NEC

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 : μPD4565821 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 ± 0.3 V power supply
- Interface: LVTTL
- 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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Printed in Japan

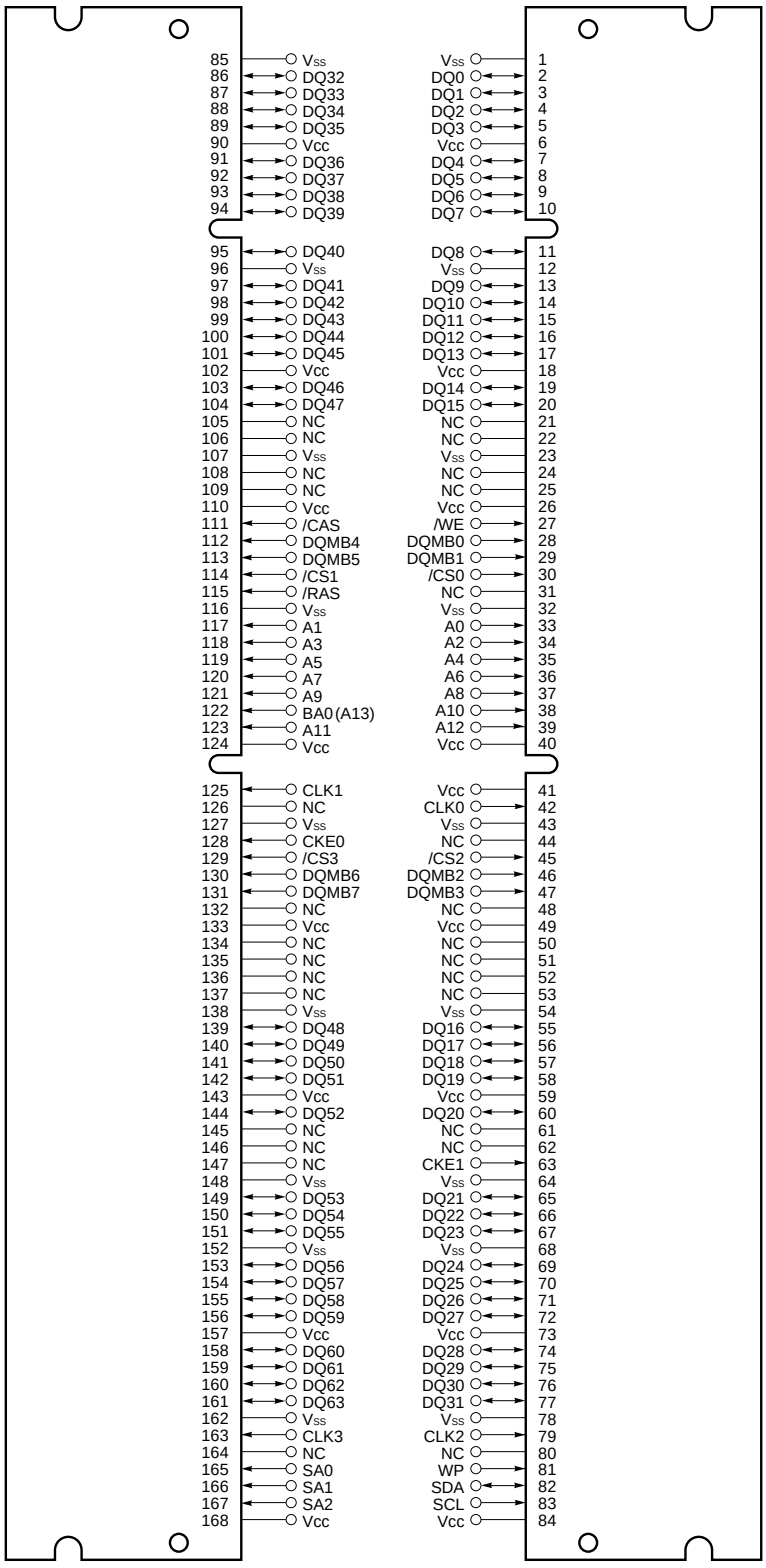
The mark ★ shows major revised points.

