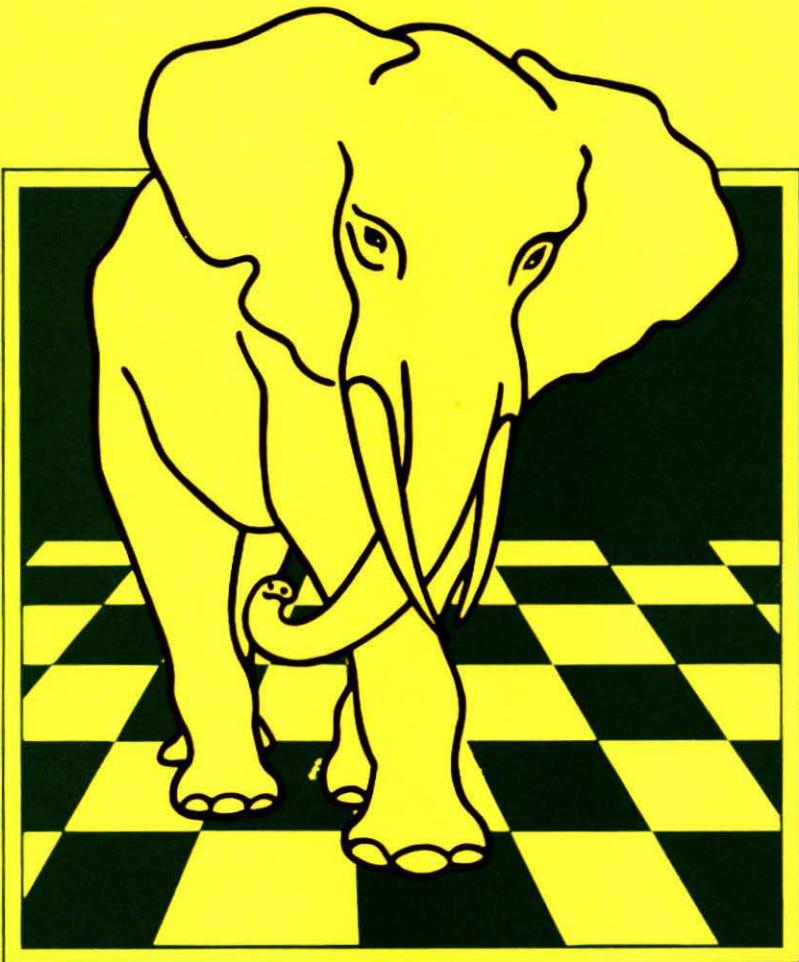


# MEMORY



DATA MANUAL 1981-82

DUALITY · RELIABILITY · TECHNOLOGY

MOTOROLA

# **SELECTOR GUIDES CROSS-REFERENCE**

**1**

**MOS Memories**  
**RAM, EPROM, EEPROM, ROM** **2**

**2**

**CMOS Memories**  
**RAM, ROM** **3**

**3**

**Bipolar Memories**  
**TTL, MECL-RAM, PROM** **4**

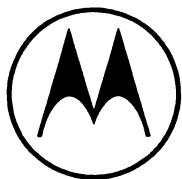
**4**

**Memory Boards** **5**

**5**

**Mechanical Data** **6**

**6**



# MOTOROLA

## MEMORIES

Motorola has developed a very broad range of reliable MOS and bipolar memories for virtually any digital data processing system application. Complete specifications for the individual circuits are provided in the form of data sheets. In addition, selector guides are included to simplify the task of choosing the best combination of circuits for optimum system architecture.

New Motorola memories are being introduced continually. For the latest releases, and additional technical information or pricing, contact your nearest authorized Motorola distributor or Motorola sales office.

The information in this book has been carefully checked; no responsibility, however, is assumed for inaccuracies. Furthermore, this information does not convey to the purchaser of microelectronic devices any license under the patent rights of the manufacturer.

© MOTOROLA INC., 1980  
"All Rights Reserved"

**MECL, EXORciser are trademarks of Motorola Inc.**

## Table of Contents

	Organization	Page
<b>Alphanumeric Index</b>		vii
<b>CHAPTER 1</b>		
<b>Memories Selection Guide</b>		1-2
<b>Memory Systems Board Selector Guide and Cross Reference</b>		1-8
<b>MOS Memory Cross-Reference</b>		1-9
<b>CHAPTER 2</b>		
<b>Dynamic RAMs</b>		
MCM4027A	4K × 1	2-3
MCM4116B	16K × 1	2-13
MCM4517	16K × 1	2-20
MCM6632	32K × 1	2-26
MCM6633	32K × 1	2-34
MCM6664	64K × 1	2-41
MCM6665	64K × 1	2-49
MCM6665L25	64K × 1	2-56
<b>Static RAMs</b>		
MCM2114, 21L14	1K × 4	2-63
MCM2115A, 21L15A, 2125A, 21L25A	1K × 1	2-68
MCM2115H, 2125H	1K × 1	2-74
MCM2147	4K × 1	2-75
MCM2147H	4K × 1	2-80
MCM2148	1K × 4	2-81
MCM2149	1K × 4	2-85
MCM2167	16K × 1	2-86
MCM4016	2K × 8	2-87
MCM6641, 66L41	4K × 1	2-88
MCM6810, 68A10, 68B10	128 × 8	2-92
<b>EPROMs</b>		
MCM2532, 25L32	4K × 8	2-96
MCM2708, 27A08	1K × 8	2-102
MCM2716, 27L16	2K × 8	2-108
TMS2716, TMS27A16	2K × 8	2-114
MCM68708, 68A708	1K × 8	2-120
MCM68732, 68L732	4K × 8	2-126
MCM68764, 68L764	8K × 8	2-131
MCM68766	8K × 8	2-136
<b>EEPROMs</b>		
MCM2801	16 × 16	2-141
MCM2802	32 × 32	2-206
MCM2816	2K × 8	2-147
<b>ROMs</b>		
MCM6670, 6674	128 × (7 × 5)	2-148
MCM66700, 710, 714, 720, 730, 734, 740, 750, 751, 760, 770, 780, 790	128 × (7 × 9)	2-155
MCM68A30A, 68B30A	1K × 8	2-169
MCM68A308, 68B308	1K × 8	2-174
MCM68A316A	2K × 8	2-179
MCM68A316E	2K × 8	2-183
MCM68A332	4K × 8	2-187
MCM68A364, 68B364	8K × 8	2-191
MCM68365	8K × 8	2-196
MCM68366	8K × 8	2-201

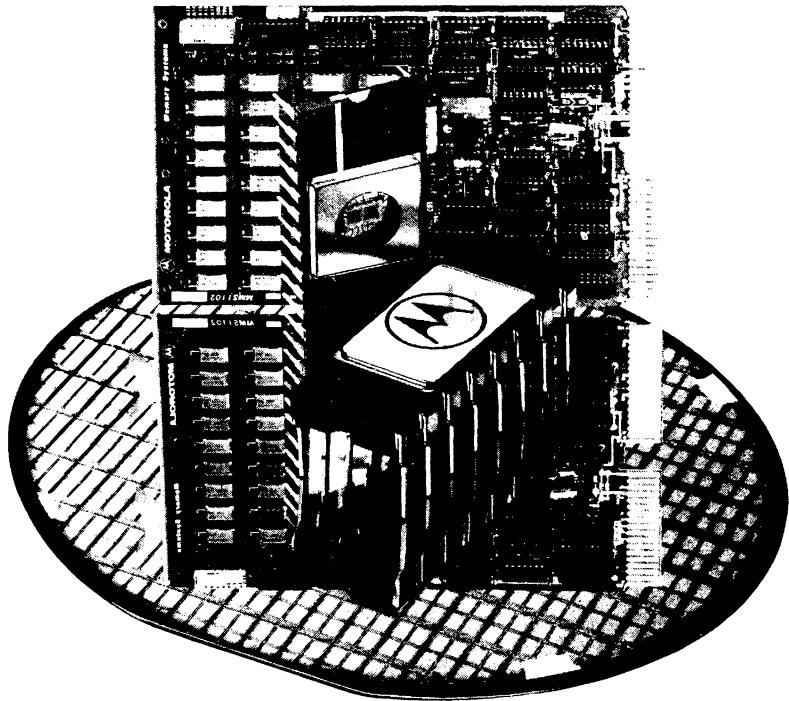
## Table of Contents (Continued)

		<b>Page</b>
	Organization	
<b>CHAPTER 3 – CMOS Memories</b>		
<b>Static RAMs</b>		
MCM14505	64 × 1 . . . . .	3-3
MCM14537	256 × 1 . . . . .	3-12
MCM14552	64 × 4 . . . . .	3-20
MCM5101, 51L01	256 × 4 . . . . .	3-27
MCM6508, 6518	1K × 1 . . . . .	3-31
MCM65116	2K × 8 . . . . .	3-35
MCM65147	4K × 1 . . . . .	3-36
MCM65148	1K × 4 . . . . .	3-37
<b>ROMs</b>		
MCM14524	256 × 4 . . . . .	3-38
MCM65516	2K × 8 . . . . .	3-44
<b>CHAPTER 4 – Bipolar Memories</b>		
<b>TTL RAMs</b>		
MCM93415	1024 × 1 . . . . .	4-3
MCM93425	1024 × 1 . . . . .	4-7
<b>TTL PROMs</b>		
MCM7680, 7681	1024 × 8 . . . . .	4-11
MCM7684, 7685	2K × 4 . . . . .	4-15
<b>MECL Memories</b>		
General Information	.....	4-19
<b>MECL RAMs</b>		
MCM10143	8 × 2 . . . . .	4-22
MCM10144, 10544	256 × 1 . . . . .	4-27
MCM10145, 10545	16 × 4 . . . . .	4-29
MCM10146, 10546	1024 × 1 . . . . .	4-31
MCM10147, 10547	128 × 1 . . . . .	4-33
MCM10148, 10548	64 × 1 . . . . .	4-35
MCM10152, 10552	256 × 1 . . . . .	4-37
<b>MECL PROMs</b>		
MCM10139, 10539	32 × 8 . . . . .	4-39
MCM10149, 10549	256 × 4 . . . . .	4-43
<b>CHAPTER 5 – Memory Subsystems</b>		
<b>Board Level</b>		
MMS1102	LSI-11 Compatible Add-In Memory (32K × 18) . . . . .	5-3
MMS1122	LSI-11, LSI-11/23 Comp. Add-In Memory (32K × 16) . . . . .	5-5
MMS1132	LSI-11, LSI-11/23 Comp. Add-In Memory (128K × 16) . . . . .	5-7
MMS1117	PDP-11 Compatible (HEX SPC) Add-In Memory (64K × 18) . . . . .	5-9
MMS1119	PDP-11 (Modified or Extended Unibus) Comp. Memory (128K × 18) . . . . .	5-11
MMS1128	PDP-11 (Modified Unibus) Memory Comp. (32K, 48K × 18) . . . . .	5-15
MMS1170	PDP-11/70 Compatible Add-In Memory . . . . .	5-20
MMS780	VAX-11/780 Compatible Add-In Memory . . . . .	5-22
MMS8064	Inter Multibus Compatible Memory . . . . .	5-25
<b>CHAPTER 6 – Mechanical Data</b> . . . . .		
		<b>6-1</b>

## Alphanumeric Index

<b>Device</b>	<b>Page</b>	<b>Device</b>	<b>Page</b>
MCM10139 . . . . .	4-39	MCM6641 . . . . .	2-88
MCM10143 . . . . .	4-22	MCM6664 . . . . .	2-41
MCM10144 . . . . .	4-27	MCM6665 . . . . .	2-49
MCM10145 . . . . .	4-29	MCM6665L25 . . . . .	2-56
MCM10146 . . . . .	4-31	MCM6670 . . . . .	2-148
MCM10147 . . . . .	4-33	MCM66700 . . . . .	2-155
MCM10148 . . . . .	4-35	MCM66710 . . . . .	2-155
MCM10149 . . . . .	4-43	MCM66714 . . . . .	2-155
MCM10152 . . . . .	4-37	MCM66720 . . . . .	2-155
MCM10539 . . . . .	4-39	MCM66730 . . . . .	2-155
MCM10544 . . . . .	4-27	MCM66734 . . . . .	2-155
MCM10545 . . . . .	4-29	MCM6674 . . . . .	2-148
MCM10546 . . . . .	4-31	MCM66740 . . . . .	2-155
MCM10547 . . . . .	4-33	MCM66750 . . . . .	2-155
MCM10548 . . . . .	4-35	MCM66751 . . . . .	2-155
MCM10549 . . . . .	4-43	MCM66760 . . . . .	2-155
MCM10552 . . . . .	4-37	MCM66770 . . . . .	2-155
MCM14505 . . . . .	3-3	MCM66780 . . . . .	2-155
MCM14524 . . . . .	3-38	MCM66790 . . . . .	2-155
MCM14537 . . . . .	3-12	MCM68A10 . . . . .	2-92
MCM14552 . . . . .	3-20	MCM68A30A . . . . .	2-169
MCM21L14 . . . . .	2-63	MCM68A308 . . . . .	2-174
MCM21L15A . . . . .	2-68	MCM68A316A . . . . .	2-179
MCM21L25A . . . . .	2-68	MCM68A316E . . . . .	2-183
MCM2114 . . . . .	2-63	MCM68A332 . . . . .	2-187
MCM2115A . . . . .	2-68	MCM68A364 . . . . .	2-191
MCM2115H . . . . .	2-74	MCM68A708 . . . . .	2-120
MCM2125A . . . . .	2-68	MCM68B10 . . . . .	2-92
MCM2125H . . . . .	2-74	MCM68B30A . . . . .	2-169
MCM2147 . . . . .	2-75	MCM68B308 . . . . .	2-174
MCM2147H . . . . .	2-80	MCM68B364 . . . . .	2-191
MCM2148 . . . . .	2-81	MCM68L732 . . . . .	2-126
MCM2149 . . . . .	2-85	MCM68L764 . . . . .	2-131
MCM2167 . . . . .	2-86	MCM6810 . . . . .	2-92
MCM25L32 . . . . .	2-96	MCM68365 . . . . .	2-196
MCM2532 . . . . .	2-96	MCM68366 . . . . .	2-201
MCM27A08 . . . . .	2-102	MCM68708 . . . . .	2-120
MCM27L16 . . . . .	2-108	MCM68732 . . . . .	2-126
MCM2708 . . . . .	2-102	MCM68764 . . . . .	2-131
MCM2716 . . . . .	2-108	MCM68766 . . . . .	2-136
MCM2801 . . . . .	2-141	MCM7680 . . . . .	4-11
MCM2802 . . . . .	2-206	MCM7681 . . . . .	4-11
MCM2816 . . . . .	2-147	MCM7684 . . . . .	4-15
MCM4016 . . . . .	2-87	MCM7685 . . . . .	4-15
MCM2047A . . . . .	2-3	MCM93415 . . . . .	4-3
MCM4116B . . . . .	2-13	MCM93425 . . . . .	4-7
MCM4517 . . . . .	2-20	MMS1102 . . . . .	5-3
MCM51L01 . . . . .	3-27	MMS1117 . . . . .	5-9
MCM5101 . . . . .	3-27	MMS1119 . . . . .	5-11
MCM6508 . . . . .	3-31	MMS1122 . . . . .	5-5
MCM65116 . . . . .	3-35	MMS1128 . . . . .	5-15
MCM65147 . . . . .	3-36	MMS1132 . . . . .	5-7
MCM65148 . . . . .	3-37	MMS1170 . . . . .	5-20
MCM6518 . . . . .	3-31	MMS780 . . . . .	5-22
MCM65516 . . . . .	3-44	MMS8064 . . . . .	5-25
MCM66L41 . . . . .	2-88	TMS27L16 . . . . .	2-114
MCM6632 . . . . .	2-26	TMS2716 . . . . .	2-114
MCM6633 . . . . .	2-34		

# **SELECTOR GUIDES CROSS-REFERENCE**



## **MEMORIES SELECTION GUIDE**

### **NOTES**

Not all package options are listed.

Operating temperature ranges:

MOS – 0°C to 70°C Selected MOS memories are offered in the following temperature ranges:  
– 40°C to +85°C ("G" series)  
– 55°C to +125°C ("E" series)

CMOS – 0°C to 70°C

ECL – Consult individual data sheets

TTL – Military – 55°C to +125°C, Commercial 0°C to 70°C

### **FOOTNOTES**

<sup>1</sup> Motorola's innovative pin #1 refresh.

<sup>2</sup> All MOS memory outputs are three-state except the open collector MCM2115A series.

<sup>3</sup> Character generators include shifted and unshifted characters, ASCII, alphanumeric control, math, Japanese, British, German, European and French symbols.

\* To be introduced.

## MEMORIES SELECTION GUIDE (continued)

### RAMs

#### MOS DYNAMIC RAMs

Organization	Part Number	Access Time (ns max)	Power Supplies	No. of Pins
4096 × 1	MCM4027AC-2 . . . . .	150	+ 12, ± 5 V	16
4096 × 1	MCM4027AC-3 . . . . .	200	+ 12, ± 5 V	16
4096 × 1	MCM4027AC-4 . . . . .	250	+ 12, ± 5 V	16
16384 × 1	MCM4116BC15 . . . . .	150	+ 12, ± 5 V	16
16384 × 1	MCM4116BC20 . . . . .	200	+ 12, ± 5 V	16
16384 × 1	MCM4116BC25 . . . . .	250	+ 12, ± 5 V	16
16384 × 1	MCM4116BC30 . . . . .	300	+ 12, ± 5 V	16
16384 × 1	MCM4517C12 . . . . .	120	+ 5 V	16
16384 × 1	MCM4517C15 . . . . .	150	+ 5 V	16
16384 × 1	MCM4517C20 . . . . .	200	+ 5 V	16
32768 × 1	MCM6632L15 <sup>1</sup> . . . . .	150	+ 5 V	16
32768 × 1	MCM6632L20 <sup>1</sup> . . . . .	200	+ 5 V	16
32768 × 1	MCM6632L25 <sup>1</sup> . . . . .	250	+ 5 V	16
32768 × 1	MCM6633L15 . . . . .	150	+ 5 V	16
32768 × 1	MCM6633L20 . . . . .	200	+ 5 V	16
32768 × 1	MCM6633L25 . . . . .	250	+ 5 V	16
65536 × 1	MCM6664L15 <sup>1</sup> . . . . .	150	+ 5 V	16
65536 × 1	MCM6664L20 <sup>1</sup> . . . . .	200	+ 5 V	16
65536 × 1	MCM6664L25 <sup>1</sup> . . . . .	250	+ 5 V	16
65536 × 1	MCM6665L15 . . . . .	150	+ 5 V	16
65536 × 1	MCM6665L20 . . . . .	200	+ 5 V	16
65536 × 1	MCM6665L25 . . . . .	250	+ 5 V	16

#### TTL BIPOLAR RAMs

Organization	Part Number	Access Time (ns max)	Output	No. of Pins
256 × 4	MCM93L412*	55	Open Collector	22
256 × 4	MCM93L422*	55	3-State	22
256 × 4	MCM93412 . . . . .	45	Open Collector	22
256 × 4	MCM93422 . . . . .	45	3-State	22
256 × 9	MCM93478*	60	Open Collector	24
256 × 9	MCM93479*	60	3-State	24
1024 × 1	MCM93415 . . . . .	45	Open Collector	16
1024 × 1	MCM93425 . . . . .	45	3-State	16

See Notes on Page 1-2.

## MEMORIES SELECTION GUIDE (continued)

### MOS STATIC RAMs (+ 5 Volts)

Organization	Part Number	Access Time (ns max)	No. of Pins
128 × 8	MCM6810 . . . . .	450	24
128 × 8	MCM68A10 . . . . .	360	24
128 × 8	MCM68B10 . . . . .	250	24
1024 × 4	MCM2114P20 . . . . .	200	18
1024 × 4	MCM2114P25 . . . . .	250	18
1024 × 4	MCM2114P30 . . . . .	300	18
1024 × 4	MCM2114P45 . . . . .	450	18
1024 × 4	MCM21L14P20 . . . . .	200	18
1024 × 4	MCM21L14P25 . . . . .	250	18
1024 × 4	MCM21L14P30 . . . . .	300	18
1024 × 4	MCM21L14P45 . . . . .	450	18
1024 × 1	MCM2115AC45 <sup>2</sup> . . . . .	45	16
1024 × 1	MCM2115AC55 <sup>2</sup> . . . . .	55	16
1024 × 1	MCM2115AC70 <sup>2</sup> . . . . .	70	16
1024 × 1	MCM21L15AC45 <sup>1</sup> . . . . .	45	16
1024 × 1	MCM21L15AC70 <sup>2</sup> . . . . .	70	16
1024 × 1	MCM2125AC45 . . . . .	45	16
1024 × 1	MCM2125AC55 . . . . .	55	16
1024 × 1	MCM2125AC70 . . . . .	70	16
1024 × 1	MCM21L25AC45 . . . . .	45	16
1024 × 1	MCM21L25AC70 . . . . .	70	16
4096 × 1	MCM2147C55 . . . . .	55	18
4096 × 1	MCM2147C70 . . . . .	70	18
4096 × 1	MCM2147C85 . . . . .	85	18
1024 × 4	MCM2148C55*	55	18
1024 × 4	MCM2148C70*	70	18
1024 × 4	MCM2148C85*	85	18
1024 × 4	MCM2149C55*	55	18
1024 × 4	MCM2149C70*	70	18
1024 × 4	MCM2149C85*	85	18

### CMOS STATIC RAMs (+ 5 Volts)

Organization	Part Number	Access Time (ns max)	No. of Pins
256 × 4	MCM5101P65 . . . . .	650	22
256 × 4	MCM5101P80 . . . . .	800	22
256 × 4	MCM51L01P45 . . . . .	450	22
256 × 4	MCM51L01P65 . . . . .	650	22
1024 × 1	MCM6508C30 . . . . .	300	16
1024 × 1	MCM6508C46 . . . . .	460	16
1024 × 1	MCM6518C30 . . . . .	300	18
1024 × 1	MCM6518C46 . . . . .	460	18

See Notes on Page 1-2.

## MEMORIES SELECTION GUIDE (continued)

### ECL BIPOLAR RAMs

Organization	Part Number	Access Time (ns max)	Output	No. of Pins
8 × 2	MCM10143 . . . . .	15	ECL output	24
256 × 1	MCM10144 . . . . .	26	ECL output	16
16 × 4	MCM10145 . . . . .	15	ECL output	16
1024 × 1	MCM10146 . . . . .	29	ECL output	16
1024 × 1	MCM10146A* . . . . .	15	ECL output	16
128 × 1	MCM10147 . . . . .	15	ECL output	16
256 × 1	MCM10152 . . . . .	15	ECL output	16
256 × 4	MCM10422 . . . . .	15	ECL output	24
4096 × 1	MCM10470 . . . . .	35	ECL output	18
4096 × 1	MCM10470A* . . . . .	20	ECL output	18
4096 × 1	MCM10470B* (Low power) . . . . .	35	ECL output	18
1024 × 4	MCM10474 . . . . .	25	ECL output	24

### EPROMs

#### MOS EPROMs

Organization	Part Number	Access Time (ns max)	Power Supplies	No. of Pins
1024 × 8	MCM2708C . . . . .	450	+ 12, ± 5 V	24
1024 × 8	MCM27A08C . . . . .	300	+ 12, ± 5 V	24
1024 × 8	MCM68708C . . . . .	450	+ 12, ± 5 V	24
1024 × 8	MCM68A708C . . . . .	300	+ 12, ± 5 V	24
2048 × 8	TMS2716C . . . . .	450	+ 12, ± 5 V	24
2048 × 8	TMS27A16C . . . . .	300	+ 12, ± 5 V	24
2048 × 8	MCM2716C . . . . .	450	+ 5 V	24
2048 × 8	MCM2716C35 . . . . .	350	+ 5 V	24
2048 × 8	MCM27L16C . . . . .	450	+ 5 V	24
2048 × 8	MCM27L16C35 . . . . .	350	+ 5 V	24
4096 × 8	MCM2532C . . . . .	450	+ 5 V	24
4096 × 8	MCM2532C35 . . . . .	350	+ 5 V	24
4096 × 8	MCM25L32C . . . . .	450	+ 5 V	24
4096 × 8	MCM25L32C35 . . . . .	350	+ 5 V	24
8192 × 8	MCM68764C . . . . .	450	+ 5 V	24
8192 × 8	MCM68764C35 . . . . .	350	+ 5 V	24
8192 × 8	MCM68L764C . . . . .	450	+ 5 V	24
8192 × 8	MCM68L764C35 . . . . .	350	+ 5 V	24
8192 × 8	MCM68766C35 . . . . .	350	+ 5 V	24

### EEPROM

#### MOS EEPROM

Organization	Part Number	Access Time	Power Supplies	No. of Pins
16 × 16	MCM2801 . . . . .	10 µs	+ 5 V	14
32 × 32	MCM2802 . . . . .	10 µs	+ 5 V	14
2K × 8	MCM2816 . . . . .	0.45	+ 5 V	24

See Notes on Page 1-2.

## MEMORIES SELECTION GUIDE (continued)

### ROMs

#### MOS STATIC ROMs (+ 5 Volts)

##### Character Generators<sup>3</sup>

Organization	Part Number	Access Time (ns max)	No. of Pins
128 × (7 × 5)	MCM6670P .....	350	18
128 × (7 × 5)	MCM6674P .....	350	18
128 × (9 × 7)	MCM66700P .....	350	24
128 × (9 × 7)	MCM66710P .....	350	24
128 × (9 × 7)	MCM66714P .....	350	24
128 × (9 × 7)	MCM66720P .....	350	24
128 × (9 × 7)	MCM66730P .....	350	24
128 × (9 × 7)	MCM66734P .....	350	24
128 × (9 × 7)	MCM66740P .....	350	24
128 × (9 × 7)	MCM66750P .....	350	24
128 × (9 × 7)	MCM66760P .....	350	24
128 × (9 × 7)	MCM66770P .....	350	24
128 × (9 × 7)	MCM66780P .....	350	24
128 × (9 × 7)	MCM66790P .....	350	24

#### Binary ROMs (+ 5 Volts)

Organization	Part Number	Access Time (ns max)	No. of Pins
1024 × 8	MCM68A308P .....	350	24
1024 × 8	MCM68A308P7 .....	350	24
1024 × 8	MCM68B308P .....	250	24
2048 × 8	MCM68A316AP .....	350	24
2048 × 8	MCM68A316EP .....	350	24
2048 × 8	MCM68A316P91 .....	350	24
4096 × 8	MCM68A332P .....	350	24
4096 × 8	MCM68A332P2 .....	350	24
8192 × 8	MCM68A364P .....	350	24
8192 × 8	MCM68A364P3 .....	350	24
8192 × 8	MCM68B364P .....	250	24
8192 × 8	MCM68365P25 .....	250	24
8192 × 8	MCM68365P35 .....	350	24
8192 × 8	MCM68366P25 .....	250	24
8192 × 8	MCM68366P35 .....	350	24
8192 × 8	MCM68766C45 .....	450	24

#### CMOS ROMs (+ 5 Volts)

Organization	Part Number	Access Time (ns max)	No. of Pins
256 × 4	MCM14524 .....	1200	16
2048 × 8	MCM65516C43 .....	430	18
2048 × 8	MCM65516C55 .....	550	18

See Notes on Page 1-2.

## MEMORIES SELECTION GUIDE (continued)

### PROMs ECL PROMs

Organization	Part Number	Access Time (ns max)	Output	No. of Pins
32 × 8	MCM10139 .....	20	ECL output	16
256 × 4	MCM10149 .....	25	ECL output	16

### TTL PROMs

Organization	Part Number	Access Time (ns max)	Output	No. of Pins
512 × 8	MCM7640 .....	70	Open Collector	24
512 × 8	MCM7641 .....	70	3-State	24
1024 × 4	MCM7642 .....	70	Open Collector	18
1024 × 4	MCM7643 .....	70	3-State	18
1024 × 8	MCM7680 .....	70	Open Collector	24
1024 × 8	MCM7681 .....	70	3-State	24
2048 × 4	MCM7684* .....	70	Open Collector	18
2048 × 4	MCM7685* .....	70	3-State	18
2048 × 4	MCM7688* .....	—	Open Collector with Registers	20
2048 × 4	MCM7689* .....	—	3-State with Registers	20
2048 × 8	MCM76161* .....	70	3-State	24

See Notes on Page 1-2.

# Memory Systems Board Selector Guide and Cross Reference

DEC COMPUTERS	MEMORY SIZE	MOTOROLA PART NUMBER	DEC PART NUMBER	INTEL PART NUMBER	MOSTEK PART NUMBER	NATIONAL PART NUMBER	MONOLITHIC SYSTEMS PART NUMBER	DATARAM PART NUMBER	PLESSEY PART NUMBER	CDC PART NUMBER	STANDARD MEMORIES PART NUMBER
+ LSI 11 LSI 11-02 LSI 11-23 PDP 11/03 (Q Bus Plus slot)	8K x 16 16K x 16 32K x 16 64K x 16 128K x 16 8K x 18 16K x 18 32K x 18 64K x 18 128K x 18	MMS1102-31 MMS1122N3032 MMS1122N3064 MMS1132 MMS1132 MMS1102-31PC MMS1102-32PC MMS1102-34PC MMS1132 MMS1132	MSV11-BG MSV11-DC MSV11-DD	CM-5004-616 CM-5004-632	MK 8005-03 MK 8005-02 MK 8005-00	NS23P	MSC4601 16K x 16 MSC4601 32K x 16	DR-1155 DR-1155 DR-1155 DR-1135 DR-1135 DR-1135 DR-1135 DR-1135 DR-1135	PM-SV32A-103 PM-SV32A-102 PM-SV32A-100	94123-16 94123-32	
- PDP 11/04 05, 10, 34, 35, 40, 45 50, 55, 60 (MUDBUS SPC slot)	16K x 16 32K x 16 48K x 16 64K x 16 16K x 18 32K x 18 48K x 18 64K x 18	MMS1117-2 MMS1117-4 MMS1117-6 MMS1117-8 MMS1117-2PC MMS1117-4PC MMS1117-6PC MMS1117-8PC	MSV11-EC MSV11-ED MSV11-ED	CM-5004-816 CM-5004-832	MK 8005-14 MK 8005-12 MK 8005-10	NS23P	MSC4604 16K x 18 MSC4604 32K x 18	DR-1155 DR-1155 DR-1135 DR-1135 DR-1135 DR-1135 DR-1135 DR-1135	PM-SV32AP-103 PM-SV32AP-102 PM-SV32AP-100		
- PDP 11/04 PDP 11/34 PDP 11/60 (Mudbus slot)	16K x 18 32K x 18 48K x 18 64K x 18 96K x 18	MMS1128P-016 MMS1128P-032 MMS1128P-048 +MMS1128P-064 †MMS1128P-096	MS11-LA MS11-LB MS11-LC	CM-5034-832 CM-5034-848	MK 8001-02 MK 8001-01 MK 8001-00 MK 8011-02 MK 8011-01 MK 8011-00	NS11-34P-16 NS11-34P-32 NS11-34P-16 NS11-34P-32	MSC3503 16K x 16 MSC3503 32K x 16 MSC3503 48K x 16 MSC3503 64K x 16 MSC3605 16K x 18 MSC3605 32K x 18 MSC3605 48K x 18 MSC3605 64K x 18	DR-1145 DR-1145 DR-1145 DR-1145 DR-1145 DR-1145 DR-1145 DR-1145	PM-S1164-102 PM-S1164-101 PM-S1164-100 PM-S1164A-102 PM-S1164A-101 PM-S1164A-100	94234-16 94234-32	+ PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS
- PDP 11/04 PDP 11/34 PDP 11/60 (Mudbus slot)	16K x 18 32K x 18 48K x 18 64K x 18 96K x 18	MMS1128P-016 MMS1128P-032 MMS1128P-048 +MMS1128P-064 †MMS1128P-096	MS11-LA MS11-LB MS11-LC	CM-5034-832 CM-5034-848	MK 8011-02 MK 8011-01 MK 8012-00	NS11-34P-16 NS11-34P-32	MSC3606 16K x 18 MSC3606 32K x 18 MSC3606 48K x 18 MSC3606 128K x 18	DR-1145 DR-1145 DR-1145 DR-1145	PM-S11L-100 PM-S11L-100	94234-16 94234-32	+ PINCOMM PS PINCOMM PS PINCOMM PS PINCOMM PS
+ PDP 11/04 PDP 11/34 PDP 11/60 (Mudbus slot)	32K x 18 64K x 18 96K x 18 128K x 18 256K x 18 512K x 18	MMS1119P-032 MMS1119P-064 MMS1119P-096 MMS1119P-128 +MMS1119P-256 †MMS1119P-512	MS11-LA MS11-LB MS11-LC MS11-LD	CM-5034-832 CM-5034-864	MK 8012-03 MK 8012-02 MK 8012-01 MK 8012-00	NS11-34Q-16 NS11-34Q-32 NS11-34Q-16 NS11-34Q-32	MSC3606 32K x 18 MSC3606 64K x 18 MSC3606 96K x 18 MSC3606 128K x 18	DR-1145 DR-1145 DR-1145 DR-1145	PM-S11L-100 PM-S11L-100 PM-S11L-100 PM-S11L-100	94134-32 94134-64 94134-128	+ PINCOMM PS PINCOMM PS
- PDP 11/70 (Add-in)	32K x 39	MMS1170E1064									+ PINCOMM 70S
+ VAX 11/780 (Memory SUB-SYSTEM slot)	32K x 72	MMS780AE1032	MS780-DA (MB210)		MK 8016-01	NS 780	MSC 3610	DR-178S			+ PINCOMM 780S

† Populated with 32K RAMS

‡ Populated with 64K RAMS

x = 3 for fast speed

x = 4 for standard speed

P/PC-Parity + Controller eliminates the need for DEC's 7850 controller

+ DEC, LSI-11, PDP-11, and VAX-11/780 are trademarks of Digital Equipment Corp

PINCOMM is a registered trademark of Trendata Standard Memories

NOTE THIS DOCUMENT IS INTENDED AS AN AID TO OUR CUSTOMERS IN SELECTING THE PROPER ADD-IN MEMORY BOARD. WE RECOMMEND THAT THE DATA SHEET & TECHNICAL MANUALS FOR THE PARTICULAR BOARD IN QUESTION BE USED BEFORE INSTALLATION

INTEL MICROCOMPUTERS	MEMORY SIZE	MOTOROLA PART NUMBER	INTEL PART NUMBER	NATIONAL PART NUMBER	CHRISLIN PART NUMBER
+ iSBC 80/10, 80/20, 86/12 + (MULTIBUS) MDS Development System SYSTEM 80	16K x 8 32K x 8 48K x 8 64K x 8 16K x 9 32K x 9 48K x 9 64K x 9	MMS8016 MMS8032 MMS8048 MMS8064 MMS8016P MMS8032P MMS8048P MMS8064P	SBC 016 SBC 032 SBC 048 SBC 064	+ BLC 016 BLC 032 BLC 048 BLC 064	Ci 8080 Ci 8080 Ci 8080 Ci 8080
+ iSBC 80/10, 80/20 † MDS Development System SYSTEM 80	16K x 8 32K x 8	MMS80810-1 MMS80810	SBC 016 SBC 032	BLC 016 BLC 032	Ci 8080 Ci 8080

+ MULTIBUS and iSBC are trademarks of INTEL Corp

BLC is a trademark of NATIONAL Semiconductor Corp

† Compatible with limitations

**THE OFFICIAL MOS MEMORY  
CROSS-REFERENCE**  
From Motorola

---

Part Number	Organization Description	Motorola's Access Time (ns Max)	Number of Pins	Power Supplies	Motorola Pin-to-Pin Replacement
<b>AMD</b>					
Am2708	1024 × 8 EPROM	300-450	24	+ 12, ± 5 V	MCM2708
Am2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
Am4044	4096 × 1 SRAM	200-450	18	+ 5 V	MCM66L41
Am9016	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
Am9114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
Am91L14	1024 × 4 SRAM	200-450	18	+ 5 V	MCM21L14
Am9147	4096 × 1 SRAM	55-85	18	+ 5 V	MCM2147
Am9208B	1024 × 8 SROM	350	24	+ 5 V	MCM68A308
Am9217	2048 × 8 SROM	350	24	+ 5 V	MCM68A316A
Am9218	2048 × 8 SROM	350	24	+ 5 V	MCM68A316E
Am9232	4096 × 8 SROM	350	24	+ 5 V	MCM68A332
<b>AMI</b>					
S2114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
S2114L	1024 × 4 SRAM	200-450	18	+ 5 V	MCM21L14
S2147	4096 × 1 SRAM	70-100	18	+ 5 V	MCM2147
S4264	8192 × 8 SROM	350	24	+ 5 V	MCM68A364
S5101	256 × 4 SRAM	450-800	22	+ 5 V	MCM5101
S6508	1024 × 1 SRAM	300-480	16	+ 5 V	MCM6508
S6518	1024 × 1 SRAM	300-460	18	+ 5 V	MCM6518
S6810	128 × 8 SRAM	250-450	24	+ 5 V	MCM6810
S6830	1024 × 8 SROM	350	24	+ 5 V	MCM68A30A
S6831A	2048 × 8 SROM	350	24	+ 5 V	MCM68A316A
S6831B	2048 × 8 SROM	350	24	+ 5 V	MCM68A316E
S6832	4096 × 8 ROM	350	24	+ 5 V	MCM68A332
<b>FAIRCHILD</b>					
F16K	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
2114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
F2708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
F2708I	1024 × 8 EPROM	300	24	+ 12, ± 5 V	MCM27A08
2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
3508	1024 × 8 SROM	350	24	+ 5 V	MCM68A308
F3516E	2048 × 8 SROM	350	24	+ 5 V	MCM68A316E
FM4027	4096 × 1 DRAM	120-250	16	+ 12, ± 5 V	MCM4027A
F68B10	128 × 8 SRAM	250-450	24	+ 5 V	MCM68B10
F68B308	1024 × 8 SROM	250-350	24	+ 5 V	MCM68B308
F68708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM68708
<b>FUJITSU</b>					
MB2147	4096 × 1 SRAM	70-100	18	+ 5 V	MCM2147
MBM2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
MB4044	4096 × 1 SRAM	200-450	18	+ 5 V	MCM6641
MB8114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
MB8116	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
MB8227	4096 × 1 DRAM	120-250	16	+ 12, ± 5 V	MCM4027A
MB8308	1024 × 8 SROM	350	24	+ 5 V	MCM68A308
MB8518H	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
<b>GENERAL INSTRUMENT</b>					
RO3-8316B	2048 × 8 SROM	350	24	+ 5 V	MCM68A316A
RO3-9316B	2048 × 8 SROM	350	24	+ 5 V	MCM68A316E
RO3-9332C	4096 × 8 SROM	350	24	+ 5 V	MCM68A332
RO3-9364B	8092 × 8 SROM	350	24	+ 5 V	MCM68365-35

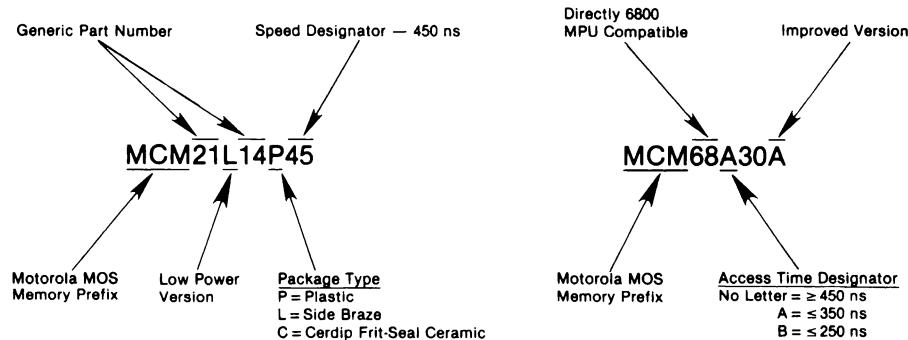
Part Number	Organization Description	Motorola's Access Time (ns Max)	Number of Pins	Power Supplies	Motorola Pin-to-Pin Replacement
<b>HARRIS</b>					
6501	256 × 4 SRAM	450-800	22	+ 5 V	MCM5101
6508	1024 × 1 SRAM	300-460	16	+ 5 V	MCM6508
6514	1024 × 1 SRAM	200-450	18	+ 5 V	MCM65114
6518	1024 × 1 SRAM	300-460	18	+ 5 V	MCM6518
<b>HITACHI</b>					
HM4334P	1024 × 4 SRAM	300-450	18	+ 5 V	MCM65114
HM435101	256 × 4 CMOS SRAM	450-800	22	+ 5 V	MCM5101
HM462316EP	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
HM462532	4096 × 8 EPROM	450	24	+ 5 V	MCM2532
HM462708	1024 × 8 EPROM	450	24	+ 5 V	MCM2708
HM462716	2048 × 8	450	24	+ 5 V	MCM2716
HM46332	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
HM46364	8192 × 8 SRAM	350	24	+ 5 V	MCM68A364
HM468A10	128 × 8 SRAM	350	24	+ 5 V	MCM68A10
HM46830	1024 × 8 SRAM	350	24	+ 5 V	MCM68A30A
HM4716	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
HM472114A	1024 × 1 SRAM	200-450	18	+ 5 V	MCM2114
HM48016	2048 × 8 EEPROM	350	24	+ 5 V	MCM2816
HM4816	16,384 × 1 DRAM	100-200	16	+ 5 V	MCM4517
HM4847	4096 × 1 SRAM	55-85	18	+ 5 V	MCM2147
HM4864	65,536 × 1 DRAM	150-200	16	+ 5 V	MCM6665
HM6116P	2048 × 8 CMOS SRAM	120-200	18	+ 5 V	MCM65116
HM6147P	4096 × 1 CMOS SRAM	55-70	18	+ 5 V	MCM65147
HM6148P	1024 × 4 CMOS SRAM	55-85	18	+ 5 V	MCM65148
<b>INTEL</b>					
2114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
2114L	1024 × 4 SRAM	200-450	18	+ 5 V	MCM21L14
2115A	1024 × 1 SRAM	45-70	16	+ 5 V	MCM2115A
2115AL	1024 × 1 SRAM	45-70	16	+ 5 V	MCM21L15A
2115H	1024 × 1 SRAM	20-35	16	+ 5 V	MCM2115H
2117	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
2118	16,384 × 1 DRAM	100-200	16	+ 5 V	MCM4517
2125A	1024 × 1 SRAM	45-70	16	+ 5 V	MCM2125A
2125AL	1024 × 1 SRAM	45-70	16	+ 5 V	MCM21L25A
2125H	1024 × 1 SRAM	20-35	16	+ 5 V	MCM2125H
2147	4096 × 1 SRAM	55-100	18	+ 5 V	MCM2147
2147H	4096 × 1 SRAM	35-55	18	+ 5 V	MCM2147H
2148	1024 × 4 SRAM	70-85	18	+ 5 V	MCM2148
2148H	1024 × 4 SRAM	45-55	18	+ 5 V	MCM2148H
2149H	1024 × 4 SRAM	45-55	18	+ 5 V	MCM2149H
2308	1024 × 8 SRAM	350	24	+ 5 V	MCM68A308
2316A	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316A
2316E	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
2332	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
2708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
2708-1	1024 × 8 EPROM	350	24	+ 12, ± 5 V	MCM27A08
2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
2716-1	2048 × 8 EPROM	350	24	+ 5 V	MCM27A16
2816	2048 × 8 EEPROM	350	24	+ 5 V	MCM2816
<b>INTERSIL</b>					
2114 (IM2114)	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
IM2147	4096 × 1 SRAM	55-85	18	+ 5 V	MCM2147
MK4027	4096 × 1 DRAM	150-250	16	+ 12, ± 5 V	MCM4027A
IM6508	1024 × 1 SRAM	300-460	16	+ 5 V	MCM6508
IM6518	1024 × 1 SRAM	300-460	18	+ 5 V	MCM6518
IM7027	4096 × 1 DRAM	120-250	6	+ 12, ± 5 V	MCM4027A
IM2114L	1024 × 4 SRAM	200-450	18	+ 5 V	MCM21L14
IM4116	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
IM7141	4096 × 1 SRAM	200-450	18	+ 5 V	MCM6641
IM7141L	4096 × 1 SRAM	200-450	18	+ 5 V	MCM66L41
<b>ITT</b>					
ITT4027	4096 × 1 DRAM	120-250	16	+ 12, ± 5 V	MCM4027A
ITT4116	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116

Part Number	Organization Description	Motorola's Access Time (ns Max)	Number of Pins	Power Supplies	Motorola Pin-to-Pin Replacement
<b>MIC</b>					
MIC2316E	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
MIC2332	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
<b>MOSTEK</b>					
MK2147	4096 × 1 SRAM	70-100	18	+ 5 V	MCM2147
MK2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
MK4027	4096 × 1 DRAM	150-250	16	+ 12, ± 5 V	MCM4027A
MK4116	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
MK4516	16,384 × 1 DRAM	120-200	16	+ 5 V	MCM4516
MK4164	65,536 × 1 DRAM	150-250	16	+ 5 V	MCM6684
MK30000	1024 × 8 SRAM	350	24	+ 5 V	MCM68A308
MK31000	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316A
MK32000	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
MK34000	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
MK36000	8192 × 8 SRAM	350	24	+ 5 V	MCM68A364
MK36000-4	8192 × 8 SRAM	250	24	+ 5 V	MCM68B364
<b>NATIONAL</b>					
MM2114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
MM2147	4096 × 1 SRAM	55-85	18	+ 5 V	MCM2147
MM2708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
MM2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
MM5235	8192 × 8 SRAM	350	24	+ 5 V	MCM68A364
MM5257	4096 × 1 SRAM	200-450	18	+ 5 V	MCM6641
MM5257L	4096 × 1 SRAM	200-450	18	+ 5 V	MCM66L41
MM5290	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
<b>NEC/EA</b>					
μPD414A	4096 × 1 DRAM	150-250	16	+ 12, ± 5 V	MCM4027A
μPD416	16,384 × 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116A
μPD2114L	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
μPD2147	4096 × 1 SRAM	55-85	18	+ 5 V	MCM2147
μPD2332	4096 × 8 ROM	350	24	+ 5 V	MCM68A332
μPD2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
μPD4104	4096 × 1 SRAM	200-450	18	+ 5 V	MCM66L41
μPD5101	256 × 4 SRAM	450-800	22	+ 5 V	MCM5101
μPD6508	1024 × 1 SRAM	300-460	16	+ 5 V	MCM6508
EA2114	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
EA2308/8308	1024 × 8 SRAM	350	24	+ 5 V	MCM68A308
μPD or EA2316A/8316A	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316A
μPD or EA2316E/8316E	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
EA2708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
μPD or EA2716 EA8332	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
μPD or EA8332	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
<b>NITRON</b>					
NC8570	128 × (7 × 9) SRAM	350	24	+ 5 V	MCM66700
NC8571	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66710
NC8572	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66720
NC8573	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66730
NC8574	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66740
NC8575	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66750
<b>SIGNETICS</b>					
2607	1024 × 8 SRAM	350	24	+ 5 V	MCM68A308
2608	1024 × 8 SRAM	350	24	+ 5 V	MCM68A30A
2609	128 × (7 × 9) SROM	350	24	+ 5 V	MCM66700
2660	4096 × 1 DRAM	120-250	16	+ 12, ± 5 V	MCM4027A
2614	1024 × 4 SRAM	200-450	18	+ 5 V	MCM2114
2616	2048 × 8 SRAM	350	24	+ 5 V	MCM68A316E
2633	4096 × 8 SRAM	350	24	+ 5 V	MCM68A332
2664	8192 × 8 SRAM	350	24	+ 5 V	MCM68A364
2690	16,384 × 1 DRAM	250-350	18	+ 12, ± 5 V	MCM4116
2708	1024 × 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
2716	2048 × 8 EPROM	450	24	+ 5 V	MCM2716
4027	4096 × 1 DRAM	150-250	16	+ 12, ± 5 V	MCM4027A
5101	256 × 4 SRAM	450-800	22	+ 5 V	MCM5101

Part Number	Organization Description	Motorola's Access Time (ns Max)	Number of Pins	Power Supplies	Motorola Pin-to-Pin Replacement
<b>SYNERTEK</b>					
SY2114	1024 x 4 SRAM	200-450	18	+ 5 V	MCM21L14
SY2147	4096 x 1 SRAM	55-85	18	+ 5 V	MCM2147
SY2316A	2048 x 8 SRAM	350	24	+ 5 V	MCM68A316A
SY2316B	2048 x 8 SROM	350	24	+ 5 V	MCM68A316E
SY2332	4096 x 8 ROM	350	24	+ 5 V	MCM68A332
SY2716	2048 x 8 EPROM	450	24	+ 5 V	MCM2716
SY5101	256 x 4 SRAM	450-800	22	+ 5 V	MCM5101
<b>TEXAS INSTRUMENTS</b>					
TMS2114	1024 x 4 SRAM	200-450	18	+ 5 V	MCM2114
TMS2147	4096 x 1 SRAM	55-85	18	+ 5 V	MCM2147
TMS2516	2048 x 8 EPROM	450	24	+ 5 V	MCM2716
TMS2532	4096 x 8 EPROM	350-450	24	+ 5 V	MCM2532
TMS2708	1024 x 8 EPROM	450	24	+ 12, ± 5 V	MCM2708
TMS2716	2048 x 8 EPROM	450	24	+ 12, ± 5 V	TMS2716
TMS4016	2048 x 8 SRAM	200	24	+ 5 V	MCM4016
TMS4044	4096 x 1 SRAM	200-450	18	+ 5 V	MCM6641
TMS4116	16,384 x 1 DRAM	150-300	16	+ 12, ± 5 V	MCM4116
TMS4164	65,536 x 1 DRAM	150-250	16	+ 5 V	MCM6685
TMS4732	4096 x 8 SRAM	350	24	+ 5 V	MCM68A332
TMS4764	8192 x 8 SRAM	350	24	+ 5 V	MCM68385
<b>TOSHIBA</b>					
TMM314	1024 x 4 SRAM	200-450	18	+ 5 V	MCM2114
TMM2147	4096 x 1 SRAM	55-85	18	+ 5 V	MCM2147
TC5516P	2048 x 8 SRAM	200	24	+ 5 V	MCM4016

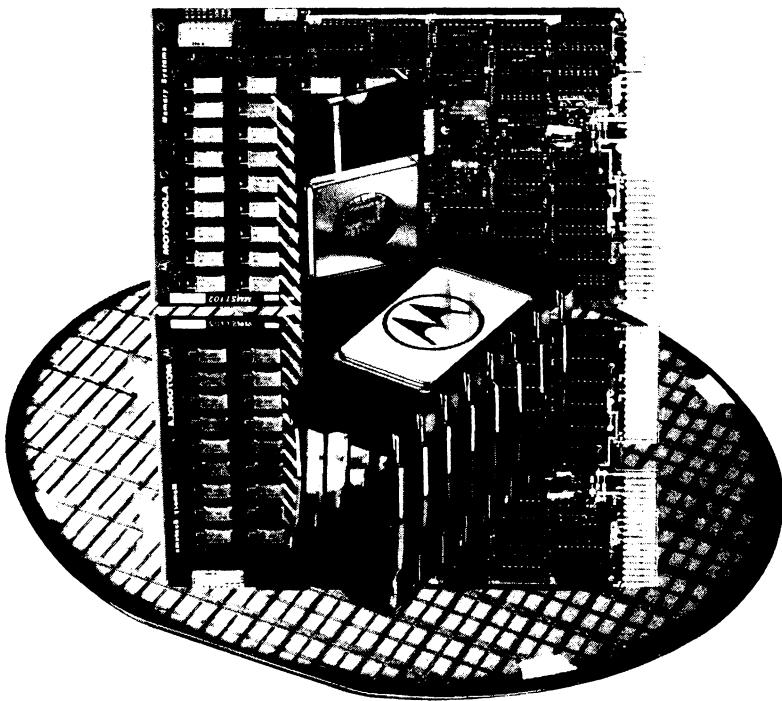
## Part Number Guide

---



## **MOS Memories**

### **RAM, EPROM, EEPROM, ROM**





**MOTOROLA**

**MCM4027A**

### 4096-BIT DYNAMIC RANDOM ACCESS MEMORY

The MCM4027A is a 4096 × 1 bit high-speed dynamic Random Access Memory. It has smaller die size than the MCM4027 providing improved speed selections. The MCM4027A is fabricated using Motorola's highly reliable N-channel silicon-gate technology.

By multiplexing row and column address inputs, the MCM4027A requires only six address lines and permits packaging in Motorola's standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated.

All inputs are TTL compatible, and the output is 3-state TTL compatible. The MCM4027A incorporates a one-transistor cell design and dynamic storage techniques, with each of the 64 row addresses requiring a refresh cycle every 2.0 milliseconds.

- Maximum Access Time = 120 ns – MCM4027AC1  
150 ns – MCM4027AC2  
200 ns – MCM4027AC3  
250 ns – MCM4027AC4
- Maximum Read and Write Cycle Time =  
320 ns – MCM4027AC1, C2  
375 ns – MCM4027AC3, C4
- Low Power Dissipation – 470 mW Max (Active)  
27 mW Max (Standby)
- 3-State Output for OR-Ties
- On-Chip Latches for Address, Chip Select, and Data In
- Power Supply Pins on Package Corners for Optimum Layout
- Industry Standard 16-Pin Package
- Page-Mode Capability
- Compatible with the Popular 2104/MK4096/MCM6604
- Second Source for MK4027

**MOS**

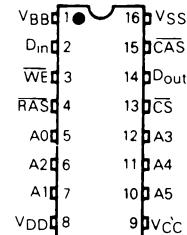
(N-CHANNEL, SILICON-GATE)

### 4096-BIT DYNAMIC RANDOM ACCESS MEMORY



C SUFFIX  
FRIT-SEAL CERAMIC PACKAGE  
CASE 620-06

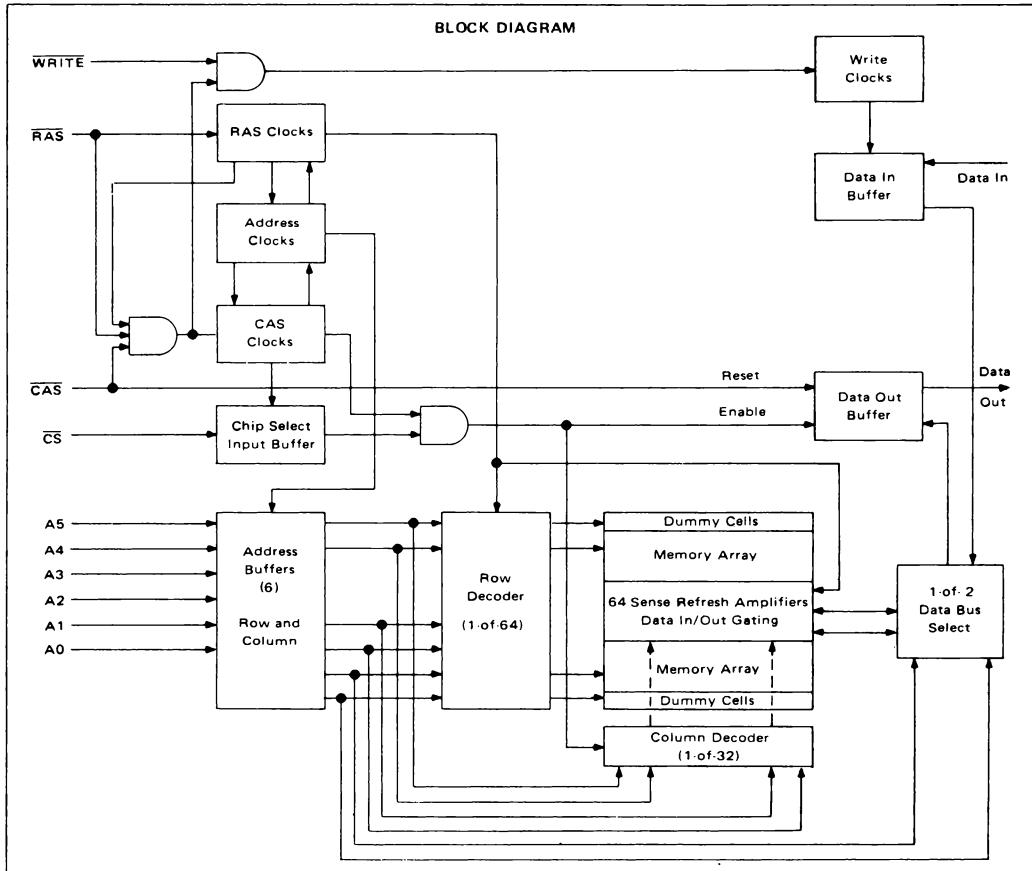
#### PIN ASSIGNMENT



#### TRUTH TABLE

Inputs				Data Out			Cycle Power	Ref	Function
RAS	CAS	CS	WE	Previous	Interim	Present			
L	L	L	L	Valid data	High Imp.	Input data	Full-operating	Yes	Write cycle
L	L	L	H	Valid data	High Imp.	Valid data (cell)	Full-operating	Yes	Read cycle
L	L	H	X	Valid data	High Imp.	High Imp.	Full-operating	Yes	Deselected-refresh
L	H	X	X	Valid data	Valid data	Valid data	Reduced operating	Yes	RAS only-refresh
H	L	X	X	Valid data	High Imp.	High Imp.	Standby	No	Standby-output disabled
H	H	X	X	Valid data	Valid data	Valid data	Standby	No	Standby-output valid

H = High, L = Low, X = Don't Care



## OPERATING CHARACTERISTICS

### ADDRESSING

The MCM4027A has six address inputs (A0–A5) and two clock signals designated Row Address Strobe ( $\overline{\text{RAS}}$ ) and Column Address Strobe ( $\overline{\text{CAS}}$ ). At the beginning of a memory cycle, the six low order address bits A0 through A5 are strobed into the chip with  $\overline{\text{RAS}}$  to select one of the 64 rows. The row address strobe also initiates the timing that will enable the 64 column sense amplifiers. After a specified hold time, the row address is removed and the six high order address bits (A6–A11) are placed on the address pins. This address is then strobed into the chip with  $\overline{\text{CAS}}$ . Two of the 64 column sense amplifiers are selected by A1 through A5. A one of two data bus select is accomplished by A0 to complete the data selection.

\* The Chip Select ( $\overline{\text{CS}}$ ) is latched into the port along with the column addresses.

### DATA OUTPUT

In order to simplify the memory system designed and reduce the total package count, the MCM4027A contains an input data latch and a buffered output data latch. The state of the output latch and buffer at the end of a memory cycle will depend on the type of memory cycle performed and whether the chip is selected or unselected for that memory cycle.

A chip will be unselected during a memory cycle if:

- (1) The chip receives both  $\overline{\text{RAS}}$  and  $\overline{\text{CAS}}$  signals, but no Chip Select signal.
- (2) The chip receives a  $\overline{\text{CAS}}$  signal but no  $\overline{\text{RAS}}$  signal. With this condition, the chip will be unselected regardless of the state of Chip Select input.

If, during a read, write, or read-modify-write cycle,

# MCM4027A

the chip is unselected, the output buffer will be in the high impedance state at the end of the memory cycle. The output buffer will remain in the high impedance state until the chip is selected for a memory cycle.

For a chip to be selected during a memory cycle, it must receive the following signals: RAS, CAS, and Chip Select. The state of the output latch and buffer of a selected chip during the following type of memory cycles would be:

- (1) Read Cycle — On the negative edge of CAS, the output buffer will unconditionally go to a high impedance state. It will remain in this state until access time. At this time, the output latch and buffer will assume the logic state of the data read from the selected cell. This output state will be maintained until the chip receives the next CAS signal.
- (2) Write Cycle — If the WE input is switched to a logic 0 before the CAS transition, the output latch and buffer will be switched to the state of the data input at the end of the access time. This logic state will be maintained until the chip receives the next CAS signal.
- (3) Read-Modify-Write — Same as read cycle.

## DATA INPUT

Data to be written into a selected storage cell of the memory chip is first stored in the on-chip data latch. The gating of this latch is performed with a combination of the WE and CAS signals. The last of these signals to make a negative transition will strobe the data into the latch. If the WE input is switching to a logic 0 in the beginning of a write cycle, the falling edge of CAS strobes the data into the latch. The data setup and hold times are then referenced to the negative edge of CAS.

If a read-modify-write cycle is being performed, the WE input would not make its negative transition until after the CAS signal was enabled. Thus, the data would not be strobed into the latch until the negative transition of WE. The data setup and hold times would now be referenced to the negative edge of the WE signal. The only other timing constraints for a write-type-cycle is that both the CAS and WE signals remain in the logic 0 state for a sufficient time to accomplish the permanent storage of the data into the selected cell.

Circuit diagrams external to or containing Motorola products are included as a means of illustration only. Complete information sufficient for construction purposes may not be fully illustrated. Although the information herein has been carefully checked and is believed to be reliable, Motorola assumes no responsibility for inaccuracies. Information herein does not convey to the purchaser any license under the patent rights of Motorola or others.

The information contained herein is for guidance only, with no warranty of any type, expressed or implied. Motorola reserves the right to make any changes to the information and the product(s) to which the information applies and to discontinue manufacture of the product(s) at any time.

## INPUT/OUTPUT LEVELS

All of the inputs to the MCM4027A are TTL-compatible, featuring high impedance and low capacitance (5 to 7 pF). The three-state data output buffer is TTL-compatible and has sufficient current sink capability (3.2 mA) to drive two TTL loads. The output buffer also has a separate VCC pin so that it can be powered from the same supply as the logic being employed.

## REFRESH

In order to maintain valid data, each of the 64 internal rows of the MCM4027A must be refreshed once every 2 ms. Any cycle in which a RAS signal occurs accomplishes a refresh operation. Any read, write, or read-modify-write cycle will refresh an entire internally selected row. However, if a write or read-modify-write cycle is used to perform a refresh cycle the chip must be deselected to prevent writing data into the selected cell. The memory can also be refreshed by employing only the RAS cycle. This refresh mode will not shorten the refresh cycle time; however, the system standby power can be reduced by approximately 30%.

If the RAS only refresh cycles are employed for an extended length of time, the output buffer may eventually lose data and assume the high impedance state. Applying CAS to the chip will restore activity of the output buffer.

## POWER DISSIPATION

Since the MCM4027A is a dynamic RAM, its power drain will be extremely small during the time the chip is unselected.

The power increases when the chip is selected and most of this increase is encountered on the address strobe edge. The circuitry of the MCM4027A is largely dynamic so power is not drawn during the whole time the strobe is active. Thus the dynamic power is a function of the operating frequency rather than the active duty cycle.

In a memory system, the CAS signal must be supplied to all the memory chips to ensure that the outputs of the unselected chips are switched to the high impedance state. Those chips that do not receive a RAS signal will not dissipate any power on the CAS edge except for that required to turn off the chip outputs. Thus, in order to ensure minimum system power, the RAS signal should be decoded so that only the chips to be selected receive a RAS signal. If the RAS signal is decoded, then the chip select input of all the chips can be set to a logic 0 state.

# MCM4027A

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS (Referenced to V<sub>SS</sub> = Ground.)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	V <sub>DD</sub>	10.8	12.0	13.2	Vdc	2
	V <sub>CC</sub>	V <sub>SS</sub>	5.0	V <sub>DD</sub>	Vdc	3
	V <sub>SS</sub>	0	0	0	Vdc	2
	V <sub>BB</sub>	-4.5	-5.0	-5.5	Vdc	2
Logic 1 Voltage, RAS, CAS, WRITE	V <sub>IHC</sub>	2.4	5.0	7.0	Vdc	2, 4
Logic 1 Voltage, all inputs except RAS, CAS, WRITE	V <sub>IH</sub>	2.2	5.0	7.0	Vdc	2, 4
Logic 0 Voltage, all inputs	V <sub>IL</sub>	-1.0	0	0.8	Vdc	2, 4

DC CHARACTERISTICS (V<sub>DD</sub> = 12 V ± 10%, V<sub>CC</sub> = 5.0 V ± 10%, V<sub>BB</sub> = -5.0 V ± 10%, V<sub>SS</sub> = 0 V, T<sub>A</sub> = 0 to 70°C.) Notes 1, 5

Characteristic	Symbol	Min	Typ	Max	Units	Notes
Average V <sub>DD</sub> Power Supply Current	I <sub>DD1</sub>			35	mA	6
V <sub>CC</sub> Power Supply Current	I <sub>CC</sub>				mA	7
Average V <sub>BB</sub> Power Supply Current	I <sub>BB</sub>			250	μA	
Standby V <sub>DD</sub> Power Supply Current	I <sub>DD2</sub>			2	mA	9
Average V <sub>DD</sub> Power Supply Current during "RAS only" cycles	I <sub>DD3</sub>			25	mA	6
Input Leakage Current (any input)	I <sub>I(L)</sub>			10	μA	8
Output Leakage Current	I <sub>O(L)</sub>			10	μA	9, 10
Output Logic 1 Voltage @ I <sub>out</sub> = -5 mA	V <sub>OH</sub>	2.4			Vdc	
Output Logic 0 Voltage @ I <sub>out</sub> = 3.2 mA	V <sub>OL</sub>			0.4	Vdc	

### NOTES 1 through 11:

- T<sub>A</sub> is specified for operation at frequencies to t<sub>RC</sub> ≥ t<sub>RC(min)</sub>. Operation at higher cycle rates with reduced ambient temperatures and higher power dissipation is permissible provided that all ac parameters are met.
- All voltages referenced to V<sub>SS</sub>.
- Output voltage will swing from V<sub>SS</sub> to V<sub>CC</sub> when enabled, with no output load. For purposes of maintaining data in standby mode, V<sub>CC</sub> may be reduced to V<sub>SS</sub> without affecting refresh operations or data retention. However, the V<sub>OH(min)</sub> specification is not guaranteed in this mode.
- Device speed is not guaranteed at input voltages greater than TTL levels (0 to 5 v).
- Several cycles are required after power-up before proper device operation is achieved. Any 8 cycles which perform refresh are adequate for this purpose.

6. Current is proportional to cycle rate. I<sub>DD1(max)</sub> is measured at the cycle rate specified by t<sub>RC(min)</sub>.

7. I<sub>CC</sub> depends on output loading. During readout of high level data V<sub>CC</sub> is connected through a low impedance (135 Ω typ) to Data Out. At all other times I<sub>CC</sub> consists of leakage currents only.

8. All device pins at 0 volts except V<sub>BB</sub> which is at -5 volts and the pin under test which is at +10 volts.

9. Output is disabled (high-impedance) and RAS and CAS are both at a logic 1. Transient stabilization is required prior to measurement of this parameter.

10. 0 V ≤ V<sub>Out</sub> ≤ +10 V.

11. Effective capacitance is calculated from the equation:

$$C = \frac{\Delta Q}{\Delta V} \text{ with } \Delta V = 3 \text{ volts.}$$

EFFECTIVE CAPACITANCE (Full operating voltage and temperature range, periodically sampled rather than 100% tested) Note 11

Characteristic	Symbol	Max	Unit
Input Capacitance (A0-A5), D <sub>in</sub> , CS RAS, CAS, WRITE	C <sub>in(EFF)</sub>	5.0	pF
		10.0	
Output Capacitance	C <sub>out(EFF)</sub>	7.0	pF

### ABSOLUTE MAXIMUM RATINGS (See Notes 1 and 2)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>BB</sub> *	V <sub>in</sub> , V <sub>out</sub>	-0.5 to +20	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Output Current (Short Circuit)	I <sub>out</sub>	50	mAdc

\* (V<sub>SS</sub> - V<sub>BB</sub>) > 4.5 V

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. V<sub>BB</sub> must be applied prior to V<sub>CC</sub> and V<sub>DD</sub>. V<sub>BB</sub> must also be the last power supply switched off.

This device contains 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 this high impedance circuit.

# MCM4027A

## AC OPERATING CONDITIONS AND CHARACTERISTICS (Read, Write, and Read-Modify-Write Cycles)

RECOMMENDED AC OPERATING CONDITIONS ( $V_{DD} = 12 \text{ V} \pm 10\%$ ,  $V_{CC} = 5.0 \text{ V} \pm 10\%$ ,  $V_{BB} = -5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = 0 \text{ V}$ ,  $T_A = 0 \text{ to } 70^\circ\text{C}$ .) Notes 1, 5, 12, 18

Parameter	Symbol	MCM4027AC1		MCM4027AC2		MCM4027AC3		MCM4027AC4		Units	Notes
		Min	Max	Min	Max	Min	Max	Min	Max		
Random Read or Write Cycle Time	'RC	320		320		375		375		ns	13
Read Write Cycle Time	'RWC	320		320		375		375		ns	13
Page Mode Cycle Time	'PC	160		170		225		285		ns	13
Access Time From Row Address Strobe	'RAC		120		150		200		250	ns	14, 16
Access Time From Column Address Strobe	'CAC		80		100		135		165	ns	15, 16
Output Buffer and Turn-Off Delay	'OFF		35		40		50		60	ns	
Row Address Strobe Precharge Time	'RP	100		100		120		120		ns	
Row Address Strobe Pulse Width	'RAS	120	10,000	150	10,000	200	10,000	250	10,000	ns	
Row Address Strobe Hold Time	'RSH	80		100		135		165		ns	
Column Address Strobe Pulse Width	'CAS	80		100		135		165		ns	
Column Address Strobe Hold Time	'CSH	120		150		200		250		ns	
Row to Column Strobe Lead Time	'RCD	15	40	20	50	25	65	35	85	ns	17
Row Address Setup Time	'ASR	0		0		0		0		ns	
Row Address Hold Time	'RAH	15		20		25		35		ns	
Column Address Setup Time	'ASC	.5		.10		.10		.10		ns	
Column Address Hold Time	'CAH	40		45		55		75		ns	
Column Address Hold Time Referenced to RAS	'AR	80		95		120		160		ns	
Chip Select Setup Time	'CSC	0		.10		.10		.10		ns	
Chip Select Hold Time	'CH	40		45		55		75		ns	
Chip Select Hold Time Referenced to RAS	'CHR	80		95		120		160		ns	
Transition Time Rise and Fall	'T	3	35	3	35	3	50	3	50	ns	18
Read Command Setup Time	'RCS	0		0		0		0		ns	
Read Command Hold Time	'RCH	0		0		0		0		ns	
Write Command Hold Time	'WCH	40		45		55		75		ns	
Write Command Hold Time Referenced to RAS	'WCR	80		95		120		160		ns	
Write Command Pulse Width	'WP	40		45		55		75		ns	
Write Command to Row Strobe Lead Time	'RWL	50		50		70		85		ns	
Write Command to Column Strobe Lead Time	'CWL	50		50		70		85		ns	
Data in Setup Time	'DS	0		0		0		0		ns	19
Data in Hold Time	'DH	40		45		55		75		ns	19
Data in Hold Time Referenced to RAS	'DHR	80		95		120		160		ns	
Column to Row Strobe Precharge Time	'CRP	0		0		0		0		ns	
Column Precharge Time	'CP	60		60		80		110		ns	
Refresh Period	'RFSH		2		2		2		2	ms	
Write Command Setup Time	'WCS	0		0		0		0		ns	
CAS to WRITE Delay	'CWD	60		60		80		90		ns	20
RAS to WRITE Delay	'RWD	100		110		145		175		ns	20
Data Out Hold Time	'DOH	10		10		10		10		μs	

### NOTES 12 through 20:

12. AC measurements assume  $t_T = 5 \text{ ns}$ .
13. The specifications for  $t_{RC}(\text{min})$  and  $t_{RWC}(\text{min})$  are used only to indicate cycle time at which proper operation over the full temperature range ( $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ) is assured.
14. Assumes that  $t_{RCD} \leq t_{RC}(\text{max})$ .
15. Assumes that  $t_{RCD} \geq t_{RC}(\text{max})$ .
16. Measured with a load circuit equivalent to 2 TTL loads and  $100 \text{ pF}$ .
17. Operation within the  $t_{RCD}(\text{max})$  limit insures that  $t_{RAC}(\text{max})$  can be met.  $t_{RCD}(\text{max})$  is specified as a reference point only; if  $t_{RCD}$  is greater than the specified  $t_{RCD}(\text{max})$  limit, then access time is controlled exclusively by  $t_{CAC}$ .

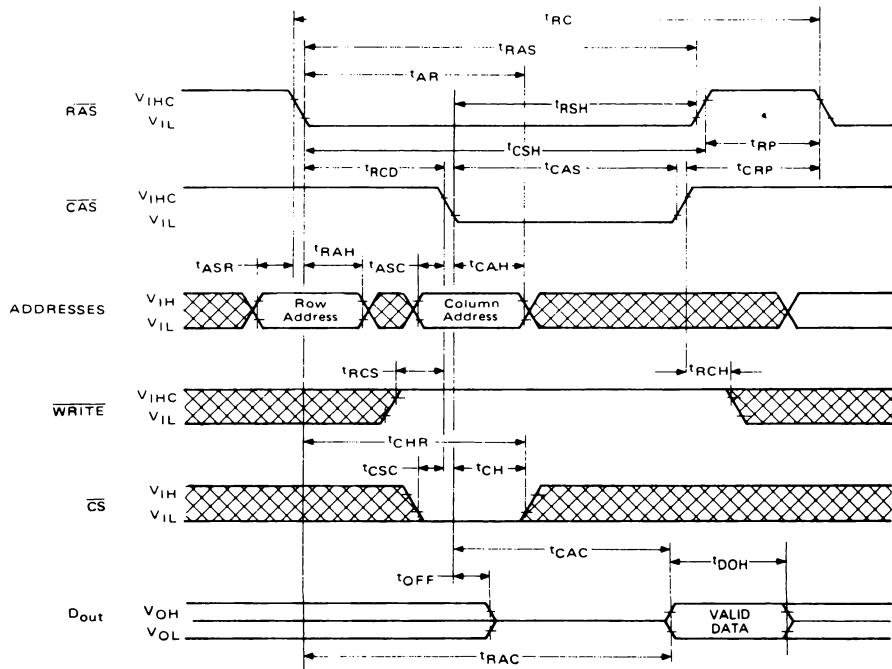
18.  $V_{IH(\text{min})}$  or  $V_{IH(\text{min})}$  and  $V_{IL(\text{max})}$  are reference levels for measuring timing of input signals. Also, transition times are measured between  $V_{IH(\text{min})}$  or  $V_{IH(\text{min})}$  and  $V_{IL(\text{max})}$ .

19. These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify write cycles.

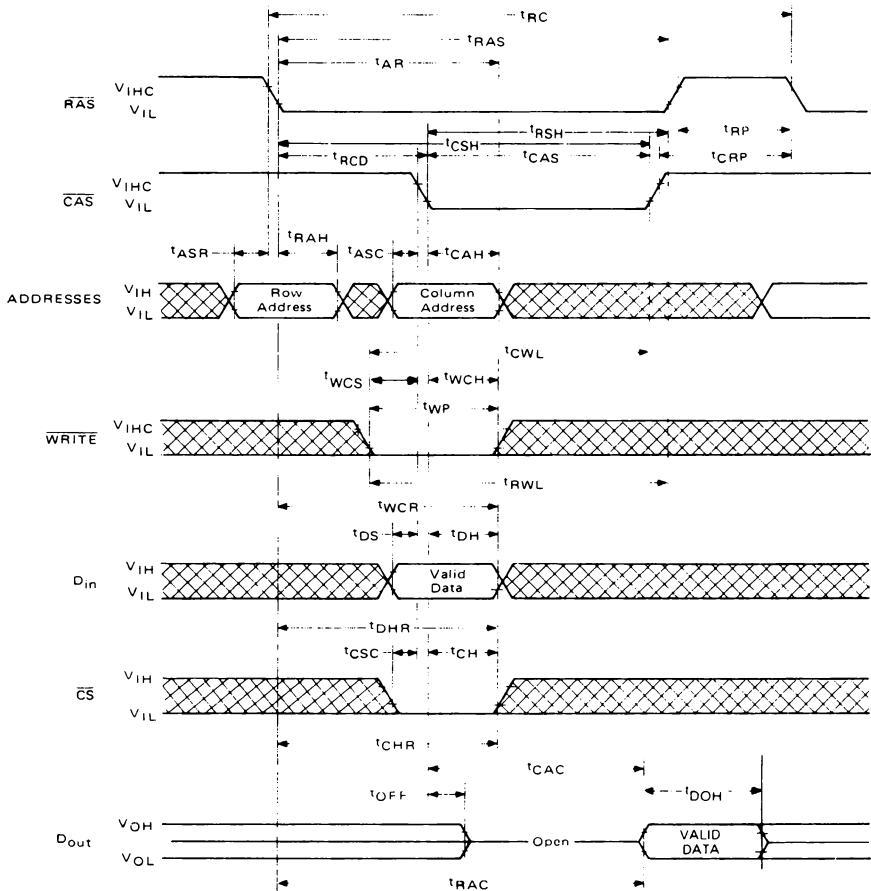
20.  $t_{WCS}$ ,  $t_{CWD}$ , and  $t_{RWD}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: If  $t_{WCS} \geq t_{WCS}(\text{min})$ , the cycle is an early write cycle and Data Out will contain the data written into the selected cell. If  $t_{CWD} \geq t_{CWD}(\text{min})$  and  $t_{RWD} \geq t_{RWD}(\text{min})$ , the cycle is a read-write cycle and Data Out will contain data read from the selected cell. If neither of the above sets of conditions is satisfied, the condition of Data Out (at access time) is indeterminate.

# MCM4027A

## READ CYCLE TIMING

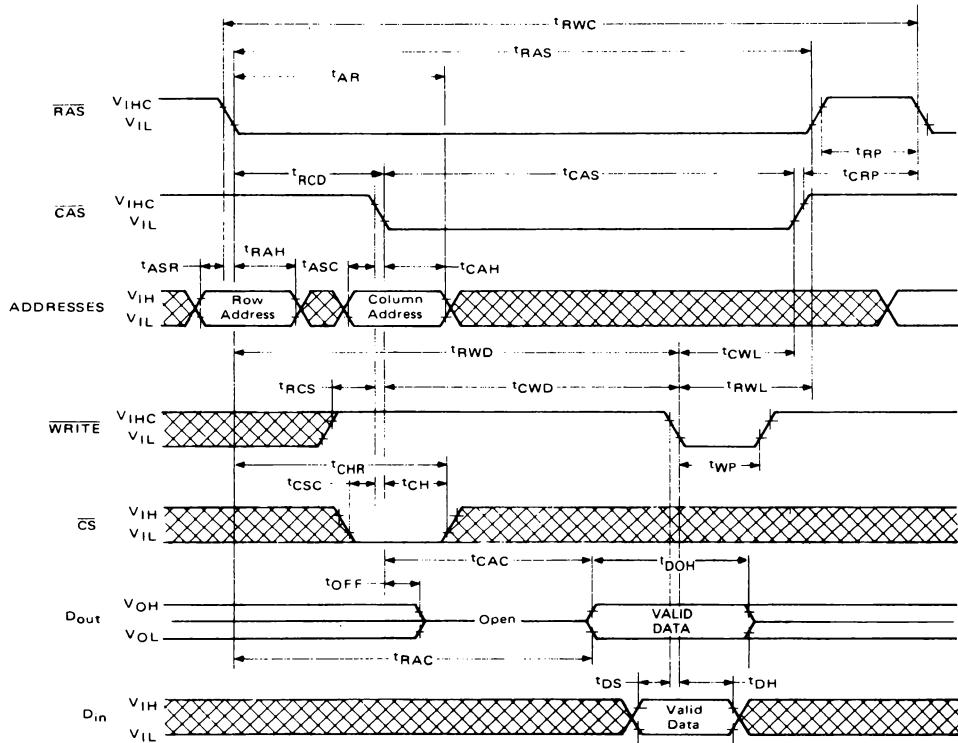


## WRITE CYCLE TIMING

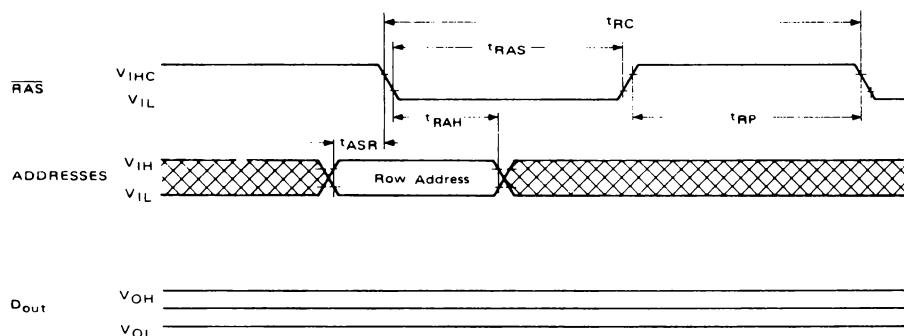


# MCM4027A

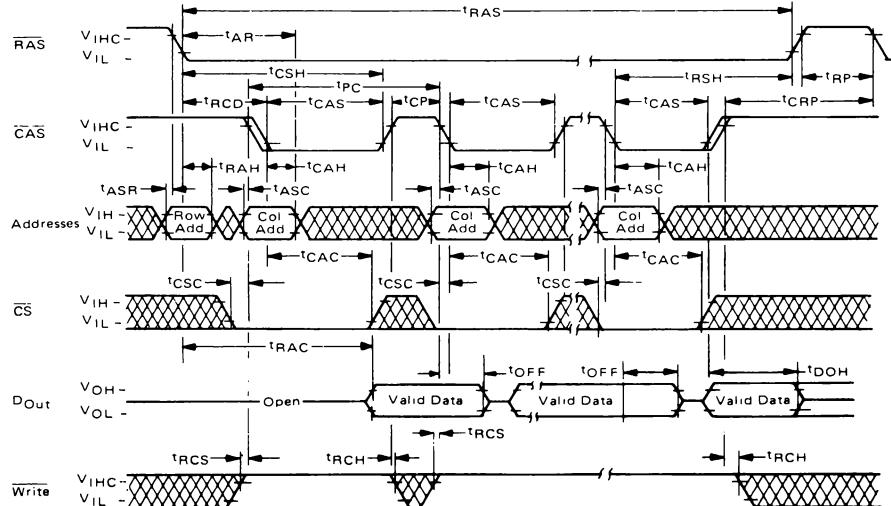
## READ-MODIFY-WRITE TIMING



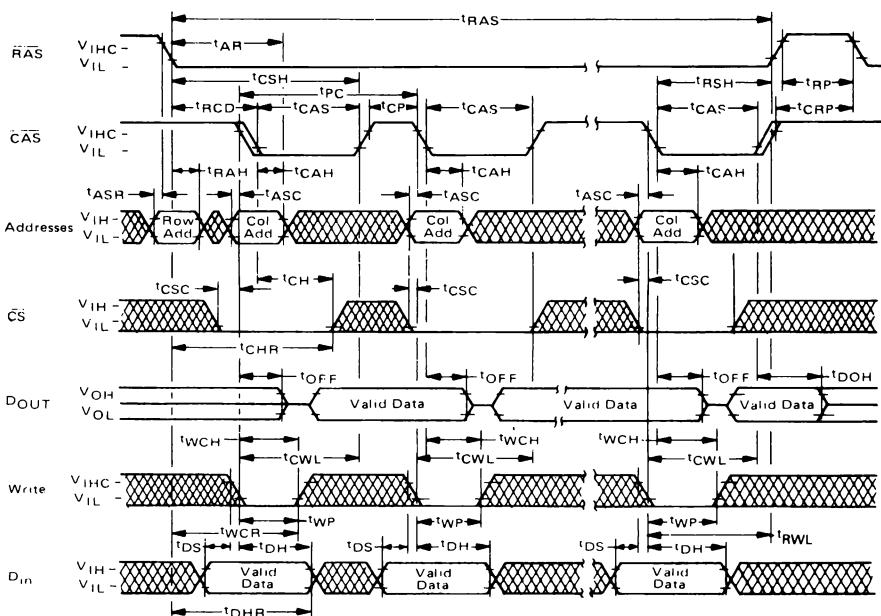
## RAS ONLY REFRESH TIMING



## PAGE MODE READ CYCLE



## PAGE MODE WRITE CYCLE



MCM4027A

MCM4027A BIT ADDRESS MAP



# MOTOROLA

## 16,384-BIT DYNAMIC RANDOM ACCESS MEMORY

The MCM4116B is a 16,384-bit, high-speed dynamic Random Access Memory designed for high-performance, low-cost applications in mainframe and buffer memories and peripheral storage. Organized as 16,384 one-bit words and fabricated using Motorola's highly reliable N-channel double-polysilicon technology, this device optimizes speed, power, and density tradeoffs.

By multiplexing row and column address inputs, the MCM4116B requires only seven address lines and permits packaging in Motorola's standard 16-pin dual in-line packages. This packaging technique allows high system density and is compatible with widely available automated test and insertion equipment. Complete address decoding is done on chip with address latches incorporated.

All inputs are TTL compatible, and the output is 3-state TTL compatible. The data output of the MCM4116B is controlled by the column address strobe and remains valid from access time until the column address strobe returns to the high state. This output scheme allows higher degrees of system design flexibility such as common input/output operation and two dimensional memory selection by decoding both row address and column address strobes.

The MCM4116B incorporates a one-transistor cell design and dynamic storage techniques, with each of the 128 row addresses requiring a refresh cycle every 2 milliseconds.

- Flexible Timing with Read-Modify-Write, RAS-Only Refresh, and Page-Mode Capability
- Industry Standard 16-Pin Package
- 16,384 X 1 Organization
- $\pm 10\%$  Tolerance on All Power Supplies
- All Inputs are Fully TTL Compatible
- Three-State Fully TTL-Compatible Output
- Common I/O Capability When Using "Early Write" Mode
- On-Chip Latches for Addresses and Data In
- Low Power Dissipation — 463 mW Active, 20 mW Standby (Max)
- Fast Access Time Options: 150 ns — MCM4116BP-15, BC-15  
200 ns — MCM4116BP-20, BC-20  
250 ns — MCM4116BP-25, BC-25  
300 ns — MCM4116BP-30, BC-30
- Easy Upgrade from 16-Pin 4K RAMs

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>BB</sub>	V <sub>in</sub> , V <sub>out</sub>	-0.5 to +20	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1.0	W
Data Out Current	I <sub>out</sub>	50	mA

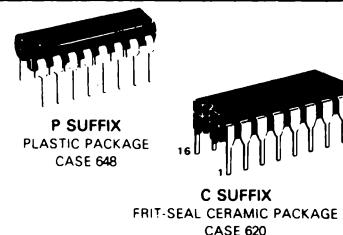
NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

## MCM4116B

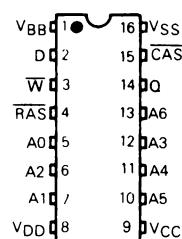
### MOS

(N-CHANNEL)

## 16,384-BIT DYNAMIC RANDOM ACCESS MEMORY



### PIN ASSIGNMENT



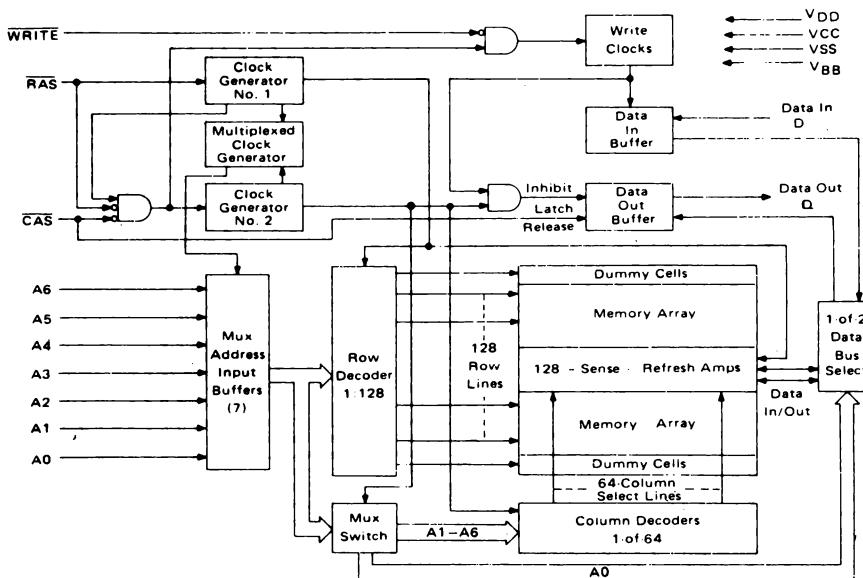
### PIN NAMES

A0-A6	Address Inputs
CAS	Column Address Strobe
D	Data In
O	Data Out
RAS	Row Address Strobe
W	Read/Write Input
V <sub>BB</sub>	Power (-5 V)
V <sub>CC</sub>	Power (+5 V)
V <sub>DD</sub>	Power (+12 V)
V <sub>SS</sub>	Ground

This device contains 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 this high impedance circuit.

# MCM4116B

BLOCK DIAGRAM



**DC OPERATING CONDITIONS AND CHARACTERISTICS**  
(Full operating voltage and temperature range unless otherwise noted.)

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage						
V <sub>DD</sub>	V <sub>DD</sub>	10.8	12.0	13.2	V	1
V <sub>CC</sub>	V <sub>CC</sub>	4.5	5.0	5.5	V	1, 2
V <sub>SS</sub>	V <sub>SS</sub>	0	0	0	V	1
V <sub>BB</sub>	V <sub>BB</sub>	-4.5	-5.0	-5.5	V	1
Logic 1 Voltage, RAS, CAS, WRITE	V <sub>IHC</sub>	2.4	—	7.0	V	1
Logic 1 Voltage, all inputs except RAS, CAS, WRITE	V <sub>IH</sub>	2.4	—	7.0	V	1
Logic 0 Voltage, all inputs	V <sub>IL</sub>	-1.0	—	0.8	V	1

**DC CHARACTERISTICS (V<sub>DD</sub> = 12 V ± 10%, V<sub>CC</sub> = 5.0 V ± 10%, V<sub>BB</sub> = -5.0 V ± 10%, V<sub>SS</sub> = 0 V, T<sub>A</sub> = 0 to 70°C.)**

Characteristic	Symbol	Min	Max	Units	Notes
Average V <sub>DD</sub> Power Supply Current	I <sub>DD1</sub>	—	35	mA	4
V <sub>CC</sub> Power Supply Current	I <sub>CC</sub>	—	—	mA	5
Average V <sub>BB</sub> Power Supply Current	I <sub>BB1,3</sub>	—	200	μA	
Standby V <sub>BB</sub> Power Supply Current	I <sub>BB2</sub>	—	100	μA	
Standby V <sub>DD</sub> Power Supply Current	I <sub>DD2</sub>	—	1.5	mA	6
Average V <sub>DD</sub> Power Supply Current during "RAS only" cycles	I <sub>DD3</sub>	—	27	mA	4
Input Leakage Current (any input)	I <sub>I(L)</sub>	—	10	μA	
Output Leakage Current	I <sub>O(L)</sub>	—	10	μA	6, 7
Output Logic 1 Voltage @ I <sub>out</sub> = -5 mA	V <sub>OH</sub>	2.4	—	V	2
Output Logic 0 Voltage @ I <sub>out</sub> = +4.2 mA	V <sub>OL</sub>	—	0.4	V	

**NOTES:**

- All voltages referenced to V<sub>SS</sub>. V<sub>BB</sub> must be applied before and removed after other supply voltages.
- Output voltage will swing from V<sub>SS</sub> to V<sub>CC</sub> under open circuit conditions. For purposes of maintaining data in power down mode, V<sub>CC</sub> may be reduced to V<sub>SS</sub> without affecting refresh operations. V<sub>OH(min)</sub> specification is not guaranteed in this mode.
- Several cycles are required after power-up before proper device operation is achieved. Any 8 cycles which perform refresh are adequate.
- Current is proportional to cycle rate; maximum current is measured at the fastest cycle rate.
- I<sub>CC</sub> depends upon output loading. The V<sub>CC</sub> supply is connected to the output buffer only.
- Output is disabled (open-circuit) when CAS is at a logic 1.
- 0 V ≤ V<sub>out</sub> ≤ +5.5 V.

