

MOS INTEGRATED CIRCUIT MC-45V16AD641

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

Description

The MC-45V16AD641 is a 16,777,216 words by 64 bits VirtualChannel synchronous dynamic RAM module on which 16 pieces of 64M VirtualChannel SDRAM : μ PD4565821 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 access time from CLK

Part number	Read latency	Clock frequency MHz (MAX.)	Access time from CLK ns (MAX.)	Maximum supply current mA				
				Operating			Refresh	
				Prefetch	Restore	Channel read / write (Burst)	Auto	Self
MC-45V16AD641KF-A75	2	133	5.4	880	720	1280	16	
MC-45V16AD641KF-A10		100	6	840	600	1120		
MC-45V16AD641EF-A75		133	5.4	880	720	1280		
MC-45V16AD641EF-A10		100	6	840	600	1120		

- Fully Standard Synchronous Dynamic RAM, with all signals referenced to a positive clock edge
- Dual internal banks controlled by BA0 (Bank Select)
- Programmable Wrap sequence (Sequential / Interleave)
- Programmable burst length (1, 2, 4, 8 and 16)
- ★ Read latency (2)
- Prefetch Read latency (4)
- Auto precharge and without auto precharge
- Auto refresh and Self refresh
- Single 3.3 V \pm 0.3 V power supply
- Interface: LVTTTL
- Refresh cycle: 4K cycles / 64 ms
- 168-pin dual in-line memory module (Pin pitch = 1.27 mm)
- Unbuffered type
- Serial PD

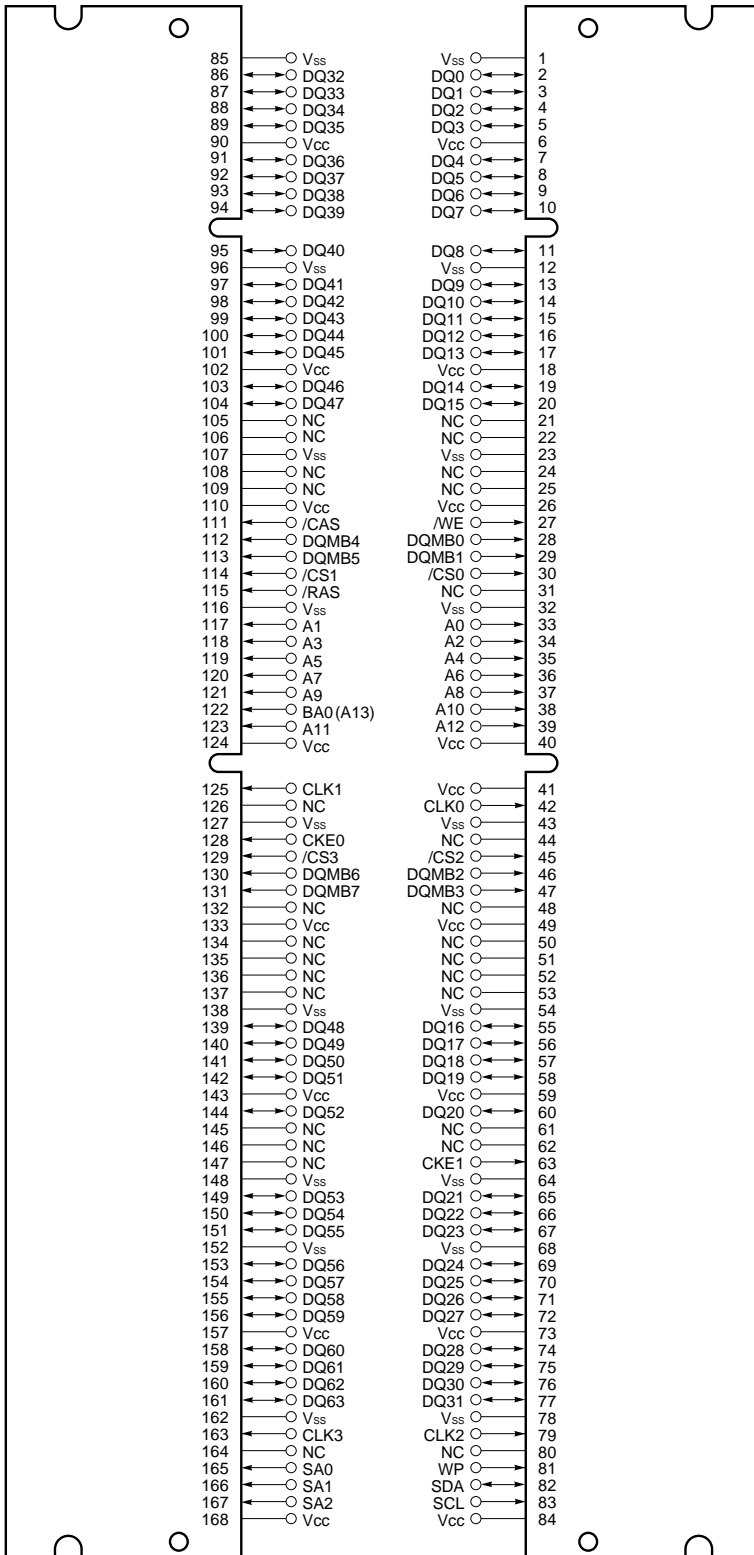
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Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

