

**MCM4464 Series**

**1MB R4000 Secondary Cache  
Fast Static RAM Module Set**

Four MCM4464 modules comprise a full 1 MB of secondary cache for the R4000 processor. Each module contains nine MCM6709J fast static RAMs for a cache data size of 64K x 36. The tag portion, dependent on word line size, contains either two MCM6709J or one MCM6706J fast static RAMs. All input signals, except A0 and  $\overline{WE}$  are buffered using 74FBT2827 drivers with series 25  $\Omega$  resistors.

The MCM6709J and MCM6706J are fabricated using high-performance silicon-gate BiCMOS technology. Static design eliminates the need for internal clocks or timing strobes.

All 1MB R4000 supported secondary cache options are available.

- Single 5 V  $\pm$  10% Power Supply
- All Inputs and Outputs are TTL Compatible
- Three State Outputs
- Fast Module Access Time: 12/15/17 ns
- Zero Wait-State Operation
- Unified or Split Secondary Cache Modules are Available (See Ordering Information for Details)
- Word Line Sizes of 4, 8, 16, and 32 are Available (See Ordering Information for Details)
- The Pin Compatible MCM44256 Series is also Available to Support a Full 4MB R4000 Secondary Cache.
- Decoupling Capacitors are Used for Each Fast Static RAM and Buffer, Along with Bulk Capacitance for Maximum Noise Immunity
- High Quality Multi-Layer FR4 PWB with Separate Power and Ground Planes

PIN NAMES	
A0 – A15	Address Inputs
$\overline{WE}$	Write Enable
$\overline{DCS}$	Data Enable
$\overline{TCS}$	Tag Enable
$\overline{OE}$	Output Enable
DQ0 – DQ35	Data Input / Output
TDQ0 – TDQ7	TAG Data Input / Output
VCC	+ 5 V Power Supply
VSS	Ground

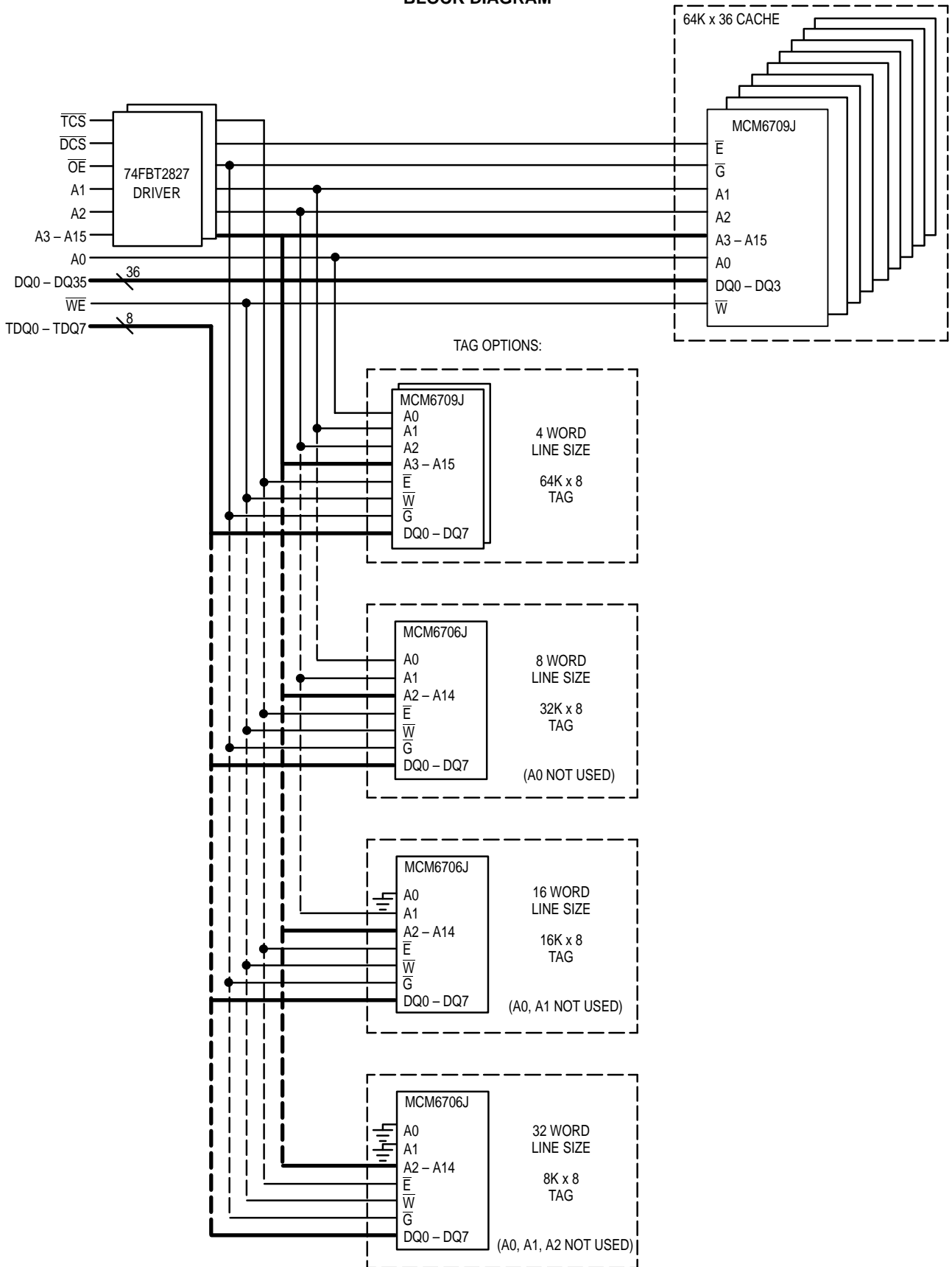
For proper operation of the device, VSS must be connected to ground.

