

TENTATIVE TOSHIBA HYBRID DIGITAL INTEGRATED CIRCUIT  
 8,388,608-WORD BY 64-BIT SYNCHRONOUS DRAM MODULE  
 DESCRIPTION

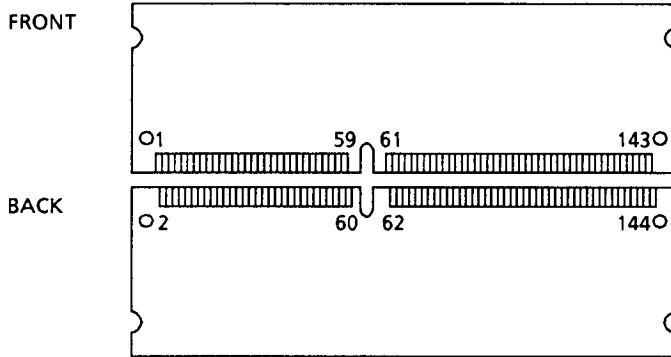
The THLY648031BFG is a 8,388,608-word by 64-bit synchronous dynamic RAM module consisting of eight TC59S6408BFT/BFTL DRAMs on a printed circuit board.

FEATURES

- 8,388,608-word by 64-bit organization
- Single power supply of 3.3 V ± 0.3 V
- Pipeline architecture
- Auto-refresh and Self-refresh capability
- All inputs and outputs LVTTTL-compatible
- 4096 refresh cycles per 64 ms
- Package: 144-pin small-outline DIMM (gold contacts)

	-80	-10
t <sub>CK</sub> Clock Cycle Time (CL = 2)	10 ns	12 ns
t <sub>RAS</sub> Active-to-Precharge Command Period (min)	48 ns	60 ns
t <sub>AC</sub> Access Time from CLK (CL = 2)	6 ns	8 ns
t <sub>RC</sub> Ref/Active-to-Ref/Active Command Period (min)	68 ns	84 ns

PIN ASSIGNMENT



PIN NAMES

A0 to A11	Address Inputs
BA0, 1	Bank Select
DQ0 to DQ63	Data Inputs/Outputs
/CS0	Chip Select
/RAS	Row Address Strobe
/CAS	Column Address Strobe
/WE	Write Enable
DQMB0 to 7	Output Disable / Write Mask
CLK0, 1	Clock Input
CKE0	Clock Enable
SDA	Serial Data/Address for PD
SCL	Clock for PD
VDD	Power (+3.3 V)
VSS	Ground
NC	No Connection

1 VSS	2 VSS	49 DQ13	50 DQ45	97 DQ22	98 DQ54
3 DQ0	4 DQ32	51 DQ14	52 DQ46	99 DQ23	100 DQ55
5 DQ1	6 DQ33	53 DQ15	54 DQ47	101 VDD	102 VDD
7 DQ2	8 DQ34	55 VSS	56 VSS	103 A6	104 A7
9 DQ3	10 DQ35	57 NC	58 NC	105 A8	106 BA0
11 VDD	12 VDD	59 NC	60 NC	107 VSS	108 VSS
13 DQ4	14 DQ36	61 CLK0	62 CE0	109 A9	110 BA1
15 DQ5	16 DQ37	63 VDD	64 VDD	111 A10	112 A11
17 DQ6	18 DQ38	65 /RAS	66 /CAS	113 VDD	114 VDD
19 DQ7	20 DQ39	67 /WE	68 NC	115 DQMB2	116 DQMB6
21 VSS	22 VSS	69 /CS0	70 NC	117 DQMB3	118 DQMB7
23 DQMB0	24 DQMB4	71 NC	72 NC	119 VSS	120 VSS
25 DQMB1	26 DQMB5	73 NC	74 CLK1	121 DQ24	122 DQ56
27 VDD	28 VDD	75 VSS	76 VSS	123 DQ25	124 DQ57
29 A0	30 A3	77 NC	78 NC	125 DQ26	126 DQ58
31 A1	32 A4	79 NC	80 NC	127 DQ27	128 DQ59
33 A2	34 A5	81 VDD	82 VDD	129 VDD	130 VDD
35 VSS	36 VSS	83 DQ16	84 DQ48	131 DQ28	132 DQ60
37 DQ8	38 DQ40	85 DQ17	86 DQ49	133 DQ29	134 DQ61
39 DQ9	40 DQ41	87 DQ18	88 DQ50	135 DQ30	136 DQ62
41 DQ10	42 DQ42	89 DQ19	90 DQ51	137 DQ31	138 DQ63
43 DQ11	44 DQ43	91 VSS	92 VSS	139 VSS	140 VSS
45 VDD	46 VDD	93 DQ20	94 DQ52	141 SDA	142 SCL
47 DQ12	48 DQ44	95 DQ21	96 DQ53	143 VDD	144 VDD