★ Ordering Information

Part number	Clock frequency MHz (MAX.)	Read latency	Prefetch read latency	Package	Mounted devices
MC-45V16AD641KF-A75	133	2	4	168-pin Dual In-line	16 pieces of μ PD4565821G5
MC-45V16AD641KF-A10	100			Memory Module (Socket Type)	(10.16 mm (400) TSOP (II)) (Rev.K)
MC-45V16AD641EF-A75	133			Edge connector : Gold plated	16 pieces of μ PD4565821G5
MC-45V16AD641EF-A10	100			34.93 mm height	(10.16 mm (400) TSOP (II)) (Rev.E)

Pin Configuration

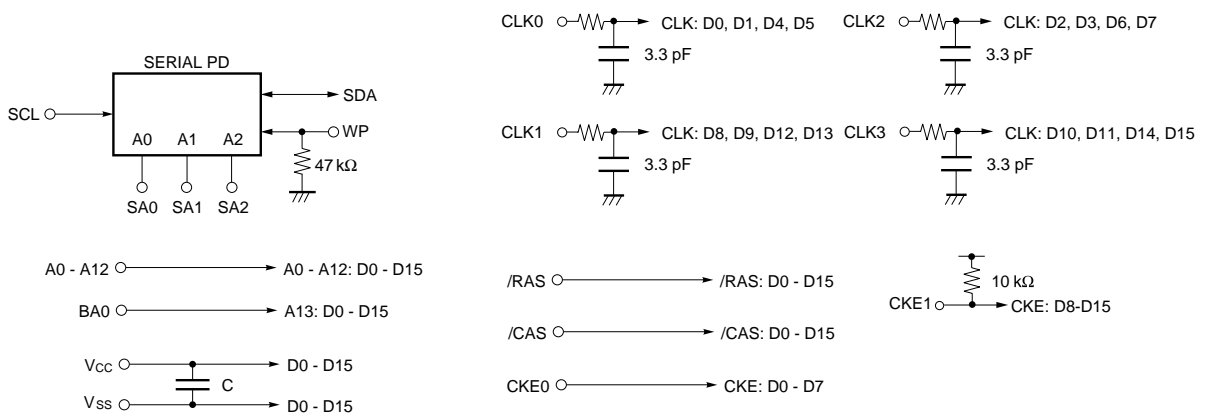
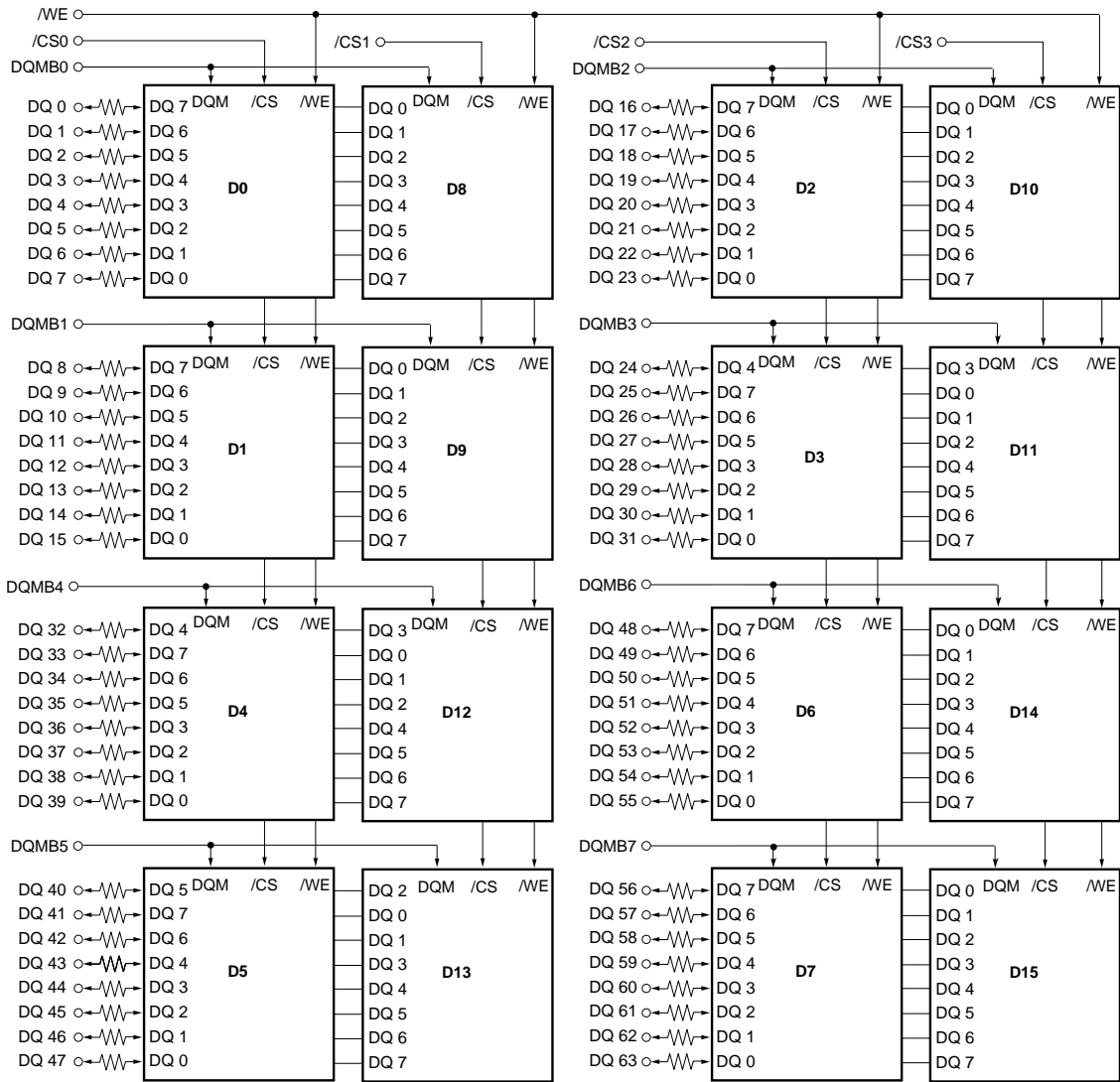
168-pin Dual In-line Memory Module Socket Type (Edge connector: Gold plated)



/xxx indicates active low signal.