**PIN ASSIGNMENT  
80 LEAD SIMM — TOP VIEW**

VCC	2	1	VSS
DQ1	4	3	DQ0
DQ3	6	5	DQ2
DQ5	8	7	DQ4
VSS	10	9	DQ6
DQ8	12	11	DQ7
DQ10	14	13	DQ9
DQ12	16	15	DQ11
DQ14	18	17	DQ13
DQ15	20	19	VSS
DQ17	22	21	DQ16
DQ19	24	23	DQ18
DQ21	26	25	DQ20
		27	DQ22
VSS	28		VCC
DQ23	30	29	DQ24
DQ25	32	31	DQ26
DQ27	34	33	DQ28
DQ29	36	35	DQ30
DQ30	38	37	VSS
DQ32	40	39	DQ31
DQ34	42	41	DQ33
VSS	44	43	DQ35
A0	46	45	$\overline{WE}$
A2	48	47	A1
A4	50	49	A3
A6	52	51	A5
VCC	54	53	VSS
$\overline{OE}$	56	55	$\overline{DCS}$
A8	58	57	A7
A10	60	59	A9
VSS	62	61	A11
A13	64	63	A12
A15	66*	65	A14
NC	68*	67	NC
TDQ0	70	69	$\overline{TCS}$
TDQ1	72	71	VSS
TDQ3	74	73	TDQ2
TDQ5	76	75	TDQ4
TDQ7	78	77	TDQ6
VSS	80	79	VCC

NOTE: Pin assignment is for unified cache. For split cache option, Pin 68 becomes Address MSB (A15) and Pin 66 is NC.

### BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATINGS** (Voltages Referenced to  $V_{SS} = 0$  V)

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{CC}$	- 0.5 to 7.0	V
Voltage Relative to $V_{SS}$	$V_{in}, V_{out}$	- 0.5 to $V_{CC} + 0.5$	V
Output Current (per I/O)	$I_{out}$	$\pm 30$	mA
Power Dissipation	$P_D$	10	W
Temperature Under Bias	$T_{bias}$	- 10 to + 85	$^{\circ}C$
Operating Temperature	$T_A$	0 to + 70	$^{\circ}C$
Storage Temperature	$T_{stg}$	- 25 to +125	$^{\circ}C$

NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

This devices on this module contain circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to these high-impedance circuits.