★ 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 μPD4565821G5
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 μPD4565821G5
MC-45V16AD641EF-A10	100			34.93 mm height	(10.16 mm (400) TSOP (II)) (Rev.E)

Pin Configuration

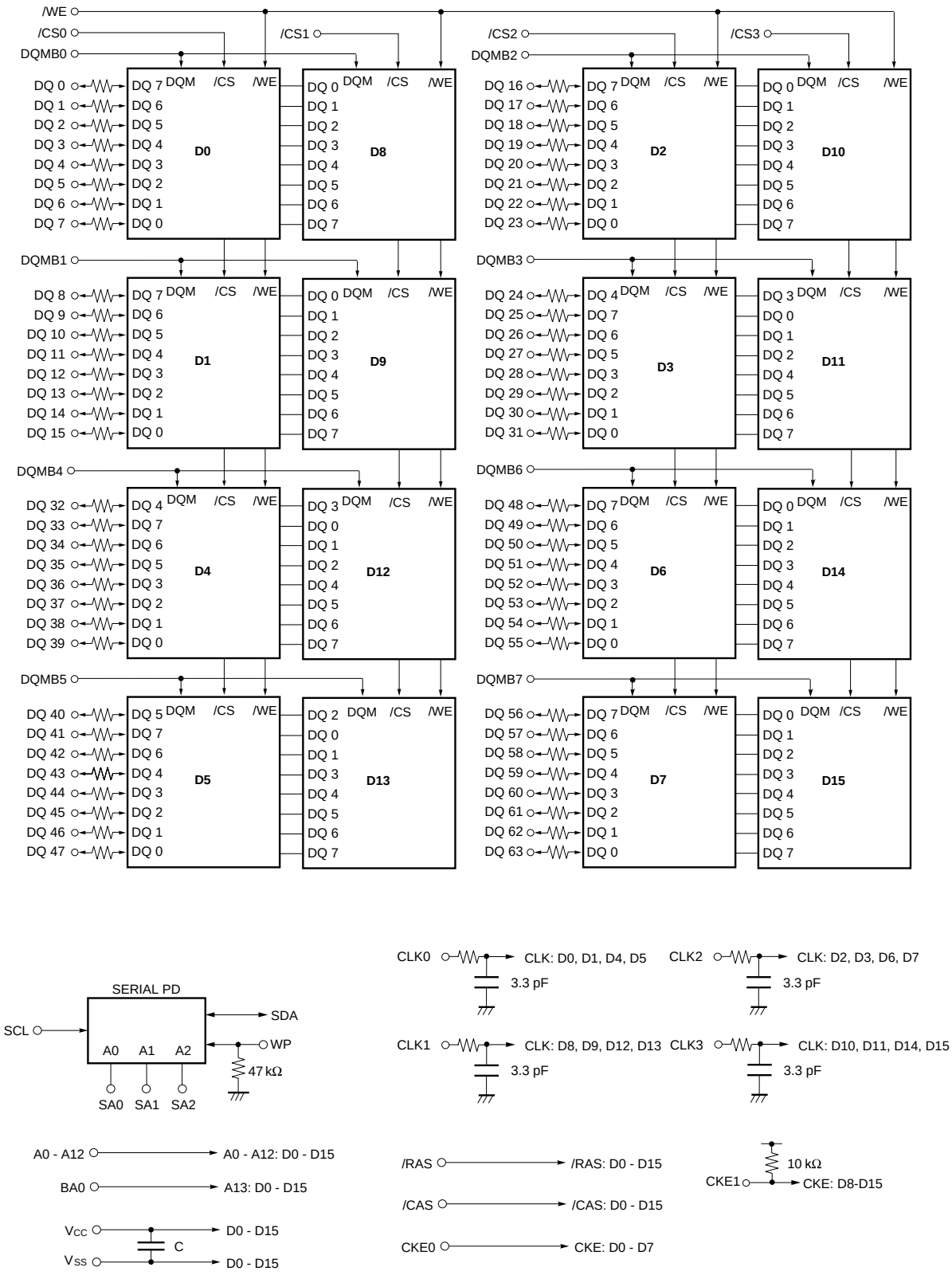
168-pin Dual In-line Memory Module Socket Type (Edge connector: Gold plated)



/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
Vcc	: Power Supply
Vss	: 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 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 ºC, f = 1 MHz)

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{I1}	A0 - A12, BA0 (A13), /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 (Prefetch mode at one bank active)	$I_{CC1}P$	$t_{RC} \geq t_{RC\ (MIN.)}$ Prefetch is executed one time during t_{RC}.	-A75		880	mA	1
				-A10		840		
★	Operating current (Restore mode at one bank active)	$I_{CC1}R$	$t_{RC} \geq t_{RC\ (MIN.)}$	-A75		880	mA	1
				-A10		840		
	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.			400	mA	
		$I_{CC2}NS$	CKE ≥ $V_{IH\ (MIN.)}$, t_{CK} = ∞ , Input signals are stable.			128		
	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 Background : precharge standby	-A75		720	mA	2
				-A10		600		
★	Auto refresh current	I_{CC5}	$t_{RC} \geq t_{RC\ (MIN.)}$	-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 $t_{CK\ (MIN.)}$.