**CAPACITANCE** (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5 V, periodically sampled rather than 100% tested) (See Note 8)

Parameter	Symbol	Typ	Max	Unit	Notes
Input Capacitance (A0-A5), D <sub>in</sub>	C <sub>I1</sub>	4.0	5.0	pF	9
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8.0	10	pF	9
Output Capacitance (D <sub>out</sub> )	C <sub>O</sub>	5.0	7.0	pF	7, 9

## AC OPERATING CONDITIONS AND CHARACTERISTICS (See Notes 3, 9, 14)

## READ, WRITE, AND READ-MODIFY-WRITE CYCLES

(V<sub>DD</sub> = 12 V ± 10%, V<sub>CC</sub> = 5.0 V ± 10%, V<sub>BB</sub> = -5.0 V ± 10%, V<sub>SS</sub> = 0 V, T<sub>A</sub> = 0 to 70°C.)

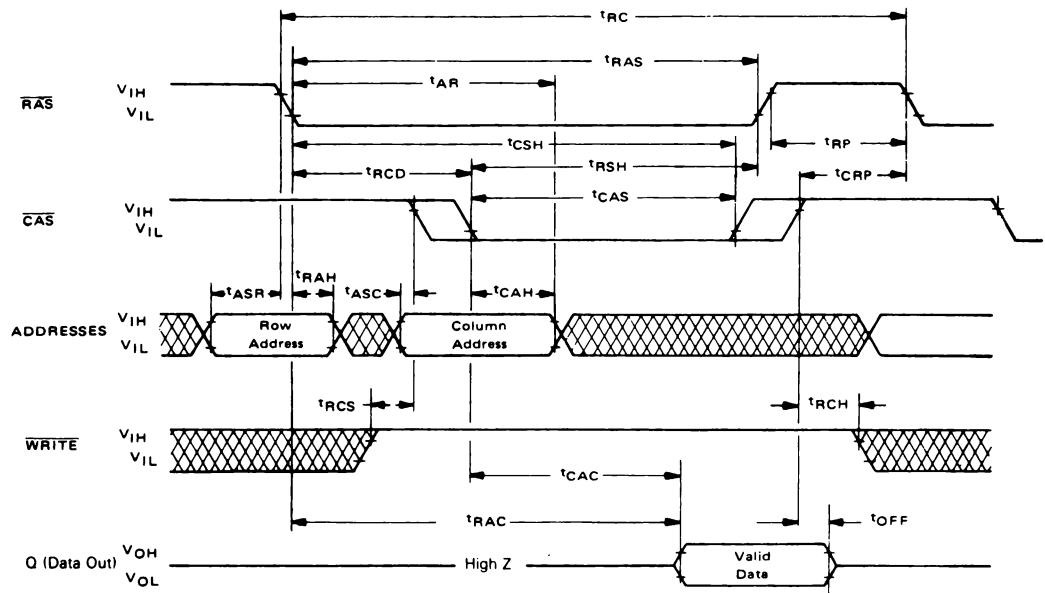
Parameter	Symbol	MCM4116B-15		MCM4116B-20		MCM4116B-25		MCM4116B-30		Units	Notes
		Min	Max	Min	Max	Min	Max	Min	Max		
Random Read or Write Cycle Time	t <sub>RC</sub>	375	—	375	—	410	—	480	—	ns	
Read Write Cycle Time	t <sub>RWC</sub>	375	—	375	—	515	—	660	—	ns	
Access Time from Row Address Strobe	t <sub>RAC</sub>	—	150	—	200	—	250	—	300	ns	10, 12
Access Time from Column Address Strobe	t <sub>CAC</sub>	—	100	—	135	—	165	—	200	ns	11, 12
Output Buffer and Turn-off Delay	t <sub>OFF</sub>	0	50	0	50	0	60	0	60	ns	17
Row Address Strobe Precharge Time	t <sub>RP</sub>	100	—	120	—	150	—	180	—	ns	
Row Address Strobe Pulse Width	t <sub>RAS</sub>	150	10,000	200	10,000	250	10,000	300	10,000	ns	
Column Address Strobe Pulse Width	t <sub>CAS</sub>	100	10,000	135	10,000	165	10,000	200	10,000	ns	
Row to Column Strobe Lead Time	t <sub>RCD</sub>	20	50	25	65	35	85	60	100	ns	13
Row Address Setup Time	t <sub>ASR</sub>	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t <sub>RAH</sub>	20	—	25	—	35	—	60	—	ns	
Column Address Setup Time	t <sub>ASC</sub>	-10	—	-10	—	-10	—	-10	—	ns	
Column Address Hold Time	t <sub>CAH</sub>	45	—	55	—	75	—	100	—	ns	
Column Address Hold Time Referenced to RAS	t <sub>AR</sub>	95	—	120	—	160	—	200	—	ns	
Transition Time (Rise and Fall)	t <sub>T</sub>	3.0	35	3.0	50	3.0	50	3.0	50	ns	14
Read Command Setup Time	t <sub>RCS</sub>	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time	t <sub>RCH</sub>	0	—	0	—	0	—	0	—	ns	
Write Command Hold Time	t <sub>WCH</sub>	45	—	55	—	75	—	100	—	ns	
Write Command Hold Time Referenced to RAS	t <sub>WCR</sub>	95	—	120	—	160	—	200	—	ns	
Write Command Pulse Width	t <sub>WP</sub>	45	—	55	—	75	—	100	—	ns	
Write Command to Row Strobe Lead Time	t <sub>RWL</sub>	60	—	80	—	100	—	180	—	ns	
Write Command to Column Strobe Lead Time	t <sub>CWL</sub>	60	—	80	—	100	—	180	—	ns	
Data in Setup Time	t <sub>DS</sub>	0	—	0	—	0	—	0	—	ns	15
Data in Hold Time	t <sub>DH</sub>	45	—	55	—	75	—	100	—	ns	15
Data in Hold Time Referenced to RAS	t <sub>DHR</sub>	95	—	120	—	160	—	200	—	ns	
Column to Row Strobe Precharge Time	t <sub>CRP</sub>	-20	—	-20	—	-20	—	-20	—	ns	
RAS Hold Time	t <sub>RSH</sub>	100	—	135	—	165	—	200	—	ns	
Refresh Period	t <sub>RFSH</sub>	—	2.0	—	2.0	—	2.0	—	2.0	ms	
WRITE Command Setup Time	t <sub>WCS</sub>	-20	—	-20	—	-20	—	-20	—	ns	
CAS to WRITE Delay	t <sub>CWD</sub>	70	—	95	—	125	—	180	—	ns	16
RAS to WRITE Delay	t <sub>RWD</sub>	120	—	160	—	210	—	280	—	ns	16
CAS Precharge Time (Page mode cycle only)	t <sub>CP</sub>	60	—	80	—	100	—	100	—	ns	
Page Mode Cycle Time	t <sub>PC</sub>	170	—	225	—	275	—	325	—	ns	
CAS Hold Time	t <sub>CSH</sub>	150	—	200	—	250	—	300	—	ns	

## NOTES: (continued)

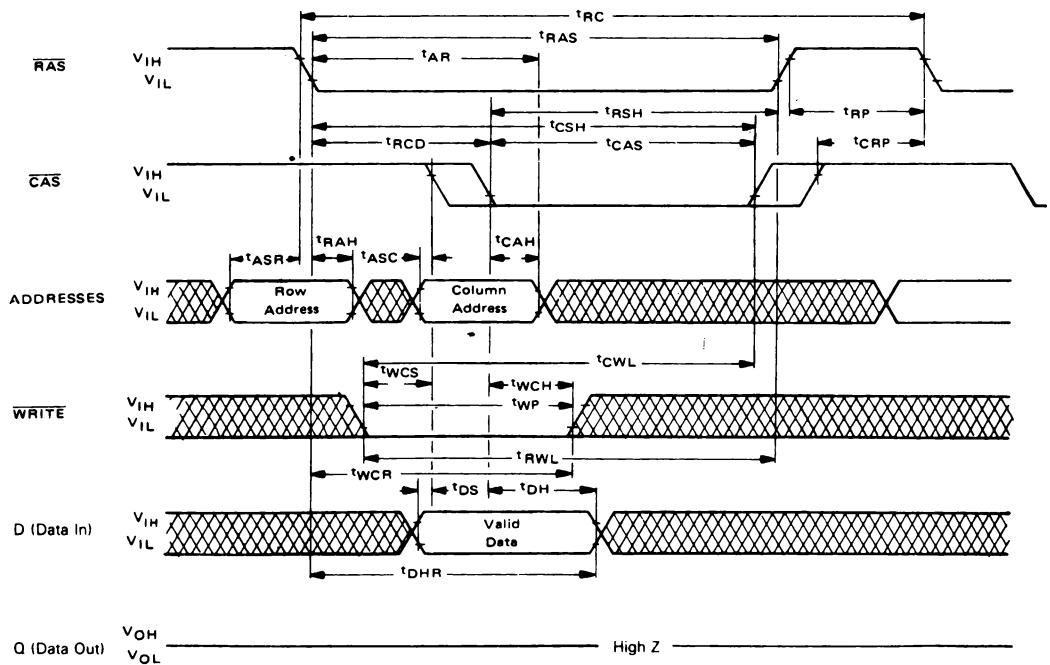
8. Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation  $C = \frac{I_{\Delta} t}{\Delta V}$ .
9. AC measurements assume  $t_T = 5.0$  ns.
10. Assumes that  $t_{RCD} + t_T \leq t_{RCD}$  (max).
11. Assumes that  $t_{RCD} + t_T \geq t_{RCD}$  (max).
12. Measured with a load circuit equivalent to 2 TTL loads and 100 pF.
13. Operation within the  $t_{RCD}$  (max) limit ensures that  $t_{RAC}$  (max) can be met.  $t_{RCD}$  (max) is specified as a reference point only; if  $t_{RCD}$  is greater than the specified  $t_{RCD}$  (max) limit, then access time is controlled exclusively by  $t_{CAC}$ .
14. VI<sub>H</sub> (min) or VI<sub>H</sub> (min) and VI<sub>L</sub> (max) are reference levels for measuring timing of input signals. Also, transition times are measured between VI<sub>H</sub> or VI<sub>H</sub> and VI<sub>L</sub>.
15. These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
16. t<sub>WCS</sub>, t<sub>CWD</sub> and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: If  $t_{WCS} \geq t_{WCS}$  (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if  $t_{CWD} \geq t_{CWD}$  (min) and  $t_{RWD} \geq t_{RWD}$  (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
17. Assumes that  $t_{CRP} > 50$  ns.

# MCM4116B

## READ CYCLE TIMING

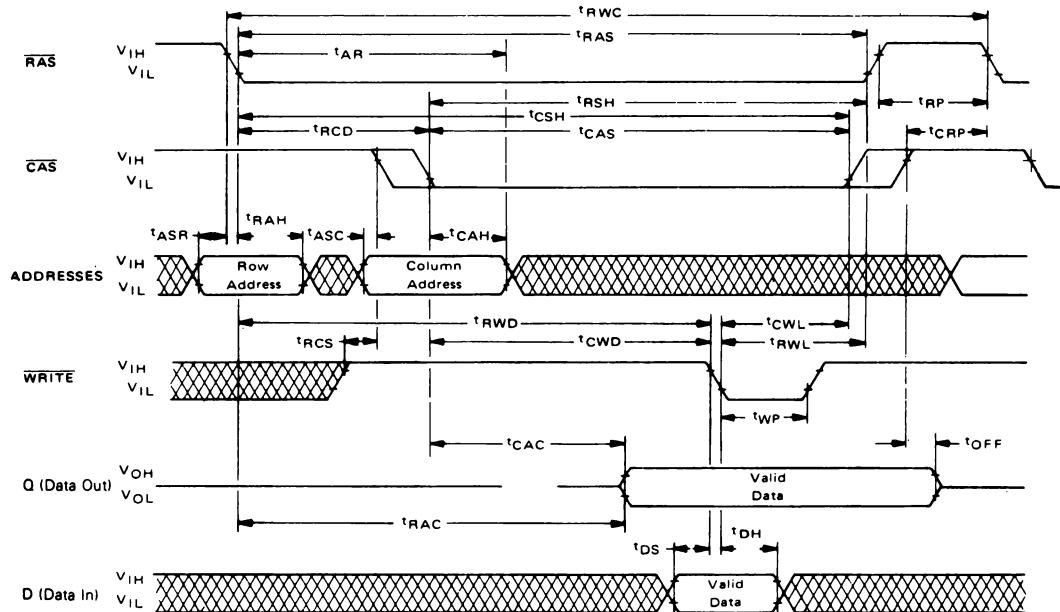


## WRITE CYCLE TIMING



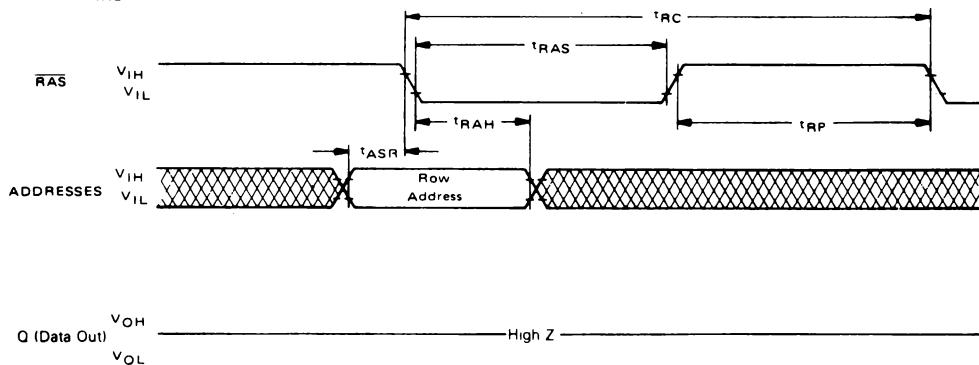
# MCM4116B

## READ-WRITE/READ-MODIFY-WRITE CYCLE

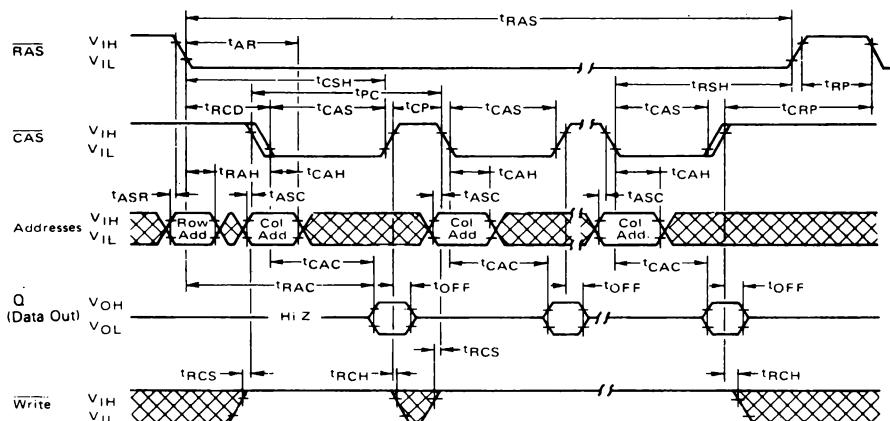


## RAS ONLY REFRESH TIMING

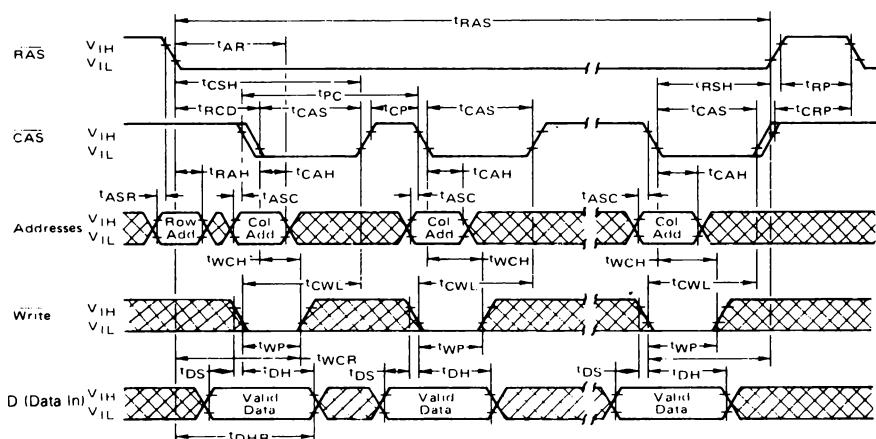
Note:  $\overline{\text{CAS}} = \text{VIHC}$ ,  $\overline{\text{WRITE}} = \text{Don't Care}$



## PAGE MODE READ CYCLE



## PAGE MODE WRITE CYCLE



# MCM4116B

## MCM4116B BIT ADDRESS MAP

Row Address A6 A5 A4 A3 A2 A1 A0										Column Addresses							
Column Address A6 A5 A4 A3 A2 A1 A0										Pin 8							
Rows										Columns							
A6 A5 A4 A3 A2 A1 A0 Dec Hex										Pin 8							
0	0	0	0	0	0	0	0	0	0	76	118	1	1	1	0	1	1
0	0	0	0	0	0	0	0	1	0	77	119	1	1	1	0	1	1
0	0	0	0	0	0	0	1	0	0	16	22	0	0	1	0	1	1
0	0	0	0	0	0	1	0	1	0	17	23	0	0	1	0	1	1
0	0	0	0	0	1	0	2	0	2	14	20	0	0	1	0	1	0
0	0	0	0	1	0	3	0	3	0003	15	21	0	0	1	0	1	0
0	0	0	1	0	4	0	4	0	0004	12	18	0	0	1	0	0	1
0	0	0	1	0	5	0	5	0	0005	13	19	0	0	1	0	0	1
0	0	0	1	0	6	0	6	0	0006	10	16	0	0	1	0	0	0
0	0	0	1	1	7	0	7	0	0007	11	17	0	0	1	0	0	1
0	0	0	1	1	8	0	8	0	0008	1E	30	0	0	1	1	1	0
0	0	1	1	1	63	3F				1F	31	0	0	1	1	1	1
0	1	0	0	0	0	64	40			1C	28	0	0	1	1	1	0
0	1	0	0	0	1	1	1	1	007F	1D	29	0	0	1	1	1	0
0	1	0	0	1	1	2	2	0002		1A	26	0	0	1	1	0	1
0	1	0	1	0	3	0	3	0003		1B	27	0	0	1	1	0	1
0	1	1	0	1	4	0	4	0004		18	24	0	0	1	1	0	0
0	1	1	1	0	5	0	5	0005		19	25	0	0	1	1	0	1
0	1	1	1	1	6	0	6	0006		OE	14	0	0	0	1	1	0
0	1	1	1	1	7	0	7	0007		OF	15	0	0	0	1	1	1
0	1	1	1	1	8	0	8	0008		OC	12	0	0	0	1	1	0
0	1	1	1	1	9					OD	13	0	0	0	1	1	0
0	1	1	1	1	10					OA	10	0	0	0	1	0	1
0	1	1	1	1	11					OB	11	0	0	0	1	0	1
0	1	1	1	1	12					08	8	0	0	0	1	0	0
0	1	1	1	1	13					09	9	0	0	0	1	0	1
0	1	1	1	1	14					06	6	0	0	0	0	1	1
0	1	1	1	1	15					07	7	0	0	0	0	1	1
0	1	1	1	1	16					04	4	0	0	0	0	1	0
0	1	1	1	1	17					05	5	0	0	0	0	1	0
0	1	1	1	1	18					02	2	0	0	0	0	0	1
0	1	1	1	1	19					03	3	0	0	0	0	0	1
0	1	1	1	1	20					00	0	0	0	0	0	0	0
0	1	1	1	1	21					01	1	0	0	0	0	0	1



**MOTOROLA**

## Advance Information

### 16,384-BIT DYNAMIC RAM

The MCM4517 is a 16,384-bit, high-speed, dynamic Random-Access Memory. Organized as 16,384 one-bit words and fabricated using HMOS high-performance, N-channel, silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row and column-address inputs, the MCM4517 requires only seven address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by  $\bar{CAS}$  allowing for greater system flexibility.

All inputs and outputs, including clocks, are fully TTL compatible. The MCM4517 incorporates a one-transistor cell design and dynamic storage techniques.

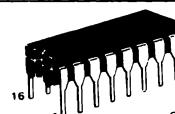
- Organized as 16,384 Words of 1 Bit
- Single +5 Volt Operation
- Fast 100 ns Operation
- Low Power Dissipation:
  - 150 mW Maximum (Active)
  - 14 mW Maximum (Standby)
- Maximum Access Time
  - MCM4517-10 — 100 ns
  - MCM4517-12 — 120 ns
  - MCM4517-15 — 150 ns
  - MCM4517-20 — 200 ns
- Three-State Data Output
- Internal Latches for Address and Data Input
- Early-Write Common I/O Output Capability
- 64K Compatible 128-cycle, 2 ms Refresh
- RAS-only Refresh Mode
- CAS Controlled Output
- Upward Pin Compatibility from the 16K RAM (MCM4116) to the 64K RAM (MCM6664)
- Allows Negative Overshoot  $V_{IL}$  Min = -2 V
- Hidden RAS Only Refresh Capability

**MCM4517**

## MOS

(N-CHANNEL, SILICON-GATE)

### 16,384-BIT DYNAMIC RAM



C SUFFIX  
CERAMIC PACKAGE  
CASE 620-06



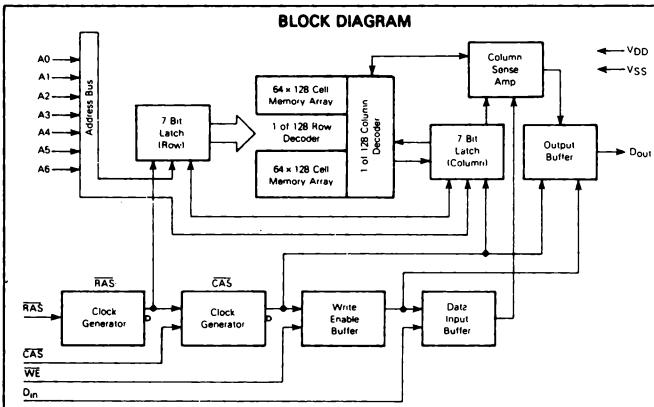
P SUFFIX  
PLASTIC PACKAGE  
CASE 648-05

#### PIN ASSIGNMENT

N/C	1	16	VSS
D	2	15	CAS
W	3	14	Q
RAS	4	13	A6
A0	5	12	A3
A2	6	11	A4
A1	7	10	A5
VCC	8	9	N/C

#### PIN NAMES

A0-A6.....	Address Input
D.....	Data In
Q.....	Data Out
W.....	Read/Write Input
RAS.....	Row Address Strobe
CAS.....	Column Address Strobe
VCC.....	Power (+5 V)
VSS.....	Ground



This device contains 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 this high-impedance circuit.

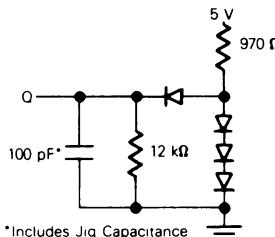
# MCM4517

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to VSS	$V_{in}, V_{out}$	-2 to +7	Vdc
Operating Temperature Range	$T_A$	0 to +70	°C
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Power Dissipation	$P_D$	1.0	W
Data Out Current	$I_{out}$	50	mA

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.

FIGURE 1 – OUTPUT LOAD



\*Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	$V_{CC}$ $V_{SS}$	4.5 0	5.0 0	5.5 0	V	1
Logic 1 Voltage, All Inputs	$V_{IH}$	2.4	—	$V_{CC} + 1$	V	1
Logic 0 Voltage, All Inputs	$V_{IL}$	-2.0	—	0.8	V	1

### DC CHARACTERISTICS

Characteristics	Symbol	Min	Typ	Max	Units	Notes
$V_{CC}$ Supply Current (Standby)	$I_{CC1}$	—	1.2	2.5	mA	5
$V_{CC}$ Supply Current (Operating) 4517-10, $t_{RC} = 225$ 4517-12, $t_{RC} = 250$ 4517-15, $t_{RC} = 300$ 4517-20, $t_{RC} = 350$	$I_{CC2}$	—	22 20 18 16	27 25 23 21	mA	4
$V_{CC}$ Supply Current (RAS-Only Cycle) 4517-10, $t_{RC} = 225$ 4517-12, $t_{RC} = 250$ 4517-15, $t_{RC} = 300$ 4517-20, $t_{RC} = 350$	$I_{CC3}$	—	14 12 11 10	18 16 14 12	mA	4
$V_{CC}$ Standby Current (Standby, Output Enable) ( $\bar{CAS}$ at $V_{IL}$ , $\bar{RAS}$ at $V_{IH}$ )	$I_{CC4}$	—	2.5	5	mA	
Input Leakage Current (Any Input)	$I_{I(L)}$	—	—	10	$\mu$ A	
Output Leakage Current ( $0 \leq V_{out} \leq 5.5$ ) ( $\bar{CAS}$ at Logic 1)	$I_{O(L)}$	—	—	10	$\mu$ A	
Output Logic 1 Voltage@ $I_{out} = -4$ mA	$V_{OH}$	2.4	—	—	V	
Output Logic 0 Voltage@ $I_{out} = 4$ mA	$V_{OL}$	—	—	0.4	V	

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 9, 14 and Figure 1) (Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

### RECOMMENDED AC OPERATING CONDITIONS

Parameter	Symbol	MCM4517-10		MCM4517-12		MCM4518-16		MCM4517-20		Unit	Notes
		Min	Max	Min	Max	Min	Max	Min	Max		
Random Read or Write Cycle Time	$t_{RC}$	225	—	250	—	300	—	350	—	ns	8, 9
Read-Modify-Write Cycle Time	$t_{RWC}$	235	—	270	—	320	—	365	—	ns	8, 9
Access Time from Row Address Strobe	$t_{RAC}$	—	100	—	120	—	150	—	200	ns	10, 12
Access Time from Column Address Strobe	$t_{CAC}$	—	60	—	75	—	95	—	120	ns	11, 12
Output Buffer and Turn-Off Delay	$t_{OFF}$	0	30	0	35	0	40	0	50	ns	18
Row Address Strobe Precharge Time	$t_{RP}$	100	—	110	—	125	—	150	—	ns	
Row Address Strobe Pulse Width	$t_{RAS}$	100	10000	120	10000	150	10000	200	10000	ns	
Column Address Strobe Pulse Width	$t_{CAS}$	60	10000	75	10000	95	10000	120	10000	ns	
Row to Column Strobe Lead Time	$t_{RCD}$	25	40	25	45	25	55	30	80	ns	13
Row Address Setup Time	$t_{ASR}$	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	$t_{RAH}$	15	—	15	—	20	—	25	—	ns	
Column Address Setup Time	$t_{ASC}$	0	—	0	—	0	—	0	—	ns	
Column Address Hold Time	$t_{CAH}$	40	—	45	—	55	—	60	—	ns	
Column Address Hold Time Referenced to RAS	$t_{AR}$	80	—	90	—	110	—	140	—	ns	
Transition Time (Rise and Fall)	$t_T$	3	50	3	50	3	50	3	50	ns	6

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 9, 14 and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

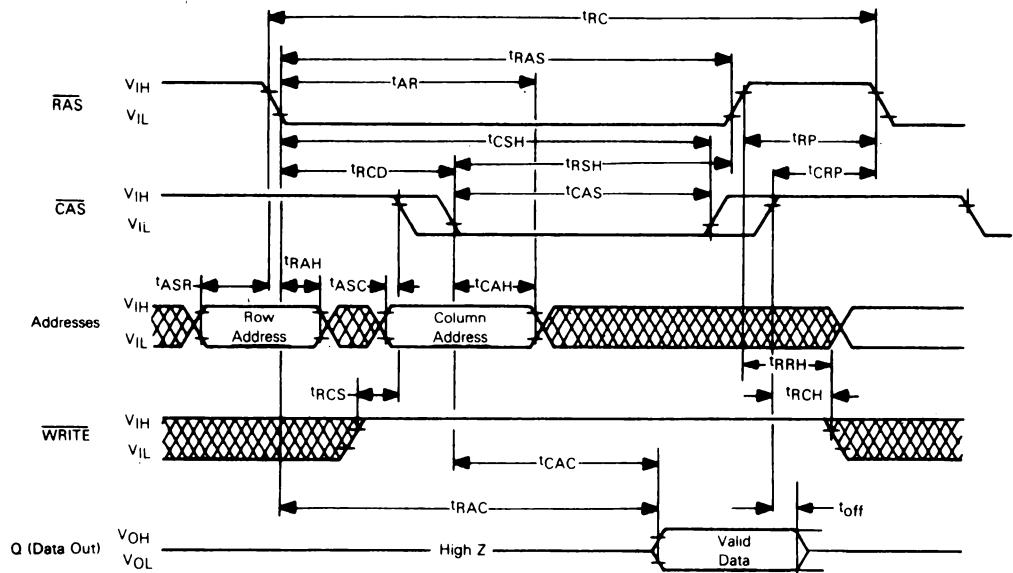
Parameter	Symbol	MCM4517-10		MCM4517-12		MCM4517-16		MCM4517-20		Unit	Notes
		Min	Max	Min	Max	Min	Max	Min	Max		
Read Command Setup Time	t <sub>RCS</sub>	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time	t <sub>RCH</sub>	0	—	0	—	0	—	0	—	ns	14
Read Command Hold Time Referenced to RAS	t <sub>RRH</sub>	20	—	25	—	35	—	40	—		14
Write Command Hold Time	t <sub>WCH</sub>	40	—	45	—	55	—	60	—	ns	
Write Command Hold Time Referenced to RAS	t <sub>WCR</sub>	90	—	100	—	120	—	140	—	ns	
Write Command Pulse Width	t <sub>WP</sub>	30	—	35	—	40	—	45	—	ns	
Write Command to Row Strobe Lead Time	t <sub>RWL</sub>	40	—	45	—	50	—	55	—	ns	
Write Command to Column Strobe Lead Time	t <sub>CWL</sub>	40	—	45	—	50	—	55	—	ns	
Data in Setup Time	t <sub>DS</sub>	0	—	0	—	0	—	0	—	ns	15
Data in Hold Time	t <sub>DH</sub>	40	—	45	—	55	—	60	—	ns	15
Data in Hold Time Referenced to RAS	t <sub>DHR</sub>	80	—	90	—	110	—	140	—	ns	
Column to Row Strobe Precharge Time	t <sub>CRP</sub>	0	—	0	—	0	—	0	—	ns	
RAS Hold Time	t <sub>RSH</sub>	60	—	75	—	95	—	120	—	ns	
Refresh Period	t <sub>REFSH</sub>	—	2.0	—	2.0	—	2.0	—	2.0	ms	
Write Command Setup Time	t <sub>WCS</sub>	0	—	0	—	0	—	0	—	ns	16
CAS to WRITE Delay	t <sub>CWD</sub>	50	—	60	—	75	—	80	—	ns	16
RAS to WRITE Delay	t <sub>RWD</sub>	90	—	110	—	140	—	160	—	ns	16
CAS Hold Time	t <sub>CSH</sub>	100	—	120	—	150	—	200	—	ns	
CAS Precharge, Non Page Mode	t <sub>CPN</sub>	30	—	35	—	40	—	50	—	ns	

CAPACITANCE (f = 1.0 MHz, TA = 25°C, VCC = +5 V. Periodically sampled rather than 100% tested.)

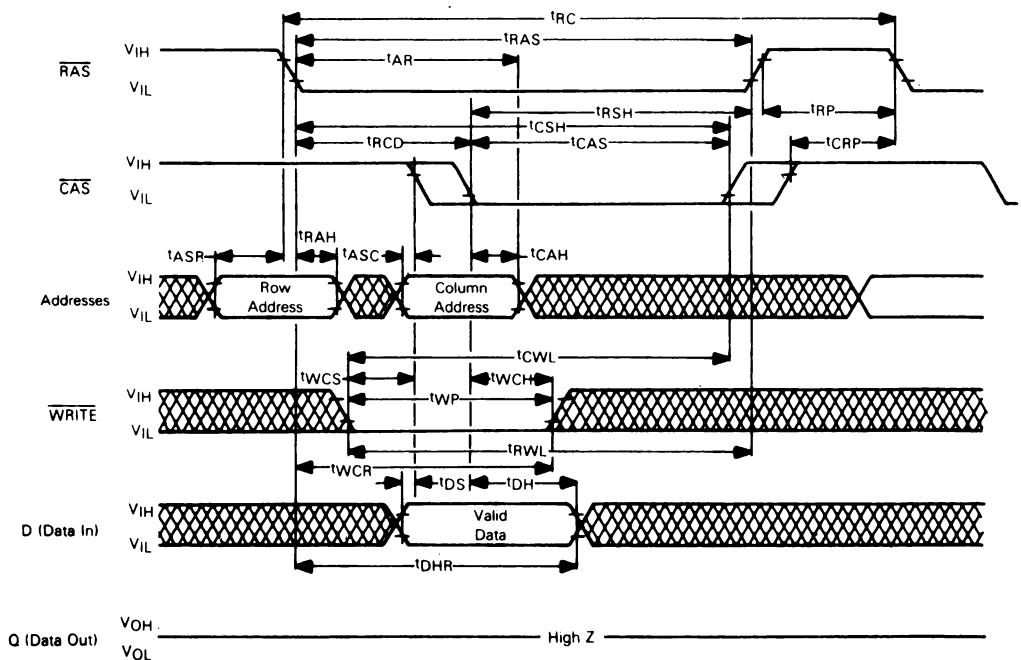
Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A6), D <sub>in</sub>	C <sub>I1</sub>	4.0	5.0	pF	7
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	5.0	7.0	pF	7

- NOTES:
- All voltages referenced to V<sub>SS</sub>.
  - V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
  - An initial pause of 100 µs is required after power-up followed by any 8 RAS cycles before proper device operation guaranteed.
  - Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
  - Output is disabled (open-circuit) and RAS and CAS are both at a logic 1.
  - The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transition between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
  - Capacitance measured with a Booton Meter or effective capacitance calculated from the equation:  $C = \frac{I\Delta t}{\Delta V}$
  - The specifications for t<sub>RC</sub> (min), and t<sub>RW</sub> (min) are used only to indicate cycle time at which proper operation over the full temperature range (0°C ≤ TA ≤ 70°C) is assured.
  - AC measurements assume t<sub>T</sub> = 5.0 ns.
  - Assumes that t<sub>RCD</sub> ≤ t<sub>RC</sub> (Max)
  - Assumes that t<sub>RC</sub> ≥ t<sub>RCD</sub> (Max)
  - Measured with a current load equivalent to 2 TTL loads (+200 µA, -4 mA) and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = 0.8 V).
  - Operation within the t<sub>RC</sub> (max) limit ensures that t<sub>RA</sub> (max) can be met. t<sub>RC</sub> (max) is specified as a reference point only; if t<sub>RC</sub> is greater than the specified t<sub>RC</sub> (max) limit, then access time is controlled exclusively by t<sub>RA</sub>.
  - Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
  - These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
  - t<sub>WCS</sub>, t<sub>CWD</sub>, and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if t<sub>WCS</sub> ≥ t<sub>WCR</sub> (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if t<sub>CWD</sub> ≥ t<sub>WCR</sub> (min) and t<sub>RWD</sub> ≥ t<sub>RWD</sub> (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
  - Addresses, data-in and WRITE are don't care. Data-out depends on the state of CAS. If CAS remains low, the previous output will remain valid. CAS is allowed to make an active to inactive transition during the RAS-only refresh cycle. When CAS is brought high, the output will assume a high-impedance state.
  - t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

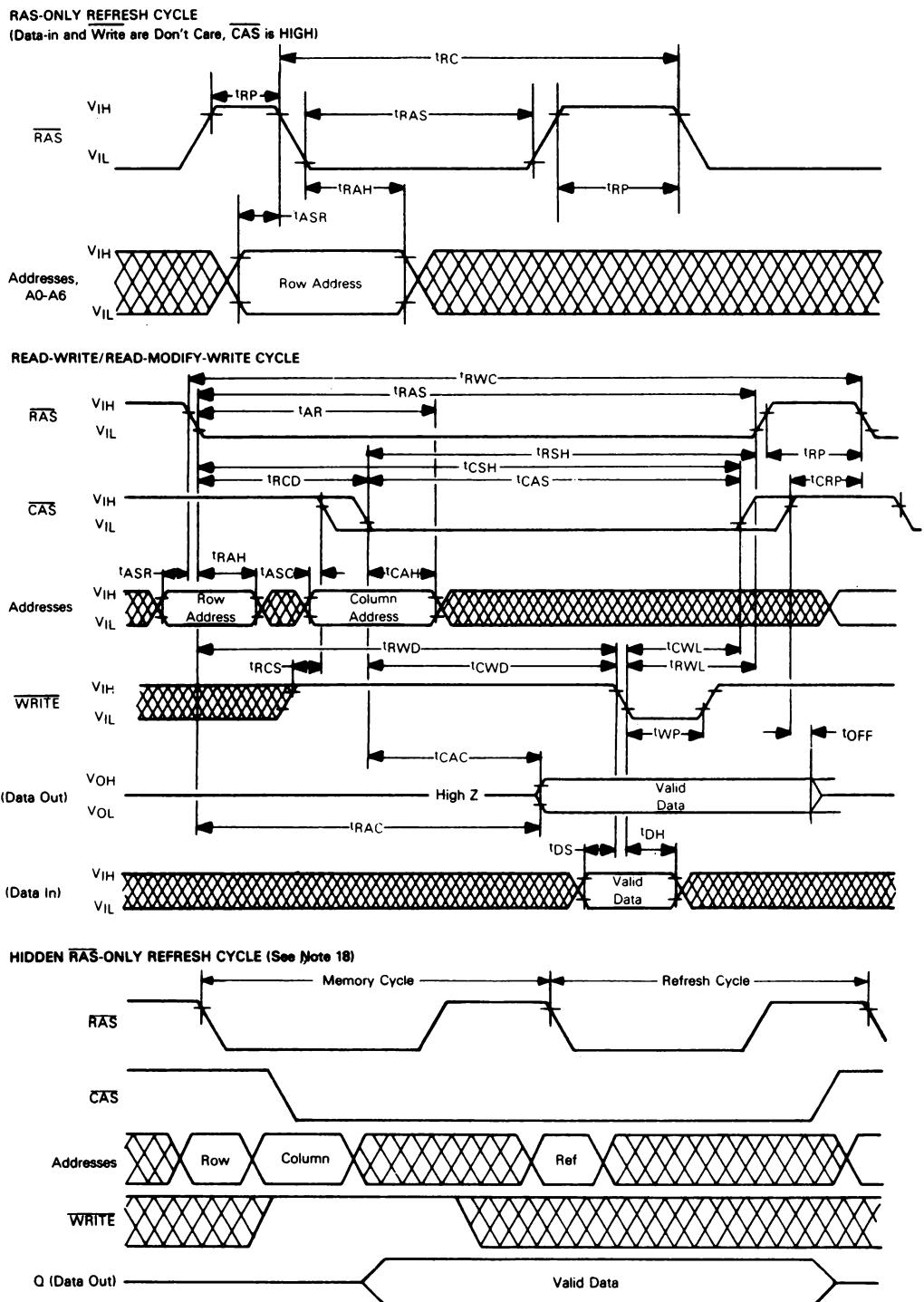
## READ CYCLE TIMING



## WRITE CYCLE TIMING

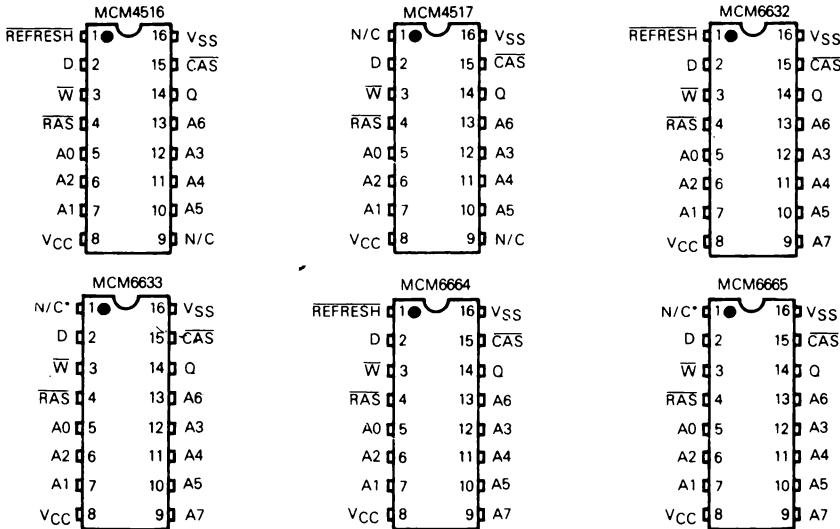


# MCM4517



# MCM4517

## PIN ASSIGNMENT COMPARISON



## PIN VARIATIONS

Pin Number	MCM4116	MCM4516	MCM4517	MCM6632	MCM6633	MCM6664	MCM6665
1	$V_{BB}(-5\text{ V})$	REFRESH	N/C	REFRESH	N/C*	REFRESH	N/C*
8	$V_{DD}(+12\text{ V})$	VCC	VCC	VCC	VCC	VCC	VCC
9	$V_{CC}(+5\text{ V})$	N/C	N/C	A7	A7	A7	A7

\*Internal pullup resistor should be left open or tied to VCC



**MOTOROLA**

**MCM6632**

### 32,768-BIT DYNAMIC RAM

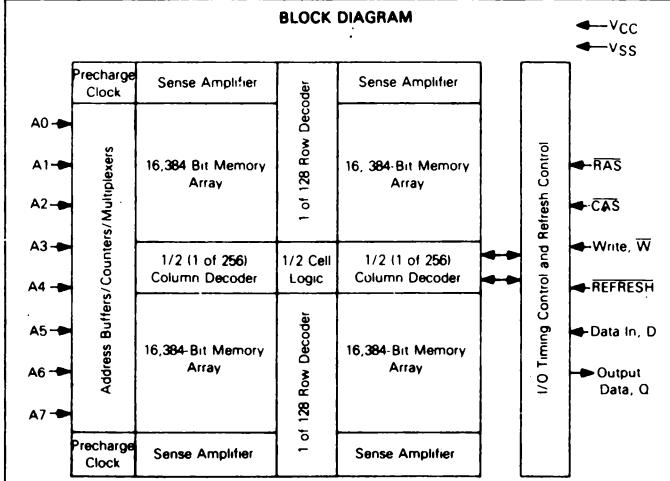
The MCM6632 is a 32,768 bit, high-speed, dynamic Random-Access Memory. Organized as 32,768 one-bit words and fabricated using HMOS high-performance N-channel silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row- and column-address inputs, the MCM6632 requires only eight address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by CAS allowing for greater system flexibility.

All inputs and outputs, including clocks, are fully TTL compatible. The MCM6632 incorporates a one-transistor cell design and dynamic storage techniques. In addition to the RAS-only refresh mode, refresh control function available on pin 1 provides automatic and self-refresh modes.

- Organized as 32,768 Words of 1 Bit
- Single +5 V Operation
- Fast 150 ns Operation
- Low Power Dissipation
  - 275 mW Maximum (Active)
  - 30 mW Maximum (Standby)
- Three-State Data Output
- Internal Latches for Address and Data Input
- Early-Write Common I/O Capability
- 16K Compatible 128-Cycle, 2 ms Refresh
- Control on Pin 1 for Automatic and Self Refresh
- RAS-only Refresh Mode
- CAS Controlled Output
- Upward Pin Compatible from the 16K RAM (MCM4116)
- One Half of the 64K RAM MCM6664
- The Operating Half of the MCM6632 is Indicated by Device Marking:  
MCM66320 Tie A7 CAS (A15) Low "0"  
MCM66321 Tie A7 CAS (A15) High "1"

### BLOCK DIAGRAM



**MOS**

(N-CHANNEL, SILICON-GATE)

### 32,768-BIT DYNAMIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 690

### PIN ASSIGNMENT

REFRESH	1	16	VSS
D	2	15	CAS
W	3	14	Q
RAS	4	13	A6
A0	5	12	A3
A2	6	11	A4
A1	7	10	A5
VCC	8	9	A7

PIN NAMES	
REFRESH	Refresh
A0-A7	Address Input
D	Data In
Q	Data Out
W	Read/Write Input
RAS	Row Address Strobe
CAS	Column Address Strobe
VCC	Power (+5 V)
VSS	Ground

This device contains 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 this high-impedance circuit.

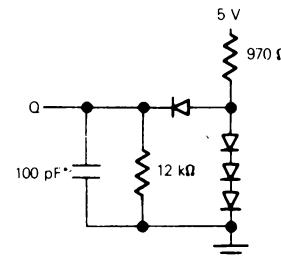
# MCM6632

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>SS</sub> (except V <sub>CC</sub> )	V <sub>IN</sub> , V <sub>OUT</sub>	-2 to +7	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>IN</sub> , V <sub>OUT</sub>	-1 to +7	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1.0	W
Data Out Current	I <sub>OUT</sub>	50	mA

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.

FIGURE 1 – OUTPUT LOAD



\*Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	MCM6664-15, -20	V <sub>CC</sub>	4.5	5.0	5.5	V 1
		V <sub>SS</sub>	0	0	0	V 1
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.4	–	V <sub>CC</sub> +1	V 1	
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-2.0	–	0.8	V 1	

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Units	Notes
V <sub>CC</sub> Power Supply Current (I <sub>RC</sub> min.)	I <sub>CC1</sub>	–	50	mA	4
Standby V <sub>CC</sub> Power Supply Current	I <sub>CC2</sub>	–	5	mA	5
V <sub>CC</sub> Power Supply Current During RAS Only Refresh Cycles	I <sub>CC3</sub>	–	40	mA	–
Input Leakage Current (any input) (except REFRESH) (V <sub>SS</sub> ≤ V <sub>IN</sub> ≤ V <sub>CC</sub> )	I <sub>IL(L)</sub>	–	10	μA	–
REFRESH Input Current (V <sub>F</sub> = V <sub>SS</sub> )	I <sub>F</sub>	–	125	μA	–
Output Leakage Current (CAS at logic 1, 0 ≤ V <sub>OUT</sub> ≤ 5.5)	I <sub>O(L)</sub>	–	10	μA	–
Output Logic 1 Voltage @ I <sub>OUT</sub> = -4 mA	V <sub>OH</sub>	2.4	–	V	–
Output Logic 0 Voltage @ I <sub>OUT</sub> = 4 mA	V <sub>OL</sub>	–	0.4	V	–

CAPACITANCE (f = 0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5 V. Periodically Sampled Rather Than 100% Tested)

Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A7), D <sub>IN</sub>	C <sub>I</sub>	4	5	pF	7
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8	10	pF	7
Output Capacitance (D <sub>OUT</sub> ) (CAS = V <sub>IH</sub> to disable output)	C <sub>O</sub>	5	7	pF	7

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6632-15		MCM6632-20		Units	Notes
		Min	Max	Min	Max		
Random Read or Write Cycle Time	t <sub>RC</sub>	300	–	350	–	ns	8, 9
Read Write Cycle Time	t <sub>RWC</sub>	300	–	350	–	ns	8, 9
Access Time from Row Address Strobe	t <sub>RAC</sub>	–	150	–	200	ns	10, 12
Access Time from Column Address Strobe	t <sub>CAC</sub>	–	75	–	110	ns	11, 12
Output Buffer Turn-Off Delay	t <sub>OFF</sub>	0	30	0	40	ns	18
Row Address Strobe Precharge Time	t <sub>RP</sub>	120	–	140	–	ns	–
Row Address Strobe Pulse Width	t <sub>RAS</sub>	150	10000	200	10000	ns	–
Column Address Strobe Pulse Width	t <sub>CAS</sub>	75	10000	110	10000	ns	–
Row to Column Strobe Lead Time	t <sub>RCD</sub>	30	75	35	90	ns	13
Row Address Setup Time	t <sub>ASR</sub>	0	–	0	–	ns	–
Row Address Hold Time	t <sub>RAH</sub>	25	–	30	–	ns	–
Column Address Setup Time	t <sub>ASC</sub>	0	–	0	–	ns	–
Column Address Hold Time	t <sub>CAH</sub>	45	–	55	–	ns	–
Column Address Hold Time Referenced to RAS	t <sub>AR</sub>	120	–	155	–	ns	–
Transition Time (Rise and Fall)	t <sub>T</sub>	3	50	3	50	ns	6

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6 and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

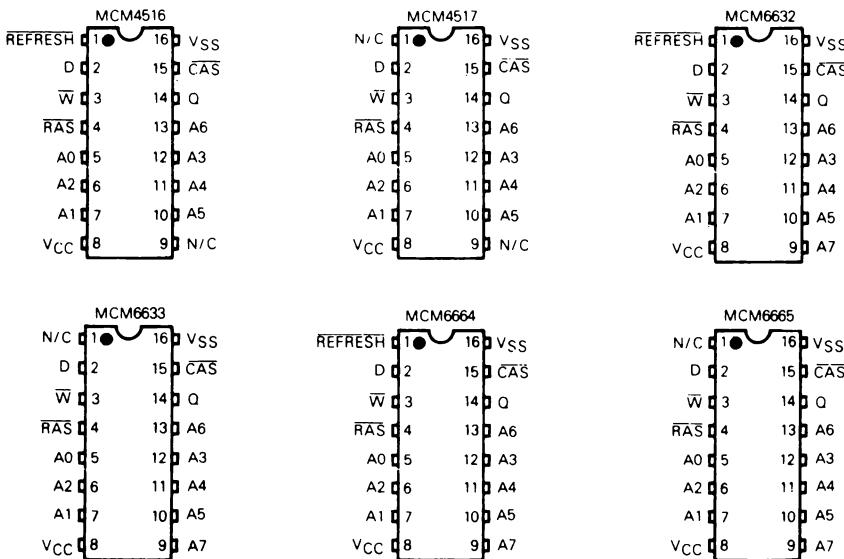
(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6632-15		MCM6632-20		Units	Notes
		Min	Max	Min	Max		
Read Command Setup Time	t <sub>RCS</sub>	0	—	0	—	ns	—
Read Command Hold Time	t <sub>RCH</sub>	10	—	10	—	ns	14
Read Command Hold Time Referenced to RAS	t <sub>RRH</sub>	30	—	35	—	ns	14
Write Command Hold Time	t <sub>WCH</sub>	45	—	55	—	ns	—
Write Command Hold Time Referenced to RAS	t <sub>WCR</sub>	120	—	155	—	ns	—
Write Command Pulse Width	t <sub>WP</sub>	45	—	55	—	ns	—
Write Command to Row Strobe Lead Time	t <sub>RWL</sub>	45	—	55	—	ns	—
Write Command to Column Strobe Lead Time	t <sub>CWL</sub>	45	—	55	—	ns	—
Data in Setup Time	t <sub>DS</sub>	0	—	0	—	ns	15
Data in Hold Time	t <sub>DH</sub>	45	—	55	—	ns	15
Data in Hold Time Referenced to RAS	t <sub>DHR</sub>	120	—	155	—	ns	—
Column to Row Strobe Precharge Time	t <sub>CRP</sub>	—10	—	—10	—	ns	—
RAS Hold Time	t <sub>RSH</sub>	75	—	110	—	ns	—
Refresh Period	t <sub>RFSH</sub>	—	2.0	—	2.0	ms	—
WRITE Command Setup Time	t <sub>WCS</sub>	—10	—	—10	—	ns	16
CAS to WRITE Delay	t <sub>CWD</sub>	45	—	55	—	ns	16
RAS to WRITE Delay	t <sub>RWD</sub>	125	—	160	—	ns	16
CAS Hold Time	t <sub>CSD</sub>	150	—	200	—	ns	—
RAS to REFRESH Delay	t <sub>RFD</sub>	0	—	0	—	ns	—
REFRESH Period (Battery Backup Mode)	t <sub>FBP</sub>	2000	—	2000	—	ns	—
REFRESH to RAS Precharge Time (Battery Backup Mode)	t <sub>FBR</sub>	390	—	460	—	ns	—
REFRESH Cycle Period (Auto Pulse Mode)	t <sub>FC</sub>	330	—	380	—	ns	—
REFRESH Pulse Period (Auto Period Mode)	t <sub>FP</sub>	60	2000	60	2000	ns	—
REFRESH to RAS Setup Time (Auto Pulse Mode)	t <sub>FSR</sub>	30	—	30	—	ns	—
REFRESH to RAS Delay Time (Auto Pulse Mode)	t <sub>FRD</sub>	390	—	460	—	ns	—
REFRESH Inactive Time	t <sub>FI</sub>	30	—	30	—	ns	—
RAS to REFRESH Lead Time	t <sub>FRL</sub>	390	—	460	—	ns	—

- NOTES:
- All voltages referenced to V<sub>SS</sub>.
  - V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
  - An initial pause of 100 µs is required after power-up followed by any 8 RAS cycles before proper device operation guaranteed.
  - Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
  - Output is disabled (open-circuit) and RAS and CAS are both at a logic 1.
  - The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transmit between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
  - Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = \frac{I\Delta t}{\Delta V}$
  - The specifications for t<sub>RC</sub> (min), and t<sub>RWC</sub> (min) are used only to indicate cycle time at which proper operation over the full temperature range (0°C ≤ T<sub>A</sub> ≤ 70°C) is assured.
  - AC measurements assume t<sub>T</sub> = 5.0 ns.
  - Assumes that t<sub>RCD</sub> ≤ t<sub>RC</sub> (Max)
  - Assumes that t<sub>RC</sub> ≥ t<sub>RCD</sub> (Max)
  - Measured with a current load equivalent to 2 TTL loads (+200 µA, -4 mA) and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = -0.8 V).
  - Operation within the t<sub>RC</sub> (max) limit ensures that t<sub>RC</sub> (max) can be met. t<sub>RCD</sub> (max) is specified as a reference point only; if t<sub>RCD</sub> is greater than the specified t<sub>RC</sub> (max) limit, then access time is controlled exclusively by t<sub>CAC</sub>.
  - Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
  - These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
  - t<sub>WCS</sub>, t<sub>CWD</sub>, and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if t<sub>WCS</sub> ≥ t<sub>WCS</sub> (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if t<sub>CWD</sub> ≥ t<sub>CWD</sub> (min) and t<sub>RWD</sub> ≥ t<sub>RWD</sub> (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
  - Addresses, data-in and WRITE are don't care. Data-out depends on the state of CAS. If CAS remains low, the previous output will remain valid. CAS is allowed to make an active to inactive transition during the pin #1 refresh cycle. When CAS is brought high, the output will assume a high-impedance state.
  - t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

# MCM6632

## PIN ASSIGNMENT COMPARISON



## PIN VARIATIONS

Pin Number	MCM4116	MCM4516	MCM4517	MCM6632	MCM6663	MCM6664	MCM6665
1	V <sub>BB</sub> (-5 V)	REFRESH	N/C	REFRESH	N/C	REFRESH	N/C
8	V <sub>DD</sub> (+12 V)	V <sub>CC</sub>					
9	V <sub>CC</sub> (+5 V)	N/C	N/C	A7	A7	A7	A7

### On-Chip Refresh Features/Benefits

Reduce System Refresh Controller Design Problem  
 Reduce System Parts Count  
 Reduce System Noise Increasing System Reliability  
 Reduce System Power During Refresh

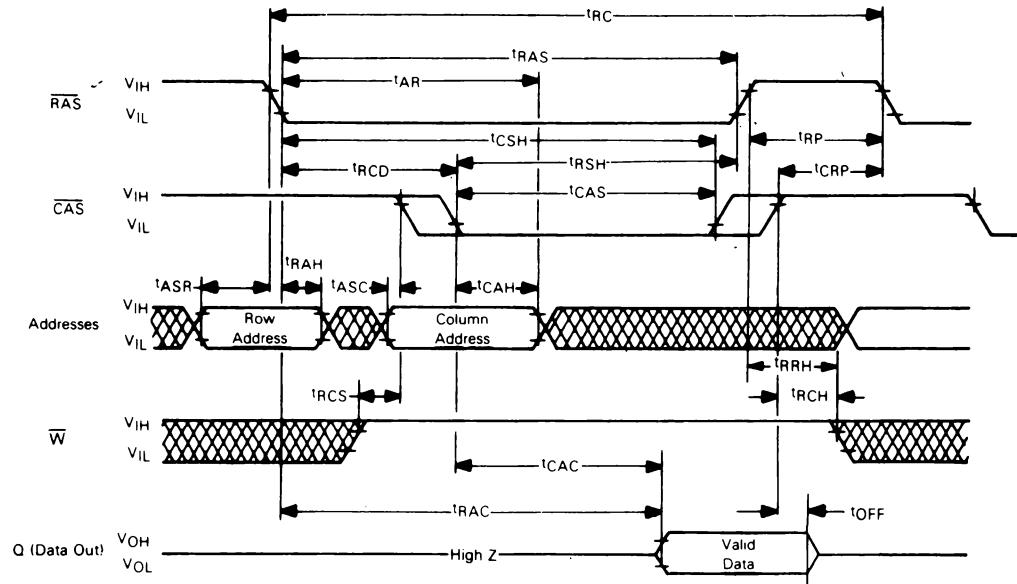
## ORDERING INFORMATION

Part Number	Description	Speed	Marking*
MCM6632L15	32K Dynamic Random Access Memory Sidebrazed Package "L"	150	MCM66320L15/MCM66321L15
MCM66320L15		150	MCM66320L15
MCM66321L15		150	MCM66321L15
MCM6632L20		200	MCM66320L20/MCM66321L20
MCM66320L20		200	MCM66320L20
MCM66321L20		200	MCM66321L20

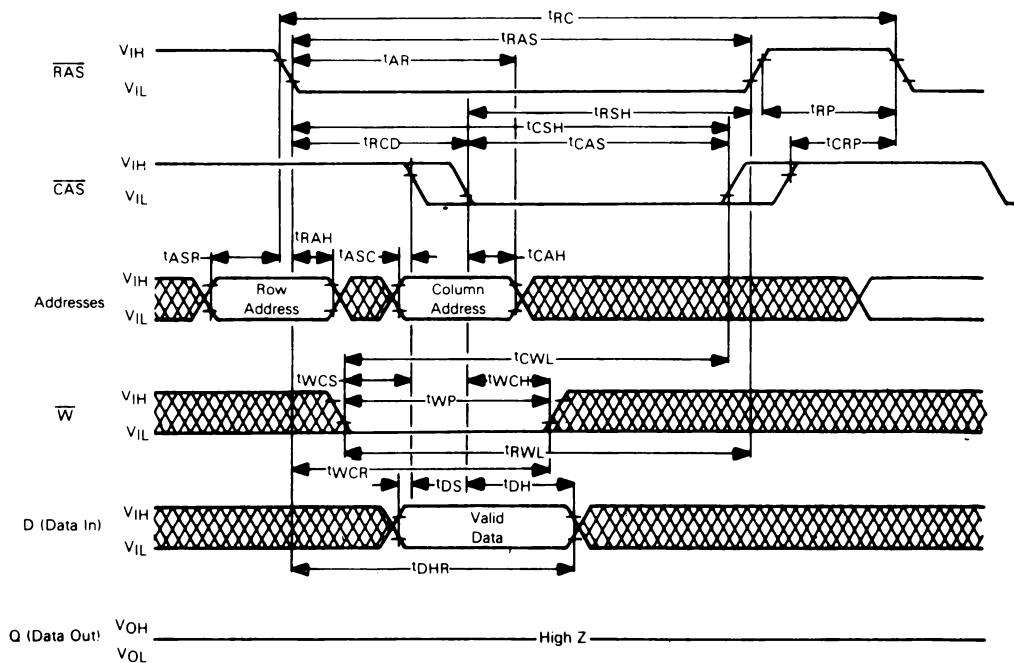
\*MCM66320 = Tie A7 CAS (A15) Low "0"  
 MCM66321 = Tie A7 CAS (A15) High "1"

# MCM6632

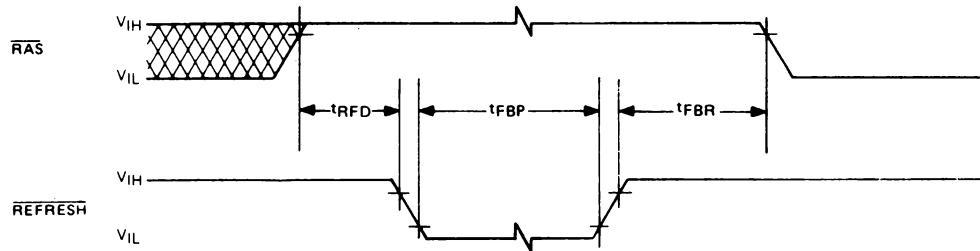
## READ CYCLE TIMING



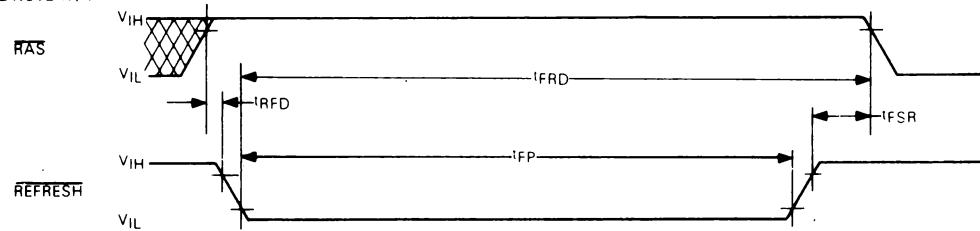
## WRITE CYCLE TIMING



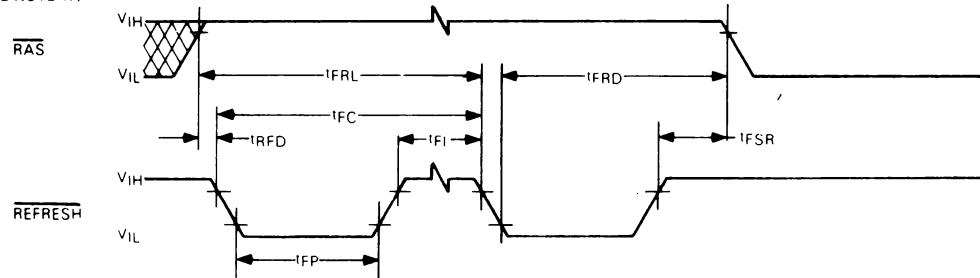
**SELF REFRESH MODE (Battery Backup)**  
(SEE NOTE 17)



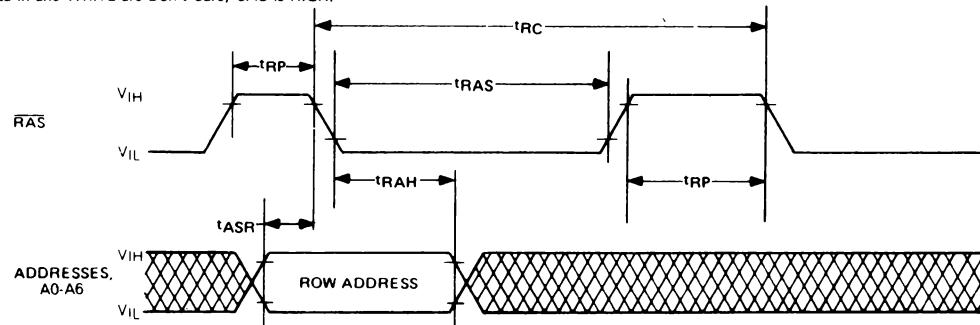
**AUTOMATIC PULSE REFRESH CYCLE – SINGLE PULSE**  
(SEE NOTE 17)



**AUTOMATIC PULSE REFRESH CYCLE – MULTIPLE PULSE**  
(SEE NOTE 17)

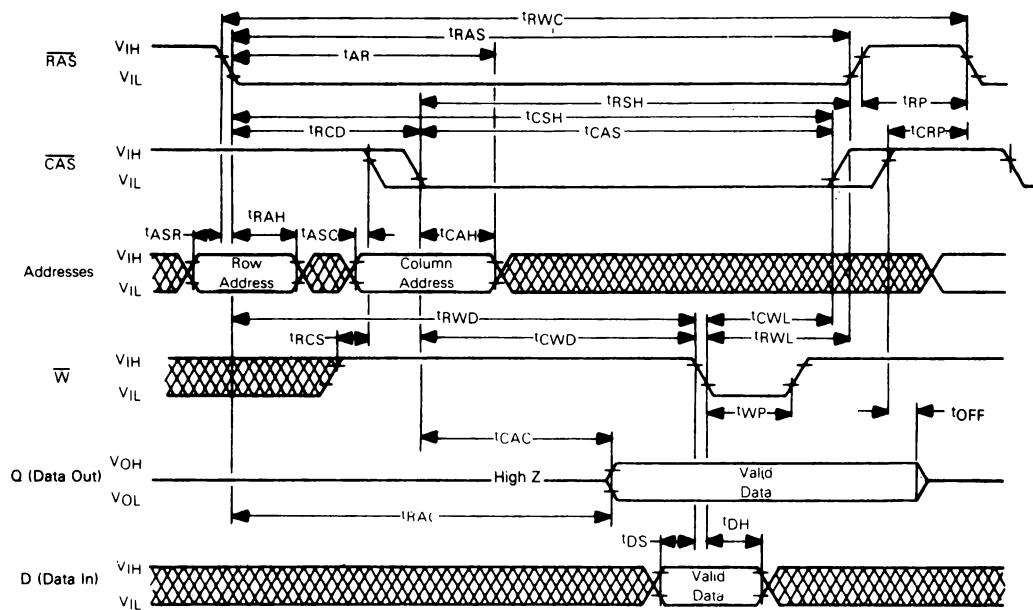


**RAS-ONLY REFRESH CYCLE**  
(Data-In and WRITE are Don't Care, **CAS** is HIGH)



# MCM6632

## READ-WRITE/READ-MODIFY-WRITE CYCLE



MCM6632

## MCM6664 BIT ADDRESS MAP

$$\text{Data Stored} = D_{in} \bullet A_{0X} \bullet A_{1Y}$$

Column Address A1	Row Address A0	Data Stored
0	0	Inverted
0	1	True
1	0	True
1	1	Inverted



**MOTOROLA**

# MCM6633

## 32,768-BIT DYNAMIC RAM

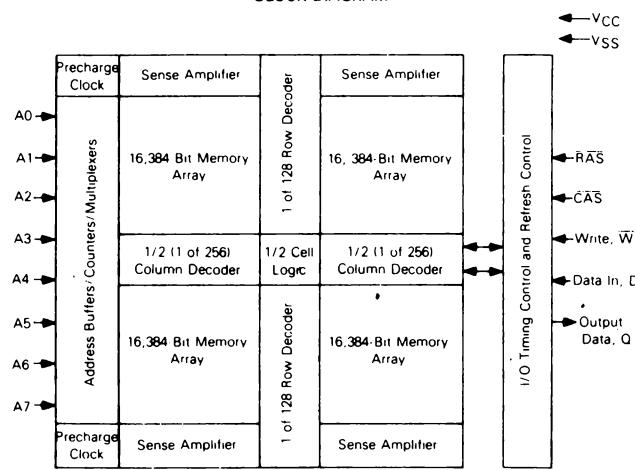
The MCM6633 is a 32,768 bit, high-speed, dynamic Random-Access Memory. Organized as 32,768 one-bit words and fabricated using HMOS high-performance N-channel silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row- and column-address inputs, the MCM6633 requires only eight address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by CAS allowing for greater system flexibility.

All inputs and outputs, including clocks, are fully TTL compatible. The MCM6633 incorporates a one-transistor cell design and dynamic storage techniques.

- Organized as 32,768 Words of 1 Bit
- Single + 5 V Operation
- Fast 150 ns Operation
- Low Power Dissipation  
275 mW Maximum (Active)  
30 mW Maximum (Standby)
- Three-State Data Output
- Internal Latches for Address and Data Input
- Early-Write Output Capability
- 16K Compatible 128-Cycle, 2 ms Refresh
- RAS-only Refresh Mode
- CAS Controlled Output
- Upward Pin Compatible from the 16K RAM (MCM4116, MCM4516, MCM4517)
- One Half of the 64K RAM MCM6665
- The Operating Half of the MCM6633 is Indicated by Device Marking:  
MCM66330 Tie A7 CAS (A15) Low "0"  
MCM66331 Tie A7 CAS (A15) High "1"

## BLOCK DIAGRAM



## MOS

(N-CHANNEL, SILICON-GATE)

## 32,768-BIT DYNAMIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 690

### PIN ASSIGNMENT

N/C	1	16	VSS
D	2	15	CAS
W	3	14	Q
RAS	4	13	A6
A0	5	12	A3
A2	6	11	A4
A1	7	10	A5
VCC	8	9	A7

\*For maximum compatibility with MCM6632 and MCM6664, a VCC trace should go to pin #1.

### PIN NAMES

A0-A7	.....	Address Input
D	.....	Data In
Q	.....	Data Out
W	.....	Read/Write Input
RAS	.....	Row Address Strobe
CAS	.....	Column Address Strobe
VCC	.....	Power (+ 5 V)
VSS	.....	Ground

This device contains 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 this high-impedance circuit.

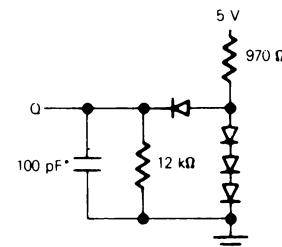
# MCM6633

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>SS</sub> (Except V <sub>CC</sub> )	V <sub>in</sub> , V <sub>out</sub>	-2 to +7	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>in</sub> , V <sub>out</sub>	-1 to +7	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1	W
Data Out Current	I <sub>out</sub>	50	mA

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.

FIGURE 1 – OUTPUT LOAD



\*Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	MCM6633L15/MCM6633L20	4.5	5.0	5.5	Vdc	1
	V <sub>CC</sub>	4.75	5.0	5.25		
	V <sub>CC</sub>	0	0	0		
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.4	—	7.0	Vdc	1
Logic 0 Voltage	V <sub>IL</sub>	-2.0	—	0.8	Vdc	1

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Units	Notes
V <sub>CC</sub> Power Supply Current (I <sub>RC</sub> min.)	I <sub>CC1</sub>	—	50	mA	4
Standby V <sub>CC</sub> Power Supply Current	I <sub>CC2</sub>	—	5	mA	5
V <sub>CC</sub> Power Supply Current During RAS Only Refresh Cycles	I <sub>CC3</sub>	—	40	mA	—
Input Leakage Current (any input) (0 ≤ V <sub>in</sub> ≤ 5.5) (Except Pin 1)	I <sub>IL(L)</sub>	—	10	μA	—
Output Leakage Current (0 ≤ V <sub>out</sub> ≤ 5.5) (CAS at Logic 1)	I <sub>O(L)</sub>	—	10	μA	—
Output Logic 1 Voltage @ I <sub>out</sub> = -4 mA	V <sub>OH</sub>	2.4	—	V	—
Output Logic 0 Voltage @ I <sub>out</sub> = 4 mA	V <sub>OL</sub>	—	0.4	V	—

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6633-15		MCM6633-20		Units	Notes
		Min	Max	Min	Max		
Random Read or Write Cycle Time	t <sub>RC</sub>	300	—	350	—	ns	8, 9
Read Write Cycle Time	t <sub>RWC</sub>	300	—	350	—	ns	8, 9
Access Time from Row Address Strobe	t <sub>RAC</sub>	—	150	—	200	ns	10, 12
Access Time from Column Address Strobe	t <sub>CAC</sub>	—	75	—	110	ns	11, 12
Output Buffer and Turn-Off Delay	t <sub>OFF</sub>	0	30	0	40	ns	17
Row Address Strobe Precharge Time	t <sub>RP</sub>	120	—	140	—	ns	—
Row Address Strobe Pulse Width	t <sub>RAS</sub>	150	10000	200	10000	ns	—
Column Address Strobe Pulse Width	t <sub>CAS</sub>	75	10000	110	10000	ns	—
Row to Column Strobe Lead Time	t <sub>RCD</sub>	30	75	35	90	ns	13
Row Address Setup Time	t <sub>ASR</sub>	0	—	0	—	ns	—
Row Address Hold Time	t <sub>RAH</sub>	25	—	30	—	ns	—
Column Address Setup Time	t <sub>ASC</sub>	0	—	0	—	ns	—
Column Address Hold Time	t <sub>CAH</sub>	45	—	55	—	ns	—
Column Address Hold Time Referenced to RAS	t <sub>AR</sub>	120	—	155	—	ns	—
Transition Time (Rise and Fall)	t <sub>T</sub>	3	50	3	50	ns	6

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6633-15		MCM6633-20		Units	Notes
		Min	Max	Min	Max		
Read Command Setup Time	tRCS	0	—	0	—	ns	—
Read Command Hold time	tRCH	10	—	10	—	ns	14
Read Command Hold Time Referenced to RAS	tRRH	30	—	35	—	ns	14
Write Command Hold Time	tWCH	45	—	55	—	ns	—
Write Command Hold Time Referenced to RAS	tWCR	120	—	155	—	ns	—
Write Command Pulse Width	tWP	45	—	55	—	ns	—
Write Command to Row Strobe Lead Time	tRWL	45	—	55	—	ns	—
Write Command to Column Strobe Lead Time	tCWL	45	—	55	—	ns	—
Data in Setup Time	tDS	0	—	0	—	ns	15
Data in Hold Time	tDH	45	—	55	—	ns	15
Data in Hold Time Referenced to RAS	tDHR	120	—	155	—	ns	—
Column to Row Strobe Precharge Time	tCRP	—10	—	—10	—	ns	—
RAS Hold Time	tRSH	75	—	110	—	ns	—
Refresh Period	tRFSH	—	—	2.0	—	ms	—
WRITE Command Setup Time	tWCS	—10	—	—10	—	ns	16
CAS to WRITE Delay	tCWD	45	—	55	—	ns	16
RAS to WRITE Delay	tRWD	125	—	160	—	ns	16
CAS Hold Time	tCSH	150	—	200	—	ns	—

**CAPACITANCE** ( $f = 1.0 \text{ MHz}$ ,  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5 \text{ V}$  Periodically Sampled Rather Than 100% Tested)

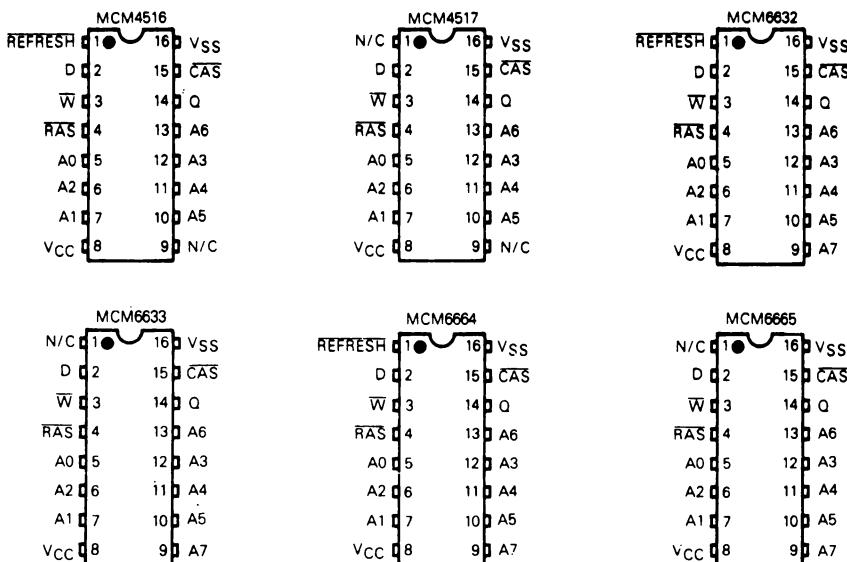
Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A7), D	C <sub>I1</sub>	4	5	pF	7
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8	10	pF	7
Output Capacitance (Q) (CAS = V <sub>IH</sub> to disable output)	C <sub>O</sub>	5	7	pF	7

### NOTES:

- All voltages referenced to V<sub>SS</sub>.
- V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
- An initial pause of 100  $\mu\text{s}$  is required after power-up followed by any 8 RAS cycles before proper device operation guaranteed.
- Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
- Output is disabled (open-circuit) and RAS and CAS are both at a logic 1.
- The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transmit between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
- Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = \frac{I\Delta t}{\Delta V}$
- The specifications for tRC (min), and tRWC (min) are used only to indicate cycle time at which proper operation over the full temperature range ( $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ) is assured.
- AC measurements assume t<sub>TF</sub> = 5.0 ns.
- Assumes that t<sub>RCD</sub> ≤ t<sub>RC</sub> (max).
- Assumes that t<sub>RCD</sub> ≥ t<sub>RC</sub> (max).
- Measured with a current load equivalent to 2 TTL loads (+200  $\mu\text{A}$ , -4 mA) and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = -0.8 V).
- Operation within the t<sub>RC</sub> (max) limit ensures that t<sub>RAC</sub> (max) can be met. t<sub>RC</sub> (max) is specified as a reference point only; if t<sub>RCD</sub> is greater than the specified t<sub>RC</sub> (max) limit, then access time is controlled exclusively by t<sub>CAC</sub>.
- Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
- These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
- t<sub>WCS</sub>, t<sub>CWD</sub>, and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if t<sub>WCS</sub> ≥ t<sub>WCS</sub> (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if t<sub>CWD</sub> ≥ t<sub>CWD</sub> (min) and t<sub>RWD</sub> ≥ t<sub>RWD</sub> (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
- t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

# MCM6633

## PIN ASSIGNMENT COMPARISON



## PIN VARIATIONS

Pin Number	MCM4116	MCM4516	MCM4517	MCM6632	MCM6633	MCM6664	MCM6665
1	V <sub>BB</sub> (-5 V)	REFRESH	N/C	REFRESH	N/C	REFRESH	' N/C
8	V <sub>DD</sub> (+12 V)	V <sub>CC</sub>					
9	V <sub>CC</sub> (+5 V)	N/C	N/C	A7	A7	A7	A7

## ORDERING INSTRUCTIONS

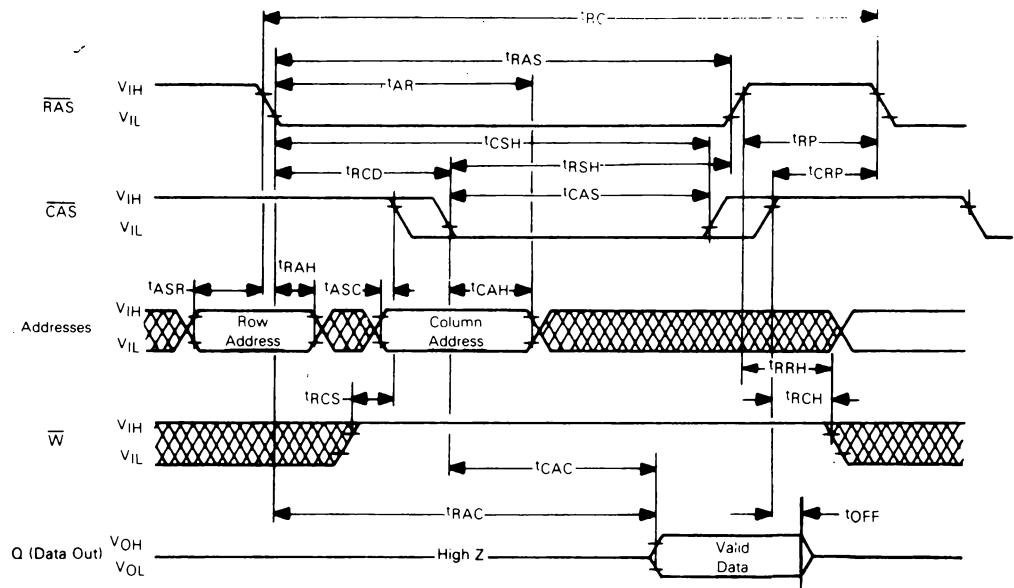
PART NUMBER	DESCRIPTION	SPEED	MARKING*
MCM6633L15		150	66330L15/66331L15
MCM66330L15		150	66330L15
MCM66331L15	32K RAM Sidebrazed	150	66331L15
MCM6633L20	Package "L"	200	66330L20/66331L20
MCM66330L20		200	66330L20
MCM66331L20		200	66331L20

\*MCM66330L20 = Tie A7 CAS (A15) Low "0"

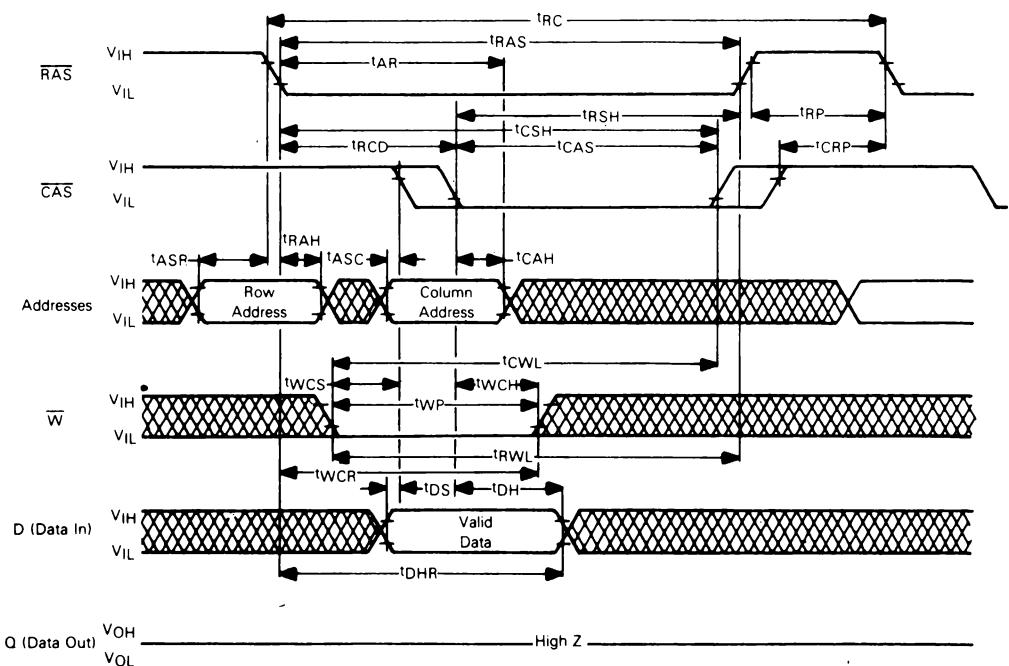
MCM66331L20 = Tie A7 CAS (A15) High "1"

# MCM6633

## READ CYCLE TIMING

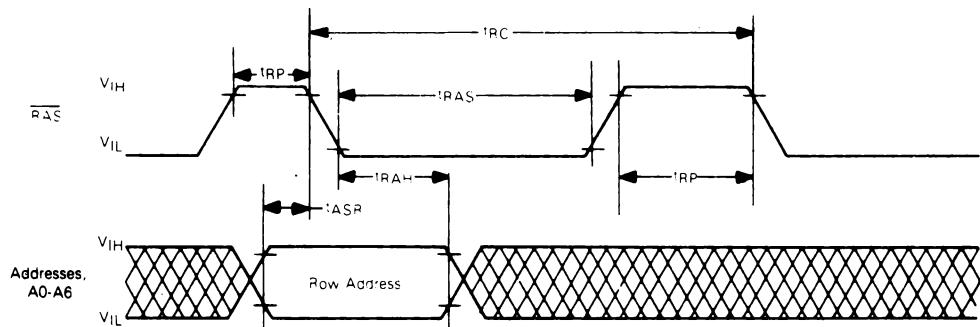


## WRITE CYCLE TIMING

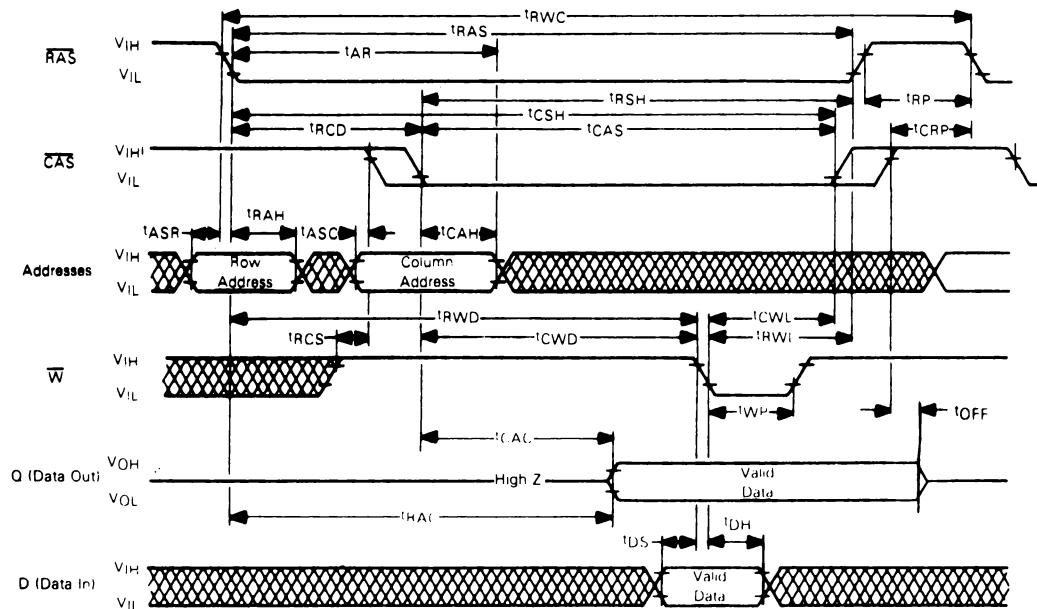


MCM6633

RAS-ONLY REFRESH CYCLE  
(Data-in and Write are Don't Care, CAS is HIGH)



## **READ-WRITE/READ-MODIFY-WRITE CYCLE**



MCM6633

## MCM8885 BIT ADDRESS MAP

Pin 8

Row Address A7 A6 A5 A4 A3 A2 A1 A0  
Column Address A7 A6 A5 A4 A3 A2 A1 A0

### Column Addresses

Row

Data Stored = D<sub>in</sub> • A<sub>0X</sub> • A<sub>1Y</sub>

Column Address	Row Address	Data Stored
A1	A0	
0	0	Inverted
0	1	True
1	0	True
1	1	Inverted



**MOTOROLA**

**MCM6664**

### 65,536-BIT DYNAMIC RAM

The MCM6664 is a 65,536 bit, high-speed, dynamic Random-Access Memory. Organized as 65,536 one-bit words and fabricated using HMOS high-performance N-channel silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row- and column-address inputs, the MCM6664 requires only eight address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by CAS allowing for greater system flexibility.

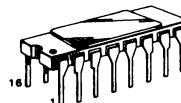
All inputs and outputs, including clocks, are fully TTL compatible. The MCM6664 incorporates a one-transistor cell design and dynamic storage techniques. In addition to the RAS-only refresh mode, refresh control function available on pin 1 provides automatic and self-refresh modes.

- Organized as 65,536 Words of 1 Bit
- Single +5 V Operation
- Fast 150 ns Operation
- Low Power Dissipation
  - 275 mW Maximum (Active)
  - 30 mW Maximum (Standby)
- Three-State Data Output
- Internal Latches for Address and Data Input
- Early-Write Common I/O Capability
- 16K Compatible 128-Cycle, 2 ms Refresh
- Control on Pin 1 for Automatic and Self Refresh
- RAS-only Refresh Mode
- CAS Controlled Output
- Upward Pin Compatible from the 16K RAM (MCM4116)

### MOS

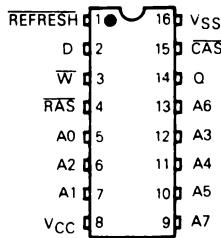
(N-CHANNEL, SILICON-GATE)

### 65,536-BIT DYNAMIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 690

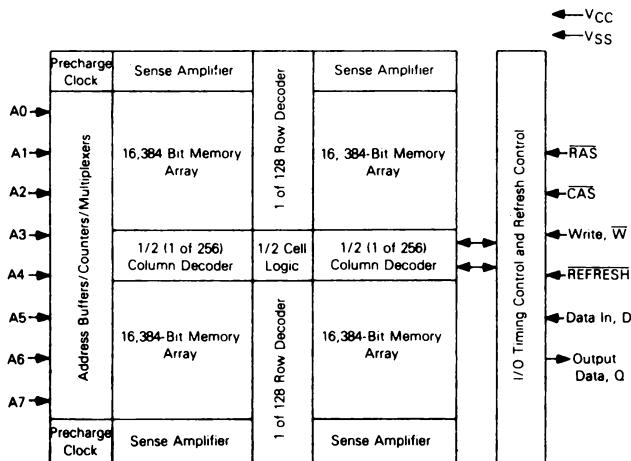
### PIN ASSIGNMENT



### PIN NAMES

REFRESH .....	Refresh
A0-A7 .....	Address Input
D..	Data In
Q..	Data Out
W.....	Read/Write Input
RAS.....	Row Address Strobe
CAS.....	Column Address Strobe
VCC.....	Power (+5 V)
VSS.....	Ground

### BLOCK DIAGRAM



This device contains 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 this high-impedance circuit.

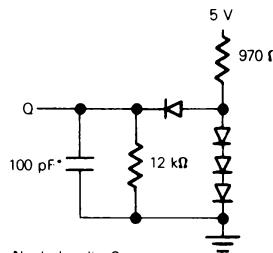
# MCM6664

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>SS</sub> (except V <sub>CC</sub> )	V <sub>in</sub> , V <sub>out</sub>	-2 to +7	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>in</sub> , V <sub>out</sub>	-1 to +7	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1.0	W
Data Out Current	I <sub>out</sub>	50	mA

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.