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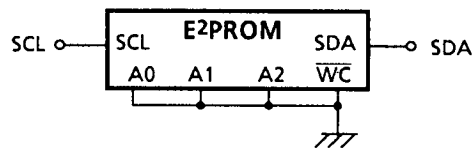
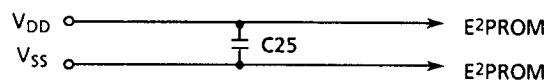
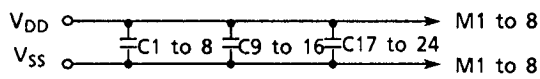
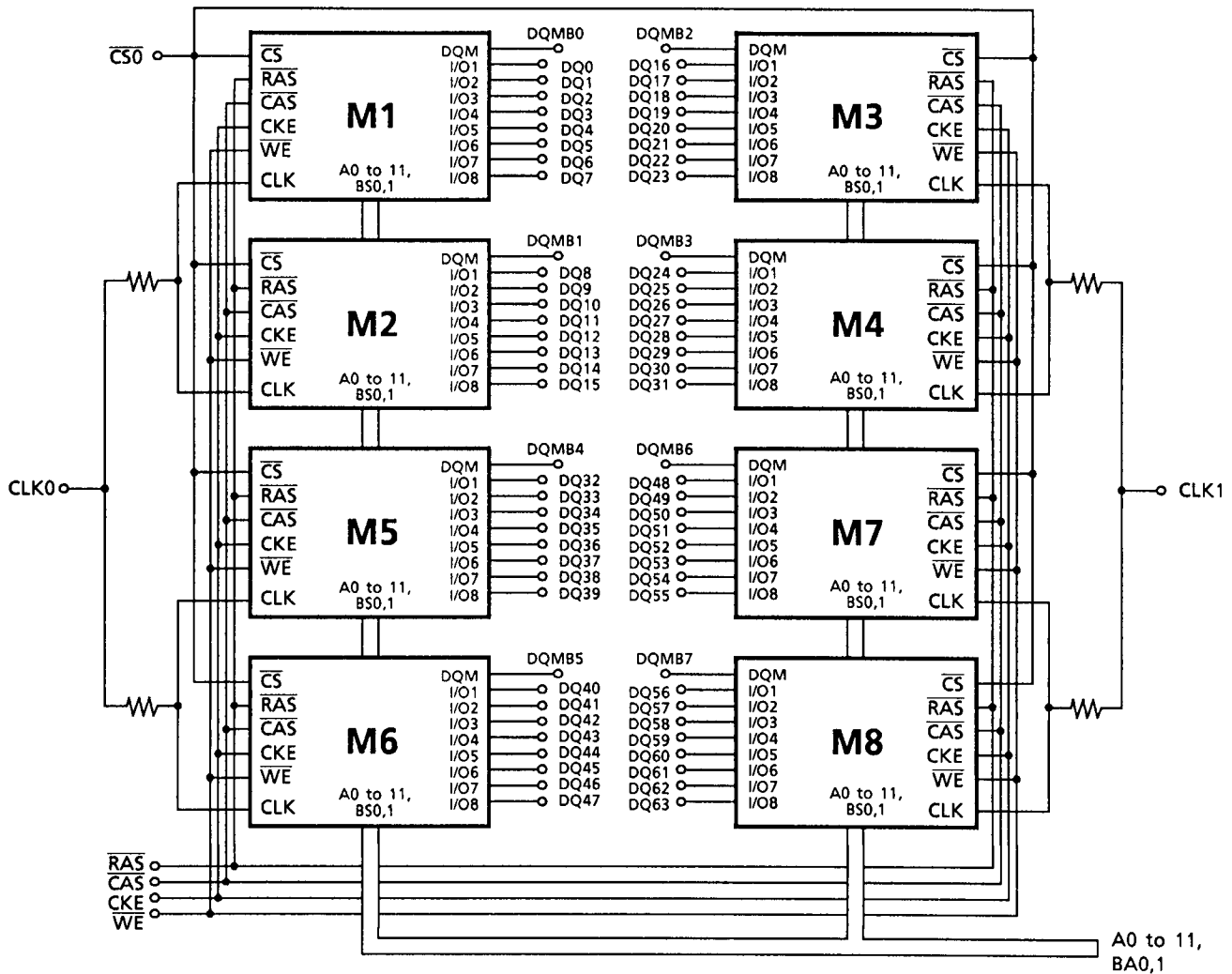
Serial Presence Detect (Rev.1.2A)