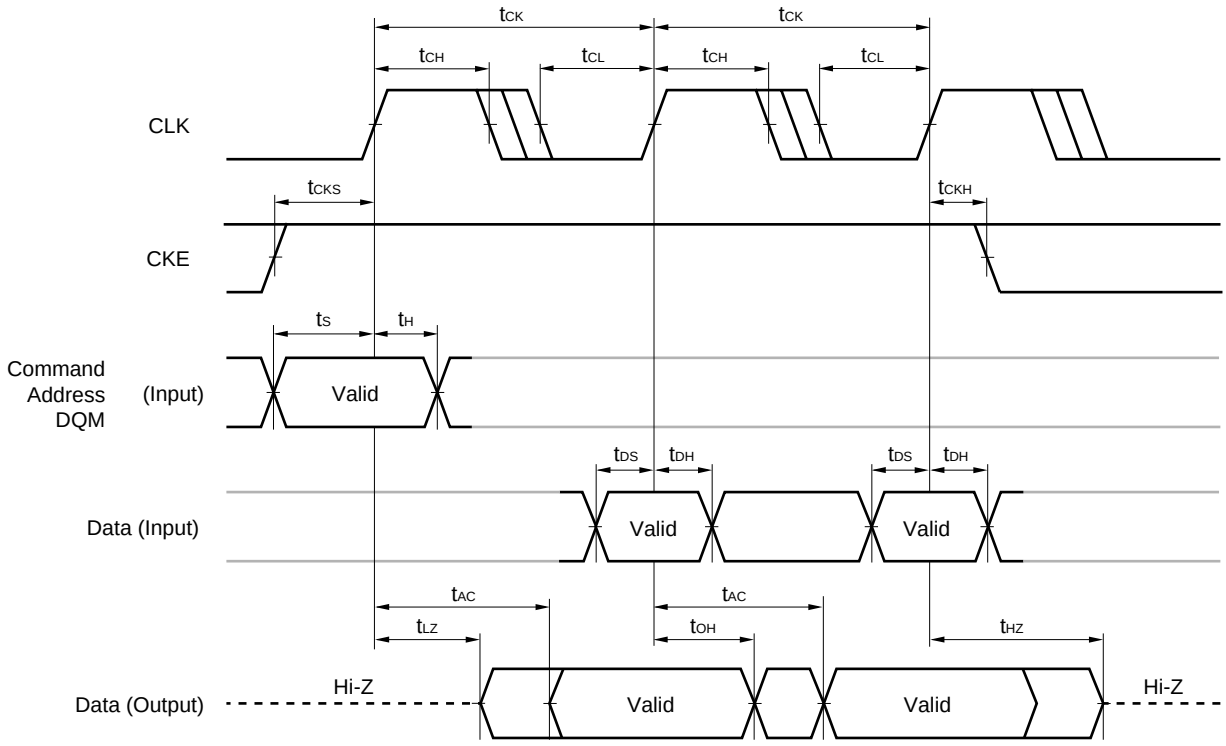
2. I_{CC4} depends on output loading and cycle rates. Specified values are obtained with the output open. In addition to this, I_{CC4} is measured on condition that addresses are changed only one time during $t_{CK\ (MIN.)}$.

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

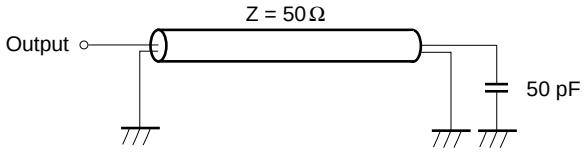
- AC measurements assume t_T = 1 ns.
- Reference level for measuring timing of input signals is 1.4 V. Transition times are measured between V_{IH} and V_{IL}.
- If t_T is longer than 1 ns, reference level for measuring timing of input signals is $V_{IH\ (MIN.)}$ and $V_{IL\ (MAX.)}$.
- An access time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



★ **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_{T}	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_{RCF}	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	LVTTL
★	9	Read latency (/CAS latency) = 2	-A75	75H	0	1	1	1	0	1	0	1	7.5 ns
		cycle time	-A10	A0H	1	0	1	0	0	0	0	0	10 ns
★	10	Read latency (/CAS latency) = 2	-A75	54H	0	1	0	1	0	1	0	0	5.4 ns
		access time	-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)

