

16M x 64/72 Two-Bank Unbuffered SDRAM Module

Features

- 168-Pin Unbuffered 8-Byte Dual In-Line Memory Module
- 16Mx64/72 Synchronous DRAM DIMM
- Three speed sorts:
 - -260 and -360 for PC100 applications
 - -10 for 66MHz applications (typical)
- Inputs and outputs are LVTTL (3.3V) compatible
- Single 3.3V $\pm$ 0.3V Power Supply
- Single Pulsed RAS interface
- SDRAMs have 4 internal banks
- Module has 2 banks
- Fully Synchronous to positive Clock Edge
- Data Mask for Byte Read/Write control
- Auto Refresh (CBR) and Self Refresh
- Automatic and controlled Precharge commands
- Programmable Operation:
 - CAS Latency: 2, 3
 - Burst Type: Sequential or Interleave
 - Burst Length: 1, 2, 4, 8, Full-Page (Full-Page supports Sequential burst only)
 - Operation: Burst Read and Write or Multiple Burst Read with Single Write
- Suspend Mode and Power Down Mode
- 12/9/2 Addressing (Row/Column/Bank)
- 4096 Refresh cycles distributed across 64ms
- Serial Presence Detect
- Card size: 5.25" x 1.375" x 0.158" max
- Gold contacts
- SDRAMs in TSOP Type II Package

Description

IBM13N16644HCC / IBM13N16734HCC are unbuffered 168-pin Synchronous DRAM Dual In-Line Memory Modules (DIMMs) which are organized as 16Mx64 and 16Mx72 high-speed memory arrays. The DIMMs use sixteen (16Mx64) or eighteen (16Mx72) 8Mx8 SDRAMs in 400mil TSOP II packages. The DIMMs achieve high-speed data-transfer rates of up to 100MHz by employing a prefetch/pipeline hybrid architecture that supports the JEDEC 1N rule while allowing very low burst power.

The -10 speed sort DIMMs comply with JEDEC standards for 168-pin unbuffered SDRAM DIMMs.

The -260 and -360 speed sort DIMMs are compatible with the Intel PC100 SDRAM unbuffered DIMM specification.

All control, address, and data input/output circuits are synchronized with the positive edge of the externally supplied clock inputs.

All inputs are sampled at the positive edge of each externally supplied clock (CK0 - CK3). Internal oper-

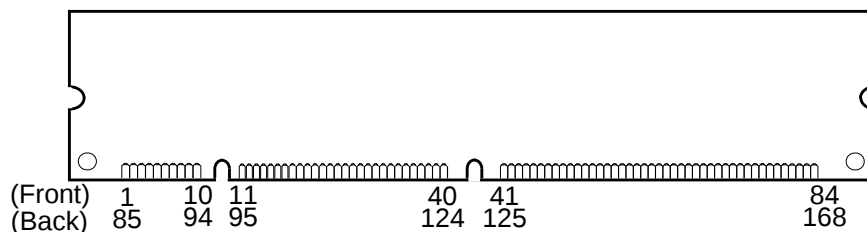
ating modes are defined by combinations of $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, $\overline{\text{S0-S3}}$, DQMB, and CKE0-CKE1 signals. A command decoder initiates the necessary timings for each operation. A 14-bit address bus accepts address information in a row/column multiplexing arrangement.

Prior to any Access operation, the $\overline{\text{CAS}}$ latency, burst type, burst length, and burst operation type must be programmed into the DIMM by address inputs A0-A9 during the Mode Register Set cycle.

The DIMM uses serial presence detects implemented via a serial EEPROM using the two pin IIC protocol. The first 128 bytes of serial PD data are used by the DIMM manufacturer. The last 128 bytes are available to the customer.

All IBM 168-pin DIMMs provide a high-performance, flexible 8-byte interface in a 5.25" long space-saving footprint. Related products include both EDO DRAM and SDRAM unbuffered DIMMs in both non-parity x64 and ECC-Optimized x72 configurations.

Card Outline





Pin Description

CK0 - CK3	Clock Inputs	DQ0 - DQ63	Data Input/Output
CKE0 - CKE1	Clock Enables	CB0 - CB7	Check Bit Data Input/Output
$\overline{\text{RAS}}$	Row Address Strobe	DQMB0 - DQMB7	Data Mask
$\overline{\text{CAS}}$	Column Address Strobe	V_{DD}	Power (3.3V)
$\overline{\text{WE}}$	Write Enable	V_{SS}	Ground
$\overline{\text{S0}}, \overline{\text{S1}}, \overline{\text{S2}}, \overline{\text{S3}}$	Chip Selects	NC	No Connect
A0 - A9, A11	Address Inputs	SCL	Serial Presence Detect Clock Input
A10 /AP	Address Input/Autoprecharge	SDA	Serial Presence Detect Data Input/Output
BA0, BA1	SDRAM Bank Address Inputs	SA0-2	Serial Presence Detect Address Inputs
		WP	Serial Presence Detect Write Protect Input