Byte Number	Function Described	-80		-10	
		Entry Value	Entry	Entry Value	Entry
0	Defines # bytes Written into Serial Memory at Module mfg	128bytes	80h	128bytes	80h
1	Total # bytes of SPD Memory Device	256bytes	08h	256bytes	08h
2	Fundamental Memory Type (FPM, EDO, SDRAM...) from Appendix A	SDRAM	04h	SDRAM	04h
3	# Row Addresses on this Assembly	RA0-RA11	0Ch	RA0-RA11	0Ch
4	# Column Addresses on this Assembly	CA0-CA8	09h	CA0-CA8	09h
5	# Module Banks on this Assembly	1Bank	01h	1Bank	01h
6	Data Width of this Assembly...	x64	40h	x64	40h
7	...Data Width Continuation	x64	00h	x64	00h
8	Voltage Interface Standard of this Assembly	LVTTTL	01h	LVTTTL	01h
9	SDRAM Cycle Time at Max. Supported CAS Latency (CL), CL = X	CL = 3, 8.0 ns	80h	CL = 3, 10 ns	A0h
10	SDRAM Access from Clock @ CL = X	CL = 3, 6.0 ns	60h	CL = 3, 7.0 ns	70h
11	DIMM Configuration Type (Non-parity, Parity, ECC)	Non-Parity	00h	Non-Parity	00h
12	Refresh Rate/Type	15.625 $\mu$ s/self	80h	15.625 $\mu$ s/self	80h
13	SDRAM Width, Primary DRAM	x8	08h	x8	08h
14	Error Checking SDRAM Data Width	N/A	00h	N/A	00h
15	Minimum Clock Delay, Back to Back Random Column Addresses	1CLK	01h	1CLK	01h
16	Burst Lengths Supported	1,2,4,8 Full page	8Fh	1,2,4,8 Full page	8Fh
17	# Banks on each SDRAM Device	4Bank	04h	4Bank	04h
18	CAS # Latencies Supported	2,3	06h	2,3	06h
19	CS # Latency		01h		01h
20	WE # Latency		01h		01h
21	SDRAM Module Attributes		00h		00h
22	SDRAM Device Attributes: General		0Eh		0Eh
23	Minimum Clock Cycle Time at CL- X-1	CL = 2, 10 ns	A0h	CL = 2, 12 ns	C0h
24	Maximum Data Access Time from Clock @ CL X-1	CL = 2, 6.0 ns	60h	CL = 2, 8.0 ns	80h
25	Minimum Clock Cycle Time at CL X-2		00h		00h
26	Maximum Data Access Time from Clock @ CL X-2		00h		00h
27	Minimum Row Precharge Time	20 ns	14h	24 ns	18h
28	Minimum Row Active to Row Active Delay	20 ns	14h	20 ns	14h
29	Minimum RAS to CAS Delay	20 ns	14h	24 ns	18h
30	Minimum RAS Pulse Width	48 ns	30h	60 ns	3Ch
31	Module/Bank Density	64MB	10h	64MB	10h
32	Command & Address signal Input Set-up Time	2 ns	20h	2.5 ns	25h
33	Command & Address signal Input Hold Time	1 ns	10h	1 ns	10h
34	Data signal Input Set-up Time	2 ns	20h	2.5 ns	25h
35	Data signal Input Hold Time	1 ns	10h	1 ns	10h
36-61	Superset Information (may be used in future)		FFh		FFh
62	SPD Revision	Rev.1.2A	12h	Rev.1.2A	12h
63	Checksum for bytes 0-62	1EC9h	C9h	1F57h	57h

Option

64	Manufacturers JEDEC ID Code per JEP-106E				
65-71					
72	Manufacturing Location				
73-90	Manufacturer's Part Number				
91-92	Revision Code				
93-94	Manufacturing Date				
95-98	Assembly Serial Number				
99-125	Manufacturer Specific Data				
126	Reserved	Intel Specification	66h	Intel Specification	66h
127	Reserved	Intel Specification	A7h	Intel Specification	A7h
128-255					

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

SYMBOL	ITEM	RATING	UNIT	NOTES
V <sub>IN</sub>	Input Voltage	-0.3 to V <sub>CC</sub> + 0.3	V	1
V <sub>OUT</sub>	Output Voltage	-0.3 to V <sub>CC</sub> + 0.3	V	1
V <sub>DD</sub>	Power Supply Voltage	-0.3 to 4.6	V	1
T <sub>OPR</sub>	Operating Temperature	0 to 70	°C	1
T <sub>STG</sub>	Storage Temperature	-55 to 125	°C	1
P <sub>D</sub>	Power Dissipation	2.4	W	1
I <sub>OUT</sub>	Short Circuit Output Current	50	mA	1

RECOMMENDED DC OPERATING CONDITIONS (Ta = 0° to 70°C)

SYMBOL	PARAMETER	MIN	TYP.	MAX	UNIT	NOTES
V <sub>DD</sub>	Supply Voltage	3.0	3.3	3.6	V	2
V <sub>IH</sub>	LVTTTL Input High Voltage	2.0	-	V <sub>DD</sub> + 0.3	V	2
V <sub>IL</sub>	LVTTTL Input Low Voltage	-0.3	-	0.8	V	2

CAPACITANCE (V<sub>CC</sub> = 3.3 V, f = 1 MHz, Ta = 0° to 70°C)

SYMBOL	PARAMETER	MIN	MAX	UNIT
C <sub>1</sub>	Input Capacitance (A0 to A11)	-	T.B.D.	pF
C <sub>2</sub>	Input Capacitance ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ )	-	T.B.D.	pF
C <sub>3</sub>	Input Capacitance (CLK0,1)	-	T.B.D.	pF
C <sub>4</sub>	Input Capacitance ( $\overline{\text{CS0}}$ )	-	T.B.D.	pF
C <sub>5</sub>	Input Capacitance (DQMB0 to 7)	-	T.B.D.	pF
C <sub>DQ</sub>	I/O Capacitance (DQ0 to DQ63)	-	T.B.D.	pF