- A0 - A12 : Address Inputs
[Row: A0 - A12, Column: A0 - A6]
- BA0 (A13) : VirtualChannel 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
- NC : No Connection

Block Diagram



- Remarks 1. The value of all resistors is 10 Ω except CKE1 and WP.
- 2. D0 - D15: μPD4565821 (4M words × 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}		-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	C11	A0 - A12, BA0 (A13), /RAS, /CAS, /WE	58		94	pF
	C12	CLK0 - CLK3	24		40	
	C13	CKE0, CKE1	32		52	
	C14	/CS0 - /CS3	17		29	
	C15	DQMB0 - DQMB7	10		17	
Data input/output capacitance	C _{I/O}	DQ0 - DQ63	11		19	pF

DC Characteristics (Recommended Operating Conditions Unless Otherwise Noted)

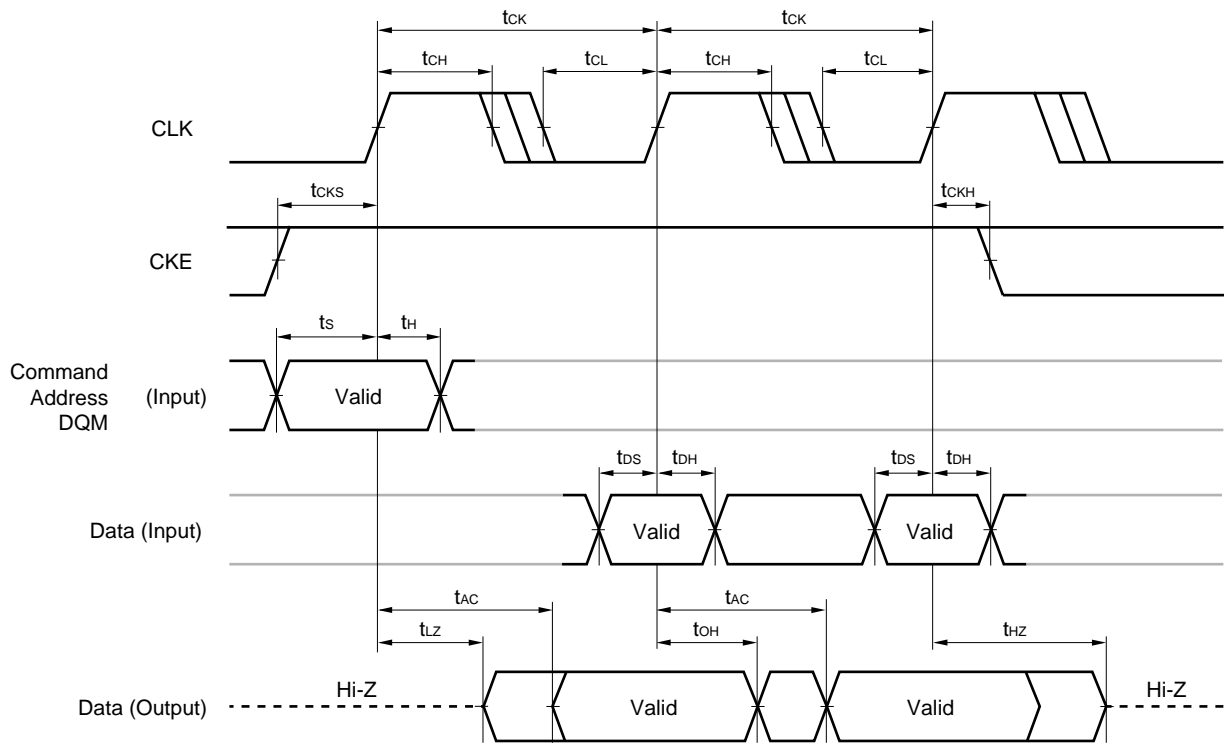
Parameter	Symbol	Test condition	Grade	MIN.	MAX.	Unit	Notes
★ Operating current (Prefetch mode at one bank active)	I _{CC1P}	t _{RC} ≥ t _{RC (MIN.)} Prefetch is executed one time during t _{RC} .	-A75		880	mA	1
			-A10		840		
★ Operating current (Restore mode at one bank active)	I _{CC1R}	t _{RC} ≥ t _{RC (MIN.)}	-A75		880	mA	1
			-A10		840		
Precharge standby current in power down mode	I _{CC2P}	CKE ≤ V _{IL (MAX.)} , t _{CK} = 15 ns			16	mA	
	I _{CC2PS}	CKE ≤ V _{IL (MAX.)} , t _{CK} = ∞			8		
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.			400	mA	
	I _{CC2NS}	CKE ≥ V _{IH (MIN.)} , t _{CK} = ∞, Input signals are stable.			128		
Active standby current in power down mode	I _{CC3P}	CKE ≤ V _{IL (MAX.)} , t _{CK} = 15 ns			80	mA	
	I _{CC3PS}	CKE ≤ V _{IL (MAX.)} , t _{CK} = ∞			64		
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.			400	mA	
	I _{CC3NS}	CKE ≥ V _{IH (MIN.)} , t _{CK} = ∞, Input signals are stable.			160		
★ Operating current (Burst mode)	I _{CC4}	t _{CK} ≥ t _{CK (MIN.)} , I _O = 0 mA Background : precharge standby	-A75		720	mA	2
			-A10		600		
★ Auto refresh current	I _{CC5}	t _{RC} ≥ t _{RC (MIN.)}	-A75		1,280	mA	3
			-A10		1,120		
★ Self refresh current	I _{CC6}	CKE ≤ 0.2 V	-A75		16	mA	
			-A10		16		
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	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 = -4.0 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)