Pinout

Pin#	Front Side	Pin#	Back Side	Pin#	Front Side	Pin#	Back Side	Pin#	Front Side	Pin#	Back Side	Pin#	Front Side	Pin#	Back Side
1	V_{SS}	85	V_{SS}	22	CB1	106	CB5	43	V_{SS}	127	V_{SS}	64	V_{SS}	148	V_{SS}
2	DQ0	86	DQ32	23	V_{SS}	107	V_{SS}	44	NC	128	CKE0	65	DQ21	149	DQ53
3	DQ1	87	DQ33	24	NC	108	NC	45	$\overline{\text{S2}}$	129	$\overline{\text{S3}}$	66	DQ22	150	DQ54
4	DQ2	88	DQ34	25	NC	109	NC	46	DQMB2	130	DQMB6	67	DQ23	151	DQ55
5	DQ3	89	DQ35	26	V_{DD}	110	V_{DD}	47	DQMB3	131	DQMB7	68	V_{SS}	152	V_{SS}
6	V_{DD}	90	V_{DD}	27	$\overline{\text{WE}}$	111	$\overline{\text{CAS}}$	48	NC	132	NC	69	DQ24	153	DQ56
7	DQ4	91	DQ36	28	DQMB0	112	DQMB4	49	V_{DD}	133	V_{DD}	70	DQ25	154	DQ57
8	DQ5	92	DQ37	29	DQMB1	113	DQMB5	50	NC	134	NC	71	DQ26	155	DQ58
9	DQ6	93	DQ38	30	$\overline{\text{S0}}$	114	$\overline{\text{S1}}$	51	NC	135	NC	72	DQ27	156	DQ59
10	DQ7	94	DQ39	31	NC	115	$\overline{\text{RAS}}$	52	CB2	136	CB6	73	V_{DD}	157	V_{DD}
11	DQ8	95	DQ40	32	V_{SS}	116	V_{SS}	53	CB3	137	CB7	74	DQ28	158	DQ60
12	V_{SS}	96	V_{SS}	33	A0	117	A1	54	V_{SS}	138	V_{SS}	75	DQ29	159	DQ61
13	DQ9	97	DQ41	34	A2	118	A3	55	DQ16	139	DQ48	76	DQ30	160	DQ62
14	DQ10	98	DQ42	35	A4	119	A5	56	DQ17	140	DQ49	77	DQ31	161	DQ63
15	DQ11	99	DQ43	36	A6	120	A7	57	DQ18	141	DQ50	78	V_{SS}	162	V_{SS}
16	DQ12	100	DQ44	37	A8	121	A9	58	DQ19	142	DQ51	79	CK2	163	CK3
17	DQ13	101	DQ45	38	A10/AP	122	BA0	59	V_{DD}	143	V_{DD}	80	NC	164	NC
18	V_{DD}	102	V_{DD}	39	BA1	123	A11	60	DQ20	144	DQ52	81	WP	165	SA0
19	DQ14	103	DQ46	40	V_{DD}	124	V_{DD}	61	NC	145	NC	82	SDA	166	SA1
20	DQ15	104	DQ47	41	V_{DD}	125	CK1	62	NC	146	NC	83	SCL	167	SA2
21	CB0	105	CB4	42	CK0	126	NC	63	*CKE1	147	NC	84	V_{DD}	168	V_{DD}

Note: All pin assignments are consistent for all 8-byte unbuffered versions. Check Bits (CB0 - CB7) are applicable only to the x72 DIMM; for the x64 DIMM these pins are no connects (NC). * CKE1 is terminated with a 10k ohm pullup resistor.



IBM13N16644HCC

IBM13N16734HCC

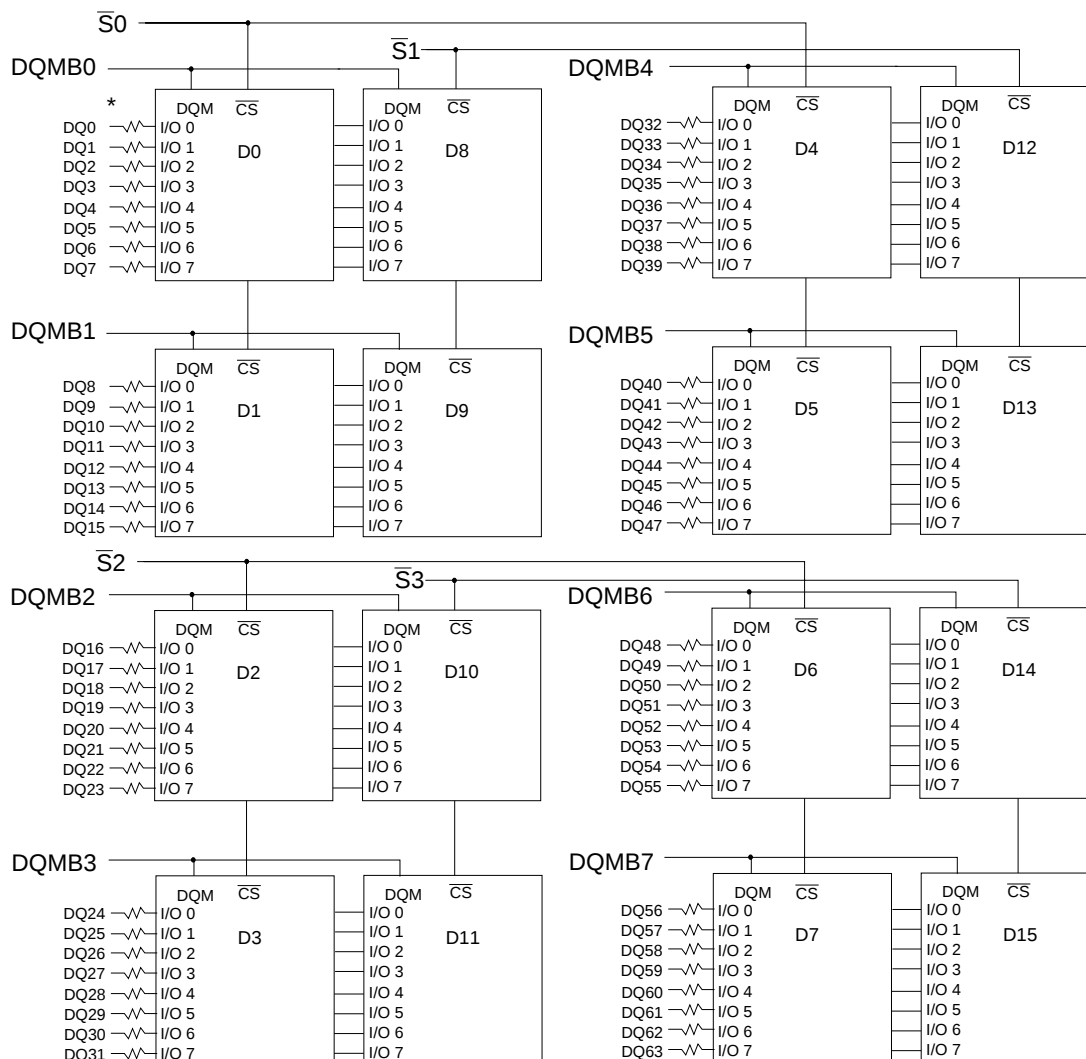
16M x 64/72 Two-Bank Unbuffered SDRAM Module

Ordering Information

Part Number	Organization	Clock Cycle	Leads	Dimension	Power	Notes
IBM13N16644HCC-260T	16Mx64	10ns	Gold	5.25" x 1.375" x 0.158"	3.3V	
IBM13N16644HCC-360T						
IBM13N16644HCC-10T						
IBM13N16734HCC-260T	16Mx72					
IBM13N16734HCC-360T						
IBM13N16734HCC-10T						
IBMB3N16644HCB-260	16M x 64					1
IBMB3N16644HCB-360						
IBMB3N16734HCB-260	16M x 72					
IBMB3N16734HCB-360						

1. Functionally equivalent assembly to IBM13N16644HCB and IBM13N16734HCB, manufactured using SDRAMs from a SDRAM technology licensee. SPD data reflects the IBM13N16644HCB and IBM13N16734HCB part numbers.