**DC CHARACTERISTICS** ( $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ ,  $T_a = 0^\circ$  to  $70^\circ\text{C}$ )

SYMBOL	ITEM		-80		-10		UNIT	NOTES	
			MIN	MAX	MIN	MAX			
$I_{CC1}$	OPERATING CURRENT Active-Precharge Command Cycling without Burst Operation ( $t_{CK} = t_{RC}$ min)	1-Bank Operation	-	720	-	560	mA	3	
$I_{CC1B}$									
$I_{CC2}$	STANDBY CURRENT ( $t_{CK} = \text{min}$ , $\overline{CS} = V_{IH}$ , $V_{IH/L} = V_{IH}(\text{min}) / V_{IL}(\text{max})$ Bank: Inactive State)	CKE = $V_{IH}$	-	400	-	320	mA	3	
$I_{CC2P}$		CKE = $V_{IL}$ (Power-down Mode)	-	8	-	8			
$I_{CC2S}$	STANDBY CURRENT ( $CLK = V_{IL}$ , $\overline{CS} = V_{IH}$ , $V_{IH/L} = V_{IH}(\text{min}) / V_{IL}(\text{max})$ Bank: Inactive State)	CKE = $V_{IH}$	-	64	-	64	mA		
$I_{CC2PS}$		CKE = $V_{IL}$ (Power-down Mode)	-	8	-	8			
$I_{CC3}$	NO OPERATING CURRENT ( $t_{CK} = \text{min}$ , $\overline{CS} = V_{IH}(\text{min})$ Bank: Active State (2 Banks))	CKE = $V_{IH}$	-	520	-	400	mA	3	
$I_{CC3P}$		CKE = $V_{IL}$ (Power-down Mode)	-	64	-	64			
$I_{CC4}$	BURST OPERATING CURRENT ( $t_{CK} = \text{min}$ , $\overline{CS} = V_{IH}(\text{min})$ Read/Write Command Cycling)		-	1120	-	880	mA	3, 4	
$I_{CC5}$	AUTO-REFRESH CURRENT ( $t_{CK} = \text{min}$ , Auto-Refresh Command Cycling)		-	1120	-	880	mA	3	
$I_{CC6}$	SELF-REFRESH CURRENT (Self-Refresh Mode, CKE = 0.2 V)		THLY648031BFG-80,-10	-	8	-	8	mA	3
			THLY648031BFG-80L,-10L	-	3.6	-	3.6		
$I_{I(L)}$	INPUT LEAKAGE CURRENT ( $0\text{ V} \leq V_{IN} \leq V_{DD}$ , All Other Pins Not under Test = 0 V)		-5	5	-5	5	$\mu\text{A}$		
$I_{O(L)}$	OUTPUT LEAKAGE CURRENT ( $D_{OUT}$ Is Disabled, $0\text{ V} \leq V_{OUT} \leq V_{DD}$ )		-5	5	-5	5	$\mu\text{A}$		
$V_{OH}$	OUTPUT LEVEL LVTTTL Output H Level Voltage ( $I_{OUT} = -2\text{ mA}$ )		2.4	-	2.4	-	V		
$V_{OL}$	OUTPUT LEVEL LVTTTL Output L Level Voltage ( $I_{OUT} = 2\text{ mA}$ )		-	0.4	-	0.4	V		

**AC CHARACTERISTICS AND RECOMMENDED OPERATING CONDITIONS**

(V<sub>CC</sub> = 3.3 V ± 0.3 V, Ta = 0° to 70°C)