FIGURE 1 — OUTPUT LOAD



\* Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	MCM6664-15, 20	V <sub>CC</sub>	4.5	5.0	5.5	V	1
		V <sub>SS</sub>	0	0	0	V	1
Logic 1 Voltage, All Inputs		V <sub>IH</sub>	2.4	—	V <sub>CC</sub> + 1	V	1
Logic 0 Voltage, All Inputs		V <sub>IL</sub>	-2.0	—	0.8	V	1

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Units	Notes
V <sub>CC</sub> Power Supply Current (I <sub>RC</sub> min.)	I <sub>CC1</sub>	—	50	mA	4
Standby V <sub>CC</sub> Power Supply Current	I <sub>CC2</sub>	—	5	mA	5
V <sub>CC</sub> Power Supply Current During RAS Only Refresh Cycles	I <sub>CC3</sub>	—	40	mA	—
Input Leakage Current (any input except REFRESH) (V <sub>SS</sub> ≤ V <sub>in</sub> ≤ V <sub>CC</sub> )	I <sub>I(L)</sub>	—	10	μA	—
REFRESH Input Current (V <sub>F</sub> = V <sub>SS</sub> )	I <sub>F</sub>	—	125	μA	—
Output Leakage Current (CAS at logic 1, 0 ≤ V <sub>out</sub> ≤ 5.5)	I <sub>O(L)</sub>	—	10	μA	—
Output Logic 1 Voltage @ I <sub>out</sub> = -4 mA	V <sub>OH</sub>	2.4	—	V	—
Output Logic 0 Voltage @ I <sub>out</sub> = 4 mA	V <sub>OL</sub>	—	0.4	V	—

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5 V. Periodically Sampled Rather Than 100% Tested)

Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A7), D	C <sub>I1</sub>	4	5	pF	7
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8	10	pF	7
Output Capacitance (Q) (CAS = V <sub>IH</sub> to disable output)	C <sub>O</sub>	5	7	pF	7

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6 and Figure 11)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6664-15		MCM6664-20		Units	Notes
		Min	Max	Min	Max		
Random Read or Write Cycle Time	I <sub>RC</sub>	300	—	350	—	ns	8, 9
Read Write Cycle Time	I <sub>RWC</sub>	300	—	350	—	ns	8, 9
Access Time from Row Address Strobe	I <sub>RAC</sub>	—	150	—	200	ns	10, 12
Access Time from Column Address Strobe	I <sub>CAC</sub>	—	75	—	110	ns	11, 12
Output Buffer and Turn-Off Delay	I <sub>OFF</sub>	0	30	0	40	ns	18
Row Address Strobe Precharge Time	I <sub>RP</sub>	120	—	140	—	ns	—
Row Address Strobe Pulse Width	I <sub>RAS</sub>	150	10000	200	10000	ns	—
Column Address Strobe Pulse Width	I <sub>CAS</sub>	75	10000	110	10000	ns	—
Row to Column Strobe Lead Time	I <sub>RCD</sub>	30	75	35	90	ns	13
Row Address Setup Time	I <sub>ASR</sub>	0	—	0	—	ns	—
Row Address Hold Time	I <sub>RAH</sub>	25	—	30	—	ns	—
Column Address Setup Time	I <sub>ASC</sub>	0	—	0	—	ns	—
Column Address Hold Time	I <sub>CAH</sub>	45	—	55	—	ns	—
Column Address Hold Time Referenced to RAS	I <sub>AR</sub>	120	—	155	—	ns	—
Transition Time (Rise and Fall)	I <sub>T</sub>	3	50	3	50	ns	6

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

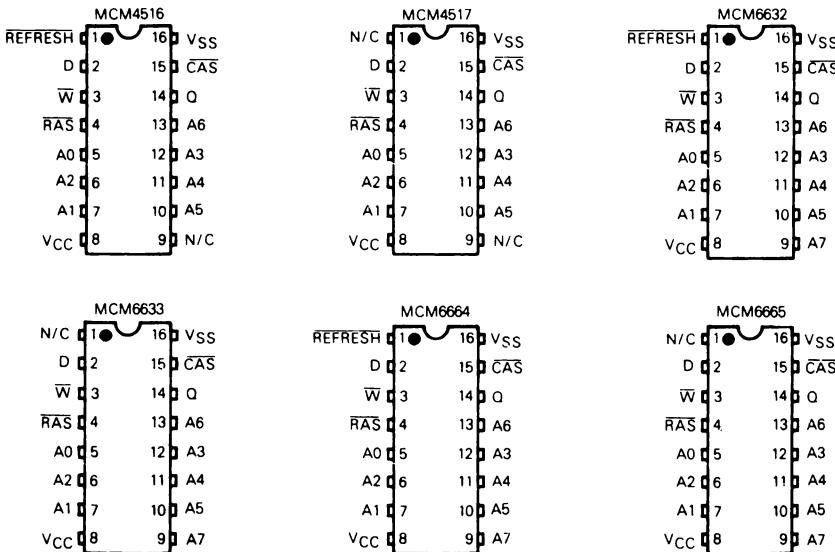
(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6664-15		MCM6664-20		Units	Notes
		Min	Max	Min	Max		
Read Command Setup Time	tRCS	0	—	0	—	ns	—
Read Command Hold Time	tRCH	10	—	10	—	ns	14
Read Command Hold Time Referenced to RAS	tRRH	30	—	35	—	ns	14
Write Command Hold Time	tWCH	45	—	55	—	ns	—
Write Command Hold Time Referenced to RAS	tWCR	120	—	155	—	ns	—
Write Command Pulse Width	tWP	45	—	55	—	ns	—
Write Command to Row Strobe Lead Time	tRWL	45	—	55	—	ns	—
Write Command to Column Strobe Lead Time	tCWL	45	—	55	—	ns	—
Data in Setup Time	tDS	0	—	0	—	ns	15
Data in Hold Time	tDH	45	—	55	—	ns	15
Data in Hold Time Referenced to RAS	tDHR	120	—	155	—	ns	—
Column to Row Strobe Precharge Time	tCRP	—10	—	—10	—	ns	—
RAS Hold Time	tRSH	75	—	110	—	ns	—
Refresh Period	tRFSH	—	20	—	2.0	ms	—
WRITE Command Setup Time	tWCS	—10	—	—10	—	ns	16
CAS to WRITE Delay	tCWD	45	—	55	—	ns	16
RAS to WRITE Delay	tRWD	125	—	160	—	ns	16
CAS Hold Time	tCSH	150	—	200	—	ns	—
RAS to REFRESH Delay	tRFD	0	—	0	—	ns	—
REFRESH Period (Battery Backup Mode)	tFBP	2000	—	2000	—	ns	—
REFRESH to RAS Precharge Time (Battery Backup Mode)	tFBR	390	—	460	—	ns	—
REFRESH Cycle Time (Auto Pulse Mode)	tFC	330	—	380	—	ns	—
REFRESH Pulse Period (Auto Period Mode)	tFP	60	2000	60	2000	ns	—
REFRESH to RAS Setup Time (Auto Pulse Mode)	tFSR	30	—	30	—	ns	—
REFRESH to RAS Delay Time (Auto Pulse Mode)	tFRD	390	—	460	—	ns	—
REFRESH Inactive Time	tFI	30	—	30	—	ns	—
RAS to REFRESH Lead Time	tFRL	390	—	460	—	ns	—

- NOTES:
- All voltages referenced to VSS.
  - V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
  - An initial pause of 100  $\mu$ s is required after power-up followed by any 8 RAS cycles before proper device operation guaranteed.
  - Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
  - Output is disabled (open-circuit) and RAS and CAS are both at a logic 1.
  - The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transmit between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
  - Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation  $C = \frac{I\Delta t}{\Delta V}$
  - The specifications for tRC (min), and tRWC (min) are used only to indicate cycle time at which proper operation over the full temperature range (0°C  $\leq$  T<sub>A</sub>  $\leq$  70°C) is assured.
  - AC measurements assume t<sub>T</sub> = 5.0 ns.
  - Assumes that tRCD  $\leq$  tRC (Max)
  - Assumes that tRCD  $\geq$  tRC (Max)
  - Measured with a current load equivalent to 2 TTL (+200  $\mu$ A, -4 mA) loads and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = -0.8 V).
  - Operation within the tRCD (max) limit ensures that t<sub>RAC</sub> (max) can be met. tRCD (max) is specified as a reference point only; if tRCD is greater than the specified tRCD (max) limit, then access time is controlled exclusively by tCAC.
  - Either tRRH or tRCH must be satisfied for a read cycle.
  - These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
  - tWCS, tCWD, and tRWD are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if tWCS  $\geq$  tWC (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if tCWD  $\geq$  tCWD (min) and tRWD  $\geq$  tRWD (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
  - Addresses, data-in and WRITE are don't care. Data-out depends on the state of CAS. If CAS remains low, the previous output will remain valid. CAS is allowed to make an active to inactive transition during the pin #1 refresh cycle. When CAS is brought high, the output will assume a high-impedance state.
  - t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

# MCM6664

## PIN ASSIGNMENT COMPARISON



## PIN VARIATIONS

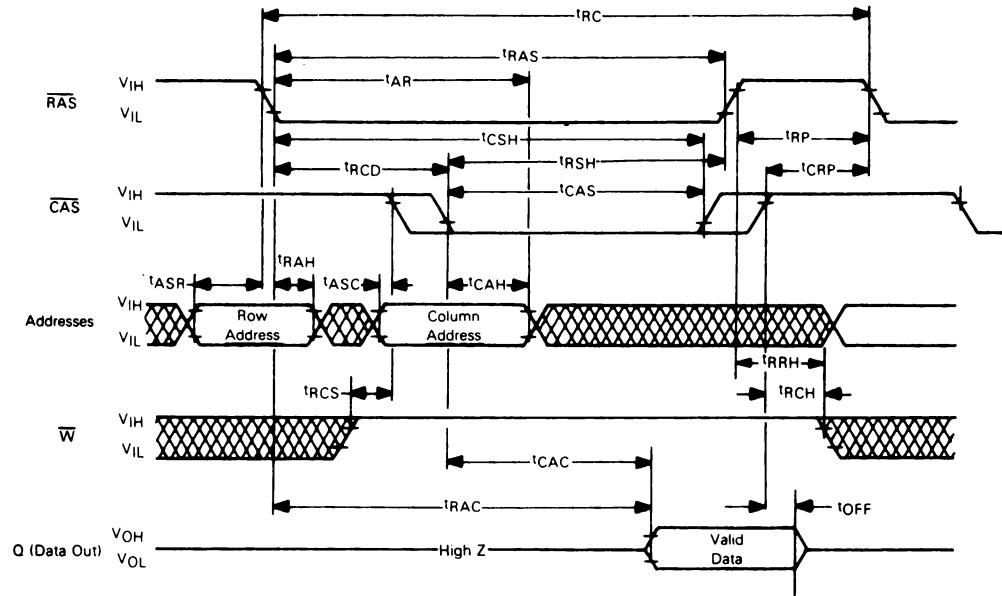
Pin Number	MCM4116	MCM4516	MCM4517	MCM6632	MCM6663	MCM6664	MCM6665
1	$V_{BB}(+5\text{ V})$	REFRESH	N/C	REFRESH	N/C	REFRESH	N/C
8	$V_{DD}(+12\text{ V})$	VCC	VCC	VCC	VCC	VCC	VCC
9	$V_{CC}(+5\text{ V})$	N/C	N/C	A7	A7	A7	A7

### On-Chip Refresh Features/Benefits

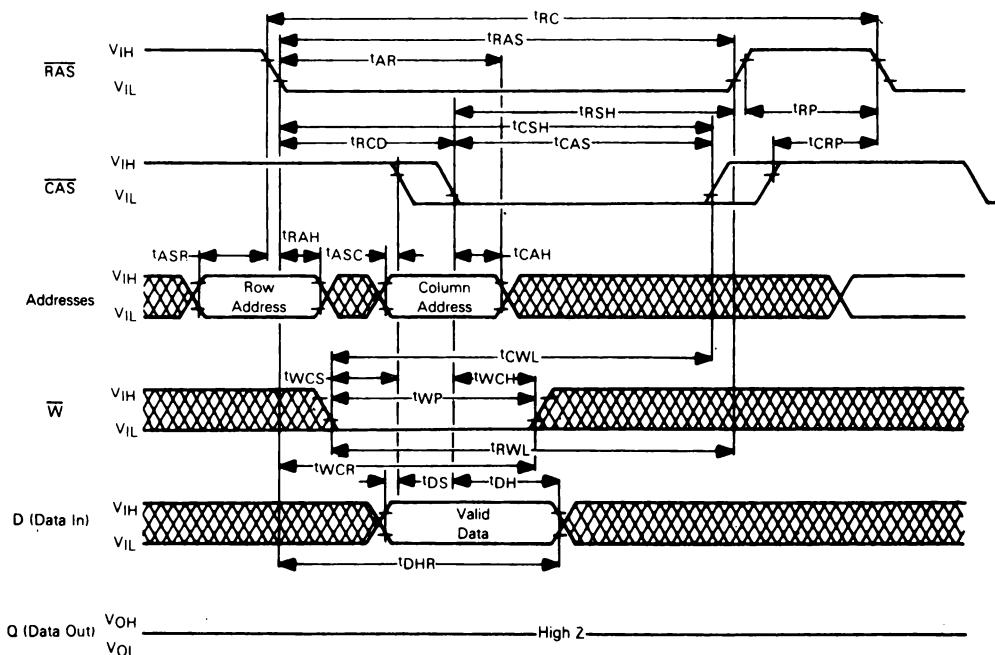
Reduce System Refresh Controller Design Problem  
 Reduce System Parts Count  
 Reduce System Noise Increasing System Reliability  
 Reduce System Power During Refresh

# MCM6664

## READ CYCLE TIMING

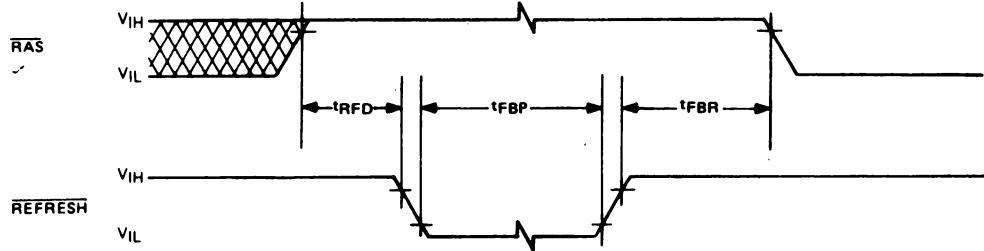


## WRITE CYCLE TIMING

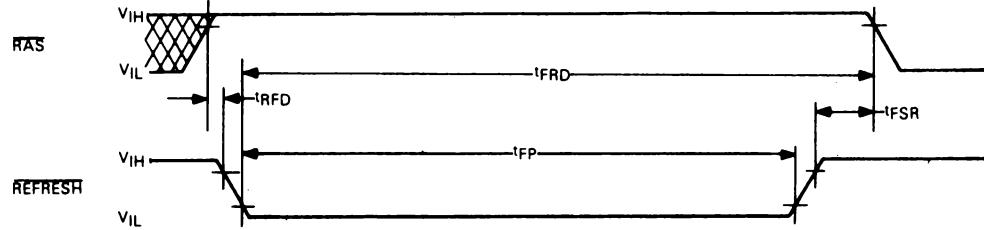


# MCM6664

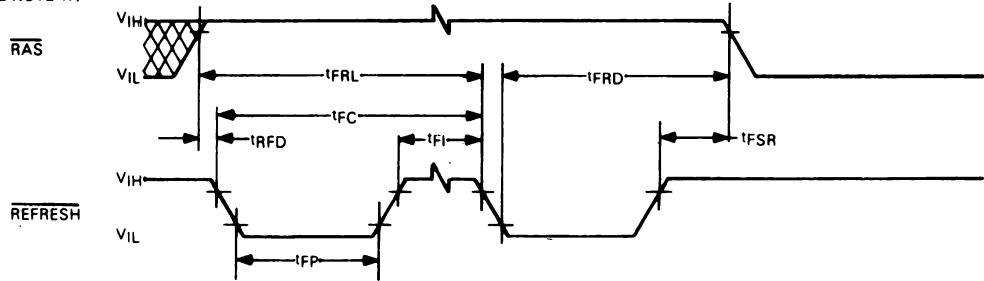
## SELF REFRESH MODE (Battery Backup) (SEE NOTE 17)



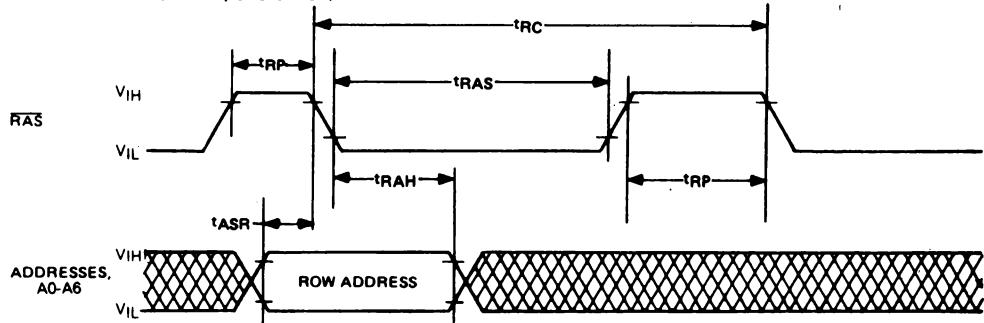
## AUTOMATIC PULSE REFRESH CYCLE – SINGLE PULSE (SEE NOTE 17)



## AUTOMATIC PULSE REFRESH CYCLE – MULTIPLE PULSE (SEE NOTE 17)

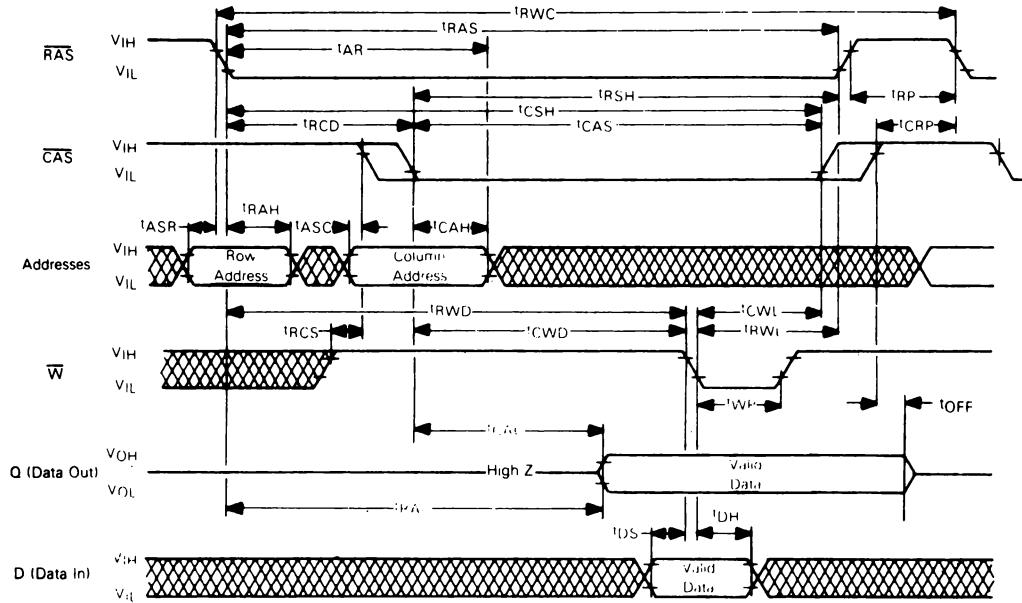


## RAS-ONLY REFRESH CYCLE (Data-In and WRITE are Don't Care, CAS is HIGH)



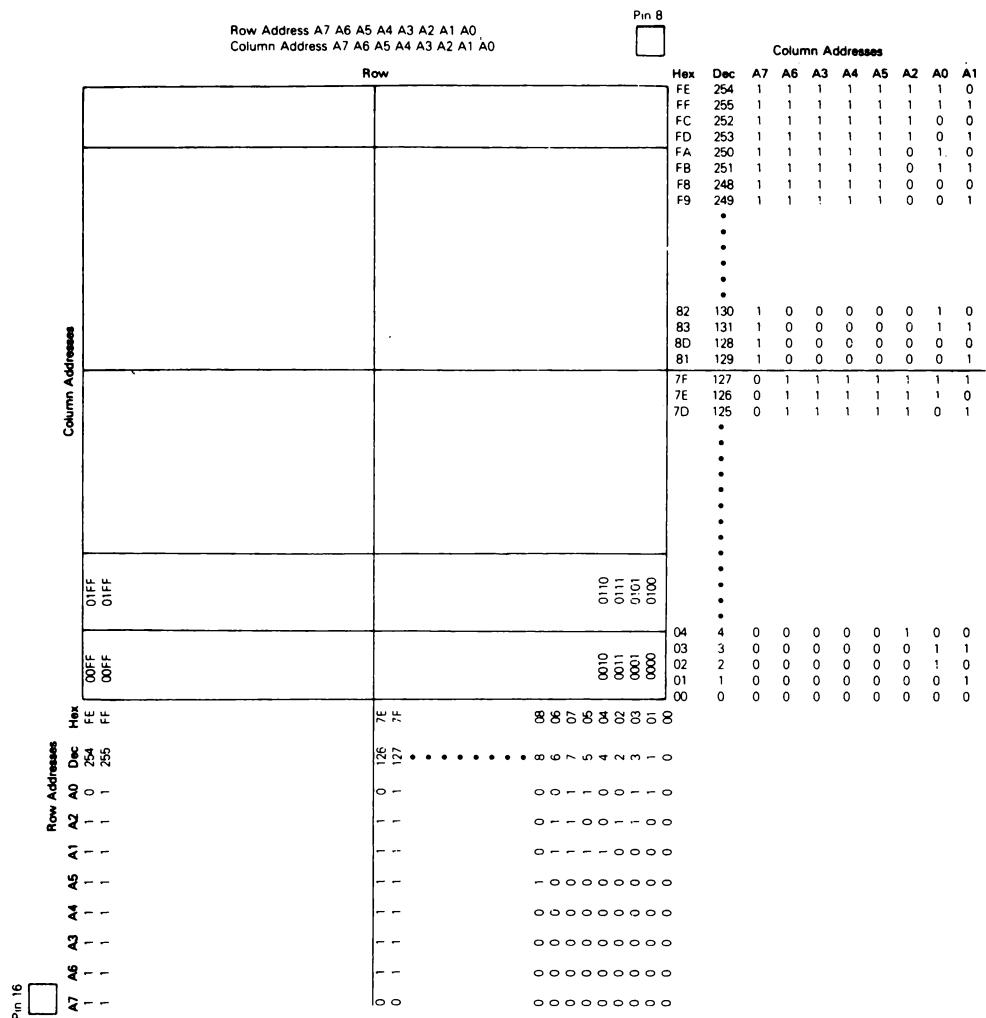
# MCM6664

READ-WRITE/READ-MODIFY-WRITE CYCLE



# MCM6664

MCM6664 BIT ADDRESS MAP



Data Stored = D<sub>in</sub> • A0X • A1Y

Column Address A1	Row Address A0	Data Stored
0	0	Inverted
0	1	True
1	0	True
1	1	Inverted



**MOTOROLA**

# MCM6665

## 65,536-BIT DYNAMIC RAM

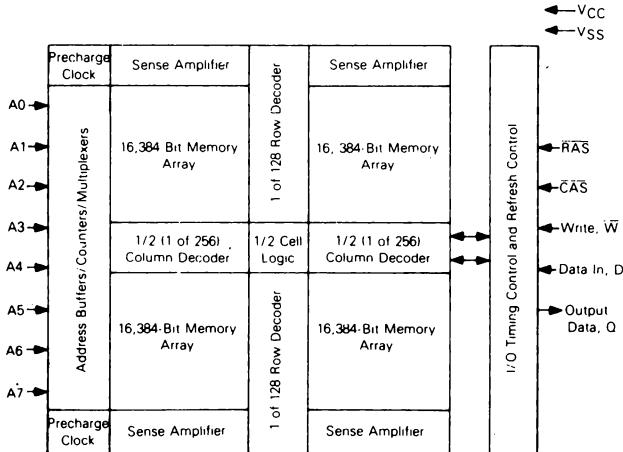
The MCM6665 is a 65,536 bit, high-speed, dynamic Random-Access Memory. Organized as 65,536 one-bit words and fabricated using HMOS high-performance N-channel silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row- and column-address inputs, the MCM6665 requires only eight address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by CAS allowing for greater system flexibility.

All inputs and outputs, including clocks, are fully TTL compatible. The MCM6665 incorporates a one-transistor cell design and dynamic storage techniques.

- Organized as 65,536 Words of 1 Bit
- Single +5 V Operation
- Fast 150 ns Operation
- Low Power Dissipation
  - 275 mW Maximum (Active)
  - 30 mW Maximum (Standby)
- Three-State Data Output
- Internal Latches for Address and Data Input
- Early-Write Common I/O Capability
- 16K Compatible 128-Cycle, 2 ms Refresh
- RAS-only Refresh Mode
- CAS Controlled Output
- Upward Pin Compatible from the 16K RAM (MCM4116, MCM4517)

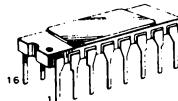
## BLOCK DIAGRAM



## MOS

(IN-CHANNEL, SILICON-GATE)

### 65,536-BIT DYNAMIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 690

#### PIN ASSIGNMENT

N/C	1	16	VSS
D	2	15	CAS
W	3	14	Q
RAS	4	13	A6
A0	5	12	A3
A2	6	11	A4
A1	7	10	A5
VCC	8	9	A7

\*For maximum compatibility with MCM6632 and MCM6664 a VCC trace should go to pin #1.

PIN NAMES	
A0-A7	Address Input
D	Data In
Q	Data Out
W	Read/Write Input
RAS	Row Address Strobe
CAS	Column Address Strobe
VCC	Power (+5 V)
VSS	Ground

This device contains 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 this high-impedance circuit.

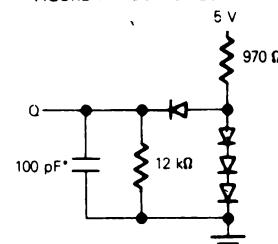
# MCM6665

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>SS</sub> (Except V <sub>CC</sub> )	V <sub>in</sub> , V <sub>out</sub>	-2 to +7	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>in</sub> , V <sub>out</sub>	-1 to +7	V
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1	W
Data Out Current	I <sub>out</sub>	50	mA

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.

FIGURE 1 – OUTPUT LOAD



\*Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V	1
	V <sub>CC</sub>	4.75	5.0	5.25	V	1
	V <sub>SS</sub>	0	0	0		
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.4	—	V <sub>CC</sub> + 1	V	1
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-2.0	—	0.8	V	1

### DC CHARACTERISTICS (Full Operating Voltage and Temperature Ranges Unless Otherwise Noted)

Characteristic	Symbol	Min	Max	Units	Notes
V <sub>CC</sub> Power Supply Current (t <sub>RC</sub> min.)	I <sub>CC1</sub>	—	50	mA	4
Standby V <sub>CC</sub> Power Supply Current	I <sub>CC2</sub>	—	5	mA	5
V <sub>CC</sub> Power Supply Current During RAS Only Refresh Cycles	I <sub>CC3</sub>	—	40	mA	—
Input Leakage Current (any input) (0 ≤ V <sub>in</sub> ≤ 5.5) (Except Pin 1)	I <sub>I(L)</sub>	—	10	μA	—
Output Leakage Current (0 ≤ V <sub>out</sub> ≤ 5.5) (CAS at Logic 1)	I <sub>O(L)</sub>	—	10	μA	—
Output Logic 1 Voltage @ I <sub>out</sub> = -4 mA	V <sub>OH</sub>	2.4	—	V	—
Output Logic 0 Voltage @ I <sub>out</sub> = 4 mA	V <sub>OL</sub>	—	0.4	V	—

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6665-15		MCM6665-20		Units	Notes
		Min	Max	Min	Max		
Random Read or Write Cycle Time	t <sub>RC</sub>	300	—	350	—	ns	8, 9
Read Write Cycle Time	t <sub>RWC</sub>	300	—	350	—	ns	8, 9
Access Time from Row Address Strobe	t <sub>RA</sub>	—	150	—	200	ns	10, 12
Access Time from Column Address Strobe	t <sub>CA</sub>	—	75	—	110	ns	11, 12
Output Buffer and Turn-Off Delay	t <sub>OFF</sub>	0	30	0	40	ns	17
Row Address Strobe Precharge Time	t <sub>RP</sub>	120	—	140	—	ns	—
Row Address Strobe Pulse Width	t <sub>RAS</sub>	150	10000	200	10000	ns	—
Column Address Strobe Pulse Width	t <sub>CAS</sub>	75	10000	110	10000	ns	—
Row to Column Strobe Lead Time	t <sub>RCD</sub>	30	75	35	90	ns	13
Row Address Setup Time	t <sub>ASR</sub>	0	—	0	—	ns	—
Row Address Hold Time	t <sub>RAH</sub>	25	—	30	—	ns	—
Column Address Setup Time	t <sub>ASC</sub>	0	—	0	—	ns	—
Column Address Hold Time	t <sub>CAH</sub>	45	—	55	—	ns	—
Column Address Hold Time Referenced to RAS	t <sub>AR</sub>	120	—	155	—	ns	—
Transition Time (Rise and Fall)	t <sub>T</sub>	3	50	3	50	ns	6

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(See Notes 2, 3, 6, and Figure 1)

(Read, Write, and Read-Modify-Write Cycles)

(Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Parameter	Symbol	MCM6665-15		MCM6665-20		Units	Notes
		Min	Max	Min	Max		
Read Command Setup Time	tRCS	0	—	0	—	ns	—
Read Command Hold time	tRCH	10	—	10	—	ns	14
Read Command Hold Time Referenced to RAS	tRRH	30	—	35	—	ns	14
Write Command Hold Time	tWCH	45	—	55	—	ns	—
Write Command Hold Time Referenced to RAS	tWCR	120	—	155	—	ns	—
Write Command Pulse Width	tWP	45	—	55	—	ns	—
Write Command to Row Strobe Lead Time	tRWL	45	—	55	—	ns	—
Write Command to Column Strobe Lead Time	tCWL	45	—	55	—	ns	—
Data in Setup Time	tDS	0	—	0	—	ns	15
Data in Hold Time	tDH	45	—	55	—	ns	15
Data in Hold Time Referenced to RAS	tDHR	120	—	155	—	ns	—
Column to Row Strobe Precharge Time	tCRP	—10	—	—10	—	ns	—
RAS Hold Time	tRSH	75	—	110	—	ns	—
Refresh Period	tRFSH	—	2.0	—	2.0	ms	—
WRITE Command Setup Time	tWCS	—10	—	—10	—	ns	16
CAS to WRITE Delay	tCWD	45	—	55	—	ns	16
RAS to WRITE Delay	tRWD	125	—	160	—	ns	16
CAS Hold Time	tCSH	150	—	200	—	ns	—

CAPACITANCE (f = 1.0 MHz, TA = 25°C, VCC = 5 V. Periodically Sampled Rather Than 100% Tested)

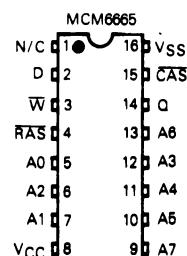
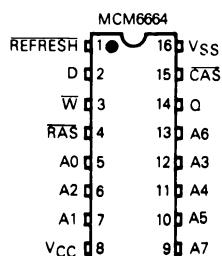
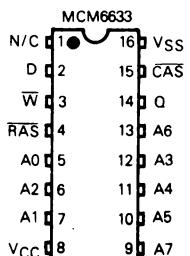
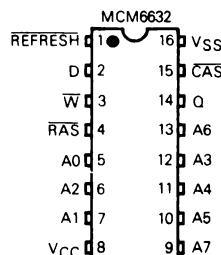
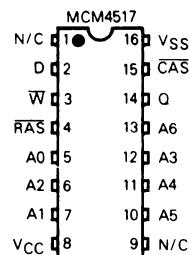
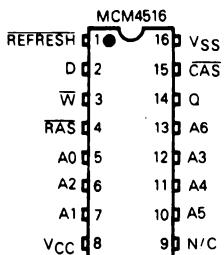
Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A7); D	C <sub>I1</sub>	4	5	pF	7,
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8	10	pF	7
Output Capacitance (Q) (CAS = V <sub>IH</sub> to disable output)	C <sub>O</sub>	5	7	pF	7

## NOTES:

- All voltages referenced to V<sub>SS</sub>.
- V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
- An initial pause of 100 µs is required after power-up followed by any 8 RAS cycles before proper device operation guaranteed.
- Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
- Output is disabled (open-circuit) and RAS and CAS are both at a logic 1.
- The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transmit between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
- Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = \frac{I\Delta t}{\Delta V}$
- The specifications for t<sub>RC</sub> (min), and t<sub>RWC</sub> (min) are used only to indicate cycle time at which proper operation over the full temperature range (0°C ≤ T<sub>A</sub> ≤ 70°C) is assured.
- AC measurements assume t<sub>T</sub> = 5.0 ns.
- Assumes that t<sub>RCD</sub> ≤ t<sub>RC</sub> (max).
- Assumes that t<sub>RC</sub> ≥ t<sub>RCD</sub> (max).
- Measured with a current load equivalent to 2 TTL loads (+200 µA, -4 mA) and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = -0.8 V).
- Operation within the t<sub>RC</sub> (max) limit ensures that t<sub>RAC</sub> (max) can be met. t<sub>RC</sub> (max) is specified as a reference point only; if t<sub>RC</sub> is greater than the specified t<sub>RC</sub> (max) limit, then access time is controlled exclusively by t<sub>CAC</sub>.
- Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
- These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify-write cycles.
- t<sub>WCS</sub>, t<sub>CWD</sub>, and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if t<sub>WCS</sub> ≥ t<sub>RC</sub> (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if t<sub>CWD</sub> ≥ t<sub>RC</sub> (min) and t<sub>RWD</sub> ≥ t<sub>RC</sub> (min), the cycle is a read-write cycle and the data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
- t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

# MCM6665

## PIN ASSIGNMENT COMPARISON

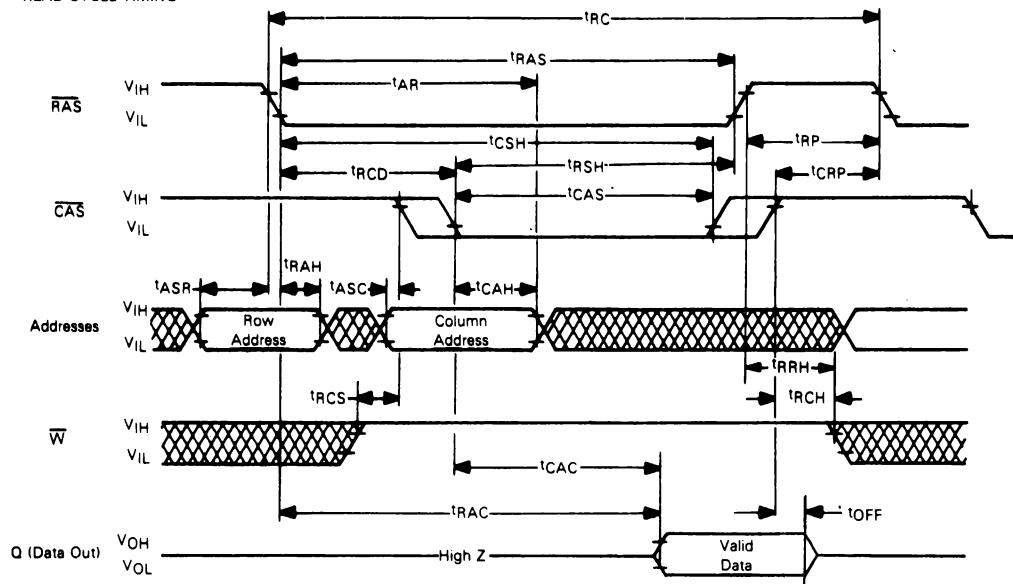


## PIN VARIATIONS

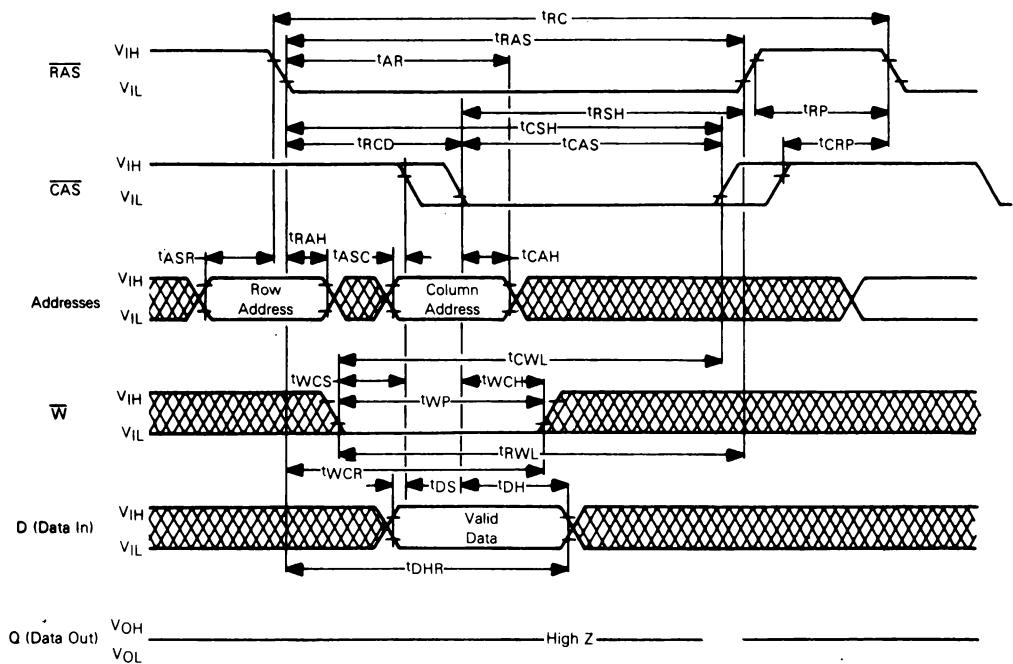
Pin Number	MCM4116	MCM4518	MCM4517	MCM6632	MCM6663	MCM6664	MCM6665
1	V <sub>BB</sub> (-5 V)	REFRESH	N/C	REFRESH	N/C	REFRESH	N/C
8	V <sub>DD</sub> (+12 V)	V <sub>CC</sub>					
9	V <sub>CC</sub> (+5 V)	N/C	N/C	A7	A7	A7	A7

# MCM6665

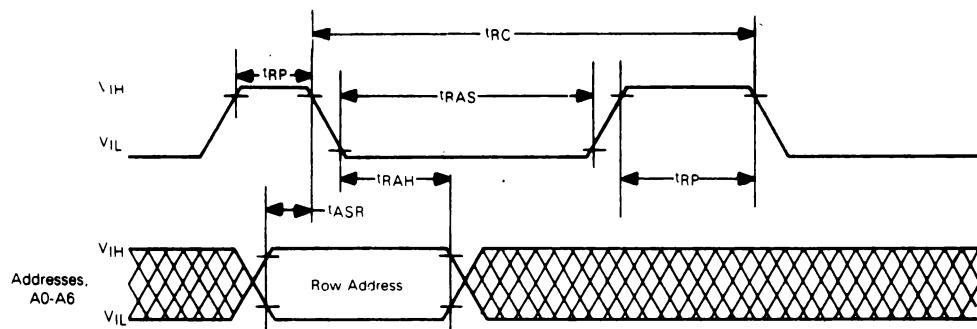
## READ CYCLE TIMING



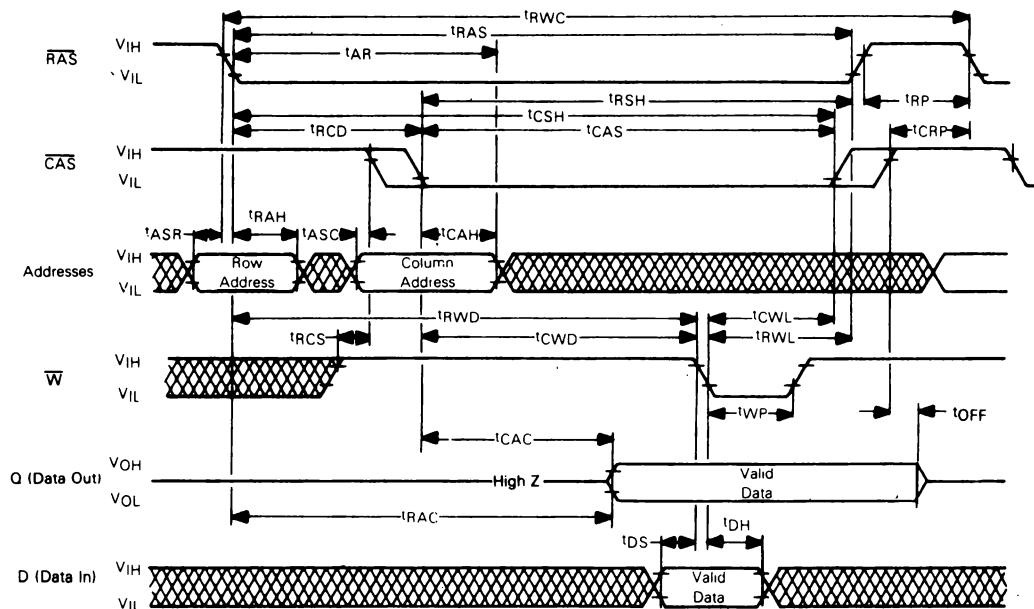
## WRITE CYCLE TIMING



**RAS-ONLY REFRESH CYCLE**  
(Data-in and Write are Don't Care, CAS is HIGH)



**READ-WRITE/READ-MODIFY-WRITE CYCLE**



MCM6665

## MCM8865 BIT ADDRESS MAP

Pin 8

Row Address A7 A6 A5 A4 A3 A2 A1 A0  
Column Address A7 A6 A5 A4 A3 A2 A1 A0

Data Stored = D<sub>In</sub> • A<sub>0X</sub> • A<sub>1Y</sub>

Column Address A1	Row Address A0	Data Stored
0	0	Inverted
0	1	True
1	0	True
1	1	Inverted



**MOTOROLA**

# **MCM6665L25**

## **65,536-BIT DYNAMIC RAM**

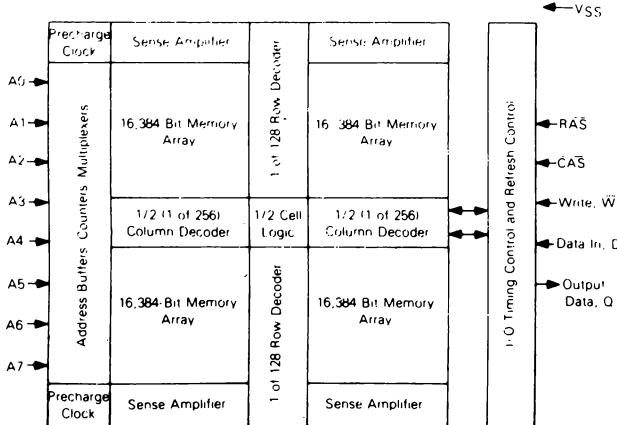
The MCM6665 is a 65,536 bit, high-speed, dynamic Random-Access Memory. Organized as 65,536 one-bit words and fabricated using HMOS high-performance N-channel silicon-gate technology. This new breed of 5-volt only dynamic RAM combines high performance with low cost and improved reliability.

By multiplexing row- and column-address inputs, the MCM6665 requires only eight address lines and permits packaging in standard 16-pin dual-in-line packages. Complete address decoding is done on chip with address latches incorporated. Data out is controlled by  $\overline{\text{CAS}}$  allowing for greater system flexibility.

All inputs and outputs, including clocks, are fully TTL compatible. The MCM6665 incorporates a one-transistor cell design and dynamic storage techniques.

- Organized as 65,536 Words of 1 Bit
- Single +5 V Operation
- 250 ns Operation
- Low Power Dissipation  
275 mW Maximum (Active)  
30 mW Maximum (Standby)
- Three State Data Output
- Internal Latches for Address and Data Input
- Early-Write Output Capability
- 16K Compatible 128-Cycle, 2 ms Refresh
- $\overline{\text{RAS}}$ -only Refresh Mode
- CAS Controlled Output Providing Latched or Unlatched Data
- Upward Pin Compatible from the 16K RAM (MCM4116, MCM4516, MCM4517)

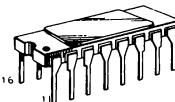
## **BLOCK DIAGRAM**



## **MOS**

(IN-CHANNEL, SILICON-GATE)

## **65,536-BIT DYNAMIC RANDOM ACCESS MEMORY**



L SUFFIX  
CERAMIC PACKAGE  
CASE 690

## **PIN ASSIGNMENT**

VCC1	16	VSS
D	12	$\overline{\text{CAS}}$
W	3	Q
RAS	4	A6
A0	5	A3
A2	6	A4
A1	7	A5
VCC	8	A7

\*VCC1 does not draw any current but must be tied to VCC to inactivate internal refresh circuitry.

## **PIN NAMES**

A0-A7	... Address Input
D	... Data In
Q	... Data Out
W	... Read/Write Input
RAS	... Row Address Strobe
CAS	... Column Address Strobe
VCC	... Power (+5 V)
VSS	... Ground

This device contains 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 this high impedance circuit.

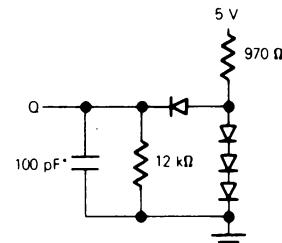
# MCM6665L25

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Voltage on Any Pin Relative to V <sub>SS</sub> (Except V <sub>CC</sub> )	V <sub>in</sub> , V <sub>out</sub>	-2 to +7	V
Voltage on V <sub>CC</sub> Supply Relative to V <sub>SS</sub>	V <sub>in</sub> , V <sub>out</sub>	-1 to +7	V
Operating Temperature Range	T <sub>A</sub>	0 to +50	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Power Dissipation	P <sub>D</sub>	1.0	W
Data Out Current	I <sub>out</sub>	50	mA

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.

FIGURE 1 – OUTPUT LOAD



\* Includes Jig Capacitance

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit	Notes	
Supply Voltage	MCM6665L25	V <sub>CC</sub> 0	4.5 0	5.0 0	5.5 0	V	1
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.4	—	V <sub>CC</sub> + 1.0	V	1	
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-2.0	—	0.8	V	1	

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit	Notes
V <sub>CC</sub> Power Supply Current (t <sub>RC</sub> min.)	I <sub>CC</sub>	—	50	mA	4
Standby V <sub>CC</sub> Power Supply Current	I <sub>CC2</sub>	—	5	mA	5
V <sub>CC</sub> Power Supply Current During RAS Only Refresh Cycles	I <sub>CC3</sub>	—	40	mA	—
Input Leakage Current (any input) (0 ≤ V <sub>in</sub> ≤ 5.5) (Except Pin 1)	I <sub>IL</sub>	—	10	μA	—
Input Leakage Current (Pin 1) (V <sub>in</sub> = V <sub>CC</sub> )	I <sub>IL</sub>	—	10	μA	—
Output Leakage Current (0 ≤ V <sub>out</sub> ≤ 5.5) (Except Pin 1)	I <sub>OL</sub>	—	10	μA	5, 6
Output Logic 1 Voltage @ I <sub>out</sub> = -4 mA	V <sub>OH</sub>	2.4	—	V	—
Output Logic 0 Voltage @ I <sub>out</sub> = 4 mA	V <sub>OL</sub>	—	0.4	V	—

## AC OPERATING CONDITIONS AND CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted)

(See Notes 2, 3, 9, 14)  
(Read, Write, and Read-Modify-Write Cycles)

Parameter	Symbol	Min	Max	Unit	Notes
Random Read or Write Cycle Time	t <sub>RC</sub>	450	—	ns	8, 9
Read Write Cycle Time	t <sub>RWC</sub>	450	—	ns	8, 9
Access Time from Row Address Strobe	t <sub>RAC</sub>	—	250	ns	10, 12
Access Time from Column Address Strobe	t <sub>CAC</sub>	—	145	ns	11, 12
Output Buffer and Turn-Off Delay	t <sub>OFF</sub>	0	50	ns	17
Row Address Strobe Precharge Time	t <sub>RP</sub>	190	—	ns	—
Row Address Strobe Pulse Width	t <sub>RAS</sub>	250	10000	ns	—
Column Address Strobe Pulse Width	t <sub>CAS</sub>	145	10000	ns	—
Row to Column Strobe Lead Time	t <sub>RCD</sub>	55	105	ns	13
Row Address Setup Time	t <sub>ASR</sub>	0	—	ns	—
Row Address Hold Time	t <sub>RAH</sub>	45	—	ns	—
Column Address Setup Time	t <sub>ASC</sub>	0	—	ns	—
Column Address Hold Time	t <sub>CAH</sub>	75	—	ns	—
Column Address Hold Time Referenced to RAS	t <sub>AR</sub>	200	—	ns	—
Transition Time (Rise and Fall)	t <sub>T</sub>	3.0	50	ns	6

**AC OPERATING CONDITIONS AND CHARACTERISTICS**  
 (Full Operating Voltage and Temperature Range Unless Otherwise Noted)  
 (See Notes 2, 3, 9, 14)  
 (Read, Write, and Read-Modify-Write Cycles)

Parameter	Symbol	Min	Max	Units	Notes
Read Command Setup Time	t <sub>RCS</sub>	0	—	ns	—
Read Command Hold Time	t <sub>RCH</sub>	10	—	ns	14
Read Command Hold Time Referenced to RAS	t <sub>RRH</sub>	40	—	ns	14
Write Command Hold Time	t <sub>WCH</sub>	75	—	ns	—
Write Command Hold Time Referenced to RAS	t <sub>WCR</sub>	200	—	ns	—
Write Command Pulse Width	t <sub>WP</sub>	70	—	ns	—
Write Command to Row Strobe Lead Time	t <sub>RWL</sub>	70	—	ns	—
Write Command to Column Strobe Lead Time	t <sub>CWL</sub>	70	—	ns	—
Data in Setup Time	t <sub>DS</sub>	0	—	ns	15
Data in Hold Time	t <sub>DH</sub>	75	—	ns	15
Data in Hold Time Referenced to RAS	t <sub>DHR</sub>	200	—	ns	—
Column to Row Strobe Precharge Time	t <sub>CRP</sub>	-10	—	ns	—
RAS Hold Time	t <sub>RSH</sub>	145	—	ns	—
Refresh Period	t <sub>RFSH</sub>	—	2.0	ms	—
WRITE Command Setup Time	t <sub>WCS</sub>	-10	—	ns	16
CAS to WRITE Delay	t <sub>CWD</sub>	70	—	ns	16
RAS to WRITE Delay	t <sub>RWD</sub>	195	—	ns	16
CAS Hold Time	t <sub>CSH</sub>	250	—	ns	—

**CAPACITANCE (f = 1.0 MHz, TA = 25°C, VCC = 5 V. Periodically Sampled Rather Than 100% Tested)**

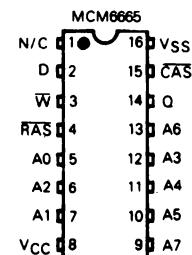
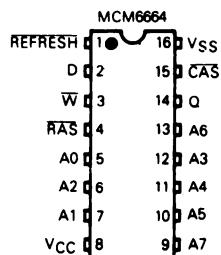
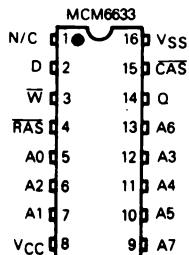
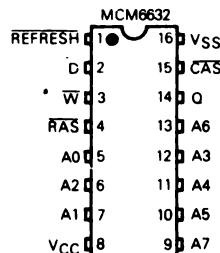
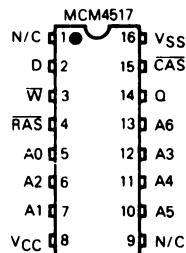
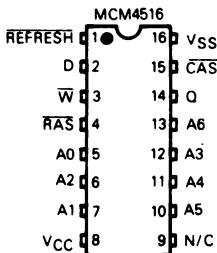
Parameter	Symbol	Typ	Max	Units	Notes
Input Capacitance (A0-A7), D	C <sub>I1</sub>	4.0	5.0	pF	7
Input Capacitance RAS, CAS, WRITE	C <sub>I2</sub>	8.0	10.0	pF	7
Output Capacitance (Q)	C <sub>O</sub>	5.0	7.0	pF	7

**NOTES**

- All voltages referenced to VSS
- V<sub>IH</sub> min and V<sub>IL</sub> max are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
- An initial pause of 100 µs is required after power up followed by any 8 RAS cycles before proper device operation guaranteed.
- Current is a function of cycle rate and output loading; maximum current is measured at the fastest cycle rate with the output open.
- Output is disabled (open circuit) and RAS and CAS are both at a logic 1.
- The transition time specification applies for all input signals. In addition to meeting the transition rate specification, all input signals must transition between V<sub>IH</sub> and V<sub>IL</sub> (or between V<sub>IL</sub> and V<sub>IH</sub>) in a monotonic manner.
- Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = \frac{I_{\Delta t}}{\Delta V}$
- The specifications for t<sub>RC</sub> (min), and t<sub>RWC</sub> (min) are used only to indicate cycle time at which proper operation over the full temperature range (0°C ≤ T<sub>A</sub> ≤ 70°C) is assured.
- AC measurements assume t<sub>1</sub> = 5.0 ns
- Assumes that t<sub>RCD</sub> ≤ t<sub>RC</sub> (max)
- Assumes that t<sub>RCD</sub> ≥ t<sub>RC</sub> (max)
- Measured with a current load equivalent to 2 TTL loads (+ 200 µA, - 4 mA) and 100 pF (V<sub>OH</sub> = 2.0 V, V<sub>OL</sub> = -0.8 V).
- Operation within the t<sub>RC</sub> (max) limit ensures that t<sub>RAAC</sub> (max) can be met. t<sub>RC</sub> (max) is specified as a reference point only, if t<sub>RCD</sub> is greater than the specified t<sub>RC</sub> (max) limit, then access time is controlled exclusively by t<sub>RAAC</sub>.
- Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
- These parameters are referenced to CAS leading edge in random write cycles and to WRITE leading edge in delayed write or read-modify write cycles.
- t<sub>WCS</sub>, t<sub>CWD</sub>, and t<sub>RWD</sub> are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only if t<sub>WCS</sub> ≥ t<sub>WCR</sub> (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle, if t<sub>CWD</sub> ≥ t<sub>CWD</sub> (min) and t<sub>RWD</sub> ≥ t<sub>RWD</sub> (min), the cycle is a read write cycle and the data out will contain data read from the selected cell, if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
- t<sub>off</sub> (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

# MCM6665L25

## PIN ASSIGNMENT COMPARISON

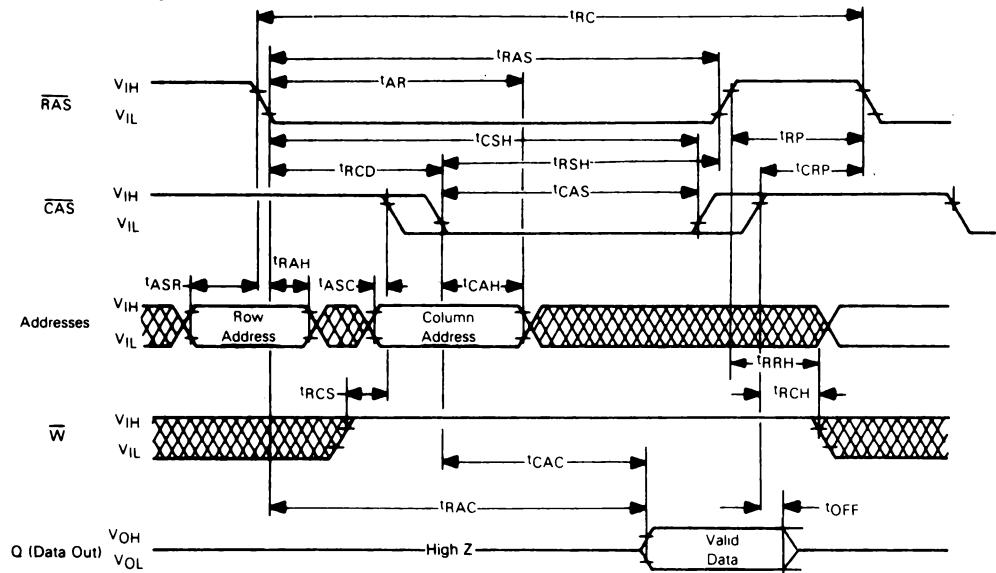


## PIN VARIATIONS

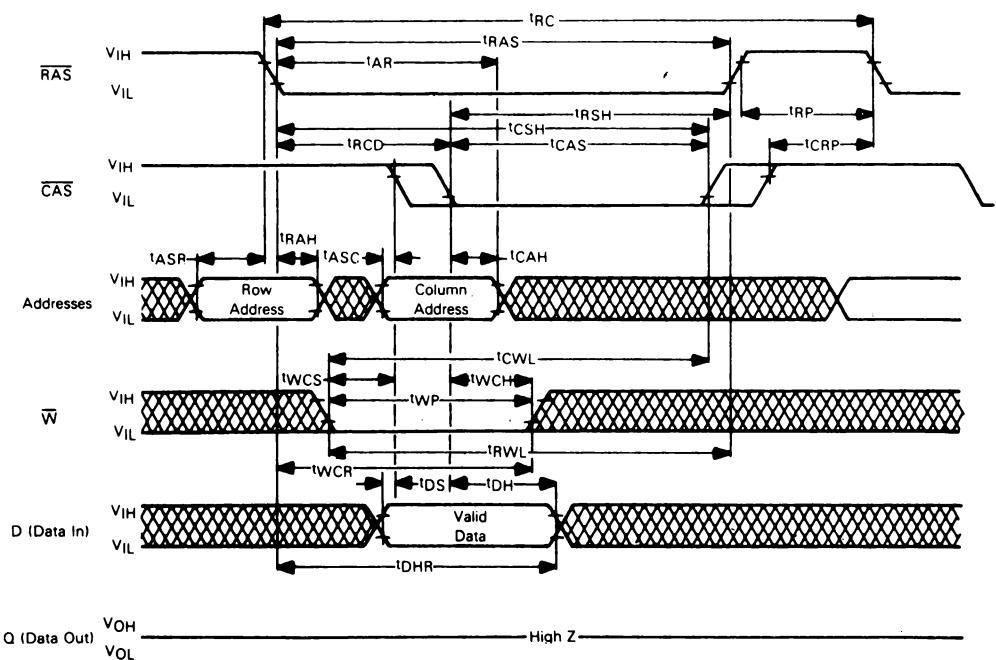
Pin Number	MCM4116	MCM4516	MCM4517	MCM6632	MCM6633	MCM6664	MCM6665
1	$V_{BB}(-5\text{ V})$	REFRESH	N/C	REFRESH	N/C	REFRESH	N/C
8	$V_{DD}(+12\text{ V})$	VCC	VCC	VCC	VCC	VCC	VCC
9	$V_{CC}(+5\text{ V})$	N/C	N/C	A7	A7	A7	A7

# MCM6665L25

## READ CYCLE TIMING

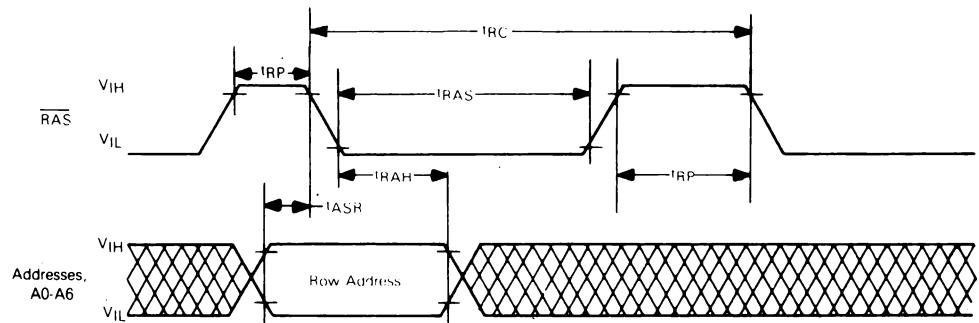


## WRITE CYCLE TIMING

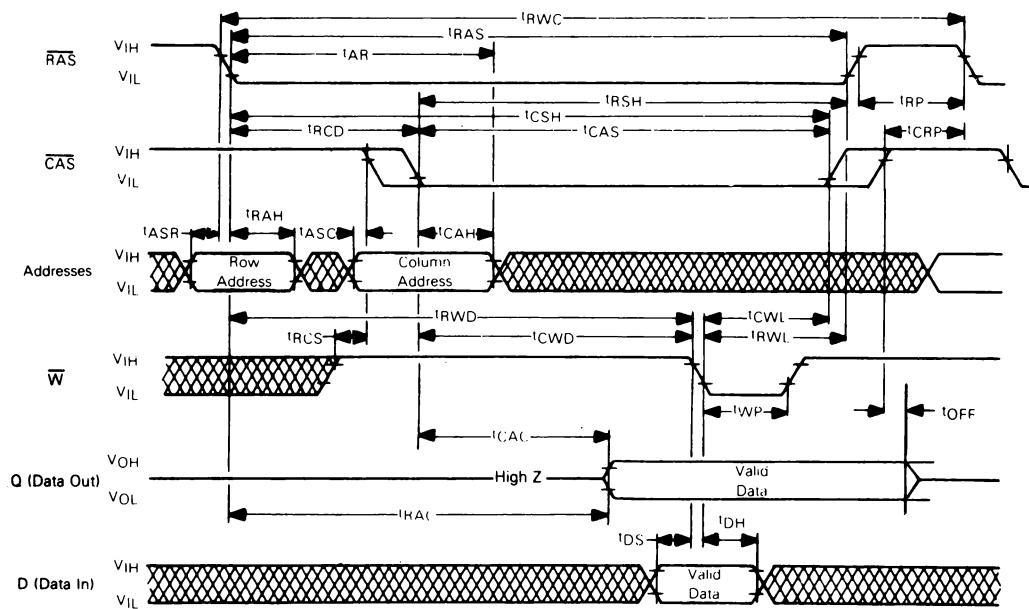


## MCM6665L25

**RAS-ONLY REFRESH CYCLE**  
 (Data-in and Write are Don't Care, CAS is HIGH)



**READ-WRITE/READ-MODIFY-WRITE CYCLE**



MCM6665L25

## MCM6665 BIT ADDRESS MAP

Pin 8

Row Address A7 A6 A5 A4 A3 A2 A1 A0  
Column Address A7 A6 A5 A4 A3 A2 A1 A0

Data Stored =  $D_{in} \oplus A_0X \oplus A_1Y$

<b>Column Address</b>	<b>Row Address</b>	<b>Data Stored</b>
A1	AC	
0	0	Inverted
0	1	True
1	0	True
1	1	Inverted



**MOTOROLA**

# MCM2114 MCM21L14

## 4096-BIT STATIC RANDOM ACCESS MEMORY

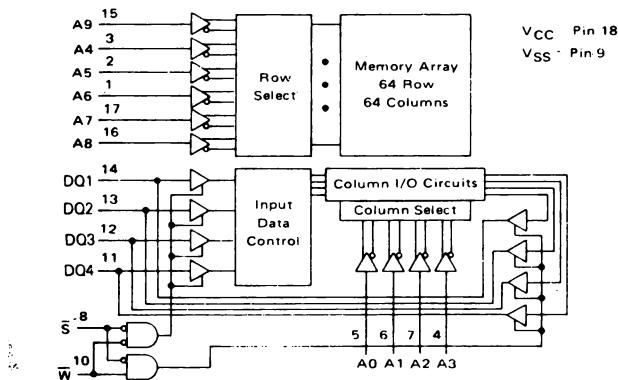
The MCM2114 is a 4096-bit random access memory fabricated with high density, high reliability N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, is directly compatible with TTL and DTL, and requires no clocks or refreshing because of fully static operation. Data access is particularly simple, since address setup times are not required. The output data has the same polarity as the input data.

The MCM2114 is designed for memory applications where simple interfacing is the design objective. The MCM2114 is assembled in 18-pin dual-in-line packages with the industry standard pin-out. A separate chip select (*S*) lead allows easy selection of an individual package when the three-state outputs are OR-tied.

The MCM2114 series has a maximum current of 100 mA. Low power versions (i.e., MCM21L14 series) are available with a maximum current of only 70 mA.

- 1024 Words by 4-Bit Organization
- Industry Standard 18-Pin Configuration
- Single +5 Volt Supply
- No Clock or Timing Strobe Required
- Fully Static. Cycle Time = Access Time
- Maximum Access Time
  - MCM2114-20/MCM21L14-20 200 ns
  - MCM2114-25/MCM21L14-25 250 ns
  - MCM2114-30/MCM21L14-30 300 ns
  - MCM2114-45/MCM21L14-45 450 ns
- Fully TTL Compatible
- Common Data Input and Output
- Three-State Outputs for OR-Ties
- Low Power Version Available

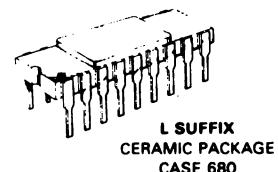
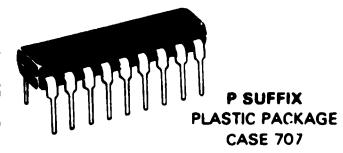
BLOCK DIAGRAM



## MOS

(IN-CHANNEL, SILICON-GATE)

## 4096-BIT STATIC RANDOM ACCESS MEMORY



### PIN ASSIGNMENT

A6	1	18	VCC
A5	2	17	A7
A4	3	16	A8
A3	4	15	A9
A0	5	14	DQ1
A1	6	13	DQ2
A2	7	12	DQ3
S	8	11	DQ4
VSS	9	10	W

### PIN NAMES

A0-A9	Address Input
W	Write Enable
S	Chip Select
DQ1-DQ4	Data Input/Output
VCC	+5 V
VSS	Ground

# MCM2114•MCM21L14

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Voltage on Any Pin With Respect to VSS	-0.5 to +7.0	V
DC Output Current	5.0	mA
Power Dissipation	1.0	Watt
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-65 to +150	°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 device contains 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 this high-impedance circuit.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	MCM2114			MCM21L14			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	—	—	—	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.0	—	6.0	—	—	—	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	—0.5	—	0.8	—	—	—	V

### DC CHARACTERISTICS

Parameter	Symbol	MCM2114			MCM21L14			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Load Current (All Input Pins, V <sub>IN</sub> = 0 to 5.5 V)	I <sub>LI</sub>	—	—	10	—	—	10	μA
I/O Leakage Current (S = 2.4 V, V <sub>DQ</sub> = 0.4 V to V <sub>CC</sub> )	I <sub>IOI</sub>	—	—	10	—	—	10	μA
Power Supply Current (V <sub>IN</sub> = 5.5 V, I <sub>DQ</sub> = 0 mA, T <sub>A</sub> = 25°C)	I <sub>CC1</sub>	—	80	95	—	—	65	mA
Power Supply Current (V <sub>IN</sub> = 5.5 V, I <sub>DQ</sub> = 0 mA, T <sub>A</sub> = 0°C)	I <sub>CC2</sub>	—	—	100	—	—	70	mA
Output Low Current V <sub>OL</sub> = 0.4 V	I <sub>OL</sub>	2.1	6.0	—	2.1	6.0	—	mA
Output High Current V <sub>OH</sub> = 2.4 V	I <sub>OH</sub>	—	—1.4	—1.0	—	—1.4	—1.0	mA

NOTE: Duration not to exceed 30 seconds.

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance (V <sub>IN</sub> = 0 V)	C <sub>IN</sub>	5.0	pF
Input/Output Capacitance (V <sub>DQ</sub> = 0 V)	C <sub>I/O</sub>	5.0	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: C = ΔI<sub>T</sub>/ΔV.

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted.)

Input Pulse Levels..... 0.8 Volt to 2.4 Volts  
Input Rise and Fall Times..... 10 ns Input and Output Timing Levels..... 1.5 Volts  
Output Load..... 1 TTL Gate and C<sub>L</sub> = 100 pF

### READ (NOTE 1), WRITE (NOTE 2) CYCLES

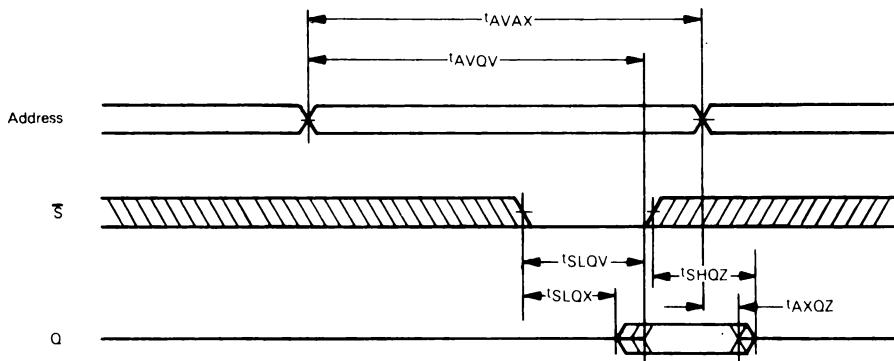
Parameter	Symbol	MCM2114-20		MCM2114-25		MCM2114-30		MCM2114-45		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Address Valid to Address Don't Care	t <sub>AVAX</sub>	200	—	250	—	300	—	450	—	ns
Address Valid to Output Valid	t <sub>AVQV</sub>	—	200	—	250	—	300	—	450	ns
Chip Select Low to Data Valid	t <sub>SLQV</sub>	—	70	—	85	—	100	—	120	ns
Chip Select Low to Output Don't Care	t <sub>SLQX</sub>	20	—	20	—	20	—	20	—	ns
Chip Select High to Output High Z	t <sub>SHQZ</sub>	—	60	—	70	—	80	—	100	ns
Address Don't Care to Output High Z	t <sub>AXQZ</sub>	50	—	50	—	50	—	50	—	ns
Write Low to Write High	t <sub>WLWH</sub>	120	—	135	—	150	—	200	—	ns
Write High to Address Don't Care	t <sub>WHAX</sub>	20	—	20	—	20	—	20	—	ns
Write Low to Output High Z	t <sub>WLQZ</sub>	—	60	—	70	—	80	—	100	ns
Data Valid to Write High	t <sub>DVWH</sub>	120	—	135	—	150	—	200	—	ns
Write High to Data Don't	t <sub>WHDX</sub>	0	—	0	—	0	—	0	—	ns

NOTES 1. A Read occurs during the overlap of a low S and a high W

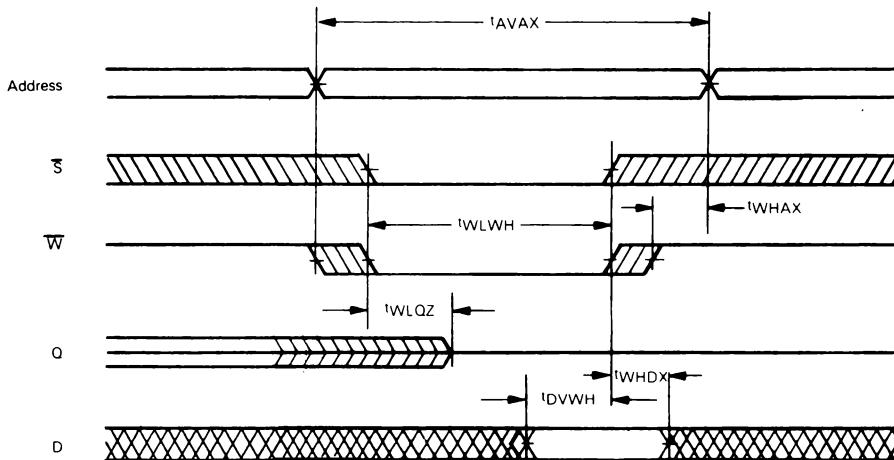
2. A Write occurs during the overlap of a low S and a low W

CM2114•MCM21L14

#### **READ CYCLE TIMING ( $\overline{W}$ HELD HIGH)**



### **WRITE CYCLE TIMING (NOTE 3)**



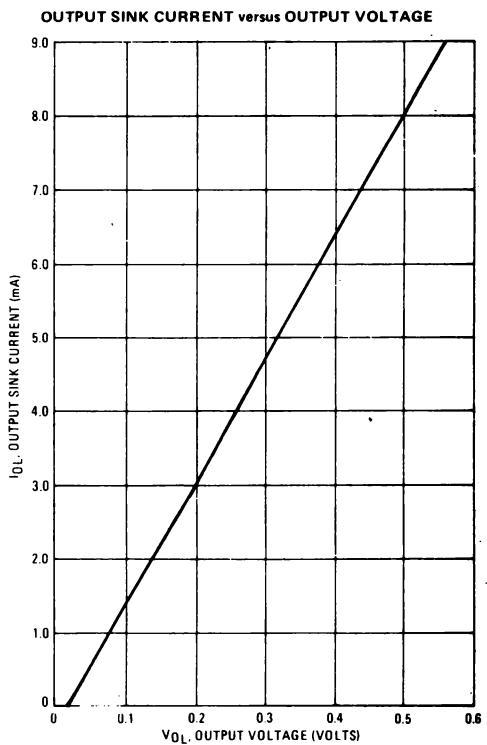
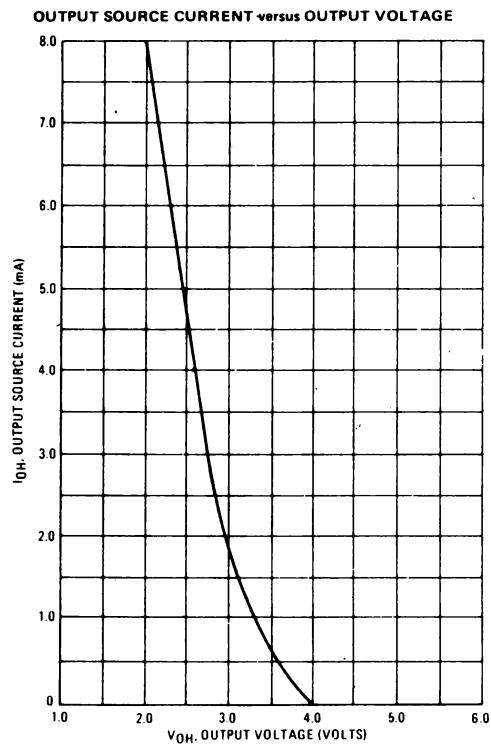
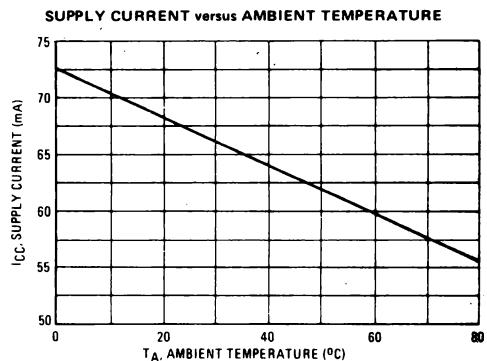
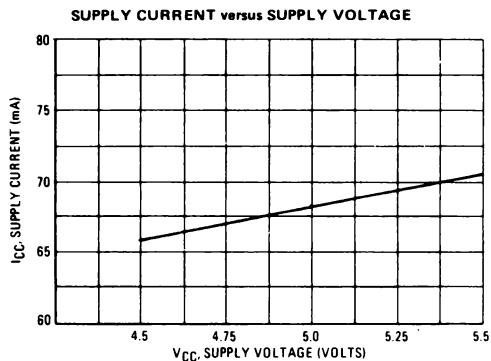
3. If the  $S$  low transition occurs simultaneously with the  $W$  low transition, the output buffers remain in a high-impedance state.

## WAVEFORMS

<b>Waveform Symbol</b>	<b>Input</b>	<b>Output*</b>
	MUST BE VALID	WILL BE VALID
	CHANGE FROM H TO L	WILL CHANGE FROM H TO L
	CHANGE FROM L TO H	WILL CHANGE FROM L TO H
	DON T CARE ANY CHANGE PERMITTED	CHANGING STATE UNKNOWN
		HIGH IMPEDANCE

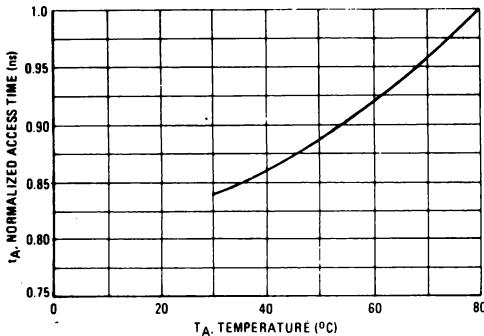
# MCM2114•MCM21L14

## TYPICAL CHARACTERISTICS

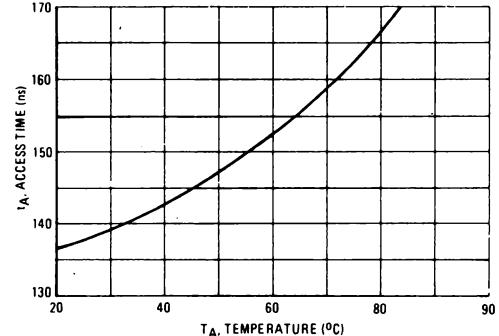


# MCM2114•MCM21L14

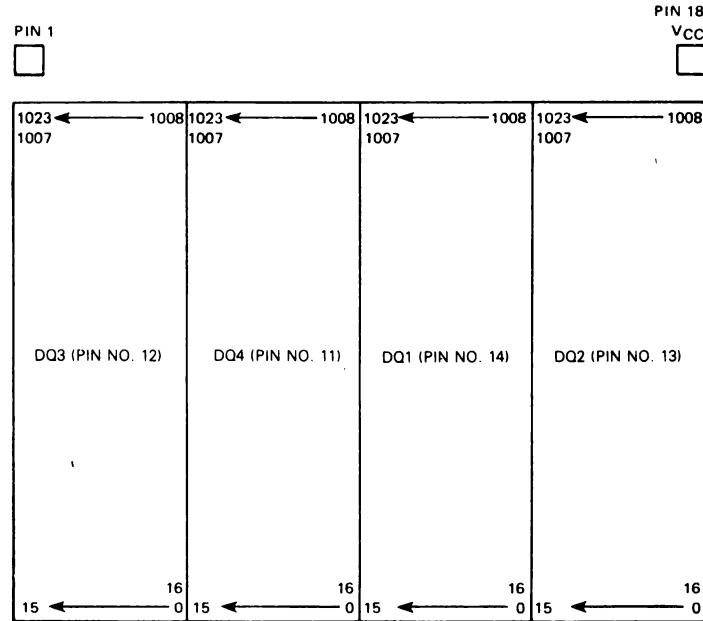
NORMALIZED ACCESS TIME versus TEMPERATURE



TYPICAL ACCESS TIME versus TEMPERATURE



MCM2114/MCM21L14 BIT MAP



To determine the precise location on the die of a word in memory, reassign address numbers to the address pins as in the table below. The bit locations can then be determined directly from the bit map.

PIN NUMBER	REASSIGNED ADDRESS NUMBER	PIN NUMBER	REASSIGNED ADDRESS NUMBER
1	A6	6	A1
2	A5	7	A2
3	A4	15	A9
4	A3	16	A8
5	A0	17	A7



**MOTOROLA**

**MCM2115A  
MCM21L15A  
MCM2125A  
MCM21L25A**

**1024 × 1 STATIC RAM**

The MCM2115A and MCM2125A families are high-speed, 1024 words by one-bit, random-access memories fabricated using HMOS, high-performance N-channel silicon-gate technology. Both open collector (MCM2115A) and three-state output (MCM2125A) are available. The devices use fully static circuitry throughout and require no clocks or timing strobes. Data out has the same polarity as the input data.

Access times are fully compatible with the industry-produced 1K Bipolar RAMs, yet offer up to 50% reduction in power over their Bipolar equivalents.

All inputs and output are directly TTL compatible. The chip select allows easy selection of an individual device when outputs are OR-tied.

- Organized as 1024 Words of 1 Bit
- Single + 5 V Operation
- Maximum Access Time of 45 ns, 55 ns, and 70 ns available
- Low Operating Power Dissipation
- Pin Compatible to 93415A (2115A) and 93425A (2125A)
- TTL Inputs and Outputs
- Uncommitted Collector (2115A) and Three-State (2125A) Output

**MOS**

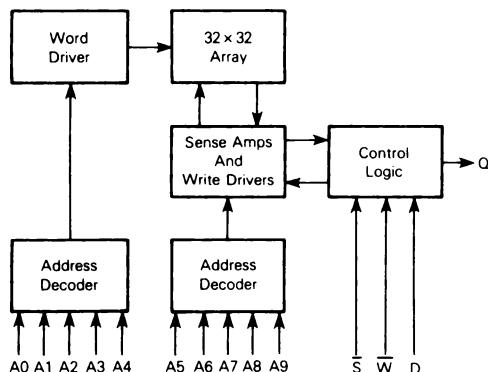
(N-CHANNEL, SILICON-GATE)

**1024-BIT STATIC  
RANDOM ACCESS  
MEMORY**



**C SUFFIX**  
FRIT-SEAL  
CERAMIC PACKAGE  
CASE 620-06

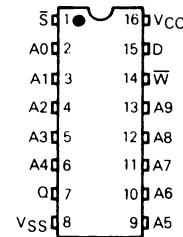
**BLOCK DIAGRAM**



**TRUTH TABLE**

Inputs			Output 2115A Family	Output 2125A Family	Mode
S	W	D	Q	Q	
H	X	X	H	High Z	Not Selected
L	L	L	H	High Z	Write "0"
L	L	H	H	High Z	Write "1"
L	H	X	Data Out	Data Out	Read

**PIN ASSIGNMENT**



**PIN NAMES**

A.....	Address
D.....	Data Input
Q.....	Data Output
S.....	Chip Select
V <sub>CC</sub> .....	+ 5 V Supply
V <sub>SS</sub> .....	Ground
W.....	Write Enable

# MCM2115A•MCM21L15A•MCM2125A•MCM21L25A

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Voltage on Any Pin With Respect to V <sub>SS</sub>	-0.5 to +7.0	Vdc
DC Output Current	20	mA
Power Dissipation	1.0	Watt
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-65 to +150	°C

This device contains 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 this high-impedance circuit.

NOTE: Permanent 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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	V
V <sub>SS</sub>	0	0	0	0	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.1	—	6	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-0.3	—	0.8	V

### DC OPERATING CHARACTERISTICS

Parameter	Symbol	MCM2115A		MCM21L15A		MCM2125A		MCM21L25A		Unit	
		Min	Max	Min	Max	Min	Max	Min	Max		
Input Low Current (All Input Pins, V <sub>IN</sub> = 0 to 5.5 V)	I <sub>IL</sub>	—	-40	—	-40	—	-40	—	-40	μA	
Input High Current	I <sub>IH</sub>	—	40	—	40	—	40	—	40	μA	
Output Leakage Current (V <sub>out</sub> = 0.5/2.4 V)	I <sub>OL</sub>	—	—	—	—	—	50	—	50	μA	
Output Leakage Current (V <sub>out</sub> = 4.5 V)	I <sub>CEX</sub>	—	100	—	100	—	—	—	—	μA	
Power Supply Current (S = V <sub>IL</sub> , Outputs Open T <sub>A</sub> = 25°C)	I <sub>CC</sub>	—	125	—	75	—	125	—	75	mA	
Output Low Voltage (I <sub>OL</sub> = 7.0 mA, 2125A, 16 mA 2115A)	V <sub>OL</sub>	—	0.45	—	0.45	—	0.45	—	0.45	V	
Output High Voltage (I <sub>OH</sub> = -4.0 mA)	V <sub>OH</sub>	—	—	—	—	2.4	—	2.4	—	V	
Current Short Circuit to Ground	I <sub>OS</sub>	—	—	—	—	—	—	100	—	100	mA

### MCM2115A FAMILY AC OPERATING CONDITIONS AND CHARACTERISTICS, READ, WRITE CYCLES

(T<sub>A</sub> = 0 to 70°C, V<sub>CC</sub> = 5.0 V ± 5%)

Parameter	Symbol	MCM2115A-45		MCM2115A-55		MCM2115A-70		Units
		Min	Max	Min	Max	Min	Max	
Chip Select Low Output Valid	t <sub>SLQV</sub>	5	30	5	35	5	40	ns
Chip Select High to Output Invalid	t <sub>SHQZ</sub>	—	30	—	35	—	40	ns
Address Valid to Output Valid	t <sub>AVQV</sub>	—	45	—	55	—	70	ns
Address Valid to Output Invalid	t <sub>AVQX</sub>	10	—	10	—	10	—	ns
Write Low to Output Disable	t <sub>WLQZ</sub>	—	30	—	35	—	40	ns
Write High to Output Valid	t <sub>WHQV</sub>	0	30	0	35	0	45	ns
Write Low to Write High (Write Pulse Width)	t <sub>WLWH</sub>	30	—	40	—	50	—	ns
Data Valid to Write Low	t <sub>DVWL</sub>	5	—	5	—	5	—	ns
Write High to Data Don't Care (Data Hold)	t <sub>WHDX</sub>	5	—	5	—	5	—	ns
Address Valid to Write Low (Address Setup)	t <sub>AVWL</sub>	5	—	5	—	15	—	ns
Write High to Address Don't Care	t <sub>WHAX</sub>	5	—	5	—	5	—	ns
Chip Select Low to Write Low	t <sub>SLWL</sub>	5	—	5	—	5	—	ns
Write High to Chip Select High	t <sub>WHSH</sub>	5	—	5	—	5	—	ns
Address Valid to Address Don't Care	t <sub>AVAX</sub>	—	45	—	55	—	70	ns
Chip Select Low to Chip Select High	t <sub>SLSH</sub>	—	45	—	55	—	70	ns

# MCM2115A•MCM21L15A•MCM2125A•MCM21L25A

**MCM21L15A FAMILY AC OPERATING CONDITIONS AND CHARACTERISTICS, READ, WRITE CYCLES**  
 $(T_A = 0 \text{ to } 70^\circ\text{C}, V_{CC} = 5.0 \text{ V} \pm 5\%)$

Parameter	Symbol	MCM21L15A-45				Units
		Min	Max	Min	Max	
Chip Select Low to Output Valid	t <sub>SLQV</sub>	5	30	5	30	ns
Chip Select High to Output Invalid	t <sub>SHQZ</sub>	—	30	—	30	ns
Address Valid to Output Valid	t <sub>AVQV</sub>	—	45	—	70	ns
Address Valid to Output Invalid	t <sub>AVQX</sub>	10	—	10	—	ns
Write Low to Output Disable	t <sub>WLQZ</sub>	—	25	—	25	ns
Write High to Output Valid	t <sub>WHQV</sub>	0	25	0	25	ns
Write Low to Write High (Write Pulse Width)	t <sub>WLWH</sub>	30	—	30	—	ns
Data Valid to Write Low	t <sub>DVWL</sub>	0	—	0	—	ns
Write High to Data Don't Care	t <sub>WHDX</sub>	5	—	5	—	ns
Address Valid to Write Low (Address Setup)	t <sub>AVWL</sub>	5	—	5	—	ns
Write High to Address Don't Care	t <sub>WHAX</sub>	5	—	5	—	ns
Chip Select Low to Write Low	t <sub>SLWL</sub>	5	—	5	—	ns
Write High to Chip Select High	t <sub>WHSH</sub>	5	—	5	—	ns
Address Valid to Address Don't Care	t <sub>AVAX</sub>	—	45	—	70	ns
Chip Select Low to Chip Select High	t <sub>SLSH</sub>	—	45	—	70	ns

**MCM2125A FAMILY AC OPERATING CONDITIONS AND CHARACTERISTICS, READ, WRITE CYCLES**  
 $(T_A = 0 \text{ to } 70^\circ\text{C}, V_{CC} = 5.0 \text{ V} \pm 5\%)$

Parameter	Symbol	MCM2125A-45		MCM2125A-55		MCM2125A-70		Units
		Min	Max	Min	Max	Min	Max	
Chip Select Low to Output Valid	t <sub>SLQV</sub>	5	30	5	35	5	40	ns
Chip Select High to Output High Z	t <sub>SHQZ</sub>	—	30	—	35	—	40	ns
Address Valid to Output Valid	t <sub>AVQV</sub>	—	45	—	55	—	70	ns
Address Valid to Output Invalid	t <sub>AVQX</sub>	10	—	10	—	10	—	ns
Write Low to Output High Z	t <sub>WLQZ</sub>	—	30	—	35	—	40	ns
Write High to Output Valid	t <sub>WHQV</sub>	0	30	0	35	0	45	ns
Write Low to Write High (Write Pulse Width)	t <sub>WLWH</sub>	30	—	40	—	50	—	ns
Data Valid to Write Low	t <sub>DVWL</sub>	5	—	5	—	5	—	ns
Write High to Data Don't Care	t <sub>WHDX</sub>	5	—	5	—	5	—	ns
Address Valid to Write Low (Address Setup)	t <sub>AVWL</sub>	5	—	5	—	15	—	ns
Write High to Address Don't Care	t <sub>WHAX</sub>	5	—	5	—	5	—	ns
Chip Select Low to Write Low	t <sub>SLWL</sub>	5	—	5	—	5	—	ns
Write High to Chip Select High	t <sub>WHSH</sub>	5	—	5	—	5	—	ns
Address Valid to Address Don't Care	t <sub>AVAX</sub>	—	45	—	55	—	70	ns
Chip Select Low to Chip Select High	t <sub>SLSH</sub>	—	45	—	55	—	70	ns

**MCM21L25A FAMILY AC OPERATING CONDITIONS AND CHARACTERISTICS, READ, WRITE CYCLES**  
 $(T_A = 0 \text{ to } 70^\circ\text{C}, V_{CC} = 5.0 \text{ V} \pm 5\%)$

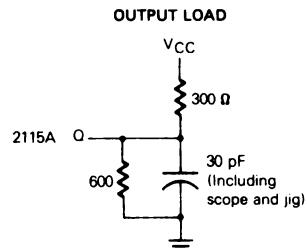
Parameter	Symbol	MCM21L25A-45		MCM21L25A-70		Units
		Min	Max	Min	Max	
Chip Select Low to Output Valid	t <sub>SLQV</sub>	5	30	5	30	ns
Chip Select High to Output High Z	t <sub>SHQZ</sub>	—	30	—	30	ns
Address Valid to Output Valid	t <sub>AVQV</sub>	—	45	—	70	ns
Address Valid to Output Invalid	t <sub>AVQX</sub>	10	—	10	—	ns
Write Low to Output High Z	t <sub>WLQZ</sub>	—	25	—	25	ns
Write High to Output Valid	t <sub>WHQV</sub>	0	25	0	25	ns
Write Low to Write High (Write Pulse Width)	t <sub>WLWH</sub>	30	—	30	—	ns
Data Valid to Write Low	t <sub>DVWL</sub>	0	—	0	—	ns
Write High to Data Don't Care	t <sub>WHDX</sub>	5	—	5	—	ns
Address Valid to Write Low (Address Setup)	t <sub>AVWL</sub>	5	—	5	—	ns
Write High to Address Don't Care	t <sub>WHAX</sub>	5	—	5	—	ns
Chip Select Low to Write Low	t <sub>SLWL</sub>	5	—	5	—	ns
Write High to Chip Select High	t <sub>WHSH</sub>	5	—	5	—	ns
Address Valid to Address Don't Care	t <sub>AVAX</sub>	—	45	—	70	ns
Chip Select Low to Chip Select High	t <sub>SLSH</sub>	—	45	—	70	ns

# MCM2115A•MCM21L15A•MCM2125A•MCM21L25A

**CAPACITANCE** ( $f = 1.0$  MHz,  $T_A = 25^\circ\text{C}$ , periodically sampled rather than 100% tested.)

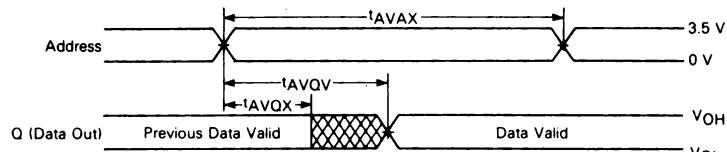
Characteristic	Symbol	Max	Unit
Input Capacitance ( $V_{in} = 0$ V)	$C_{in}$	5	pF
Output Capacitance ( $V_{out} = 0$ V)	$C_{out}$	8	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = I\Delta t / \Delta V$ .