16Mx64 SDRAM DIMM Block Diagram (2 Bank, 8Mx8 SDRAMs)



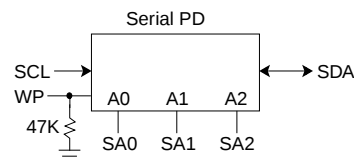
Note: Exact DQ wiring may differ from that shown above.

CK0 → CLK: SDRAMs D0 - D1, D4 - D5, 3.3pF Cap
 CK1 → CLK: SDRAMs D8 - D9, D12 - D13, 3.3pF Cap
 CK2 → CLK: SDRAMs D2 - D3, D6 - D7, 3.3pF Cap
 CK3 → CLK: SDRAMs D10 - D11, D14 - D15, 3.3pF Cap
 A0 - A11 → A0-A11: SDRAMs D0 - D15
 BA0 → A13/BS0: SDRAMs D0 - D15
 BA1 → A12/BS1: SDRAMs D0 - D15

V_{DD} → D0 - D15
 V_{SS} → D0 - D15

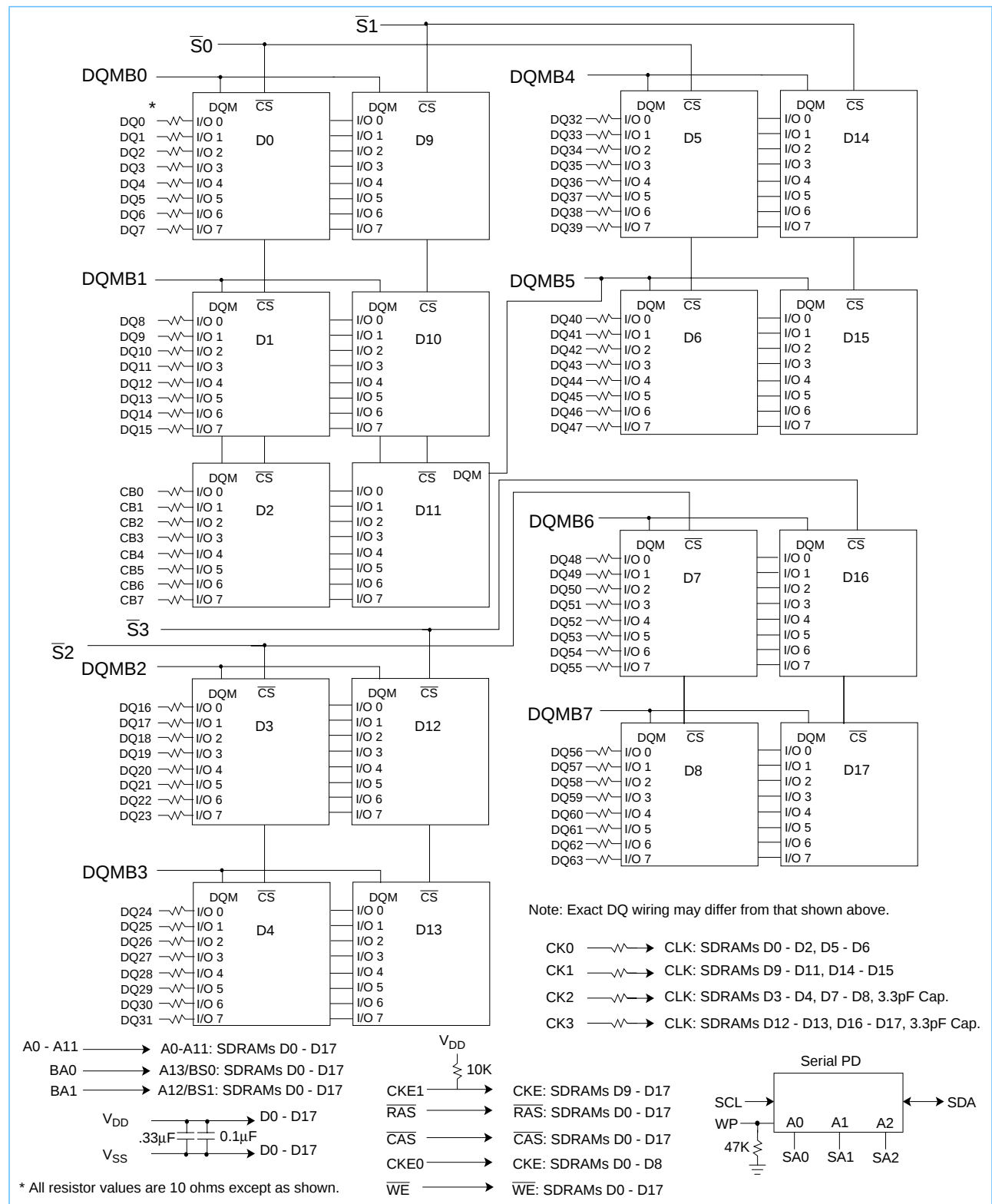
$\overline{RAS}$ → $\overline{RAS}$: SDRAMs D0 - D15
 $\overline{CAS}$ → $\overline{CAS}$: SDRAMs D0 - D15
 $\overline{CKE0}$ → $\overline{CKE}$: SDRAMs D0 - D7
 $\overline{WE}$ → $\overline{WE}$: SDRAMs D0 - D15

V_{DD} → 10K → CKE1 → CKE: SDRAMs D8 - D15



* All resistor values are 10 ohms except as shown.