These BiCMOS memory circuits have been designed to meet the dc and ac specifications shown in the tables, after thermal equilibrium has been established. The module is in a test socket or mounted on a printed circuit board and transverse air flow of at least 500 linear feet per minute is maintained.

**DC OPERATING CONDITIONS AND CHARACTERISTICS**

( $V_{CC} = 5.0$  V  $\pm 10\%$ ,  $T_A = 0$  to + 70 $^{\circ}C$ , Unless Otherwise Noted)

**RECOMMENDED OPERATING CONDITIONS** (Voltages referenced to  $V_{SS} = 0$  V)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage (Operating Voltage Range)	$V_{CC}$	4.5	5.0	5.5	V
Input High Voltage (DQ0 - 35, TDQ0 - 7, $\overline{WE}$ , A0) (A1 - A15, $\overline{OE}$ , $\overline{DCS}$ , $\overline{TCS}$ )	$V_{IH}$	2.2 2.0	— —	$V_{CC} + 0.3$ V* $V_{CC} + 0.3$ V*	V
Input Low Voltage	$V_{IL}$	- 0.5**	—	0.8	V

\*  $V_{IH}$  (max) =  $V_{CC} + 0.3$  V dc;  $V_{IH}$  (max) =  $V_{CC} + 2$  V ac (pulse width  $\leq 20$  ns)

\*\*  $V_{IL}$  (min) = - 3.0 V ac (pulse width  $\leq 20$  ns)

**DC CHARACTERISTICS**

Parameter	Symbol	Min	Typ	Max	Unit
Input Leakage Current (All Inputs, $V_{in} = 0$ to $V_{CC}$ )	$I_{lkg}(I)$	—	—	$\pm 10$	$\mu A$
Output Leakage Current ( $\overline{G}$ , $\overline{xCS} = V_{IH}$ , $V_{out} = 0$ to $V_{CC}$ )	$I_{lkg}(O)$	—	—	$\pm 10$	$\mu A$
AC Supply Current ( $\overline{G}$ , $\overline{xCS} = V_{IL}$ , $I_{out} = 0$ mA)	$I_{CCA}$	—	—	1850	mA
Output Low Voltage ( $I_{OL} = + 8$ mA)	$V_{OL}$	—	—	0.4	V
Output High Voltage ( $I_{OH} = - 4.0$ mA)	$V_{OH}$	2.4	—	—	V

Note: Good decoupling of the local power supply should always be used.

**CAPACITANCE** (f = 1.0 MHz, dV = 3.0 V,  $T_A = 25^{\circ}C$ , Periodically Sampled Rather Than 100% Tested)

Parameter	Symbol	Typ	Max	Unit
Input Capacitance (A0, $\overline{WE}$ ) (A1 - A15, $\overline{OE}$ , $\overline{DCS}$ , $\overline{TCS}$ )	$C_{in}$ $C_{in}$	— —	110 10	pF pF
Input/Output Capacitance	$C_{out}$	—	10	pF

## AC OPERATING CONDITIONS AND CHARACTERISTICS

( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $T_A = 0\text{ to } +70^\circ\text{C}$ , Unless Otherwise Noted)

Input Timing Measurement Reference Level ..... 1.5 V  
 Input Pulse Levels ..... 0 to 3.0 V  
 Input Rise/Fall Time ..... 3 ns

Output Timing Measurement Reference Level ..... 1.5 V  
 Output Load ..... See Figure 1A

### READ CYCLE (See Notes 1 and 2)

Parameter	Symbol	-12		-15		-17		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Address Access Time	$t_{AVQV}$	—	12	—	15	—	17	ns	
A0 Access Time	$t_{A0QV}$	—	10	—	12	—	14	ns	
Data/Tag Enable Access Time	$t_{ELQV}$	—	12	—	15	—	17	ns	
Output Enable Access Time	$t_{GLQV}$	—	9	—	10	—	11	ns	
Output Hold from Address Change	$t_{AXQX}$	4	—	4	—	4	—	ns	
Output Hold from A0 Change	$t_{A0XQX}$	4	—	4	—	4	—	ns	
Data/Tag Enable Low to Output Active	$t_{ELQX}$	2	—	2	—	2	—	ns	3, 4
Data/Tag Enable High to Output High-Z	$t_{EHQZ}$	1	9	1	10	1	11	ns	3, 4
Output Enable Low to Output Active	$t_{GLQX}$	1	—	1	—	1	—	ns	3, 4
Output Enable High to Output High-Z	$t_{GHQZ}$	1	9	1	10	1	11	ns	3, 4