Test Conditions

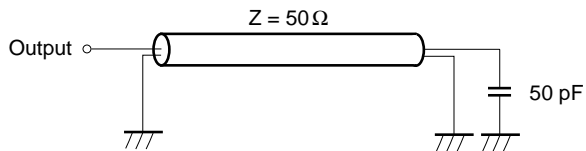
- AC measurements assume $t_r = 1$ ns.
- Reference level for measuring timing of input signals is 1.4 V. Transition times are measured between V_{IH} and V_{IL} .
- If t_r is longer than 1 ns, reference level for measuring timing of input signals is $V_{IH(MIN.)}$ and $V_{IL(MAX.)}$.
- An access time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



★ AC characteristics

Parameter	Symbol	-A75		-A10		Unit	Note
		MIN.	MAX.	MIN.	MAX.		
Clock cycle time	t _{CK}	7.5	–	10	–	ns	
Access time from CLK	t _{AC}	–	5.4	–	6	ns	1
CLK high level width	t _{CH}	2.5	–	3	–	ns	
CLK low level width	t _{CL}	2.5	–	3	–	ns	
Data-out hold time	t _{OH}	2.7	–	3	–	ns	1
Data-out low-impedance time	t _{LZ}	0	–	0	–	ns	
Data-out high-impedance time	t _{HZ}	2.5	5.4	3	6	ns	
Data-in setup time	t _{DS}	1.5	–	2	–	ns	
Data-in hold time	t _{DH}	0.8	–	1	–	ns	
Address, Command, DQM setup time	t _S	1.5	–	2	–	ns	
Address, Command, DQM hold time	t _H	0.8	–	1	–	ns	
CKE setup time	t _{CKS}	1.5	–	2	–	ns	
CKE hold time	t _{CKH}	0.8	–	1	–	ns	
CKE setup time (Power down exit)	t _{CKSP}	1.5	–	2	–	ns	
Transition time	t _r	0.5	30	1	30	ns	
Refresh time (4,096 refresh cycles)	t _{REF}	–	64	–	64	ms	
Mode register set cycle time	t _{RSC}	2	–	2	–	CLK	

Note 1. Output load.