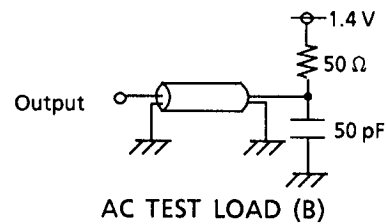
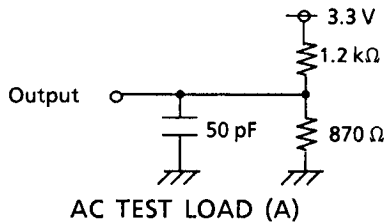
SYMBOL	PARAMETER	-80		-10		UNIT	NOTES			
		MIN	MAX	MIN	MAX					
t <sub>RC</sub>	Ref/Active-Ref/Active Command Period	68		84		ns	9			
t <sub>RAS</sub>	Active- Precharge Command Period	48	100000	60	100000					
t <sub>RCD</sub>	Active-Read/Write Command Delay Time	20		24						
t <sub>CCD</sub>	Read/Write(a) -Read/Write(b) Command Period	1		1		cycle				
t <sub>RP</sub>	Precharge-Active Command Period	20		24		ns				
t <sub>RRD</sub>	Active(a)-Active(b) Command Period	20		20						
t <sub>WR</sub>	Write Recovery Time	CL* = 2	10	12						
		CL* = 3	8	10						
t <sub>CK</sub>	CLK Cycle Time	CL* = 2	10	1000	1000					
		CL* = 3	8	1000	1000					
t <sub>CH</sub>	CLK High Level Width	3		3				10		
t <sub>CL</sub>	CLK Low Level Width	3		3						
t <sub>AC</sub>	Access Time from CLK	CL* = 2		6	8					
		CL* = 3		6	7					
t <sub>OH</sub>	Output Data Hold Time	3		3				ns		
t <sub>HZ</sub>	Output Data High Impedance Time	3	8	3	10					8
t <sub>LZ</sub>	Output Data Low Impedance Time	0		0						
t <sub>SB</sub>	Power-down Mode Entry Time	0	8	0	10					
t <sub>T</sub>	Transition Time of CLK (Rise and Fall)	0.5	10	0.5	10					
t <sub>DS</sub>	Data-in Set-up Time	2		2.5						
t <sub>DH</sub>	Data-in Hold Time	1		1						
t <sub>AS</sub>	Address Set-up Time	2		2.5						
t <sub>AH</sub>	Address Hold Time	1		1						
t <sub>CKS</sub>	CKE Set-up Time	2		2.5						
t <sub>CKH</sub>	CKE Hold Time	1		1						
t <sub>CMS</sub>	Command Set-up Time	2		2.5						
t <sub>CMH</sub>	Command Hold Time	1		1						
t <sub>REF</sub>	Refresh Time		64		64	ms				
t <sub>RSC</sub>	Mode Register Set Cycle Time	16		20		ns	9			

\* CL is  $\overline{\text{CAS}}$  latency.

NOTES:

1. Conditions outside the limits listed under Absolute Maximum Ratings may cause permanent damage to the device.
2. All voltages are referenced to Vss.
3. These parameters depend on the cycle rate and their values are measured at the minimum cycle rate values  $t_{CK}$  and  $t_{RC}$ . Input signals are changed once during  $t_{CK}$ .
4. These parameters depend on the output loading. The specified values are obtained with the output open.
5. The power-up sequence is described in Note 11.
6. AC TEST CONDITIONS

Reference Level of Output Signals	1.4 V/1.4 V
Output Load	See the diagram for AC Test Load (B) below
Input Signal Levels	2.4 V/0.4 V
Transition Time (Rise and Fall) of Input Signals	2 ns
Reference Level of Input Signals	1.4 V



7. Transition times are measured between the  $V_{IH}$  and  $V_{IL}$  levels. Transition (rise and fall) of input signals has a fixed slope.
8.  $t_{HZ}$  defines the time at which the outputs go open circuit and are not reference levels.
9. These parameters depend on the number of clock cycles and depend on the operating frequency of the clock as follows:  

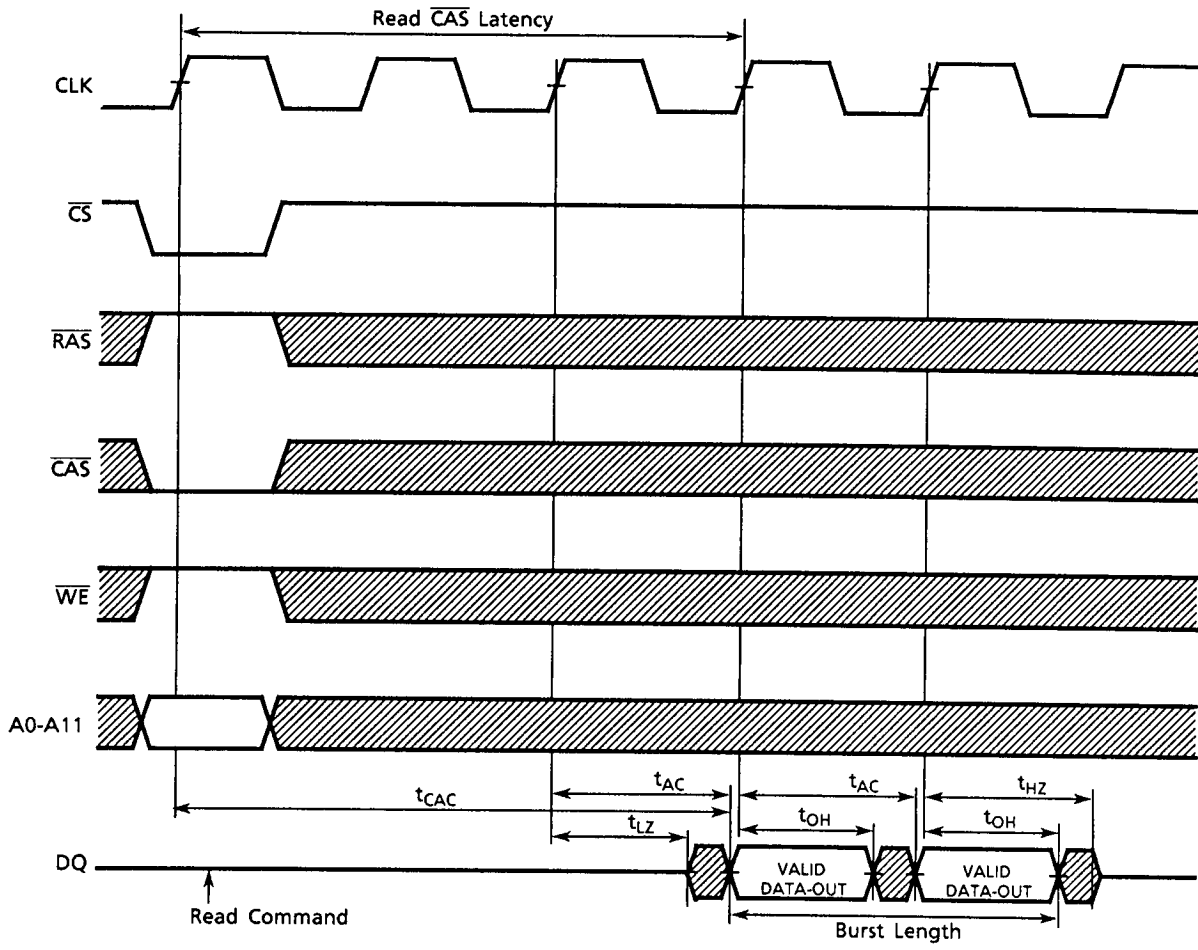
$$\text{Number of clock cycles} = \frac{\text{Specified value of timing}}{\text{Clock period}}$$
 (Round up fractions to a whole number.)