#### NOTES:

1.  $\overline{WE}$  is high for read cycle.
2. Enable timings are the same for both  $\overline{DCS}$  and  $\overline{TCS}$ .
3. Transition is measured 200 mV from steady-state voltage with load of Figure 1B.
4. This parameter is sampled and not 100% tested.

### AC TEST LOADS

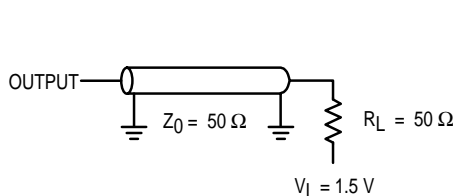


Figure 1A

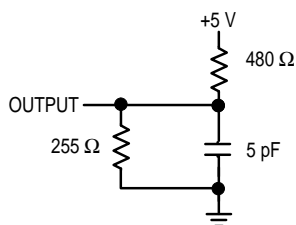
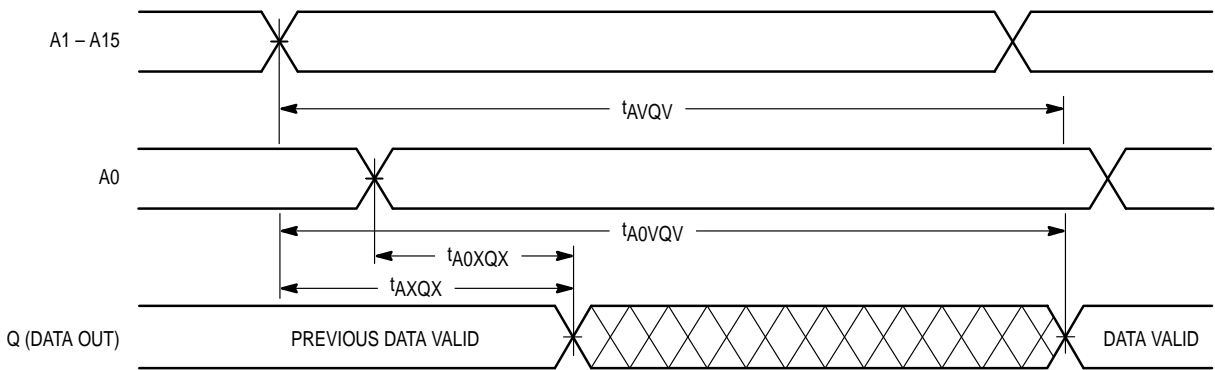