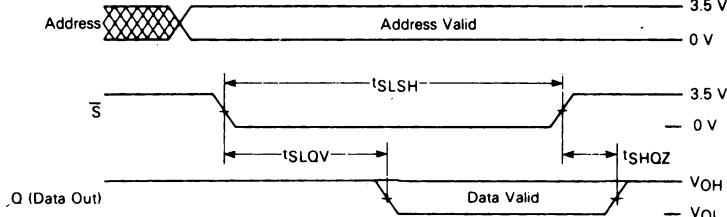


## 2115A FAMILY

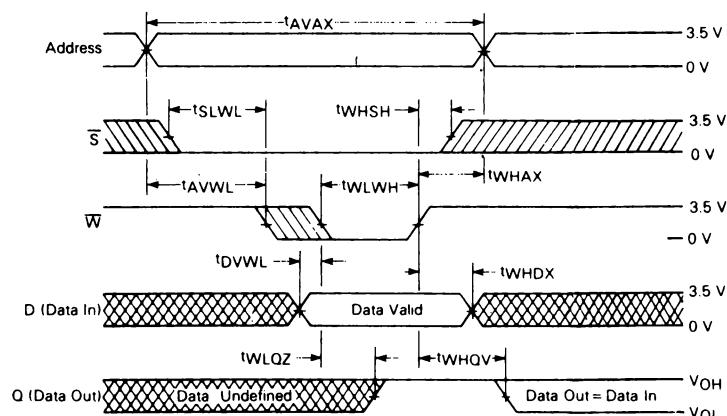
### READ CYCLE TIMING 1 ( $\bar{S}$ Held Low, $\bar{W}$ Held High)



### READ CYCLE TIMING 2' ( $\bar{W}$ Held High)



### WRITE CYCLE TIMING



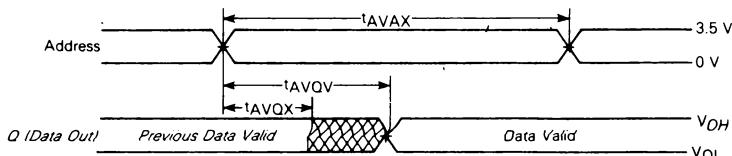
(All Time Measurements Referenced to 1.5 V)

## MCM2115A•MCM21L15A•MCM2125A•MCM21L25A

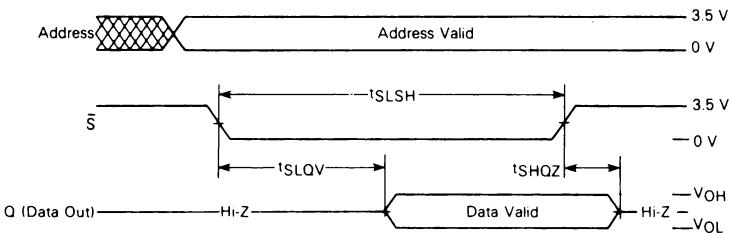
WAVEFORMS			OUTPUT LOAD
<u>Waveform Symbol</u>	<u>Input</u>	<u>Output</u>	
—	Must Be Valid	Will Be Valid	
	Change From H to L	Will Change From H to L	
	Change From L to H	Will Change From L to H	
	Don't Care: Any Change Permitted	Changing State Unknown	
	—	High Impedance	

2125A FAMILY

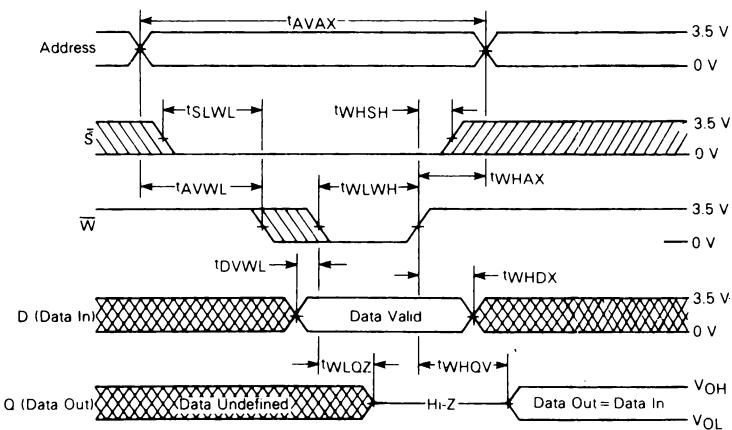
#### **READ CYCLE TIMING 1** **(S Held Low, W Held High)**



#### **READ CYCLE TIMING 2 (W Held High)**



## **WRITE CYCLE TIMING**

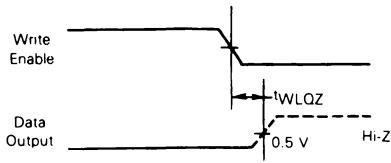


(All time measurements referenced to 1.5 V)

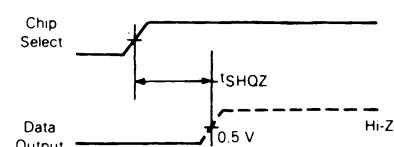
# MCM2115A•MCM21L15A•MCM2125A•MCM21L25A

## 2115A FAMILY

WRITE ENABLE TO HIGH-Z DELAY

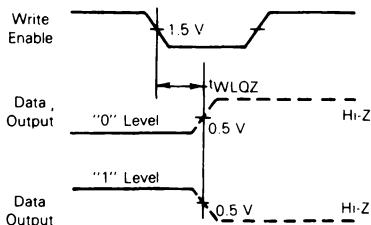


PROPAGATION DELAY FROM CHIP SELECT TO HIGH-Z

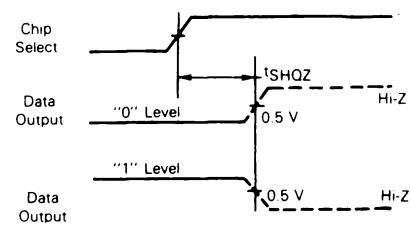


## 2125A FAMILY

WRITE ENABLE TO HIGH-Z DELAY



PROPAGATION DELAY FROM CHIP SELECT TO HIGH-Z





**MOTOROLA**

**MCM2115H  
MCM2125H**

## Product Preview

### 1024 × 1 STATIC RAM

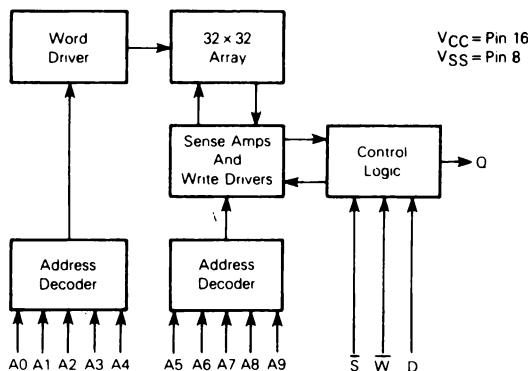
The MCM2115H and MCM2125H families are high-speed, 1024 words by one-bit, random-access memories fabricated using HMOS, high-performance N-channel silicon-gate technology. Both open collector (MCM2115H) and three-state output (MCM2125H) are available. The devices use fully static circuitry throughout and require no clocks or refreshing to operate. Data out has the same polarity as the input data.

Access times are fully compatible with the industry-produced 1K Bipolar RAMs, yet offer up to 50% reduction in power over their Bipolar equivalents.

All inputs and outputs are directly TTL compatible. A separate chip select allows easy selection of an individual device when outputs are OR-tied.

- Organized as 1024 Words of 1 Bit
- Single +5 V Operation
- Maximum Access Time of 20 ns, 25 ns, 30 ns, and 35 ns Available
- Low Operating Power Dissipation
- Pin Compatible to 93415A (2115H) and 93425A (2125H)
- TTL Inputs and Outputs
- Uncommitted Collector (2115H) and Three-State (2125H) Output

### BLOCK DIAGRAM



### TRUTH TABLE

Inputs			Output 2115H Family	Output 2125H Family	Mode
S	W	D	Q	Q	
H	X	X	H	High Z	Not Selected
L	L	L	H	High Z	Write "0"
L	L	H	H	High Z	Write "1"
L	H	X	Data Out	Data Out	Read

### MOS

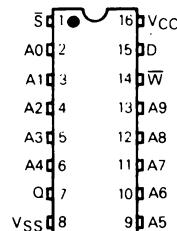
(N-CHANNEL, SILICON-GATE)

### 1024-BIT STATIC RANDOM ACCESS MEMORY



C SUFFIX  
FRIT-SEAL  
CERAMIC PACKAGE  
CASE 620-06

### PIN ASSIGNMENT



### PIN NAMES

A.....	Address
D.....	Data Input
Q.....	Data Output
S.....	Chip Select
VCC.....	+5 V Supply
VSS.....	Ground
W.....	Write Enable

Motorola reserves the right to make changes to any product herein to improve reliability, function or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM2147**

### 4096-BIT STATIC RANDOM ACCESS MEMORY

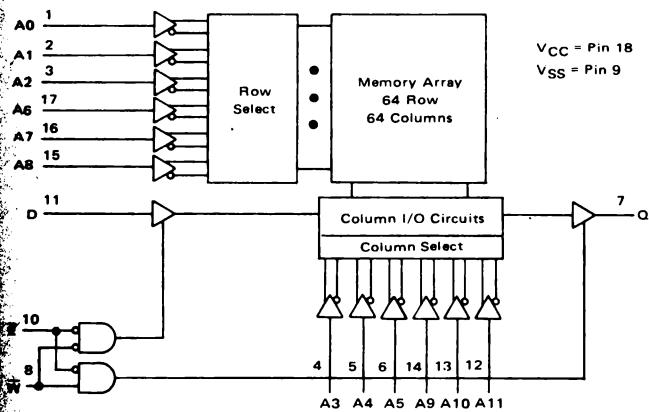
The MCM2147 is a 4096-bit static random access memory organized as 4096 words by 1-bit using Motorola's N-channel silicon-gate MOS technology. It uses a design approach which provides the simple timing features associated with fully static memories and the reduced standby power associated with semi-static and dynamic memories. This means low standby power without the need for clocks, nor reduced data rates due to cycle times that exceed access times.

$\bar{E}$  controls the power-down feature. It is not a clock but rather a chip select that affects power consumption. In less than a cycle time after  $\bar{E}$  goes high, deselect mode, the part automatically reduces its power requirements and remains in this low-power standby mode as long as  $\bar{E}$  remains high. This feature results in system power savings as great as 85% in larger systems, where most devices are deselected. The automatic power-down feature causes no performance degradation.

The MCM2147 is in an 18 pin dual in-line package with the industry standard pinout. It is TTL compatible in all respects. The data out has the same polarity as the input data. A data input and a separate three-state output provide flexibility and allow easy OR-ties.

- Fully Static Memory — No Clock or Timing Strobe Required
- Single +5 V Supply
- High Density 18 Pin Package
- Automatic Power-Down
- Directly TTL Compatible—All Inputs and Outputs
- Separate Data Input and Output
- Three-State Output
- Access Time — MCM2147-55 = 55 ns max  
MCM2147-70 = 70 ns max  
MCM2147-85 = 85 ns max  
MCM2147-100 = 100 ns max

**BLOCK DIAGRAM**

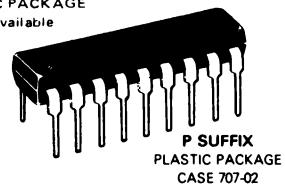


**MOS**

(N-CHANNEL, SILICON-GATE)

### 4096-BIT STATIC RANDOM ACCESS MEMORY

C SUFFIX  
FRIT SEAL  
CERAMIC PACKAGE  
also available



### PIN ASSIGNMENT

A0	1	18	VCC
A1	2	17	A6
A2	3	16	A7
A3	4	15	A8
A4	5	14	A9
A5	6	13	A10
Q	7	12	A11
W	8	11	D
VSS	9	10	$\bar{E}$

### PIN NAMES

A0-A11	Address Input
W	Write Enable
$\bar{E}$	Chip Enable
D	Data Input
Q	Data Output
VCC	Power (+5 V)
VSS	Ground

### TRUTH TABLE

E	W	Mode	Output	Power
H	X	Not Selected	High Z	Standby
L	L	Write	High Z	Active
L	H	Read	Data Out	Active

# MCM2147

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	-10 to +85	°C
Voltage on Any Pin With Respect to V <sub>CC</sub>	-0.5 to +7.0	Vdc
DC Output Current	20	mA
Power Dissipation	1.0	Watt
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-65 to +150	°C

This device contains 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 this high-impedance circuit.

**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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.0	—	V <sub>CC</sub>	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-0.3	—	0.8	V

### DC CHARACTERISTICS

Parameter	Symbol	MCM2147-55			MCM 2147-70			MCM2147-85			MCM2147-100			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Load Current (All Input Pins, V <sub>in</sub> = 0 to 5.5 V)	I <sub>IL</sub>	—	0.01	10	—	0.01	10	—	0.01	10	—	0.01	10	μA
Output Leakage Current (E = 2.0 V, V <sub>out</sub> = 0 to 5.5 V)	I <sub>OL</sub>	—	0.1	50	--	0.1	50	—	0.1	50	—	0.1	50	μA
Power Supply Current (E = V <sub>IL</sub> , Outputs Open, T <sub>A</sub> = 25°C)	I <sub>CC1</sub>	—	120	170	—	100	150	—	95	130	—	90	110	mA
Power Supply Current (E = V <sub>IL</sub> , Outputs Open, T <sub>A</sub> = 0°C)	I <sub>CC2</sub>	—	—	180	—	—	160	—	—	140	—	—	120	mA
Standby Current (E = V <sub>IH</sub> )	I <sub>SB</sub>	—	15	30	—	10	20	—	15	25	—	10	20	mA
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	-0.3	—	0.8	-0.3	—	0.8	-0.3	—	0.8	V
Input High Voltage	V <sub>IH</sub>	2.0	—	6.0	2.0	—	6.0	2.0	—	6.0	2.0	—	6.0	V
Output Low Voltage (I <sub>OL</sub> = 8.0 mA)	V <sub>OL</sub>	—	—	0.4	—	—	0.4	—	—	0.4	—	—	0.4	V
Output High Voltage (I <sub>OH</sub> = -4.0 mA)	V <sub>OH</sub>	2.4	—	—	2.4	—	—	2.4	—	—	2.4	—	—	V

Typical values are for T<sub>A</sub> = 25°C and V<sub>CC</sub> = +5.0 V.

### CAPACITANCE

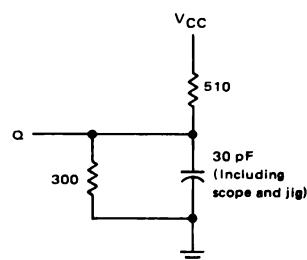
(f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V)	C <sub>in</sub>	5.0	pF
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	10	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated

$$\text{from the equation: } C = \frac{I\Delta t}{\Delta V}$$

FIGURE 1 – OUTPUT LOAD



**AC OPERATING CONDITIONS AND CHARACTERISTICS**  
 (Full operating voltage and temperature unless otherwise noted)

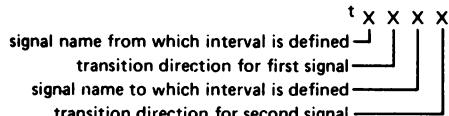
Input Pulse Levels.....0 Volt to 3.5 Volts      Input and Output Timing Levels.....1.5 Volts  
 Input Rise and Fall Times.....10 ns      Output Load.....See Figure 1

## READ, WRITE CYCLES

Parameter	Symbol	MCM2147-55		MCM2147-70		MCM2147-85		MCM2147-100		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Address Valid to Address Don't Care (Cycle Time When Chip Enable is Held Active)	tAVAX	55	—	70	—	85	—	100	—	ns
Chip Enable Low to Chip Enable High	tELEH	55	—	70	—	85	—	100	—	ns
Address Valid to Output Valid (Access)	tAVQV	—	55	—	70	—	85	—	100	ns
Chip Enable Low to Output Valid (Access)	tELQV1*	—	55	—	70	—	85	—	100	ns
	tELQV2*	—	65	—	80	—	95	—	110	ns
Address Valid to Output Invalid	tAVOX	10	—	10	—	10	—	10	—	ns
Chip Enable Low to Output Invalid	tELQX	10	—	10	—	10	—	10	—	ns
Chip Enable High to Output High Z	tEHQZ	0	40	0	40	0	40	0	40	ns
Chip Selection to Power-Up Time	tPU	0	—	0	—	0	—	0	—	ns
Chip Deselection to Power-Down Time	tPD	0	30	0	30	0	30	0	30	ns
Address Valid to Chip Enable Low (Address Setup)	tAVEL	0	—	0	—	0	—	0	—	ns
Chip Enable Low to Write High	tELWH	45	—	55	—	70	—	80	—	ns
Address Valid to Write High	tAVWH	45	—	55	—	70	—	80	—	ns
Address Valid to Write Low (Address Setup)	tAVWL	0	—	0	—	0	—	0	—	ns
Write Low to Write High (Write Pulse Width)	tWLWH	35	—	40	—	55	—	65	—	ns
Write High to Address Don't Care	tWHAX	10	—	15	—	15	—	15	—	ns
Data Valid to Write High	tDVWH	25	—	30	—	45	—	55	—	ns
Write High to Data Don't Care (Data Hold)	tWHDX	10	—	10	—	10	—	10	—	ns
Write Low to Output High Z	tWLQZ	0	30	0	35	0	45	0	50	ns
Write High to Output Valid	tWHQV	0	—	0	—	0	—	0	—	ns

\*tELQV1 is access from chip enable when the 2147 is deselected for at least 55 ns prior to this cycle. tELQV2 is access from chip enable for 0 ns < deselect time < 55 ns. If deselect time = 0 ns, then tELQV = tAVQV.

## TIMING PARAMETER ABBREVIATIONS

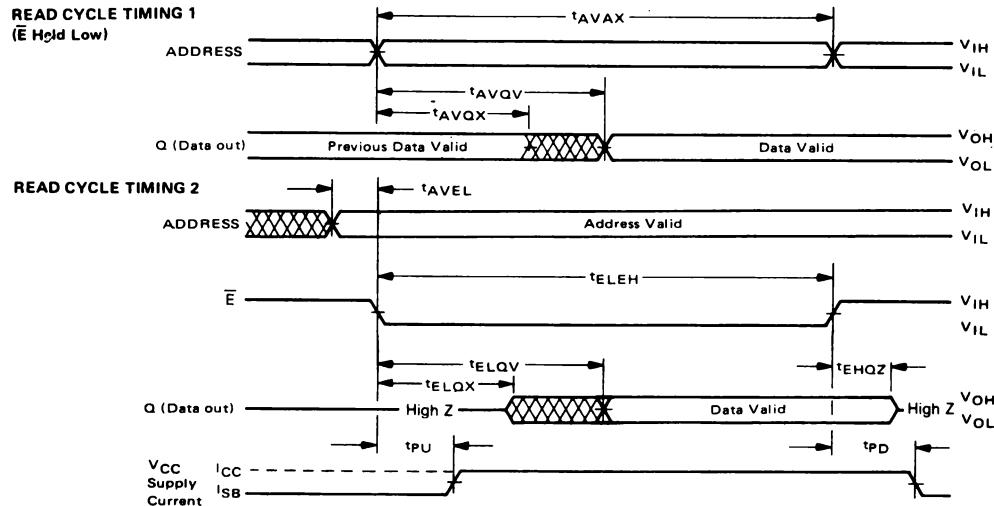


The transition definitions used in this data sheet are:

- H = transition to high
- L = transition to low
- V = transition to valid
- X = transition to invalid or don't care
- Z = transition to off (high impedance)

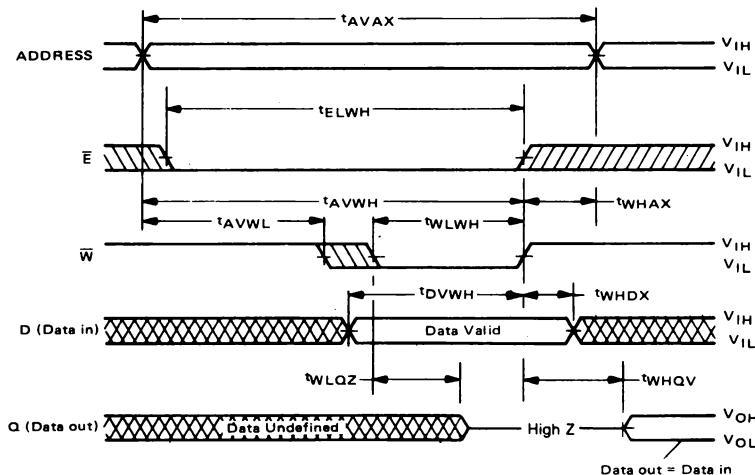
## TIMING LIMITS

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.



**NOTE:**  $\overline{W}$  is high for Read Cycles

## **WRITE CYCLE TIMING**



## **WAVEFORMS**

Waveform Symbol	Input	Output
	MUST BE VALID	WILL BE VALID
	CHANGE FROM H TO L	WILL CHANGE FROM H TO L
	CHANGE FROM L TO H	WILL CHANGE FROM L TO H
	DON'T CARE: ANY CHANGE PERMITTED	CHANGING STATE UNKNOWN
	-	HIGH IMPEDANCE

### DEVICE DESCRIPTION

The MCM2147 is produced with a high-performance MOS technology which combines on-chip substrate bias generation with device scaling to achieve high speed. The speed-power product of this process is about four times better than earlier MOS processes.

This gives the MCM2147 its high speed, low power and ease-of-use. The low-power standby feature is controlled with the  $\bar{E}$  input.  $\bar{E}$  is not a clock and does not have to be cycled. This allows the user to tie  $\bar{E}$  directly to system addresses and use the line as part of the normal decoding logic. Whenever the MCM2147 is deselected, it automatically reduces its power requirements.

### SYSTEM POWER SAVINGS

The automatic power-down feature adds up to significant system power savings. Unselected devices draw low standby power and only the active devices draw active power. Thus the average power consumed by a device declines as the system size increases, asymptotically approaching the standby power level as shown in Figure 2.

The automatic power-down feature is obtained without any performance degradation, since access time from chip enable is  $\leq$  access time from address valid. Also the fully static design gives access time equal cycle time so multiple read or write operations are possible during a single select period. The resultant data rates are 14.3 MHz and 18 MHz for the MCM2147-70 and MCM2147-55 respectively.

### DECOUPLING AND BOARD LAYOUT CONSIDERATIONS

The power switching characteristic of the MCM2147 requires careful decoupling. It is recommended that a 0.1  $\mu F$  to 0.3  $\mu F$  ceramic capacitor be used on every other device, with a 22  $\mu F$  to 47  $\mu F$  bulk electrolytic decoupler every 16 devices. The actual values to be used will depend on board layout, trace widths and duty cycle.

Power supply gridding is recommended for PC board layout. A very satisfactory grid can be developed on a two-layer board with vertical traces on one side and horizontal traces on the other, as shown in Figure 3. If fast drivers are used, terminations are recommended on input signal lines to the MCM2147 because significant reflections are possible when driving their high impedance inputs. Terminations may be required to match the impedance of the line to the driver.

FIGURE 2 – AVERAGE DEVICE DISSIPATION versus MEMORY SIZE

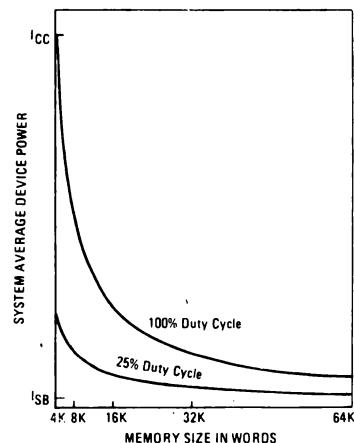
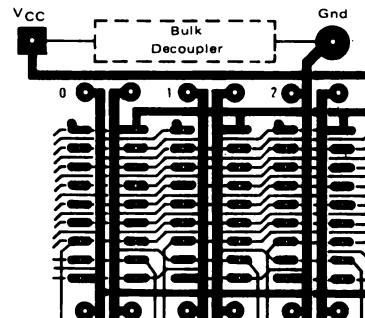


FIGURE 3 – PC LAYOUT





**MOTOROLA**

**MCM2147H**

## Product Preview

### 4096-BIT STATIC RANDOM ACCESS MEMORY

The MCM2147H is a 4096-bit static random access memory organized as 4096 words by 1-bit using Motorola's high-performance N-channel silicon-gate MOS technology (HMOS). It uses a design approach which provides the simple timing features associated with fully static memories and the reduced standby power associated with semi-static and dynamic memories. This means low standby power without the need for clocks, nor reduced data rates due to cycle times that exceed access times.

$\bar{E}$  controls the power-down feature. It is not a clock but rather a chip select that affects power consumption. In less than a cycle time after  $\bar{E}$  goes high, deselect mode, the part automatically reduces its power requirements and remains in this low-power standby mode as long as  $\bar{E}$  remains high. This feature results in system power savings as great as 85% in larger systems, where most devices are deselected. The automatic power-down feature causes no performance degradation.

The MCM2147H is in an 18 pin dual in-line package with the industry standard pinout. It is TTL compatible in all respects. The data out has the same polarity as the input data. A data input and a separate three-state output provide flexibility and allow easy OR-ties.

- Fully Static Memory – No Clock or Timing Strobe Required
- HMOS Technology
- Single +5 V Supply
- High Density 18 Pin Package
- Automatic Power-Down
- Directly TTL Compatible – All Inputs and Outputs
- Separate Data Input and Output
- Three-State Output
- Access Time

MCM2147H-35 = 35 ns Max

MCM2147H-45 = 45 ns Max

MCM2147H-55 = 55 ns Max

## MOS

(N CHANNEL, SILICON-GATE)

### 4096-BIT STATIC RANDOM ACCESS MEMORY



C SUFFIX  
FRIT-SEAL  
CERAMIC PACKAGE  
CASE 726-02

#### PIN ASSIGNMENT

A0	1	18	V <sub>CC</sub>
A1	2	17	A6
A2	3	16	A7
A3	4	15	A8
A4	5	14	A9
A5	6	13	A10
Q	7	12	A11
W	8	11	D
V <sub>SS</sub>	9	10	$\bar{E}$

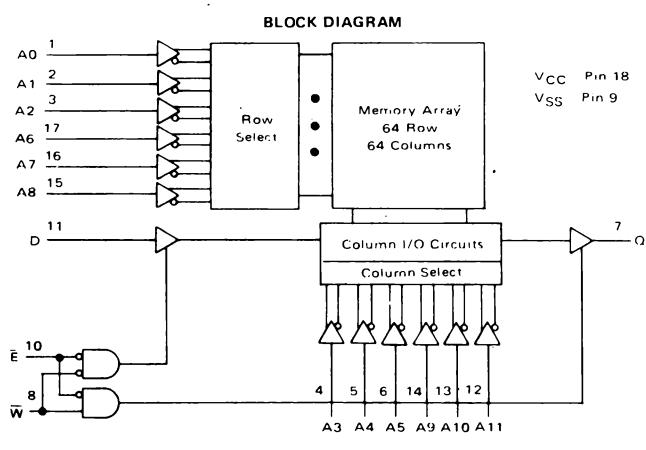
#### PIN NAMES

A0 A11	Address Input
W	Write Enable
$\bar{E}$	Chip Enable
D	Data Input
Q	Data Output
V <sub>CC</sub>	Power (+5 V)
V <sub>SS</sub>	Ground

#### TRUTH TABLE

$\bar{E}$	W	Mode	Output	Power
H	X	Not Selected	High Z	Standby
L	L	Write	High Z	Active
L	H	Read	Data Out	Active

Motorola reserves the right to make changes to any product herein to improve reliability, function or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein, neither does it convey any license under its patent rights nor the rights of others.





**MOTOROLA**

**MCM2148**

## Advance Information

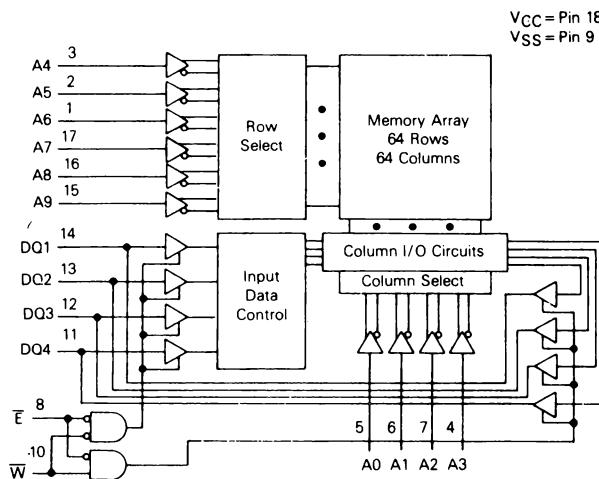
### 4096-BIT STATIC RANDOM ACCESS MEMORY

The MCM2148 is a 4096-bit random access memory fabricated using HMOS, high performance MOS technology. For ease of use, the device operates from a single power supply, is directly compatible with TTL and requires no clocks or refreshing because of fully static operation. Data access is particularly simple, since address setup times are not required. The output data has the same polarity as the input data.

The MCM2148 is designed for memory applications where simple interfacing is the design objective. The MCM2148 is assembled in 18-pin dual-in-line packages with the industry standard pin-out. A separate chip select ( $\bar{E}$ ) lead allows easy selection of an individual package when the three-state outputs are OR-tied.

- 1024 Words by 4-Bit Organization
- HMOS Technology
- Industry Standard 18-Pin Configuration
- Single +5 Volt Supply
- No Clock or Timing Strobe Required
- Maximum Access Time  
70 ns MCM2148-70  
85 ns MCM2148-85
- Power Dissipation  
140 mA Maximum (Active)  
30 mA Maximum (Standby)
- Fully TTL/DTL Compatible
- Common Data Input and Output
- Three-State Outputs for OR-Ties
- Automatic Power Down

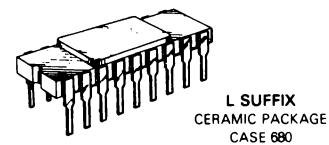
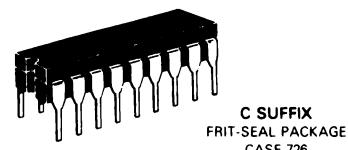
### BLOCK DIAGRAM



## MOS

(N-CHANNEL, SILICON-GATE)

### 4096-BIT STATIC RANDOM ACCESS MEMORY



### PIN ASSIGNMENT

A6	1	VCC
A5	2	A7
A4	3	A8
A3	4	A9
A0	5	DQ1
A1	6	DQ2
A2	7	DQ3
$\bar{E}$	8	DQ4
VSS	9	W

PIN NAMES	
A0-A9	Address Input
W	Write Enable
$\bar{E}$	Chip Select
DQ1-DQ4	Data Input/Output
VCC	+5 V
VSS	Ground

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Voltage on Any Pin With Respect to V <sub>SS</sub>	-3.5 to +7.0	V
DC Output Current	20	mA
Power Dissipation	1.2	Watt
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-65 to +150	°C

This device contains 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 this high-impedance circuit.

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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature ranges unless otherwise noted.)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub> V <sub>SS</sub>	4.5 0	5.0 0	5.5 0	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.0	—	6.0	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-3.0	—	0.8	V

### DC CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Input Load Current (All Input Pins, V <sub>in</sub> =0 to 5.5 V, V <sub>CC</sub> =Max)	I <sub>LI</sub>	—	0.01	10	μA
Output Leakage Current ( $\bar{E}=V_{IH}$ , V <sub>CC</sub> =Max, V <sub>out</sub> =0 to 4.5 V)	I <sub>LOI</sub>	—	0.1	50	μA
Output Low Voltage (I <sub>OL</sub> =8 mA)	V <sub>OL</sub>	—	—	0.4	mA
Output High Voltage (I <sub>OH</sub> = -2.0 mA)	V <sub>OH</sub>	2.4	—	—	mA
Power Supply Current (V <sub>in</sub> =5.5, I <sub>DQ</sub> =0 mA, T <sub>A</sub> =25°C, $\bar{E}=V_{IL}$ )	I <sub>CC1</sub>	—	100	135	mA
Power Supply Current (V <sub>in</sub> =5.5 V, I <sub>DQ</sub> =0 mA, T <sub>A</sub> =0°C, $\bar{E}=V_{IL}$ )	I <sub>CC2</sub>	—	—	140	mA
Standby Current (V <sub>CC</sub> =Min to Max, $\bar{E}=V_{IH}$ )	I <sub>CC3</sub>	—	12	30	mA
Peak Power on Current (V <sub>CC</sub> =0 to V <sub>CC</sub> Min, $\bar{E}=V_{IH}$ min)*	I <sub>P0</sub>	—	25	50	mA
Output Short Circuit Current (V <sub>out</sub> =GND to V <sub>CC</sub> )	I <sub>OS</sub>	-150	—	+150	mA

\*A pullup resistor to V<sub>CC</sub> on the  $\bar{E}$  input is required to keep the device deselected, otherwise, power-on current approaches I<sub>CC</sub>.

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Max	Unit
Input Capacitance (V <sub>in</sub> =0 V)	C <sub>in</sub>	5	pF
Output Capacitance (V <sub>out</sub> =0 V)	C <sub>out</sub>	7	pF

FIGURE 1

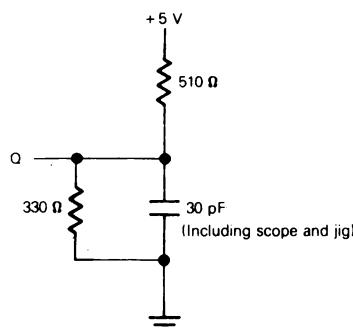
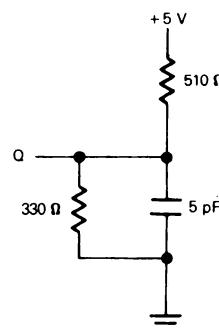


FIGURE 2



## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted.)

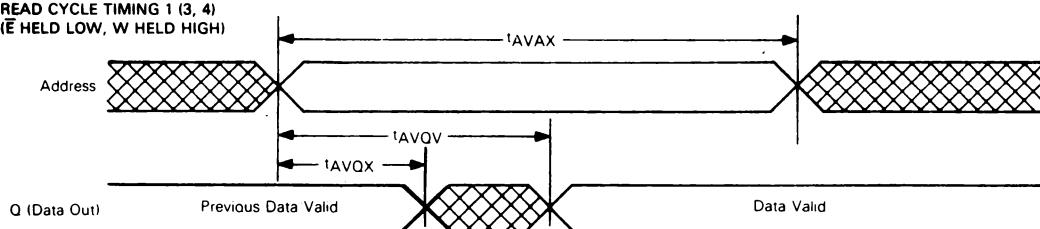
Input Pulse Levels ..... 0 Volt to 3.0 Volts  
 Input Rise and Fall Times ..... 10 ns      Input and Output Timing Levels ..... 1.5 Volts  
 See Figure 1  
 Output Load .....

Parameter	Symbol	MCM2148-70 MCM2148-85				Unit	Notes
		Min	Max	Min	Max		
Address Valid to Address Don't Care (Cycle Time if $\bar{E} = V_{IL}$ )	$t_{AVAX}$	70	—	85	—	ns	
Address Valid to Output Valid (Address Access Time)	$t_{AVQV}$	—	70	—	85	ns	
Address Valid to Output Undefined	$t_{AVQX}$	5	—	5	—	ns	
Chip Enable Low to Chip Enable High (Cycle Time)	$t_{ELEH}$	70	—	85	—	ns	
Chip Enable Low to Output Undefined	$t_{ELOX}$	25	—	25	—	ns	6
Chip Enable Low to Output Valid (Chip Select Access Time)	$t_{ELQV1}$	—	70	—	85	ns	1
	$t_{ELQV2}$	—	80	—	95	ns	2
Chip Selection to Powerup Time	$t_{PU}$	0	—	0	—	ns	
Chip Deselection to Powerdown Time	$t_{PD}$	—	30	—	30	ns	
Chip Enable High to Output High Z	$t_{EHQZ}$	0	20	0	20	ns	6
Chip Enable Low to Write High	$t_{ELWH}$	65	—	80	—	ns	
Address Valid to Write Low (Address Setup)	$t_{AVWL}$	0	—	0	—	ns	
Write High to Address Don't Care	$t_{WHAX}$	5	—	5	—	ns	
Write Low to Write High (Write Pulse Width)	$t_{WLWH}$	50	—	60	—	ns	
Data Valid to Write High	$t_{DVWH}$	25	—	30	—	ns	
Write High to Data Don't Care	$t_{WHDX}$	5	—	5	—	ns	
Write Low to Output High Z	$t_{WLQZ}$	0	25	0	30	ns	6
Write High to Output Active	$t_{WHQV}$	0	—	0	—	ns	6

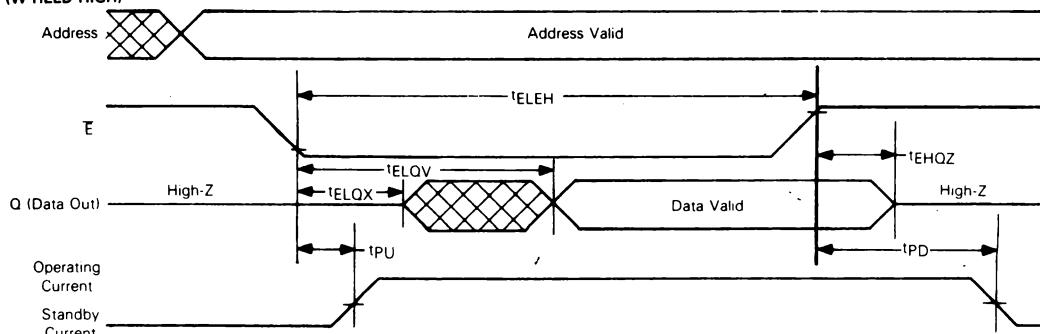
### NOTES:

1. Chip deselected for greater than 55 ns prior to  $\bar{E}$  transition low.
2. Chip deselected for a finite time that is less than 55 ns prior to  $\bar{E}$  transition low. (If the deselect time is 0 ns, the chip is by definition selected and access occurs according to Read Cycle 1.)
3.  $\bar{W}$  is high for read cycles.
4. Device is continuously selected,  $\bar{E} = V_{IL}$ .
5. Addresses valid prior to or coincident with  $\bar{E}$  transition low.
6. Transition is measured  $\pm 500$  mV from high impedance with the load in Figure 2. This parameter is sampled and not 100% tested.

### READ CYCLE TIMING 1 (3, 4) ( $\bar{E}$ HELD LOW, W HELD HIGH)

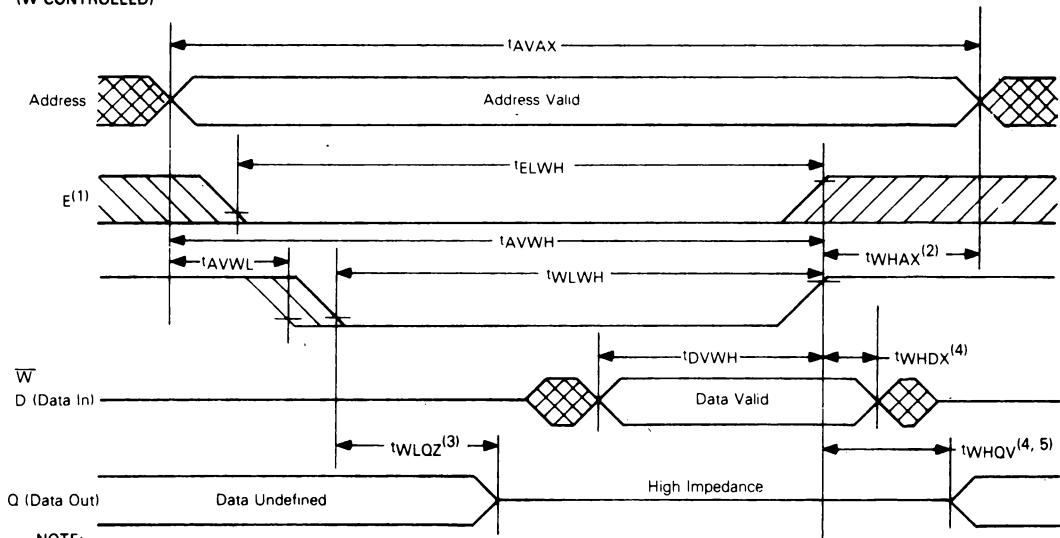


### READ CYCLE TIMING 2 (3, 5) (W HELD HIGH)



## MCM2148

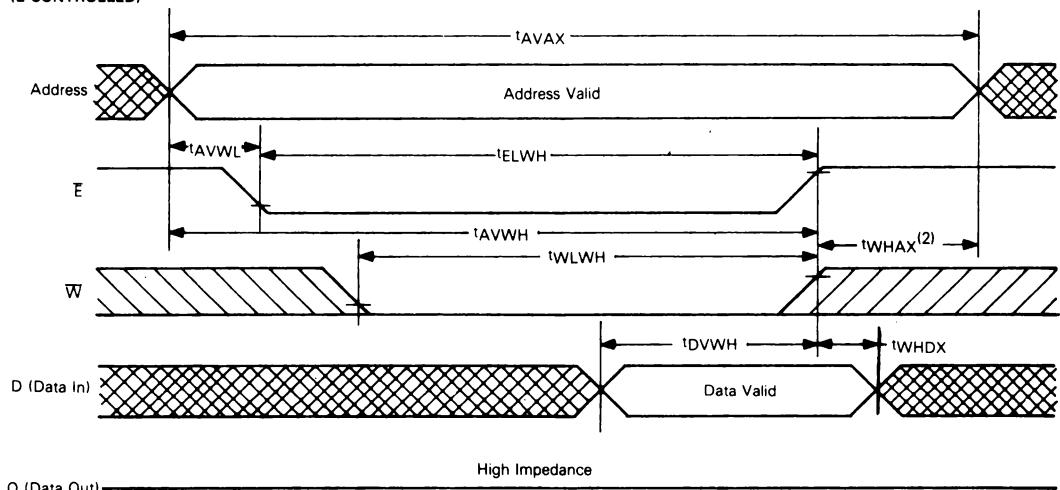
### WRITE CYCLE 1 (W CONTROLLED)



#### NOTE:

1. If E goes high simultaneously with W high, the output remains in a high-impedance state.
2. tWHAX is measured from the earlier of S or W going high to the end of the write cycle.
3. During this period, DQ pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If S is low during this period, the DQ pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
5. Q is the same phase of write data of this write cycle.

### WRITE CYCLE 2 (E CONTROLLED)





**MOTOROLA**

## Product Preview

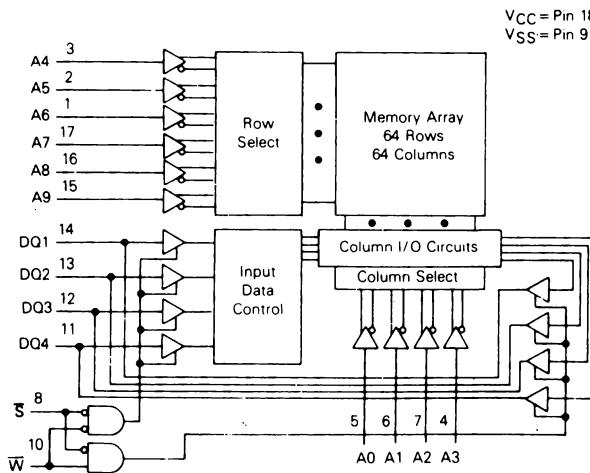
### 4096-BIT STATIC RANDOM ACCESS MEMORY

The MCM2149 is a 4096-bit random access memory fabricated using HMOS, high performance MOS technology. For ease of use, the device operates from a single power supply, is directly compatible with TTL and requires no clocks or refreshing because of fully static operation. Data access is particularly simple, since address setup times are not required. The output data has the same polarity as the input data.

The MCM2149 is designed for memory applications where simple interfacing is the design objective. The MCM2149 is assembled in 18-pin dual-in-line packages with the industry standard pin-out. A separate chip select ( $\overline{S}$ ) lead allows easy selection of an individual package when the three-state outputs are OR-tied.

- 1024 Words by 4-Bit Organization
- HMOS Technology
- Industry Standard 18-Pin Configuration
- Single +5 Volt Supply
- No Clock or Timing Strobe Required
- Maximum Access Time  
MCM2149-70 = 70 ns Max.  
MCM2149-85 = 85 ns Max.
- Chip Select Access Time  
MCM2149-70 = 30 ns Max.  
MCM2149-85 = 35 ns Max.
- Power Dissipation — 140 mA Maximum (Active)
- Fully TTL Compatible
- Common Data Input and Output
- Three-State Outputs for OR-Ties
- Automatic Power Down Version Available — MCM2148

BLOCK DIAGRAM

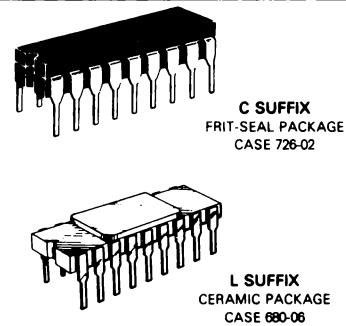


**MCM2149**

**MOS**

(IN-CHANNEL, SILICON-GATE)

### 4096-BIT STATIC RANDOM ACCESS MEMORY



#### PIN ASSIGNMENT

A6	1	18	VCC
A5	2	17	A7
A4	3	16	A8
A3	4	15	A9
A0	5	14	DQ1
A1	6	13	DQ2
A2	7	12	DQ3
S	8	11	DQ4
VSS	9	10	W

#### PIN NAMES

A0-A9	Address Input
W	Write Enable
S	Chip Select
DQ1-DQ4	Data Input/Output
VCC	Power (+5 V)
VSS	Ground

Motorola reserves the right to make changes to any product herein to improve reliability, functionality or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM2167**

## Product Preview

### 16,384-BIT STATIC RANDOM ACCESS MEMORY

The MCM2167 is a 16,384-bit static random access memory organized as 16,384 words by 1-bit using Motorola's N-channel silicon-gate MOS technology. It uses a design approach which provides the simple timing features associated with fully static memories and the reduced standby power associated with semi-static and dynamic memories. This means low standby power without the need for clocks, nor reduced data rates due to cycle times that exceed access times.

$\bar{E}$  controls the power-down feature. It is not a clock but rather a chip select that affects power consumption. In less than a cycle time after  $\bar{E}$  goes high, deselect mode, the part automatically reduces its power requirements and remains in this low-power standby mode as long as  $\bar{E}$  remains high. This feature results in system power savings as great as 85% in larger systems, where most devices are deselected. The automatic power-down feature causes no performance degradation.

The MCM2167 is in a 20 pin dual in-line package with the industry standard pinout. It is TTL compatible in all respects. The data out has the same polarity as the input data. A data input and a separate three-state output provide flexibility and allow easy OR-ties.

- Fully Static Memory – No Clock or Timing Strobe Required
- Single +5 V Supply
- High Density 20 Pin Package
- Automatic Power-Down
- Directly TTL Compatible – All Inputs and Three-State Output
- Separate Data Input and Output
- Access Time

MCM2167-55 – 55 ns max

MCM2167-70 – 70 ns max

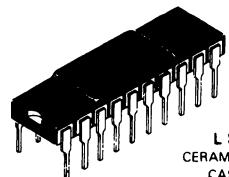
MCM2167-85 – 85 ns max

MCM2167-100 – 100 ns max

### MOS

(N-CHANNEL, SILICON-GATE)

### 16,384-BIT STATIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 729-02

#### PIN ASSIGNMENT

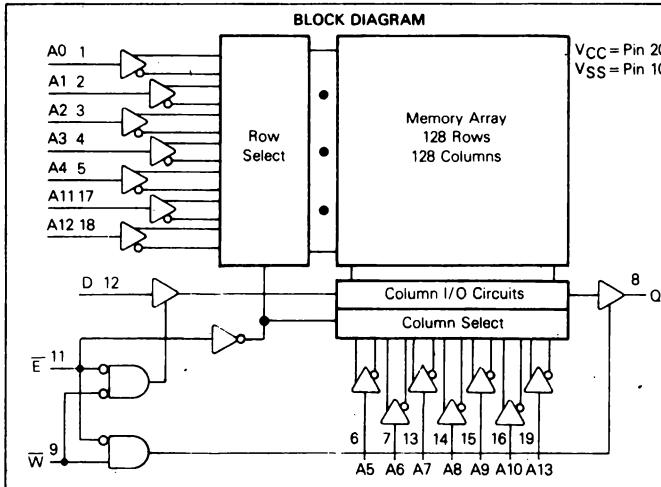
A0	1	20	VCC
A1	2	19	A13
A2	3	18	A12
A3	4	17	A11
A4	5	16	A10
A5	6	15	A9
A6	7	14	A8
Q	8	13	A7
W	9	12	D
VSS	10	11	$\bar{E}$

#### PIN NAMES

A0-A13	.....	Address Input
W	.....	Write Enable
$\bar{E}$	.....	Chip Enable
D	.....	Data Input
Q	.....	Data Output
VCC	.....	Power (+5 V)
VSS	.....	Ground

#### TRUTH TABLE

$\bar{E}$	$\bar{W}$	Mode	Output	Power
H	X	Not Selected	High Z	Standby
L	L	Write	High Z	Active
L	H	Read	Data Out	Active





**MOTOROLA**

## MCM4016

### Product Preview

#### 2048×8-BIT STATIC RANDOM ACCESS MEMORY

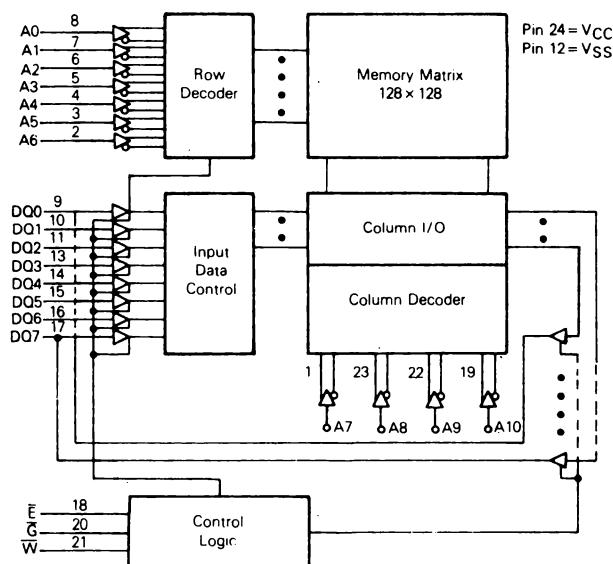
The MCM4016 is a 16,384-bit static Random Access Memory organized as 2048 words by 8-bits, fabricated using Motorola's high-performance silicon-gate metal oxide semiconductor (HMOS) technology. Its static design means that no refresh clocking circuitry is needed and timing requirements are simplified. Access time is equal to cycle time.

A chip select control is provided for controlling the flow of data in and data out, and an output enable function is provided which eliminates the need for external bus buffers.

The MCM4016 is in a 24-pin dual-in-line package with the industry standard pinout and is pinout compatible with the industry standard 16K EPROM and 16K mask programmable ROM.

- 2048 Words by 8-Bits Organization
- HMOS Technology
- Single +5 V Supply
- Fully Static: No Clock or Timing Strobe Required
- Low Power Dissipation –  
35 mW Typical (Standby)  
400 mW Typical (Active)
- Maximum Access Time: MCM4016-20 – 200 ns
- Fully TTL Compatible
- Pinout Compatible with Industry Standard 2716 16K EPROM and Mask Programmable ROM
- Output Enable ( $\bar{G}$ ) Eliminates Need for External Bus Buffers

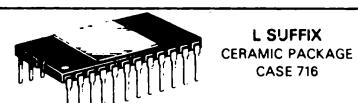
BLOCK DIAGRAM



#### MOS

(N-CHANNEL, SILICON-GATE)

#### 2048×8 BIT STATIC RANDOM ACCESS MEMORY



#### PIN ASSIGNMENTS

A7	1	●	24	VCC
A6	2		23	IA8
A5	3		22	IA9
A4	4		21	IW
A3	5		20	IG
A2	6		19	IA10
A1	7		18	I $E$
A0	8		17	IDQ7
DQ0	9		16	IDQ6
DQ1	10		15	IDQ5
DQ2	11		14	IDQ4
VSS	12		13	IDQ3

#### PIN NAMES

A0-A10	.....	Address Input
DQ0-DQ7	.....	Data Input/Output
$\bar{G}$	.....	Output Enable
$E$	.....	Chip Select
W	.....	Write Enable
VCC	.....	Power (+5 V)
VSS	.....	Ground

Motorola reserves the right to make changes to any product herein to improve reliability, function or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM6641  
MCM66L41**

## Advance Information

### 4096-BIT STATIC RANDOM ACCESS MEMORIES

The MCM6641 series 4096×1-bit Random Access Memory is fabricated with high density, high reliability N-channel silicon-gate technology. For ease of use, the device operates from a single 5-volt power supply, is directly compatible with TTL and DTL, and requires no clocks or refreshing because of fully static operation. The fully static operation allows chip selects to be tied low, further simplifying system timing. Data access is particularly simple, since address setup times are not required. The output data has the same polarity as the data input.

The MCM6641 is designed for memory applications where simple interfacing is the design objective, and is assembled in 18-pin dual-in-line packages with the industry standard pin-outs.

- Single  $\pm 10\%$  +5 V Supply
- Fully Static Operation – No Clock, Timing Strobe, Pre-Charge, or Refresh Required
- Industry Standard 18-Pin Configuration
- Fully TTL Compatible
- Common Data Input and Output Capability
- Three-State Outputs for OR-Tie Capability
- Power Dissipation MCM6641 Less Than 550 mW (Maximum)  
MCM66L41 Less Than 385 mW (Maximum)
- Standby Power Dissipation Less Than 125 mW (Typical)
- Plug-In Replacement For TMS4044

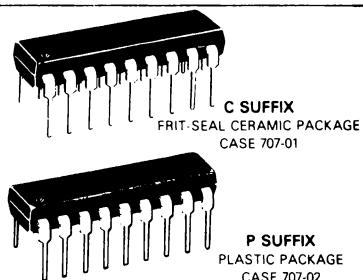
### MAXIMUM ACCESS TIME/MINIMUM CYCLE TIME

MCM6641-20	200 ns	MCM6641-30	300 ns
MCM66L41-20		MCM66L41-30	
MCM6641-25	250 ns	MCM6641-45	450 ns
MCM66L41-25		MCM66L41-45	

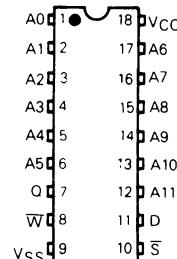
## MOS

(IN-CHANNEL, SILICON-GATE)

### 4096-BIT STATIC RANDOM ACCESS MEMORIES



### PIN ASSIGNMENT

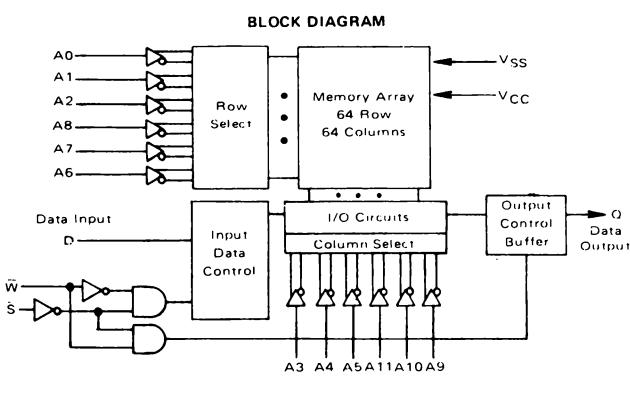


### PIN NAMES

A0-A11.....	Address Input
D .....	Data Input
Q .....	Data Output
S .....	Chip Select
V <sub>CC</sub> .....	Power Supply (+5 V)
V <sub>SS</sub> .....	Ground
W .....	Write Enable

### TRUTH TABLE

S	W	D	Q	Mode
H	X	X	High Z	Not Selected
L	L	L	High Z	Write "0"
L	L	H	High Z	Write "1"
I	H	X	Output data	Read



# MCM6641•MCM66L41

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Voltage on Any Pin With Respect to V <sub>SS</sub>	-0.5 to +7.0	Vdc
DC Output Current	20	mA
Power Dissipation	1.0	Watt
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-65 to +150	°C

This device contains 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 this high-impedance circuit.

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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	MCM6641			MCM66L41			Unit
		Min	Typ	Max	Min	Typ	Max	
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	—	—	—	V
Supply Voltage	V <sub>SS</sub>	0	0	0	—	—	—	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.0	—	6.0	—	—	—	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-0.5	—	0.8	—	—	—	V

### DC CHARACTERISTICS

Parameter	Symbol	MCM6641			MCM66L41			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Load Current (All Input Pins, V <sub>in</sub> = 0 to 5.5 V)	I <sub>LI</sub>	—	—	10	—	—	10	μA
Output Leakage Current (I <sub>S</sub> = 2.4 V, V <sub>in</sub> = 0.4 to V <sub>CC</sub> )	I <sub>LO</sub>	—	—	10	—	—	10	μA
Power Supply Current (V <sub>CC</sub> = 5.5 V, I <sub>out</sub> = 0 mA, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	80	100	—	55	70	mA
Output Low Voltage, I <sub>OL</sub> = 2.1 mA	V <sub>OL</sub>	—	0.15	0.4	—	0.15	0.4	V
Output High Voltage, I <sub>OH</sub> = 1.0 mA	V <sub>OH</sub>	2.4	—	—	2.4	—	—	V
Output Short Circuit Current	I <sub>OS</sub> *	—	—	40	—	—	40	mA

\*Duration not to exceed 30 seconds.

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5.0 V, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V)	C <sub>in</sub>	5.0	pF
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	10	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: C = IΔt/ΔV.

### STANDBY OPERATION (Typical Supply Values)

Device	Supply	Operating	Standby	Max Standby Power
MCM6641	V <sub>CC</sub>	+5 V	+2.4 V	225 mW
MCM66L41	V <sub>CC</sub>	+5 V	+2.4 V	150 mW

# MCM6641•MCM66L41

## AC OPERATING CONDITIONS AND CHARACTERISTICS

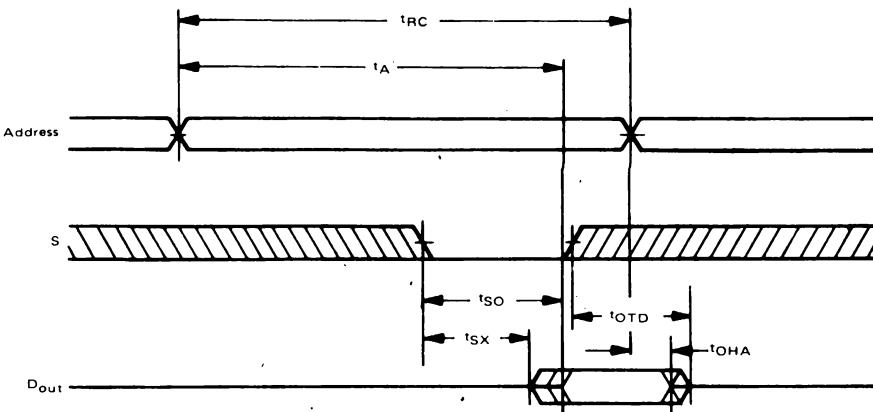
(Full operating voltage and temperature range unless otherwise noted)

Input Pulse Levels.....	0.8 Volt to 2.0 Volts	Input and Output Timing Levels.....	1.5 Volts
Input Rise and Fall Times.....	10 ns	Output Load.....	1 TTL Gate and $C_L = 100 \mu F$

### READ (NOTE 1), WRITE (NOTE 2) CYCLES

Parameter	Symbol	MCM6641-20 MCM66L41-20		MCM6641-25 MCM66L41-25		MCM6641-30 MCM66L41-30		MCM6641-45 MCM66L41-45		Units
		Min	Max	Min	Max	Min	Max	Min	Max	
Read Cycle Time	$t_{RC}$	200	—	250	—	300	—	450	—	ns
Access Time	$t_A$	—	200	—	250	—	300	—	450	ns
Chip Selection to Output Valid	$t_{SO}$	—	70	—	85	—	100	—	120	ns
Chip Selection to Output Active	$t_{SX}$	10	—	10	—	10	—	10	—	ns
Output 3-State From Deselection	$t_{OTD}$	—	40	—	60	—	80	—	100	ns
Output Hold From Address Change	$t_{OHA}$	50	—	50	—	50	—	50	—	ns
Write Cycle Time	$t_{WC}$	200	—	250	—	300	—	450	—	ns
Write Time	$t_W$	100	—	125	—	150	—	200	—	ns
Write Release Time	$t_{WR}$	0	—	0	—	0	—	0	—	ns
Output 3-State From Write	$t_{OTW}$	—	40	—	60	—	80	—	100	ns
Data to Write Time Overlap	$t_{DW}$	100	—	125	—	150	—	200	—	ns
Data Hold From Write Time	$t_{DH}$	0	—	0	—	0	—	0	—	ns

### READ CYCLE TIMING (W HELD HIGH)

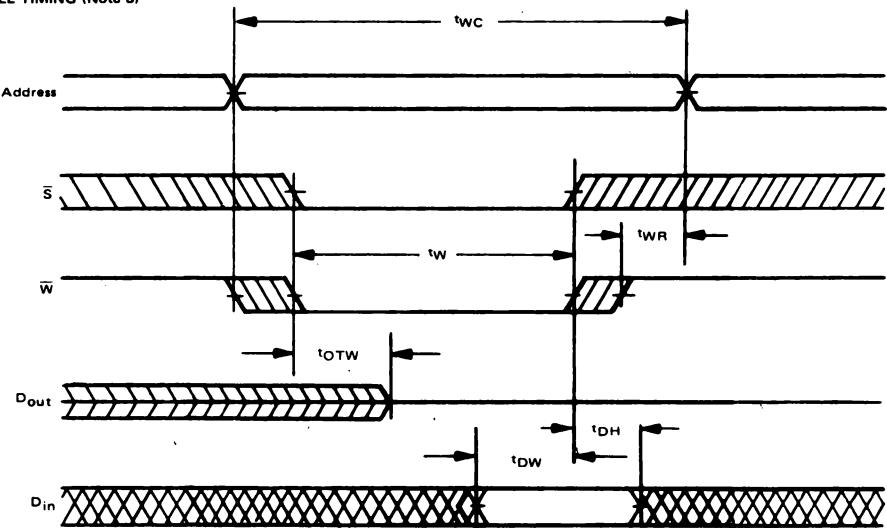


#### NOTES:

1. A Read occurs during the overlap of a low  $\bar{S}$  and a high  $\bar{W}$ .
2. A Write occurs during the overlap of a low  $\bar{S}$  and a low  $\bar{W}$ .
3. If the  $\bar{S}$  low transition occurs simultaneously with the  $\bar{W}$  low transition, the output buffers remain in a high-impedance state.

## MCM6641•MCM66L41

WRITE CYCLE TIMING (Note 3)





**MOTOROLA**

**MCM6810**  
1.0 MHz  
**MCM68A10**  
1.5 MHz  
**MCM68B10**  
2.0 MHz

### 128 X 8-BIT STATIC RANDOM ACCESS MEMORY

The MCM6810 is a byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

The memory is compatible with the M6800 Microcomputer Family, providing random storage in byte increments. Memory expansion is provided through multiple Chip Select inputs.

- Organized as 128 Bytes of 8 Bits
- Static Operation
- Bidirectional Three-State Data Input/Output
- Six Chip Select Inputs (Four Active Low; Two Active High)
- Single 5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 450 ns — MCM6810  
360 ns — MCM68A10  
250 ns — MCM68B10

### ORDERING INFORMATION

Speed	Device	Temperature Range
1.0 MHz	MC6810P, L	0 to 70°C
	MC6810CP, CL	-40 to +85°C
	MC6810BJCS	-55 to +125°C
	MC6810CJCS	
1.5 MHz	MC68A10P, L	0 to +70°C
	MC68A10CP, CL	-40 to +85°C
2.0 MHz	MC68B10P, L	0 to +70°C

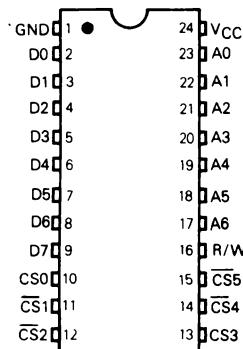
**MOS**  
(N CHANNEL, SILICON-GATE)  
128 X 8-BIT STATIC  
RANDOM ACCESS  
MEMORY

P SUFFIX  
PLASTIC PACKAGE  
CASE 709-02

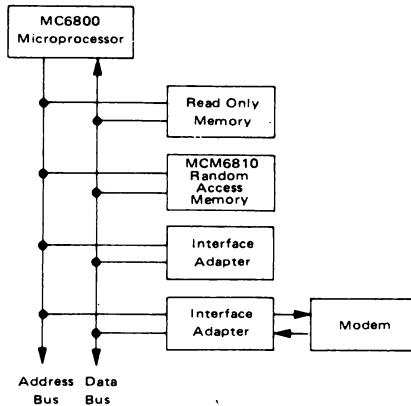


L SUFFIX  
CERAMIC PACKAGE  
CASE 716-06

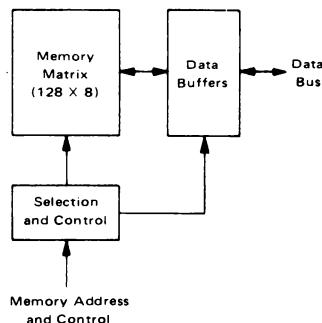
### PIN ASSIGNMENT



### M6800 MICROCOMPUTER FAMILY BLOCK DIAGRAM



### MCM6810 — RANDOM ACCESS MEMORY BLOCK DIAGRAM



# MCM6810•MCM68A10•MCM68B10

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	T <sub>L</sub> to T <sub>H</sub> 0 to 70 -40 to 85 -55 to 125	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Thermal Resistance	θ <sub>JA</sub>	82.5	°C/W

This device contains 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 this high impedance circuit.

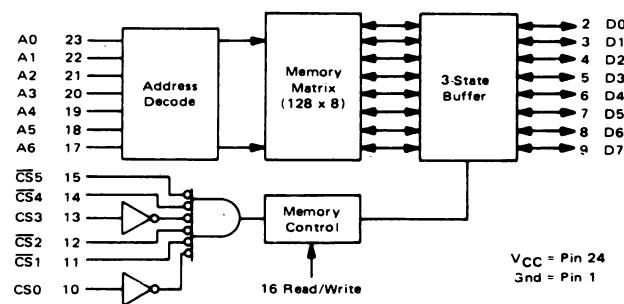
## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 5.0 V ± 5%, V<sub>SS</sub> = 0, T<sub>A</sub> = T<sub>L</sub> to T<sub>H</sub> unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (A <sub>n</sub> , R/W, CS <sub>n</sub> , $\bar{CS}_n$ ) (V <sub>in</sub> = 0 to 5.25 V)	I <sub>in</sub>	—	—	2.5	μAdc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	—	0.4	Vdc
Output Leakage Current (Three-State) (CS = 0.8 V or $\bar{CS}$ = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>TSI</sub>	—	—	10	μAdc
Supply Current (V <sub>CC</sub> = 5.25 V, all other pins grounded)	I <sub>CC</sub>	—	—	80 100	mAdc
Input Capacitance (A <sub>n</sub> , R/W, CS <sub>n</sub> , $\bar{CS}_n$ ) (V <sub>in</sub> = 0, T <sub>A</sub> = 25°C, f = 1.0 MHz)	C <sub>in</sub>	—	—	7.5	pF
Output Capacitance (D <sub>n</sub> ) (V <sub>out</sub> = 0, T <sub>A</sub> = 25°C, f = 1.0 MHz, CS0 = 0)	C <sub>out</sub>	—	—	12.5	pF

## RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Input High Voltage	V <sub>IH</sub>	2.0	—	5.25	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

## BLOCK DIAGRAM

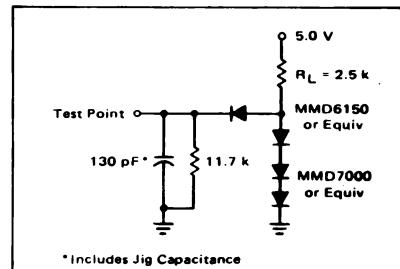


# MCM6810•MCM68A10•MCM68B10

## AC TEST CONDITIONS

Condition	Value
Input Pulse Levels	0.8 V to 2.0 V
Input Rise and Fall Times	20 ns
Output Load	See Figure 1

FIGURE 1 – AC TEST LOAD

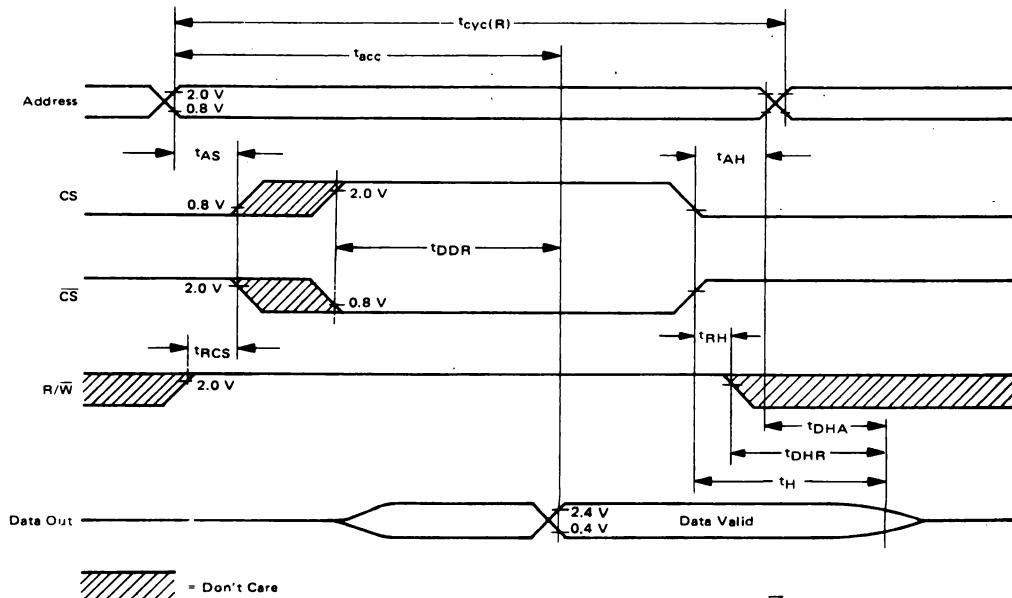


## AC OPERATING CONDITIONS AND CHARACTERISTICS

READ CYCLE ( $V_{CC} = 5.0 \text{ V} \pm 5\%$ ,  $V_{SS} = 0$ ,  $T_A = T_L$  to  $T_H$  unless otherwise noted.)

Characteristic	Symbol	MCM6810		MCM68A10		MCM68B10		Unit
		Min	Max	Min	Max	Min	Max	
Read Cycle Time	$t_{cyc(R)}$	450	—	360	—	250	—	ns
Access Time	$t_{acc}$	—	450	—	360	—	250	ns
Address Setup Time	$t_{AS}$	20	—	20	—	20	—	ns
Address Hold Time	$t_{AH}$	0	—	0	—	0	—	ns
Data Delay Time (Read)	$t_{DDR}$	—	230	—	220	—	180	ns
Read to Select Delay Time	$t_{RCS}$	0	—	0	—	0	—	ns
Data Hold from Address	$t_{DHA}$	10	—	10	—	10	—	ns
Output Hold Time	$t_H$	10	—	10	—	10	—	ns
Data Hold from Read	$t_{DHR}$	10	80	10	60	10	60	ns
Read Hold from Chip Select	$t_{RH}$	0	—	0	—	0	—	ns

## READ CYCLE TIMING

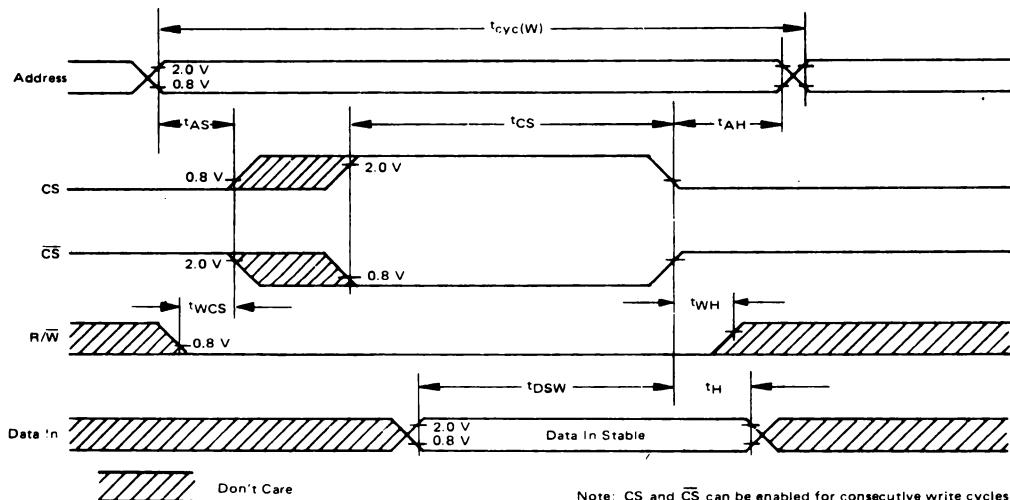


# MCM6810•MCM68A10•MCM68B10

**WRITE CYCLE (V<sub>CC</sub> = 5.0 V ± 5%, V<sub>SS</sub> = 0, T<sub>A</sub> = T<sub>L</sub> to T<sub>H</sub> unless otherwise noted.)**

Characteristic	Symbol	MCM6810		MCM68A10		MCM68B10		Unit
		Min	Max	Min	Max	Min	Max	
Write Cycle Time	$t_{cyc(W)}$	450	—	360	—	250	—	ns
Address Setup Time	$t_{AS}$	20	—	20	—	20	—	ns
Address Hold Time	$t_{AH}$	0	—	0	—	0	—	ns
Chip Select Pulse Width	$t_{CS}$	300	—	250	—	210	—	ns
Write to Chip Select Delay Time	$t_{WCS}$	0	—	0	—	0	—	ns
Data Setup Time (Write)	$t_{DSW}$	190	—	80	—	60	—	ns
Input Hold Time	$t_H$	10	—	10	—	10	—	ns
Write Hold Time from Chip Select	$t_{WH}$	0	—	—	—	—	—	—

## WRITE CYCLE TIMING



Note: CS and  $\bar{CS}$  can be enabled for consecutive write cycles provided R/W is strobed to V<sub>H</sub> before or coincident with the Address change, and remains high for time  $t_{AS}$ .



**MOTOROLA**

## MCM2532 MCM25L32

### 4096 × 8-BIT UV ERASABLE PROM

The MCM2532/25L32 is a 32,768-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent window in the package allows the memory content to be erased with ultraviolet light.

For ease of use, the device operates from a single power supply and has static power-down mode. Pin-for-pin compatible mask programmable ROMs are available for large volume production runs of systems initially using the MCM2532.

- Single +5 V Power Supply
- Organized as 4096 Bytes of 8 Bits
- Automatic Power-Down Mode (Standby)
- Fully Static Operation (No Clocks)
- TTL Compatible During Both Read and Program
- Maximum Access Time = 450 ns MCM2532  
350 ns MCM2532-35  
250 ns MCM2532-25
- Pin Compatible with MCM68A332 Mask Programmable ROMs
- Low Power Version  
MCM25L32 Active - 50 mA Max  
Standby - 10 mA Max  
MCM25L32-25 Active - 70 mA  
Standby - 15 mA

### MOS

(N-CHANNEL, SILICON-GATE)

### 4096 × 8-BIT UV ERASABLE PROM



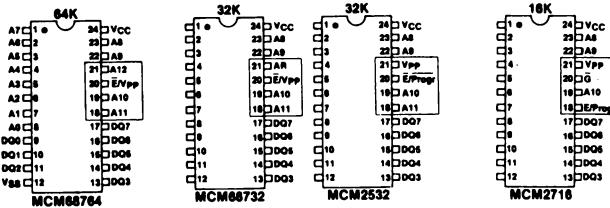
C SUFFIX  
FRIT-SEAL CERAMIC PACKAGE  
CASE 623A-02

L SUFFIX CERAMIC PACKAGE  
ALSO AVAILABLE — CASE 716

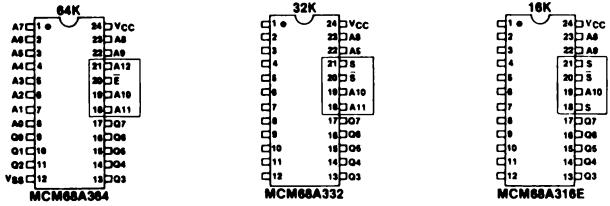
### PIN ASSIGNMENT

A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	VPP
A3	5	20	E/Progr
A2	6	19	A10
A1	7	18	A11
A0	8	17	DQ7
DQ0	9	16	DQ6
DQ1	10	15	DQ5
DQ2	11	14	DQ4
VSS	12	13	DQ3

### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY



### INDUSTRY STANDARD PINOUTS

#### \*PIN NAMES

A	.....	Address
DQ	.....	Data Input/Output
E/Prog.	.....	Dual Function Enable (Power-Down/Program Pulse)

\*New Industry standard nomenclature

# MCM2532•MCM25L32

## ABSOLUTE MAXIMUM RATINGS

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Operating Temperature Range	0 to +70	°C
Storage Temperature	-65 to +125	°C
All Input/Output Voltages with Respect to V <sub>SS</sub>	+6 to -0.3	Vdc
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+28 to -0.3	Vdc

This device contains 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 this high-impedance circuit.

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.

## MODE SELECTION

Mode	Pin Number				
	9-11, 13-17 DQ	12 V <sub>SS</sub>	20 E/Progr	21 V <sub>PP</sub>	24 V <sub>CC</sub>
Read	Data Out	V <sub>SS</sub>	V <sub>IL</sub>	5 V	V <sub>CC</sub>
Output Disable	High Z	V <sub>SS</sub>	V <sub>IH</sub>	5 to 25 V	V <sub>CC</sub>
Standby	High Z	V <sub>SS</sub>	V <sub>IH</sub>	5 V	V <sub>CC</sub>
Program	Data In	V <sub>SS</sub>	Pulsed V <sub>IH</sub> to V <sub>IL</sub>	V <sub>PPH</sub>	V <sub>CC</sub>
Program Verify	Data Out	V <sub>SS</sub>	V <sub>IL</sub>	5 V	V <sub>CC</sub>
Program Inhibit	High Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>PPH</sub>	V <sub>CC</sub>

## BLOCK DIAGRAM

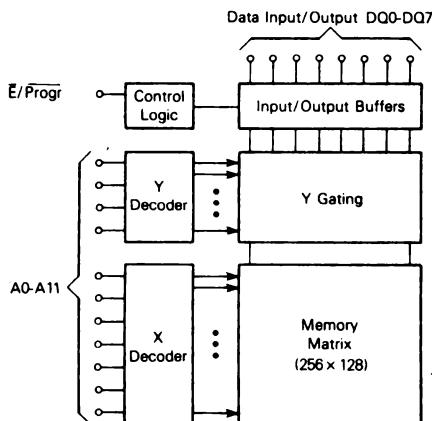
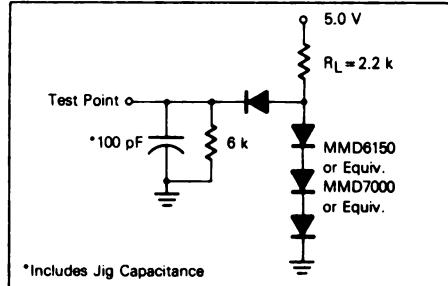


FIGURE 1 – AC TEST LOAD



# MCM2532•MCM25L32

CAPACITANCE ( $f = 1.0 \text{ MHz}$ ,  $T_A = 25^\circ\text{C}$ , periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance ( $V_{in} = 0 \text{ V}$ )	$C_{in}$	4.0	6.0	pF
Output Capacitance ( $V_{out} = 0 \text{ V}$ )	$C_{out}$	8.0	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = I\Delta t / \Delta V$ .

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Fully operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min		Typ		Max		Unit
		Min	Max	Min	Max	Min	Max	
Supply Voltage*	$V_{CC}$	4.75	5.0	5.25	5.5	$V_{CC} - 0.6$	5.0	Vdc
	$V_{PP}$	4.5	5.0	5.5	5.5			
Input High Voltage	$V_{IH}$	2.2	—	—	—	$V_{CC} + 1.0$	—	Vdc
Input Low Voltage	$V_{IL}$	—0.1	—	—	0.65	—	0.65	Vdc

### RECOMMENDED DC OPERATING CHARACTERISTICS

Characteristic	Condition	Symbol	MCM2532		MCM25L32		Unit
			Min	Max	Min	Max	
Address and $\bar{E}$ Input Sink Current	$V_{in} = 5.25 \text{ V}$	$I_{in}$	—	10	—	10	$\mu\text{A}$
Output Leakage Current	$V_{out} = 5.25 \text{ V}$	$I_{LO}$	—	10	—	10	$\mu\text{A}$
$V_{CC}$ Supply Current* (Standby)	$E = V_{IH}$	$I_{CC1}$	—	25	—	10	mA
$V_{CC}$ Standby Current* (Standby)	$MCM2532-25$	$I_{CC1}$	—	25	—	15	mA
$V_{CC}$ Supply Current* (Active)	$MCM2532$	$I_{CC2}$	—	100	—	50	mA
$V_{CC}$ Supply Current* (Active)	$MCM2532-35$	$I_{CC2}$	—	120	—	70	mA
$V_{PP}$ Supply Current*	$V_{PP} = 5.85 \text{ V}$	$I_{PP1}$	—	5.0	—	5.0	mA
Output Low Voltage	$I_{OL} = 2.1 \text{ mA}$	$V_{OL}$	—	0.45	—	0.45	V
Output High Voltage	$I_{OH} = -400 \mu\text{A}$	$V_{OH}$	2.4	—	2.4	—	V

\* $V_{CC}$  must be applied simultaneously or prior to  $V_{PP}$ .  $V_{CC}$  must also be switched off simultaneously with or after  $V_{PP}$ . With  $V_{PP}$  connected directly to  $V_{CC}$  during the read operation, the supply current would be the sum of  $I_{PP1}$  and  $I_{CC}$ . The additional 0.6 V tolerance on  $V_{PP}$  makes it possible to use a driver circuit for switching  $V_{PP}$  supply from  $V_{CC}$  in Read mode to +25 V for programming. Typical values are for  $T_A = 25^\circ\text{C}$  and nominal supply voltages.

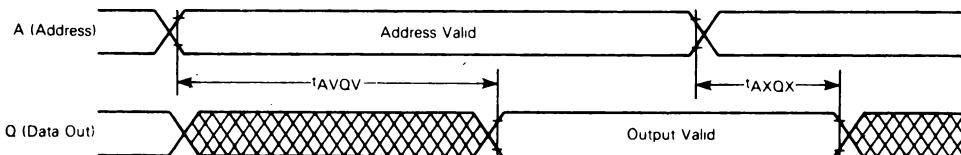
## AC READ OPERATING CONDITIONS AND CHARACTERISTICS (Full Operating Voltage and Temperature Range Unless Otherwise Noted)

Input Pulse Levels ..... 0.65 Volt and 2.2 Volts  
Input Rise and Fall Times ..... 20 ns      Input and Output Timing Levels ..... 0.8 and 2.0 Volts  
Output Load ..... See Figure 1

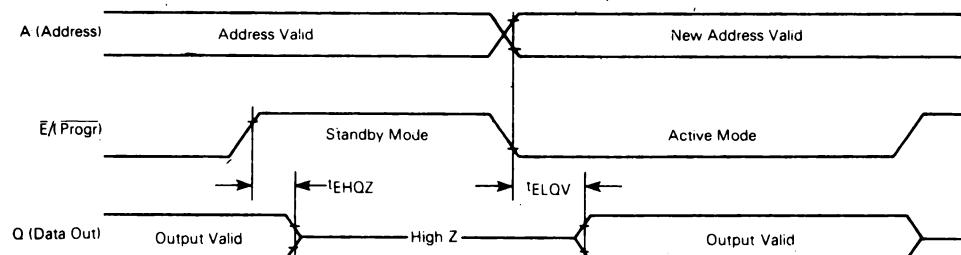
Characteristic	Symbol	MCM2532-25		MCM2532-35		MCM2532		Unit
		Min	Max	Min	Max	Min	Max	
Address Valid to Output Valid ( $\bar{E}/\bar{\text{Prog}} = V_{IL}$ )	$t_{AVQV}$	—	250	—	350	—	450	ns
$\bar{E}$ to Output Valid	$t_{ELQV}$	—	250	—	350	—	450	ns
$\bar{E}$ to High Z Output	$t_{EHQZ}$	0	100	0	100	0	100	ns
Data Hold from Address ( $\bar{E} = V_{IL}$ )	$t_{AXDX}$	0	—	0	—	0	—	ns

# MCM2532•MCM25L32

## READ MODE TIMING DIAGRAMS ( $\bar{E} = V_{IL}$ )



## STANDBY MODE



## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS ( $T_A = 25^\circ C \pm 5^\circ C$ )

### RECOMMENDED PROGRAMMING OPERATION CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}, V_{PPL}, V_{PPH}$	4.75 24	5.0 25	5.25 26	Vdc
Input High Voltage for Data	$V_{IH}$	2.2	—	$V_{CC} + 1$	Vdc
Input Low Voltage for Data	$V_{IL}$	-0.1	—	0.65	Vdc

\* $V_{CC}$  must be applied simultaneously or prior to  $V_{PP}$ .  $V_{CC}$  must also be switched off simultaneously with or after  $V_{PP}$ . The device must not be inserted into or removed from a board with  $V_{PP}$  at +25 V.  $V_{PP}$  must not exceed the +26 V maximum specifications.

### PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address and $\bar{E}/\text{Progr}$ Input Sink Current	$V_{IN} = 5.25 \text{ V}/0.45 \text{ V}$	$I_{LI}$	—	—	10	$\mu\text{A/dc}$
$V_{PP}$ Supply Current ( $V_{PP} = 25 \text{ V} \pm 1 \text{ V}$ )	$\bar{E}/\text{Progr} = V_{IH}$	$I_{PP1}$	—	—	10	$\text{mA/dc}$
$V_{PP}$ Programming Pulse Supply Current ( $V_{PP} = 25 \text{ V} \pm 1 \text{ V}$ )	$\bar{E}/\text{Progr} = V_{IL}$	$I_{PP2}$	—	—	30	$\text{mA/dc}$
$V_{CC}$ Supply Current – MCM2532	—	$I_{CC}$	—	—	160	$\text{mA/dc}$

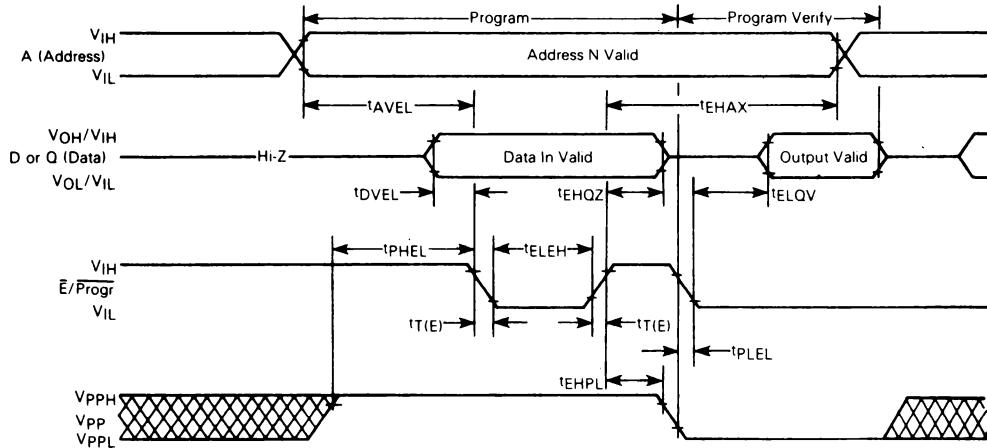
### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	$t_{AVEL}$	2.0	—	$\mu\text{s}$
$V_{PP}$ Setup Time	$t_{PHEL}$	0	—	ns
Data Setup Time	$t_{DVEL}$	2.0	—	$\mu\text{s}$
Address Hold Time	$t_{EHAX}$	2.0	—	$\mu\text{s}$
$V_{PP}$ to Enable Low Time	$t_{PLEL}$	0	—	ns
Data Hold Time	$t_{EHQZ}$	2.0	—	$\mu\text{s}$
$V_{PP}$ Hold Time	$t_{EHPL}$	0	—	ns
Enable (Program) Active Time	$t_{LELH}$	1*	55	ms
Enable (E/Progr) Pulse Transition Time	$t_{T(PE)}$	5	—	ns
$V_{PP}$ Rise and Fall Time from 5 to 25 V	$t_R, t_F$	0.5	2	$\mu\text{s}$

\*If shorter than 45 ms (min) pulses are used, the same number of pulses should be applied after the specific data has been verified.