10.  $t_{CH}$  is the pulse width of CLK measured from the positive edge to the negative edge and referenced to  $V_{IH}$  (min).  $t_{CL}$  is the pulse width of CLK measured from the negative edge to the positive edge and referenced to  $V_{IL}$  (max).
11. Power-up Sequence  
Power-up must be performed in the following sequence.
  - 1) Power must be applied to  $V_{CC}$  and  $V_{CCQ}$  (simultaneously) with all input signals held in the NOP state. The CLK signal must be started at the same time as power is applied.
  - 2) After power-up a pause of at least  $200 \mu$  seconds is required. Then, DQM and CKE must be held High (at the  $V_{CC}$  level) to ensure that the DQ output is high-impedance.
  - 3) Both banks must be precharged.
  - 4) The Mode Register Set command must be asserted to initialize the Mode register.
  - 5) An Auto-Refresh operation must consist of at least eight Auto-Refresh cycles.The order in which 4) and 5) are performed is interchangeable.

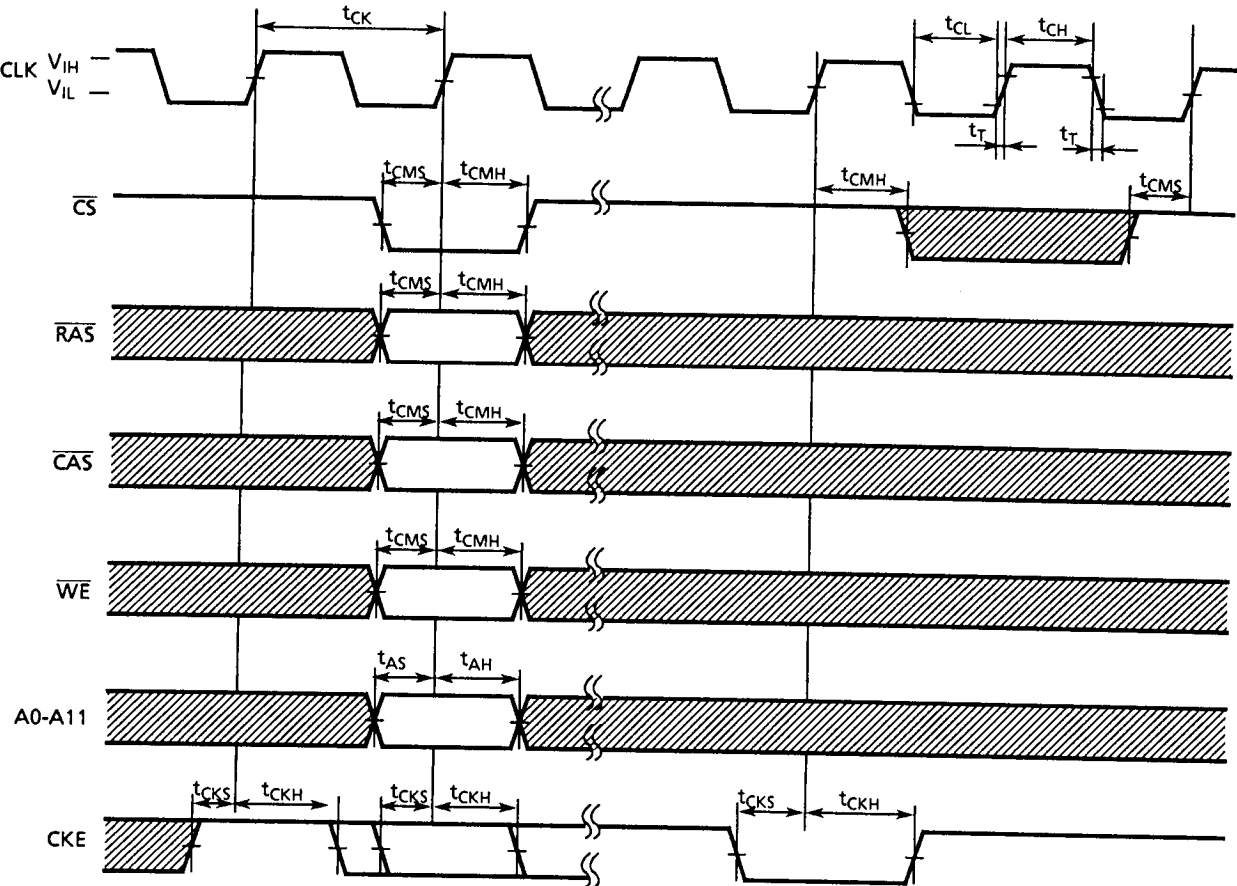


TIMING DIAGRAMS

Read Timing

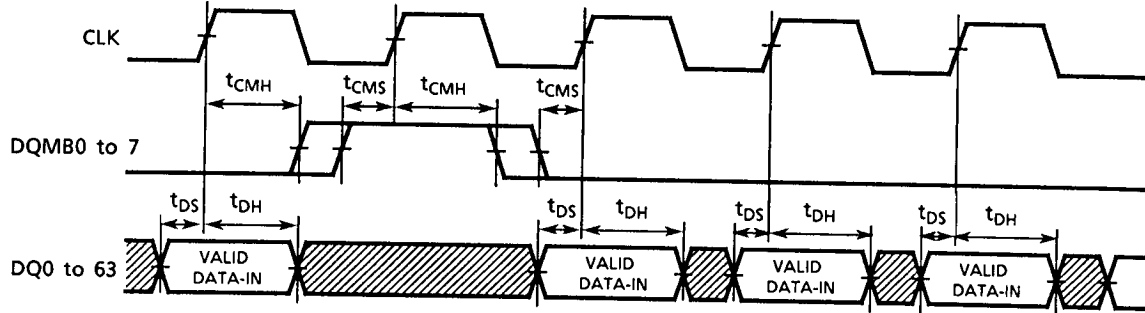


Command Input Timing

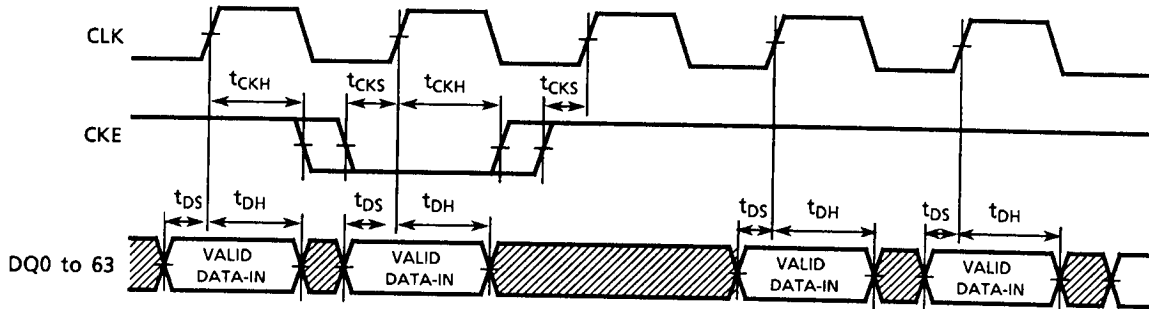


Control Timing for Input Data

(Word Mask)

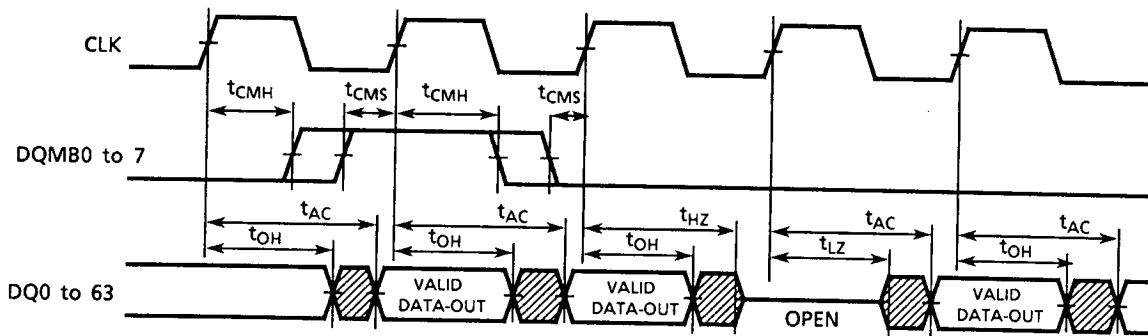


(Clock Mask)