16Mx72 SDRAM DIMM Block Diagram (2 Bank, 8Mx8 SDRAMs)



Input/Output Functional Description

Symbol	Type	Signal	Polarity	Function
CK0 - CK3	Input	Pulse	Positive Edge	The system clock inputs. All of the SDRAM inputs are sampled on the rising edge of their associated clock.
CKE0, CKE1	Input	Level	Active High	Activates the SDRAM CLK signals when high and deactivates them when low. By deactivating the clocks, CKE0/CKE1 low initiates the Power Down mode, Suspend mode, or the Self Refresh mode.
$\overline{S0} - \overline{S3}$	Input	Pulse	Active Low	Enables the associated SDRAM command decoder when low and disables the command decoder when high. When the command decoder is disabled, new commands are ignored but previous operations continue.
$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	Input	Pulse	Active Low	When sampled at the positive rising edge of the clock, $\overline{CAS}$, $\overline{RAS}$, and $\overline{WE}$ define the operation to be executed by the SDRAM.
BA0, BA1	Input	Level	—	Selects which SDRAM bank is to be active.
A0 - A9 A10/AP A11	Input	Level	—	During a Bank Activate command cycle, A0-A11 defines the row address (RA0-RA11) when sampled at the rising clock edge. During a Read or Write command cycle, A0-A8 defines the column address (CA0-CA8) when sampled at the rising clock edge. In addition to the column address, AP is used to invoke Autoprecharge operation at the end of the Burst Read or Write cycle. If AP is high, autoprecharge is selected and BA0/BA1 define the bank to be precharged. If AP is low, autoprecharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA0/BA1 to control which bank(s) to precharge. If AP is high all 4 banks will be precharged regardless of the state of BA0/BA1. If AP is low, then BA0/BA1 are used to define which bank to precharge.
DQ0 - DQ63, CB0 - CB7	Input Output	Level	—	Data and Check Bit Input/Output pins operate in the same manner as on conventional DRAMs.
DQMB0 - DQMB7	Input	Pulse	Active High	The Data Input/Output mask places the DQ buffers in a high impedance state when sampled high. In Read mode, DQM has a latency of two clock cycles and controls the output buffers like an output enable. In Write mode, DQM has a latency of zero and operates as a byte mask by allowing input data to be written if it is low but blocks the Write operation if DQM is high.
SA0 - SA2	Input	Level	—	Address inputs. Connected to either V_{DD} or V_{SS} on the system board to configure the Serial Presence Detect EEPROM address.
SDA	Input Output	Level	—	Serial Data. Bidirectional signal used to transfer data into and out of the Serial Presence Detect EEPROM. Since the SDA signal is Open Drain/Open Collector at the EEPROM, a pull-up resistor is required on the system board.
SCL	Input	Pulse	—	Serial Clock. Used to clock all Serial Presence Detect data into and out of the EEPROM. Since the SCL signal is inactive in the "high" state, a pull-up resistor is recommended on the system board.
WP	Input	Level	Active High	Hardware Write Protect. When WP is active, writing to the EEPROM array is inhibited. On the DIMM, this input is connected to the EEPROM Write Protect input and is also tied to ground through a 47K ohm pull-down resistor.
V_{DD} , V_{SS}	Supply			Power and ground for the module.

**Serial Presence Detect (Part 1 of 3)**

Byte #	Description		SPD Entry Value	Serial PD Data Entry (Hexadecimal)	Notes
0	Number of Serial PD Bytes Written during Production		128	80	
1	Total Number of Bytes in Serial PD device		256	08	
2	Fundamental Memory Type		SDRAM	04	
3	Number of Row Addresses on Assembly		12	0C	
4	Number of Column Addresses on Assembly		9	09	
5	Number of DIMM Banks		2	02	
6 - 7	Data Width of Assembly	16M x 64	x64	4000	
		16M x 72	x72	4800	
8	Voltage Interface Level of this Assembly		LVTTL	01	
9	SDRAM Device Cycle Time at CL=3		10.0ns	A0	
10	SDRAM Device Access Time from Clock at CL=3	-260, -360	6.0ns	60	1
		-10	7.0ns	70	
11	DIMM Configuration Type	16M x 64	Non-Parity	00	
		16M x 72	ECC	02	
12	Refresh Rate/Type		SR/1x(15.625us)	80	
13	Primary SDRAM Device Width		x8	08	
14	Error Checking SDRAM Device Width	16M x 64	N/A	00	
		16M x 72	x8	08	
15	SDRAM Device Attr: Min Clk Delay, Random Col Access		1 Clock	01	
16	SDRAM Device Attributes: Burst Lengths Supported		1,2,4,8, Full Page	8F	
17	SDRAM Device Attributes: Number of Device Banks		4	04	
18	SDRAM Device Attributes: CAS Latencies Supported		2, 3	06	
19	SDRAM Device Attributes: CS Latency		0	01	
20	SDRAM Device Attributes: WE Latency		0	01	
21	SDRAM Module Attributes		Unbuffered	00	
22	SDRAM Device Attributes: General		Wr-1/Rd Burst, Precharge All, Auto-Precharge, V _{DD} +/- 10%	0E	
23	Minimum Clock Cycle at CL=2	-260	10.0ns	A0	
		-360	15.0ns	F0	
		-10	15.0ns	F0	
24	Maximum Data Access Time (t _{AC}) from Clock at CL=2	-260	6.0ns	60	1
		-360	9.0ns	90	
		-10	8.0ns	80	
25	Minimum Clock Cycle Time at CL=1		N/A	00	
26	Maximum Data Access Time (t _{AC}) from Clock at CL=1		N/A	00	
27	Minimum Row Precharge Time (t _{RP})	-260, -360	20ns	14	
		-10	30ns	1E	
28	Minimum Row Active to Row Active delay (t _{RRD})	-260, -360	20ns	14	
		-10	20ns	14	
29	Minimum $\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ delay (t _{RCD})	-260, -360	20ns	14	
		-10	30ns	1E	
1. See the AC output load circuit in the AC Characteristics section below 2. cc = Checksum Data byte, 00-FF (Hex) 3. "R" = Alphanumeric revision code, A-Z, 0-9 4. rr = ASCII coded revision code byte "R" 5. yy = Binary coded decimal year code, 00-99 (Decimal) → 00-63 (Hex) 6. ww = Binary coded decimal week code, 01-52 (Decimal) → 01-34 (Hex) 7. ss = Serial number data byte, 00-FF (Hex)					