# MCM2532•MCM25L32

PROGRAMMING OPERATION TIMING DIAGRAM



## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for PROGRAM mode, the V<sub>PP</sub> input (pin 21) should be raised to +25 V. The V<sub>CC</sub> supply voltage is the same as for the READ operation. Programming data is entered in 8-bit words through the data out (DQ) terminals while E/Progr is high. Only "0's" will be programmed when "0's" and "1's" are entered in the data word.

After address and data setup, a 50 ms program pulse (V<sub>IH</sub> to V<sub>IL</sub>) is applied to the E/Progr input. A program pulse is applied to each address location to be programmed. To minimize programming time, a 2 ms pulse width is recommended. The maximum program pulse width is 55 ms; therefore, programming must not be attempted with a dc signal applied to the E/Progr input.

Multiple MCM2532s may be programmed in parallel with the same data by connecting together like inputs and apply-

ing the program pulse to the E/Progr inputs. Different data may be programmed into multiple MCM2532s connected in parallel by using the PROGRAM INHIBIT mode. Except for the E/Progr pin, all like inputs may be common.

PROGRAM VERIFY for the MCM2532 is the read operation.

## READ OPERATION

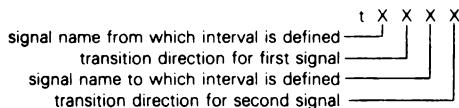
After access time, data is valid at the outputs in the READ mode.

## ERASING INSTRUCTIONS

The MCM2532/25L32 can be erased by exposure to high intensity shortwave ultraviolet light, with a wave-length of 2537 angstroms. The recommended integrated dose (i.e., UV-intensity X exposure time) is 15 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser Turner Designs, Mountain View, CA94043) the ERASE-time is 36 minutes. The lamps should be used without shortwave filters and the MCM2532/25L32 should be positioned about one inch away from the UV-tubes.

# MCM2532•MCM25L32

## TIMING PARAMETER ABBREVIATIONS



The transition definitions used in this data sheet are:

- H = transition to high
- L = transition to low
- V = transition to valid
- X = transition to invalid or don't care
- Z = transition to off (high impedance)

## 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.

## WAVEFORMS

Waveform Symbol	Input	Output
	Must Be Valid	Will Be Valid
	Change From H to L	Will Change From H to L
	Change From L to H	Will Change From L to H
	Don't Care Any Change Permitted	Changing State Unknown
		High Impedance



**MOTOROLA**

**MCM2708  
MCM27A08**

**1024 X 8 ERASABLE PROM**

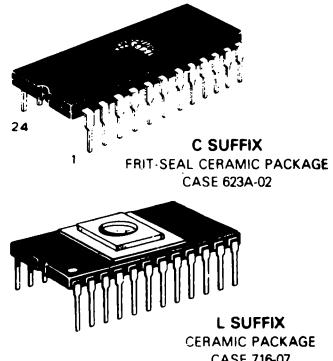
The MCM2708/27A08 is an 8192-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent window on the package allows the memory content to be erased with ultraviolet light. Pin-for-pin mask-programmable ROMs are available for large volume production runs of systems initially using the MCM2708/27A08.

- Organized as 1024 Bytes of 8 Bits
- Static Operation
- Standard Power Supplies of +12 V, +5 V and -5 V
- Maximum Access Time = 300 ns — MCM27A08  
450 ns — MCM2708
- Low Power Dissipation
- Chip-Select Input for Memory Expansion
- TTL Compatible
- Three-State Outputs
- Pin Equivalent to the 2708
- Pin-for-Pin Compatible to MCM65308, MCM68308 or 2308 Mask-Programmable ROMs

**MOS**

(N-CHANNEL, SILICON-GATE)

**1024 X 8-BIT  
UV ERASABLE PROM**



**PIN CONNECTION DURING READ OR PROGRAM**

Mode	Pin Number						
	9-11, 13-17	12	18	19	20	21	24
Read	D <sub>out</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD</sub>	V <sub>IIL</sub>	V <sub>BB</sub>	V <sub>CC</sub>
Program	D <sub>in</sub>	V <sub>SS</sub>	Pulsed VIHP	V <sub>DD</sub>	V <sub>IHW</sub>	V <sub>BB</sub>	V <sub>CC</sub>

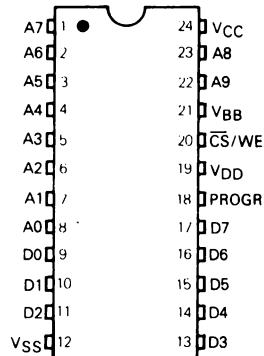
**ABSOLUTE MAXIMUM RATINGS (1)**

Rating	Value	Unit
Operating Temperature	0 to +70	°C
Storage Temperature	-65 to +125	°C
V <sub>DD</sub> with Respect to V <sub>BB</sub>	+20 to -0.3	Vdc
V <sub>CC</sub> and V <sub>SS</sub> with Respect to V <sub>BB</sub>	+15 to -0.3	Vdc
All Input or Output Voltages with Respect to V <sub>BB</sub> during Read	+15 to -0.3	Vdc
CS/WE Input with Respect to V <sub>BB</sub> during Programming	+20 to -0.3	Vdc
Program Input with Respect to V <sub>BB</sub>	+35 to -0.3	Vdc
Power Dissipation	1.8	Watts

**Note 1:**

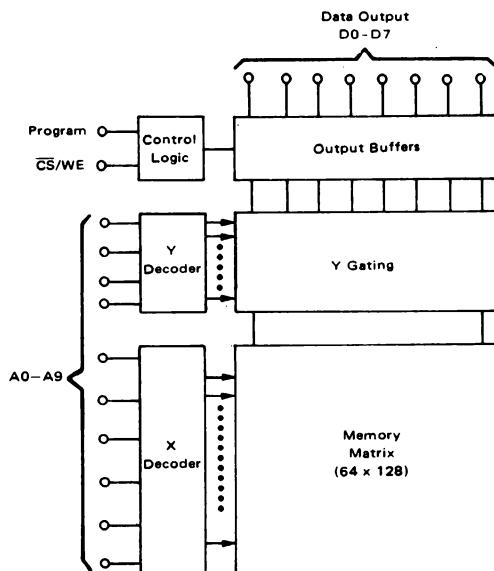
Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

**PIN ASSIGNMENT**



# MCM2708•MCM27A08

BLOCK DIAGRAM



## DC READ OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC READ OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	Vdc
	$V_{DD}$	11.4	12	12.6	Vdc
	$V_{BB}$	-5.25	-5.0	-4.75	Vdc
Input High Voltage	$V_{IH}$	3.0	—	$V_{CC} + 1.0$	Vdc
Input Low Voltage	$V_{IL}$	$V_{SS}$	—	0.65	Vdc

### READ OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit	
Address and CS Input Sink Current	$V_{in} = 5.25 \text{ V}$ or $V_{in} = V_{IL}$	$I_{in}$	—	1	10	$\mu\text{A}$	
Output Leakage Current	$V_{out} = 5.25 \text{ V}$ , $\overline{CS}/WE = 5 \text{ V}$	$I_{LO}$	—	1	10	$\mu\text{A}$	
$V_{DD}$ Supply Current	(Note 2)	Worst-Case Supply Currents	$I_{DD}$	—	50	65	$\text{mA}$
$V_{CC}$ Supply Current		All Inputs High	$I_{CC}$	—	6	10	$\text{mA}$
$V_{BB}$ Supply Current		$CS/WE = 5.0 \text{ V}$ , $T_A = 0^\circ\text{C}$	$I_{BB}$	—	30	45	$\text{mA}$
Output Low Voltage	$I_{OL} = 1.6 \text{ mA}$	$V_{OL}$	—	—	0.45	V	
Output High Voltage	$I_{OH} = -100 \mu\text{A}$	$V_{OH1}$	3.7	—	—	V	
Output High Voltage	$I_{OH} = -1.0 \text{ mA}$	$V_{OH2}$	2.4	—	—	V	
Power Dissipation	(Note 2)	$P_D$	—	—	800	$\text{mW}$	

Note 2:

The total power dissipation is specified at 800 mW. It is not calculable by summing the various current ( $I_{DD}$ ,  $I_{CC}$ , and  $I_{BB}$ ) multiplied by their respective voltages, since current paths exist between the various power supplies and  $V_{SS}$ . The  $I_{DD}$ ,  $I_{CC}$ , and  $I_{BB}$  currents should be used to determine power supply capacity only.

$V_{BB}$  must be applied prior to  $V_{CC}$  and  $V_{DD}$ .  $V_{BB}$  must also be the last power supply switched off.

# MCM2708•MCM27A08

## AC READ OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.) (All timing with $t_r = t_f = 20$ ns, Load per Note 3)

Characteristic	Symbol	MCM27A08			MCM2708			Unit
		Min	Typ	Max	Min	Typ	Max	
Address to Output Delay	$t_{AO}$	—	220	300	—	280	450	ns
Chip Select to Output Delay	$t_{CO}$	—	60	120	—	60	120	ns
Data Hold from Address	$t_{DHA}$	0	—	—	0	—	—	ns
Data Hold from Deselection	$t_{DHD}$	0	—	120	0	—	120	ns

### CAPACITANCE (periodically sampled rather than 100% tested.)

Characteristic	Condition	Symbol	Typ	Max	Unit
Input Capacitance (f = 1.0 MHz)	$V_{in} = 0$ V, $T_A = 25^\circ\text{C}$	$C_{in}$	4.0	6.0	pF
Output Capacitance (f = 1.0 MHz)	$V_{out} = 0$ V, $T_A = 25^\circ\text{C}$	$C_{out}$	8.0	12	pF

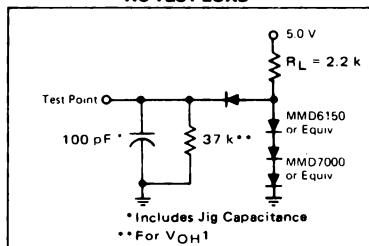
#### Note 3:

Output Load = 1 TTL Gate and  $C_L = 100$  pF (Includes Jig Capacitance)

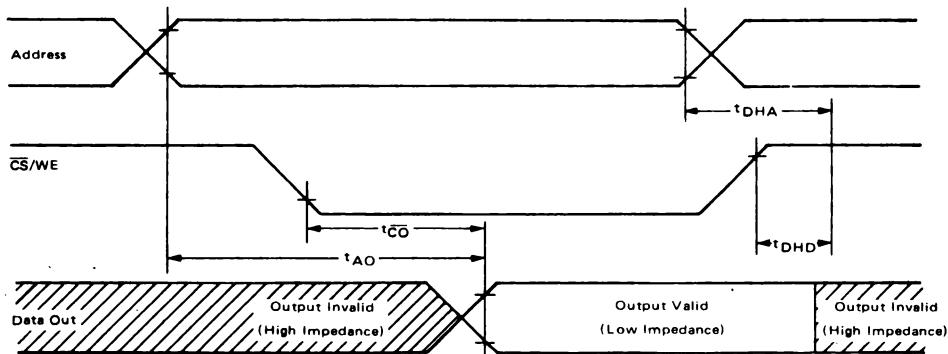
Timing Measurement Reference Levels: Inputs: 0.8 V and 2.8 V

Outputs: 0.8 V and 2.4 V

### AC TEST LOAD



### READ OPERATION TIMING DIAGRAM



# MCM2708•MCM27A08

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	Vdc
	V <sub>DD</sub>	11.4	12	12.6	Vdc
	V <sub>BB</sub>	-5.25	-5.0	-4.75	Vdc
Input High Voltage for All Addresses and Data	V <sub>IH</sub>	3.0	—	V <sub>CC</sub> + 1.0	Vdc
Input Low Voltage (except Program)	V <sub>IL</sub>	V <sub>SS</sub>	—	0.65	Vdc
CS/WE Input High Voltage (Note 4)	V <sub>IHW</sub>	11.4	12	12.6	Vdc
Program Pulse Input High Voltage (Note 4)	V <sub>IHP</sub>	25	—	27	Vdc
Program Pulse Input Low Voltage (Note 5)	V <sub>ILP</sub>	V <sub>SS</sub>	—	1.0	Vdc

Note 4: Referenced to V<sub>SS</sub>.

Note 5: V<sub>IHP</sub> - V<sub>ILP</sub> = 25 V min.

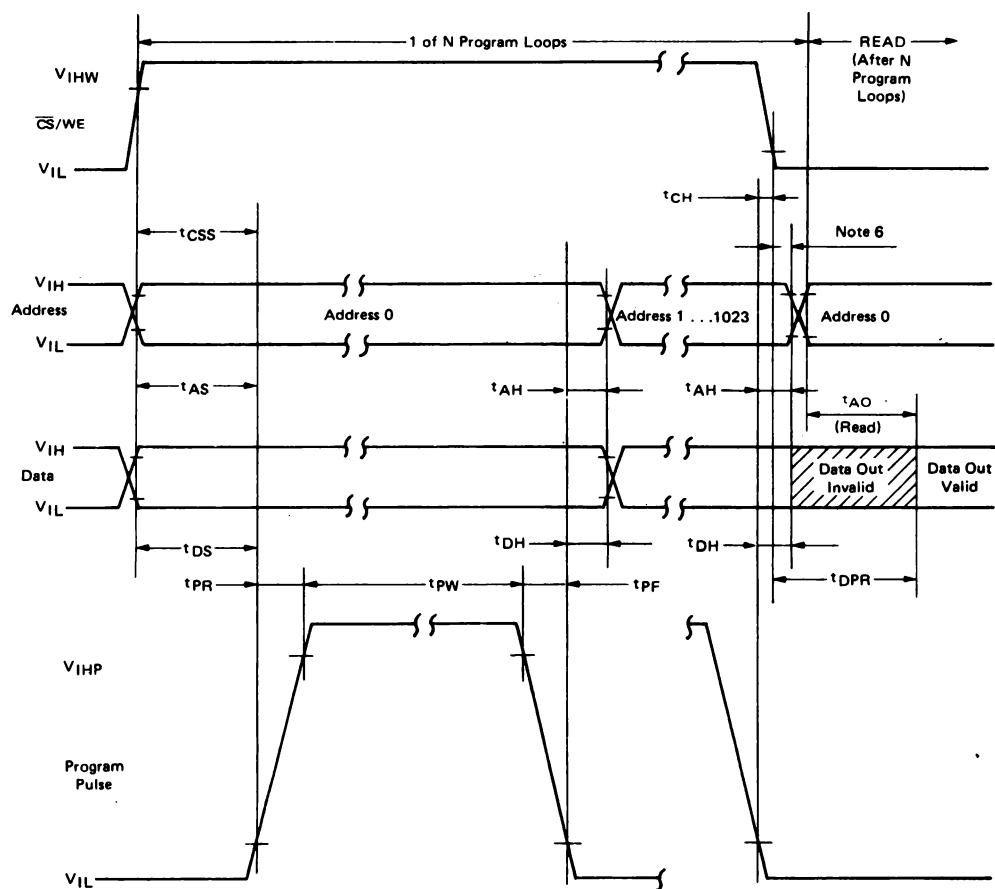
### PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address and CS/WE Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>LI</sub>	—	—	10	μAdc
Program Pulse Source Current		I <sub>IPL</sub>	—	—	3.0	mAdc
Program Pulse Sink Current		I <sub>IPH</sub>	—	—	20	mAdc
V <sub>DD</sub> Supply Current	Worst-Case Supply Currents All Inputs High CS/WE = 5 V, T <sub>A</sub> = 0°C	I <sub>DD</sub>	—	50	65	mAdc
V <sub>CC</sub> Supply Current		I <sub>CC</sub>	—	6	10	mAdc
V <sub>BB</sub> Supply current		I <sub>BB</sub>	—	30	45	mAdc

### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	t <sub>AS</sub>	10	—	μs
CS/WE Setup Time	t <sub>CSS</sub>	10	—	μs
Data Setup Time	t <sub>DS</sub>	10	—	μs
Address Hold Time	t <sub>AH</sub>	1.0	—	μs
CS/WE Hold Time	t <sub>CH</sub>	0.5	—	μs
Date Hold Time	t <sub>DH</sub>	1.0	—	μs
Chip Deselect to Output Float Delay	t <sub>DF</sub>	0	120	ns
Program to Read Delay	t <sub>DPR</sub>	—	10	μs
Program Pulse Width	t <sub>PW</sub>	0.1	1.0	ms
Program Pulse Rise Time	t <sub>PR</sub>	0.5	2.0	μs
Program Pulse Fall Time	t <sub>PF</sub>	0.5	2.0	μs

PROGRAMMING OPERATION TIMING DIAGRAM



Note 6: The CS/WE transition must occur after the Program Pulse transition and before the Address Transition.

# MCM2708•MCM27A08

## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultra-violet light erasure.

To set the memory up for programming mode, the CS/WE input (Pin 20) should be raised to +12 V. Programming data is entered in 8-bit words through the data output terminals (D0 to D7).

Logic levels for the data lines and addresses and the supply voltages ( $V_{CC}$ ,  $V_{DD}$ ,  $V_{BB}$ ) are the same as for the READ operation.

After address and data setup one program pulse per address is applied to the program input (Pin 18). A program loop is a full pass through all addresses. Total programming time,  $T_{Ptotal} = N \times t_{PW} \geq 100$  ms. The required number of program loops ( $N$ ) is a function of the program pulse width ( $t_{PW}$ ), where:  $0.1$  ms  $\leq t_{PW} \leq 1.0$  ms; correspondingly  $N$  is:  $100 \leq N \leq 1000$ . There must be  $N$  successive loops through all 1024 addresses. It is not permitted to apply more than one program pulse in succession to the same address (i.e.,  $N$  program pulses to an address and then change to the next address to be programmed). At the end of a program sequence the CS/WE falling edge transition must occur before the first address transition, when changing from a PROGRAM to a READ cycle. The program pin (Pin 18) should be pulled down to  $V_{ILP}$  with an active device, because this pin sources a small amount of current ( $I_{ILP}$ ) when CS/WE is at  $V_{IHW}$  (12 V) and the program pulse is at  $V_{ILP}$ .

### EXAMPLES FOR PROGRAMMING

Always use the  $T_{Ptotal} = N \times t_{PW} \geq 100$  ms relationship.

1. All 8192 bits should be programmed with a 0.2 ms program pulse width.

The minimum number of program loops:

$$N = \frac{T_{Ptotal}}{t_{PW}} = \frac{100 \text{ ms}}{0.2 \text{ ms}} = 500. \text{ One program loop}$$

consists of words 0 to 1023.

2. Words 0 to 200 and 300 to 700 are to be programmed. All other bits are "don't care". The program pulse width is 0.5 ms. The minimum number of program loops,  $N = \frac{100}{0.5} = 200$ . One program loop consists of words 0 to 1023. The data entered into the "don't care" bits should be all 1s.

3. Same requirements as example 2, but the EPROM is now to be updated to include data for words 850 to 880. The minimum number of program loops is the same as in the previous example,  $N = 200$ . One program loop consists of words 0 to 1023. The data entered into the "don't care" bits should be all 1s. Addresses 0 to 200 and 300 to 700 must be re-programmed with their original data pattern.

## ERASING INSTRUCTIONS

The MCM2708/27A08 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 Å. The recommended integrated dose (i.e., UV-intensity  $\times$  exposure time) is 12.5 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA94043) the ERASE-time is 30 minutes. The lamps should be used without shortwave filters and the MCM2708/27A08 should be positioned about one inch away from the UV-tubes.



**MOTOROLA**

**MCM2716  
MCM27L16**

**2048 × 8-BIT UV ERASABLE PROM**

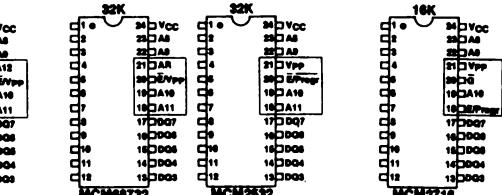
The MCM2716/27L16 is a 16,384-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent lid on the package allows the memory content to be erased with ultraviolet light.

For ease of use, the device operates from a single power supply and has a static power-down mode. Pin-for-pin mask programmable ROMs are available for large volume production runs of systems initially using the MCM2716/27L16.

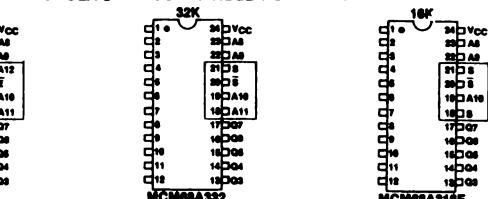
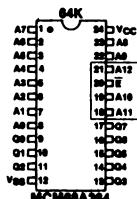
- Single 5 V Power Supply
- Automatic Power-down Mode (Standby)
- Organized as 2048 Bytes of 8 Bits
- Low Power Version 27L16/27L16-35 Active 50 mA Max  
Standby 10 mA Max
- 27L16-25 Active 70 mA Max  
Standby 15 mA Max
- TTL Compatible During Read and Program
- Maximum Access Time = 450 ns MCM2716  
350 ns MCM2716-35  
250 ns MCM2716-25
- Pin Equivalent to Intel's 2716
- Pin Compatible to MCM68A316E
- Output Enable Active Level is User Selectable



**MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY**



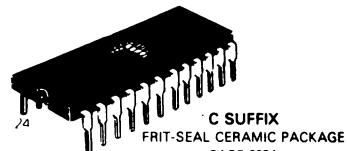
**MOTOROLA'S PIN-COMPATIBLE ROM FAMILY**



**INDUSTRY STANDARD PINOUTS**

**MOS**  
(N-CHANNEL, SILICON-GATE)

**2048 × 8-BIT  
UV ERASABLE PROM**



**L SUFFIX CERAMIC PACKAGE  
ALSO AVAILABLE — CASE 718**

**PIN ASSIGNMENT**

A7	1	24	V <sub>CC</sub>
A6	2	23	A8
A5	3	22	A9
A4	4	21	V <sub>PP</sub>
A3	5	20	G
A2	6	19	A10
A1	7	18	E/Prog
A0	8	17	DQ7
DQ0	9	16	DQ6
DQ1	10	15	DQ5
DQ2	11	14	DQ4
V <sub>SS</sub>	12	13	DQ3

**\*Pin Names**

- |              |                     |
|--------------|---------------------|
| A . . .      | Address             |
| DQ . . .     | Data Input/Output   |
| E/Prog . . . | Chip Enable/Program |
| G . . .      | Output Enable       |

\*New industry standard nomenclature

# MCM2716•MCM27L16

## ABSOLUTE MAXIMUM RATINGS

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Operating Temperature Range	0 to +70	°C
Storage Temperature	-65 to +125	°C
All Input or Output Voltages with Respect to V <sub>SS</sub>	+6 to -0.3	Vdc
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+28 to -0.3	Vdc

This device contains 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 this high-impedance circuit.

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.

## MODE SELECTION

Mode	Pin Number				
	9-11, 13-17 DQ	12 V <sub>SS</sub>	18 E/Progr	20 G*	21 V <sub>PP</sub>
Read	Data Out	V <sub>SS</sub>	V <sub>I</sub> L	V <sub>I</sub> L	V <sub>CC</sub> * V <sub>CC</sub>
Output Disable	High Z	V <sub>SS</sub>	Don't Care	V <sub>I</sub> H	V <sub>CC</sub> * V <sub>CC</sub>
Standby	High Z	V <sub>SS</sub>	V <sub>I</sub> H	Don't Care	V <sub>CC</sub> * V <sub>CC</sub>
Program	Data In	V <sub>SS</sub>	Pulsed V <sub>I</sub> L to V <sub>I</sub> H	V <sub>I</sub> H	V <sub>I</sub> H P V <sub>CC</sub>
Program Verify	Data Out	V <sub>SS</sub>	V <sub>I</sub> L	V <sub>I</sub> L	V <sub>I</sub> H P V <sub>CC</sub>
Program Inhibit	High Z	V <sub>SS</sub>	V <sub>I</sub> L	V <sub>I</sub> H	V <sub>I</sub> H P V <sub>CC</sub>

\*In the Read Mode if V<sub>PP</sub> ≥ V<sub>I</sub>H, then G (active low)  
V<sub>PP</sub> ≤ V<sub>I</sub>L, then G (active high)

## BLOCK DIAGRAM

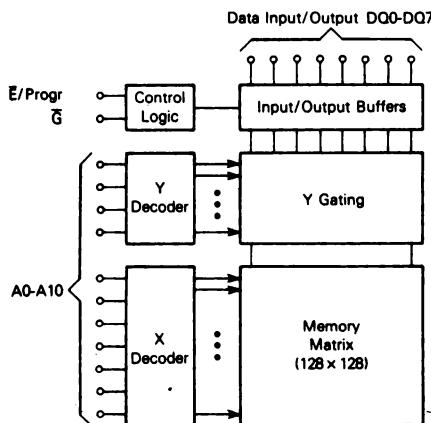
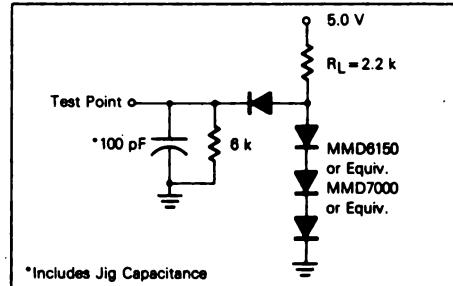


FIGURE 1 – AC TEST LOAD



\*Includes Jig Capacitance

# MCM2716•MCM27L16

CAPACITANCE (f = 1.0 MHz, TA = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance (V <sub>IN</sub> = 0 V)	C <sub>IN</sub>	4.0	6.0	pF
Output Capacitance (V <sub>OUT</sub> = 0 V)	C <sub>OUT</sub>	8.0	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: C =  $\frac{1\Delta t}{\Delta V}$ .

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max		Unit
				Min	Typ	
Supply Voltage* MCM27L16/MCM2716 MCM27L16-35/MCM27L16-25/MCM2716-35/MCM2716-25	V <sub>CC</sub>	4.75 4.5	5.0 5.0	5.25 5.5	V <sub>CC</sub> +0.6	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	V <sub>CC</sub> +1.0	—	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.1	—	0.8	—	Vdc

### RECOMMENDED DC OPERATING CHARACTERISTICS

Characteristic	Condition	Symbol	MCM2716			MCM27L16			Units
			Min	Typ	Max	Min	Typ	Max	
Address, G and E/Progr Input Sink Current	V <sub>IN</sub> = 5.25 V	I <sub>IN</sub>	—	—	10	—	—	10	μA
Output Leakage Current	V <sub>OUT</sub> = 5.25 V G = 5.0 V	I <sub>LO</sub>	—	—	10	—	—	10	μA
V <sub>CC</sub> Supply Current (Standby) 2716/2716-35	E/Progr = V <sub>IH</sub> G = V <sub>IL</sub>	I <sub>CC1</sub>	—	—	25	—	—	10	mA
V <sub>CC</sub> Supply Current (Standby) 2716-25	E/Progr = V <sub>IH</sub> G/V <sub>IL</sub>	I <sub>CC1</sub>	—	—	25	—	—	15	mA
V <sub>CC</sub> Supply Current (Active) 2716/2716-35 (Outputs Open)	G = E/Progr = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	100	—	—	50	mA
V <sub>CC</sub> Supply Current (Active) 2716-25 (Outputs Open)	G = E/Progr = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	120	—	—	70	mA
V <sub>PP</sub> Supply Current*	V <sub>PP</sub> = 5.85 V	I <sub>PP1</sub>	—	—	5.0	—	—	5.0	mA
Output Low Voltage	I <sub>OL</sub> = 2.1 mA	V <sub>OL</sub>	—	—	0.45	—	—	0.45	V
Output High Voltage	I <sub>OH</sub> = -400 μA	V <sub>OH</sub>	2.4	—	—	2.4	—	—	V

\*V<sub>CC</sub> must be applied simultaneously or prior to V<sub>PP</sub>. V<sub>CC</sub> must also be switched off simultaneously with or after V<sub>PP</sub>. With V<sub>PP</sub> connected directly to V<sub>CC</sub> during the read operation, the supply current would then be the sum of I<sub>PP1</sub> and I<sub>CC</sub>. The additional 0.6 V tolerance on V<sub>PP</sub> makes it possible to use a driver circuit for switching the V<sub>PP</sub> supply pin from V<sub>CC</sub> in Read mode to ±25 V for programming. Typical values are for T<sub>A</sub> = 25°C and nominal supply voltages.

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

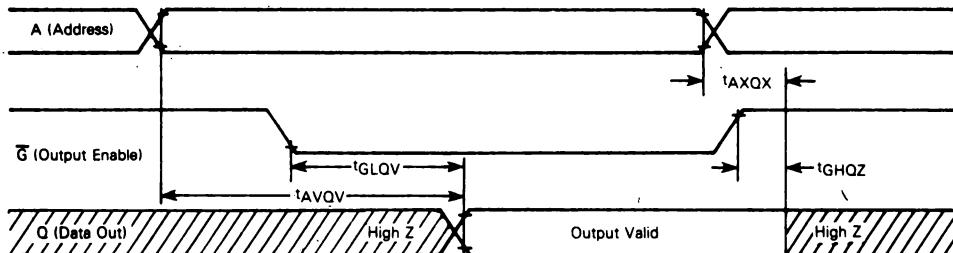
Input Pulse Levels ..... 0.8 Volt and 2.2 Volts  
Input Rise and Fall Times ..... 20 ns

Input and Output Timing Levels ..... 2.0 and 0.8 Volts  
Output Load ..... See Figure 1

Characteristic	Condition	Symbol	MCM2716-25		MCM2716-35		MCM2716		Units
			Min	Max	Min	Max	Min	Max	
Address Valid to Output Valid	E/Progr = G = V <sub>IL</sub> (Note 2)	t <sub>AVQV</sub>	—	250	—	350	—	450	
E/Progr to Output Valid	E/Progr = V <sub>IL</sub>	t <sub>ELQV</sub>	—	250	—	350	—	450	
Output Enable to Output Valid	E/Progr = V <sub>IL</sub>	t <sub>GLQV</sub>	—	150	—	150	—	150	
E/Progr to Hi-Z Output	—	t <sub>EHQZ</sub>	0	100	0	100	0	100	ns
Output Disable to Hi-Z Output	E/Progr = V <sub>IL</sub>	t <sub>GHQZ</sub>	0	100	0	100	0	100	
Data Hold from Address	E/Progr = G = V <sub>IL</sub>	t <sub>AQDX</sub>	0	—	0	—	0	—	

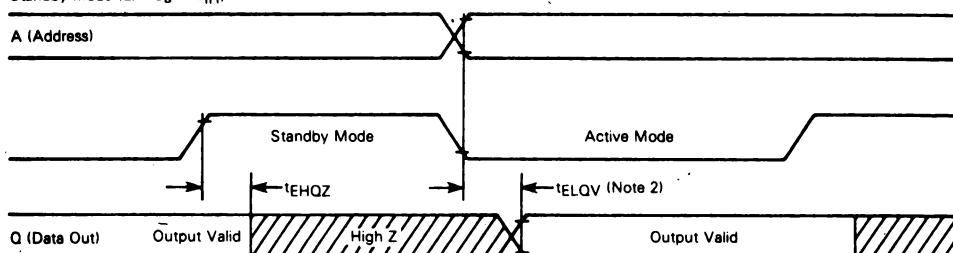
# MCM2716•MCM27L16

## READ MODE TIMING DIAGRAMS ( $\bar{E}/\text{Progr} = V_{IL}$ )



## STANDBY MODE (Output Enable = $V_{IL}$ )

Standby Mode ( $\bar{E}/\text{Progr} = V_{IH}$ )



NOTE 2:  $t_{ELQV}$  is referenced to  $\bar{E}/\text{Progr}$  or stable address, whichever occurs last.

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS

( $T_A = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$ $V_{PP}$	4.75 24	5.0 25	5.25 26	Vdc
Input High Voltage for Data	$V_{IH}$	2.2	—	$V_{CC} + 1$	Vdc
Input Low Voltage for Data	$V_{IL}$	-0.1	—	0.8	Vdc

### PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address, $\bar{G}$ and $\bar{E}/\text{Progr}$ Input Sink Current	$V_{in} = 5.25 \text{ V}/0.45 \text{ V}$	$I_{LI}$	—	—	10	$\mu\text{A}/\text{dc}$
$V_{PP}$ Supply Current ( $V_{PP} = 25 \text{ V} \pm 1 \text{ V}$ )	$\bar{E}/\text{Progr} = V_{IL}$	$I_{PP1}$	—	—	10	$\text{mA}/\text{dc}$
$V_{PP}$ Programming Pulse Supply Current ( $V_{PP} = 25 \text{ V} \pm 1 \text{ V}$ )	$\bar{E}/\text{Progr} = V_{IH}$	$I_{PP2}$	—	—	30	$\text{mA}/\text{dc}$
$V_{CC}$ Supply Current (Outputs Open)	—	$I_{CC}$	—	—	160	$\text{mA}/\text{dc}$

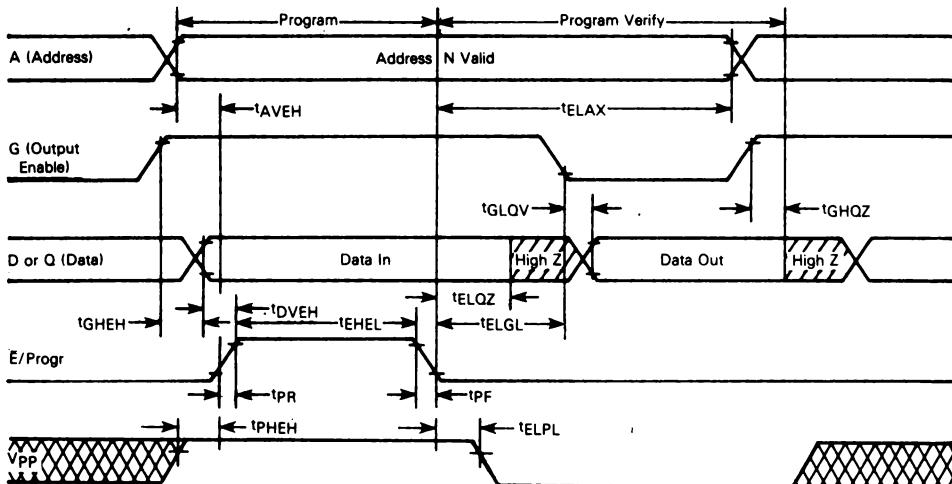
### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	$t_{AVEH}$	2.0	—	$\mu\text{s}$
Output Enable High to Program Pulse	$t_{GHEH}$	2.0	—	$\mu\text{s}$
Data Setup Time	$t_{DVEH}$	2.0	—	$\mu\text{s}$
Address Hold Time	$t_{ELAX}$	2.0	—	$\mu\text{s}$
Output Enable Hold Time	$t_{ELGL}$	2.0	—	$\mu\text{s}$
Data Hold Time	$t_{ELQZ}$	2.0	—	$\mu\text{s}$
$V_{PP}$ Setup Time	$t_{PHEH}$	0	—	ns
$V_{PP}$ to Enable Low Time	$t_{ELPL}$	0	—	ns
Output Disable to High Z Output	$t_{GHQZ}$	0	150	ns
Output Enable to Valid Data ( $\bar{E}/\text{Progr} = V_{IL}$ )	$t_{GLOV}$	—	150	ns
Program Pulse Width	$t_{EHEL}$	1°	56	ms
Program Pulse Rise Time	$t_{PR}$	5	—	ns
Program Pulse Fall Time	$t_{PF}$	5	—	ns

\*If shorter than 45 ms (min) pulses are used, the same number of pulses should be applied after the specific data has been verified.

# MCM2716•MCM27L16

PROGRAMMING OPERATION TIMING DIAGRAM



## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for Program Mode, the V<sub>PP</sub> input (Pin 21) should be raised to +25 V. The V<sub>CC</sub> supply voltage is the same as for the Read operation and G is at V<sub>IH</sub>. Programming data is entered in 8-bit words through the data out (DQ) terminals. Only "0's" will be programmed when "0's" and "1's" are entered in the 8-bit data word.

After address and data setup, a program pulse (V<sub>IL</sub> to V<sub>IH</sub>) is applied to the E/Progr input. A program pulse is applied to each address location to be programmed. To minimize programming time, a 2 ms pulse width is recommended. The maximum program pulse width is 55 ms; therefore, programming must not be attempted with a dc signal applied to the E/Progr input.

Multiple MCM2716s may be programmed in parallel by connecting together like inputs and applying the program pulse to the E/Progr inputs. Different data may be programmed into multiple MCM2716s connected in parallel by using the PROGRAM INHIBIT mode. Except for the E/Progr pin, all like inputs (including Output Enable) may be common.

The PROGRAM VERIFY mode with V<sub>PP</sub> at 25 V is used to determine that all programmed bits were correctly programmed.

## READ OPERATION

After access time, data is valid at the outputs in the READ mode. With stable system addresses, effectively faster access time can be obtained by gating the data onto the bus with Output Enable.

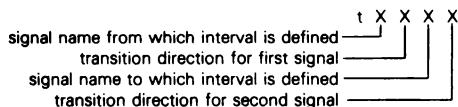
The Standby mode is available to reduce active power dissipation. The outputs are in the high impedance state when the E/Progr input pin is high (V<sub>IH</sub>) independent of the Output Enable input.

## ERASING INSTRUCTIONS

The MCM2716/27L16 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 angstroms. The recommended integrated dose (i.e., UV-intensity X exposure time) is 15 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 36 minutes. The lamps should be used without shortwave filters and the MCM2716/MCM27L16 should be positioned about one inch away from the UV-tubes.

MCM2716•MCM27L16

## TIMING PARAMETER ABBREVIATIONS



The transition definitions used in this data sheet are:

$H$  = transition to high

$\downarrow$  = transition to high

L = transition to low  
V = transition to valid

✓ = transition to valid  
✗ = transition to invalid or don't care

$\lambda$  = transition to invalid or don't care  
 $\gamma$  = transition to off (high impedance)

## **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.

## WAVEFORMS



**MOTOROLA**

### 2048 X 8 ERASABLE PROM

The TMS2716 and TMS27A16 are 16,384-bit Erasable and Electrically Reprogrammable PROMs designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent window on the package allows the memory content to be erased with ultraviolet light. The TMS2716 is pin compatible with 2708 EPROMs, allowing easy memory size doubling.

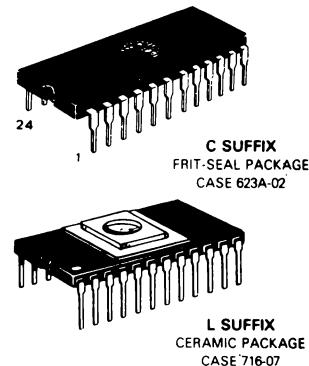
- Organized as 2048 Bytes of 8 Bits
- Fully Static Operation (No Clocks, No Refresh)
- Standard Power Supplies of +12 V, +5 V, and -5 V
- Maximum Access Time = 300 ns – TMS27A16  
450 ns – TMS2716
- Chip-Select Input for Memory Expansion
- TTL Compatible – No Pull-up Resistors Required
- Three-State Outputs for OR-Tie Capability
- The TMS2716 is Pin Compatible to MCM2708 and MCM68708 EPROMs

**TMS2716  
TMS27A16**

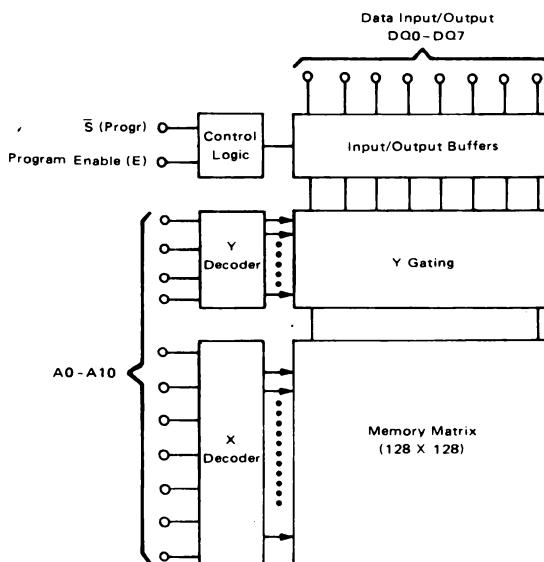
**MOS**

(N-CHANNEL, SILICON-GATE)

**2048 X 8-BIT  
UV ERASABLE PROM**



BLOCK DIAGRAM



PIN ASSIGNMENT

A7	1	●	24	VCC(E)
A6	2		23	IA8
A5	3		22	IA9
A4	4		21	IVBB
A3	5		20	IA10
A2	6		19	IVDD
A1	7		18	S (Prog)
A0	8		17	IDQ7
DQ0	9		16	IDQ6
DQ1	10		15	IDQ5
DQ2	11		14	IDQ4
VSS	12		13	IDQ3

PIN NAMES

A0-A10.....	Address Inputs
DQ0-DQ7.....	Data Input (Program or Output (Read))
(E).....	Program Enable
S (Prog).....	Chip Select
IVBB.....	Program Pulse
VCC.....	- 5 V Power Supply
VDD.....	+ 5 V Power Supply
VSS.....	+ 12 V Power Supply
	Ground

# TMS2716•TMS27A16

## ABSOLUTE MAXIMUM RATINGS (1)

Rating	Value	Unit
Operating Temperature	0 to +70	°C
Storage Temperature	-65 to +125	°C
$V_{DD}$ with Respect to $V_{BB}$	+20 to -0.3	V
$V_{CC}$ and $V_{SS}$ with Respect to $V_{BB}$	+15 to -0.3	V
All Input or Output Voltage with Respect to $V_{BB}$ During Read	+15 to -0.3	V
(E) Input with Respect to $V_{BB}$ During Programming	+20 to -0.3	V
Program Input with Respect to $V_{BB}$	+35 to -0.3	V
Power Dissipation	1.8	Watts

## PIN CONNECTION DURING READ OR PROGRAM

Mode	Pin Number		
	9-11, 13-17	18	24
Read	$D_{out}$	$V_{IL}$ or $V_{IH}$	$V_{CC}$
Program	$D_{in}$	Pulsed $V_{IHP}$	$V_{IHW}$

NOTE 1: 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.

## DC READ OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC READ OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	V
	$V_{DD}$	11.4	12	12.6	V
	$V_{BB}$	-5.25	-5.0	-4.75	V
	$V_{CC}$	4.5	5.0	5.5	V
	$V_{DD}$	10.8	12	13.2	V
	$V_{BB}$	-5.5	-5.0	-4.5	V
Input High Voltage	$V_{IH}$	2.2	—	$V_{CC} + 1.0$	V
Input Low Voltage	$V_{IL}$	$V_{SS}$	—	0.65	V

### READ OPERATING DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	$V_{in} = V_{CCmax}$ or $V_{in} = V_{IL}$	$I_{in}$	—	1	10	$\mu A$
Output Leakage Current	$V_{out} = V_{CCmax}$ and $S = 5\text{ V}$	$I_{LO}$	—	1	10	$\mu A$
$V_{DD}$ Supply Current	Worst-Case Supply Currents	$I_{DD}$	—	—	65	mA
$V_{CC}$ Supply Current	All Inputs High	$I_{CC}$	—	—	12	mA
$V_{BB}$ Supply Current	(E) = 5.0 V, $T_A = 0^\circ C$	$I_{BB}$	—	—	45	mA
Output Low Voltage	$I_{OL} = 1.6\text{ mA}$	$V_{OL}$	—	—	0.45	V
Output High Voltage	$I_{OH} = -100\text{ }\mu A$	$V_{OH1}$	3.7	—	—	V
Output High Voltage	$I_{OH} = -1.0\text{ mA}$	$V_{OH2}$	2.4	—	—	V

$V_{BB}$  must be applied prior to  $V_{CC}$  and  $V_{DD}$ .  $V_{BB}$  must also be the last power supply switched off.

### CAPACITANCE (periodically sampled rather than 100% tested)

Characteristic	Condition	Symbol	Typ	Max	Unit
Input Capacitance (f = 1.0 MHz)	$V_{in} = 0\text{ V}$ , $T_A = 25^\circ C$	$C_{in}$	4.0	6.0	pF
Output Capacitance (f = 1.0 MHz)	$V_{out} = 0\text{ V}$ , $T_A = 25^\circ C$	$C_{out}$	8.0	12	pF

# TMS2716•TMS27A16

## AC READ OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

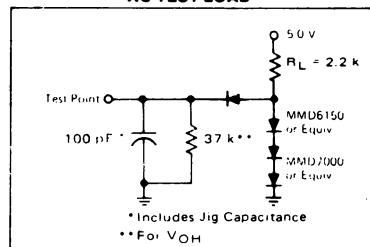
(All timing with  $t_r = t_f = 20$  ns, Load per Note 2)

Characteristic	Symbol	TMS2716		TMS27A16		Unit
		Min	Max	Min	Max	
Address to Output Delay	$t_{AVQV}$		450	..	300	ns
Chip Select to Output Delay	$t_{SLQV}$	..	120	..	120	ns
Data Hold from Address	$t_{AXQZ}$	10	-	10	..	ns
Data Hold from Deselection	$t_{SHQZ}$	10	120	10	120	ns

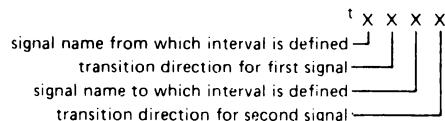
NOTE 2: Output Load = 1 TTL Gate and  $C_L = 100$  pF (Includes Jig Capacitance)

Timing Measurement Reference Levels – Inputs: 0.8 V and 2.8 V  
Outputs: 0.8 V and 2.4 V

## AC TEST LOAD



## TIMING PARAMETER ABBREVIATIONS



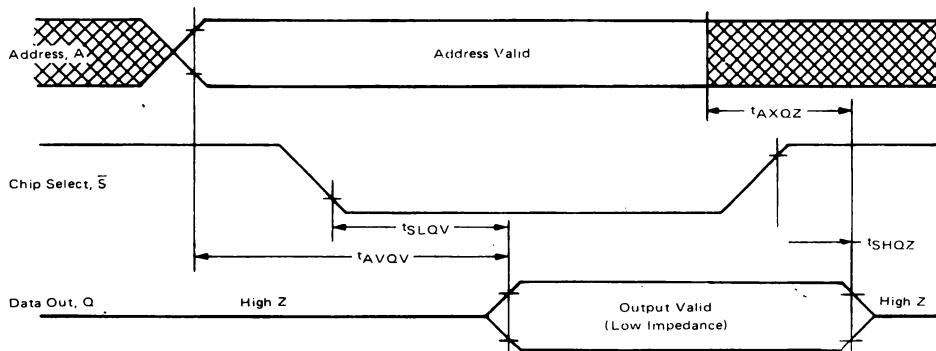
The transition definitions used in this data sheet are:

- H = transition to high
- L = transition to low
- V = transition to valid
- X = transition to invalid or don't care
- Z = transition to off (high impedance)

## 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 OPERATION TIMING DIAGRAM



**DC PROGRAMMING CONDITIONS AND CHARACTERISTICS**

(Full operating voltage and temperature range unless otherwise noted)

**RECOMMENDED PROGRAMMING OPERATING CONDITIONS**

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage – TMS2716 and TMS27A16	V <sub>CC</sub>	4.75	5.0	5.25	V <sub>d</sub> c
	V <sub>DD</sub>	11.4	12	12.6	V <sub>d</sub> c
	V <sub>BB</sub>	-5.25	-5.0	-4.75	V <sub>d</sub> c
Input High Voltage for Data	V <sub>IHD</sub>	3.8	—	V <sub>CC</sub> + 1	V <sub>d</sub> c
Input Low Voltage for Data	V <sub>ILD</sub>	V <sub>SS</sub>	—	0.65	V <sub>d</sub> c
Input High Voltage for Addresses	V <sub>IHA</sub>	3.8	—	V <sub>CC</sub> + 1	V <sub>d</sub> c
Input Low Voltage for Addresses	V <sub>ILA</sub>	V <sub>SS</sub>	—	0.4	V <sub>d</sub> c
Program Enable (E) Input High Voltage (Note 3)	V <sub>IHW</sub>	11.4	12	12.6	V <sub>d</sub> c
Program Enable (E) Input Low Voltage (Note 3)	V <sub>ILW</sub> =V <sub>CC</sub>	4.75	5.0	5.25	V <sub>d</sub> c
Program Pulse Input High Voltage (Note 3)	V <sub>IHP</sub>	25	—	27	V <sub>d</sub> c
Program Pulse Input Low Voltage (Note 4)	V <sub>ILP</sub>	V <sub>SS</sub>	—	1.0	V <sub>d</sub> c

NOTE 3: Referenced to V<sub>SS</sub>.

NOTE 4: V<sub>IHP</sub> – V<sub>ILP</sub> = 25 V min.

**PROGRAMMING OPERATION DC CHARACTERISTICS**

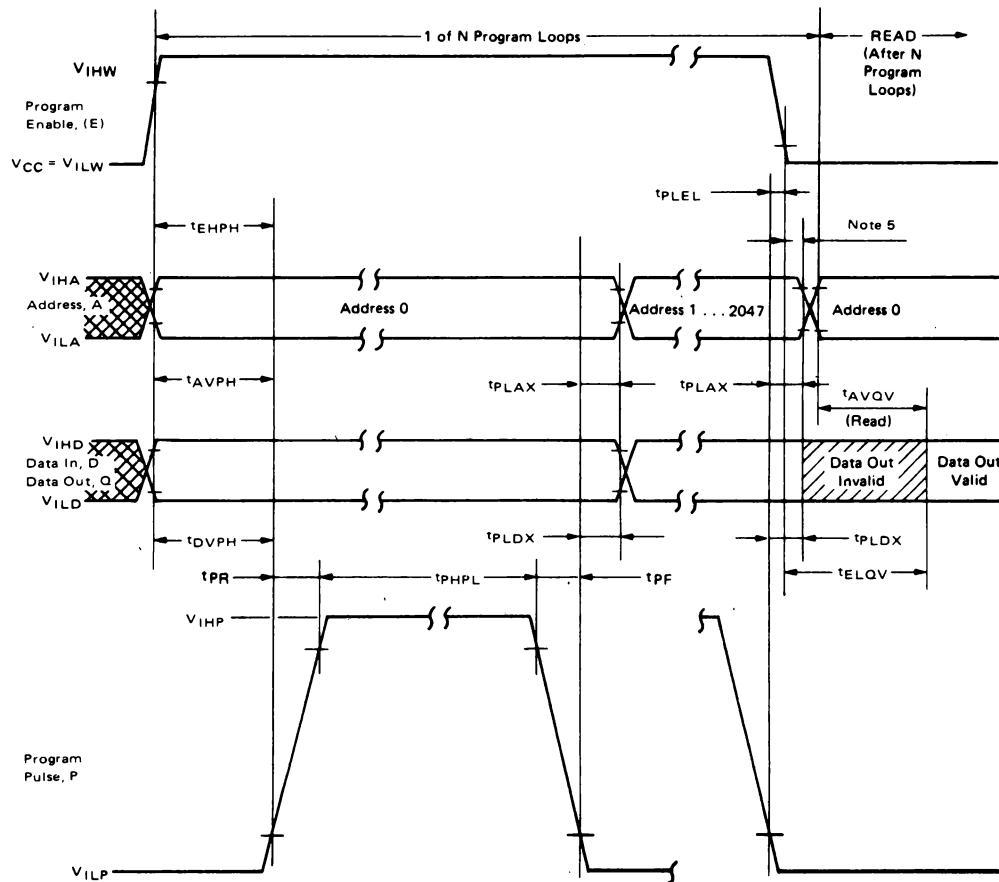
Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>L1</sub>	—	—	10	μA <sub>d</sub> c
Program Pulse Source Current		I <sub>IPL</sub>	—	—	3.0	mA <sub>d</sub> c
Program Pulse Sink Current		I <sub>IPH</sub>	—	—	20	mA <sub>d</sub> c
V <sub>DD</sub> Supply Current	Worst-Case Supply Currents All Inputs High (E) = 5 V, T <sub>A</sub> = 0°C	I <sub>DD</sub>	—	—	65	mA <sub>d</sub> c
V <sub>CC</sub> Supply Current		I <sub>CC</sub>	—	—	15	mA <sub>d</sub> c
V <sub>BB</sub> Supply current		I <sub>BB</sub>	—	—	45	mA <sub>d</sub> c

**AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS**

(Full operating voltage and temperature unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	t <sub>AVPH</sub>	10	—	μs
(E) Setup Time	t <sub>EHPH</sub>	10	—	μs
Data Setup Time	t <sub>DVPH</sub>	10	—	μs
Address Hold Time	t <sub>PLAX</sub>	1.0	—	μs
(E) Hold Time	t <sub>PLEL</sub>	0.5	—	μs
Data Hold Time	t <sub>PLDX</sub>	1.0	—	μs
Program to Read Delay	t <sub>ELQV</sub>	—	10	μs
Program Pulse Width	t <sub>PHPL</sub>	0.1	1.0	ms
Program Pulse Rise Time	t <sub>PR</sub>	0.5	2.0	μs
Program Pulse Fall Time	t <sub>PF</sub>	0.5	2.0	μs

PROGRAMMING OPERATION TIMING DIAGRAM



NOTE 5: This Program Enable transition must occur after the Program Pulse transition and before the Address Transition.

WAVEFORM DEFINITIONS

Waveform Symbol	Input	Output	Waveform Symbol	Input	Output
—	MUST BE VALID	WILL BE VALID	—	DON'T CARE	CHANGING STATE UNKNOWN
—	CHANGE FROM H TO L	WILL CHANGE FROM H TO L	—	ANY CHANGE PERMITTED	HIGH IMPEDANCE
—	CHANGE FROM L TO H	WILL CHANGE FROM L TO H	—		

## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for programming mode, the V<sub>CC(E)</sub> input (Pin 24) should be raised to +12 V. Programming data is entered in 8-bit words through the data output terminals (DQ0 to DQ7).

The V<sub>DD</sub> and V<sub>BB</sub> supply voltages are the same as for the READ operation.

After address and data setup, one program pulse per address is applied to the program input. A program loop is a full pass through all addresses. Total programming time/address, T<sub>Ptotal</sub> = N × t<sub>PHPL</sub> ≥ 100 ms. The required number of program loops (N) is a function of the program pulse width (t<sub>PHPL</sub>) where: 0.1 ms ≤ t<sub>PHPL</sub> ≤ 1.0 ms; correspondingly, N is: 100 ≤ N ≤ 1000. There must be N successive loops through all 2048 addresses. It is not permitted to apply more than one program pulse in succession to the same address (i.e., N program pulses to an address and then change to the next address to be programmed). At the end of a program sequence the Program Enable (E) falling edge transition must occur before the first address transition, when changing from a PROGRAM to a READ cycle. The program pin should be pulled down to V<sub>IPL</sub> with an active device, because this pin sources a small amount of current (I<sub>IPL</sub>) when (E) is at V<sub>IHW</sub> (12 V) and the program pulse is at V<sub>IPL</sub>.

## EXAMPLE FOR PROGRAMMING

Always use the T<sub>Ptotal</sub> = N × t<sub>PHPL</sub> ≥ 100 ms relationship:

1. All 16,384 bits should be programmed with a 0.2 ms program pulse width.

The minimum number of program loops:

$$N = \frac{T_{Ptotal}}{t_{PHPL}} = \frac{100 \text{ ms}}{0.2 \text{ ms}} = 500.$$

One program loop consists of words 0 to 2047.

2. Words 0 to 200 and 300 to 700 are to be programmed. All other bits are "don't care". The program pulse width is 0.5 ms. The minimum number of program loops, N = 100/0.5 = 200. One program loop consists of words 0 to 2047. The data entered into the "don't care" bits should be all 1s.

3. Same requirements as example 2, but the EPROM is now to be updated to include data for words 850 to 880. The minimum number of program loops is the same as in the previous example, N = 200. One program loop consists of words 0 to 2047. The data entered into the "don't care" bits should be all 1s. Addresses 0 to 200 and 300 to 700 must be reprogrammed with their original data pattern.

## ERASING INSTRUCTIONS

The TMS2716/27A16 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 Å. The recommended integrated dose (i.e., UV-intensity × exposure time) is 12.5 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 30 minutes. The lamps should be used without shortwave filters and the TMS2716/27A16 should be positioned about one inch away from the UV-tubes.



**MOTOROLA**

# MCM68708 MCM68A708

## 1024 X 8 ERASABLE PROM

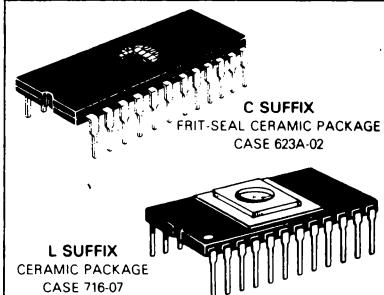
The MCM68708/68A708 is a 8192-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent window on the package allows the memory content to be erased with ultraviolet light. Pin-for-pin mask-programmable ROMs are available for large volume production runs of systems initially using the MCM68708/68A708.

- Organized as 1024 Bytes of 8 Bits
- Fully Static Operation
- Standard Power Supplies of +12 V, +5 V and -5 V
- Maximum Access Time = 300 ns – MCM68A708  
450 ns – MCM68708
- Low Power Dissipation
- Chip-Select Input for Memory Expansion
- TTL Compatible
- Three-State Outputs
- Pin Equivalent to the 2708
- Pin-for-Pin Compatible to MCM65308, MCM68308 or 2308 Mask-Programmable ROMs
- Bus Compatible to the M6800 Family

## MOS

(N-CHANNEL, SILICON-GATE)

## 1024 X 8-BIT UV ERASABLE PROM

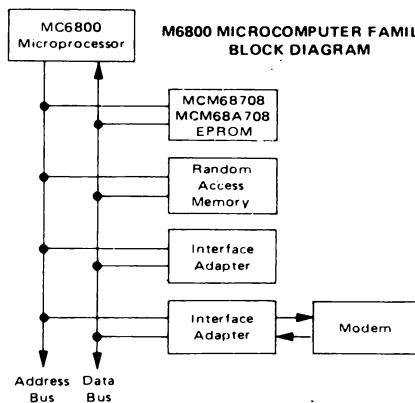


### PIN ASSIGNMENT

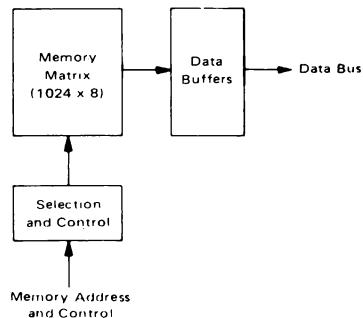
A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	VBB
A3	5	20	CS/WE
A2	6	19	VDD
A1	7	18	PROGR.
A0	8	17	D7
D0	9	16	D6
D1	10	15	D5
D2	11	14	D4
VSS	12	13	D3

### PIN CONNECTION DURING READ OR PROGRAM

Mode	Pin Number						
	9-11, 13-17	12	18	19	20	21	24
Read	Dout	VSS	VSS	VDD	VIL	VBB	VCC
Program	Din	VSS	Pulsed V <sub>IHP</sub>	VDD	V <sub>IHW</sub>	VBB	VCC

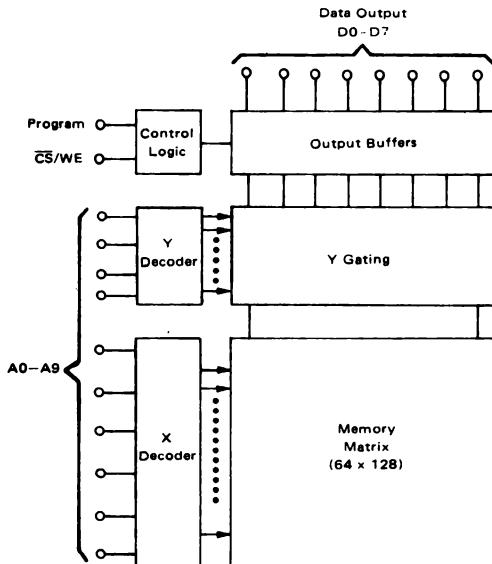


### MCM68708/68A708 READ ONLY MEMORY BLOCK DIAGRAM



# MCM68708•MCM68A708

BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

Rating	Value	Unit
Operating Temperature	0 to +70	°C
Storage Temperature	-65 to +125	°C
V <sub>DD</sub> with Respect to V <sub>BB</sub>	+20 to -0.3	Vdc
V <sub>CC</sub> and V <sub>SS</sub> with Respect to V <sub>BB</sub>	+15 to -0.3	Vdc
All Input or Output Voltages with Respect to V <sub>BB</sub> during Read	+15 to -0.3	Vdc
CS/WE Input with Respect to V <sub>BB</sub> during Programming	+20 to -0.3	Vdc
Program Input with Respect to V <sub>BB</sub>	+35 to -0.3	Vdc
Power Dissipation	1.8	Watts

### Note 1:

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.

## DC READ OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC READ OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	Vdc
	V <sub>DD</sub>	11.4	12	12.6	Vdc
	V <sub>BB</sub>	-5.25	-5.0	-4.75	Vdc
Input High Voltage	V <sub>IH</sub>	V <sub>SS</sub> +2.0	—	V <sub>CC</sub>	Vdc
Input Low Voltage	V <sub>IL</sub>	V <sub>SS</sub> -0.3	—	V <sub>SS</sub> +0.8	Vdc

### READ OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address and CS Input Sink Current	V <sub>in</sub> = 5.25 V or V <sub>in</sub> = V <sub>IL</sub>	I <sub>in</sub>	—	1	10	μA
Output Leakage Current	V <sub>out</sub> = 5.25 V, CS/WE = 5 V	I <sub>OL</sub>	—	1	10	μA
V <sub>DD</sub> Supply Current	(Note 2)	I <sub>DD</sub>	—	50	65	mA
V <sub>CC</sub> Supply Current		I <sub>CC</sub>	—	6	10	mA
V <sub>BB</sub> Supply Current	CS/WE = 5.0 V, T <sub>A</sub> = 0°C	I <sub>BB</sub>	—	30	45	mA
Output Low Voltage	I <sub>OL</sub> = 1.6 mA	V <sub>OL</sub>	—	—	V <sub>SS</sub> +0.4	V
Output High Voltage	I <sub>OH</sub> = -100 μA	V <sub>OH</sub>	V <sub>SS</sub> +2.4	—	—	V
Power Dissipation	(Note 2)	P <sub>D</sub>	—	—	800	mW

### Note 2:

The total power dissipation is specified at 800 mW. It is not calculable by summing the various currents (I<sub>DD</sub>, I<sub>CC</sub>, and I<sub>BB</sub>) multiplied by their respective voltages, since current paths exist between the various power supplies and V<sub>SS</sub>. The I<sub>DD</sub>, I<sub>CC</sub>, and I<sub>BB</sub> currents should be used to determine power supply capacity only.

V<sub>BB</sub> must be applied prior to V<sub>CC</sub> and V<sub>DD</sub>. V<sub>BB</sub> must also be the last power supply switched off.

# MCM68708•MCM68A708

## AC READ OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.) (All timing with $t_r = t_f = 20$ ns, Load per Note 3)

Characteristic	Symbol	MCM68A708			MCM68708			Unit
		Min	Typ	Max	Min	Typ	Max	
Address to Output Delay	$t_{AO}$	—	220	300	—	280	450	ns
Chip Select to Output Delay	$t_{CO}$	—	60	120	—	60	120	ns
Data Hold from Address	$t_{DHA}$	10	—	—	10	—	—	ns
Data Hold from Deselection	$t_{DHD}$	10	—	120	10	—	120	ns

### CAPACITANCE (periodically sampled rather than 100% tested.)

Characteristic	Condition	Symbol	Typ	Max	Unit
Input Capacitance (f = 1.0 MHz)	$V_{in} = 0$ V, $T_A = 25^\circ C$	$C_{in}$	4.0	6.0	pF
Output Capacitance (f = 1.0 MHz)	$V_{out} = 0$ V, $T_A = 25^\circ C$	$C_{out}$	8.0	12	pF

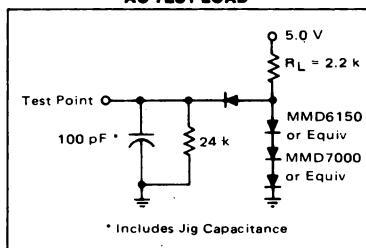
### Note 3:

Output Load = 1 TTL Gate and  $C_L = 100$  pF (Includes Jig Capacitance)

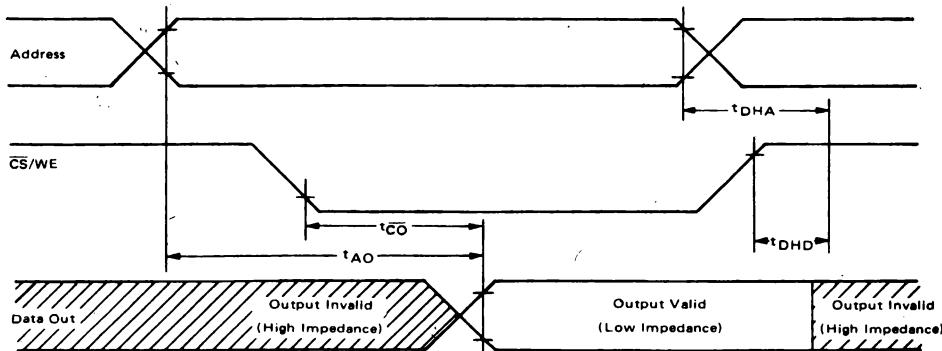
Timing Measurement Reference Levels: Inputs: 0.8 V and 2.8 V

Outputs: 0.8 V and 2.4 V

### AC TEST LOAD



### READ OPERATION TIMING DIAGRAM



# MCM68708•MCM68A708

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	V <sub>d</sub> c
	V <sub>DD</sub>	11.4	12	12.6	V <sub>d</sub> c
	V <sub>BB</sub>	-5.25	-5.0	-4.75	V <sub>d</sub> c
Input High Voltage for All Addresses and Data	V <sub>IH</sub>	3.0	—	V <sub>CC</sub> + 1.0	V <sub>d</sub> c
Input Low Voltage (except Program)	V <sub>IL</sub>	V <sub>SS</sub>	—	0.65	V <sub>d</sub> c
CS/WE Input High Voltage (Note 4)	V <sub>IHW</sub>	11.4	12	12.6	V <sub>d</sub> c
Program Pulse Input High Voltage (Note 4)	V <sub>IHP</sub>	25	—	27	V <sub>d</sub> c
Program Pulse Input Low Voltage (Note 5)	V <sub>ILP</sub>	V <sub>SS</sub>	—	1.0	V <sub>d</sub> c

Note 4: Referenced to V<sub>SS</sub>.

Note 5: V<sub>IHP</sub> - V<sub>ILP</sub> = 25 V min.

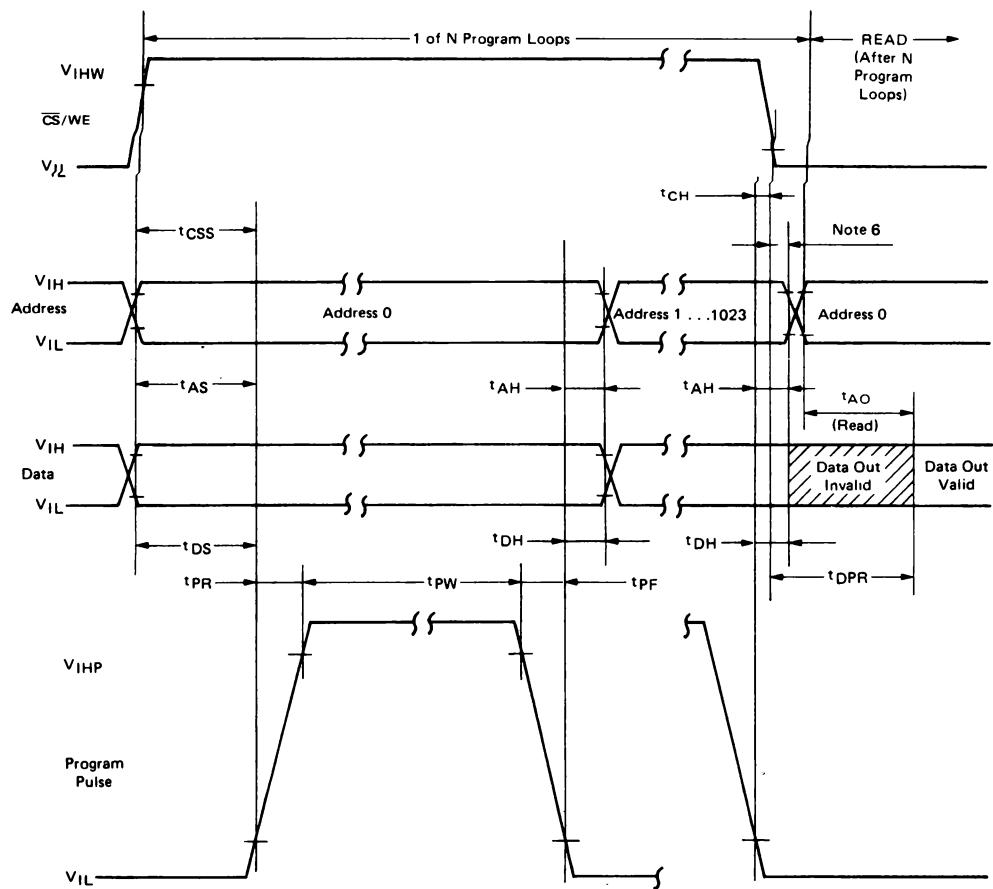
### PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address and CS/WE Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>L1</sub>	—	—	10	μA/dc
Program Pulse Source Current		I <sub>IPL</sub>	—	—	3.0	mA/dc
Program Pulse Sink Current		I <sub>IPH</sub>	—	—	20	mA/dc
V <sub>DD</sub> Supply Current	Worst-Case Supply Currents	I <sub>DD</sub>	—	50	65	mA/dc
V <sub>CC</sub> Supply Current		I <sub>CC</sub>	—	6	10	mA/dc
V <sub>BB</sub> Supply current		I <sub>BB</sub>	—	30	45	mA/dc

### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	t <sub>AS</sub>	10	—	μs
CS/WE Setup Time	t <sub>CSS</sub>	10	—	μs
Data Setup Time	t <sub>DS</sub>	10	—	μs
Address Hold Time	t <sub>AH</sub>	1.0	—	μs
CS/WE Hold Time	t <sub>CH</sub>	0.5	—	μs
Data Hold Time	t <sub>DH</sub>	1.0	—	μs
Chip Deselect to Output Float Delay	t <sub>DF</sub>	0	120	ns
Program to Read Delay	t <sub>DPR</sub>	—	10	μs
Program Pulse Width	t <sub>PW</sub>	0.1	1.0	ms
Program Pulse Rise Time	t <sub>PR</sub>	0.5	2.0	μs
Program Pulse Fall Time	t <sub>PF</sub>	0.5	2.0	μs

PROGRAMMING OPERATION TIMING DIAGRAM



**Note 6:** The CS/WE transition must occur after the Program Pulse transition and before the Address Transition.

## MCM68708•MCM68A708

### PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for programming mode, the  $\overline{\text{CS}}/\text{WE}$  input (Pin 20) should be raised to +12 V. Programming data is entered in 8-bit words through the data output terminals (D0 to D7).

Logic levels for the data lines and addresses and the supply voltages ( $V_{CC}$ ,  $V_{DD}$ ,  $V_{BG}$ ) are the same as for the READ operation.

After address and data setup one program pulse per address is applied to the program input (Pin 18). A program loop is a full pass through all addresses. Total programming time,  $T_{Ptotal} = N \times t_{PW} \geq 100$  ms. The required number of program loops (N) is a function of the program pulse width ( $t_{PW}$ ), where:  $0.1 \text{ ms} \leq t_{PW} \leq 1.0 \text{ ms}$ ; correspondingly N is:  $100 \leq N \leq 1000$ . There must be N successive loops through all 1024 addresses. It is not permitted to apply more than one program pulse in succession to the same address (i.e., N program pulses to an address and then change to the next address to be programmed). At the end of a program sequence the  $\overline{\text{CS}}/\text{WE}$  falling edge transition must occur before the first address transition, when changing from a PROGRAM to a READ cycle. The program pin (Pin 18) should be pulled down to  $V_{ILP}$  with an active device, because this pin sources a small amount of current ( $I_{ILP}$ ) when  $\overline{\text{CS}}/\text{WE}$  is at  $V_{IHW}$  (12 V) and the program pulse is at  $V_{ILP}$ .

#### EXAMPLES FOR PROGRAMMING

Always use the  $T_{Ptotal} = N \times t_{PW} \geq 100$  ms relationship.

1. All 8092 bits should be programmed with a 0.2 ms program pulse width.

The minimum number of program loops:

$$N = \frac{T_{Ptotal}}{t_{PW}} = \frac{100 \text{ ms}}{0.2 \text{ ms}} = 500. \text{ One program loop}$$

consists of words 0 to 1023.

2. Words 0 to 200 and 300 to 700 are to be programmed. All other bits are "don't care". The program pulse width is 0.5 ms. The minimum number of program loops,  $N = \frac{100}{0.5} = 200$ . One program loop consists of words 0 to 1023. The data entered into the "don't care" bits should be all 1s.

3. Same requirements as example 2, but the EPROM is now to be updated to include data for words 850 to 880. The minimum number of program loops is the same as in the previous example,  $N = 200$ . One program loop consists of words 0 to 1023. The data entered into the "don't care" bits should be all 1s. Addresses 0 to 200 and 300 to 700 must be re-programmed with their original data pattern.

### ERASING INSTRUCTIONS

The MCM68708/68A708 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 Å. The recommended integrated dose (i.e., UV-intensity  $\times$  exposure time) is 12.5 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 30 minutes. The lamps should be used without shortwave filters and the MCM68708/68A708 should be positioned about one inch away from the UV-tubes.



**MOTOROLA**

# MCM68732 MCM68L732

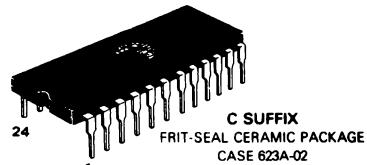
## 4096 × 8-BIT UV ERASABLE PROM

The MCM68732/68L732 is a 32,768-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically, or for replacing 32K ROMs for fast turnaround time. The transparent window on the package allows the memory content to be erased with ultraviolet light.

For ease of use, the device operates from a single power supply and has a static power-down mode. Pin-for-pin compatible mask programmable ROMs are available for large volume production runs of systems initially using the MCM68732/68L732.

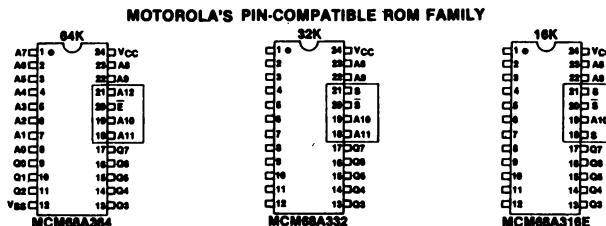
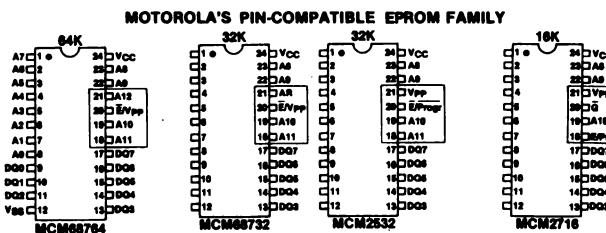
- Single +5 V Power Supply
- Automatic Power-down Mode (Standby) with Chip Enable
- Organized as 4096 Bytes of 8 Bits
- Low Power Dissipation
- Fully TTL Compatible
- Maximum Access Time = 450 ns MCM68732  
350 ns MCM68732-35
- Standard 24-Pin DIP for EPROM Upgradability
- Pin Compatible to MCM68A332 Mask Programmable ROM
- AR Selects the Operational 32K Portion of the Die  
MCM68732-1 AR=1=HIGH  
MCM68732-0 AR=0=LOW
- Pin Compatible With the MCM2532 32K EPROM in the Read Mode
- Low Power Version  
MCM68L732 Active 60 mA Maximum  
Standby 15 mA Maximum  
MCM68L732-35 Active 100 mA Maximum  
Standby 25 mA Maximum

**MOS**  
(N-CHANNEL, SILICON-GATE)  
**4096 × 8-BIT**  
**UV ERASABLE PROGRAMMABLE**  
**READ ONLY MEMORY**



L SUFFIX SIDE BRAZE CERAMIC PACKAGE  
ALSO AVAILABLE — CASE 718

PIN ASSIGNMENT	
A7	1 ●
A6	2
A5	3
A4	4
A3	5
A2	6
A1	7
A0	8
DQ0	9
DQ1	10
DQ2	11
VSS	12
	24 VCC
	23 A8
	22 A9
	21 AR
	20 E/VPP
	19 A10
	18 A11
	17 DQ7
	16 DQ6
	15 DQ5
	14 DQ4
	13 DQ3



INDUSTRY STANDARD PINOUTS

*Pin Names
A . . . Address
AR . . . Address Reference
DQ . . . Data Input/Output
E/VPP . . . Chip Enable/Program

\*New industry standard nomenclature

# MCM68732•MCM68L732

## ABSOLUTE MAXIMUM RATINGS (1)

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Operating Temperature Range	0 to +70	°C
Storage Temperature	-65 to +125	°C
All Input or Output Voltages with Respect to V <sub>SS</sub>	+6 to -0.3	Vdc
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+28 to -0.3	Vdc

This device contains 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 this high-impedance circuit.

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.

## MODE SELECTION

Mode	Pin Number			
	9-11, 13-17, DQ	12 V <sub>SS</sub>	20 E/V <sub>PP</sub>	24 V <sub>CC</sub>
Read	Data out	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Output Disable	High Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Standby	High Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Program	Data in	V <sub>SS</sub>	Pulsed V <sub>ILP</sub> to V <sub>IHP</sub>	V <sub>CC</sub>

## BLOCK DIAGRAM

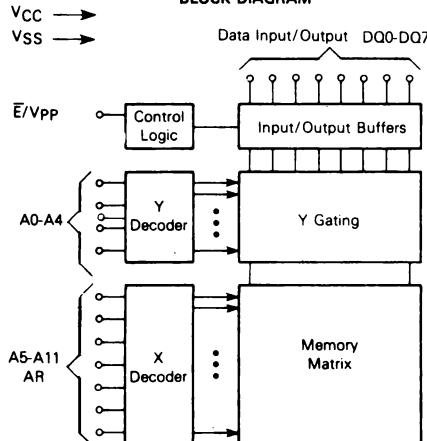
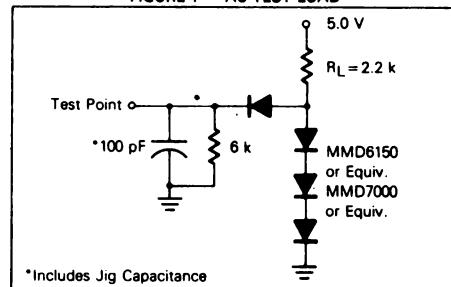


FIGURE 1 – AC TEST LOAD



CAPACITANCE ( $f = 1.0$  MHz,  $T_A = 25^\circ\text{C}$ , periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance ( $V_{IN} = 0$ V) Except E/V <sub>PP</sub>	$C_{in}$	4.0	6.0	pF
Input Capacitance E/V <sub>PP</sub>	$C_{in}$	60	100	pF
Output Capacitance ( $V_{OUT} = 0$ V)	$C_{out}$	8.0	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = I\Delta t / \Delta V$

# MCM68732•MCM68L732

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75 4.5	5.0 5.0	5.25 5.5	V
Input High Voltage	V <sub>IH</sub>	2.0	—	V <sub>CC</sub> + 1.0	V
Input Low Voltage	V <sub>IL</sub>	-0.1	—	0.8	V

### RECOMMENDED DC OPERATING CHARACTERISTICS

Characteristic	Condition	Symbol	MCM68732			MCM68L732			Units
			Min	Typ	Max	Min	Typ	Max	
Address Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>in</sub>	—	—	10	—	—	10	μA
Output Leakage Current	V <sub>out</sub> = 5.25 V	I <sub>LO</sub>	—	—	10	—	—	10	μA
Ē/V <sub>PP</sub> Input Sink Current	Ē/V <sub>PP</sub> = 0.4	I <sub>EL</sub>	—	—	100	—	—	100	μA
	Ē/V <sub>PP</sub> = 2.4	I <sub>EH</sub> = I <sub>PL</sub>	—	—	400	—	—	400	μA
V <sub>CC</sub> Supply Current (Standby) MCM68732	Ē/V <sub>PP</sub> = V <sub>IH</sub>	I <sub>CC1</sub>	—	—	25	—	—	15	mA
V <sub>CC</sub> Supply Current (Standby) MCM68732-35	Ē/V <sub>PP</sub> = V <sub>IH</sub>	I <sub>CC1</sub>	—	—	25	—	—	25	mA
V <sub>CC</sub> Supply Current (Active) MCM68732 (Outputs Open)	Ē/V <sub>PP</sub> = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	120	—	—	60	mA
V <sub>CC</sub> Supply Current (Active) MCM68732-35 (Outputs Open)	Ē/V <sub>PP</sub> = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	160	—	—	100	mA
Output Low Voltage	I <sub>OL</sub> = 2.1 mA	V <sub>OL</sub>	—	—	0.45	—	—	0.45	V
Output High Voltage	I <sub>OH</sub> = -400 μA	V <sub>OH</sub>	2.4	—	—	2.4	—	—	V

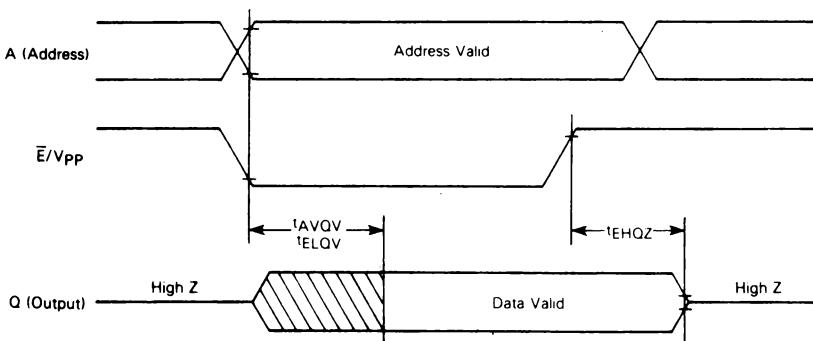
## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

- Input Pulse Levels ..... 0.8 Volt and 2.2 Volts      Output Timing Levels ..... 0.8 Volt and 2 Volts  
 Input Rise and Fall Times ..... 20 ns      Output Load ..... See Figure 1  
 Input Timing Levels ..... 1.0 Volt and 2 Volts

Characteristic	Condition	Symbol	MCM68732-35		MCM68732		Units
			Min	Max	Min	Max	
Address Valid to Output Valid	Ē = V <sub>IL</sub>	t <sub>AVQV</sub>	—	350	—	450	ns
Ē to Output Valid	—	t <sub>ELQV</sub>	—	350	—	450	ns
Ē to Hi-Z Output	—	t <sub>EHQZ</sub>	0	100	0	100	ns
Data Hold from Address	Ē = V <sub>IL</sub>	t <sub>AXDX</sub>	0	—	0	—	ns

### READ MODE TIMING DIAGRAM



# MCM68732•MCM68L732

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS ( $T_A = 25 \pm 5^\circ C$ )

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	V
Input High Voltage for All Addresses and Data	$V_{IH}$	2.2	—	$V_{CC} + 1$	V
Input Low Voltage for All Addresses and Data	$V_{IL}$	-0.1	—	0.8	V
Program Pulse Input High Voltage	$V_{IHP}$	24	25	26	V
Program Pulse Input Low Voltage	$V_{ILP}$	2.0	$V_{CC}$	6.0	V

### PROGRAMMING OPERATION DC CHARACTERISTICS

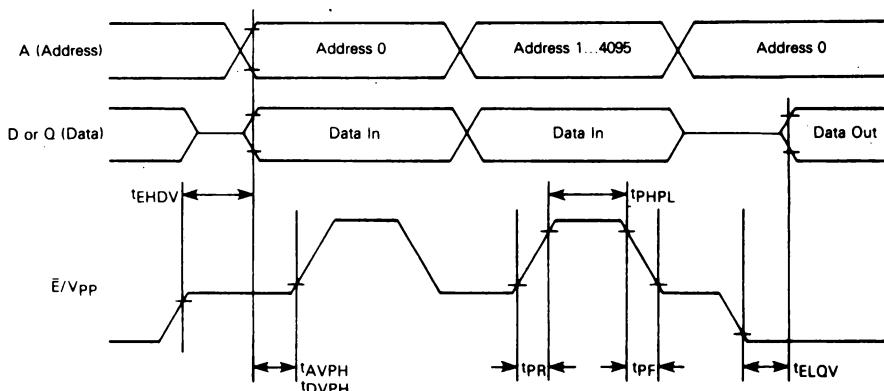
Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	$V_{in} = 5.25 V$	$I_{LI}$	—	—	10	$\mu A$
$V_{PP}$ Program Pulse Supply Current ( $V_{PP} = 25 V \pm 1 V$ )	—	$I_{PH}$	—	—	30	mA
$V_{PP}$ Supply Current ( $V_{PP} = 2.4 V$ )	—	$I_{PL} = I_{EH}$	—	—	400	$\mu A$
$V_{CC}$ Supply Current ( $V_{PP} = 5.0 V$ )	—	$I_{CC}$	—	—	160	mA

### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	$t_{AVPH}$	2.0	—	$\mu s$
Data Setup Time	$t_{DVPH}$	2.0	—	$\mu s$
Chip Enable to Valid Data	$t_{ELOV}$	450	—	ns
Chip Disable to Data In	$t_{EHDV}$	2.0	—	$\mu s$
Program Pulse Width	$t_{PHPL}$	1.9	2.1	ms
Program Pulse Rise Time	$t_{PR}$	0.5	2.0	$\mu s$
Program Pulse Fall Time	$t_{PF}$	0.5	2.0	$\mu s$
Cumulative Programming Time Per Word*	$t_{CP}$	12	50	ms

\*Block mode programming must be used. Block mode programming is defined as one program pulse applied to each of the 4096 address locations in sequence. Multiple blocks are used to accumulate programming time ( $t_{CP}$ ).

### PROGRAMMING OPERATION TIMING DIAGRAM



**MCM68732•MCM68L732**

## **PROGRAMMING INSTRUCTIONS**

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for Program Mode, the  $\bar{E}/V_{PP}$  input (Pin 20) should be between +2.0 and +6.0 V, which will three-state the outputs and allow data to be setup on the DQ terminals. The  $V_{CC}$  voltage is the same as for the Read operation. Only "0's" will be programmed when "0's" and "1's" are entered in the 8-bit data word.

After address and data setup, 25-volt programming pulse ( $V_{IH}$  to  $V_{IHP}$ ) is applied to the E/Vpp input. A program pulse is applied to each address location to be programmed. The maximum program pulse width is 2 ms and the maximum program pulse amplitude is 26 V.

Multiple MCM68732s may be programmed in parallel by connecting like inputs and applying the program pulse to the E/V<sub>PP</sub> inputs. Different data may be programmed into multiple MCM68732s connected in parallel by selectively applying the programming pulse only to the MCM68732s to be programmed.

## TIMING PARAMETER ABBREVIATIONS

signal name from which interval is defined      t  
 transition direction for first signal      X  
 signal name to which interval is defined      X  
 transition direction for second signal      X

The transition definitions used in this data sheet are:

H = transition to high

L = transition to low

V = transition to valid

X = transition to invalid or don't care

Z = transition to off (high impedance)

## **READ OPERATION**

After access time, data is valid at the outputs in the Read mode. A single input ( $\bar{E}/V_{PP}$ ) enables the outputs and puts the chip in active or standby mode. With  $\bar{E}/V_{PP} = 0$ " the outputs are enabled and the chip is in active mode; with  $\bar{E}/V_{PP} = 1$ " the outputs are three-stated and the chip is in standby mode. During standby mode, the power dissipation is reduced.

Multiple MCM68732s may share a common data bus with like outputs OR-tied together. In this configuration the E/VPP input should be high on all unselected MCM68732s to prevent data contention.

ERASING INSTRUCTIONS

The MCM68732 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 angstroms. The recommended integrated dose (i.e., UV-intensity X exposure time) is 15 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 36 minutes. The lamps should be used without shortwave filters and the MCM68732 should be positioned about one inch away from the UV-tubes.

## **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.

## WAVEFORMS

<u>Waveform Symbol</u>	<u>Input</u>	<u>Output</u>
—	Must Be Valid	Will Be Valid
—		
	Change From H to L	*Will Change From H to L
	Change From L to H	Will Change From L to H
	Don't Care: Any Change Permitted	Changing State Unknown
		High Impedance



**MOTOROLA**

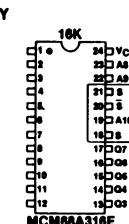
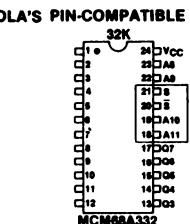
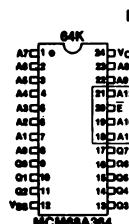
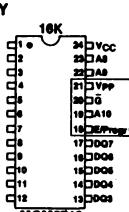
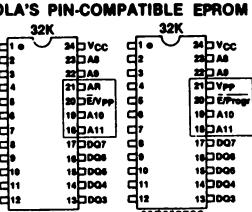
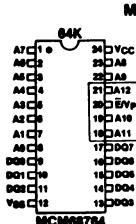
# MCM68764 MCM68L764

## 8192 × 8-BIT UV ERASABLE PROM

The MCM68764/68L764 is a 65,536-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically, or for replacing 64K ROMs for fast turnaround time. The transparent window on the package allows the memory content to be erased with ultraviolet light.

For ease of use, the device operates from a single power supply and has a static power-down mode. Pin-for-pin mask programmable ROMs are available for large volume production runs of systems initially using the MCM68764/68L764.