Figure 1B

### TIMING LIMITS

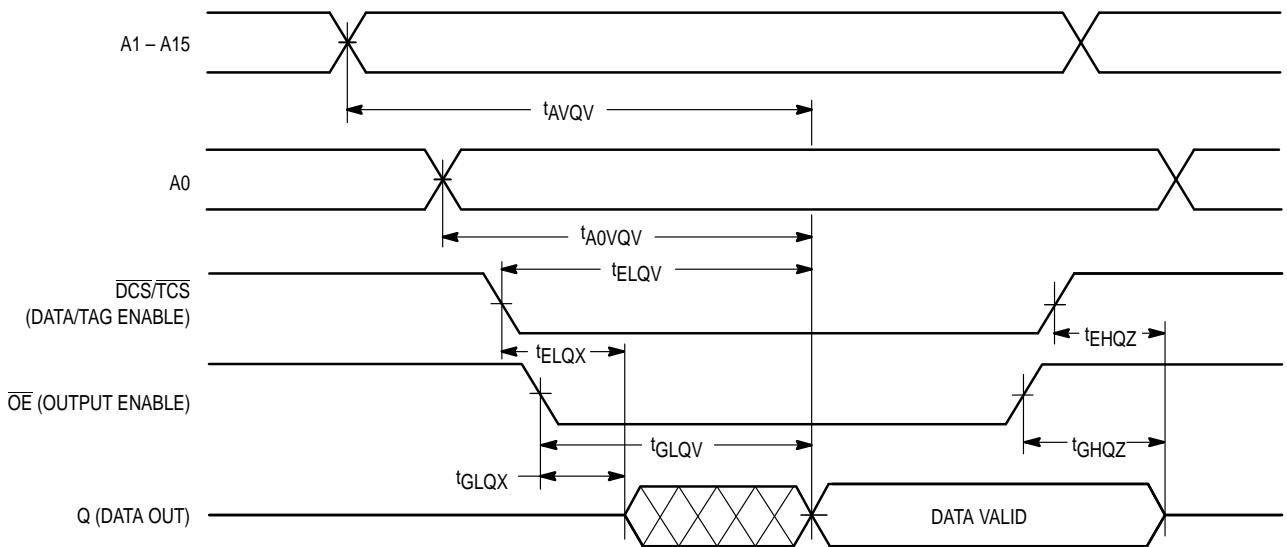
The table of timing values shows either a minimum or a maximum limit for each parameter. Input requirements are specified from the external system point of view. Thus, address setup time is shown as a minimum since the system must supply at least that much time (even though most devices do not require it). On the other hand, responses from the memory are specified from the device point of view. Thus, the access time is shown as a maximum since the device never provides data later than that time.

**READ CYCLE 1 (See Note)**



NOTE: Module is continuously selected ( $\overline{DCS}$  or  $\overline{TCS} = V_{IL}$ ,  $\overline{OE} = V_{IL}$ ).

**READ CYCLE 2 (See Note)**



NOTE: Address valid prior to or coincident with  $\overline{DCS}$  or  $\overline{TCS}$  going low.

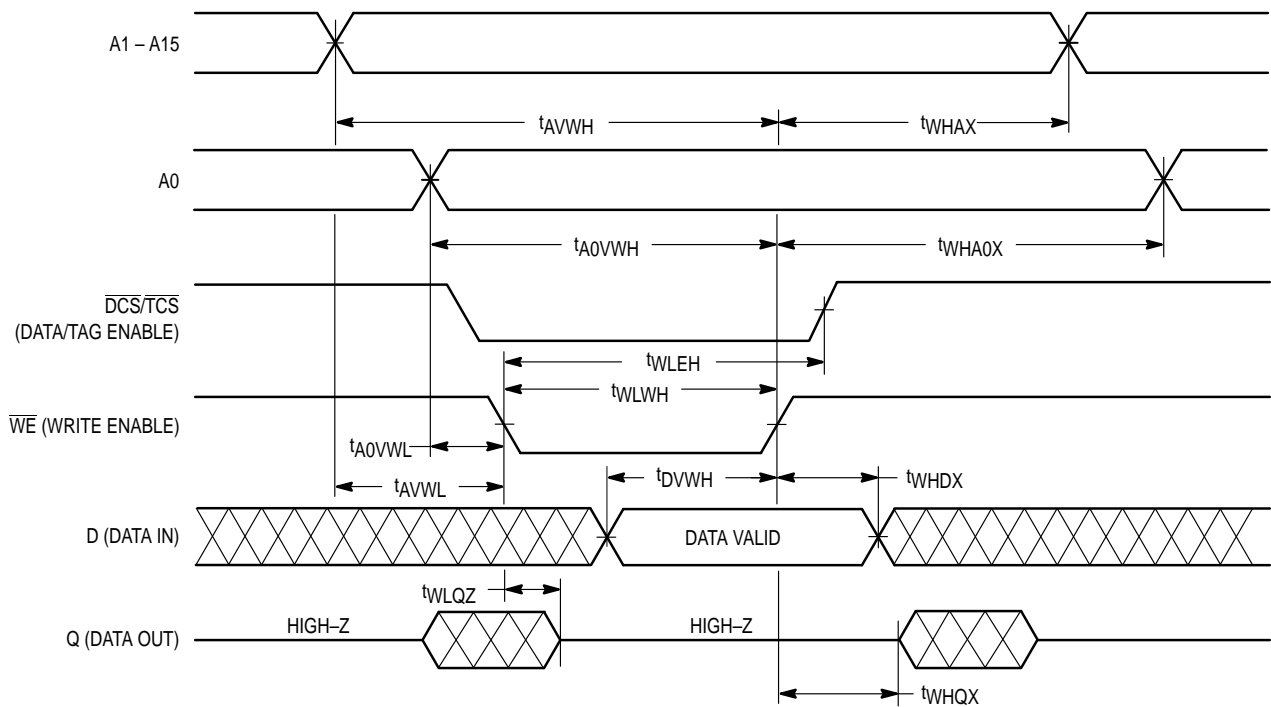
**WRITE CYCLE 1** ( $\overline{WE}$  Controlled, See Notes 1 and 2)