Serial Presence Detect (Part 2 of 3)

Byte #	Description	SPD Entry Value	Serial PD Data Entry (Hexadecimal)	Notes
30	Minimum $\overline{\text{RAS}}$ Pulse width (t_{RAS})	-260, -360	50ns	32
		-10	60ns	3C
31	Module Bank Density	64MB	10	
32	Address and Command Setup Time Before Clock	-260, -360	2.0ns	20
		-10	3.0ns	30
33	Address and Command Hold Time After Clock	-260, -360	1.0ns	10
		-10	1.0ns	10
34	Data Input Setup Time Before Clock	-260, -360	2.0ns	20
		-10	3.0ns	30
35	Data Input Hold Time After Clock	-260, -360	1.0ns	10
		-10	1.0ns	10
36 - 61	Reserved	Undefined	00	
62	SPD Revision	-260, -360	1.2A	12
		-10	2	02
63	Checksum for bytes 0 - 62	Checksum Data	cc	2
64 - 71	Manufacturers' JEDEC ID Code	IBM	A400000000000000	
72	Module Manufacturing Location	Toronto, Canada	91	
		Vimercate, Italy	53	
73 - 90	Module Part Number	16M x 64, -260	ASCII '13N16644HC"R"-260T'	31334E31363634344843rr 2D323630542020
		16M x 64, -360	ASCII '13N16644HC"R"-360T'	31334E31363634344843rr 2D333630542020
		16M x 64, -10	ASCII '13N16644HC"R"-10T'	31334E31363634344843rr 2D313054202020
		16M x 72, -260	ASCII '13N16734HC"R"-260T'	31334E31363733344843rr 2D323630542020
		16M x 72, -360	ASCII '13N16734HC"R"-360T'	31334E31363733344843rr 2D333630542020
		16M x 72, -10	ASCII '13N16734HC"R"-10T'	31334E31363733344843rr 2D313054202020
91 - 92	Module Revision Code	"R" plus ASCII blank	rr20	3, 4
93 - 94	Module Manufacturing Date	Year/Week Code	yyww	5, 6
95 - 98	Module Serial Number	Serial Number	ssssssss	7
99 - 125	Reserved	Undefined	00	
126	Module Supports this Clock Frequency	-260, -360	100 MHz	64
		-10	66 MHz	66

1. See the AC output load circuit in the AC Characteristics section below
2. cc = Checksum Data byte, 00-FF (Hex)
3. "R" = Alphanumeric revision code, A-Z, 0-9
4. rr = ASCII coded revision code byte "R"
5. yy = Binary coded decimal year code, 00-99 (Decimal) → 00-63 (Hex)
6. ww = Binary coded decimal week code, 01-52 (Decimal) → 01-34 (Hex)
7. ss = Serial number data byte, 00-FF (Hex)

**Serial Presence Detect (Part 3 of 3)**

Byte #	Description		SPD Entry Value	Serial PD Data Entry (Hexadecimal)	Notes
127	Attributes for Clock Frequency defined in byte 126	-260	CK0, CK1, CK2, CK3, CL3, CL2, concurrent AP	F7	
		-360	CK0, CK1, CK2, CK3, CL3, concurrent AP	F5	
		-10	CL3, CL2, concurrent AP	07	
128 - 255	Open for Customer Use		Undefined	00	

1. See the AC output load circuit in the AC Characteristics section below
2. cc = Checksum Data byte, 00-FF (Hex)
3. "R" = Alphanumeric revision code, A-Z, 0-9
4. rr = ASCII coded revision code byte "R"
5. yy = Binary coded decimal year code, 00-99 (Decimal) → 00-63 (Hex)
6. ww = Binary coded decimal week code, 01-52 (Decimal) → 01-34 (Hex)
7. ss = Serial number data byte, 00-FF (Hex)

Absolute Maximum Ratings

Symbol	Parameter		Rating	Units	Notes
V_{DD}	Power Supply Voltage		-0.3 to +4.6	V	1
V_{IN}	Input Voltage	SDRAM Devices	-0.3 to $V_{DD}+0.3$		
		Serial PD Device	-0.3 to +6.5		
V_{OUT}	Output Voltage	SDRAM Devices	-0.3 to $V_{DD}+3.3$		
		Serial PD Device	-0.3 to +6.5		
T_A	Operating Temperature (ambient)		0 to +70	°C	1
T_{STG}	Storage Temperature		-55 to +125	°C	1
P_D	Power Dissipation	x64	4.9	W	1
		x72	5.5		
I_{OUT}	Short Circuit Output Current		50	mA	1

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended DC Operating Conditions ($T_A = 0$ to 70°C)

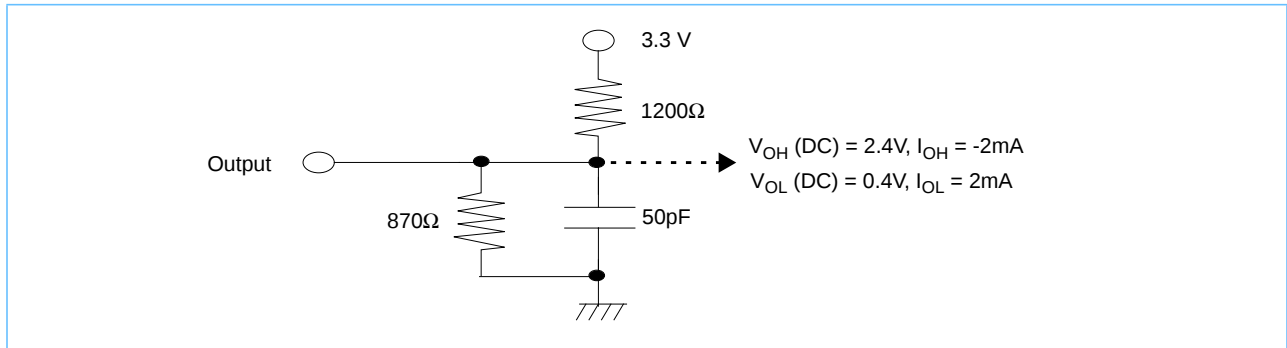
Symbol	Parameter	Rating			Units	Notes
		Min.	Typ.	Max.		
V_{DD}	Supply Voltage	3.0	3.3	3.6	V	1
V_{IH}	Input High Voltage	2.0	—	$V_{DD} + 0.3$	V	1, 2
V_{IL}	Input Low Voltage	-0.3	—	0.8	V	1, 3

1. All voltages referenced to V_{SS} .
 2. $V_{IH}(\text{max}) = V_{DD} + 1.2\text{V}$ for pulse width $\leq 5\text{ns}$.
 3. $V_{IL}(\text{min}) = V_{DD} - 1.2\text{V}$ for pulse width $\leq 5\text{ns}$.