- Single +5 V Power Supply
- Automatic Power-down Mode (Standby) with Chip Enable
- Organized as 8192 Bytes of 8 Bits
- Low Power Dissipation
- Fully TTL Compatible
- Maximum Access Time = 450 ns MCM68764  
350 ns MCM68764-35
- Standard 24-Pin DIP for EPROM Upgradability
- Pin Compatible to MCM68A364 Mask Programmable ROM
- Low Power Version  
MCM68L764 Active 60 mA Maximum  
Standby 15 mA Maximum  
MCM68L764-35 Active 100 mA Maximum  
Standby 25 mA Maximum



## INDUSTRY STANDARD PINOUTS

### PIN ASSIGNMENT

A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	A12
A3	5	20	E/VPP
A2	6	19	A10
A1	7	18	A11
A0	8	17	DQ7
DQ0	9	16	DQ6
DQ1	10	15	DQ5
DQ2	11	14	DQ4
VSS	12	13	DQ3

### \*Pin Names

A	Address
DO	Data Input/Output
E/VPP	Chip Enable/Program

\*New industry standard nomenclature

# MCM68764•MCM68L764

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Value	Unit
Temperature Under Bias	- 10 to + 80	°C
Operating Temperature Range	0 to + 70	°C
Storage Temperature	- 65 to + 125	°C
All Input or Output Voltages with Respect to V <sub>SS</sub>	+ 6 to - 0.3	Vdc
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+ 28 to - 0.3	Vdc

This device contains 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 this high-impedance circuit.

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.

## MODE SELECTION

Mode	Pin Number			
	9-11, 13-17, DQ	12 V <sub>SS</sub>	20 E/V <sub>PP</sub>	24 V <sub>CC</sub>
Read	Data out	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Output Disable	High-Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Standby	High-Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Program	Data in	V <sub>SS</sub>	Pulsed V <sub>ILP</sub> to V <sub>IHP</sub>	V <sub>CC</sub>

BLOCK DIAGRAM

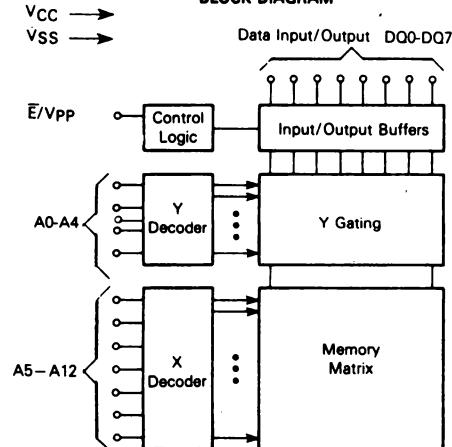
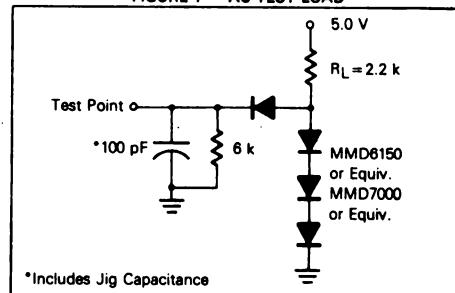


FIGURE 1 — AC TEST LOAD



# MCM68764•MCM68L764

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage MCM68L764/MCM68764 MCM68764-35/MCM68L764-35	V <sub>CC</sub>	4.75 4.5	5.0 5.0	5.25 5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	V <sub>CC</sub> + 1.0	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.1	—	0.8	Vdc

### RECOMMENDED DC OPERATING CHARACTERISTICS

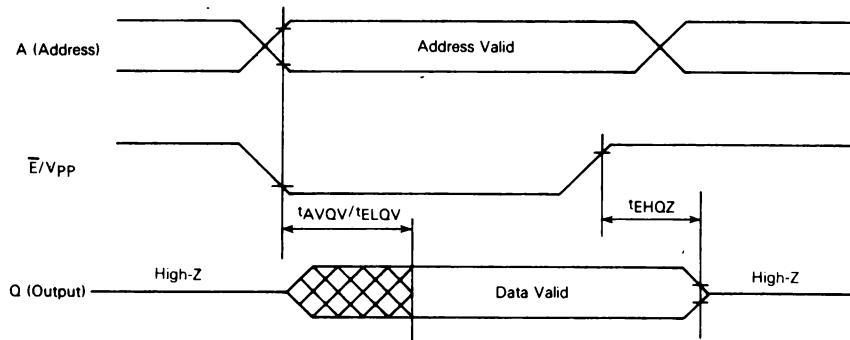
Characteristic	Condition	Symbol	MCM68764			MCM68L764			Units
			Min	Typ	Max	Min	Typ	Max	
Address Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>in</sub>	—	—	10	—	—	10	μA
Output Leakage Current	V <sub>out</sub> = 5.25 V	I <sub>LO</sub>	—	—	10	—	—	10	μA
E/V <sub>PP</sub> Input Sink Current	E/V <sub>PP</sub> = 0.4	I <sub>EL</sub>	—	—	100	—	—	100	μA
E/V <sub>PP</sub> Input Sink Current	E/V <sub>PP</sub> = 2.4	I <sub>EH</sub> = I <sub>PL</sub>	—	—	400	—	—	400	μA
V <sub>CC</sub> Supply Current (Standby) MCM68764	E/V <sub>PP</sub> = V <sub>IH</sub>	I <sub>CC1</sub>	—	—	25	—	—	15	mA
V <sub>CC</sub> Supply Current (Standby) MCM68764-35	E/V <sub>PP</sub> = V <sub>IH</sub>	I <sub>CC1</sub>	—	—	25	—	—	25	mA
V <sub>CC</sub> Supply Current (Active) MCM68764 (Outputs Open)	E/V <sub>PP</sub> = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	120	—	—	60	mA
V <sub>CC</sub> Supply Current (Active) MCM68764-35 (Outputs Open)	E/V <sub>PP</sub> = V <sub>IL</sub>	I <sub>CC2</sub>	—	—	160	—	—	100	mA
Output Low Voltage	I <sub>OL</sub> = 2.1 mA	V <sub>OL</sub>	—	—	0.45	—	—	0.45	V
Output High Voltage	I <sub>OH</sub> = -400 μA	V <sub>OH</sub>	2.4	—	—	2.4	—	—	V

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V) Except E/V <sub>PP</sub>	C <sub>in</sub>	4.0	6.0	pF
Input Capacitance E/V <sub>PP</sub>	C <sub>in</sub>	60	100	pF
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	8.0	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: C =  $\frac{I\Delta t}{\Delta V}$ .

### READ MODE TIMING DIAGRAM



# MCM68764•MCM68L764

## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

Input Pulse Levels .....	0.8 Volt and 2.2 Volts	Output Timing Levels .....	0.8 Volt and 2 Volts
Input Rise and Fall Times .....	20 ns	Output Load .....	See Figure 1
Input Timing Levels .....	1.0 and 2 Volts		

Characteristic	Condition	Symbol	MCM68764-35		MCM68764		Units
			Min	Max	Min	Max	
Address Valid to Output Valid	$\bar{E} = V_{IL}$	$t_{AVQV}$	—	350	—	450	ns
$\bar{E}$ to Output Valid	—	$t_{ELQV}$	—	350	—	450	ns
$\bar{E}$ to Hi-Z Output	—	$t_{EHQZ}$	0	100	0	100	ns
Data Hold from Address	$E = V_{IL}$	$t_{AXDX}$	0	—	0	—	ns

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS

$T_A = 25 \pm 5^\circ C$

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	V
Input High Voltage for All Addresses and Data	$V_{IH}$	2.2	—	$V_{CC} + 1$	V
Input Low Voltage for All Addresses and Data	$V_{IL}$	-0.1	—	0.8	V
Program Pulse Input High Voltage	$V_{IHP}$	24	25	26	V
Program Pulse Input Low Voltage	$V_{ILP}$	2.0	$V_{CC}$	6.0	V

### PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	$V_{in} = 5.25$ V	$I_{LI}$	—	—	10	$\mu A$
$V_{PP}$ Program Pulse Supply Current ( $V_{PP} = 25$ V $\pm 1$ V)	—	$I_{PH}$	—	—	30	mA
$V_{PP}$ Supply Current ( $V_{PP} = 2.4$ V)	—	$I_{PL} = I_{EH}$	—	—	400	$\mu A$
$V_{CC}$ Supply Current ( $V_{PP} = 6.0$ V)	—	$I_{CC}$	—	—	160	mA

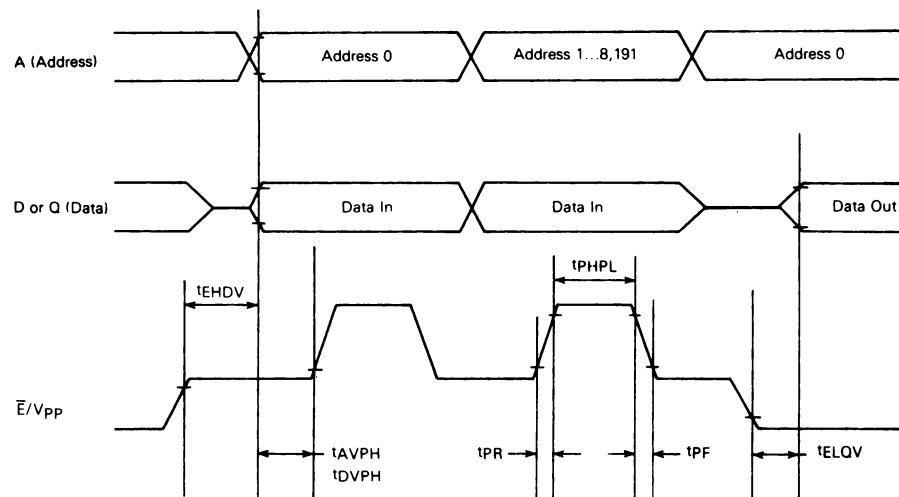
### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	$t_{AVPH}$	2.0	—	$\mu s$
Data Setup Time	$t_{DVPH}$	2.0	—	$\mu s$
Chip Enable to Valid Data	$t_{ELQV}$	450	—	ns
Chip Disable to Data In	$t_{EHDV}$	2.0	—	$\mu s$
Program Pulse Width	$t_{PHPL}$	1.9	2.1	ms
Program Pulse Rise Time	$t_{PR}$	0.5	2.0	$\mu s$
Program Pulse Fall Time	$t_{PF}$	0.5	2.0	$\mu s$
Cumulative Programming Time Per Word*	$t_{CP}$	12	50	ms

\*Block mode programming must be used. Block mode programming is defined as one program pulse applied to each of the 8,192 address locations in sequence. Multiple blocks are used to accumulate programming time ( $t_{CP}$ ).

# MCM68764•MCM68L764

PROGRAMMING OPERATION TIMING DIAGRAM



## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for Program Mode, the  $\bar{E}/V_{PP}$  input (Pin 20) should be between +2.0 and +6.0 V, which will three-state the outputs and allow data to be setup on the DQ terminals. The  $V_{CC}$  voltage is the same as for the Read operation. Only "0's" will be programmed when "0's" and "1's" are entered in the 8-bit data word.

After address and data setup, 25-volt programming pulse ( $V_{IH}$  to  $V_{HPL}$ ) is applied to the  $\bar{E}/V_{PP}$  input. The program pulse width is 2 ms and the maximum program pulse amplitude is 26 V.

Multiple MCM68764s may be programmed in parallel by connecting like inputs and applying the program pulse to the  $\bar{E}/V_{PP}$  inputs. Different data may be programmed into multiple MCM68764s connected in parallel by selectively applying the programming pulse only to the MCM68764s to be programmed.

## READ OPERATION

After access time, data is valid at the outputs in the Read mode. A single input ( $\bar{E}/V_{PP}$ ) enables the outputs and puts the chip in active or standby mode. With  $\bar{E}/V_{PP} = 0$  the outputs are enabled and the chip is in active mode; with  $\bar{E}/V_{PP} = 1$  the outputs are three-stated and the chip is in standby mode. During standby mode, the power dissipation is reduced.

Multiple MCM68764s may share a common data bus with like outputs OR-tied together. In this configuration, only one  $\bar{E}/V_{PP}$  input should be low and no other device outputs should be active on the same bus. This will prevent data contention on the bus.

## ERASING INSTRUCTIONS

The MCM68764 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 angstroms. The recommended integrated dose (i.e., UV-intensity X exposure time) is 15 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 36 minutes. The lamps should be used without shortwave filters and the MCM68764 should be positioned about one inch away from the UV-tubes.



**MOTOROLA**

# MCM68766

## Advance Information

### 8192×8-BIT UV ERASABLE PROM

The MC68766 is a 65,536-bit Erasable and Electrically Reprogrammable PROM designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically, or for replacing 64K ROMs for fast turnaround time. The transparent window on the package allows the memory content to be erased with ultraviolet light.

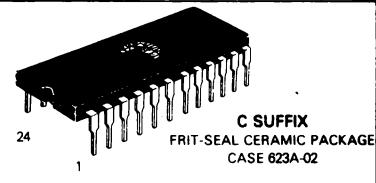
For ease of use, the device operates from a single power supply that has an output enable control and is pin-for-pin compatible with the MCM68366 mask programmable ROMs, which are available for large volume production runs of systems initially using the MC68766.

- Single +5 V Power Supply
- Organized as 8192 Bytes of 8 Bits
- Fully TTL Compatible
- Maximum Access Time = 450 ns MCM68766  
350 ns MCM68766-35
- Standard 24-Pin DIP for EPROM Upgradability
- Pin Compatible to MCM68366 Mask Programmable ROM
- Power Dissipation – 160 mA Maximum

## MOS

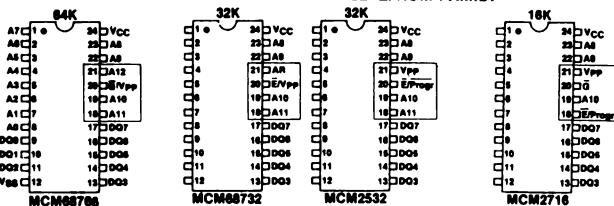
(N-CHANNEL, SILICON-GATE)

### 8192×8-BIT UV ERASABLE PROGRAMMABLE READ ONLY MEMORY



L SUFFIX CERAMIC PACKAGE  
ALSO AVAILABLE – CASE 716-07

### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



# MCM68766

## ABSOLUTE MAXIMUM RATINGS

Rating	Value	Unit
Temperature Under Bias	-10 to +80	°C
Operating Temperature Range	0 to +70	°C
Storage Temperature	-65 to +125	°C
All Input or Output Voltages with Respect to V <sub>SS</sub>	+6 to -0.3	Vdc
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+28 to -0.3	Vdc

This device contains 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 this high-impedance circuit.

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.

## MODE SELECTION

Mode	Pin Number			
	9-11, 13-17, DQ	12 V <sub>SS</sub>	20 G/V <sub>PP</sub>	24 V <sub>CC</sub>
Read	Data Out	V <sub>SS</sub>	V <sub>IIL</sub>	V <sub>CC</sub>
Output Disable	High-Z	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Program	Data In	V <sub>SS</sub>	Pulsed V <sub>ILP</sub> to V <sub>IHP</sub>	V <sub>CC</sub>

## BLOCK DIAGRAM

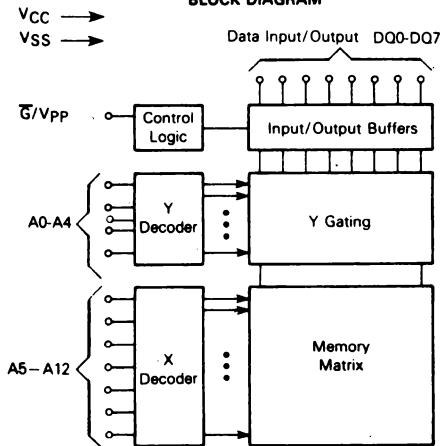
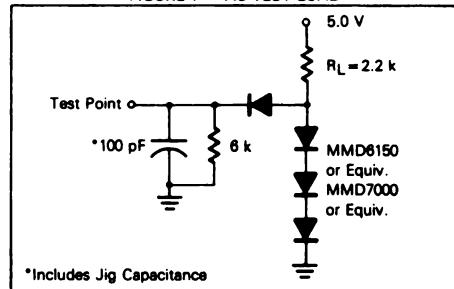


FIGURE 1 – AC TEST LOAD



\*Includes Jig Capacitance

# MCM68766

**CAPACITANCE** ( $f = 1.0$  MHz,  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5$  V periodically sampled rather than 100% tested)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance ( $V_{in} = 0$ V) Except $\bar{G}/V_{PP}$	$C_{in}$	4.0	6.0	pF
Input Capacitance ( $\bar{G}/V_{PP}$ )	$C_{in}$	60	100	pF
Output Capacitance ( $V_{out} = 0$ V)	$C_{out}$	8.0	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation:  $C = I\Delta t/\Delta V$ .

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	Vdc
		4.5	5.0	5.5	
Input High Voltage	$V_{IH}$	2.0	—	$V_{CC} + 1.0$	Vdc
Input Low Voltage	$V_{IL}$	-0.1	—	0.8	Vdc

### DC OPERATING CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Units
Address Input Sink Current	$V_{in} = 5.25$ V	$I_{in}$	—	—	10	$\mu\text{A}$
Output Leakage Current	$V_{out} = 5.25$ V	$I_{LO}$	—	—	10	$\mu\text{A}$
$\bar{G}/V_{PP}$ Input Sink Current	$\bar{G}/V_{PP} = 0.4$ V	$I_{GL}$	—	—	100	$\mu\text{A}$
	$\bar{G}/V_{PP} = 2.4$ V	$I_{GH} = I_{PL}$	—	—	400	$\mu\text{A}$
$V_{CC}$ Supply Current (Outputs Open)	$\bar{G}/V_{PP} = V_{IL}$	$I_{CC}$	—	—	160	mA
Output Low Voltage	$I_{OL} = 2.1$ mA	$V_{OL}$	—	—	0.45	V
Output High Voltage	$I_{OH} = -400$ $\mu\text{A}$	$V_{OH}$	2.4	—	—	V

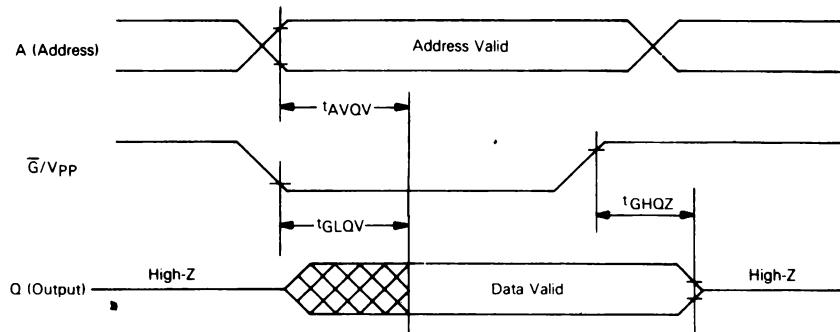
## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

Input Pulse Levels.....	0.8 Volt and 2.2 Volts	Input Timing Levels.....	1.0 Volt and 2 Volts
Input Rise and Fall Times.....	20 ns	Output Timing Levels.....	0.8 Volt and 2 Volts
		Output Load.....	See Figure 1

Characteristic	Condition	Symbol	MCM68766-35		MCM68766		Units
			Min	Max	Min	Max	
Address Valid to Output Valid	$\bar{G} = V_{IL}$	$t_{AVQV}$	—	350	—	450	ns
$\bar{G}$ to Output Valid	—	$t_{GLQV}$	—	150	—	150	ns
$\bar{G}$ to Hi-Z Output	—	$t_{GHQZ}$	0	100	0	100	ns
Data Hold from Address	$\bar{G} = V_{IL}$	$t_{AXDX}$	0	—	0	—	ns

### READ MODE TIMING DIAGRAM



# MCM68766

## DC PROGRAMMING CONDITIONS AND CHARACTERISTICS (TA = 25 ± 5°C)

### RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.75	5.0	5.25	Vdc
Input High Voltage for All Addresses and Data	V <sub>IH</sub>	2.2	—	V <sub>CC</sub> + 1	Vdc
Input Low Voltage for All Addresses and Data	V <sub>IL</sub>	-0.1	—	0.8	Vdc
Program Pulse Input High Voltage	V <sub>IHP</sub>	24	25	26	Vdc
Program Pulse Input Low Voltage	V <sub>ILP</sub>	2.0	V <sub>CC</sub>	6.0	Vdc

### PROGRAMMING OPERATION DC CHARACTERISTICS

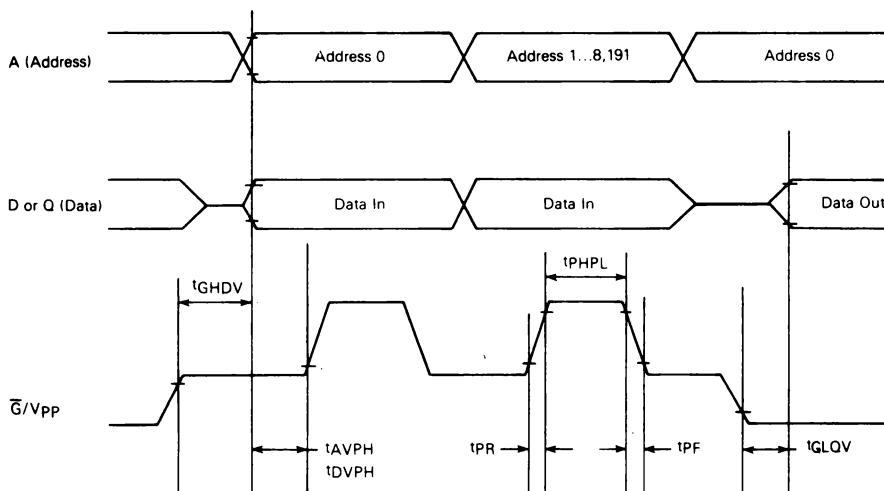
Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	V <sub>in</sub> = 5.25 V	I <sub>L1</sub>	—	—	10	μAdc
V <sub>PP</sub> Program Pulse Supply Current (V <sub>PP</sub> = 25 V ± 1 V)	—	I <sub>PH</sub>	—	—	30	mAdc
V <sub>PP</sub> Supply Current (V <sub>PP</sub> = 2.4 V)	—	I <sub>PL</sub> = I <sub>GH</sub>	—	—	400	μA
V <sub>CC</sub> Supply Current (V <sub>PP</sub> = 5 V)	—	I <sub>CC</sub>	—	—	160	mAdc

### AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	t <sub>AVPH</sub>	2.0	—	μs
Data Setup Time	t <sub>DVPH</sub>	2.0	—	μs
Output Enable to Valid Data	t <sub>GLQV</sub>	150	—	ns
Output Disable to Data In	t <sub>GHDV</sub>	2.0	—	μs
Program Pulse Width	t <sub>PHPL</sub>	1.9	2.1	ms
Program Pulse Rise Time	t <sub>PR</sub>	0.5	2.0	μs
Program Pulse Fall Time	t <sub>PF</sub>	0.5	2.0	μs
Cumulative Programming Time Per Word*	t <sub>CP</sub>	12	50	ms

\* Block mode programming must be used. Block mode programming is defined as one program pulse applied to each of the 8,192 address locations in sequence. Multiple blocks are used to accumulate programming time (t<sub>CP</sub>).

### PROGRAMMING OPERATION TIMING DIAGRAM



# MCM68766

## PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for Program Mode, the  $\bar{G}/V_{PP}$  input (Pin 20) should be between +2.0 and +6.0 V, which will three-state the outputs and allow data to be set up on the DQ terminals. The  $V_{CC}$  voltage is the same as for the Read operation. Only "0's" will be programmed when "0's" and "1's" are entered in the 8-bit data word.

After address and data setup, 25-volt programming pulse ( $V_{IH}$  to  $V_{HP}$ ) is applied to the  $G/V_{PP}$  input. The program pulse width is 2 ms and the maximum program pulse amplitude is 26 V.

Multiple MCM68766s may be programmed in parallel by connecting like inputs and applying the program pulse to the  $G/V_{PP}$  inputs. Different data may be programmed into multiple MCM68766s connected in parallel by selectively applying the programming pulse only to the MCM68766s to be programmed.

## READ OPERATION

After access time, data is valid at the outputs in the Read mode. With  $\bar{G}/V_{PP} = 0$  the outputs are enabled; with  $\bar{G}/V_{PP} = 1$  the outputs are three-stated.

Multiple MCM68766s may share a common data bus with like outputs OR-tied together. In this configuration only one  $\bar{G}/V_{PP}$  input should be low and no other device outputs should be active on the same bus. This will prevent data contention on the bus.

## ERASING INSTRUCTIONS

The MCM68766 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 angstroms. The recommended integrated dose (i.e., UV-intensity X exposure time) is 15 Ws/cm<sup>2</sup>. As an example, using the "Model 30-000" UV Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 36 minutes. The lamps should be used without shortwave filters and the MCM68766 should be positioned about one inch away from the UV-tubes.



MOTOROLA

## SEMICONDUCTORS

3501 ED BLUESTEIN BLVD AUSTIN, TEXAS 78721

## MCM2801

## Advance Information

## 16×16-BIT SERIAL ELECTRICALLY ERASABLE PROM

The MCM2801 is a 256-bit serial Electrically Erasable PROM designed for handling small amounts of data in applications requiring both non-volatile memory and in-system information updates.

The MCM2801 offers in-system erase and reprogram capability. It has external control of timing functions and serial format for data and address. The MCM2801 is fabricated in floating gate technology for high reliability and producibility.

- Single +5 V Power Supply
- Organized as 16 Words of 16 Bits
- MPU Bus Compatible
- Single +25 V Power Supply for Erase and Program
- In-System Program/Erase Capability
- Both Word and Whole Array Erasable

## BLOCK DIAGRAM

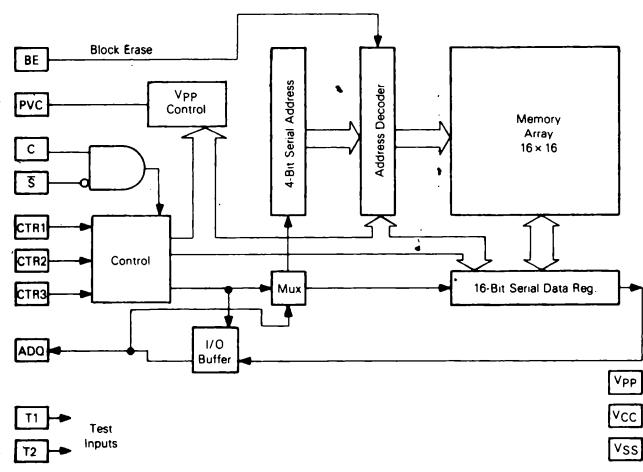
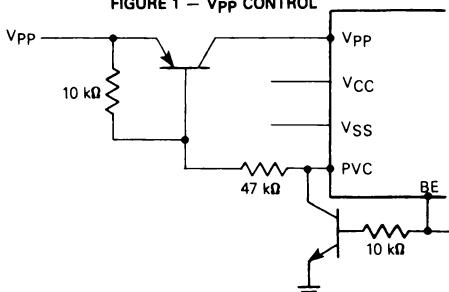


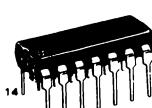
FIGURE 1 — VPP CONTROL



This is advance information and specifications are subject to change without notice.

## MOS

(N-CHANNEL, SILICON GATE)

16×16 BIT  
ELECTRICALLY ERASABLE  
PROGRAMMABLE READ  
ONLY MEMORYPLASTIC PACKAGE  
CASE 646-05

## PIN ASSIGNMENT

VPP	14	VCC
*T2	2	13 CTR1
N/C	3	12 CTR2
BE	4	11 CTR3
*T1	5	10 PVC
S	6	9 C
VSS	7	8 ADQ

\*For normal operation, these inputs should be hardwired to VSS.

## PIN NAMES

ADQ.....	Multiplexed Address/ Data-In/Data-Out
C.....	Clock
PVC.....	Program Voltage Control
CTR1, 2, 3.....	Control
BE.....	Block Erase
S.....	Chip Select
T1, T2.....	Test Pins

This device contains 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 this high-impedance circuit.

## MODE SELECTION

Mode	Pin Number						
	1 V <sub>PP</sub>	6 S	7 V <sub>SS</sub>	11 CTR3	12 CTR2	13 CTR1	14 V <sub>CC</sub>
Standby	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IH</sub>	V <sub>SS</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>IH</sub>	V <sub>CC</sub>
Word Erase	V <sub>PP</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Write	V <sub>PP</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Serial Data Out	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Serial Address In	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Serial Data In	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Read	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IL</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>
Standby	V <sub>SS</sub> or V <sub>CC</sub>	V <sub>IH</sub>	V <sub>SS</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>CC</sub>

## ABSOLUTE MAXIMUM RATINGS (1)

Rating	Value	Unit
Temperature Under Bias	-40 to +85	°C
Operating Temperature Range	0 to +70	°C
Storage Temperature	-55 to +150	°C
All Input or Output Voltages with Respect to V <sub>SS</sub> (Except PVC)	+8 to -0.5	V
V <sub>PP</sub> Supply Voltage with Respect to V <sub>SS</sub>	+28 to -0.5	V
PVC Voltage with Respect to V <sub>SS</sub>	+28 to -0.5	V

NOTE 1: 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.

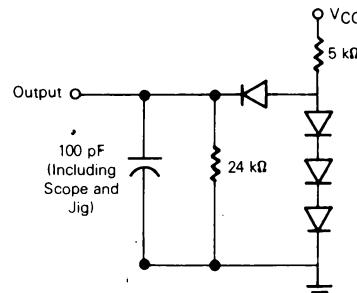
## RECOMMENDED DC OPERATING CONDITIONS(Full operating voltage and temperature range unless otherwise noted.)

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub> V <sub>PP</sub>	4.5 24.0	5.0 25	5.5 26.0	V
Input High Voltage	V <sub>IH</sub>	2.4	—	V <sub>CC</sub> + 1.0	V
Input Low Voltage	V <sub>IL</sub>	-0.1	—	0.8	V

## OPERATING DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Units
Input Sink Current	0 < V <sub>in</sub> < V <sub>CC</sub>	I <sub>in</sub>	—	—	10	μA
V <sub>CC</sub> Supply Current	V <sub>CC</sub> = 5.5 V	I <sub>CC</sub>	—	—	30	mA
V <sub>PP</sub> Supply Current	V <sub>PP</sub> = 26.0 V	I <sub>PP</sub>	—	—	4.0	mA
Output Low Voltage	I <sub>OL</sub> = 1.0 mA	V <sub>OL</sub>	—	—	0.5	V
Output High Voltage	I <sub>OH</sub> = -0.1 mA	V <sub>OH</sub>	2.4	—	—	V
PVC Current (Write or Word Erase)	PVCL = 1 V	PVC <sub>ON</sub>	200	—	—	μA
PVC Leakage	PVCH = 26 V	PVC <sub>OFF</sub>	—	—	5	μA

FIGURE 2 – OUTPUT LOAD



CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = +5 V,  
periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V)	C <sub>in</sub>	—	6.0	pF
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	—	12	pF

Capacitance measured with a Boonton Meter or effective capacitance calculated from the equation: C = ΔI<sub>f</sub>/ΔV.

Motorola reserves the right to make changes to any products herein to improve reliability, function or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.

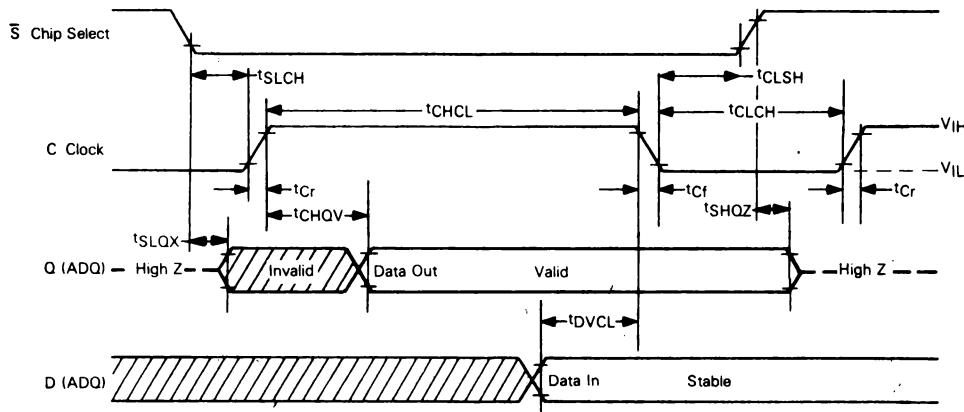
### AC OPERATING CONDITIONS AND CHARACTERISTICS

Input Pulse Levels.....	0.65 Volts and 2.6 Volts	Output Timing Levels.....	1.0 Volt and 2 Volts
Input Rise and Fall Times .....	20 ns	Output Load.....	See Figure 2
Input Timing Levels .....	1.0 Volt and 3.8 Volts		

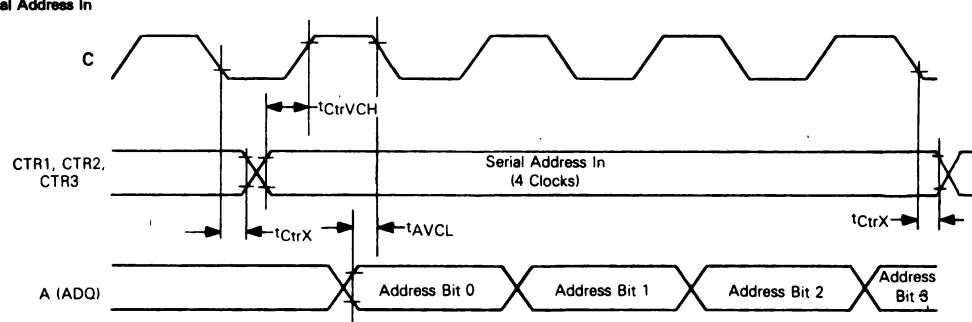
Characteristic	Symbol	Min	Max	Unit
Erase Time	$t_{ERASE}$	100	—	ms
Write Time	$t_{WRITE}$	10	—	ms
Clock High Level Hold Time	$t_{CHCL}$	4	10	$\mu s$
Clock Low Level Hold Time	$t_{CLCH}$	4	—	$\mu s$
Clock Rise Time	$t_{Cr}$	5	1000	ns
Clock Fall Time	$t_{Cf}$	5	1000	ns
Chip Select Setup	$t_{SLCH}$	1	—	$\mu s$
Chip Select Hold	$t_{CLSH}$	1	—	$\mu s$
Data Out Delay	$t_{CHQV}$	—	1	$\mu s$
Address In Setup	$t_{AVCL}$	1	—	$\mu s$
Data In Setup	$t_{DVCL}$	1	—	$\mu s$
Control Setup Time	$t_{CtrVCH}$	1	—	$\mu s$
Control Hold Time	$t_{CtrX}$	50	—	ns
Data-Off Time (from the Clock)	$t_{CHQZ}$	—	3.0	$\mu s$
Chip Select Low to Output Active Time	$t_{SLQX}$	—	2.0	$\mu s$
Data-Off Time (from Chip Select)	$t_{SHQZ}$	—	2.0	$\mu s$

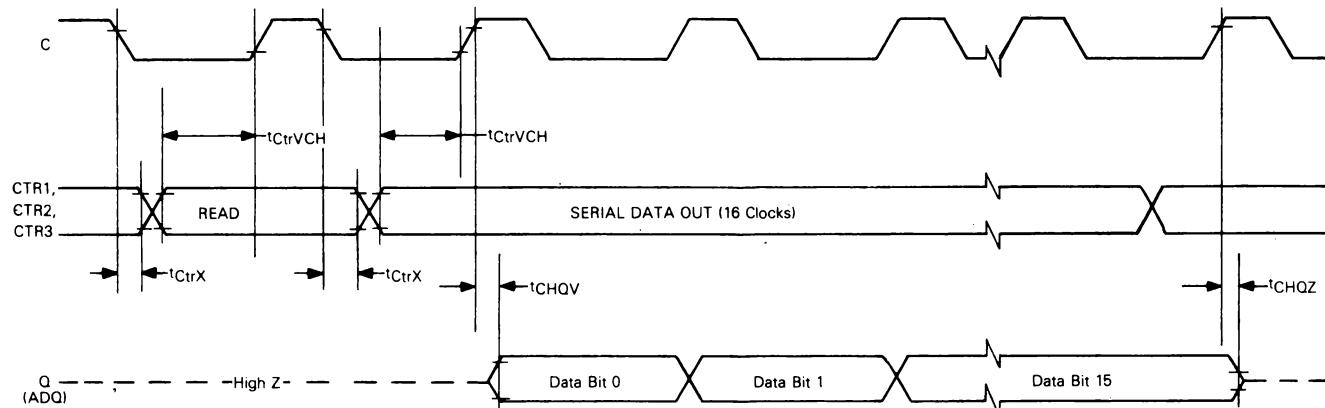
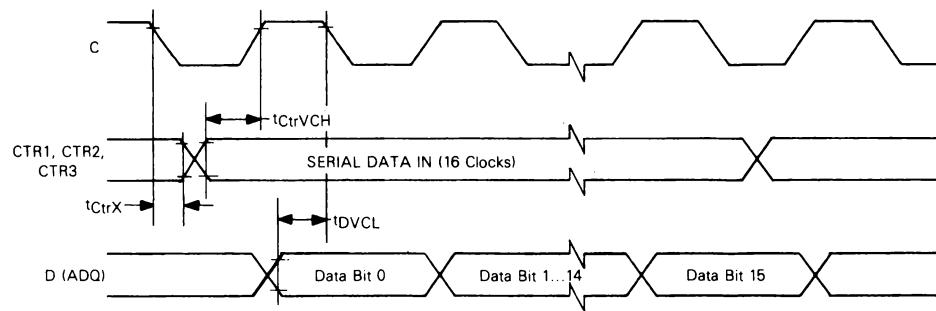
### TIMING DIAGRAMS

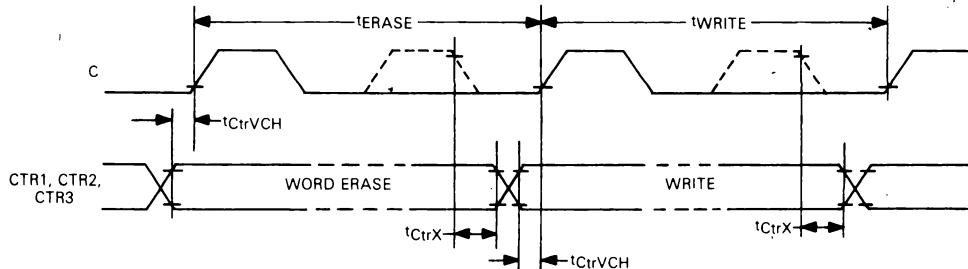
#### Clock Cycle Detail



#### Serial Address In



**READ AND SERIAL DATA OUT****SERIAL DATA IN**

**ERASE-WRITE SEQUENCE**

NOTE: One clock pulse is sufficient to load a new control code.

**FUNCTIONAL DESCRIPTION**

The memory stores sixteen words, each of sixteen bits. All functions are selected by a 3-bit parallel control code. The clock line is used to strobe these codes and to serially shift data and addresses.

**Read-Out**

1. The 4-bit serial address is shifted on the ADQ line while the SERIAL ADDRESS-IN code is applied on the three control pins.
2. The READ instruction is strobed with one clock pulse. This reads the word from the new address in the memory array and parallel loads it into the data register.
3. While the SERIAL DATA-OUT code is being applied, data is shifted out on the ADQ pin with 16 clock pulses. In this mode, the ADQ pin output buffer is active.

**Writing**

1. The address is changed, if necessary, in the same manner as in the readout.
2. While the SERIAL DATA-IN code is being applied, data is shifted in on the ADQ pin with 16 clock pulses. If the data to be written has already been shifted into the data register, it is not necessary to re-enter the 16 bits, so this step may be omitted.
3. The WORD ERASE code is strobed in with one clock pulse. After the specified ERASE time, the addressed word is erased.
4. The WRITE code is strobed in with one clock pulse. After the specified WRITE time, a STANDBY code can be strobed in to stop writing. Data will be programmed at the specified address.

It is also possible to change the sequence by erasing a memory location before starting a write sequence.

**Standby**

Either of the two STANDBY codes, when strobed in with a clock pulse, puts the memory in a quiescent state. The output is then in the high-impedance state and the absence or presence of the clock will not affect the device.

**Pin Description**

The active high clock signal (C) is used for shifting addresses and data into or out of the chip. It is also used for strobing control codes.

The I/O pin (ADQ) is used for entering addresses and data-in. It is in the output state only for shifting output data.

The active low Chip Select pin ( $\bar{S}$ ) is only used to block the clock and put the ADQ buffer into the high-impedance mode. It has no influence on the operating status of the device and does not force a standby condition.

The programming voltage control pin (PVC) is an open-drain output that is active when a WORD ERASE or WRITE control code is strobed in. As shown in Figure 1, it can be used to control the V<sub>PP</sub> supply applied to the circuit. The BLOCK ERASE (BE) pin can be used to clear the whole array. As the PVC output is not active in this state, the programming voltage should be directly applied to the V<sub>PP</sub> pin for the specified erase time.

The Test inputs (TEST1 and TEST2) are provided for testing purpose only and should be connected to V<sub>SS</sub> in any application.

**Data Protection**

When V<sub>PP</sub> is turned off, data stored in the array is protected. The programming voltage should not be applied to the V<sub>PP</sub> pin if V<sub>CC</sub> is not present. Therefore, use of the PVC control output, which is controlled by the V<sub>CC</sub> supply is recommended. Using this feature, V<sub>PP</sub> and V<sub>CC</sub> can be turned on or off in any sequence without disturbing data in the array. However, to avoid spurious control codes being strobed into the device, all inputs should be stable when V<sub>PP</sub> is on.

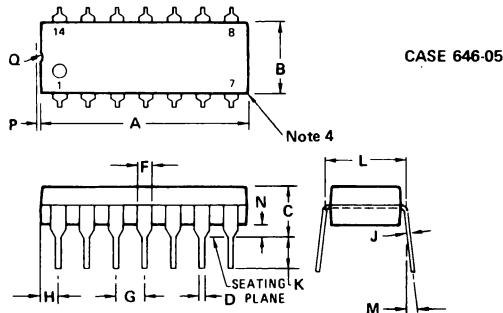
**General Comments**

The erased state corresponds to a logical zero at the ADQ output.

WRITE (for any address) must be preceded by an ERASE at the same address.

V<sub>PP</sub> is necessary for WRITE, WORD ERASE or BLOCK ERASE. In all other cases, it can be switched to high impedance, V<sub>CC</sub> or V<sub>SS</sub>.

## OUTLINE DIMENSIONS



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.16	19.56	0.715	0.770
B	6.10	6.60	0.240	0.260
C	4.06	5.08	0.160	0.200
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.32	2.41	0.052	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.51	1.02	0.020	0.040

## NOTES:

1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

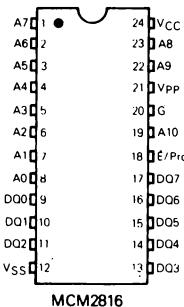
**MOTOROLA****MCM2816****Product Preview****2048×8-BIT ELECTRICALLY ERASABLE PROM**

The MCM2816 is a 16,384-bit Electrically Erasable Programmable Read Only Memory designed for handling data in applications requiring both nonvolatile memory and in-system reprogramming. The industry standard pinout in a 24-pin dual-in-line package makes the MCM2816 EEPROM compatible with the popular MCM2716 EPROM.

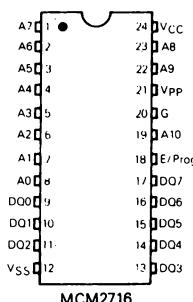
The MCM2816 saves time and money because of the in-system erase and reprogram capability. While V<sub>PP</sub> is at 25 V and G is at V<sub>IL</sub>, a 100 ms active high TTL erase pulse applied to the E/Progr pin allows the entire memory to be erased to the "1" state. In addition to in-system programmability, this new-generation PROM is programmable on the standard EEPROM programmer.

For ease of use, the device operates in the read mode from a single power supply and has a static power-down mode. The MCM2816 is fabricated in floating gate technology for high reliability and producibility.

- Single +5 V Power Supply
- Automatic Power-Down Mode (Standby)
- Single +25 V Power Supply for Erase and Program
- Organized as 2048 Bytes of 8 Bits
- TTL Compatible During Read and Program (No High Voltage Pulses)
- Maximum Access Time = 450 ns MCM2816  
350 ns MCM2816-35
- Pin Compatible to MCM68316E and MCM2716
- In-System Program/Erase Capability

**PINOUT COMPARISON 2816 AND 2716**

MCM2816



MCM2716

**MOS  
(IN-CHANNEL, SILICON GATE)****2048×8-BIT ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY****C SUFFIX  
FRIT-SEAL CERAMIC  
PACKAGE  
CASE 623-04****L SUFFIX CERAMIC PACKAGE  
ALSO AVAILABLE — CASE 718-07****PIN ASSIGNMENT**

A7	1	●	24	V <sub>CC</sub>
A6	2		23	A8
A5	3		22	A9
A4	4		21	V <sub>PP</sub>
A3	5		20	G
A2	6		19	A10
A1	7		18	E/Progr
A0	8		17	DQ7
DQ0	9		16	DQ6
DQ1	10		15	DQ5
DQ2	11		14	DQ4
VSS	12		13	DQ3

**\*Pin Names**

A.....	Address
DQ.....	Data Input/Output
E/Progr.....	Chip Enable/Program-Erase
G.....	Output Enable

**\*New industry standard nomenclature**

Motorola reserves the right to make changes to any product herein to improve reliability, functionality or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM6670  
MCM6674**

### 128c X 7 X 5 CHARACTER GENERATOR

The MCM6670 is a mask-programmable horizontal-scan (row select) character generator containing 128 characters in a 5 X 7 matrix. A 7-bit address code is used to select one of the 128 available characters, and a 3-bit row select code chooses the appropriate row to appear at the outputs. The rows are sequentially displayed, providing a 7-word sequence of 5 parallel bits per word for each character selected by the address inputs.

The MCM6674 is a preprogrammed version of the MCM6670. The complete pattern of this device is contained in this data sheet.

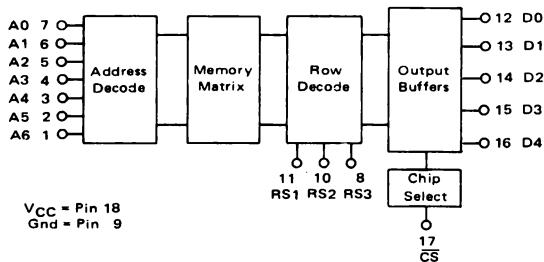
- Fully Static Operation
- TTL Compatibility
- Single  $\pm 10\%$  +5 Volt Power Supply
- 18-Pin Package
- Diagonal Corner Power Supply Pins
- Fast Access Time, 350 ns (max)

#### ABSOLUTE MAXIMUM RATINGS (See Note 1)

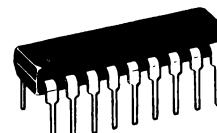
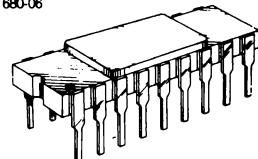
Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

NOTE 1: 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.

#### BLOCK DIAGRAM



**L SUFFIX**  
CERAMIC PACKAGE  
CASE 680-06



**P SUFFIX**  
PLASTIC PACKAGE  
CASE 707-02

#### PIN ASSIGNMENT

A6	1	18	V <sub>CC</sub>
A5	2	17	CS
A4	3	16	D4
A3	4	15	D3
A2	5	14	D2
A1	6	13	D1
A0	7	12	D0
RS3	8	11	RS1
GND	9	10	RS2

This device contains 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 this high impedance circuit.

# MCM6670•MCM6674

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	--	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	--	0.8	Vdc

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	--	--	2.5	μAdc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	--	V <sub>CC</sub>	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	--	--	0.4	Vdc
Output Leakage Current (Three-State) (CS = 2.0 V or CS = 0.8 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	--	--	10	μAdc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	--	--	130	mAdc

### CAPACITANCE (T<sub>A</sub> = 25°C, f = 1.0 MHz)

Characteristic	Symbol	Typ	Unit
Input Capacitance	C <sub>in</sub>	5.0	pF
Output Capacitance	C <sub>out</sub>	5.0	pF

# MCM6670•MCM6674

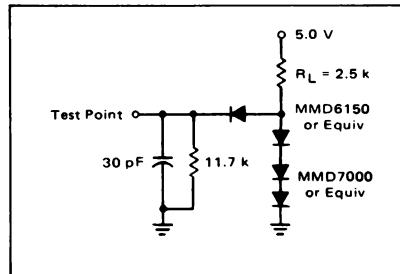
## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### AC TEST CONDITIONS

Condition	Value
Input Pulse Levels	0.8 V to 2.0 V
Input Rise and Fall Times	20 ns
Output Load	1 TTL Gate and $C_L = 30 \text{ pF}$

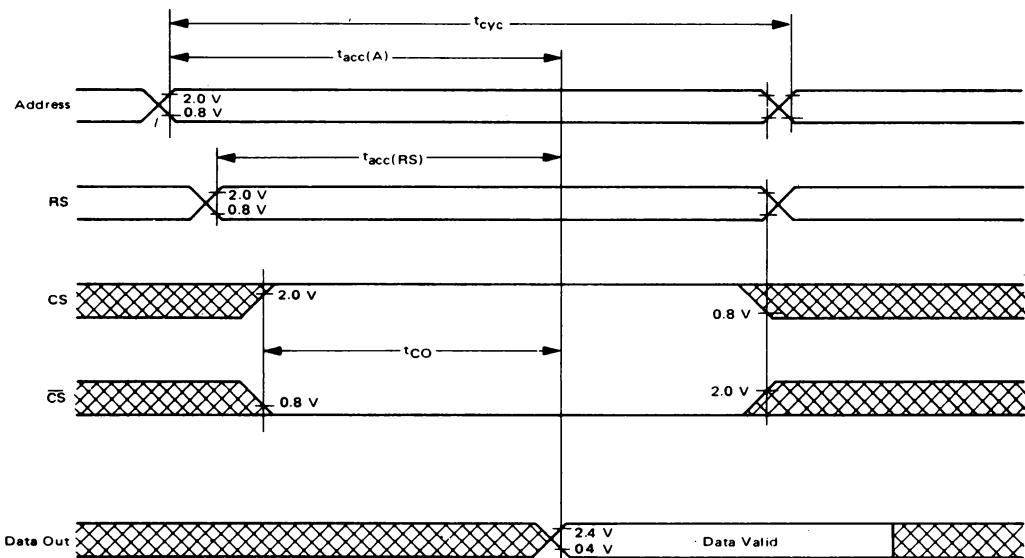
### AC TEST LOAD



### AC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Cycle Time	$t_{cyc}$	350	—	ns
Address Access Time	$t_{acc(A)}$	—	350	ns
Row Select Access Time	$t_{acc(RS)}$	—	350	ns
Chip Select to Output Delay	$t_{CO}$	—	150	ns

### TIMING DIAGRAM



= Don't Care

# MCM6670•MCM6674

## CUSTOM PROGRAMMING FOR MCM6670

By the programming of a single photomask, the customer may specify the content of the MCM6670. Encoding of the photomask is done with the aid of a computer to provide quick, efficient implementation of the custom bit pattern while reducing the cost of implementation.

Information for the custom memory content may be sent to Motorola in the following forms, in order of preference:

1. Hexadecimal coding using IBM Punch Cards (Figures 3 and 4).
2. Hexadecimal coding using ASCII Paper Tape Punch (Figure 5).

Programming of the MCM6670 can be achieved by using the following sequence:

1. Create the 128 characters in a 5 x 7 font using the format shown in Figure 1. Note that information at output D4 appears in column one, D3 in column two, thru D0 information in column five. The dots filled in and programmed as a logic "1" will appear at the outputs

as V<sub>OH</sub>; the dots left blank will be at V<sub>OL</sub>. R0 is always programmed to be blank (V<sub>OL</sub>). (Blank formats appear at the end of this data sheet for your convenience; they are not to be submitted to Motorola, however.)

2. Convert the characters to hexadecimal coding treating dots as ones and blanks as zeros, and enter this information in the blocks to the right of the character font format. The information for D4 must be a hex one or zero, and is entered in the left block. The information for D3 thru D0 is entered in the right block, with D3 the most significant bit for the hex coding, and D0 the least significant.

3. Transfer the hexadecimal figures either to punched cards (Figure 3) or to paper tape (Figure 5).

4. Transmit this data to Motorola, along with the customer name, customer part number and revision, and an indication that the source device is the MCM6670.

5. Information should be submitted on an organizational data form such as that shown in Figure 2.

FIGURE 1 – CHARACTER FORMAT

ROW SELECT TRUTH TABLE				Character Number ( <u>CUSTOMER INPUT</u> )			Character Number ( <u>CUSTOMER INPUT</u> )		
RS3	RS2	RS1	OUTPUT	MSB	LSB	HEX	MSB	LSB	HEX
0	0	0	R0	R0	0	0	R0	0	0
0	0	1	R1	R1	0	1	R1	0	F
0	1	0	R2	R2	1	0	R2	1	0
0	1	1	R3	R3	1	1	R3	1	1
1	0	0	R4	R4	0	0	R4	0	0
1	0	1	R5	R5	0	1	R5	0	F
1	1	0	R6	R6	1	0	R6	1	0
1	1	1	R7	R7	1	1	R7	1	1
				D4	D3	D0	D4	D3	D0

FIGURE 2 – FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM6670 MOS READ ONLY MEMORY										
Customer:										
Company _____					Motorola Use Only:					
Part No. _____					Quote: _____					
Originator _____					Part No.: _____					
Phone No. _____					Specif. No.: _____					
Chip-Select Options:					Active High	Active Low	No-Connect			
					1	0				
CS					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			

MCM6670•MCM6674

**FIGURE 3 – CARD PUNCH FORMAT**

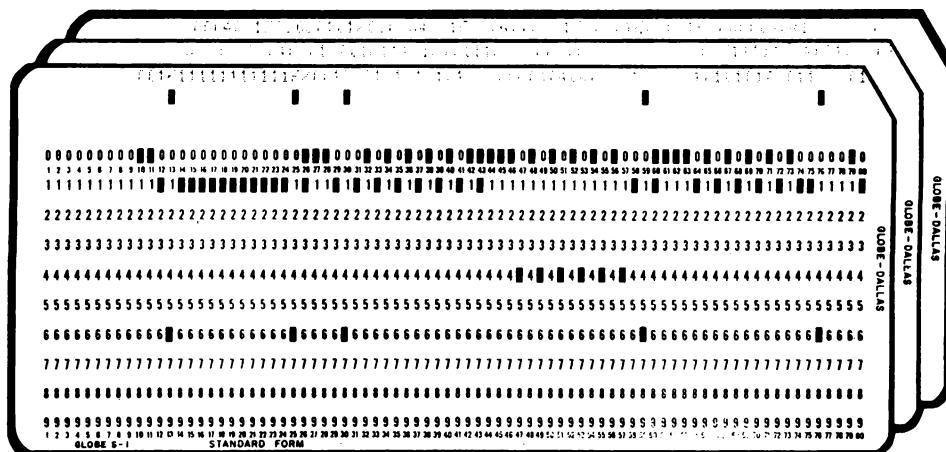
**Columns**

1-9	Blank
10-25	Hex coding for first character
26	Slash (/)
27-42	Hex coding for second character
43	Slash (/)
44-59	Hex coding for third character
60	Slash (/)
61-76	Hex coding for fourth character
77-78	Blank
79-80	Card number (starting 01: thru 32)

Column 10 on the first card contains either a zero or a one to program D4 of row R0 for the first character. Column 11 contains the hex character for D3 thru D0. Columns 12 and 13 contain the information to program R1. The entire first character is coded in columns 10 thru 25. Each card contains the coding for four characters; 32 cards are required to program the entire 128 characters. The characters must be programmed in sequence from the first character to the last in order to establish proper addressing for the part. Figure 3 provides an illustration of the correct format.

**FIGURE 4 – EXAMPLE OF CARD PUNCH FORMAT**

(First 12 Characters of MCM6670P4)



**FIGURE 5 – PAPER TAPE FORMAT**

Frames	
Leader	Blank Tape
1 to M	Allowed for customer use ( $M \leq 64$ )
M + 1, M + 2	CR; LF (Carriage Return; Line Feed)
M + 3 to M + 66	First line of pattern information (64 hex figures per line)
M + 67, M + 68	CR; LF
M + 69 to	Remaining 31 lines of hex figures, each line followed by a Carriage Re- turn and Line Feed.
M + 2114	

**Blank Tape**  
Frames 1 to M are left to the customer for internal identification, where  $M \leq 64$ . Any combination of alphanumerics may be used. This information is terminated with a Carriage Return and Line Feed, delineating the

start of data entry. (Note that the tape cannot begin with a CR and/or LF, or the customer identification will be assumed to be programming data.)

' Frame M + 3 contains a zero or a one to program D4 of row R0 for the first character. Frame M + 4 contains the hex character for D3 thru D0, completing the programming information for R0. Frames M + 5 and M + 6 contain the information to program R1. The entire first character is coded in Frames M + 3 thru M + 18. Four complete characters are programmed with each line. A total of 32 lines program all 128 characters (32 x 4). The characters must be programmed in sequence from the first character to the last in order to establish proper addressing for the part.

## MCM6670•MCM6674

The formats below are given for your convenience in preparing character information for MCM6670 programming. THESE FORMATS ARE NOT TO BE USED TO TRANSMIT THE INFORMATION TO MOTOROLA. Refer to the Custom Programming instructions for detailed procedures.

Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_ Character Number \_\_\_\_\_

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

	MSB	LSB	HEX
R0	□	□	0 0
R1	□	□	
R2	□	□	
R3	□	□	
R4	□	□	
R5	□	□	
R6	□	□	
R7	□	□	
D4 D3	D0		

## MCM6670•MCM6674

FIGURE 6 – MCM6674 PATTERN

A3 . . . A0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111	
A6 . . . A4	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	D4 D0	
000	R0 R7																
001	R0 R7																
010	R0 R7																
011	R0 R7																
100	R0 R7																
101	R0 R7																
110	R0 R7																
111	R0 R7																



**MOTOROLA**

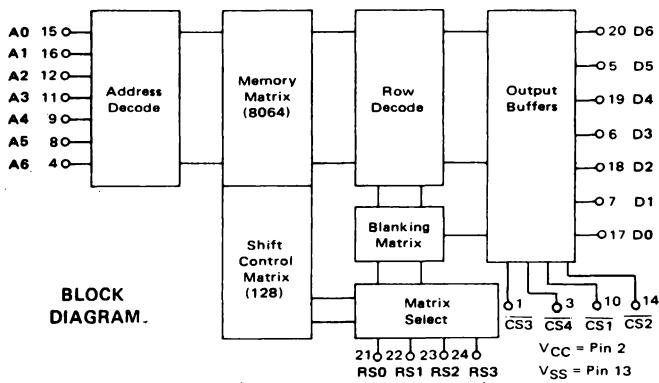
**8192-BIT READ ONLY MEMORIES  
ROW SELECT CHARACTER GENERATORS**

The MCM66700 is a mask-programmable 8192-bit horizontal-scan (row select) character generator. It contains 128 characters in a 7 X 9 matrix, and has the capability of shifting certain characters that normally extend below the baseline such as j, y, g, p, and q. Circuitry is supplied internally to effectively lower the whole matrix for this type of character—a feature previously requiring external circuitry.

A seven-bit address-code is used to select one of the 128 available characters. Each character is defined as a specific combination of logic 1s and 0s stored in a 7 X 9 matrix. When a specific four-bit binary row select code is applied, a word of seven parallel bits appears at the output. The rows can be sequentially selected, providing a nine-word sequence of seven parallel bits per word for each character selected by the address inputs. As the row select inputs are sequentially addressed, the devices will automatically place the 7 X 9 character in one of two preprogrammed positions on the 16-row matrix, with the positions defined by the four row select inputs. Rows that are not part of the character are automatically blanked.

The devices listed are preprogrammed versions of the MCM66700. They contain various sets of characters to meet the requirements of diverse applications. The complete patterns of these devices are contained in this data sheet.

- Fully Static Operation
- Fully TTL Compatible with Three-State Outputs
- CMOS and MPU Compatible, Single  $\pm 10\%$  5 Volt Supply
- Shifted Character Capability  
(Except MCM66720, MCM66730, and MCM66734)
- Maximum Access Time = 350 ns
- 4 Programmable Chip Selects (0, 1, or X)
- Pin-for-Pin Replacement for the MCM6570,  
Including All Standard Patterns



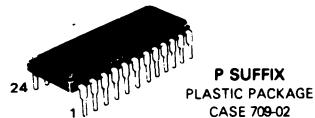
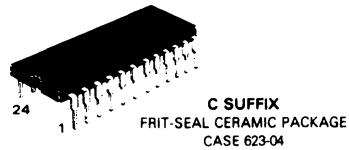
**MCM66700 MCM66710  
MCM66714 MCM66720  
MCM66730 MCM66734  
MCM66740 MCM66750  
MCM66751 MCM66760  
MCM66770 MCM66780  
MCM66790**

**MOS**

(N-CHANNEL, SILICON-GATE)

**8K READ ONLY MEMORIES**

**HORIZONTAL-SCAN  
CHARACTER GENERATORS  
WITH SHIFTED CHARACTERS**



PIN ASSIGNMENT	
CS3	1 ●
VCC	2
CS4	3
A6	4
D5	5
D3	6
D1	7
A5	8
A4	9
CS1	10
A3	11
A2	12
RS3	24
RS2	23
RS1	22
RS0	21
D6	20
D4	19
D2	18
D0	17
A1	16
A0	15
CS2	14
CS1	13
VSS	13

# MCM66700 Series

## ABSOLUTE MAXIMUM RATINGS (See Note 1, Voltages Referenced to V<sub>SS</sub>)

Rating	Symbol	Value	Unit
Supply Voltages	V <sub>CC</sub>	-0.3 to 7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to 7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +125	°C

NOTE 1: 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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS (Referenced to V<sub>SS</sub>)

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input Logic "1" Voltage	V <sub>IH</sub>	2.0	—	V <sub>CC</sub>	Vdc
Input Logic "0" Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Leakage Current (V <sub>IH</sub> = 5.5 Vdc, V <sub>CC</sub> = 4.5 Vdc)	I <sub>IH</sub>	—	—	2.5	µAdc
Output Low Voltage (Blank) (I <sub>O_L</sub> = 1.8 mAdc)	V <sub>OL</sub>	0	—	0.4	Vdc
Output High Voltage (Dot) (I <sub>OH</sub> = -205 µAdc)	V <sub>OH</sub>	2.4	—	—	Vdc
Power Supply Current	I <sub>CC</sub>	—	—	80	mAdc
Power Dissipation	P <sub>D</sub>	—	200	440	mW

### CAPACITANCE (Periodically sampled rather than 100% tested)

Input Capacitance (f = 1.0 MHz)	C <sub>in</sub>	—	4.0	7.0	pF
Output Capacitance (f = 1.0 MHz)	C <sub>out</sub>	—	4.0	7.0	pF

This device contains 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 this high-impedance circuit.

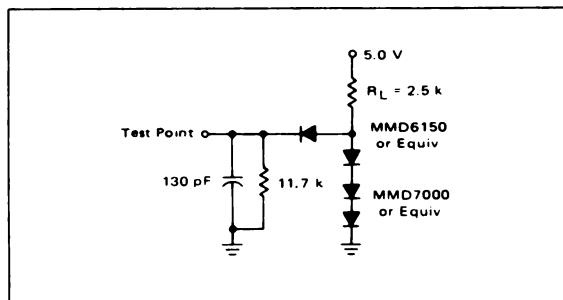
## MCM66700 Series

### AC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

#### AC TEST CONDITIONS

Condition	Value
Input Pulse Levels	0.8 V to 2.0 V
Input Rise and Fall Times	20 ns
Output Load	1 TTL Gate and $C_L = 130 \text{ pF}$

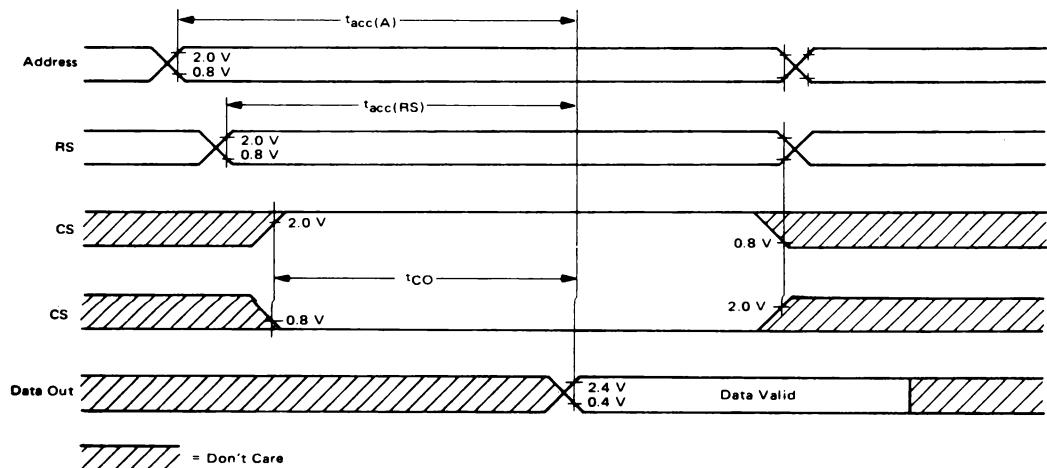
#### AC TEST LOAD



#### AC CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Address Access Time	$t_{acc(A)}$	250	350	ns
Row Select Access Time	$t_{acc(RS)}$	250	350	ns
Chip Select to Output Delay	$t_{CO}$	100	150	ns

#### TIMING DIAGRAM



# MCM66700 Series

## MEMORY OPERATION (Using Positive Logic)

Most positive level = 1, most negative level = 0.

### Address

To select one of the 128 characters, apply the appropriate binary code to the Address inputs (A0 through A6).

can be programmed to occupy either of the two positions in a 7 X 16 matrix. (Shifted characters are not available on MCM66720, MCM66730, or MCM66734.)

### Row Select

To select one of the rows of the addressed character to appear at the seven output lines, apply the appropriate binary code to the Row Select inputs (RS0 through RS3).

### Output

For these devices, an output dot is defined as a logic 1 level, and an output blank is defined as a logic 0 level.

### Shifted Characters

These devices have the capability of displaying characters that descend below the bottom line (such as lowercase letters j, y, g, p, and q). Internal circuitry effectively drops the whole matrix for this type of character. Any character

### Programmable Chip Select

The MCM66700 has four Chip Select inputs that can be programmed with a 1, 0, or don't care (not connected). A don't care must always be the highest chip select pin or pins. All standard patterns have Don't Care Chip Select—except MCM66751.

## DISPLAY FORMAT

Figure 1 shows the relationship between the logic levels at the row select inputs and the character row at the outputs. The MCM66700 allows the user to locate the basic 7 X 9 font anywhere in the 7 X 16 array. In addition, a shifted font can be placed anywhere in the same 7 X 16 array. For example, the basic MCM66710 font is established in rows R14 through R6. All other rows are automatically blanked. The shifted font is established in rows R11 through R3, with all other rows blanked. Thus, while any one character is contained in a 7 X 9 array, the MCM66710 requires a 7 X 12 array on the CRT screen to contain both normal and descending characters. Other

uses of the shift option may require as much as the full 7 X 16 array, or as little as the basic 7 X 9 array (when no shifting occurs, as in the MCM66720).

The MCM66700 can be programmed to be scanned either from bottom to top or from top to bottom. This is achieved through the option of assigning row numbers in ascending or descending count, as long as both the basic font and the shifted font are the same. For example, an up counter will scan the MCM66710 from bottom to top, whereas an up counter will scan the MCM66714 from top to bottom (see Figures 7 and 8 for row designation).

FIGURE 1 – ROW SELECT INPUT CODE AND SAMPLE CHARACTERS FOR MCM66710 AND MCM66720

ROW SELECT TRUTH TABLE					MCM66710								MCM66720							
RS3	RS2	RS1	RS0	OUTPUT	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.	ROW NO.		
0	0	0	0	R0	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	0	0	1	R1	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	0	1	0	R2	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	0	1	1	R3	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	1	0	0	R4	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	1	0	1	R5	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	1	1	0	R6	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
0	1	1	1	R7	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	0	0	0	R8	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	0	0	1	R9	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	0	1	0	R10	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	0	1	1	R11	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	1	0	0	R12	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	1	0	1	R13	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	1	1	0	R14	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		
1	1	1	1	R15	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	D6	D0	D6	D0		

# MCM66700 Series

## CUSTOM PROGRAMMING FOR MCM66700

By the programming of a single photomask, the customer may specify the content of the MCM66700. Encoding of the photomask is done with the aid of a computer to provide quick, efficient implementation of the custom bit pattern while reducing the cost of implementation.

Information for the custom memory content may be sent to Motorola in the following forms, in order of preference:

1. Hexadecimal coding using IBM Punch Cards (Figures 3 and 4)
2. Hexadecimal coding using ASCII Paper Tape Punch (Figure 5)

Programming of the MCM66700 can be achieved by using the follow sequence:

1. Create the 128 characters in a 7 X 9 font using the format shown in Figure 2. Note that information at output D6 appears in column one, D5 in column two, through D0 information in column seven. The dots filled in and programmed as a logic 1 will appear at the outputs as V<sub>OH</sub>; the dots left blank will be at V<sub>OL</sub>. (Blank formats appear at the end of this data sheet for your convenience;

they are not to be submitted to Motorola, however.)

2. Indicate which characters are shifted by filling in the extra square (dot) in the top row, at the left (column S).

3. Convert the characters to hexadecimal coding treating dots as 1s and blanks as 0s, and enter this information in the blocks to the right of the character font format. High order bits are at the left, in columns S and D3. For the bottom eight rows, the bit in Column S must be 0, so these locations have been omitted. For the top row, the bit in Column S will be 0 for an unshifted character, and 1 for a shifted character.

4. Transfer the hexadecimal figures either to punched cards (Figure 3) or to paper tape (Figure 5).

5. Assign row numbers to the unshifted font. These must be nine sequential numbers (values 0 through 15) assigned consecutively to the rows. The shifted font is similarly placed in any position in the 16 rows.

6. Provide, in writing, the information indicated in Figure 6 (a copy of Figure 10 may be used for this purpose). Submit this information to Motorola together with the punched cards or paper tape.

FIGURE 2 – CHARACTER FORMAT

Character Number		(Customer Input)										
		MSB	LSB HEX									
R 14	S	□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	0 0	
R 13		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	0 0	
R 12		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	0 0	
R 11		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	0 0	
R 10		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	3 1	
R 9		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	4 A	
R 8		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	4 4	
R 7		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	4 A	
R 6		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	3 1	
	S	D 6	D 4	D 3	D 0							
Character Number		(Customer Input)										
R 11	S	□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	8 C	
R 10		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	2 2	
R 9		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	3 C	
R 8		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	2 2	
R 7		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	2 2	
R 6		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	3 C	
R 5		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	2 0	
R 4		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	2 0	
R 3		□	□□□	□□□□	□□□□□	□□□□□□	□□□□□□□	□□□□□□□□	□□□□□□□□□	□□□□□□□□□□	4 0	
	S	D 6	D 4	D 3	D 0							

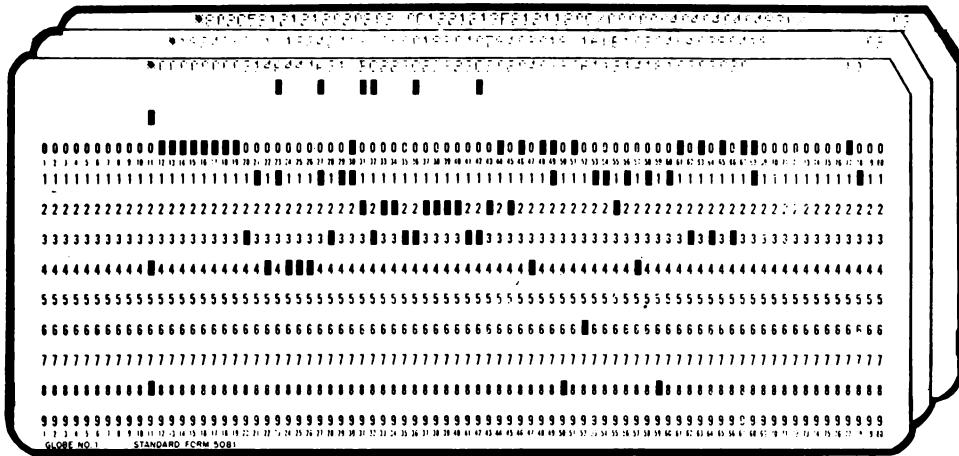
FIGURE 3 – CARD PUNCH FORMAT

Columns											
1 – 10	Blank										
11	Asterisk (*)										
12 – 29	Hex coding for first character										
30	Slash (/)										
31 – 48	Hex coding for second character										
49	Slash (/)										
50 – 67	Hex coding for third character										
68	Slash (/)										
69 – 76	Blank										
77 – 78	Card number (starting 01; through 43)										
79 – 80	Blank										
Column 12 on the first card contains the hexadecimal equivalent of column S and D6 through D4 for the top row of the first character. Column 13 contains D3 through D0. Columns 14 and 15 contain the information for the next row. The entire first character is coded in columns 12 through 29. Each card contains the coding for three characters. 43 cards are required to program the entire 128 characters, the last card containing only two characters. The characters must be programmed in sequence from the first character to the last in order to establish proper addressing for the part. As an example, the first nine characters of the MCM66710 are correctly coded and punched in Figure 4.											

\*NOTE: Motorola can accept magnetic tape and truth table formats. For further information contact your local Motorola sales representative.

## MCM66700 Series

**FIGURE 4 – EXAMPLE OF CARD PUNCH FORMAT  
(First 9 Characters of MCM66710)**



**FIGURE 5 – PAPER TAPE FORMAT**

Frames	
Leader	Blank Tape
1 to M	Allowed for customer use ( $M \leq 64$ )
M + 1, M + 2	CR; LF (Carriage Return; Line Feed)
M + 3 to M + 66	First line of pattern information (64 hex figures per line)
M + 67, M + 68	CR; LF
M + 69 to M + 2378	Remaining 35 lines of hex figures, each line followed by a Carriage Return and Line Feed
Blank Tape	
Frames 1 to M are left to the customer for internal identification, where $M \leq 64$ . Any combination of alphanumerics may be used. This information is terminated with a Carriage Return and Line Feed, delineating the start of data entry. (Note that the tape cannot begin with a CR and/or LF, or the customer identification will be assumed to be programming data.)	
Frame M + 3 contains the hexadecimal equivalent of column S and D6 thru D4 for the top row of the first character. Frame M + 4 contains D3 thru D0. Frames M + 5 and M + 6 program the second row of the first character. Frames M + 3 to M + 66 comprise the first line of the printout. The line is terminated with a CR and LF.	
The remaining 35 lines of data are punched in sequence using the same format, each line terminated with a CR and LF. The total 36 lines of data contain $36 \times 64$ or 2304 hex figures. Since 18 hex figures are required to program each $7 \times 9$ character, the full 128 (2304 $\div$ 18) characters are programmed.	

**FIGURE 6 – FORMAT FOR ORGANIZATIONAL DATA**

ORGANIZATIONAL DATA MCM66700 MOS READ ONLY MEMORY			
Customer	_____		
Customer Part No.	_____ Rev. _____		
Row Number for top row of non-shifted font	_____		
Row Number for bottom row of non-shifted font	_____		
Row Number for top row of shifted font	_____		
Programmable Chip Select information: 1 = Active High 0 = Active Low X = Don't Care (Not Connected)			
CS1	CS2	CS3	CS4

## **MCM66700 Series**

**FIGURE 7 – MCM66710 PATTERN**

**FIGURE 8 – MCM66714 PATTERN**

A3 - A0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
A6 - A4	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
000	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
001	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
010	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
011	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
100	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
101	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
110	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
111	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F

## **MCM66700 Series**

**FIGURE 9 – MCM66734 PATTERN\***

\*Shifted characters are not used.

**FIGURE 10 – MCM66720 PATTERN\*\***

*\*\* Shifted characters are not used*

# MCM66700 Series

FIGURE 11 – MCM66730 PATTERN\*\*

A3..A0		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
A8..A4		D4 D0															
	000	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	001	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	010	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	011	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	100	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	101	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	110	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	111	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

\*\* Shifted characters are not used

FIGURE 12 – MCM66740 PATTERN

A3..A0		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
A8..A4		D4 D0															
	000	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	001	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	010	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	011	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	100	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	101	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	110	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	111	no ..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

■ = Shifted character. The character is shifted three rows to R3 at the top of the font and R11 at the bottom.

## **MCM66700 Series**

**FIGURE 13 – MCM66750 PATTERN**

**MCM66751** – Same as MCM66750 except CS1 = 0, CS2 = 0, CS3 = X, and CS4 = X.

**FIGURE 14 – MCM66760 PATTERN**

A3	A0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111				
A6	A4		D6	D0	D1	D0	D6	D0	D1	D6	D0	D6	D0	D6	D0	D6	D0	D6			
	000																				
	001																				
	010																				
	011																				
	100																				
	101																				
	110																				
	111																				

- Shifted character. The character is shifted three rows to R3 at the top of the font and R11 at the bottom.

## **MCM66700 Series**

**FIGURE 15 – MCM66770 PATTERN**

**FIGURE 16 – MCM66780 PATTERN**

## MCM66700 Series

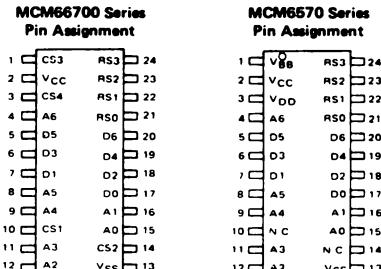
FIGURE 17 – MCM66700 PATTERN

A3 A0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
A8 A4	D6 D6	D4 D0	D4 D0	D8 D0												
000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
001	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
100	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
101	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
110	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
111	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000

▀ - Shifted character. The character is shifted three rows to R3 at the top of the font and R11 at the bottom.

## **MCM66700 Series**

MCM6570 Series	MCM66700 Equivalent	Description
MCM6571	MCM66710	ASCII, shifted
MCM6571A	MCM66714	ASCII, shifted
MCM6572	MCM66720	ASCII
MCM6573	MCM66730	Japanese
MCM6573A	MCM66734	Japanese
MCM6574	MCM66740	Math Symbols
MCM6575	MCM66750	Alphanumeric Co.
MCM6576	MCM66760	British, shifted
MCM6577	MCM66770	German, shifted
MCM6578	MCM66780	French, shifted
MCM6579	MCM66790	European, shifted



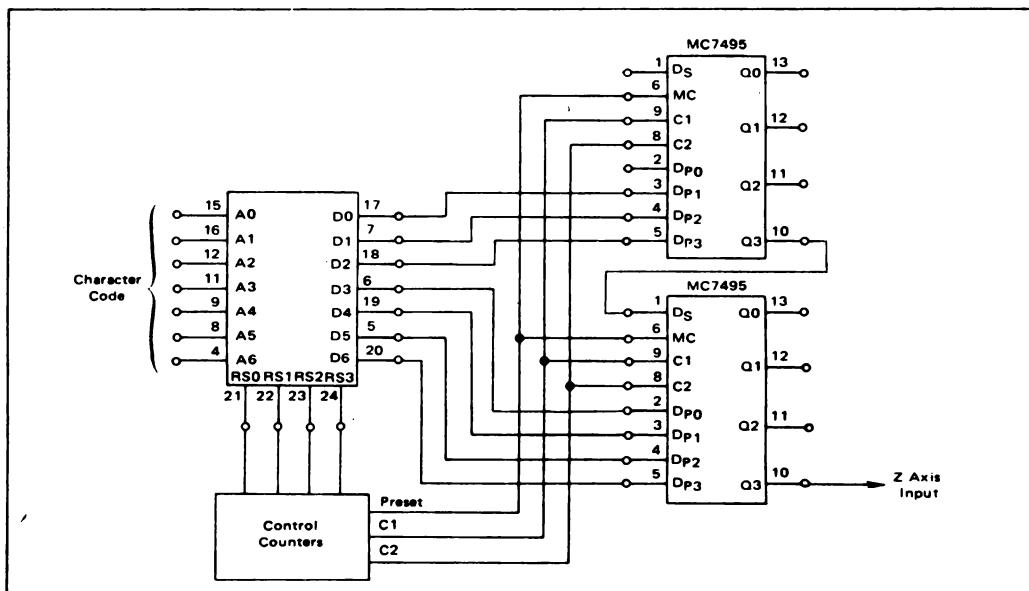
## **APPLICATIONS INFORMATION**

One important application for the MCM66700 series is in CRT display systems (Figure 18). A set of buffer shift registers or random access memories applies a 7-bit character code to the input of the character generator, which then supplies one row of the character according to the count at the four row select inputs. As each row is available, it is put into the TTL MC7495 shift registers. The parallel information in these shift registers is clocked

serially out to the Z-axis where it modulates the raster to form the character.

The MCM66700 series require one power supply of +5.0 volts. When powering this device from laboratory or system power supplies, it is important that the Absolute Maximum Ratings not be exceeded or device failure can result. Some power supplies exhibit spikes or glitches on their outputs when the ac power is switched on and off.

**FIGURE 18 – CRT DISPLAY APPLICATION USING MCM66710**



## **MCM66700 Series**

The formats below are given for your convenience in preparing character information for MCM66700 programming. **THESE FORMATS ARE NOT TO BE USED TO TRANSMIT THE INFORMATION TO MOTOROLA.** Refer to the Custom Programming instructions for detailed procedures.

Character Number _____									
MSB					LSB HEX				
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
S	D6	D4	D3						D0

Character Number _____							
	MSB					LSB	HEX
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3			D0	

Character Number _____							
	MSB				LSB		HEX
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3	D0			

Character Number _____							
	MSB		LSB	HEX			
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3	DO			

Character Number _____									
	MSB				LSB				HEX
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
R	<input type="checkbox"/>								
S	D6	D4	D3		D0				

Character Number _____							
MSB				LSB			
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3	D2	D1	D0	

Character Number _____							
	<b>MSB</b>			<b>LSB</b>	<b>HEX</b>		
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3	D0			

Character Number _____							
MSB				LSB			
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
R	<input type="checkbox"/>						
S	D6	D4	D3	D0			



**MOTOROLA**

## MCM68A30A MCM68B30A

### 1024 X 8-BIT READ ONLY MEMORY

The MCM68A30A/MCM68B30A are mask-programmable byte-organized memories designed for use in bus-organized systems. They are fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. Memory expansion is provided through multiple Chip Select inputs. The active level of the Chip Select inputs and the memory content are defined by the customer.

- Organized as 1024 Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- Four Chip Select Inputs (Programmable)
- Single  $\pm 10\%$  5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 350 ns — MCM68A30A  
250 ns — MCM68B30A

### ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>In</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

NOTE 1. 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.

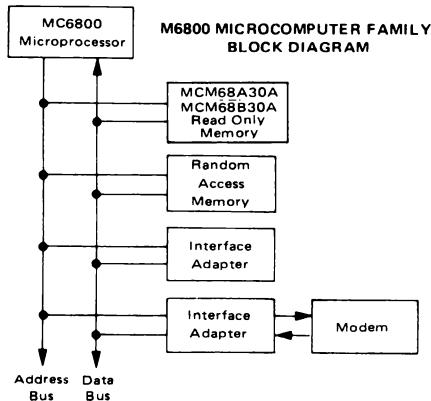
### MOS (N-CHANNEL, SILICON-GATE)

### 1024 X 8-BIT READ ONLY MEMORY

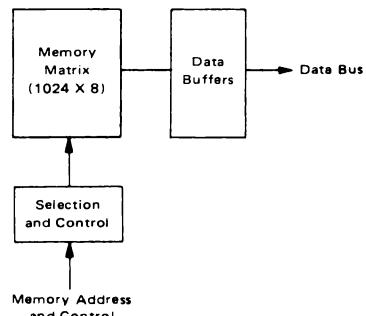


### PIN ASSIGNMENT

GND	1	●	24	JA0
D0	2		23	JA1
D1	3		22	JA2
D2	4		21	JA3
D3	5		20	JA4
D4	6		19	JA5
D5	7		18	JA6
D6	8		17	JA7
D7	9		16	JA8
CS1	10		15	JA9
CS2	11		14	CS4
V <sub>CC</sub>	12		13	CS3



### MCM68A30A/MCM68B30A READ ONLY MEMORY BLOCK DIAGRAM



# MCM68A30A•MCM68B30A

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### DC CHARACTERISTICS

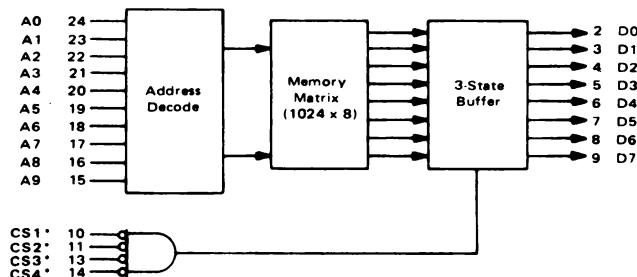
Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	—	2.5	μAdc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	—	0.4	Vdc
Output Leakage Current (Thre. State) (CS = 0.8 V or CS = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	—	10	μAdc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	--	—	130	mAdc

**CAPACITANCE** (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	7.5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF

This device contains 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 this high-impedance circuit.

BLOCK DIAGRAM



\* Active level defined by the customer.

V<sub>CC</sub> = Pin 12

Gnd = Pin 1

# MCM68A30A•MCM68B30A

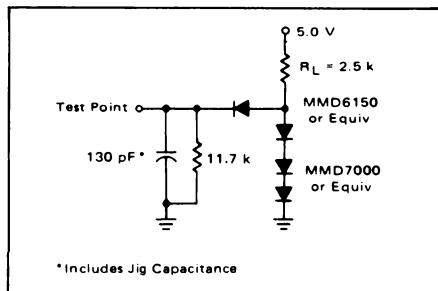
## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted.)

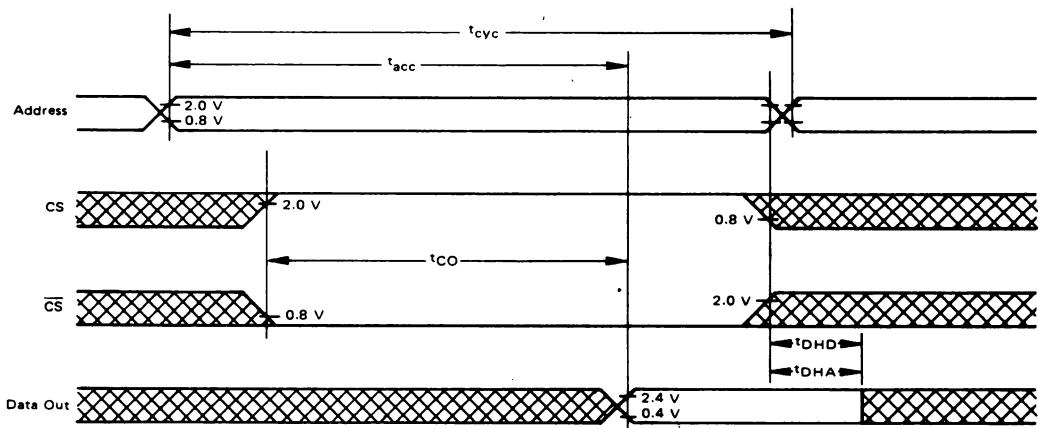
(All timing with  $t_r = t_f = 20$  ns, Load of Figure 1)

Characteristic	Symbol	MCM68A30AL		MCM68B30AL		Unit
		Min	Max	Min	Max	
Cycle Time	$t_{cyc}$	350	—	250	—	ns
Access Time	$t_{acc}$	—	350	—	250	ns
Chip Select to Output Delay	$t_{CO}$	—	150	—	125	ns
Data Hold from Address	$t_{DHA}$	10	—	10	—	ns
Data Hold from Deselection	$t_{DHD}$	10	150	10	125	ns

FIGURE 1 – AC TEST LOAD



TIMING DIAGRAM



## MCM68A30A•MCM68B30A

### CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68A30A/MCM68B30A, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68A30A/MCM68B30A should be submitted on an Organizational Data form such as that shown in Figure 3. ("No Connect" must always be the highest order Chip Select pin(s).)

Information for custom memory content may be sent to Motorola in one of four forms (shown in order of preference):

1. Paper tape output of the Motorola M6800 Software.
2. Hexadecimal coding using IBM Punch Cards.
3. EPROM (MCM2708, MCM27A08, or MCM68708).
4. Hand-punched paper tape (Figure 3).

#### PAPER TAPE

Included in the software packages developed for the M6800 Microcomputer Family is the ability to produce a paper tape output for computerized mask generation. The assembler directives are used to control allocation of memory, to assign values for stored data, and for controlling the assembly process. The paper tape must specify the full 1024 bytes.

