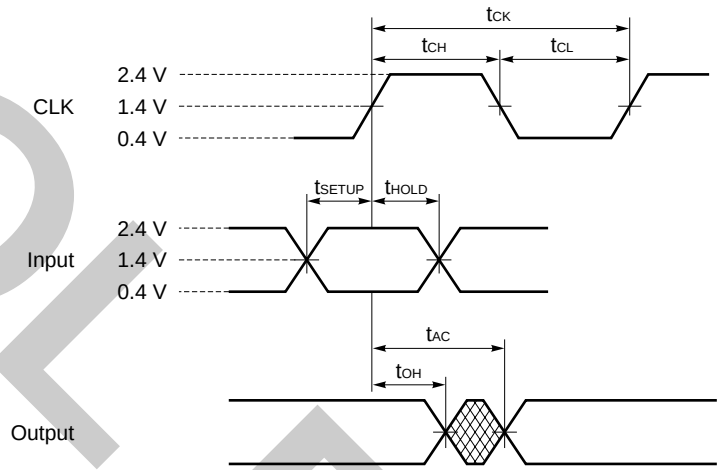
2. I_{CC4} depends on output loading and cycle rates. Specified values are obtained with the output open. In addition to this, I_{CC4} is measured on condition that addresses are changed only one time during $t_{CK (MIN.)}$.

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)

Test Conditions

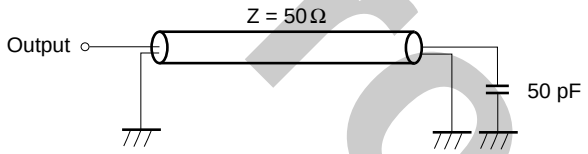
Parameter	Value	Unit
AC high level input voltage / low level input voltage	2.4 / 0.4	V
Input timing measurement reference level	1.4	V
Transition time (Input rise and fall time)	1	ns
Output timing measurement reference level	1.4	V



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, /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.		
ACT to REF/ACT command period (Operation)		t_{RC}	70		70		ns	
REF to REF/ACT command period (Refresh)		t_{RC1}	70		78		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(one) to ACT(another) command period		t_{RRD}	16		20		ns	
Data-in to PRE command period		t_{DPL}	8		10		ns	
Data-in to ACT(REF) command	/CAS latency = 3	t_{DAL3}	1CLK+20		1CLK+20		ns	
period (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 (4,096 refresh cycles)		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		0AH	0	0	0	0	1	0	1	0	10 columns
5	Number of banks		01H	0	0	0	0	0	0	0	1	1 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	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		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		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		20H	0	0	1	0	0	0	0	0	128M bytes

(2/2)

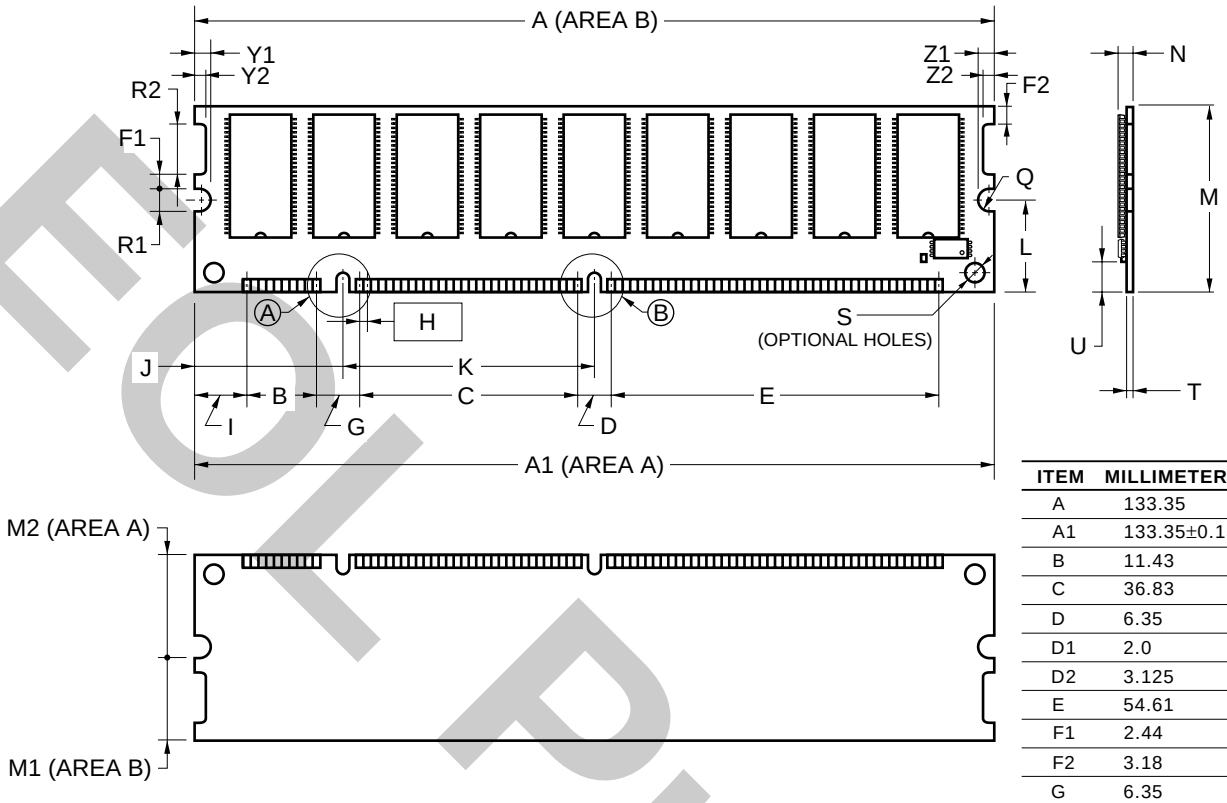
Byte No.	Function Described		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
32	Command and address signal input setup time		20H	0	0	1	0	0	0	0	0	2 ns
33	Command and address signal input hold time		10H	0	0	0	1	0	0	0	0	1 ns
34	Data signal input setup time		20H	0	0	1	0	0	0	0	0	2 ns
35	Data signal 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	02H	0	0	0	0	0	0	1	0	
		-A10	68H	0	1	1	0	1	0	0	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 latency support	-A80	A7H	1	0	1	0	0	1	1	1	
		-A10	A5H	1	0	1	0	0	1	0	1	

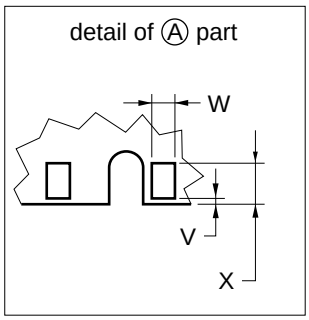
Timing Chart

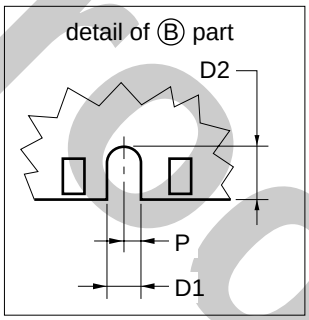
Refer to the **µPD45128441, 45128841, 45128163 Data sheet (E0031N)**.

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	3.0 MAX.
P	1.0
Q	R2.0
R1	4.0±0.10
R2	9.53
S	ϕ3.0
T	1.27±0.1
U	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-50A109

[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 devices 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.

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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