Capacitance ($T_A = 25^\circ\text{C}$, $f = 1\text{MHz}$, $V_{DD} = 3.3\text{V} \pm 0.3\text{V}$)

Symbol	Parameter	Organization		Units
		x64 Max.	x72 Max.	
C_{I1}	Input Capacitance (A0 - A9, A10/AP, A11, BA0, BA1, $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$)	104	112	pF
C_{I2}	Input Capacitance (CKE0 - CKE1)	54	58	pF
C_{I3}	Input Capacitance ($\overline{\text{S0}}$ - $\overline{\text{S3}}$)	30	33	pF
C_{I4}	Input Capacitance (CK0 - CK3)	40	40	pF
C_{I5}	Input Capacitance (DQMB0 - DQMB7)	17	21	pF
C_{I6}	Input Capacitance (SA0 - SA2, SCL, WP)	9	9	pF
C_{IO1}	Input/Output Capacitance (DQ0 - DQ63, CB0 - CB7)	17	17	pF
C_{IO2}	Input/Output Capacitance (SDA)	11	11	pF

DC Output Load Circuit



Output Characteristics $(T_A = 0 \text{ to } +70^\circ\text{C}, V_{DD} = 3.3V \pm 0.3V)$

Symbol	Parameter	x64		x72		Units	Notes
		Min.	Max.	Min.	Max.		
$I_{I(L)}$	Input Leakage Current, any input ($0.0V \leq V_{IN} \leq V_{DD}$), All Other Pins Not Under Test = 0V	$\overline{RAS}, \overline{CAS}, \overline{WE},$ A0-A9, A10/AP, A11, BA0, BA1		-80	+80	-90	+90
		CK0, CK1		-20	+20	-25	+25
		CK2, CK3		-20	+20	-20	+20
		CKE0, CKE1		-40	+40	-45	+45
		$\overline{S0}, \overline{S1}$		-20	+20	-25	+25
		$\overline{S2}, \overline{S3}$		-20	+20	-20	+20
		DQMB1, 5		-10	+10	-15	+15
		DQMB0, 2, 3, 4, 5, 6, 7		-10	+10	-10	+10
		DQ0 - 63		-10	+10	-10	+10
		CB0 - 7		0	0	-10	+10
		SA0, SA1, SA2, SCL, SDA		-10	+10	-10	+10
		WP		-10	+50	-10	+50
$I_{O(L)}$	Output Leakage Current (D_{OUT} is disabled, $0.0V \leq V_{OUT} \leq V_{DD}$)	DQ0 - 63		-10	+10	-10	+10
		CB0 - 7		0	0	-10	+10
		SDA		-10	+10	-10	+10
V_{OH}	Output Level (LVTTTL) Output "H" Level Voltage ($I_{OUT} = -2.0mA$)	2.4	-	2.4	-	V	1
V_{OL}	Output Level (LVTTTL) Output "L" Level Voltage ($I_{OUT} = +2.0mA$)	-	0.4	-	0.4		

1. See DC output load circuit.

Operating, Standby, and Refresh Currents $(T_A = 0 \text{ to } +70^\circ\text{C}, V_{DD} = 3.3\text{V} \pm 0.3\text{V})$