FIGURE 2 - BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

#### IBM PUNCH CARDS

The hexadecimal equivalent (from Figure 2) may be placed on 80 column IBM punch cards as follows:

Step Column

- |   |       |  |
|---|-------|--|
| 1 | 12    | Byte "0" Hexadecimal equivalent for outputs D7 thru D4 (D7 = M.S.B.) |
| 2 | 13    | Byte "0" Hexadecimal equivalent for outputs D3 thru D0 (D3 = M.S.B.) |
| 3 | 14-75 | Alternate steps 1 and 2 for consecutive bytes.                       |
| 4 | 77-80 | Card number (starting 0001)  |

# MCM68A30A•MCM68B30A

FIGURE 3 – HAND-PUNCHED PAPER TAPE FORMAT

Frames	
Leader	Blank Tape
1 to M	Allowed for customer use ( $M \leq 64$ )
M + 1, M + 2	CR; LF (Carriage Return; Line Feed)
M + 3 to M + 66	First line of pattern information (64 hex figures per line)
M + 67, M + 68	CR; LF
M + 69 to M + 2112	Remaining 31 lines of hex figures, each line followed by a Carriage Return and Line Feed
Blank Tape	
<p>Frames 1 to M are left to the customer for internal identification, where <math>M \leq 64</math>. Any combination of alphanumerics may be used. This information is terminated with a Carriage Return and Line Feed, delineating the start of data entry. (Note that the tape cannot begin with a CR and/or LF, or the customer identification will be assumed to be programming data.)</p>	
<b>Option A (1024 x 8)</b>	
Frame M + 3 contains the hexadecimal equivalent of	
<p>bits D7 thru D4 of byte 0. Frame M + 4 contains bits D3 thru D0. These two hex figures together program byte 0. Likewise, frames M + 5 and M + 6 program byte 1, while M + 7 and M + 8 program byte 2. Frames M + 3 to M + 66 comprise the first line of the printout and program, in sequence, the first 32 bytes of storage. The line is terminated with a CR and LF.</p>	
<b>Option B (2048 x 4)</b>	
<p>Frame M + 3 contains the hexadecimal equivalent of byte 0, bits D3 thru D0. Frame M + 4 contains byte 1, frame M + 5 byte 2, and so on. Frames M + 3 to M + 66 sequentially program bytes 0 to 31 (the first 32 bytes). The line is terminated with a CR and LF.</p>	
<b>Both Options</b>	
<p>The remaining 31 lines of data are punched in sequence using the same format, each line terminated with a CR and LF. The total 32 lines of data contain <math>32 \times 64</math> or 2048 characters. Since each character programs 4 bits of information, a full 8192 bits are programmed.</p>	
<p>As an example, a printout of the punched tape for Figure 13 would read as shown in Figure 10 (a CR and LF is implicit at the end of each line).</p>	

FIGURE 4 – FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68A30A/68B30A MOS READ ONLY MEMORY																							
Customer:																							
Company																							
Part No.																							
Originator																							
Phone No.																							
<p style="text-align: center;">Motorola Use Only:</p>																							
<p>Quote: _____</p>																							
<p>Part No.: _____</p>																							
<p>Specif. No.: _____</p>																							
<p><b>Chip Select Options:</b></p> <table border="0"> <thead> <tr> <th></th> <th>Active High</th> <th>Active Low</th> <th>No Connect "Don't Care"</th> </tr> </thead> <tbody> <tr> <td>CS1</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>CS2</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>CS3</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>CS4</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table>					Active High	Active Low	No Connect "Don't Care"	CS1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CS2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CS3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CS4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Active High	Active Low	No Connect "Don't Care"																				
CS1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																				
CS2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																				
CS3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																				
CS4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																				



**MOTOROLA**

## MCM68A308 MCM68B308

### 1024 X 8-BIT READ ONLY MEMORY

The MCM68A308/MCM68B308 is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

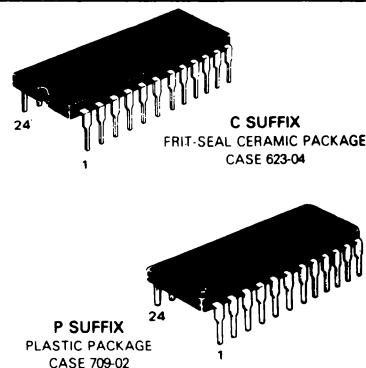
The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. Memory expansion is provided through multiple Chip Select inputs. The active level of the Chip Select inputs and the memory content are defined by the customer.

- Organized as 1024 Bytes of 8 Bits
- Static Operation
- Three-State Data Output
- Mask-Programmable Chip Selects for Simplified Memory Expansion
- Single  $\pm 10\%$  5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 350 ns — MCM68A308  
250 ns — MCM68B308
- 350 mW Typical Power Dissipation

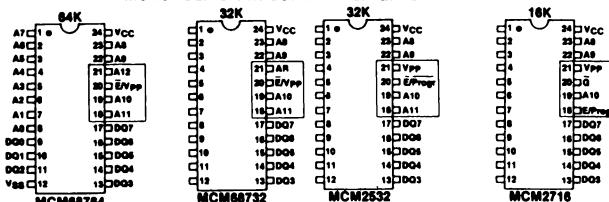
### MOS

(IN-CHANNEL, SILICON-GATE)

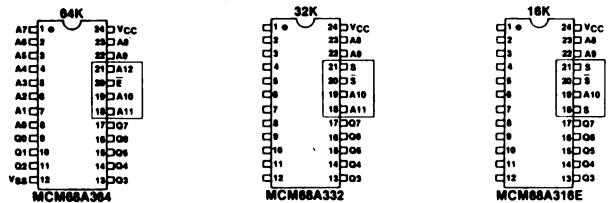
### 1024 X 8-BIT READ ONLY MEMORY



### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY



### INDUSTRY STANDARD PINOUTS

### PIN ASSIGNMENT

A7	1	●	24	VCC
A6	2		23	I <sub>A8</sub>
A5	3		22	I <sub>A9</sub>
A4	4		21	I <sub>S3</sub>
A3	5		20	I <sub>S1</sub>
A2	6		19	I <sub>S4</sub>
A1	7		18	I <sub>S2</sub>
A0	8		17	I <sub>Q7</sub>
Q0	9		16	I <sub>Q6</sub>
Q1	10		15	I <sub>Q5</sub>
Q2	11		14	I <sub>Q4</sub>
VSS	12		13	I <sub>Q3</sub>

### PIN NAMES

A0 - A9	Address Inputs
S1 - S4	Chip Selects
Q0 - Q7	Data Output
VCC	15 V Power Supply
VSS	Ground

# MCM68A308•MCM68B308

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### DC CHARACTERISTICS

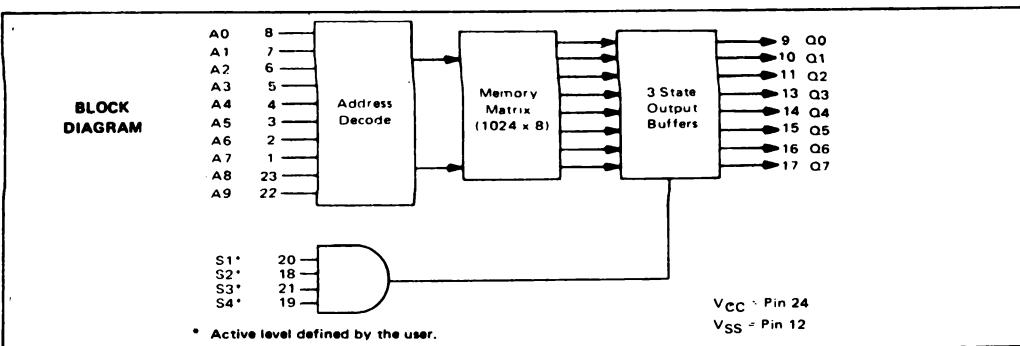
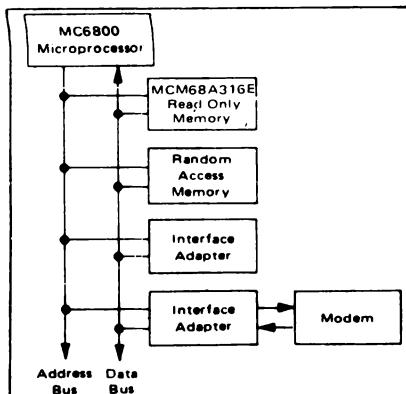
Characteristic	Symbol	Min	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>IN</sub>	—	2.5	μA/dc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	0.4	Vdc
Output Leakage Current (Three-State) (S = 0.8 V or S = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	10	μA/dc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	130	mA/dc

### ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

**NOTE 1:** 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.

### M6800 MICROCOMPUTER FAMILY BLOCK DIAGRAM



# MCM68A308•MCM68B308

## AC OPERATING CONDITIONS AND CHARACTERISTICS\*

(Full operating voltage and temperature unless otherwise noted.)

All timing with  $t_r = t_f = 20$  ns, Load of Figure 1)

Characteristic	Symbol	MCM68A308		MCM68B308		Unit
		Min	Max	Min	Max	
Cycle Time	$t_{cyc}$	350	—	250	—	ns
Access Time	$t_{acc}$	—	350	—	250	ns
Chip Select to Output Delay	$t_{SO}$	—	150	—	150	ns
Data Hold from Address	$t_{DHA}$	10	—	10	—	ns
Data Hold from Deselection	$t_{DHD}$	10	150	10	150	ns

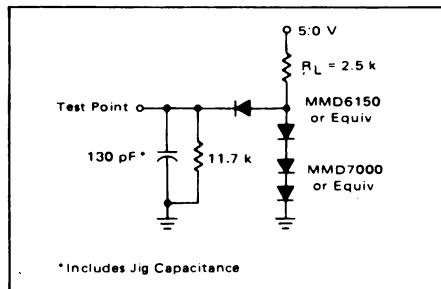
### CAPACITANCE

(f = 2.0 MHz,  $T_A = 25^\circ\text{C}$ , periodically sampled rather than 100% tested)

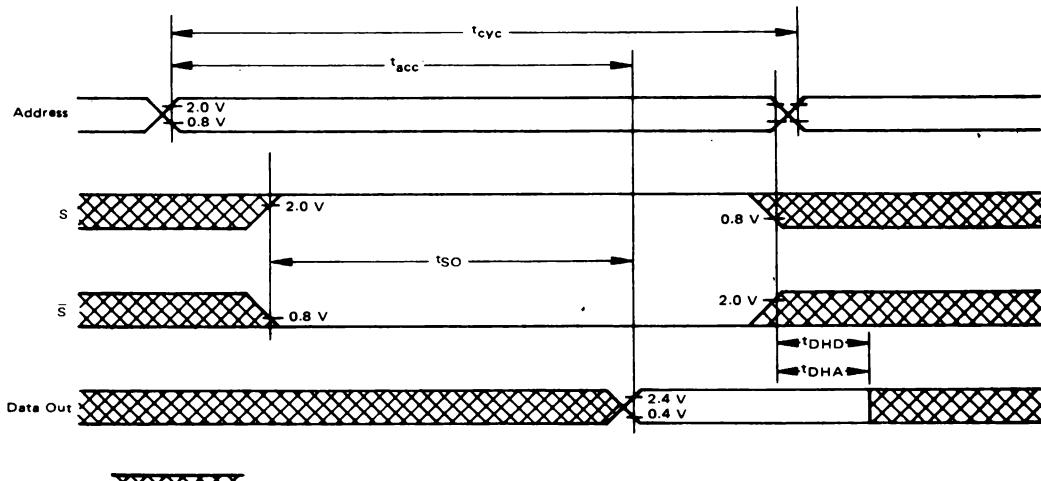
Characteristic	Symbol	Max	Unit
Input Capacitance	$C_{in}$	7.5	pF
Output Capacitance	$C_{out}$	12.5	pF

This device contains 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 this high-impedance circuit.

FIGURE 1 – AC TEST LOAD



TIMING DIAGRAM



# MCM68A308•MCM68B308

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68A308/MCM68B308, the customer may specify the content of the memory and the method of enabling the outputs. (A "no-connect" must always be the highest order chip-select(s).)

Information on the general options of the MCM68A308/MCM68B308 should be submitted on an Organizational Data form such as that shown in Figure 4.

Information for customer memory content may be sent to Motorola in one of four forms (shown in order of preference):

1. Paper tape output of the Motorola M6800 Software.
2. Hexadecimal coding using IBM Punch Cards.
3. EPROM one MCM68A708 or equivalent.
4. Hand punched paper tape (Figure 3).

### PAPER TAPE

Included in the software packages developed for the M6800 Microcomputer Family is the ability to produce a paper tape output for computerized mask generation. The assembler directives are used to control allocation of memory, to assign values for stored data, and for controlling the assembly process. The paper tape must specify the full 1024 bytes.

FIGURE 2 - BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

### IBM PUNCH CARDS

The hexadecimal equivalent (from Figure 2) may be placed on 80 column IBM punch cards as follows:

Step	Column	Description
1	12	Byte "0" Hexadecimal equivalent for outputs Q7 thru Q4 (Q7 = M.S.B.)
2	13	Byte "0" Hexadecimal equivalent for outputs Q3 thru Q0 (Q3 = M.S.B.)
3	14-75	Alternate steps 1 and 2 for consecutive bytes.
4	77-80	Card number (starting 0001)

FIGURE 3 - HAND-PUNCHED PAPER TAPE FORMAT

### Frames

Leader	Blank Tape
1 to M	Allowed for customer use ( $M \leq 64$ )
M + 1, M + 2	CR; LF (Carriage Return; Line Feed)
M + 3 to M + 66	First line of pattern information (64 hex figures per line)
M + 67, M + 68	CR; LF
M + 69 to M + 2112	Remaining 31 lines of hex figures, each line followed by a Carriage Return and Line Feed
Blank Tape	

Frames 1 to M are left to the customer for internal identification, where  $M \leq 64$ . Any combination of alphanumerics may be used. This information is terminated with a Carriage Return and Line Feed, delineating the start of data entry. (Note that the tape cannot begin

with a CR and/or LF, or the customer identification will be assumed to be programming data.)

Frame M + 3 contains the hexadecimal equivalent of bits Q7 thru Q4 of byte 0. Frame M + 4 contains bits Q3 thru Q0. These two hex figures together program byte 0. Likewise, frames M + 5 and M + 6 program byte 1, while M + 7 and M + 8 program byte 2. Frames M + 3 to M + 66 comprise the first line of the printout and program, in sequence, the first 32 bytes of storage. The line is terminated with a CR and LF.

The remaining 31 lines of data are punched in sequence using the same format, each line terminated with a CR and LF. The total 32 lines of data contain  $32 \times 64$  or 2048 characters. Since each character programs 4 bits of information, a full 8192 bits are programmed.

**MCM68A308•MCM68B308**

**FIGURE 4 – FORMAT FOR PROGRAMMING GENERAL OPTIONS**

ORGANIZATIONAL DATA MCM68308 MOS READ ONLY MEMORY			
Customer:			
Company	Motorola Use Only:		
Part No.	Quote: _____		
Originator	Part No.: _____		
Phone No.	Specif. No.: _____		
Chip Select:	Active High	Active Low	No Connect
S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



# MOTOROLA

## 2048 X 8-BIT READ ONLY MEMORY

The MCM68A316A is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of fully static operation.

The memory is compatible with the M6800 Microcomputer Family, providing read-only storage in byte increments. Memory expansion is provided through multiple Chip Select inputs. The active level of the Chip Select inputs and the memory content are defined by the user.

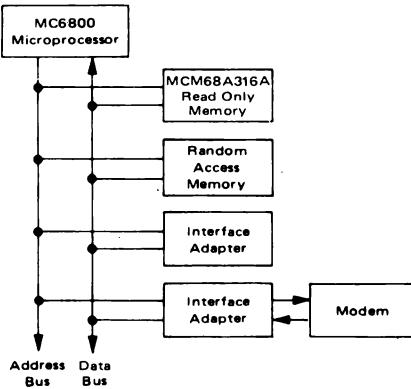
- Fully Static Operation
- Three-State Data Output
- Mask-Programmable Chip Selects for Simplified Memory Expansion
- Single  $\pm 10\%$  5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 350 ns
- Plug-in Compatible with 2316A

## ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	V <sub>dc</sub>
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	V <sub>dc</sub>
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

NOTE 1: 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.

## M6800 MICROCOMPUTER FAMILY BLOCK DIAGRAM

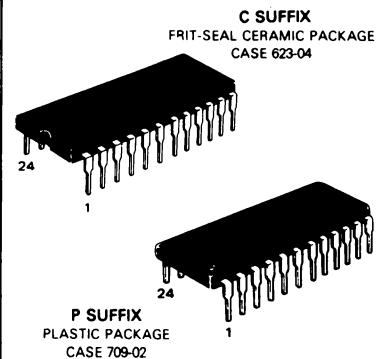


# MCM68A316A

## MOS

(N-CHANNEL, SILICON-GATE)

## 2048 X 8-BIT READ ONLY MEMORY



## PIN ASSIGNMENT

A7	1	24	V <sub>CC</sub>
A8	2	23	Q0
A9	3	22	Q1
A10	4	21	Q2
A0	5	20	Q3
A1	6	19	Q4
A2	7	18	Q5
A3	8	17	Q6
A4	9	16	Q7
A5	10	15	S1
A6	11	14	S2
V <sub>SS</sub>	12	13	S3

## PIN NAMES

A0-A10 . . .	Address Inputs
S1-S3 . . .	Chip Selects
Q0-Q7 . . .	Data Output
V <sub>CC</sub> . . .	+5 V Power Supply
V <sub>SS</sub> . . .	Ground

# MCM68A316A

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	2.5	μAdc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	0.4	Vdc
Output Leakage Current (Three-State) (S = 0.8 V or S̄ = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	10	μAdc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	--	130	mAdc

### CAPACITANCE

(f = 2.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	7.5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF

### AC OPERATING CONDITIONS AND CHARACTERISTICS

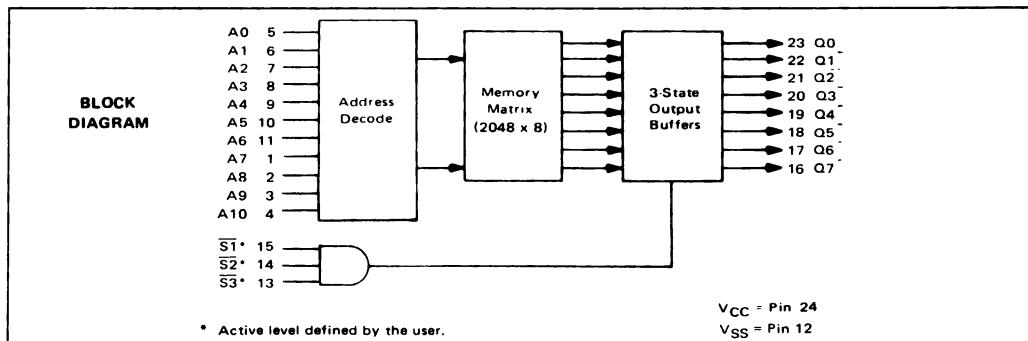
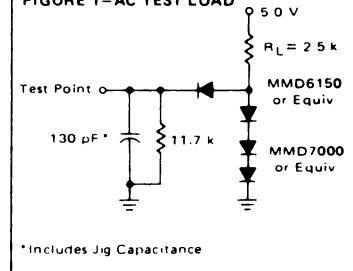
(Full operating voltage and temperature unless otherwise noted.

All timing with t<sub>r</sub> = t<sub>f</sub> = 20 ns, Load of Figure 1)

Characteristic	Symbol	Min	Max	Unit
Cycle Time	t <sub>cyc</sub>	350	—	ns
Access Time	t <sub>acc</sub>	—	350	ns
Chip Select to Output Delay	t <sub>SO</sub>	—	150	ns
Data Hold from Address	t <sub>DHA</sub>	10	—	ns
Data Hold from Deselection	t <sub>H</sub>	10	150	ns

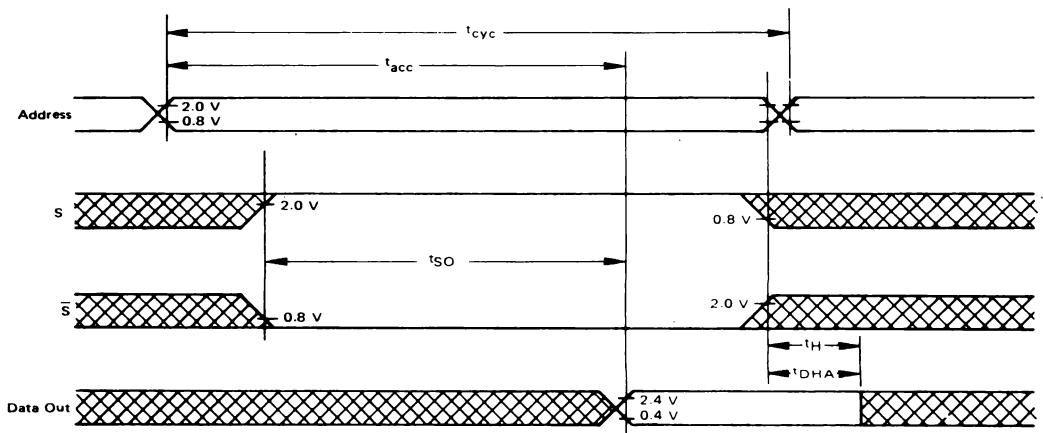
This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

FIGURE 1—AC TEST LOAD



## MCM68A316A

TIMING DIAGRAM



# MCM68A316A

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68316A, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68A316A should be submitted on an Organizational Data form such as that shown in Figure 3.

Information for custom memory content may be sent to Motorola in one of four forms (shown in order of preference):

1. Paper tape output of the Motorola M6800 Software.
2. Hexadecimal coding using IBM Punch Cards.
3. EPROM (TMS2716 or MCM2716).
4. Hand-punched paper tape.

### PAPER TAPE

Included in the software packages developed for the M6800 Microcomputer Family is the ability to produce a paper tape output for computerized mask generation. The assembler directives are used to control allocation of memory, to assign values for stored data, and for controlling the assembly process. The paper tape must specify the full 2048 bytes.

FIGURE 2 - BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

### IBM PUNCH CARDS

The hexadecimal equivalent (from Figure 2) may be placed on 80 column IBM punch cards as follows:

#### Step Column

- |   |       |  |
|---|-------|--|
| 1 | 12    | Byte "0" Hexadecimal equivalent for outputs Q7 thru Q4 (Q7 = M.S.B.) |
| 2 | 13    | Byte "0" Hexadecimal equivalent for outputs Q3 thru Q0 (Q3 = M.S.B.) |
| 3 | 14-75 | Alternate steps 1 and 2 for consecutive bytes.                       |
| 4 | 77-80 | Card number (starting 0001)<br>Total number of cards (64)            |

FIGURE 3 - FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68A316A MOS READ ONLY MEMORY			
Customer:			
Company _____		Motorola Use Only:	
Part No. _____		Quote: _____	
Originator _____		Part No.: _____	
Phone No. _____		Specif. No.: _____	
Chip Select:			
S1		Active High <input type="checkbox"/>	Active Low <input type="checkbox"/>
S2		<input type="checkbox"/>	<input type="checkbox"/>
S3		<input type="checkbox"/>	<input type="checkbox"/>
*Don't Care (No Connect)			
*A don't care must always be the highest order Chip Select(s).			



**MOTOROLA**

## MCM68A316E

### 2048 X 8 BIT READ ONLY MEMORY

The MCM68A316E is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

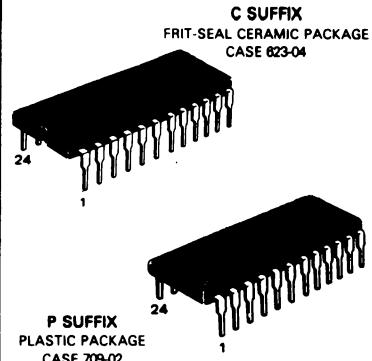
The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. Memory expansion is provided through multiple Chip Select inputs. The active level of the Chip Select inputs and the memory content are defined by the user.

- Fully Static Operation
- Three-State Data Output
- Mask-Programmable Chip Selects for Simplified Memory Expansion
- Single  $\pm 10\%$  5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 350 ns
- Plug-in Compatible with 2316E
- Pin Compatible with 2708 and TMS2716 EPROMs

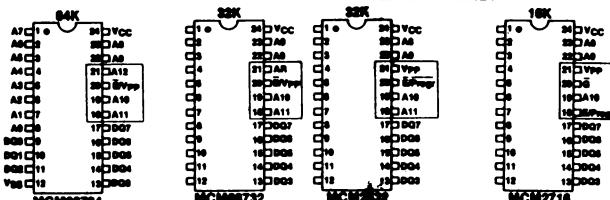
### MOS

(IN-CHANNEL, SILICON-GATE)

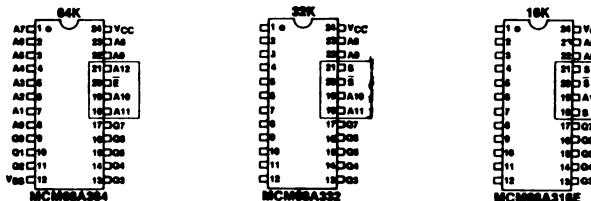
### 2048 X 8 BIT READ ONLY MEMORY



### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY



### INDUSTRY STANDARD PINOUTS

### PIN ASSIGNMENT

A7	1	24	V <sub>CC</sub>
A6	2	23	I <sub>A8</sub>
A5	3	22	I <sub>A9</sub>
A4	4	21	I <sub>S3</sub>
A3	5	20	I <sub>S1</sub>
A2	6	19	I <sub>A10</sub>
A1	7	18	I <sub>S2</sub>
A0	8	17	I <sub>Q7</sub>
Q0	9	16	I <sub>Q8</sub>
Q1	10	15	I <sub>Q6</sub>
Q2	11	14	I <sub>Q4</sub>
V <sub>SS</sub>	12	13	I <sub>Q3</sub>

### PIN NAMES

A0-A10 . . .	Address Inputs
S1-S3 . . .	Chip Selects
Q0-Q7 . . .	Data Output
V <sub>CC</sub> . . .	+5 V Power Supply
V <sub>SS</sub> . . .	Ground

# MCM68A316E

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V <sub>d</sub> c
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	V <sub>d</sub> c
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	V <sub>d</sub> c

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	2.5	μA <sub>d</sub> c
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	V <sub>d</sub> c
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	0.4	V <sub>d</sub> c
Output Leakage Current (Three-State) (S = 0.8 V or S = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	10	μA <sub>d</sub> c
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	130	mA <sub>d</sub> c

### ABSOLUTE MAXIMUM RATINGS (See Note 1)

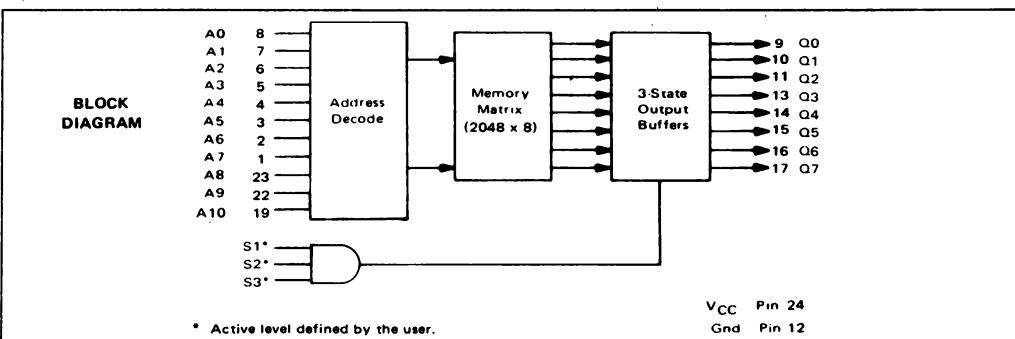
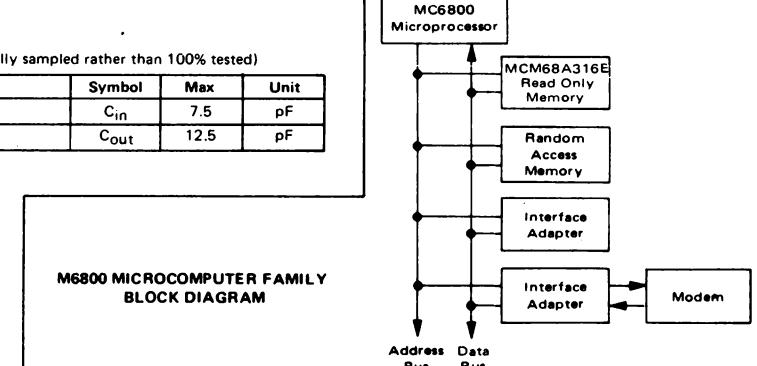
Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	V <sub>d</sub> c
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	V <sub>d</sub> c
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

NOTE 1: 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.

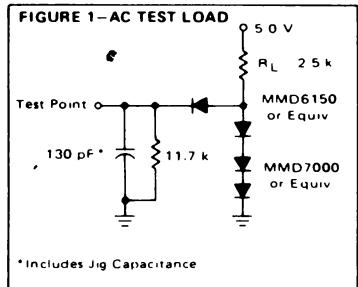
### CAPACITANCE

(f = 2.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	7.5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF



\* Active level defined by the user.



This device contains 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 this high-impedance circuit.

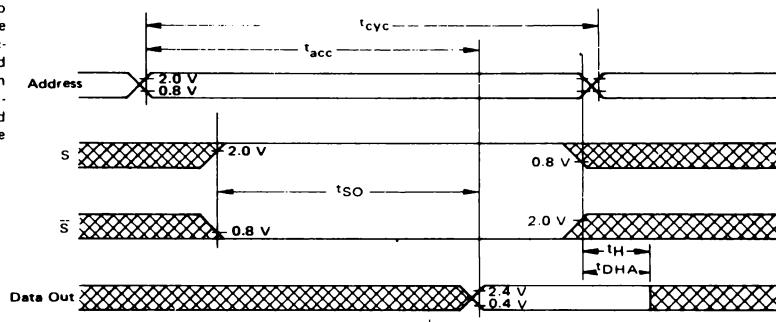
#### AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted.)

All timing with  $t_r = t_f = 20$  ns, Load of Figure 1)

Characteristic	Symbol	Min	Max	Unit
Cycle Time	$t_{cyc}$	350	—	ns
Access Time	$t_{acc}$	—	350	ns
Chip Select to Output Delay	$t_{SO}$	—	150	ns
Data Hold from Address	$t_{DHA}$	10	—	ns
Data Hold from Deselection	$t_H$	10	150	ns

#### TIMING DIAGRAM



# MCM68A316E

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68A316E, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68A316E should be submitted on an Organizational Data form such as that shown in Figure 3. ("No-Connect" must always be the highest order Chip Select(s).)

Information for custom memory content may be sent to Motorola in one of three forms (shown in order of preference):

1. Paper tape output of the Motorola M6800 Software.
2. Hexadecimal coding using IBM Punch Cards.
3. EPROM (TMS2716 or MCM2716).

### PAPER TAPE

Included in the software packages developed for the M6800 Microcomputer Family is the ability to produce a paper tape output for computerized mask generation. The assembler directives are used to control allocation of memory, to assign values for stored data, and for controlling the assembly process. The paper tape must specify the full 2048 bytes.

FIGURE 2 - BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

### IBM PUNCH CARDS

The hexadecimal equivalent (from Figure 2) may be placed on **80** column IBM punch cards as follows:

Step Column

- |   |       |  |
|---|-------|--|
| 1 | 12    | Byte "0" Hexadecimal equivalent for outputs Q7 thru Q4 (Q7 = M.S.B.) |
| 2 | 13    | Byte "0" Hexadecimal equivalent for outputs Q3 thru Q0 (Q3 = M.S.B.) |
| 3 | 14-75 | Alternate steps 1 and 2 for consecutive bytes.                       |
| 4 | 77-80 | Card number (starting 0001)<br>Total number of cards (64)            |

FIGURE 3 - FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68A316E MOS READ ONLY MEMORY				
Customer:				
Company _____		Motorola Use Only:		
Part No. _____		Quote: _____		
Originator _____		Part No.: _____		
Phone No. _____		Specif. No.: _____		
Chip Select:		Active High	Active Low	No Connect
S1		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S2		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
S3		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



**MOTOROLA**

### 4096 X 8-BIT READ ONLY MEMORY

The MCM68A332 is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. Memory expansion is provided through multiple Chip Select inputs. The active level of the Chip Select inputs and the memory content are defined by the user.

- Fully Static Operation
- Three-State Data Output for OR-Ties
- Mask-Programmable Chip Selects for Simplified Memory Expansion
- Single  $\pm 10\%$  5-Volt Power Supply
- Fully TTL Compatible
- Maximum Access Time = 350 ns
- Directly Compatible with 4732
- Pin Compatible with 2708 and 2716 EPROMs
- Preprogrammed MCM68A332-2 Available

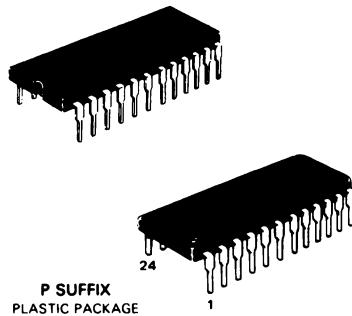
**MCM68A332**

**MOS**

(IN CHANNEL, SILICON-GATE)

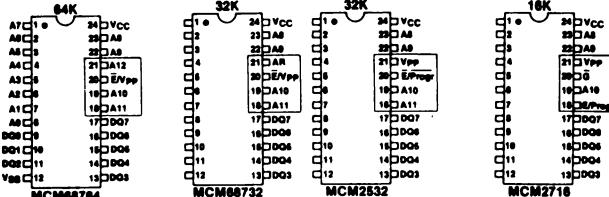
**4096 X 8-BIT  
READ ONLY MEMORY**

**C SUFFIX**  
FRIT-SEAL CERAMIC PACKAGE  
CASE 623-04

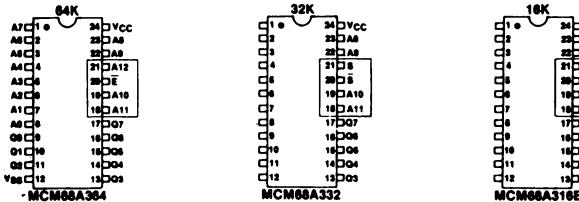


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 709-02

### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY



### INDUSTRY STANDARD PINOUTS

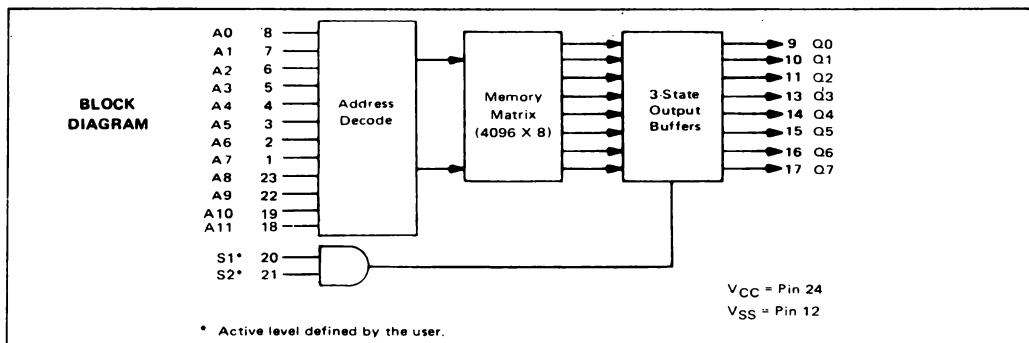
### PIN ASSIGNMENT

A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	S2
A3	5	20	ST
A2	6	19	A10
A1	7	18	A11
A0	8	17	Q7
Q0	9	16	Q6
Q1	10	15	Q5
Q2	11	14	Q4
VSS	12	13	Q3

### PIN NAMES

A0-A11	Address Inputs
S	Programmable Chip Selects
Q0-Q7	Data Output
VCC	+5 V Power Supply
VSS	Ground

# MCM68A332



## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter .	Symbol	Min	Typ	Max	Unit
Supply Voltage (V <sub>CC</sub> must be applied at least 100 $\mu$ s before proper device operation is achieved.)	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### DC CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	2.5	$\mu$ Adc
Output High Voltage (I <sub>OH</sub> = -205 $\mu$ A)	V <sub>OH</sub>	2.4	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 1.6 mA)	V <sub>OL</sub>	—	0.4	Vdc
Output Leakage Current (Three-State) (S = 0.8 V or S = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	10	$\mu$ Adc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	80	mAdc

### ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

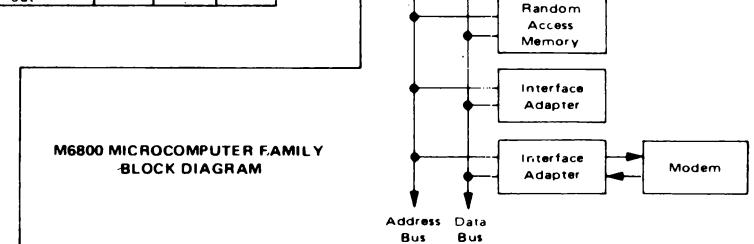
NOTE 1 Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

This device contains 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 this high-impedance circuit.

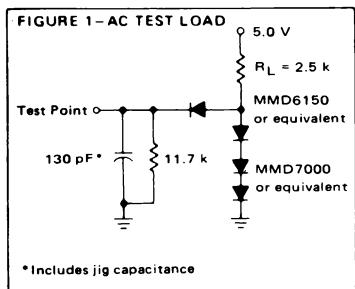
### CAPACITANCE

(f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance	C <sub>in</sub>	5.0	7.5	pF
Output Capacitance	C <sub>out</sub>	9.0	12.5	pF



# MCM68A332

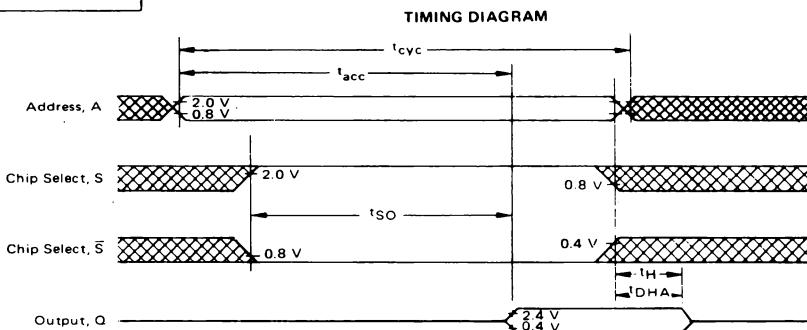


## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted.)

All timing with  $t_r = t_f = 20$  ns, Load of Figure 1

Characteristic	Symbol	Min	Max	Unit
Cycle Time	$t_{cyc}$	350	..	ns
Access Time	$t_{acc}$	—	350	ns
Chip Select to Output Delay	$t_{SO}$	..	150	ns
Data Hold from Address	$t_{DHA}$	10	..	ns
Data Hold from Deselection	$t_H$	10	150	ns



Waveform Symbol	Input	Output	Waveform Symbol	Input	Output	Waveform Symbol	Input	Output
—	MUST BE VALID	WILL BE VALID	X	DON'T CARE ANY CHANGE PERMITTED	CHANGING STATE UNKNOWN	—		HIGH IMPEDANCE

# MCM68A332

## MCM68A332 CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68A332, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68A332 should be submitted on an Organizational Data form such as that shown in Figure 3. (A "No-Connect" or "Don't Care" must always be the highest order Chip Select(s).)

Information for custom memory content may be sent to Motorola in one of four forms (shown in order of preference):

1. IBM Punch Cards:
  - A. Hexadecimal Format
  - B. Intel Format
  - C. Binary Negative-Positive Format
2. EPROMs—two 16K (MCM2716 or TMS2716) or four 8K (MCM2708)
3. Paper tape output of the Motorola M6800 software
4. Hand punched paper tape

### PAPER TAPE

Included in the software packages developed for the M6800 Microcomputer Family is the ability to produce a paper tape output for computerized mask generation. The assembler directives are used to control allocation of memory, to assign values for stored data, and for controlling the assembly process. The paper tape must specify the full 4096 bytes.

### IBM PUNCH CARDS, HEXADECIMAL FORMAT

The hexadecimal equivalent (from Figure 2) may be placed on 80 column IBM punch cards as follows:

#### Step Column

- |   |       |   |
|---|-------|---|
| 1 | 12    | Byte "0" Hexadecimal equivalent for outputs Q7 through Q4 (Q7 = M.S.B.) |
| 2 | 13    | Byte "0" Hexadecimal equivalent for outputs Q3 through Q0 (Q3 = M.S.B.) |
| 3 | 14-75 | Alternate steps 1 and 2 for consecutive bytes.                          |
| 4 | 77-79 | Card number (starting 001).   |
| 5 |       | Total number of cards must equal 128.                                   |

FIGURE 2 – BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

### PRE-PROGRAMMED MCM68A332P2, MCM68A332C2

The -2 standard ROM pattern contains sine-lookup and arctan-lookup tables.

Locations 0000 through 2001 contain the sine values. The sine's first quadrant is divided into 1000 parts with sine values corresponding to these angles stored in the ROM. Sin  $\pi/2$  is included and is rounded to 0.9999.

The arctan values contain angles in radians corresponding to the arc tangents of 0 through 1 in steps of 0.001 and are contained in locations 2048 through 4049.

Locations 2002 through 2047 and 4050 through 4095 are zero filled.

All values are represented in absolute decimal format with four digit precision. They are stored in BCD format with the two most significant digits in the lower byte and the two least significant digits in the upper byte. The decimal point is assumed to be to the left of the most significant digit.

Example: $\text{Sin}(\frac{1}{1000} \frac{\pi}{2}) = 0.0016$ decimal	
Address	Contents
0002	0000 0000
0003	0001 0110

FIGURE 3 – FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68A332 MOS READ ONLY MEMORY			
Customer:			
Company _____		Motorola Use Only	
Part No. _____		Quote _____	
Originator _____		Part No. _____	
Phone No. _____		Specif. No. _____	
Chip Select Options:		Active High	Active Low      No-Connect
		S1 <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
		S2 <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>



**MOTOROLA**

## MCM68A364 MCM68B364

### 8192 X 8-BIT READ ONLY MEMORY

The MCM68A364/MCM68B364 is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, and has compatibility with TTL. The addresses are latched with the Chip Enable input — no external latches required.

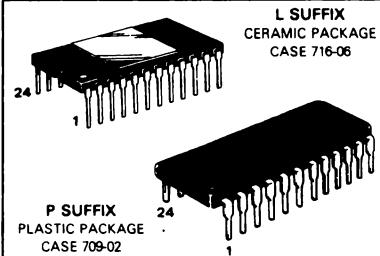
The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. The Chip Enable input deselects the output and puts the chip in a power-down mode.

- Automatic Power Down
- Low Power Dissipation — 150 mW active (typical)  
35 mW standby (typical)
- Single  $\pm 10\%$  5-Volt Power Supply
- High Output Drive Capability (2 TTL Loads)
- Three-State Data Output for OR-Ties
- TTL Compatible
- Maximum Access Time — 250 ns — MCM68B364  
350 ns — MCM68A364
- Pin Compatible with 8K — MCM68A308, 16K — MCM68A316E, and 32K — MCM68A332 Mask-Programmable ROMs
- Pin Compatible with 24-pin 64K EPROM MCM68764

### MOS

(N-CHANNEL, SILICON-GATE)

### 8192 X 8-BIT READ ONLY MEMORY

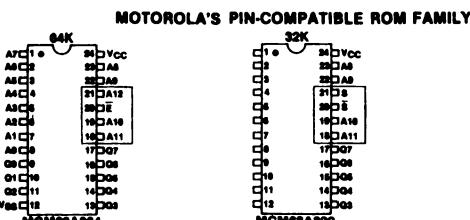
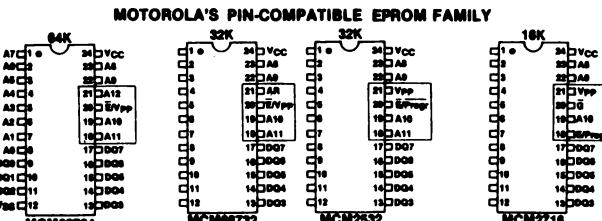


#### PIN ASSIGNMENT

A7	1	VCC
A6	2	A8
A5	3	A9
A4	4	A12
A3	5	E
A2	6	A10
A1	7	A11
A0	8	Q7
Q0	9	Q6
Q1	10	Q5
Q2	11	Q4
VSS	12	Q3

#### PIN NAMES

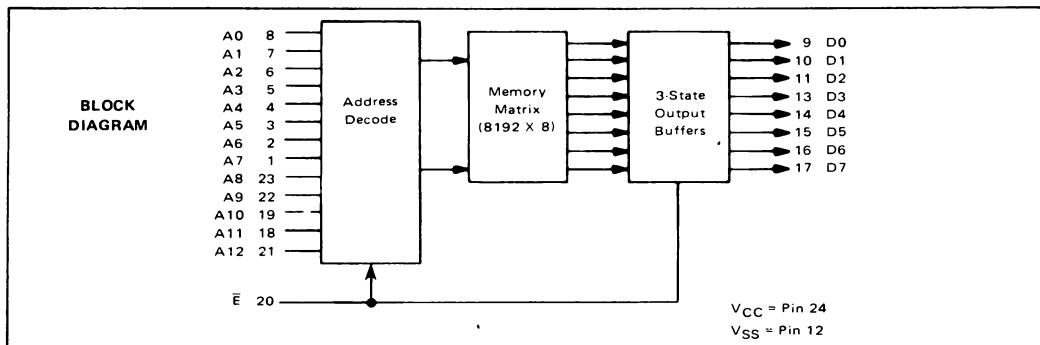
A0 - A12	Address
E	Chip Enable
Q0 - Q7	Data Output
VCC	+5 V Power Supply
VSS	Ground



#### INDUSTRY STANDARD PINOUTS

This device contains 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 this high-impedance circuit.

## MCM68A364•MCM68B364



### ABSOLUTE MAXIMUM RATINGS (See note)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.5 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.5 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°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.

### DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage (V <sub>CC</sub> must be applied at least 100 $\mu$ s before proper device operation is achieved)	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	Vdc
Input Low Voltage	V <sub>IL</sub>	-0.5	—	0.8	Vdc

### RECOMMENDED OPERATING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	i <sub>in</sub>	-10	—	10	$\mu$ Adc
Output High Voltage (I <sub>OH</sub> = -220 $\mu$ A)	V <sub>OH</sub>	2.4	—	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 3.2 mA)	V <sub>OL</sub>	—	—	0.4	Vdc
Output Leakage Current (Three-State) (E = 2.0 V, V <sub>out</sub> = 0 V to 5.5 V)	I <sub>LO</sub>	-10	—	10	$\mu$ Adc
Supply Current — Active* (Minimum Cycle Rate)	I <sub>CC</sub>	—	25	40	mAdc
Supply Current — Standby (E = V <sub>IH</sub> )	I <sub>SB</sub>	—	7	10	mAdc

\*Current is proportional to cycle rate.

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	8	pF
Output Capacitance	C <sub>out</sub>	15	pF

# MCM68A364•MCM68B364

## AC OPERATING CONDITIONS AND CHARACTERISTICS Read Cycle

### RECOMMENDED OPERATING CONDITIONS

( $T_A = 0$  to  $70^\circ\text{C}$ ,  $V_{CC} = 5.0 \text{ V} \pm 10\%$ . All timing with  $t_r = t_f = 20 \text{ ns}$ , load of Figure 1)

Parameter	Symbol	MCM68B364		MCM68A364		Unit
		Min	Max	Min	Max	
Chip Enable Low to Chip Enable Low of Next Cycle (Cycle Time)	$\text{t}_{EEL}$	375	—	450	—	ns
Chip Enable Low to Chip Enable High	$\text{t}_{ELEH}$	250	—	300	—	ns
Chip Enable Low to Output Valid (Access)	$\text{t}_{ELQV}$	—	250	—	300	ns
Chip Enable High to Output High Z (Off Time)	$\text{t}_{EHQZ}$	—	60	—	75	ns
Chip Enable Low to Address Don't Care (Hold)	$\text{t}_{ELAX}$	60	—	75	—	ns
Address Valid to Chip Enable Low (Address Setup)	$\text{t}_{AVEL}$	0	—	0	—	ns
Chip Enable Precharge Time	$\text{t}_{EHEL}$	125	—	150	—	ns

### TIMING DIAGRAM

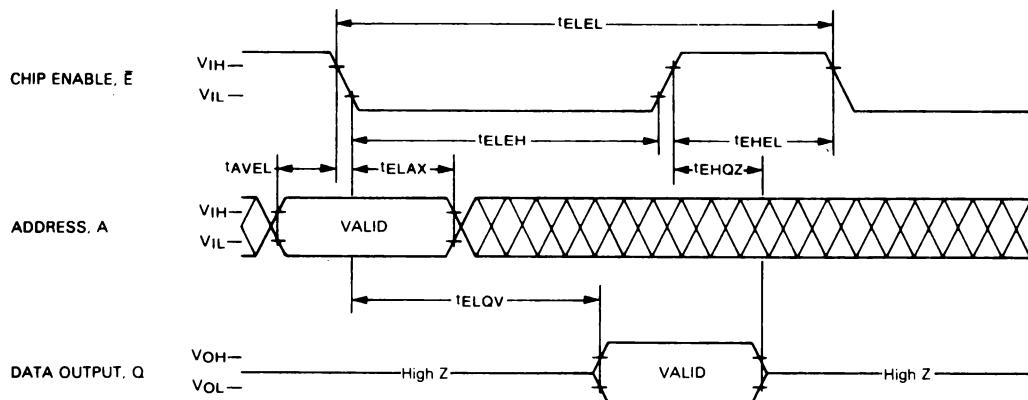
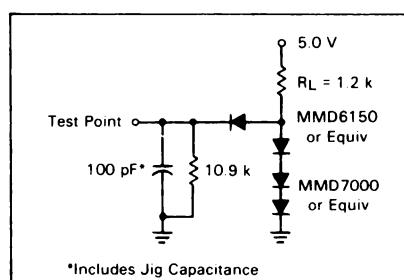


FIGURE 1 – AC TEST LOAD

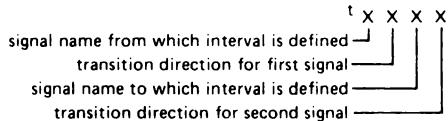


### WAVEFORMS

Waveform Symbol	Input	Output
—	MUST BE VALID	WILL BE VALID
	CHANGE FROM H TO L	WILL CHANGE FROM H TO L
	CHANGE FROM L TO H	WILL CHANGE FROM L TO H
	DON'T CARE ANY CHANGE PERMITTED	CHANGING STATE UNKNOWN
		HIGH IMPEDANCE

# MCM68A364•MCM68B364

## TIMING PARAMETER ABBREVIATIONS



The transition definitions used in this data sheet are:

- H = transition to high
- L = transition to low
- V = transition to valid
- X = transition to invalid or don't care
- Z = transition to off (high impedance)

## 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.

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68A364/MCM68B364, the customer may specify the contents of the memory.

Information for custom memory content may be sent to Motorola in one of two forms (shown in order of preference):

1. Magnetic Tape — 9 Track, 800 bpi, odd parity written in EBCDIC character code. Motorola's R.O.M.S. format.
2. EPROMs — one 64K (MCM68764), two 32K (MCM2532), four 16K (MCM2716 or TMS2716), or eight 8K (MCM2708).
3. IBM Punch Cards
  - A. Hexadecimal Format
  - B. INTEL Hexadecimal Format

## IBM PUNCH CARDS, HEXADECIMAL FORMAT

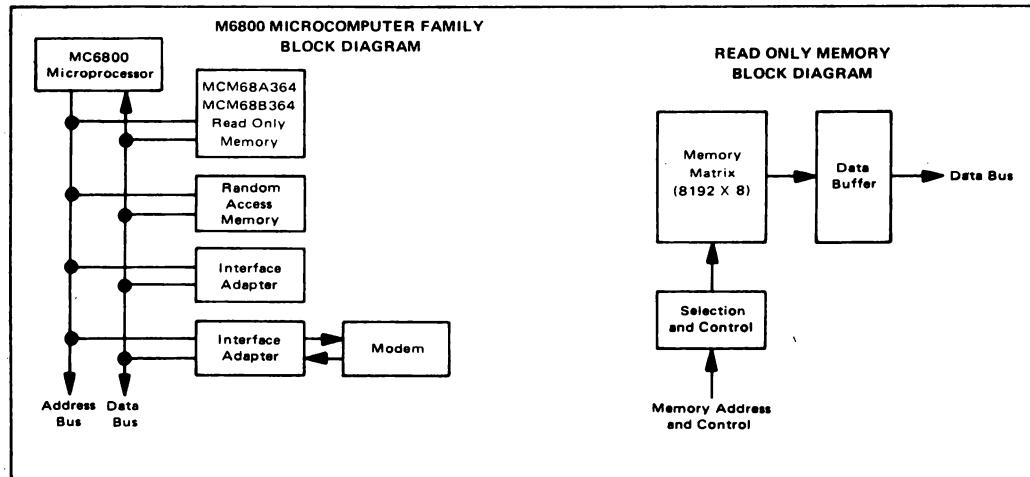
The hexadecimal equivalent (from Figure 2) may be placed on 80 column IBM punch cards as follows:

Step	Column	
1	12	Byte "0" Hexadecimal equivalent for outputs Q7 through Q4 (Q7=M.S.B.)
2	13	Byte "0" Hexadecimal equivalent for outputs Q3 through Q0 (Q3=M.S.B.)
3	14-75	Alternate steps 1 and 2 for consecutive bytes
4	77-79	Card number (starting 001)
5		Total number of cards must equal 256

FIGURE 2 - BINARY TO HEXADECIMAL CONVERSION

Binary Data				Hexadecimal Character
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	A
1	0	1	1	B
1	1	0	0	C
1	1	0	1	D
1	1	1	0	E
1	1	1	1	F

# MCM68A364•MCM68B364



## PRE-PROGRAMMED MCM68A364P3/L3

The -3 standard ROM pattern contains log (base 10) and antilog (base 10) lookup tables for the 64K ROM.

Locations 0000 through 3599 contain log base 10 values. The arguments for the log table range from 1.00 through 9.99 incrementing in steps of 1/100. Each log value is represented by an eight-digit decimal number with decimal point assumed to be to the left of the most-significant digit.

Antilog (base 10) are stored in locations 4096 through 8095. The arguments range from .000 through .999 incrementing in steps of 1/1000. Each antilog value is

represented by an eight-digit decimal number with decimal point assumed to be to the right of the most-significant digit.

Locations 3600 through 4095 and 8096 through 8191 are zero filled.

All values are represented in absolute decimal format with eight digit precision. They are stored in BCD format with the two most significant digits in the lower byte and the remaining six digits in the three consecutive locations.

Example:  
 $\log_{10}(1.01) = .00432137$  decimal

Address	Contents
4	0000 0000
5	0100 0011
6	0010 0001
7	0011 0111



**MOTOROLA**

## Advance Information

### 8192 × 8-BIT READ ONLY MEMORY

The MCM68365 is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL, and needs no clocks or refreshing because of static operation.

The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. The active level of the Chip Enable input and the memory content is defined by the user. The Chip Enable input deselects the output and puts the chip in a power-down mode.

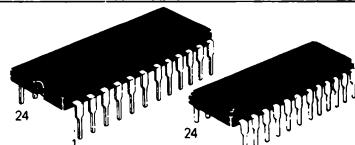
- Fully Static Operation
- Automatic Power Down
- Low Power Dissipation — 225 mW Active (Typical)  
30 mW Standby (Typical)
- Single  $\pm$  10% 5-Volt Power Supply
- High Output Drive Capability (2 TTL Loads)
- Three-State Data Output for OR-Ties
- Mask Programmable Chip Enable
- TTL Compatible
- Maximum Access Time — 250 ns — MCM68365-25  
350 ns — MCM68365-35
- Pin Compatible with 8K — MCM68A308, 16K — MCM68A316E, and 32K — MCM68A332 Mask-Programmable ROMs

## MCM68365

### MOS

(N-CHANNEL, SILICON-GATE)

### 8192 × 8-BIT READ ONLY MEMORY



C SUFFIX  
FRIT-SEAL  
CERAMIC PACKAGE  
CASE 623

P SUFFIX  
PLASTIC PACKAGE  
CASE 709

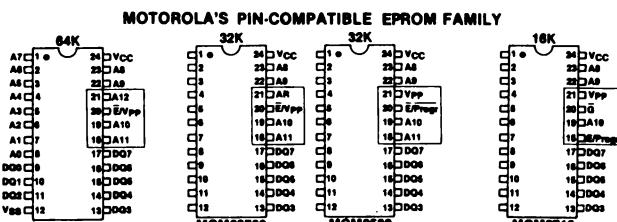
### PIN ASSIGNMENT

A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	A12
A3	5	20	E
A2	6	19	A10
A1	7	18	A11
A0	8	17	Q7
Q0	9	16	Q6
Q1	10	15	Q5
Q2	11	14	Q4
VSS	12	13	Q3

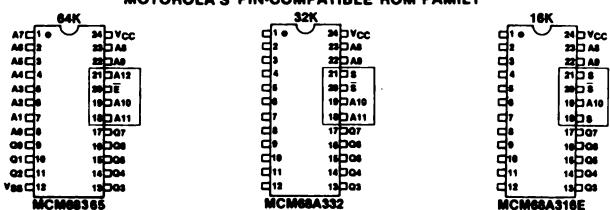
### PIN NAMES

A0-A12	..... Address
E	..... Chip Enable
Q0-Q7	..... Data Output
VCC	..... + 5 V Power Supply
VSS	..... Ground

This device contains 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 this high impedance circuit.



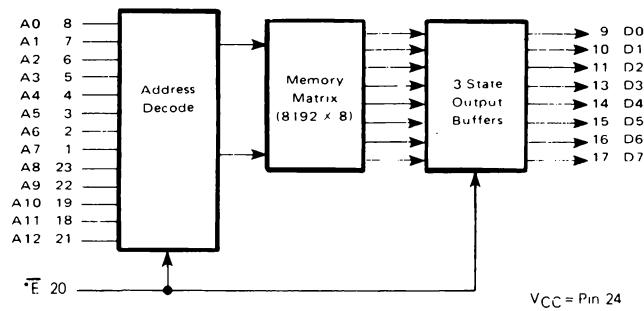
### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY



### INDUSTRY STANDARD PINOUTS

# MCM68365

BLOCK DIAGRAM



\* Active level defined by the user

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	V
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage (V <sub>CC</sub> must be applied at least 100 μs before proper device operation is achieved)	V <sub>CC</sub>	4.5	5.0	5.5	V
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	V

### RECOMMENDED OPERATING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	—	10	μA
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	—	V
Output Low Voltage (I <sub>OL</sub> = 3.2 mA)	V <sub>OL</sub>	—	—	0.4	V
Output Leakage Current (Three-State) (E = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	—	10	μA
Supply Current - Active (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	45	80	mA
Supply Current - Standby (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C, E = V <sub>IH</sub> )	I <sub>SB</sub>	—	6.0	15	mA

### CAPACITANCE

(f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	7.5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF

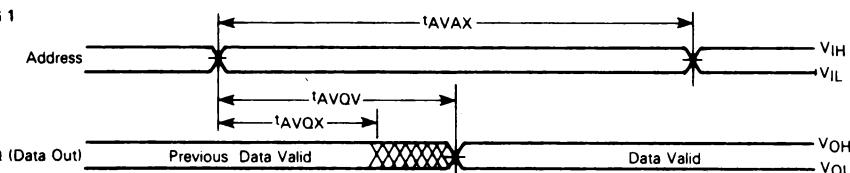
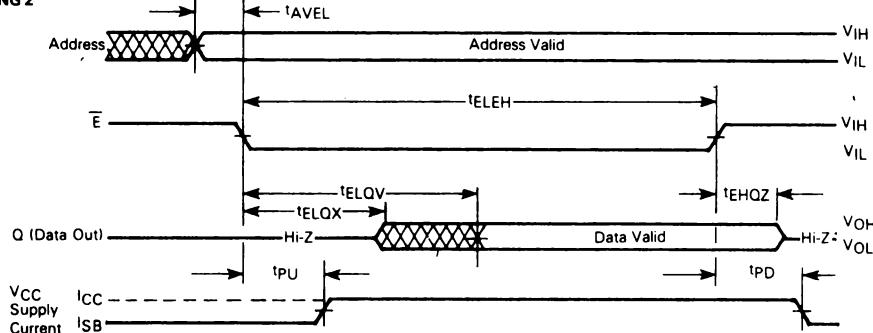
**AC OPERATING CONDITIONS AND CHARACTERISTICS**  
**Read Cycle**

**RECOMMENDED OPERATING CONDITIONS**(TA = 0 to 70°C, VCC = 5.0 V ± 10%. All timing with t<sub>r</sub> = t<sub>f</sub> = 10 ns, load of Figure 1)

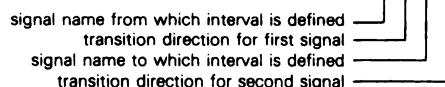
Parameter	Symbol	MCM68365-25		MCM68365-36	
		Min	Max	Min	Max
Address Valid to Address Don't Care (Cycle Time when Chip Enable is held Active)	tAVAX	250	—	350	—
Chip Enable Low to Chip Enable High	tELEH	250	—	350	—
Address Valid to Output Valid (Access)	tAVQV	—	250	—	350
Chip Enable Low to Output Valid (Access)	tELOV	—	250	—	350
Address Valid to Output Invalid	tAVQX	10	—	10	—
Chip Enable Low to Output Invalid	tELQX	10	—	10	—
Chip Enable High to Output High-Z	tEHQZ	0	70	0	80
Chip Selection to Power Up Time	tPU	0	—	0	—
Chip Deselection to Power Down Time	tPD	—	100	—	120
Address Valid to Chip Enable Low (Address Setup)	tAVEL	0	—	0	—

**READ CYCLE TIMING 1**

(E Held Low)

**READ CYCLE TIMING 2****TIMING PARAMETER ABBREVIATIONS**

t X X X X



The transition definitions used in this data sheet are:

H = transition to high

L = transition to low

V = transition to valid

X = transition to invalid or don't care

Z = transition to off (high impedance)

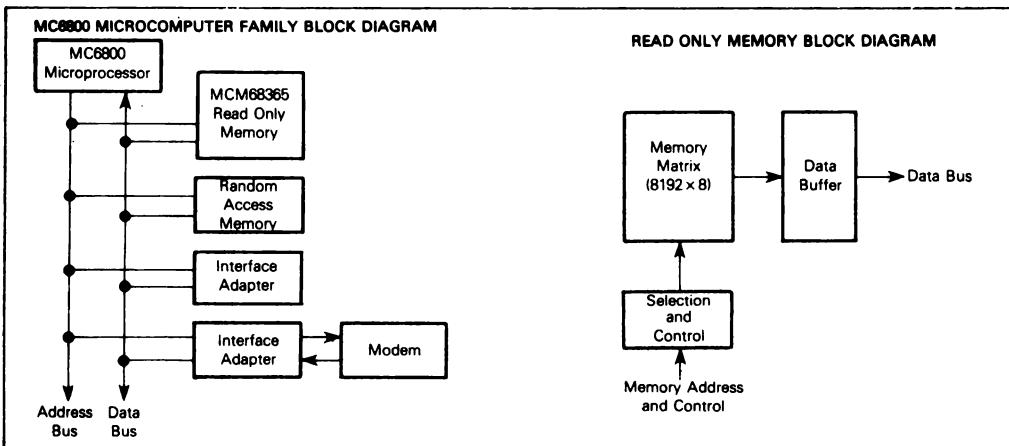
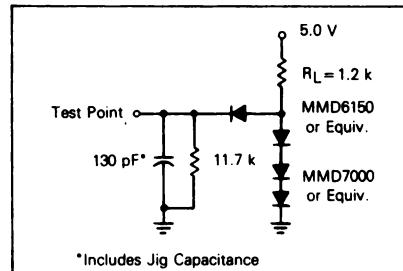
**TIMING LIMITS**

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.

# MCM68365

Waveform Symbol	WAVEFORMS	
	Input	Output
	Must Be Valid	Will Be Valid
	Change From H to L	Will Change From H to L
	Change From L to H	Will Change From L to H
	Don't Care: Any Change Permitted	Changing: State Unknown
		High Impedance

FIGURE 1 — AC TEST LOAD



## PRE-PROGRAMMED MCM68365P35-3/C35-3, MCM68365P25-3/C25-3

The -3 standard ROM pattern contains log (base 10) and antilog (base 10) lookup tables for the 64K ROM.

Locations 0000 through 3599 contain log base 10 values. The arguments for the log table range from 1.00 through 9.99 incrementing in steps of 1/100. Each log value is represented by an eight-digit decimal number with decimal point assumed to be to the left of the most-significant digit.

Antilog (base 10) are stored in locations 4096 through 8095. The arguments range from .000 through .999 incrementing in steps of 1/1000. Each antilog value is represented by an eight-digit decimal number with decimal point assumed to be to the right of the most-significant digit.

Locations 3600 through 4095 and 8096 through 8191 are zero filled.

All values are represented in absolute decimal format with eight digit precision. They are stored in BCD format with the two most significant digits in the lower byte and the remaining six digits in the three consecutive locations.

Example:  $\log_{10}(1.01) = 0.00432137$  decimal

Address	Contents
4	0000 0000
5	0100 0011
6	0010 0001
7	0011 0111

# MCM68365

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68365, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68365 should be submitted on an Organizational Data form such as that shown in Figure 2.

Information for custom memory content may be sent to Motorola in one of two forms (shown in order of preference):

1. Magnetic Tape  
9 track, 800 bpi, odd parity written in EBCDIC character code. Motorola R.O.M.S. format.
2. EPROMs — four 16K (MCM2716, or TMS2716, or eight 8K (MCM2708), one 64K or two 32K)

FIGURE 2 — FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68365 MOS READ ONLY MEMORY	
Customer:	
Company	_____
Part No.	_____
Originator	_____
Phone No.	_____
Motorola Use Only:	
Quote:	_____
Part No.:	_____
Specif. No.:	_____
Enable Options:	
Active High   Active Low	
Chip Enable	<input type="checkbox"/> <input checked="" type="checkbox"/>



**MOTOROLA**

# MCM68366

## Advance Information

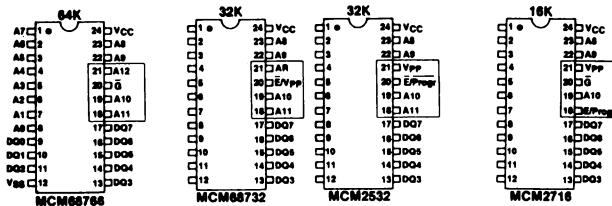
### 8192×8-BIT READ ONLY MEMORY

The MCM68366 is a mask-programmable byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

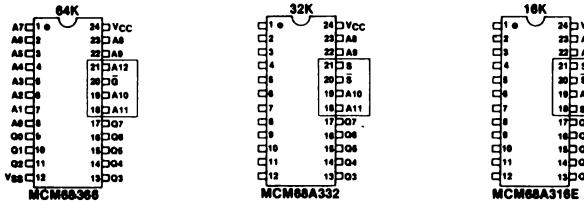
The memory is compatible with the M6800 Microcomputer Family, providing read only storage in byte increments. The active level of the Output Enable input and the memory content is defined by the user. The Output Enable input deselects the output.

- Fully Static Operation
- Fast Data Valid Time for High Speed Microprocessors
- Low Power Dissipation – 225 mW Active (Typical)
- Single  $\pm 10\%$  5-Volt Power Supply
- High Output Drive Capability (2 TTL Loads)
- Three-State Data Output for OR-Ties
- Mask Programmable Output Enable
- TTL Compatible
- Maximum Access Time – 120 ns from Output Enable  
250 ns from Address – MCM68366-25  
350 ns from Address – MCM68366-35
- Pin Compatible with 8K and 32K – Mask-Programmable ROMs
- Pin Compatible with MCM68766 64K EPROM

### MOTOROLA'S PIN-COMPATIBLE EPROM FAMILY



### MOTOROLA'S PIN-COMPATIBLE ROM FAMILY

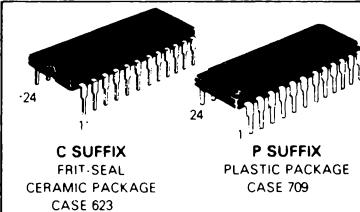


### INDUSTRY STANDARD PINOUTS

## MOS

(IN-CHANNEL, SILICON-GATE)

### 8192×8-BIT READ ONLY MEMORY



### PIN ASSIGNMENT

A7	1	V <sub>CC</sub>
A6	2	A8
A5	3	A9
A4	4	A12
A3	5	G
A2	6	A10
A1	7	A11
A0	8	Q7
Q0	9	Q6
Q1	10	Q5
Q2	11	Q4
VSS	12	Q3

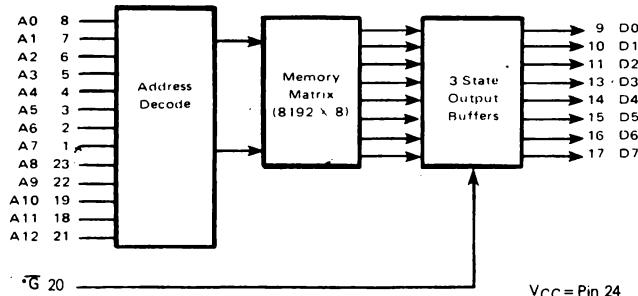
### PIN NAMES

A0-A12.....	Address
G.....	Output Enable
Q0-Q7.....	Data Output
V <sub>CC</sub> .....	+5 V Power Supply
V <sub>SS</sub> .....	Ground

This device contains 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 this high impedance circuit.

# MCM68366

BLOCK DIAGRAM



\*Active Level Defined by the User

## ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	Vdc
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	Vdc
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

NOTE 1: 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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage IV <sub>CC</sub> must be applied at least 100 μs before proper device operation is achieved)	V <sub>CC</sub>	4.5	5.0	5.5	Vdc
Input High Voltage	V <sub>IH</sub>	2.0	—	5.5	—
Input Low Voltage	V <sub>IL</sub>	-0.3	—	0.8	Vdc

### RECOMMENDED OPERATING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (V <sub>in</sub> = 0 to 5.5 V)	I <sub>in</sub>	—	—	10	μA/dc
Output High Voltage (I <sub>OH</sub> = -205 μA)	V <sub>OH</sub>	2.4	—	—	Vdc
Output Low Voltage (I <sub>OL</sub> = 3.2 mA)	V <sub>OL</sub>	—	—	0.4	Vdc
Output Leakage Current (Three-State) (G = 2.0 V, V <sub>out</sub> = 0.4 V to 2.4 V)	I <sub>LO</sub>	—	—	10	μA/dc
Supply Current (V <sub>CC</sub> = 5.5 V, T <sub>A</sub> = 0°C)	I <sub>CC</sub>	—	45	80	mADC

### CAPACITANCE

(f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	7.5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF

# MCM68366

## AC OPERATING CONDITIONS AND CHARACTERISTICS Read Cycle

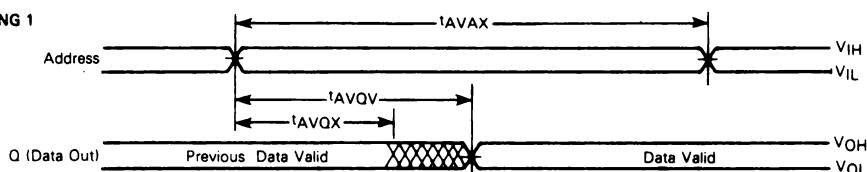
### RECOMMENDED OPERATING CONDITIONS

( $T_A = 0$  to  $70^\circ\text{C}$ ,  $V_{CC} = 5.0 \text{ V} \pm 10\%$ . All timing with  $t_r = t_f = 10 \text{ ns}$ , load of Figure 1)

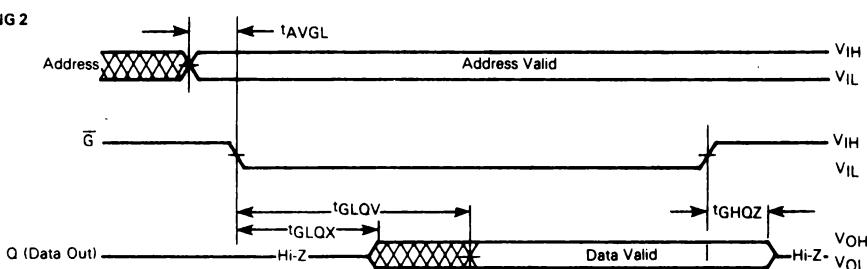
Parameter	Symbol	MCM68366-25		MCM68366-35		Unit
		Min	Max	Min	Max	
Address Valid to Address Don't Care (Cycle Time when Output Enable is Held Active)	$t_{AVAX}$	250	—	350	—	ns
Address Valid to Output Valid (Access)	$t_{AVQV}$	—	250	—	350	ns
Output Enable Low to Output Valid (Access)	$t_{GLQV}$	—	120	—	120	ns
Address Valid to Output Invalid	$t_{AVQX}$	10	—	10	—	ns
Output Enable Low to Output Invalid	$t_{GLQX}$	10	—	10	—	ns
Output Enable High to Output High-Z	$t_{GHQZ}$	0	70	0	80	ns
Address Valid to Output Enable Low (Address Setup)	$t_{AVQL}$	0	—	0	—	ns

### READ CYCLE TIMING 1

$\cdot \bar{G}$  Hold Low)



### READ CYCLE TIMING 2



# MCM68366

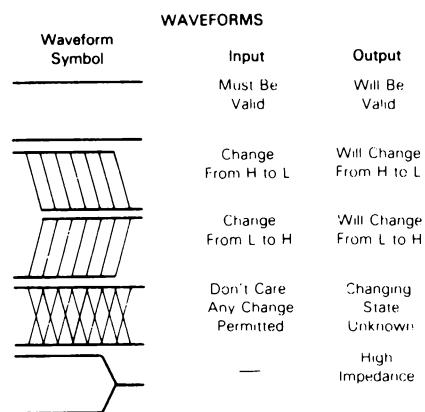
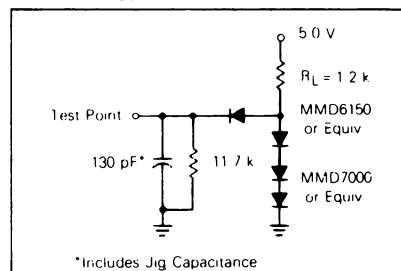
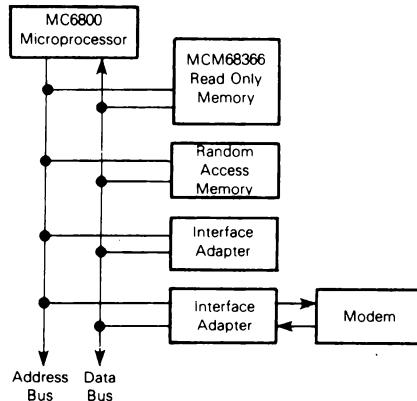


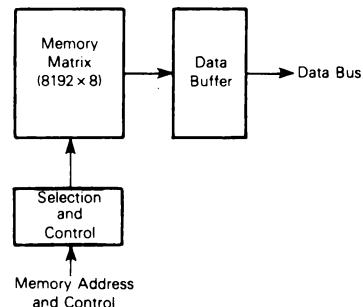
FIGURE 1 – AC TEST LOAD



MC6800 MICROCOMPUTER FAMILY BLOCK DIAGRAM



READ ONLY MEMORY BLOCK DIAGRAM



## PRE-PROGRAMMED MCM68366P35-3/C35-3, MCM68366P25-3/C25-3

The -3 standard ROM pattern contains log (base 10) and antilog (base 10) lookup tables for the 64K ROM.

Locations 0000 through 3599 contain log base 10 values. The arguments for the log table range from 1.00 through 9.99 incrementing in steps of 1/100. Each log value is represented by an eight-digit decimal number with decimal point assumed to be to the left of the most-significant digit.

Antilog (base 10) are stored in locations 4096 through 8095. The arguments range from 0.000 through 0.999 incrementing in steps of 1/1000. Each antilog value is represented by an eight-digit decimal number with decimal point assumed to be to the right of the most-significant digit.

Locations 3600 through 4095 and 8096 through 8191 are zero filled.

All values are represented in absolute decimal format with eight digit precision. They are stored in BCD format with the two most significant digits in the lower byte and the remaining six digits in the three consecutive locations.

Example:  $\log_{10} (1.01) = .00432137$  decimal

Address	Contents
4	0000. 0000
5	0100 0011
6	0010 0001
7	0011 0111

# MCM68366

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM68366, the customer may specify the content of the memory and the method of enabling the outputs.

Information on the general options of the MCM68366 should be submitted on an Organizational Data form such as that shown in Figure 3.

Information for custom memory content may be sent to Motorola in one of two forms (shown in order of preference):

1. Magnetic Tape  
9 track, 800 bpi, odd parity written in EBCDIC character Code. Motorola's R.O.M.S. format.
2. EPROMs – one 64K (MCM68764, MCM68766), two 32K (MCM2532), four 16K (MCM2716, or TMS2716), or eight 8K (MCM2708).

FIGURE 3 – FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MCM68366 MOS READ ONLY MEMORY	
<b>Customer:</b>	
Company	_____
Part No.	_____
Originator	_____
Phone No.	_____
<b>Enable Options:</b>	
Active High Active Low	
Output Enable	<input type="checkbox"/> <input checked="" type="checkbox"/>
<b>Motorola Use Only:</b>	
Quote	_____
Part No.	_____
Specif. No.	_____



# MOTOROLA Semiconductors

# MCM2802

## Advance Information

### 32 × 32 BIT SERIAL ELECTRICALLY ERASABLE PROM

The MCM2802 is a 1K-bit serial Electrically Erasable PROM designed for applications requiring both non-volatile memory and in-system information updates. In digital tuning systems, it provides storage for up to 32 channels. It has external control of timing functions and serial format for data and address.

- Single 5V supply in Read mode
- 5V and 25V supply for Erase and Program
- In-System Program/Erase Capability
- 0-100kHz clock rate
- Floating gate process
- Expandable to 16K-bit systems
- Word and Array erasable

## MOS

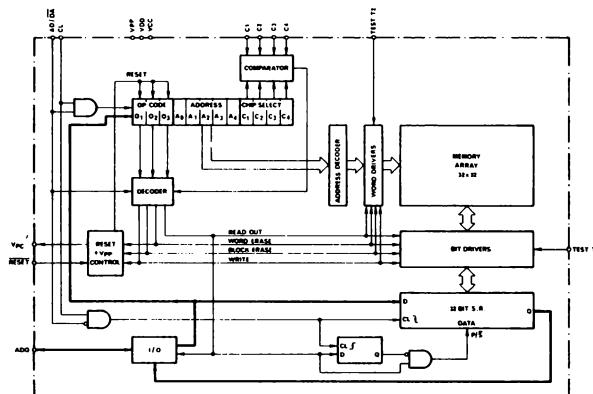
(N-CHANNEL, SILICON GATE)

### 32 × 32 BIT ELECTRICALLY ERASABLE PROM

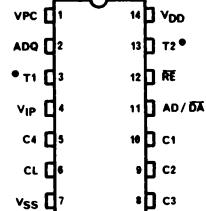


P SUFFIX CERAMIC PACKAGE  
CASE 632.06  
PLASTIC PACKAGE ALSO AVAILABLE  
CASE 646.05

FIGURE 1 – BLOCK DIAGRAM



## PIN ASSIGNMENT



\* For normal operation, hardwired to V<sub>SS</sub>.

## PIN NAMES

VPC	.....	Program Voltage Control
ADQ	.....	Address Input + Data Input/Output
T1, T2	.....	Margin Testing
C1, C2, C3, C4	.....	Chip Address 1 to 4
CL	.....	Clock
RE	.....	Reset
AD/DA	.....	Shift Register Select

This device contains 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 this high impedance circuit.

**ABSOLUTE MAXIMUM RATINGS (Voltages referred to V<sub>SS</sub>)**

Rating	Symbol	Min	Max	Unit
DC Supply Voltage	V <sub>DD</sub>	- 0,5	8	Vdc
Programming Voltage	V <sub>PP</sub>	- 0,5	28	Vdc
Input Voltage	V <sub>IN</sub>	- 0,5	8	Vdc
VP Control Output	V <sub>PC</sub>	- 0,5	28	Vdc
Operating Temperature Range	T <sub>A</sub>	- 40	85	°C
Storage Temperature Range	T <sub>STC</sub>	- 55	150	°C

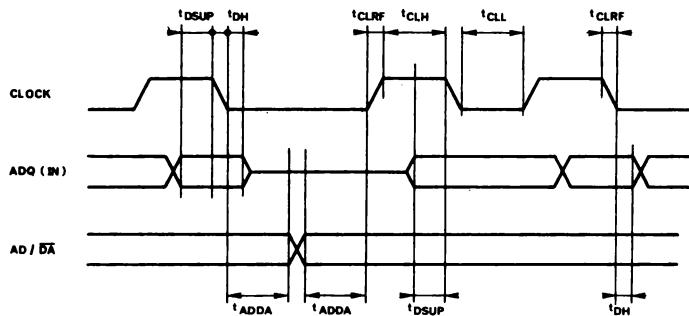
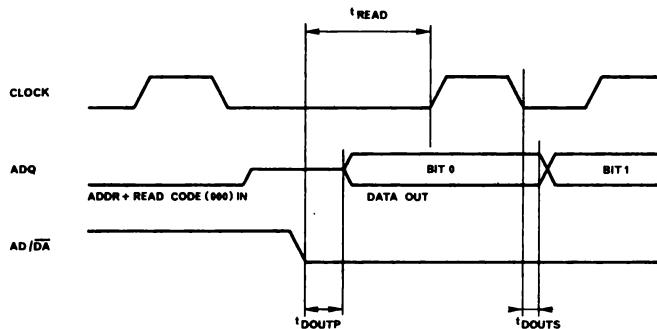
NOTE – Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

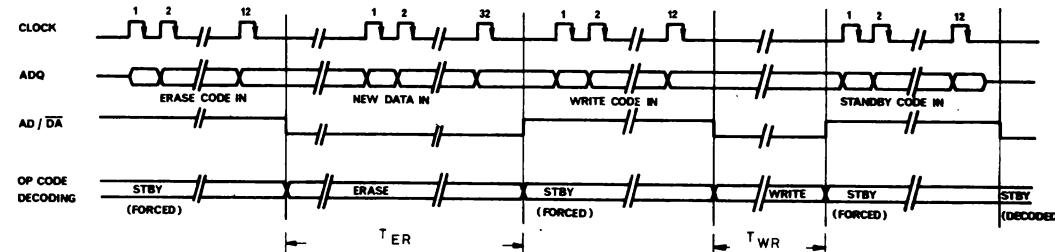
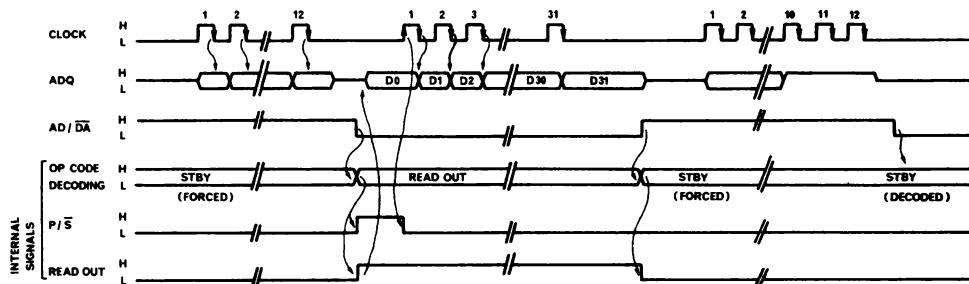
**SWITCHING CHARACTERISTICS (T<sub>A</sub> = 0 . . . 70 °C; V<sub>DD</sub> = 5V ± 10 %; V<sub>P</sub> = 24.5V ± 1.5 V**

Pin	Symbol	Parameter	Fig No	Min	Max	Unit
	t <sub>ER</sub>	Erase time		100		ms
	t <sub>WR</sub>	Write time		10		ms
CL	F <sub>CL</sub>	Clock Frequency F <sub>CL</sub> = 1/T <sub>CL</sub>	2		100	kHz
CL	t <sub>CLH</sub>	Clock High Level Hold Time	2	4		μs
CL	t <sub>CLL</sub>	Clock Low Level Hold Time	2	4		μs
CL	t <sub>CLRF</sub>	Clock Fall Time and Rise Time	2		1	μs
AD/DA	t <sub>AD/DA</sub>	Register Control to Clock				
		Delay Time except for t <sub>READ</sub>	2	1		μs
	t <sub>READ</sub>	After READ opcode only	3	2	100	μs
I/O	t <sub>DSUP</sub>	Data In Set-Up	2, 3	2		μs
I/O	t <sub>DH</sub>	Data In Hold	2, 3	0.1		μs
I/O	t <sub>DOUTS</sub>	Data Out Serial Delay	3		1	μs
I/O	t <sub>DOUTP</sub>	Data Out Parallel Delay	3		3	μs
O	C <sub>out</sub>	Output Capacitance (V <sub>out</sub> = 0 V)			12	pF

**DC CHARACTERISTICS ( $T_A = 0 \dots 70^\circ\text{C}$ ;  $V_{DD} = 5V \pm 10\%$ ;  $V_P = 24.5V \pm 1.5V$ )**

Pin	Characteristic	Condition	Symbol	Min	Max	Unit
$V_{PP}$	Supply Current		$I_{PP}$		3	mA
$V_{DD}$	Supply Current		$I_{DD}$		20	mA
I/O	Tristate Input/ Output	$V_{OH} = 2.4V$ $V_{OL} = 0.5V$ Tristate	$I_{OH}$ $I_{OL}$ $I_{IN}$	-0.1 1.6 10		mA mA $\mu A$
All Inputs Except I/O	Input Leakage		$I_{IN}$		10	$\mu A$
$V_{PC}$	VP Control! Pull down device	$V_{ON} = 1V$ OFF state $V_{OFF} = V_P$	$I_{ON}$ $V_{MAX}$ $I_{OFF}$	0.7	$V_{PP}$ 10	mA $\mu A$
All Inputs	Input Low Voltage Input High Voltage	$V_{IL}$ $V_{IH}$		2.4	0.8	V V

**FIGURE 2 – GENERAL TIMINGS****FIGURE 3 – READOUT TIMINGS**



## FUNCTIONAL DESCRIPTION

The circuit accepts 12 bits of Address/Op code in the address register and 32 bits of data in the data register (see figure 1: Block diagram).

### Address/Op code format (figure 1)

The four shifted bits C1 to C4 are used as chip select word in multichip systems. The chip address is defined by hardwiring the C1 to C4 pins. These bits are adjacent to the address field, so that no software modification is required in a program designed for a multi-1K memory application.

The five following A1 to A5 bits select one of the word addresses. The last 3 bits 01 to 03 control the operating modes.

Function	01	02	03
Read	0	0	0
Word Erase	0	1	0
Block Erase	1	1	0
Write	1	0	0
Standby	x	x	1

### Read operation (figure 4)

- 1) The ADDRESS/OP CODE is loaded. The address selecting the word to be read and the op code bits being the READ code.
- 2) The AD/DA is switched to the data mode, thus initiating the parallel transfer from the core to the shift register. First bit of data is present at the output.
- 3) As soon as the first of the 31 data out clock pulses is applied, the parallel transfer is stopped and data is shifted at the output. Data is recirculated in the data register.
- 4) The output buffer is turned on only, when READ is internally decoded, AD/DA is low and chip is selected by C1 and C4. Otherwise it is in the high impedance state.

Addresses and data are clocked in and out with the falling edge of block.

### Writing (figure 5)

- 1) ADDRESS/OP CODE is shifted in, the op code being either BLOCK ERASE or WORD ERASE.
- 2) Switching the AD/DA line low for  $t = t_{ERASE}$  initiates the erase process. During this period of time, a data word can be shifted into the data register.
- 3) Then the WRITE code and the same address is loaded to the address register.

- 4) The AD/DA line is switched low again for a  $t = t_{WRITE}$ , during which the selected word is programmed.

- 5) At the end of the WRITE operation it is recommended to load op code STANDBY and to return input AD/DA to the low state.

### Erase

Both BLOCK ERASE and WORD ERASE are provided and are controlled by the op code. V<sub>pp</sub> has to be applied for BLOCK ERASE, WORD ERASE and for WRITE. For all other conditions it can be switched off to high impedance or V<sub>DD</sub> or V<sub>SS</sub>.

### Standby

When AD/DA is high, the instruction decoder is disabled and hence STANDBY is forced. By shifting the STANDBY op code into the address register, STANDBY will be recognized independently of the state of AD/DA.

### Clock

The active high clock is only used for shifting data and addresses. This shift occurs on the clock falling edge.

### Chip selection

The ADDRESS/DATA line can be used as a chip select in a system having other serial I/O devices. DATA and CLOCK lines being shared the non-volatile memory is only activated when the AD/DA line is low. Shifting information to the data register has no effect to the core while the chip is deselected.

In a multi-memory arrangement, all the lines including ADDRESS/DATA, CLOCK and DATA, are shared, with the exception of C1 to C4 which are hardwired to V<sub>DD</sub> or V<sub>SS</sub>, thus defining the circuit address. All V<sub>p</sub> control outputs of the memory circuits can be combined in a wired OR configuration.

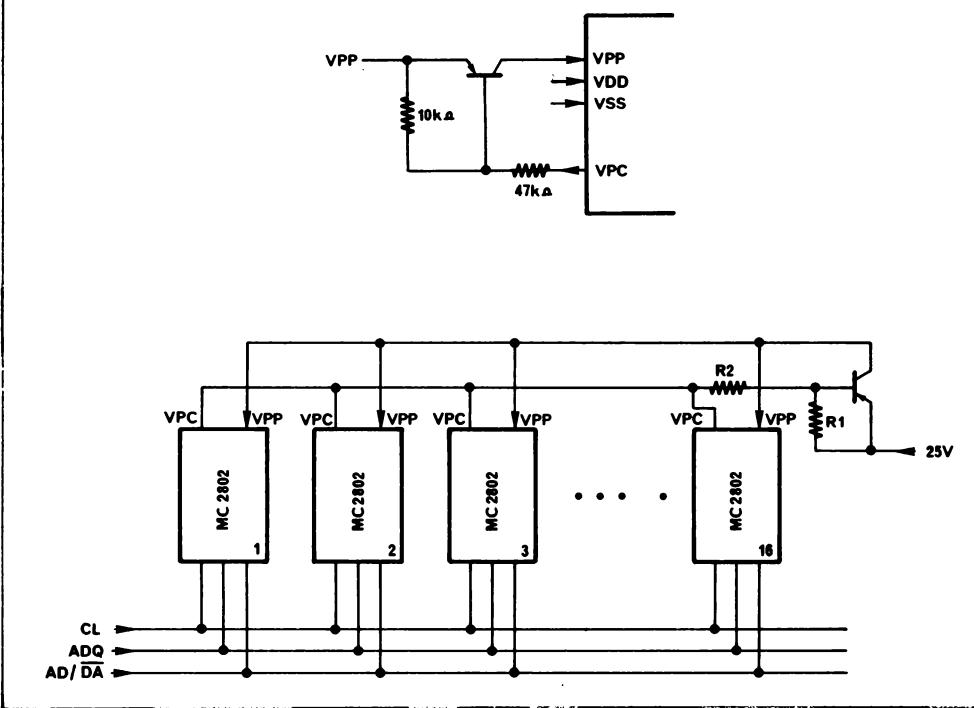
### Data protection

When V<sub>pp</sub> is turned off, data stored in the array is always protected. A V<sub>pp</sub> control output is provided for switching the V<sub>pp</sub> supply. It consists of a pull down device to V<sub>SS</sub>. This device is turned on only when V<sub>DD</sub> is present, a WRITE or ERASE code has been loaded in the address register and AD/DA is low.