Parameter	Symbol	-12		-15		-17		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Address Setup Time	$t_{AVWL}$	5	—	5	—	5	—	ns	
A0 Setup Time	$t_{A0VWL}$	0	—	0	—	0	—	ns	
Address Valid to End of Write	$t_{AVWH}$	12	—	15	—	17	—	ns	
A0 Valid to End of Write	$t_{A0VWH}$	10	—	12	—	14	—	ns	
Write Pulse Width	$t_{WLWH}$ $t_{WLEH}$	7	—	10	—	12	—	ns	
Data Valid to End of Write	$t_{DVWH}$	6	—	7	—	8	—	ns	
Data Hold Time	$t_{WHDX}$	0	—	0	—	0	—	ns	
Write Low to Data High-Z	$t_{WLQZ}$	0	4	0	5	0	6	ns	3, 4
Write High to Output Active	$t_{WHQX}$	3	—	3	—	3	—	ns	3, 4
Write Recovery Time	$t_{WHAX}$	0	—	0	—	0	—	ns	
Write Recovery Time – A0	$t_{WHA0X}$	0	—	0	—	0	—	ns	

**NOTES:**

1. A write occurs during the overlap of  $\overline{DCS}$  or  $\overline{TCS}$  low and  $\overline{WE}$  low.
2. Enable timings are the same for both  $\overline{DCS}$  and  $\overline{TCS}$ .
3. Transition is measured 200 mV from steady-state voltage with load of Figure 1B.
4. This parameter is sampled and not 100% tested.