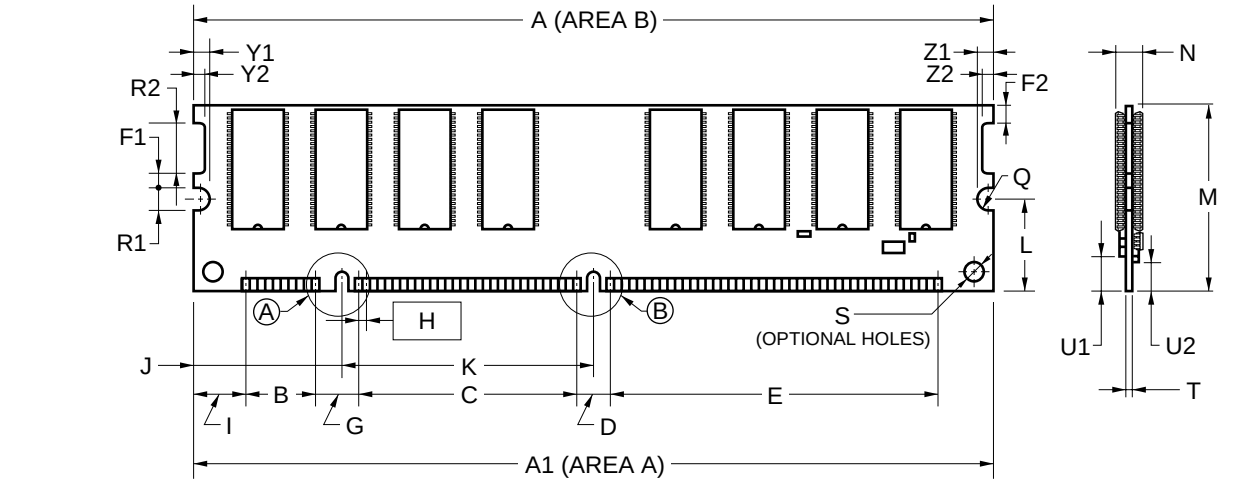
	Byte No.	Function Described		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Notes
	31	Module bank density		10H	0	0	0	1	0	0	0	0	64M bytes
★	32	Address and command signal	-A75	15H	0	0	0	1	0	1	0	1	1.5 ns
		input setup time	-A10	20H	0	0	1	0	0	0	0	0	2 ns
★	33	Address and command signal	-A75	08H	0	0	0	0	1	0	0	0	0.8 ns
		input hold time	-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											

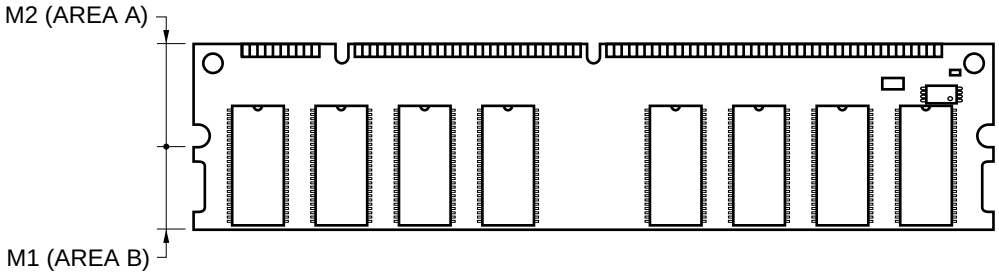
Timing Charts

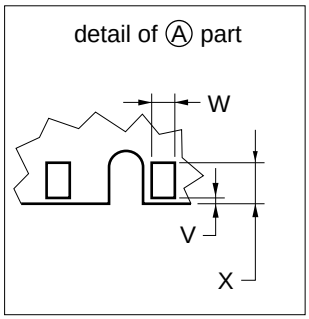
Please refer to the **μPD4565421, 4565821, 4565161 Data sheet** (M13022E).

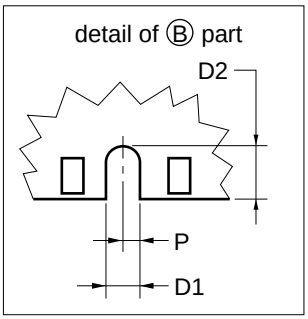
Package Drawing

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	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

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	p.8		
			Modification	Note 1
	p.9	p.9	Deletion	-A70, t_{RCPD}, t_{DAL}
			Modification	t_{APD} (Parameter), t_{RPD} (Parameter)
	p.10	p.10	Deletion	-A70
			Modification	t_{PCD} (Parameter)
	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_T (-A75(MIN.))
	p.9	p.9	Deletion	-A15
	p.10	p.10		
	p.11	p.11		
			Modification	Byte No. 18
			Deletion	Byte No. 23, 24
	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.