★ AC characteristics (Background to Background operation)

Parameter	Symbol	-A75		-A10		Unit	Notes
		MIN.	MAX.	MIN.	MAX.		
Same Bank Operation							
ACT to ACT/REF Command period	t _{RC}	67.5	–	80	–	ns	
REF to REF/ ACT Command period	t _{R_{CF}}	67.5	–	80	–	ns	
ACT to PRE Command period	t _{RAS}	52	120,000	60	120,000	ns	
PRE to ACT / REF Command period	t _{RP}	20	–	20	–	ns	
ACT to PFC/PFCA/ PPF/PPFA Command delay time	t _{APD}	15	–	20	–	ns	
ACT to PFR Command delay time (Prefetch Read Operation)	t _{APRD}	20	–	20	–	ns	
PFC to PRE Command delay time	t _{PPL}	22.5	–	30	–	ns	
PFCA / PFR to ACT/REF Command delay time	t _{PAL}	45	–	50	–	ns	
PPF to PRE Command delay time	t _{PPP}	45	–	60	–	ns	
PPFA to ACT/REF Command delay time	t _{PPA}	67.5	–	80	–	ns	
RST / RSTA to ACT(R) ^{Note1} Command delay time	t _{RAD}	7.5	30	10	40	ns	2
Same, Other Bank Operation							
ACT(R) ^{Note1} to PFC/PFCA/PFR/ PPF/PPFA Command delay time	t _{RPD}	37.5	–	40	–	ns	
PFC to PFC / PFCA Command delay time	t _{PPD}	22.5	–	30	–	ns	
PPF to PPF / PPFA Command delay time	t _{PPPD}	45	–	60	–	ns	
Other Bank Operation							
ACT to ACT/ACT(R) or ACT(R) to ACT Command delay time	t _{RRD}	15	–	20	–	ns	
ACT(R) to ACT(R) Command delay time	t _{RRDR}	30	–	40	–	ns	
PFC /PFCA to RST /RSTA Command delay time	t _{PRD}	22.5	–	30	–	ns	
PPF /PPFA to RST /RSTA Command delay time	t _{PPRD}	45	–	60	–	ns	

- Notes**
1. ACT (R) command is ACT command after RST command.
 2. The another background operation and same channel foreground operation are illegal while t_{RAD} period.

★ AC characteristics (Foreground to Foreground operation)

Parameter	Symbol	-A75		-A10		Unit	Note
		MIN.	MAX.	MIN.	MAX.		
READ/WRITE to READ/WRITE Command delay time	t _{CCD}	7.5	–	10	–	ns	

★ AC characteristics (Background to Foreground operation)
(after same channel Prefetch/Restore)

Parameter	Symbol	-A75		-A10		Unit	Note
		MIN.	MAX.	MIN.	MAX.		
PFC/PFCA/PPF/PPFA to READ/WRITE Command delay time	t _{PCD}	15	–	20	–	ns	
PPF/PPFA to READ/WRITE Command delay time (2nd prefetch channel read write)	t _{PPCD}	37.5	–	50	–	ns	
ACT(R) to READ/WRITE Command delay time	t _{RCD}	30	–	40	–	ns	1

Note 1. ACT (R) command is ACT command after RST command.

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	08H	0	0	0	0	1	0	0	0	VC SDRAM		
3	Number of row addresses	0DH	0	0	0	0	1	1	0	1	13 rows		
4	Number of column addresses	07H	0	0	0	0	0	1	1	1	7 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 standard	01H	0	0	0	0	0	0	0	1	LVTTTL		
★	Read latency (/CAS latency) = 2 cycle time	-A75	75H	0	1	1	1	0	1	0	1	7.5 ns	
		-A10	A0H	1	0	1	0	0	0	0	0	10 ns	
★	Read latency (/CAS latency) = 2 access time	-A75	54H	0	1	0	1	0	1	0	0	5.4 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	VC 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	1FH	0	0	0	1	1	1	1	1	1, 2, 4, 8, 16		
17	Number of banks on each VC SDRAM	02H	0	0	0	0	0	0	1	0	2 banks		
★	18	Read latency (/CAS latency) supported	02H	0	0	0	0	0	0	1	0	2	
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	VC SDRAM module attributes	00H	0	0	0	0	0	0	0	0			
22	VC SDRAM device attributes : general	0EH	0	0	0	0	1	1	1	0			
★	23-26	00H	0	0	0	0	0	0	0	0			
★	27	t _{RP} (MIN.)	-A75	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.)	-A75	0FH	0	0	0	0	1	1	1	1	15 ns
			-A10	14H	0	0	0	1	0	1	0	0	20 ns
★	29	t _{APD} (MIN.)	-A75	0FH	0	0	0	0	1	1	1	1	15 ns
			-A10	14H	0	0	0	1	0	1	0	0	20 ns
★	30	t _{RAS} (MIN.)	-A75	34H	0	0	1	1	0	1	0	0	52 ns
			-A10	3CH	0	0	1	1	1	1	0	0	60 ns