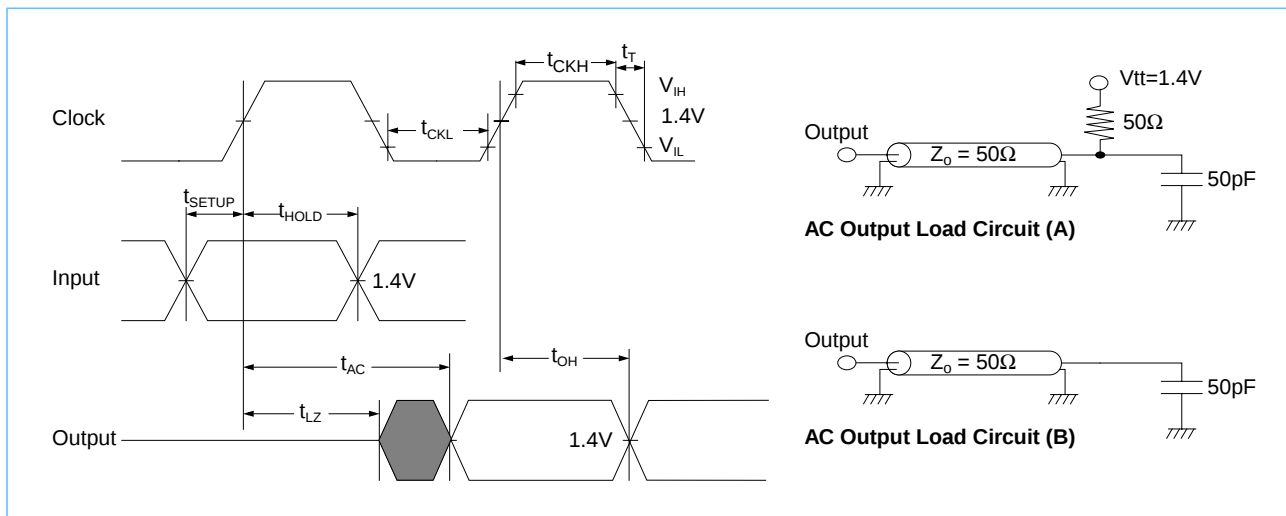
Parameter	Symbol	Test Condition	Speed/Organization				Units	Notes
			-260, -360/x64	-10/x64	-260, -360/x72	-10/x72		
Operating Current $t_{RC} = t_{RC}(\text{min}), t_{CK} = \text{min}$ Active-Precharge command cycling without Burst operation	I_{CC1}	1 bank operation	920	680	1035	765	mA	1, 3, 4
Precharge Standby Current in Power Down Mode	I_{CC2P}	CKE0, CKE1 $\leq V_{IL}(\text{max})$, $t_{CK} = \text{min}$, S0 - S3 = $V_{IH}(\text{min})$	16	16	18	18	mA	2
	I_{CC2PS}	CKE0, CKE1 $\leq V_{IL}(\text{max})$, $t_{CK} = \text{Infinity}$, S0 - S3 = $V_{IH}(\text{min})$	16	16	18	18	mA	2
Precharge Standby Current in Non-Power Down Mode	I_{CC2N}	CKE0, CKE1 $\geq V_{IH}(\text{min})$, $t_{CK} = \text{min}$, S0 - S3 = $V_{IH}(\text{min})$	400	400	450	450	mA	2, 5
	I_{CC2NS}	CKE0, CKE1 $\geq V_{IH}(\text{min})$, $t_{CK} = \text{Infinity}$, S0 - S3 = $V_{IH}(\text{min})$	96	96	108	108	mA	2, 6
No Operating Current (Active state: 4 bank)	I_{CC3N}	CKE0, CKE1 $\geq V_{IH}(\text{min})$, $t_{CK} = \text{min}$, S0 - S3 = $V_{IH}(\text{min})$	640	480	720	540	mA	2, 5
	I_{CC3P}	CKE0, CKE1 $\leq V_{IL}(\text{max})$, $t_{CK} = \text{min}$, S0 - S3 = $V_{IH}(\text{min})$ (Power Down Mode)	112	112	126	126	mA	2, 7
Burst Operating Current	I_{CC4}	$t_{CK} = \text{min}$, Read/ Write command cycling, multiple banks active, gapless data, BL = 4	960	960	1080	1080	mA	1, 4, 8
Auto (CBR) Refresh Current	I_{CC5}	$t_{CK} = \text{min}$, CBR command cycling	1360	1120	1530	1260	mA	1
Self Refresh Current	I_{CC6}	CKE0, CKE1 $\leq 0.2\text{V}$	16	16	18	18	mA	2
Serial PD Device Standby Current	I_{SB}	$V_{IN} = \text{GND or } V_{DD}$	30	30	30	30	μA	9
Serial PD Device Active Power Supply Current	I_{CCA}	SCL Clock Frequency = 100KHz	1	1	1	1	mA	10

1. The specified values are for one DIMM bank in the specified mode, and the other DIMM bank in Active Standby (I_{CC3N}).
2. The specified values are for both DIMM banks operating in the specified mode.
3. These parameters depend on the cycle rate and are measured with the cycle determined by the minimum value of t_{CK} and t_{RC} .
Input signals are changed up to three times during $t_{RC}(\text{min})$.
4. The specified values are obtained with the output open.
5. Input signals are changed once during three clock cycles.
6. Input signals are stable.
7. Active Standby current will be higher if clock suspend is entered during a Burst Read cycle (add 1mA per DQ).
8. Input signals are changed once during $t_{CK}(\text{min})$.
9. $V_{DD} = 3.3\text{V}$.
10. As follows:
 - Input pulse levels $V_{DD} \times 0.1$ to $V_{DD} \times 0.9$
 - Input rise and fall times 10ns
 - Input and output timing levels $V_{DD} \times 0.5$
 - Output load 1 TTL gate and CL=100pf

AC Characteristics ($T_A = 0$ to $+70^\circ\text{C}$, $V_{DD} = 3.3\text{V} \pm 0.3\text{V}$)

1. An initial pause of $200\mu\text{s}$, with DQMB0-7 and CKE0-CKE1 held high, is required after power-up. A Pre-charge All Banks command must be given followed by a minimum of eight Auto (CBR) Refresh cycles before or after the Mode Register Set operation.
2. The Transition time is measured between V_{IH} and V_{IL} (or between V_{IL} and V_{IH}).
3. In addition to meeting the transition rate specification, the clock and CKE must transit between V_{IH} and V_{IL} (or between V_{IL} and V_{IH}) in a monotonic manner.
4. Load Circuit A: AC timing tests have $V_{IL} = 0.4\text{ V}$ and $V_{IH} = 2.4\text{ V}$ with the timing referenced to the 1.40V crossover point
5. Load Circuit A: AC measurements assume $t_T = 1.0\text{ ns}$.
6. Load Circuit B: AC timing tests have $V_{IL} = 0.8\text{ V}$ and $V_{IH} = 2.0\text{ V}$ with the timing referenced to the 1.40V crossover point
7. Load Circuit B: AC measurements assume $t_T = 1.2\text{ ns}$.

AC Characteristics Diagrams



Clock and Clock Enable Parameters

Symbol	Parameter	-260		-360		-10		Units	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{CK3}	Clock Cycle Time, $\overline{CAS}$ Latency = 3	10	1000	10	1000	10	1000	ns	
t_{CK2}	Clock Cycle Time, $\overline{CAS}$ Latency = 2	10	1000	15	1000	15	1000	ns	1
$t_{AC3(A)}$	Clock Access Time, $\overline{CAS}$ Latency = 3	—	—	—	—	—	7	ns	2
$t_{AC2(A)}$	Clock Access Time, $\overline{CAS}$ Latency = 2	—	—	—	—	—	8	ns	2
$t_{AC3(B)}$	Clock Access Time, $\overline{CAS}$ Latency = 3	—	6	—	6	—	9	ns	3
$t_{AC2(B)}$	Clock Access Time, $\overline{CAS}$ Latency = 2	—	6	—	9	—	9	ns	3
t_{CKH}	Clock High Pulse Width	3	—	3	—	3	—	ns	4
t_{CKL}	Clock Low Pulse Width	3	—	3	—	3	—	ns	4
t_{CES}	Clock Enable Set-up Time	2	—	2	—	3	—	ns	
t_{CEH}	Clock Enable Hold Time	1	—	1	—	1	—	ns	
t_{SB}	Power down mode Entry Time	0	10	0	10	0	10	ns	
t_T	Transition Time (Rise and Fall)	0.5	10	0.5	10	0.5	10	ns	

- For -360 sort, 66Mhz clock: $\overline{CAS}$ Latency = 2.
- Access time is measured at 1.4V. See AC Characteristics: notes: 1, 2, 3, 4, 5 and load circuit A.
- Access time is measured at 1.4V. See AC Characteristics: notes: 1, 2, 3, 6, 7 and load circuit B.
- t_{CKH} is the pulse width of CLK measured from the positive edge to the negative edge referenced to V_{IH} (min). t_{CKL} is the pulse width of CLK measured from the negative edge to the positive edge referenced to V_{IL} (max).