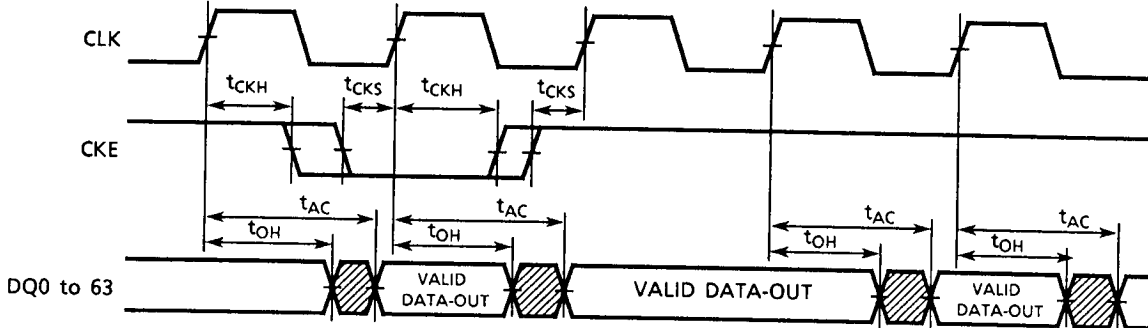


Control Timing for Output Data

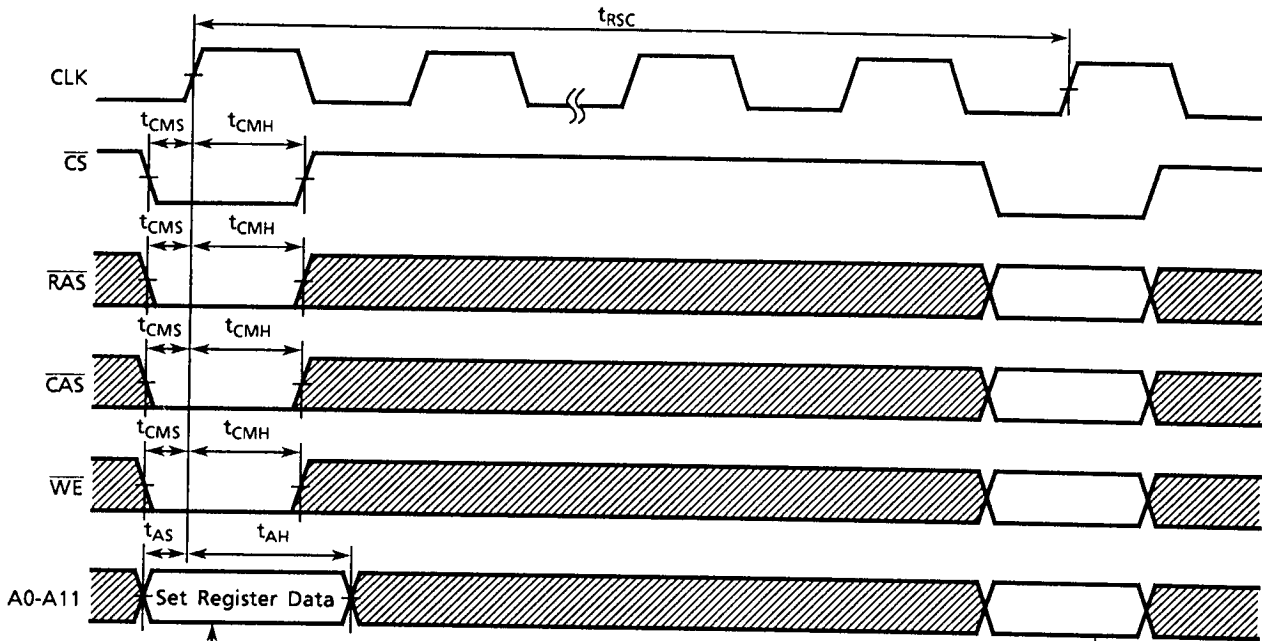
(Output Enable)



(Clock Mask)



Mode Register Set Cycle



A0	Burst Length	
A1		
A2		
A3	Addressing Mode	
A4	$\overline{CAS}$ Latency	
A5		
A6		
A7	0	(Test Mode)
A8	0	Reserved
A9	Write Mode	
A10	0	Reserved
BA0	0	
BA1	0	

			Burst Length	
A2	A1	A0	Sequential	Interleave
0	0	0	1	1
0	0	1	2	2
0	1	0	4	4
0	1	1	8	8
1	0	0	Reserved	Reserved
1	0	1		
1	1	0	Full Page	
1	1	1		

A3	Addressing Mode
0	Sequential
1	Interleave

A6	A5	A4	$\overline{CAS}$ Latency
0	0	0	Reserved
0	0	1	Reserved
0	1	0	2
0	1	1	3
1	0	0	4

A9	Single-Write Mode
0	Burst Read and Burst Write
1	Burst Read and Single Write

Next Command