(2/2)

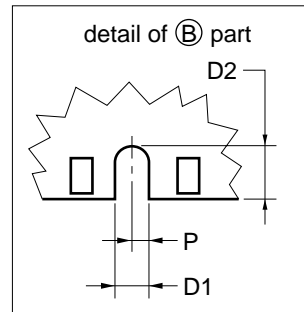
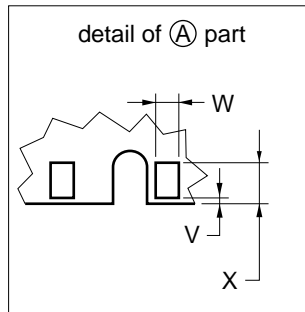
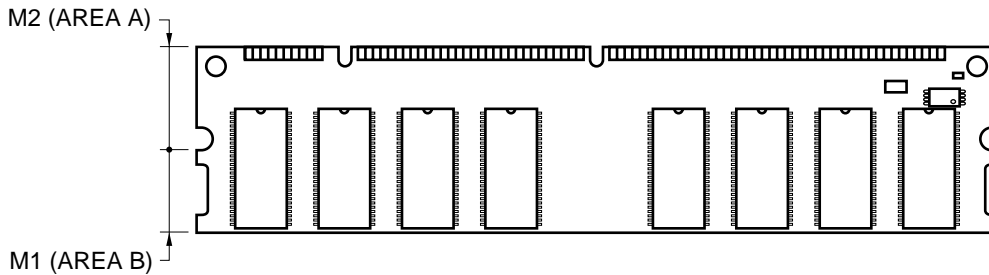
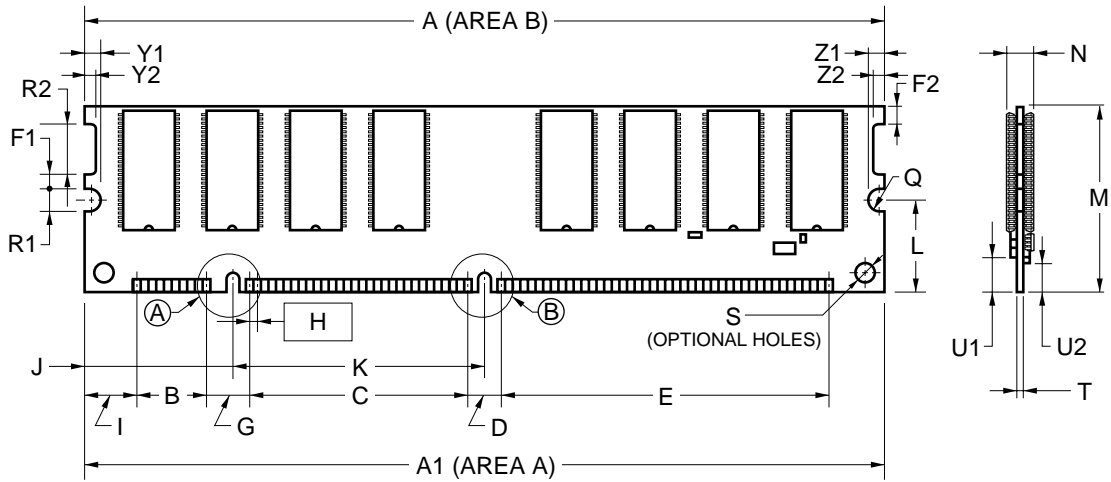
Byte No.	Function Described	Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes	
31	Module bank density	10H	0	0	0	1	0	0	0	0	64M bytes	
★ 32	Address and command signal input setup time	-A75	15H	0	0	0	1	0	1	0	1	1.5 ns
		-A10	20H	0	0	1	0	0	0	0	0	2 ns
★ 33	Address and command signal input hold time	-A75	08H	0	0	0	0	1	0	0	0	0.8 ns
		-A10	10H	0	0	0	1	0	0	0	0	1 ns
★ 34	Data signal input setup time	-A75	15H	0	0	0	1	0	1	0	1	1.5 ns
		-A10	20H	0	0	1	0	0	0	0	0	2 ns
★ 35	Data signal input hold time	-A75	08H	0	0	0	0	1	0	0	0	0.8 ns
		-A10	10H	0	0	0	1	0	0	0	0	1 ns
★ 36	Prefetch read latency	-A75	04H	0	0	0	0	0	1	0	0	4 clocks
		-A10	04H	0	0	0	0	0	1	0	0	4 clocks
★ 37	t _{PCD} (MIN.)	-A75	0FH	0	0	0	0	1	1	1	1	15 ns
		-A10	14H	0	0	0	1	0	1	0	0	20 ns
38	Number of segment addresses	02H	0	0	0	0	0	0	1	0	2 bits	
39	Number of channels	04H	0	0	0	0	0	1	0	0	16	
40	Depth of channels	07H	0	0	0	0	0	1	1	1	128 bits	
41-61												
62	SPD revision	02H	0	0	0	0	0	0	1	0	2.0	
★ 63	Checksum for bytes 0 - 62	-A75	3EH	0	0	1	1	1	1	1	0	
		-A10	B2H	1	0	1	1	0	0	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											