Common Parameters

Symbol	Parameter	-260		-36		-10		Units	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{CS}	Command Setup Time	2	—	2	—	3	—	ns	
t_{CH}	Command Hold Time	1	—	1	—	1	—	ns	
t_{AS}	Address and Bank Select Set-up Time	2	—	2	—	3	—	ns	
t_{AH}	Address and Bank Select Hold Time	1	—	1	—	1	—	ns	
t_{RCD}	$\overline{RAS}$ to $\overline{CAS}$ Delay	20	—	20	—	30	—	ns	1
t_{RC}	Bank Cycle Time	70	—	70	—	90	—	ns	1
t_{RAS}	Active Command Period	50	100000	50	100000	60	100000	ns	1
t_{RP}	Precharge Time	20	—	20	—	30	—	ns	1
t_{RRD}	Bank to Bank Delay Time	20	—	20	—	20	—	ns	1
t_{CCD}	$\overline{CAS}$ to $\overline{CAS}$ Delay Time	1	—	1	—	1	—	CLK	

- These parameters account for the number of clock cycle and depend on the operating frequency of the clock, as follows:
the number of clock cycles = specified value of timing / clock period (count fractions as a whole number).

Mode Register Set Cycle

Symbol	Parameter	-260		-360		-10		Units	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{RSC}	Mode Register Set Cycle Time	2	—	2	—	2	—	clk	1

- These parameters account for the number of clock cycle and depend on the operating frequency of the clock, as follows:
the number of clock cycles = specified value of timing / clock period (count fractions as a whole number).

Read Cycle

Symbol	Parameter	-260		-360		-10		Units	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{OH}	Data Out Hold Time	2.5	—	2.5	—	2.5	—	ns	2
		3	—	3	—	3	—	ns	3
t_{LZ}	Data Out to Low Impedance Time	0	—	0	—	0	—	ns	
t_{HZ3}	Data Out to High Impedance Time	3	6	3	6	3	7	ns	1
t_{HZ2}	Data Out to High Impedance Time	3	6	3	8	3	8	ns	1
t_{DQZ}	DQM Data Out Disable Latency	2	—	2	—	2	—	CLK	1

- Referenced to the time at which the output achieves the open circuit condition, not to output voltage levels.
- AC Output Load Circuit A.
- AC Output Load Circuit B.

Refresh Cycle

Symbol	Parameter	-260		-360		-10		Units	Notes
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{REF}	Refresh Period	—	64	—	64	—	64	ms	1
t_{SREX}	Self Refresh Exit Time	10	—	10	—	10	—	ns	

- 4096 auto refresh cycles.

Write Cycle

Symbol	Parameter	-260		-360		-10		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{DS}	Data In Set-up Time	2	—	2	—	3	—	ns
t_{DH}	Data In Hold Time	1	—	1	—	1	—	ns
t_{DPL}	Data input to Precharge	15	—	15	—	15	—	ns
t_{DAL2}	Data In to Active Delay CAS Latency = 2	5	—	5	—	5	—	CLK
t_{DAL3}	Data In to Active Delay CAS Latency = 3	4	—	4	—	4	—	CLK
t_{DQW}	DQM Write Mask Latency	0	—	0	—	0	—	CLK

Presence Detect Read and Write Cycle

Symbol	Parameter	Min	Max	Unit	Notes
f_{SCL}	SCL Clock Frequency		100	kHz	
T_I	Noise Suppression Time Constant at SCL, SDA Inputs		100	ns	
t_{AA}	SCL Low to SDA Data Out Valid	0.3	3.5	μ s	
t_{BUF}	Time the Bus Must Be Free before a New Transmission Can Start	4.7		μ s	
$t_{HD:STA}$	Start Condition Hold Time	4.0		μ s	
t_{LOW}	Clock Low Period	4.7		μ s	
t_{HIGH}	Clock High Period	4.0		μ s	
$t_{SU:STA}$	Start Condition Setup Time (for a Repeated Start Condition)	4.7		μ s	
$t_{HD:DAT}$	Data in Hold Time	0		μ s	
$t_{SU:DAT}$	Data in Setup Time	250		ns	
t_r	SDA and SCL Rise Time		1	μ s	
t_f	SDA and SCL Fall Time		300	ns	
$t_{SU:STO}$	Stop Condition Setup Time	4.7		μ s	
t_{DH}	Data Out Hold Time	300		ns	
t_{WR}	Write Cycle Time		15	ms	1

1. The Write cycle time (t_{WR}) is the time from a valid stop condition of a write sequence to the end of the internal Erase/Program cycle. During the Write cycle, the bus interface circuits are disabled, SDA is allowed to remain high per the bus-level pull-up resistor, and the device does not respond to its slave address.



Functional Description and Timing Diagrams

Refer to the IBM 64Mb Synchronous DRAM Die Revision C data sheet, document 19L3265.E35856, for the functional description and timing diagrams for SDRAM operation.

Refer to the IBM Application Notes *Serial Presence Detect on Memory DIMMs* and *SDRAM Presence Detect Definitions* for the Serial Presence Detect functional description and timings.

All AC timing information refers to the timings at the SDRAM devices.



IBM13N16644HCC

IBM13N16734HCC

16M x 64/72 Two-Bank Unbuffered SDRAM Module

Revision Log

Rev	Contents of Modification
3/99	Initial Release. (Reflects PC100 Rev 1.2 and Die Rev. C Synchronous devices)
5/99	Updated part number information & I _{CC2NS} in Operating, Standby & Refresh Currents Table.
8/99	Removed Preliminary
12/99	Updated ordering information



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Printed in the United States of America December 1999

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19L7296.E93875B
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