**WRITE CYCLE 1**



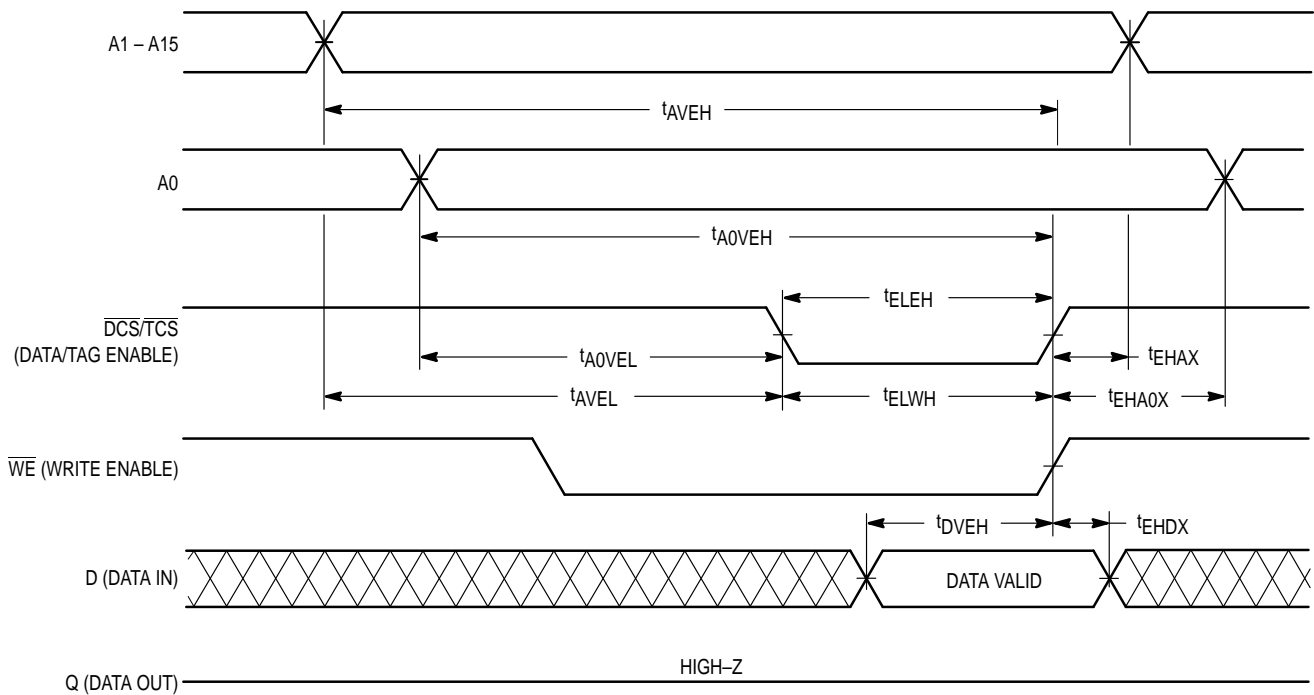
**WRITE CYCLE 2** ( $\overline{DCS}$  or  $\overline{TCS}$  Controlled, See Notes 1 and 2)

Parameter	Symbol	-12		-15		-17		Unit	Notes
		Min	Max	Min	Max	Min	Max		
Address Setup Time	$t_{AVEH}$	0	—	0	—	0	—	ns	
A0 Setup Time	$t_{A0VEH}$	0	—	0	—	0	—	ns	
Address Valid to End of Write	$t_{AVEH}$	12	—	15	—	17	—	ns	
A0 Valid to End of Write	$t_{A0VEH}$	10	—	12	—	14	—	ns	
Data/Tag Enable to End of Write	$t_{ELEH}$ , $t_{ELWH}$	12	—	15	—	17	—	ns	
Data Valid to End of Write	$t_{DVEH}$	6	—	7	—	8	—	ns	
Data Hold Time	$t_{EHDX}$	5	—	5	—	5	—	ns	
Write Recovery Time	$t_{EHAX}$	5	—	5	—	5	—	ns	
Write Recovery Time – A0	$t_{EHA0X}$	5	—	5	—	5	—	ns	

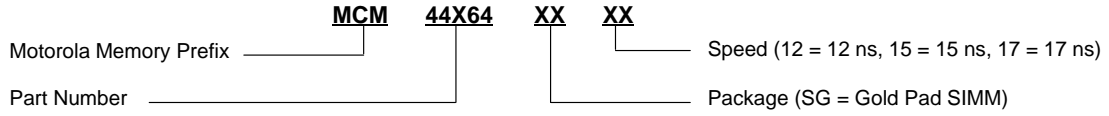
NOTES:

1. A write occurs during the overlap of  $\overline{DCS}$  or  $\overline{TCS}$  low and  $\overline{WE}$  low.
2. Enable timings are the same for both  $\overline{DCS}$  and  $\overline{TCS}$ .


**WRITE CYCLE 2**



**ORDERING INFORMATION**  
(Order by Full Part Number)



Part Number	Unified/Split	Word Line Size	TAG Depth
MCM44A64	Unified	4	64K
MCM44B64	Unified	8	32K
MCM44C64	Unified	16	16K
MCM44D64	Unified	32	8K
MCM44E64	Split	4	64K
MCM44F64	Split	8	32K
MCM44G64	Split	16	16K
MCM44H64	Split	32	8K

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**Literature Distribution Centers:**

USA/EUROPE: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.

JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan.

ASIA PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.



◇ CODELINE TO BE PLACED HERE

MCM4464/D