Timing Charts

Please refer to the **μPD4565421, 4565821, 4565161 Data sheet (M13022E)**.

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	∅3.0
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

Revision History

Edition / Date	Page		Description		
	This edition	Previous edition	Type of revision	Location	
4th edition / Jun. 1999	p.1	p.1	Deletion	-A70	
	p.2	p.2			
	p.3	p.3	Modification	PIN No.53, No.63	
	p.6	p.6	Deletion	-A70	
					p.8
			Modification	Note 1	
	p.9	p.9	Deletion	-A70, t _{RCPD} , t _{DAL}	
					Modification
	p.10	p.10	Deletion	-A70	
					Modification
p.11	p.11	Deletion	-A70		
p.12	p.12				
p.14	p.14	Addition	Revision History		
5th edition / Dec. 1999	p.1	p.1	Addition	MC-45V16AD641EF-A75, MC-45V16AD641EF-A10, MC-45V16AD641EF-A15	
	p.2	p.2	Addition	MC-45V16AD641EF-A75, MC-45V16AD641EF-A10, MC-45V16AD641EF-A15	
	p.3	p.3	Modification	Pin Configuration (WP)	
			Deletion	Note	
	p.4	p.4	Modification	Block Diagram (WP)	
			Deletion	Remarks 2	
	p.5	p.5	Modification	Capacitance	
	p.8	p.8	Modification	t _{HZ} (-A75 (MAX.), -A15 (MAX.))	
p.13	p.13	Modification	Package Drawing		
6th edition / Jun. 2000	p.1	p.1	Deletion	-A15	
	p.2	p.2			
	p.6	p.6			
	p.8	p.8			
			Modification	t _r (-A75(MIN.))	
	p.9	p.9	Deletion	-A15	
					p.10
	p.11	p.11	Modification	Byte No. 18	
				Deletion	Byte No. 23, 24
				Deletion	-A15
p.12	p.11, 12	Deletion	-A15		
	p.12	Addition	Byte No. 32-35, -A75		
		Modification	Byte No. 63		

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.

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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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