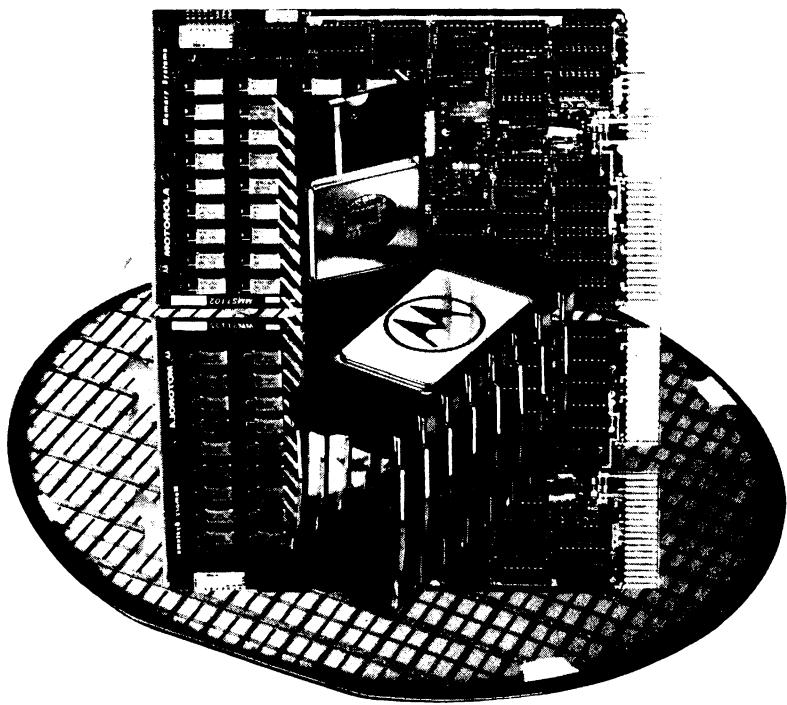
Schematics for this external V<sub>pp</sub> control are proposed in figure 6.

### Reset

V<sub>pp</sub> and V<sub>DD</sub> may be turned on or off in any sequence without disturbing data in the NVM array. During power-up, the op code is preset to the standby mode. The RESET input can be connected to the system RESET.

FIGURE 6 – V<sub>PP</sub> CONTROL AND MULTICHP SETUP

## **CMOS Memories RAM, ROM**





**MOTOROLA**

**MCM14505**

### 64-BIT STATIC RANDOM ACCESS MEMORY

The MCM14505 64-bit random access memory is fully decoded on the chip and organized as 64 one-bit words (64 X 1). Medium speed operation and micropower supply requirements make this device useful for scratch pad or buffer memory applications where power must be conserved or where battery operation is required.

When used with a battery backup, the MCM14505 can be utilized as an alterable read-only memory, allowing the battery to retain information in the memory when the system is powered down, and allowing the battery to charge when power is applied. The micropower requirements of this memory allow quiescent battery operation for great lengths of time without significant discharging.

- Quiescent Current = 50 nA/package typical @ 5 Vdc
- Noise Immunity = 45% of VDD typical
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Single Read/Write Control Line
- Wired-OR Output Capability (3-State Output) for Memory Expansion
- Access Time = 180 ns typical at VDD = 10 Vdc
- Write Cycle Time = 275 ns typical at VDD = 10 Vdc
- Fully Buffered Low Capacitance Inputs
- Capable of Driving Two Low-power TTL Loads, One Low-power Schottky TTL Load or Two HTL Loads Over the Rated Temperature Range

### MAXIMUM RATINGS (Voltages referenced to V<sub>SS</sub>)

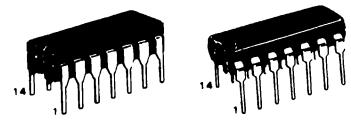
Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>DD</sub>	-0.5 to +18	Vdc
Input Voltage, All Inputs	V <sub>in</sub>	-0.5 to V <sub>DD</sub> + 0.5	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range - AL Device CL/CP Device	T <sub>A</sub>	-55 to +125 -40 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

This device contains 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 this high impedance circuit. For proper operation it is recommended that V<sub>in</sub> and V<sub>out</sub> be constrained to the range V<sub>SS</sub> ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>DD</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>).

### CMOS LSI

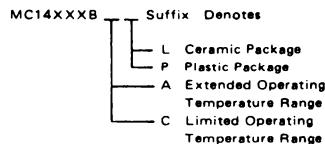
(LOW-POWER COMPLEMENTARY MOS)

### 64-BIT (64 x 1) STATIC RANDOM ACCESS MEMORY

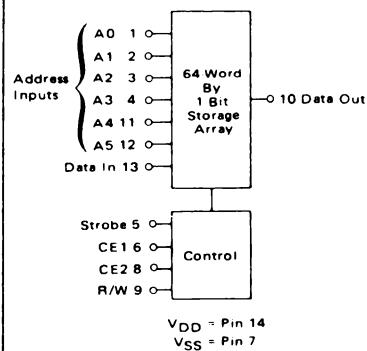


L SUFFIX CERAMIC PACKAGE CASE 632  
P SUFFIX PLASTIC PACKAGE CASE 646

#### ORDERING INFORMATION



#### BLOCK DIAGRAM



# MCM14505

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub> Vdc	T <sub>low</sub> *		25°C			T <sub>high</sub> *		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Voltage V <sub>in</sub> = V <sub>DD</sub> or 0	V <sub>OL</sub>	5.0		0.05		0	0.05	-	0.05	Vdc
		10		0.05		0	0.05	-	0.05	
		15		0.05	-	0	0.05	-	0.05	
	V <sub>OH</sub>	5.0	4.95		4.95	5.0		4.95	-	Vdc
		10	9.95		9.95	10		9.95	-	
		15	14.95		14.95	15	-	14.95	-	
Noise Immunity # (V <sub>out</sub> = 0.8 Vdc) (V <sub>out</sub> = 1.0 Vdc) (V <sub>out</sub> = 1.5 Vdc)	V <sub>NL</sub>	5.0	1.5		1.5	2.25		1.4		Vdc
		10	3.0		3.0	4.50		2.9		
		15	4.5		4.5	6.75	-	4.4	-	
	V <sub>NH</sub>	5.0	1.4		1.5	2.25		1.5	-	Vdc
		10	2.9		3.0	4.50	-	3.0	-	
		15	4.4	-	4.5	6.75	-	4.5	-	
Output Drive Current (AL Device) (VOH = 2.5 Vdc) Source (VOH = 4.6 Vdc) (VOH = 9.5 Vdc) (VOH = 13.5 Vdc)	I <sub>OH</sub>	5.0	-1.2	-	-1.0	-1.7	-	-0.7	-	mAdc
		5.0	-0.25	-	-0.2	-0.36	-	-0.14	-	
		10	-0.62		-0.5	-0.9	-	-0.35	-	
		15	-1.8		-1.5	-3.5	-	-1.1	-	
	I <sub>OL</sub>	5.0	0.3	-	0.25	0.35	-	0.18	-	mAdc
		10	0.9		0.75	1.2	-	0.50	-	
Output Drive Current (CL/CP Device) (VOH = 2.5 Vdc) Source (VOH = 4.6 Vdc) (VOH = 9.5 Vdc) (VOH = 13.5 Vdc)	I <sub>OH</sub>	5.0	-1.0		-0.8	-1.7		-0.6	-	mAdc
		5.0	-0.2		-0.16	-0.36	-	-0.12	-	
		10	-0.5		-0.4	-0.9	-	-0.3	-	
		15	-1.4	-	-1.2	-3.5	-	-1.0	-	
	I <sub>OL</sub>	5.0	0.2		0.15	0.35	-	0.1	-	mAdc
		10	0.6		0.5	1.2	-	0.4	-	
Input Current (AL Device)	I <sub>IN</sub>	15		± 0.1		± 0.00001	± 0.1	-	± 1.0	μAdc
	I <sub>IN</sub>	15		± 1.0		± 0.00001	± 1.0	-	± 14	μAdc
	C <sub>IN</sub>	-			..	5.0	7.5	..		pF
Quiescent Current (AL Device) (Per Package)	I <sub>DD</sub>	5.0		5.0	-	0.050	5.0	-	150	μAdc
		10		10		0.100	10		300	
		15		20		0.150	20	-	600	
Quiescent Current (CL/CP Device) (Per Package)	I <sub>DD</sub>	5.0		50		0.050	50	-	375	μAdc
		10		100		0.100	100	-	750	
		15		200	-	0.150	200	-	1500	
Total Supply Current ***† (Dynamic plus Quiescent, Per Package) (C <sub>L</sub> = 50 pF on all outputs, all buffers switching)	I <sub>T</sub>	5.0				I <sub>T</sub> (1.28 μA/kHz) f + I <sub>DD</sub>				μAdc
		10				I <sub>T</sub> (2.56 μA/kHz) f + I <sub>DD</sub>				
		15				I <sub>T</sub> (3.85 μA/kHz) f + I <sub>DD</sub>				
Three-State Leakage Current (AL Device)	I <sub>TL</sub>	15		± 0.1		± 0.00001	± 0.1	-	± 3.0	μAdc
Three-State Leakage Current (CL/CP Device)	I <sub>TL</sub>	15	-	± 1.0		± 0.00001	± 1.0	-	± 7.5	μAdc

\*T<sub>low</sub> = -55°C for AL Device, -40°C for CL/CP Device.

†T<sub>high</sub> = +125°C for AL Device, +85°C for CL/CP Device.

#Noise immunity specified for worst-case input combination.

†To calculate total supply current at loads other than 50 pF.

$$I_T(C_L) = I_T(50 \text{ pF}) + 1 \times 10^{-3} (C_L - 50) \text{ VDDf}$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V<sub>DD</sub> in Vdc, and f in kHz is input frequency.

\*\*The formulas given are for the typical characteristics only at 25°C.

# MCM14505

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

Characteristic	Symbol	V <sub>DD</sub>	Min	Typ	Max	Unit
Output Rise Time $t_{TLH} = (2.43 \text{ ns/pF}) C_L + 58.5 \text{ ns}$ $t_{TLH} = (1.08 \text{ ns/pF}) C_L + 36 \text{ ns}$ $t_{TLH} = (0.72 \text{ ns/pF}) C_L + 39 \text{ ns}$	$t_{TLH}$	5.0 10 15	— — —	180 90 75	360 180 150	ns
Output Fall Time $t_{TTHL} = (2.16 \text{ ns/pF}) C_L + 52 \text{ ns}$ $t_{TTHL} = (0.96 \text{ ns/pF}) C_L + 32 \text{ ns}$ $t_{TTHL} = (0.69 \text{ ns/pF}) C_L + 33 \text{ ns}$	$t_{TTHL}$	5.0 10 15	— — —	160 80 65	320 160 130	ns
Propagation Delay Time Read Access Time $t_{acc(R)} = (1.4 \text{ ns/pF}) C_L + 385 \text{ ns}$ $t_{acc(R)} = (10.7 \text{ ns/pF}) C_L + 175 \text{ ns}$ $t_{acc(R)} = (0.5 \text{ ns/pF}) C_L + 105 \text{ ns}$	$t_{acc(R)}$		5.0 10 15	— — —	455 210 130	750 400 300
Strobe Down Time	$t_{WL}$	5.0 10 15	500 125 95	100 50 75	— — —	ns
Address Setup Time	$t_{su}$	5.0 10 15	300 120 90	-100 -40 -25	— — —	ns
Data Setup Time	$t_{su(D)}$	5.0 10 15	200 75 55	70 25 20	— — —	ns
Read Setup Time	$t_{su(R)}$	5.0 10 15	270 60 45	90 20 15	— — —	ns
Write Setup Time	$t_{su(W)}$	5.0 10 15	400 100 75	80 25 11	— — —	ns
Address Release Time	$t_{rel(R)}$	5.0 10 15	75 25 20	15 10 5.0	— — —	ns
Data Hold Time	$t_h(D)$	5.0 10 15	50 15 10	0 0 0	— — —	ns
Read Release Time	$t_{rel(R)}$	5.0 10 15	0 0 0	-90 -25 -10	— — —	ns
Write Release Time	$t_{rel(W)}$	5.0 10 15	0 0 0	5.0 10 30	— — —	ns
Read Cycle Time	$t_{cyc(R)}$	5.0 10 15	— — —	500 200 150	750 400 300	ns
Write Cycle Time	$t_{cyc(W)}$	5.0 10 15	— — —	440 275 200	700 550 415	ns
Output Disable Delay (10% Output Change into 1.0 kΩ Load)	$t_{dis}$	5.0 10 15	— — —	200 80 60	600 200 150	ns

\*The formula is for the typical characteristics only.

# MCM14505

FIGURE 1 – READ CYCLE TIMING DIAGRAM

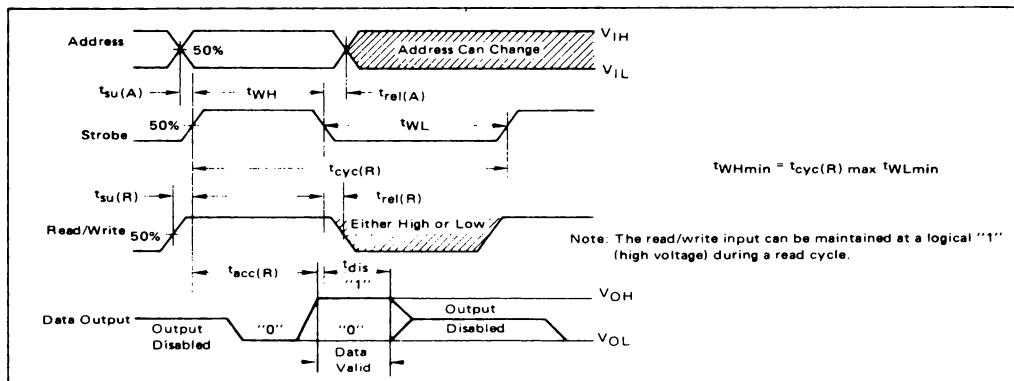


FIGURE 2 – WRITE CYCLE TIMING DIAGRAM

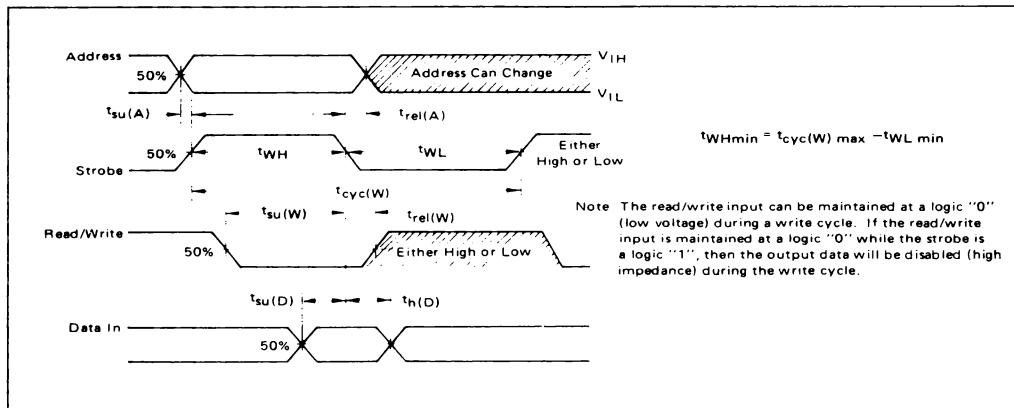


FIGURE 3 – MAXIMUM STROBE PULSE WIDTH versus TEMPERATURE

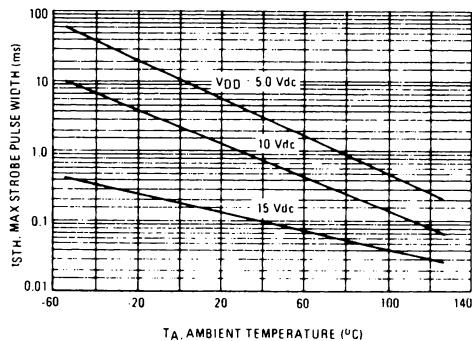
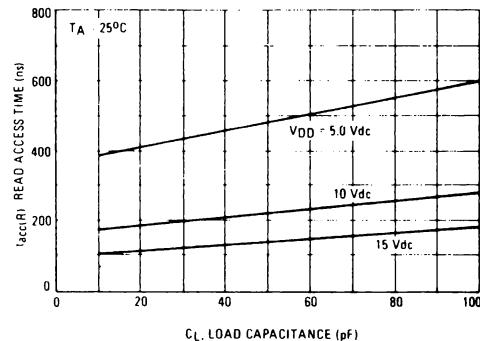


FIGURE 4 – TYPICAL READ ACCESS TIME versus LOAD CAPACITANCE



# MCM14505

FIGURE 5 – TYPICAL OUTPUT SOURCE CAPABILITY versus TEMPERATURE

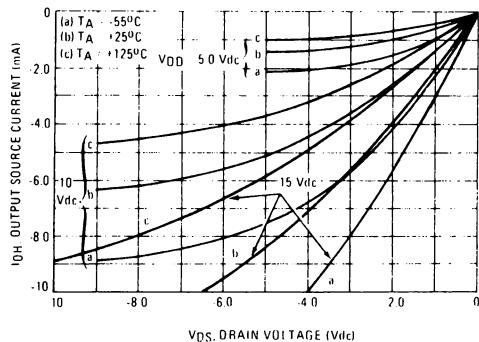
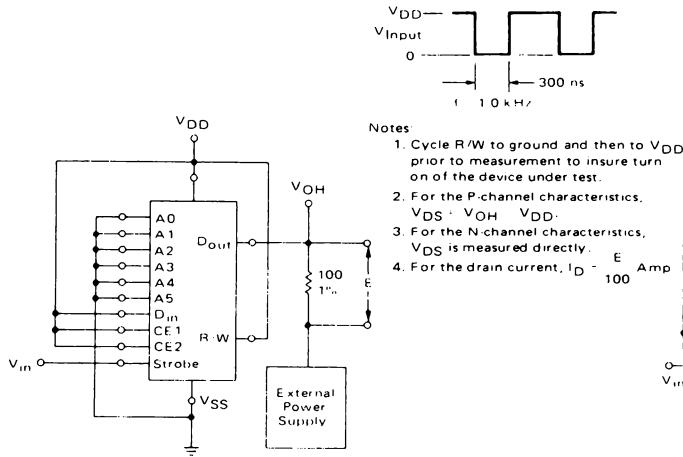
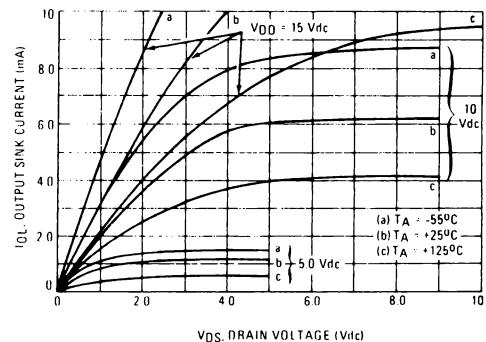
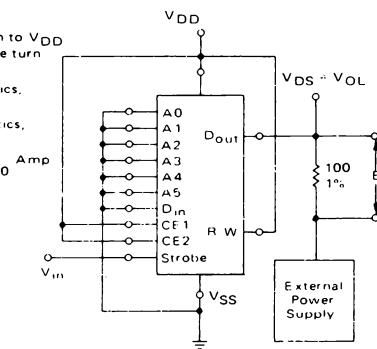
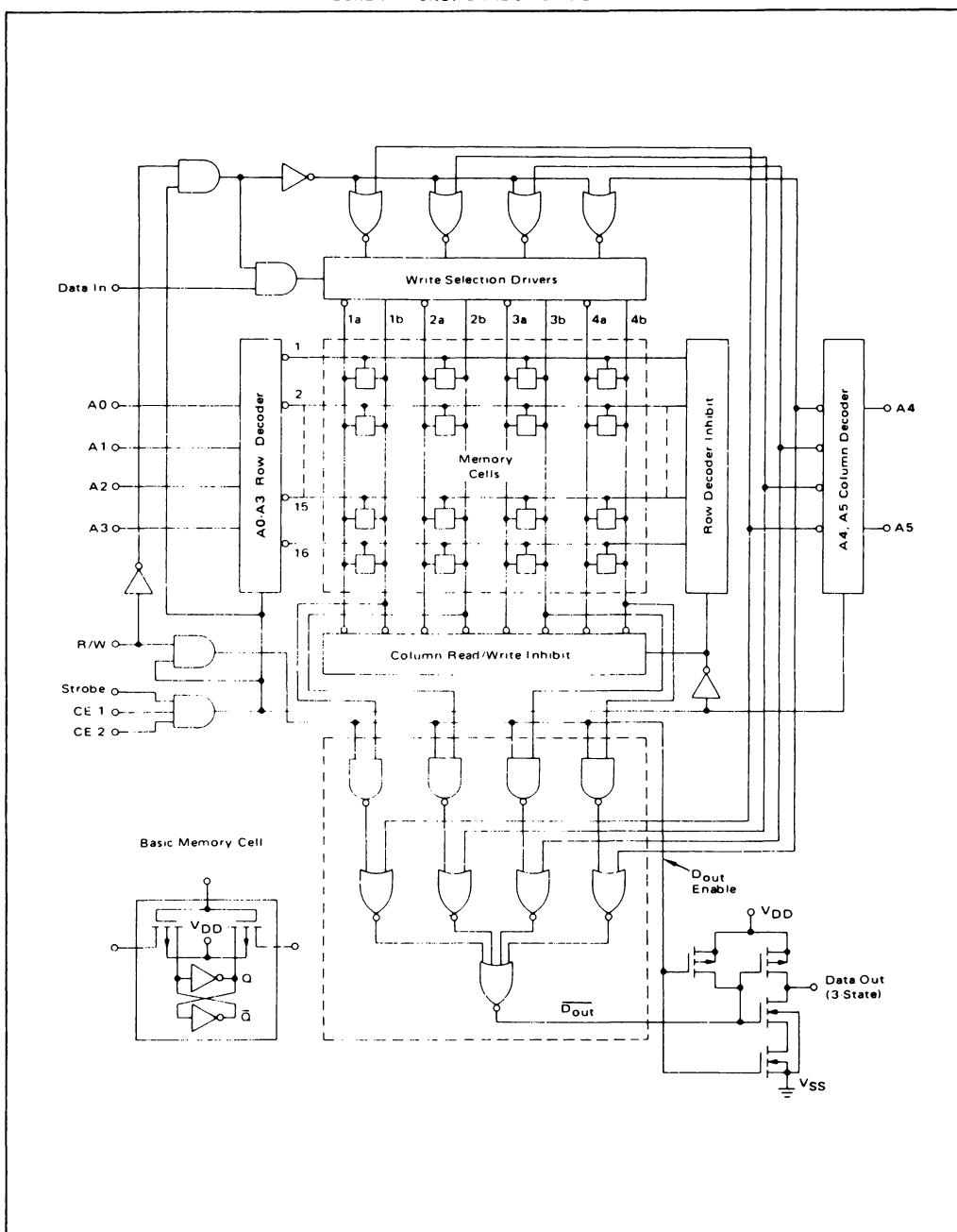


FIGURE 6 – TYPICAL OUTPUT SINK CAPABILITY versus TEMPERATURE



# MCM14505

FIGURE 7 – FUNCTIONAL CIRCUIT DIAGRAM



## OPERATING CHARACTERISTICS

In considering the operation of the MCM14505 CMOS memory, refer to the functional circuit diagram of Figure 7 and timing diagrams shown in Figures 1 and 2. The basic memory cell is a cross-coupled flip-flop consisting of two inverter gates and two P-channel devices for read/write control. The push-pull cell provides high speed as well as low power.

During a read cycle, when the strobe line is high the write selection drivers are disabled and the data from the selected row is available on columns 1b, 2b, 3b, and 4b. The A4 and A5 address bits are decoded to select output data from one of the four columns. The output data is available on the data output pin only when the strobe and read/write lines are high simultaneously and after the read access time,  $t_{acc}(q)$ , has occurred (see Figure 1). Note that the output is initially disabled and always goes to the logic "0" state (low voltage) before data is valid. The output is in the high-impedance state (disabled) when the strobe line or the R/W line is in the low state. The memory is strobed for reading or writing only when the strobe, CE1, and CE2 are high simultaneously. The R/W line can be a dc voltage during a read or write cycle and need not be pulsed, as shown in the timing diagrams. For this case the R/W line should be a logic "1" (high) for reading and a logic "0" for writing.

When the strobe line is high, the column read/write inhibit gates and the row decoder inhibit gates are disabled, the selected

row is in the low state, and the unselected 15 rows retain their logic "1" level due to the row capacitance that exists when the row decoder inhibit gates are disabled. This capacitive storage mechanism requires a maximum strobe width (see Figure 3) equal to the junction reverse bias RC time constant. When the strobe is returned to a logic "0" the rows are forced to  $V_{DD}$  by the row decoder inhibit gates (pullup devices). Similarly the column read/write inhibit gates (pulldown devices) force the column lines to a logic "0" state.

Two column lines are associated with each memory cell in order to write into the cell. The write selection drivers are enabled when the R/W line is a logic "0" and the strobe line is a logic "1". The input data is written into the column selected by the column decoder. For instance, if a "11" is to be written in the memory cell associated with row 1 and column 1, then row 1 would be enabled (logic "0") while column 1b is forced high and column 1a is forced low by the write selection drivers. If a logic "0" is to be written into the cell, then column 1a is forced high and 1b is forced low. The data that is retained in the memory cell is the data that was present on the data input pin at the moment the strobe goes low when R/W is low, or when R/W goes high when the strobe is high.

## APPLICATIONS INFORMATION

Figure 8 shows a 256-word by n-bit static RAM memory system. The outputs of four MCM14505 devices are tied together to form 256 words by 1 bit. Additional bits are attained by paralleling the inputs in groups of four. Memories of larger words can be attained by decoding the most significant bits of the address and ANDing them with the strobe input.

Fan-in and fan-out of the memory is limited only by speed requirements. The extremely low input and output leakage current (100 nA maximum) keep the output voltage levels from changing significantly as more outputs are tied together. With the output levels independent of fan-out, most of the power supply range is available as logic swing, regardless of the number of units wired together. As a result, high noise immunity is maintained under all conditions.

Power dissipation is 0.1  $\mu$ W per bit at a 1.0-kHz rate for a 5.0-volt power supply, while the static power dissipation is 2.0 nW per bit. This low power allows non-volatile information storage when the memory is powered by a small standby battery.

Figure 9 shows an optional standby power supply circuit for making a CMOS memory "non-volatile". When the usual power fails, a battery is used to sustain operation or maintain stored information. While normal power supply voltage is present, the battery is trickle-charged through a resistor which sets the charging rate.  $V_B$  is the sustaining voltage, and  $V^+$  is the ordinary voltage from a power supply.  $V_{DD}$  connects to the power pin on the memory. Low-leakage diodes are recommended to conserve battery power.

The memory system shown in Figure 8 can be interfaced directly with the other devices in the McMOS family. No external components are required.

At the inputs to the CMOS memory, TTL devices can interface directly if an open-collector logic gate such as the MC7407 is used as shown in Figure 10. Driver circuits are not required since the input capacitance is low (4.0 to 6.0 pF). The address, data, and read/write inputs do not need to be fast since they can be changed for the duration when the strobe pulse is low,  $t_{STL}$  (see Figures 1 and 2). For high-speed operation, a push-pull driver should be used if more than five strobe inputs must be driven at one time. One circuit of the type shown in Figure 10 can be used for every ten strobe inputs.

Figures 11, 12, and 13 show methods of interfacing the memory output to TTL logic at various memory voltages. If a  $V_{DD}$  of 5.0 volts is used for slow-speed, low-power applications, one transistor and one resistor must be used (Figure 11). The MCM14505AL will drive one low-power TTL gate directly.

If a  $V_{DD}$  of 10 volts is used, the output of the memory device can fan out to two low-power TTL gates (Figure 12a) or to a discrete transistor (Figure 12b). The discrete transistor circuit provides higher speed and/or high fan-out. A pulldown resistor at the base of the transistor is not needed for fast turn-off because of the push-pull output of the memory. Turn-on time of the transistor is much faster in Figure 12b since the voltage rise is only 0.75 volt. The low output capacitance of the MCM14505 means that several outputs can be wire-ORed without significantly degrading performance. The read access time is increased by only 20 ns typically for 16 outputs tied together when Figure 12b is used.

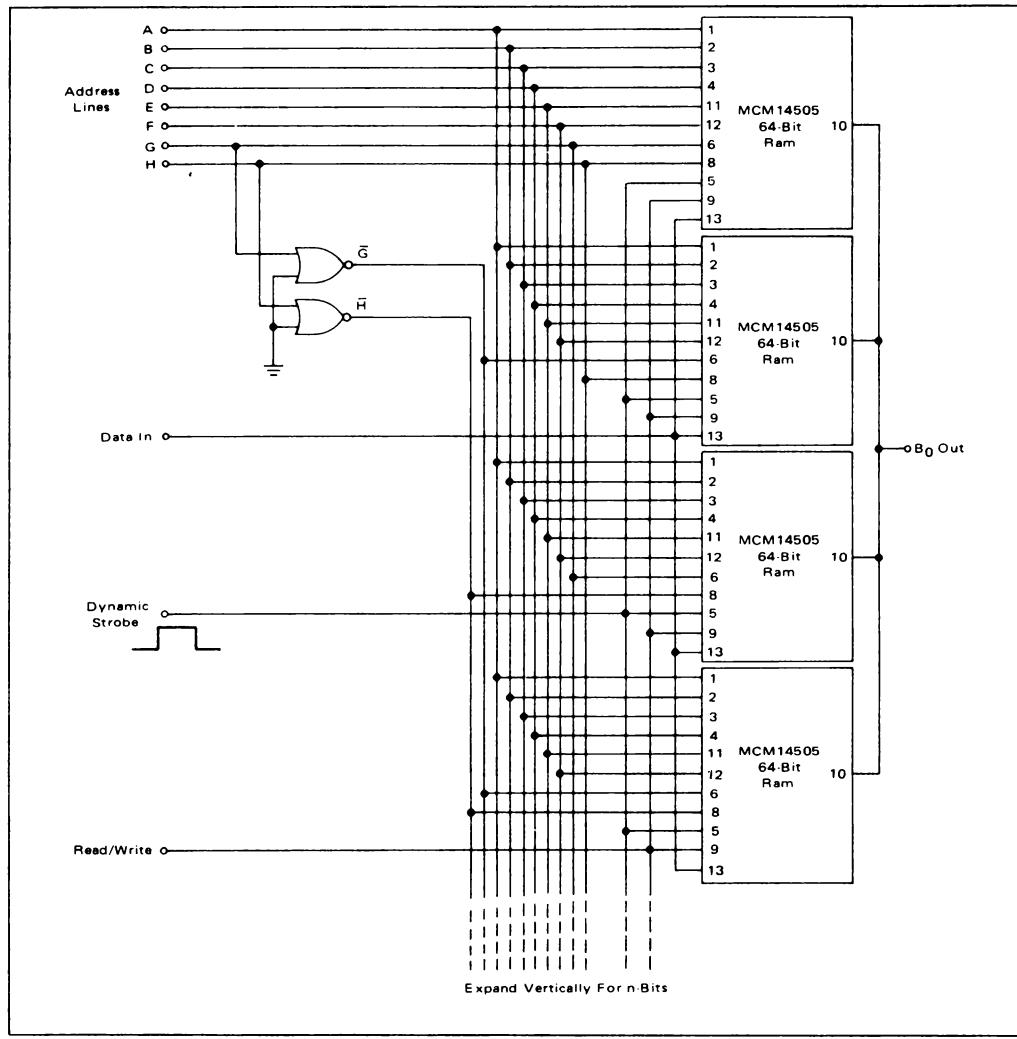
Five low-power TTL gates can be driven from the memory output if a  $V_{DD}$  of 15 volts is used (Figure 13a). Figure 13b shows the interface if a discrete transistor is used. The 1.0 kilohm resistor in the base is required to insure that not more than 10 mA flows through the output as listed in the maximum ratings. If a 2.0 kilohm collector resistor is used (fan-out = 3), the turn-on time of the transistor is only slightly faster than in the circuit shown in Figure 12b due to the lower output impedance when  $V_{DD} = 15$  volts. The voltage at the memory data output has to rise to only 1.3 volts to insure driving a fan-out of three TTL devices.

If a 510-ohm collector resistor is used, 20 TTL loads may be driven. The read access time is increased about 20 ns when four memory outputs are tied together since the output voltage must rise to 3.7 volts before the transistor can sink the full  $I_{OL}$  for a fan-out of 20 TTL devices. Almost any NPN transistor with a minimum beta of 15 can be used for the interface shown in Figures 11, 12 and 13.

The high source current from the push-pull output stage of the MCM14505 makes for a simpler interface circuit since a low source current memory requires a differential comparator to achieve high-speed operation.

# MCM14505

FIGURE 8 – CMOS 256-WORD BY n-BIT STATIC  
READ/WRITE MEMORY

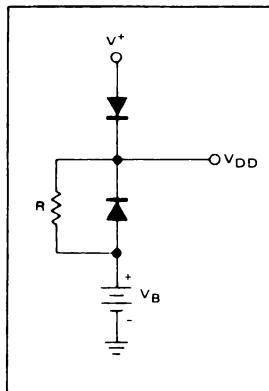


Circuit diagrams utilizing Motorola products are included as a means of illustrating typical semiconductor applications; consequently, complete information sufficient for construction purposes is not necessarily given. The information has been carefully checked and

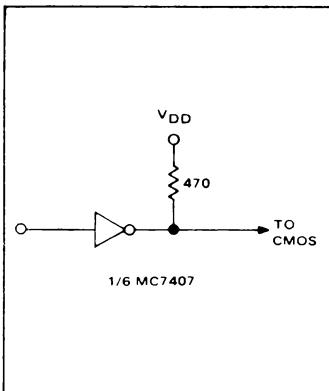
is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies. Furthermore, such information does not convey to the purchaser of the semiconductor devices described any license under the patent rights of Motorola Inc. or others.

# MCM14505

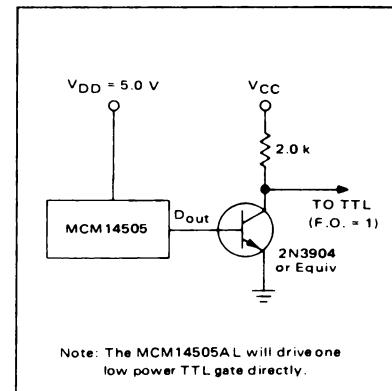
**FIGURE 9 – STAND BY BATTERY CIRCUIT**



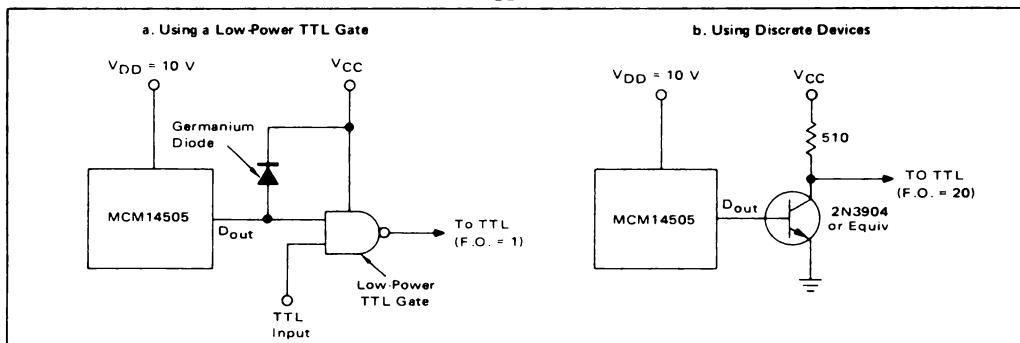
**FIGURE 10 – TTL TO CMOS INTERFACE**



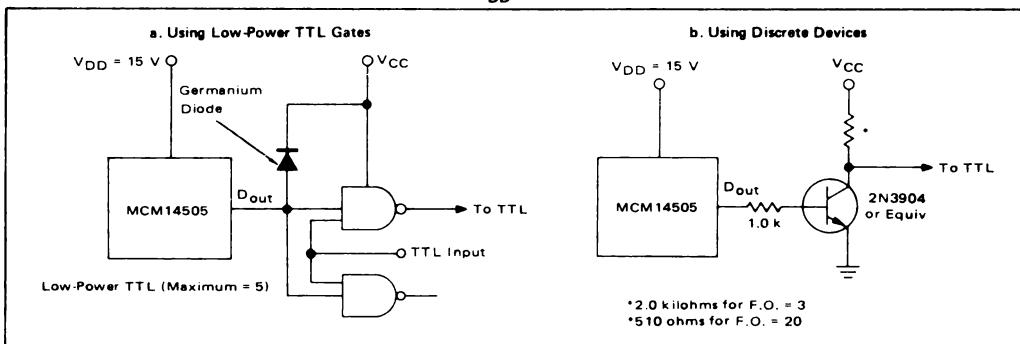
**FIGURE 11 – CMOS-TO-TTL INTERFACE FOR  $V_{DD} = 5.0$  V**



**FIGURE 12 – CMOS-TO-TTL INTERFACE FOR  $V_{DD} = 10$  V**



**FIGURE 13 – CMOS-TO-TTL INTERFACE FOR  $V_{DD} = 15$  V**





**MOTOROLA**

**MCM14537**

### 256-BIT STATIC RANDOM ACCESS MEMORY

The MCM14537 is a static random access memory (RAM) organized in a 256 x 1-bit pattern and constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. The circuit consists of eight address inputs ( $A_n$ ), one data input ( $D_{in}$ ), one write enable input (WE), one strobe input (ST), two chip enable inputs ( $CE_n$ ), and one data output ( $D_{out}$ ).

Using both chip enable inputs as extensions of the address inputs, a 10-bit address scheme may be employed. Four MCM14537 devices may be used to comprise a 1024-bit memory without additional address decoding. The CE and ST inputs are dissimilarly designed to enable usage of the memory in a variety of applications. An output latch is provided on the chip for storing the data read or written into memory, making a data-out storage register unnecessary. The CE inputs control the data output for third-state (high output impedance) or active operation which makes the memory very useful in a bus oriented system. When  $CE_2$  is high the chip is fully disabled. When  $CE_1$  is high the output is in the third state but data can be written into the output latch during a read cycle. This enables the use of the memory for fast reading by using the  $CE_1$  input to enable the latch. The memory is also designed so that dc signals can operate the memory with no maximum pulse width required on the CE and ST lines.

Medium speed operation and micropower operation make the device useful in scratch pad and buffer applications where micropower or battery operation and high noise immunity are required.

- Quiescent Current = 0.5  $\mu$ A/package typical @ 5 Vdc
- Noise Immunity = 45% of  $V_{DD}$  typical
- 3-state Output Capability for Memory Expansion
- Output Data Latch Eliminates Need for Storage Buffer
- Access Time = 700 ns typical @  $V_{DD}$  = 10 Vdc
- Fully Decoded and Buffered
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads, One Low-power Schottky TTL Load or Two HTL Loads Over the Rated Temperature Range

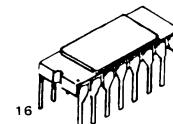
### MAXIMUM RATINGS (Voltages referenced to $V_{SS}$ )

Rating	Symbol	Value	Unit
DC Supply Voltage	$V_{DD}$	-0.5 to +18	Vdc
Input Voltage, All Inputs	$V_{in}$	-0.5 to $V_{DD} + 0.5$	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range -- AL Device CL/CP Device	$T_A$	-55 to +125 -40 to +85	°C
Storage Temperature Range	$T_{stg}$	-65 to +150	°C

### CMOS LSI

(LOW-POWER COMPLEMENTARY MOS)

### 256-BIT (256 x 1) STATIC RANDOM ACCESS MEMORY

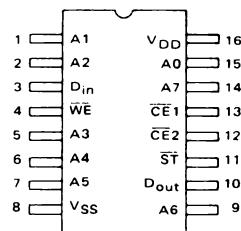


CERAMIC PACKAGE  
CASE 690

### ORDERING INFORMATION

MCM14XXX	Suffix Denotes
	L Ceramic Package
	A Extended Operating Temperature Range
	C Limited Operating Temperature Range

### PIN ASSIGNMENT



This device contains 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 this high impedance circuit. For proper operation it is recommended that  $V_{in}$  and  $V_{out}$  be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ).

# MCM14537

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub> Vdc	T <sub>low</sub> *		25°C			T <sub>high</sub> *		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Voltage V <sub>in</sub> = V <sub>DD</sub> or 0	V <sub>OL</sub>	5.0	0.05	-	0	0.05	-	0.05	-	Vdc
	V <sub>OL</sub>	10	0.05	-	0	0.05	-	0.05	-	Vdc
	V <sub>OL</sub>	15	0.05	-	0	0.05	-	0.05	-	Vdc
	V <sub>OH</sub>	5.0	4.95	-	4.95	5.0	-	4.95	-	Vdc
	V <sub>OH</sub>	10	9.95	-	9.95	10	-	9.95	-	Vdc
	V <sub>OH</sub>	15	14.95	-	14.95	15	-	14.95	-	Vdc
Noise Immunity # (V <sub>out</sub> = 0.8 Vdc) (V <sub>out</sub> = 1.0 Vdc) (V <sub>out</sub> = 1.5 Vdc) (V <sub>out</sub> = 0.8 Vdc) (V <sub>out</sub> = 1.0 Vdc) (V <sub>out</sub> = 1.5 Vdc)	V <sub>NL</sub>	5.0	1.5	-	1.5	2.25	-	1.4	-	Vdc
	V <sub>NL</sub>	10	3.0	-	3.0	4.50	-	2.9	-	Vdc
	V <sub>NL</sub>	15	4.5	-	4.5	6.75	-	4.4	-	Vdc
	V <sub>NH</sub>	5.0	1.4	-	1.5	2.25	-	1.5	-	Vdc
	V <sub>NH</sub>	10	2.9	-	3.0	4.50	-	3.0	-	Vdc
	V <sub>NH</sub>	15	4.4	-	4.5	6.75	-	4.5	-	Vdc
Output Drive Current (AL Device) (V <sub>OH</sub> = 2.5 Vdc) Source (V <sub>OH</sub> = 4.6 Vdc) (V <sub>OH</sub> = 9.5 Vdc) (V <sub>OH</sub> = 13.5 Vdc) (V <sub>OL</sub> = 0.4 Vdc) Sink (V <sub>OL</sub> = 0.5 Vdc) (V <sub>OL</sub> = 1.5 Vdc)	I <sub>OH</sub>	5.0	-1.2	-	-1.0	-1.7	-	-0.7	-	mA
	I <sub>OH</sub>	5.0	-0.25	-	-0.2	-0.36	-	-0.14	-	mA
	I <sub>OH</sub>	10	-0.62	-	-0.5	-0.9	-	-0.35	-	mA
	I <sub>OH</sub>	15	-1.8	-	-1.5	-3.5	-	-1.1	-	mA
	I <sub>OL</sub>	5.0	0.64	-	0.51	0.88	-	0.36	-	mA
	I <sub>OL</sub>	10	1.6	-	1.3	2.25	-	0.9	-	mA
	I <sub>OL</sub>	15	4.2	-	3.4	8.8	-	2.4	-	mA
Output Drive Current (CL/CP Device) (V <sub>OH</sub> = 2.5 Vdc) Source (V <sub>OH</sub> = 4.6 Vdc) (V <sub>OH</sub> = 9.5 Vdc) (V <sub>OH</sub> = 13.5 Vdc) (V <sub>OL</sub> = 0.4 Vdc) Sink (V <sub>OL</sub> = 0.5 Vdc) (V <sub>OL</sub> = 1.5 Vdc)	I <sub>OH</sub>	5.0	-1.0	-	-0.8	-1.7	-	-0.6	-	mA
	I <sub>OH</sub>	5.0	-0.2	-	-0.16	-0.36	-	-0.12	-	mA
	I <sub>OH</sub>	10	-0.5	-	-0.4	-0.9	-	-0.3	-	mA
	I <sub>OH</sub>	15	-1.4	-	-1.2	-3.5	-	-1.0	-	mA
	I <sub>OL</sub>	5.0	0.52	-	0.44	0.88	-	0.36	-	mA
	I <sub>OL</sub>	10	1.3	-	1.1	2.25	-	0.9	-	mA
	I <sub>OL</sub>	15	3.6	-	3.0	8.8	-	2.4	-	mA
Input Current (AL Device)	I <sub>IN</sub>	15	-	±0.1	-	+0.00001	±0.1	-	±1.0	μA
Input Current (CL/CP Device)	I <sub>IN</sub>	15	-	±1.0	-	+0.00001	±1.0	-	±14	μA
Input Capacitance (V <sub>in</sub> = 0)	C <sub>IN</sub>	-	-	-	-	5.0	7.5	-	-	pF
Quiescent Current (AL Device) (Per Package)	I <sub>DD</sub>	5.0	-	100	-	0.5	100	-	1800	μA
I <sub>DD</sub>	10	-	200	-	1.0	200	-	3600	μA	
I <sub>DD</sub>	15	-	400	-	1.5	400	-	7200	μA	
Quiescent Current (CL/CP Device) (Per Package)	I <sub>DD</sub>	5.0	-	100	-	0.5	100	-	1800	μA
I <sub>DD</sub>	10	-	200	-	1.0	200	-	3600	μA	
I <sub>DD</sub>	15	-	400	-	1.5	400	-	7200	μA	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) (C <sub>L</sub> = 50 pF on all outputs, all buffers switching)	I <sub>T</sub>	5.0	-	-	I <sub>T</sub> (1.46 μA/kHz) f + I <sub>DD</sub>	-	-	-	-	μA
I <sub>T</sub>	10	-	-	I <sub>T</sub> (2.91 μA/kHz) f + I <sub>DD</sub>	-	-	-	-	μA	
I <sub>T</sub>	15	-	-	I <sub>T</sub> (4.37 μA/kHz) f + I <sub>DD</sub>	-	-	-	-	μA	
Three State Leakage Current (AL Device)	I <sub>TL</sub>	15	-	±0.1	-	+0.00001	±0.1	-	±3.0	μA
Three State Leakage Current (CL/CP Device)	I <sub>TL</sub>	15	-	±1.0	-	+0.00001	±1.0	-	±7.5	μA

\*T<sub>low</sub> = -55°C for AL Device, -40°C for CL/CP Device.

T<sub>high</sub> = +125°C for AL Device, +85°C for CL/CP Device.

#Noise immunity specified for worst-case input combination

Noise Margin for both "1" and "0" level = 1.0 Vdc min @ V<sub>DD</sub> = 5.0 Vdc

2.0 Vdc min @ V<sub>DD</sub> = 10 Vdc

2.5 Vdc min @ V<sub>DD</sub> = 15 Vdc

†To calculate total supply current at loads other than 50 pF

$$I_T(C_L) = I_T(50 \text{ pF}) + 1 \times 10^{-3} (C_L - 50) \text{ VDD f}$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V<sub>DD</sub> in Vdc, and f in kHz is input frequency

\*\*The formulas given are for the typical characteristics only at 25°C.

# MCM14537

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

Characteristic	Figure	Symbol	V <sub>DD</sub>	Min	Typ	Max	Unit
Output Rise Time $t_{TLH} = (3.0 \text{ ns/pF}) C_L + 30 \text{ ns}$ $t_{TLH} = (1.5 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{TLH} = (1.1 \text{ ns/pF}) C_L + 10 \text{ ns}$	3	$t_{TLH}$	5.0 10 15	— — —	180 90 65	360 180 130	ns
Output Fall Time $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$	3	$t_{THL}$	5.0 10 15	— — —	100 50 40	200 100 80	ns
Read Access Time from ST or CE2 $t_{acc} = (1.4 \text{ ns/pF}) C_L + 2480 \text{ ns}$ $t_{acc} = (0.7 \text{ ns/pF}) C_L + 690 \text{ ns}$ $t_{acc} = (0.5 \text{ ns/pF}) C_L + 393 \text{ ns}$	4, 5	$t_{acc}(R)$	5.0 10 15	400 150 115	2500 700 400	6000 2000 1500	ns
Output Enable Delay from CE1 or CE2	5, 6	$t_{acc}(\bar{CE}_n)$	5.0 10 15	70 25 20	300 100 70	900 300 225	ns
Setup Time from A <sub>n</sub> to ST or CE2	4, 5, 6, 7	$t_{su}(A)$	5.0 10 15	1800 600 450	600 200 140	— — —	ns
Hold Time from A <sub>n</sub> to ST or CE2	4, 5, 6, 7	$t_h(A)$	5.0 10 15	600 240 180	200 80 55	— — —	ns
Data Hold Time	7	$t_h(D)$	5.0 10 15	1400 500 375	480 160 110	— — —	ns
Data Setup Time	7	$t_{su}(D)$	5.0 10 15	3600 1800 1350	1200 600 420	— — —	ns
Write Enable Hold Time	7	$t_h(W\bar{E})$	5.0 10 15	150 60 45	50 20 15	— — —	ns
Write Enable Setup Time	7	$t_{su}(\bar{W}\bar{E})$	5.0 10 15	720 240 180	240 80 55	— — —	ns
Write Enable to D <sub>out</sub> Disable**	4	$t_{WE}$	5.0 10 15	720 240 180	240 80 55	— — —	ns
Strobe or CE2 Pulse Width When Reading	4, 5, 6	$t_{WL}(R)$	5.0 10 15	1350 450 340	450 150 100	— — —	ns
Strobe, CE1 or CE2 Pulse Width When Writing	7	$t_{WL}(W)$	5.0 10 15	2400 1260 945	1200 600 420	— — —	ns
Write Recovery Time $t_W = (1.4 \text{ ns/pF}) C_L + 219 \text{ ns}$ $t_W = (0.7 \text{ ns/pF}) C_L + 70 \text{ ns}$ $t_W = (0.5 \text{ ns/pF}) C_L + 47.5 \text{ ns}$	4	$t_R(W)$	5.0 10 15	70 25 20	240 80 55	720 240 180	ns
CE1 or CE2 to D <sub>out</sub> Disable Delay**	6	$t_{\bar{CE}_n}$	5.0 10 15	70 25 20	300 100 70	900 300 225	ns
Read Setup Time	4, 5	$t_{su}(R)$	5.0 10 15	0 0 0	-100 -40 -30	— — —	ns
Read Hold Time	4, 5	$t_h(R)$	5.0 10 15	540 240 180	180 60 45	— — —	ns
Read Cycle Time	4, 5	$t_{cyc}(R)$	5.0 10 15	— — —	2500 700 500	6000 2100 1575	ns
Write Cycle Time	7	$t_{cyc}(W)$	5.0 10 15	— — —	1400 700 500	4800 2100 1575	ns

\* The formula given is for the typical characteristics only.

\*\*10% output change into a 1.0 k $\Omega$  load.

# MCM14537

FIGURE 1 – TYPICAL OUTPUT SOURCE AND SINK CURRENT CHARACTERISTICS TEST CIRCUIT

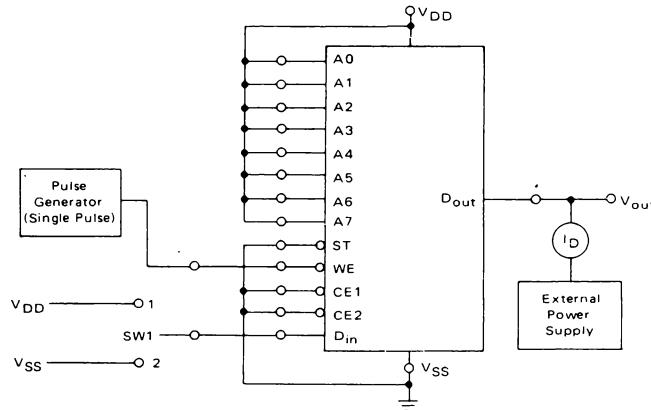


FIGURE 2 – POWER DISSIPATION TEST CIRCUIT AND WAVEFORMS

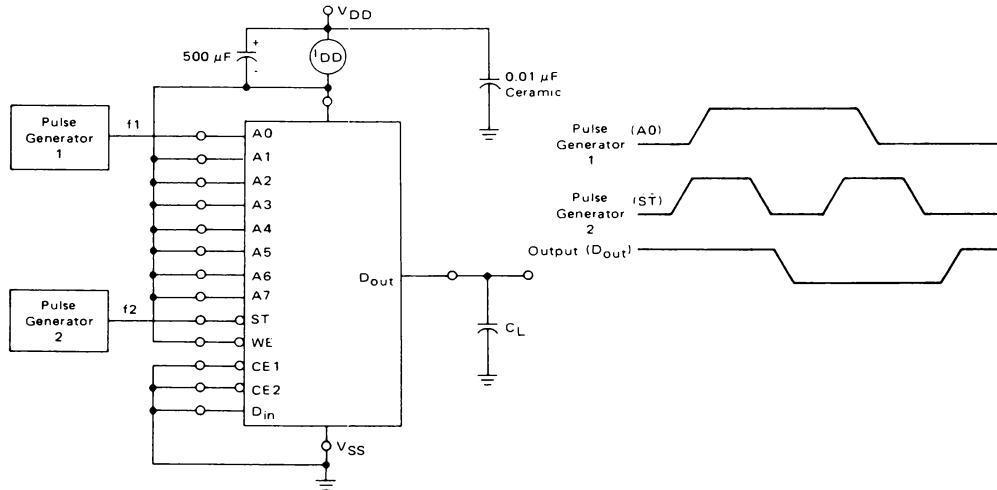


FIGURE 3 – AC TEST CIRCUIT

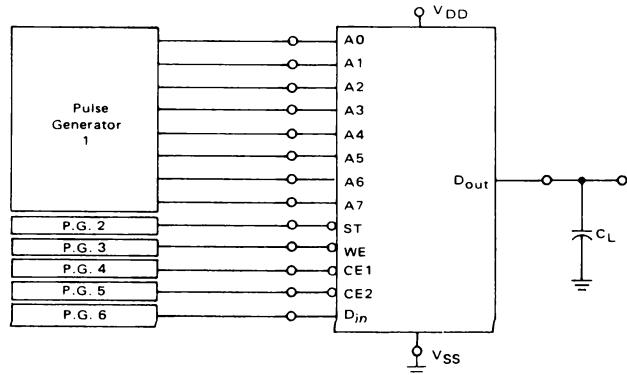


FIGURE 4 – READ CYCLE WAVEFORMS UTILIZING STROBE-TO-ACCESS MEMORY

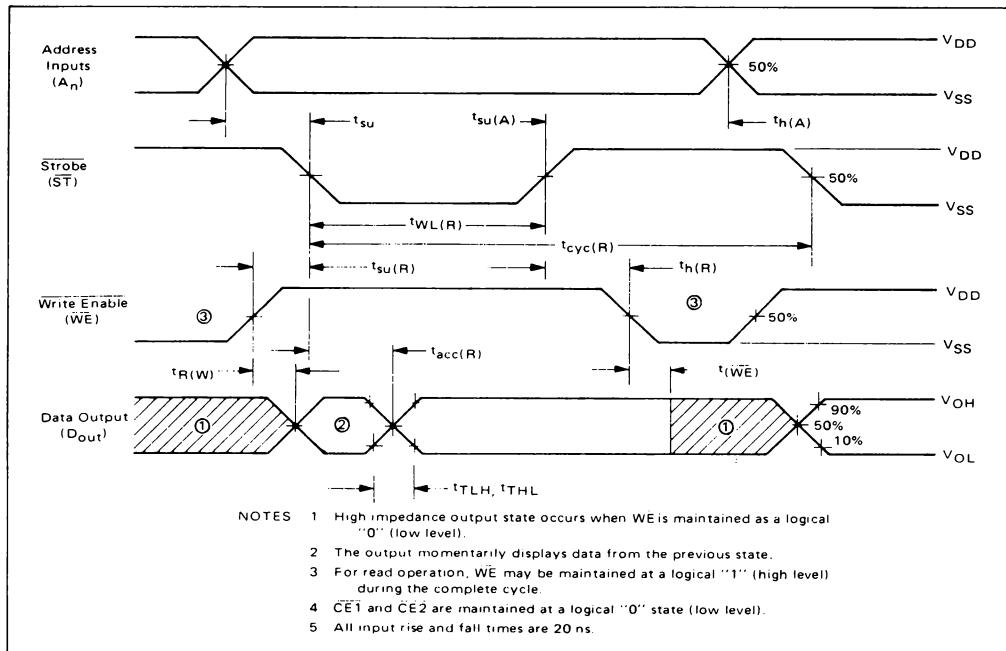


FIGURE 5 – READ CYCLE WAVEFORMS UTILIZING  $\overline{CE}_2$  FOR ACCESS MEMORY

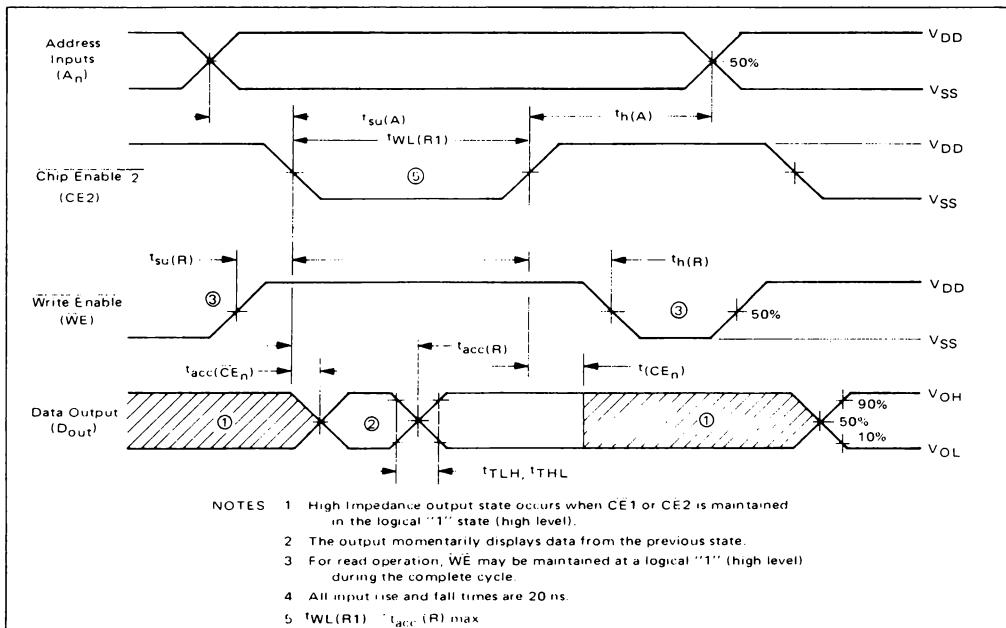


FIGURE 6 – READ CYCLE WAVEFORMS UTILIZING  $\overline{CE1}$  AND  $\overline{CE2}$  TO ACCESS MEMORY

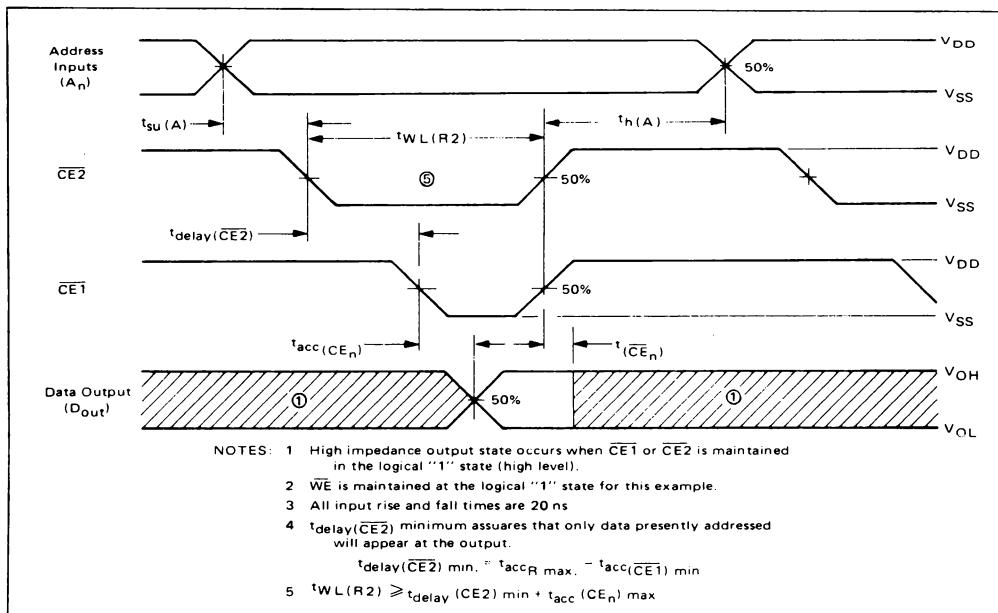
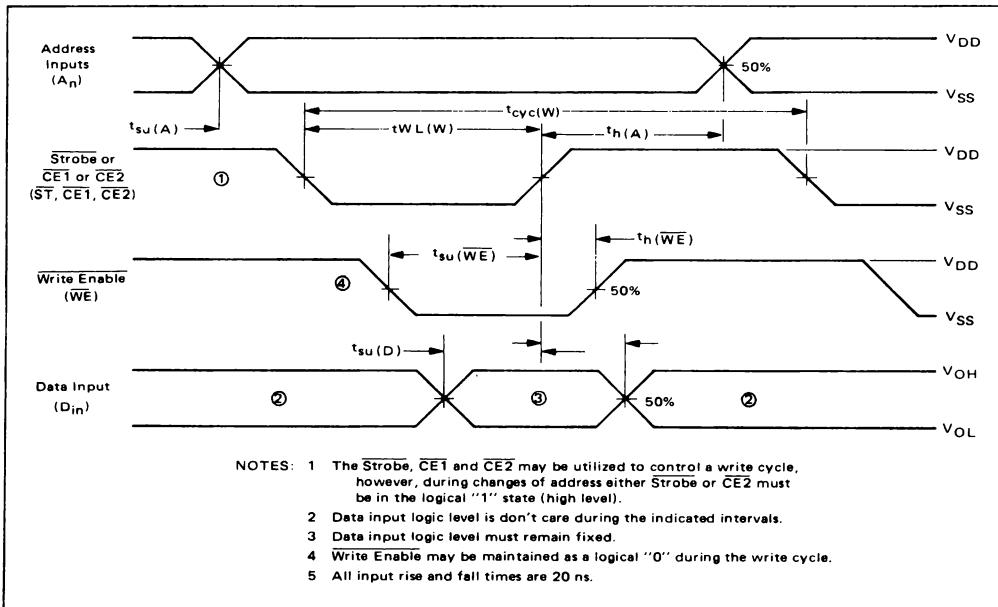
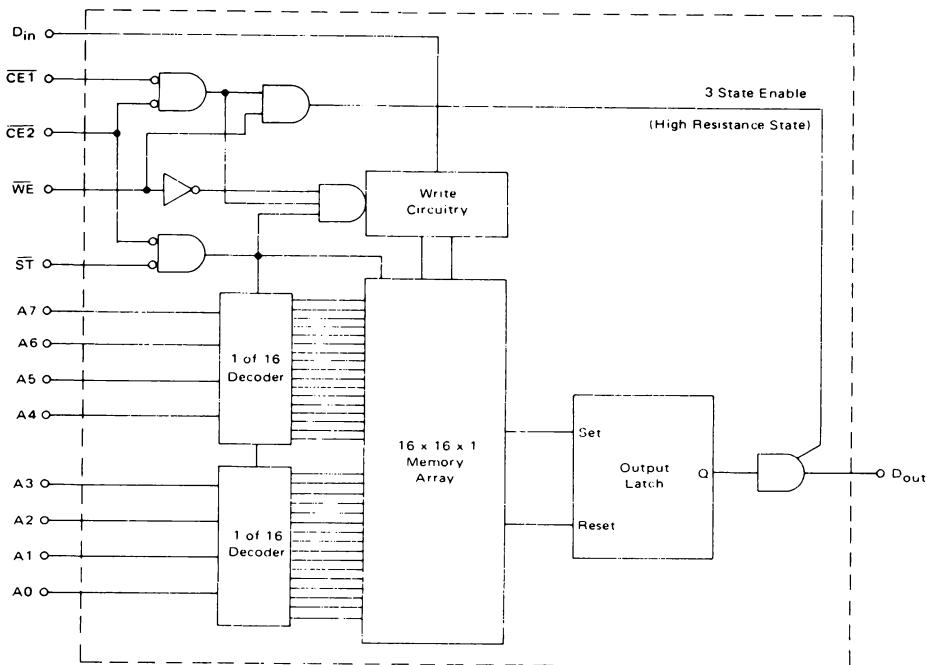


FIGURE 7 – WRITE CYCLE WAVEFORMS



LOGIC/BLOCK DIAGRAM



FUNCTION	CE1	CE2	ST	WE	D <sub>in</sub>	D <sub>out</sub>	COMMENTS
Address changing valid	X	X	1	X	X	R/A	D <sub>out</sub> will be active if CE1 and CE2 = "0" and WE = "1".
	X	1	X	X	X	R	CE2 = "1", fully disables internal logic and output.
Address changing not valid	X	0	0	X	X	R/A	Changing address in this mode may result in altered data.
D <sub>out</sub> disabled in high resistance state	1	X	X	X	X	R	CE1 = "1" disables write cycle and D <sub>out</sub> .
	X	1	X	X	X	R	The chip is fully disabled.
	X	X	X	0	X	R	WE = "0" enables writing into memory if CE1, CE2, and ST = "0".
D <sub>out</sub> enabled in active state	0	0	X	1	X	A	If ST = "1", the output stores and reads the previous data from or written into memory.
Read addressed memory location into output latch.	0	0	0	1	X	A	The output reads the present contents that are addressed.
	1	0	0	1	X	R	The addressed location is read into output latch with output in the "R" state.
Disable reading from memory	X	1	X	X	X	R	Address changing can take place in this condition.
Write into memory	0	0	0	0	A	R	D <sub>in</sub> is written into memory and into the output latch.
Write disabled	1	X	X	X	X	R	WE = "1" is a read enable.
	X	1	X	X	X	R	WE = "0" is a write enable.
	X	X	1	X	X	R/A	
	X	X	X	1	X	R/A	

R : High resistance state at D<sub>out</sub>

A : An active level of either V<sub>SS</sub> or V<sub>DD</sub>

R/A : An R or A condition depending on the don't care condition

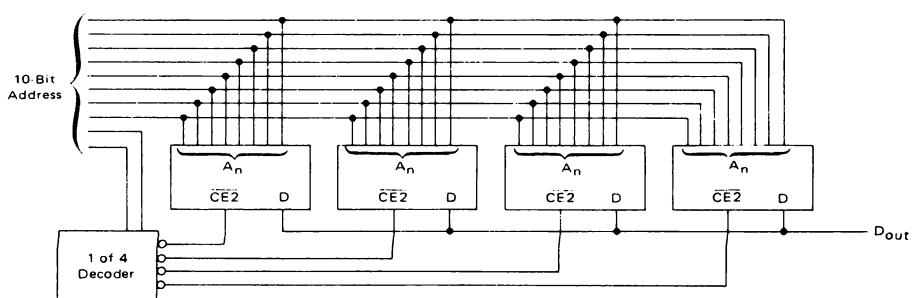
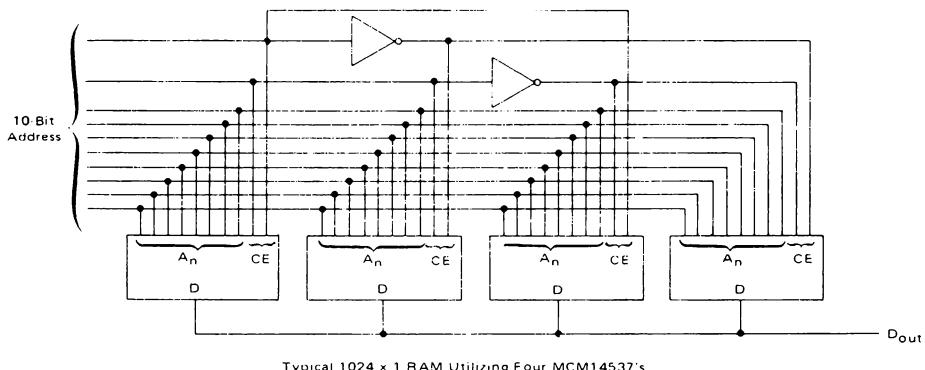
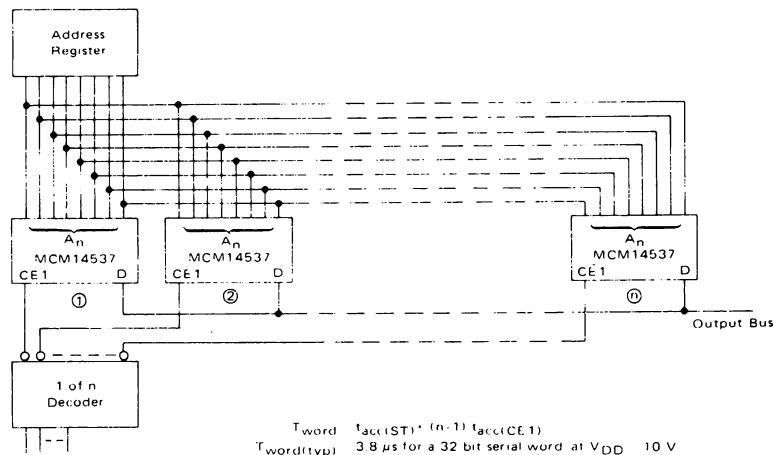
X : Don't care condition (must be in the "1" or "0" state)

1 : A high level at V<sub>DD</sub>

0 : A low level at V<sub>SS</sub>

# MCM14537

TYPICAL APPLICATION FOR SERIAL WORDS UTILIZING BUS TECHNIQUES





**MOTOROLA**

**MCM14552**

### 256-BIT STATIC RANDOM ACCESS MEMORY

The MCM14552 is a static random access memory (RAM) organized in a 64 x 4 bit pattern. The three chip enable inputs can be used as extensions of the six address inputs, creating 9-bit address scheme. Eight MCM14552 devices may be used to comprise a 2048-bit memory (512 x 4) without additional address decoding.

The mode control (M) is used to change the control logic characteristic of the circuit. For example, with M high, the 3-state input (T) fully controls the 3-state characteristic of the output. With M low, the output 3-state characteristic is controlled by chip enable inputs (CE), write enable input (WE) and T.

The memory is designed so that dc signals may operate the memory, with no maximum pulse width restrictions.

Medium speed, micropower operation, and control flexibility make the device useful in scratch pad or buffer applications where battery operation or high noise immunity are required.

- Quiescent Current = 50  $\mu$ A/package typical @ 5 Vdc
- Noise Immunity = 45% of VDD typical
- 3-state Output Capability for Memory Expansion
- Output Data Latch Eliminates Need for Storage Buffer
- Access Time = 700 ns typical @ VDD = 10 Vdc
- Fully Decoded and Buffered
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads, One Low-power Schottky TTL Load or Two HTL Loads Over the Rated Temperature Range

NOTE: Pin 20(LE) must be connected to VSS

### MAXIMUM RATINGS (Voltages referenced to VSS)

Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>DD</sub>	-0.5 to +18	Vdc
Input Voltage, All Inputs	V <sub>in</sub>	-0.5 to V <sub>DD</sub> + 0.5	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range – AL Device CL/CP Device	T <sub>A</sub>	-55 to +125 -40 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

This device contains 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 this high impedance circuit. For proper operation it is recommended that V<sub>in</sub> and V<sub>out</sub> be constrained to the range V<sub>SS</sub>  $\leq$  (V<sub>in</sub> or V<sub>out</sub>)  $\leq$  V<sub>DD</sub>.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>).

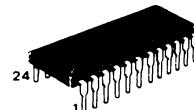
### CMOS LSI

(LOW-POWER COMPLEMENTARY MOS)

### 256-BIT (64 x 4) STATIC RANDOM ACCESS MEMORY



L SUFFIX  
CERAMIC PACKAGE  
CASE 623

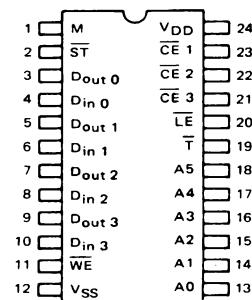


P SUFFIX  
PLASTIC PACKAGE  
CASE 709

### ORDERING INFORMATION

MCM14XXX	Suffix	Denotes
	L	Ceramic Package
	P	Plastic Package
	A	Extended Operating Temperature Range
	C	Limited Operating Temperature Range

### PIN ASSIGNMENT



## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub> Vdc	T <sub>low</sub> <sup>*</sup>		25 <sup>o</sup> C			T <sub>high</sub> <sup>*</sup>		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Voltage <sup>†</sup> V <sub>in</sub> = V <sub>DD</sub> or 0	V <sub>OL</sub>	5.0 10 15		0.05 0.05 0.05	- - 0	0 0.05 0.05	0.05	-	0.05 0.05 0.05	Vdc
	V <sub>OH</sub>	5.0 10 15	4.95 9.95 14.95	- 9.95 14.95	4.95 9.95 15	5.0 10 15		4.95 9.95 14.95		Vdc
	Input Voltage <sup>‡</sup> (V <sub>O</sub> = 4.5 or 0.5 Vdc) (V <sub>O</sub> = 9.0 or 1.0 Vdc) (V <sub>O</sub> = 13.5 or 1.5 Vdc)	V <sub>IL</sub>	5.0 10 15		1.5 3.0 4.0		2.25 4.50 6.75	1.5 3.0 4.0	--	Vdc
		V <sub>IH</sub>	5.0 10 15	3.5 7.0 11.0	--	3.5 7.0 11.0	2.75 5.50 8.25	--	3.5 7.0 11.0	Vdc
		I <sub>OH</sub>	5.0 5.0 10 15	-1.2 -0.25 -0.62 -1.8		-1.0 -0.2 -0.5 -1.5	-1.7 -0.36 -0.9 -3.5	--	-0.7 -0.14 -0.35 -1.1	μAdc
		I <sub>OL</sub>	5.0 10 15	0.64 1.6 4.2		0.51 1.3 3.4	0.88 2.25 8.8	--	0.36 0.9 2.4	μAdc
Output Drive Current (AL Device) (V <sub>OH</sub> = 2.5 Vdc) Source (V <sub>OH</sub> = 4.6 Vdc) (V <sub>OH</sub> = 9.5 Vdc) (V <sub>OH</sub> = 13.5 Vdc)	I <sub>OH</sub>	5.0 5.0 10 15	-1.0 -0.2 -0.5 -1.4		-0.8 -0.16 -0.4 -1.2	-1.7 -0.36 -0.9 -3.5		-0.6 -0.12 -0.3 -1.0	--	μAdc
	I <sub>OL</sub>	5.0 10 15	0.52 1.3 3.6		0.44 1.1 3.0	0.88 2.25 8.8	--	0.36 0.9 2.4	μAdc	
	I <sub>in</sub>	15		-0.1		+0.00001	+0.1	--	+1.0	μAdc
	I <sub>in</sub>	15		-1.0		+0.00001	+1.0		+14.0	μAdc
	C <sub>in</sub>	—			5.0	7.5			pF	
	I <sub>DD</sub>	5.0 10 15		5.0 10 20		0.050 0.100 0.150	5.0 10 20		150 300 600	μAdc
Quiescent Current (CL/CP Device) (Per Package)	I <sub>DD</sub>	5.0 10 15		50 100 200		0.050 0.100 0.150	50 100 200		375 750 1500	μAdc
	I <sub>T</sub>	5.0 10 15			I <sub>T</sub> (1.98 μA/kHz) f + I <sub>DD</sub> I <sub>T</sub> (3.96 μA/kHz) f + I <sub>DD</sub> I <sub>T</sub> (5.86 μA/kHz) f + I <sub>DD</sub>					μAdc
	I <sub>TL</sub>	15		-0.1		+0.00001	+0.1		+3.0	μAdc
Three-State Leakage Current (AL Device)	I <sub>TL</sub>	15		-1.0		+0.00001	+1.0		+7.5	μAdc
Three-State Leakage Current (CL/CP Device)	I <sub>TL</sub>	15		-1.0		+0.00001	+1.0			

\* T<sub>low</sub> = -55<sup>o</sup>C for AL Device, -40<sup>o</sup>C for CL/CP Device

† T<sub>high</sub> = 125<sup>o</sup>C for AL Device, +85<sup>o</sup>C for CL/CP Device

‡ Noise immunity specified for worst-case input combination

Noise Margin for both "1" and "0" level = 1.0 Vdc min @ V<sub>DD</sub> = 5.0 Vdc

2.0 Vdc min @ V<sub>DD</sub> = 10 Vdc

2.5 Vdc min @ V<sub>DD</sub> = 15 Vdc

To calculate total supply current at loads other than 50 pF

$$I_{(C_L)} = I_T(50 \text{ pF}) + 4 \times 10^{-3} (C_L - 50) V_{DD}$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V<sub>DD</sub> in Vdc, and f in kHz is input frequency.

\*\* The formulas given are for the typical characteristics only at 25<sup>o</sup>C

# MCM14552

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

Characteristic	Figure	Symbol	V <sub>DD</sub>	Min	Typ	Max	Unit
Output Rise Time	1	t <sub>TLH</sub>	5.0	—	180	360	ns
$t_{TLH} = (3.0 \text{ ns/pF}) C_L + 30 \text{ ns}$			10	—	90	180	
$t_{TLH} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$			15	—	65	130	
Output Fall Time	1	t <sub>THL</sub>	5.0	—	100	200	ns
$t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$			10	—	50	100	
$t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$			15	—	40	80	
$t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$							
Read Cycle Time	1, 2	t <sub>cyc(R)</sub>	5.0	—	2000	6000	ns
			10	—	750	2200	
			15	—	500	1650	
Write Cycle Time	3, 4	t <sub>cyc(W)</sub>	5.0	—	1200	3600	ns
			10	—	750	2200	
			15	—	500	1650	
Address to Strobe Setup Time	1, 3	t <sub>su(A-ST)</sub>	5.0	1500	500	—	ns
			10	450	150	—	
			15	350	120	—	
Strobe to Address Hold Time	1, 3	t <sub>h(ST-A)</sub>	5.0	150	50	—	ns
			10	100	0	—	
			15	75	0	—	
Address to Chip Enable Setup Time	2, 4	t <sub>su(A-C\bar{E})</sub>	5.0	1800	600	—	ns
			10	600	200	—	
			15	450	150	—	
Chip Enable to Address Hold Time	2, 4	t <sub>h(C\bar{E}-A)</sub>	5.0	450	150	—	ns
			10	300	100	—	
			15	225	75	—	
Strobe or Chip Enable Pulse Width When Reading	1, 2	t <sub>WL(R)</sub>	5.0	1800	450	—	ns
			10	450	150	—	
			15	350	100	—	
Strobe or Chip Enable Pulse Width When Writing	3, 4	t <sub>WL(W)</sub>	5.0	3600	1200	—	ns
			10	1800	600	—	
			15	1350	400	—	
Read Setup Time	1	t <sub>su(R)</sub>	5.0	0	-100	—	ns
			10	0	-40	—	
			15	0	-30	—	
Read Hold Time	1	t <sub>h(R)</sub>	5.0	540	180	—	ns
			10	240	60	—	
			15	180	45	—	
Data Setup Time	3, 4	t <sub>su(D)</sub>	5.0	1800	600	—	ns
			10	600	200	—	
			15	450	150	—	
Data Hold Time	3, 4	t <sub>h(D)</sub>	5.0	600	200	—	ns
			10	150	50	—	
			15	120	30	—	

\*The formula given is for the typical characteristics only.

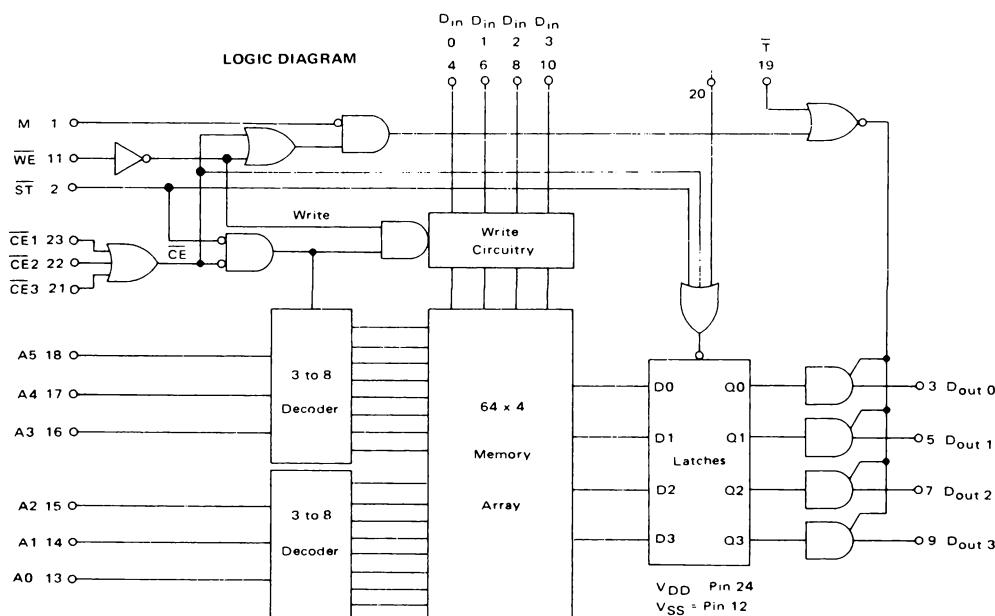
(continued)

# MCM14552

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ ) (continued)

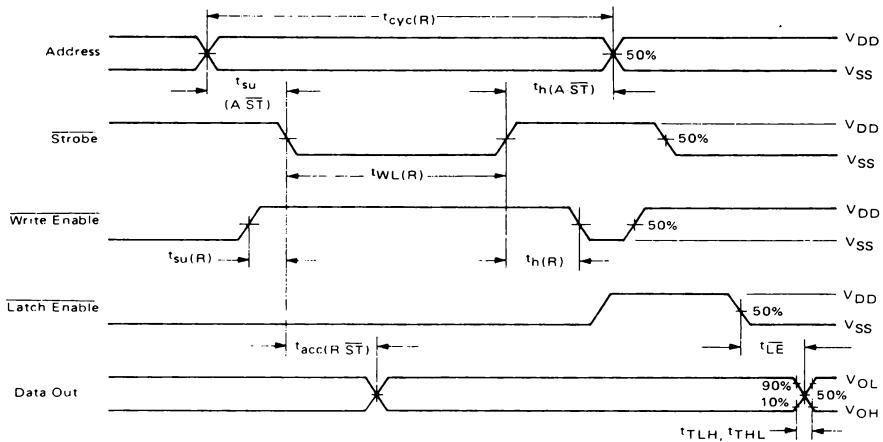
Characteristic	Figure	Symbol	$V_{DD}$	Min	Typ	Max	Unit
Write Enable Setup Time	3, 4	$t_{su(WE)}$	5.0	720	240	-	ns
			10	240	80	-	ns
			15	180	55	-	ns
Write Enable Hold Time	3, 4	$t_{h(WE)}$	5.0	150	50	-	ns
			10	60	20	-	ns
			15	45	15	-	ns
Read Access Time from Strobe	1, 3	$t_{acc(R-ST)}$	5.0	-	2000	6000	ns
			10	-	700	2100	ns
			15	-	350	1600	ns
Read Access Time from Chip Enable	2	$t_{acc(R-CE)}$	5.0	-	2100	6300	ns
			10	-	750	2250	ns
			15	-	400	1700	ns
Output Enable/Disable Delay from Chip Enable or Write Enable	2, 4	$t_{R(CE)}$ , $t_{R(WE)}$	5.0	-	400	1200	ns
			10	-	200	600	ns
			15	-	150	450	ns
Three-State Enable/Disable Output Delay	2	$t_{T}$	5.0	-	400	1200	ns
			10	-	160	480	ns
			15	-	120	360	ns
Latch to Output Propagation Delay	1	$t_{LE}$	5.0	-	500	1500	ns
			10	-	200	600	ns
			15	-	150	450	ns

\*The formula given is for the typical characteristics only.



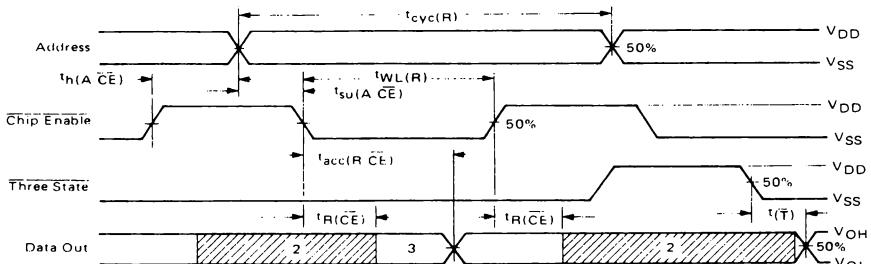
# MCM14552

FIGURE 1 – READ CYCLE WAVEFORMS UTILIZING STROBE TO ACCESS MEMORY



- Notes
- 1  $\bar{CE}_1, \bar{CE}_2, \bar{CE}_3$  and  $\bar{T}$  are low, M is high.
  - 2 WE may be held high during the complete read cycle.

FIGURE 2 – READ CYCLE WAVEFORMS UTILIZING CHIP ENABLE TO ACCESS MEMORY



- Notes
- 1 Unused  $\bar{CE}, \bar{ST}, M$  and  $\bar{T}$  are low and WE is high.
  - 2 High impedance output state occurs when any  $\bar{CE}$  is high and M is low, or when  $\bar{T}$  is high.
  - 3 The output displays data from the previous state.
  - 4  $t_{WL}(R) \leq t_{acc}(R \bar{CE})_{max}$

FIGURE 3 – WRITE CYCLE WAVEFORMS UTILIZING STROBE

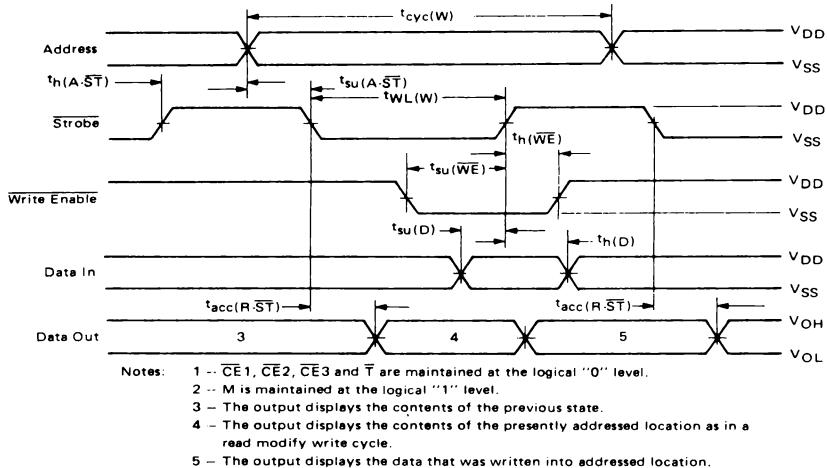
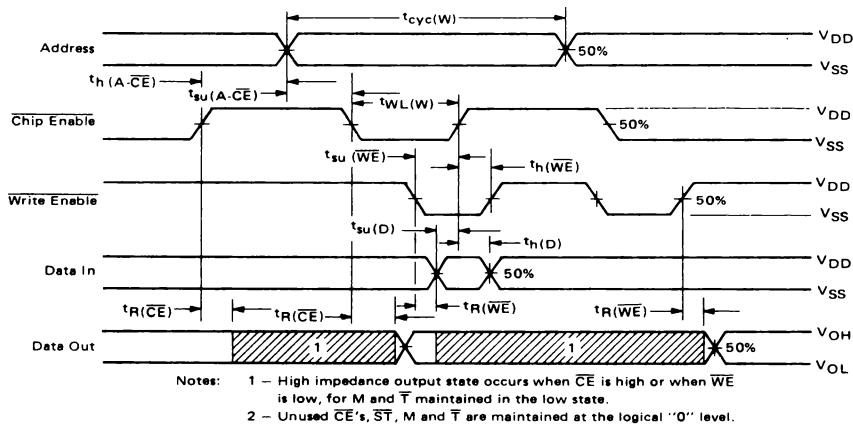


FIGURE 4 – WRITE CYCLE WAVEFORM UTILIZING CHIP ENABLE



# MCM14552

TRUTH TABLE

Function	CE 1	CE 2	CE 3	T	LE	M	ST	WE	D <sub>in</sub>	D <sub>out</sub>	Comments
Address Changing Valid	X	X	X	X	X	X	I	X	X	R A	D <sub>out</sub> will be active if all CE = 0, T = 0 and WE = 1 or if M = 1 and T = 0
Address Changing Not Valid	X	X	X	X	X	X	X	X	X	R A	D <sub>out</sub> will be active if T = 0 and WE = 1 or if M = 1 and T = 0
D <sub>out</sub> Disabled (in high resistance state)	X	X	I	X	X	0	X	X	X	R	Disables write circuitry
X	1	X	X	X	0	X	X	X	X	R	
X	X	X	X	X	0	X	X	X	X	R	
X	X	X	I	X	X	X	X	X	X	R	
CE <sub>1</sub> , CE <sub>2</sub> , CE <sub>3</sub> active state	0	0	0	0	X	X	X	I	X	A	Read operation, D <sub>out</sub> active
X	X	X	Y	0	X	I	X	X	X	A	Read or write, D <sub>out</sub> active
CE <sub>1</sub> , Address M, LE, ST, T, WE inactive state	0	0		X	0	X	0	X	X	R A	If WE = 0, D <sub>in</sub> = D <sub>out</sub>
CE <sub>1</sub> , Address M, LE, ST, T, WE active state	X	X	I	X	X	X	X	X	X	R A	
X	1	X	X	X	X	X	X	X	X	R A	
X	X	X	X	X	X	X	I	X	X	R A	
X	X	X	X	X	X	X	0	X	X	R A	
Write Into Memory	X	0	0	X	X	X	0	0	0	R A	
Write Disabled	X	1	I	X	X	X	X	X	X	R A	
X	X	X	X	X	X	X	X	X	X	R A	
X	X	X	X	X	X	X	I	X	X	R A	
X	X	X	I	X	X	X	1	X	X	R A	
Output Latch Enabled	0	1	I	X	0	X	0	X	X	R A	
Output Latch Disabled	X	X	I	X	X	X	X	X	X	R A	
X	1	X	X	X	X	X	X	X	X	R A	
X	X	X	X	X	X	I	X	X	X	R A	
X	X	X	I	X	X	X	1	X	X	R A	

X = High resistance state (open)

A = An active level at either V<sub>DD</sub> or V<sub>SS</sub>

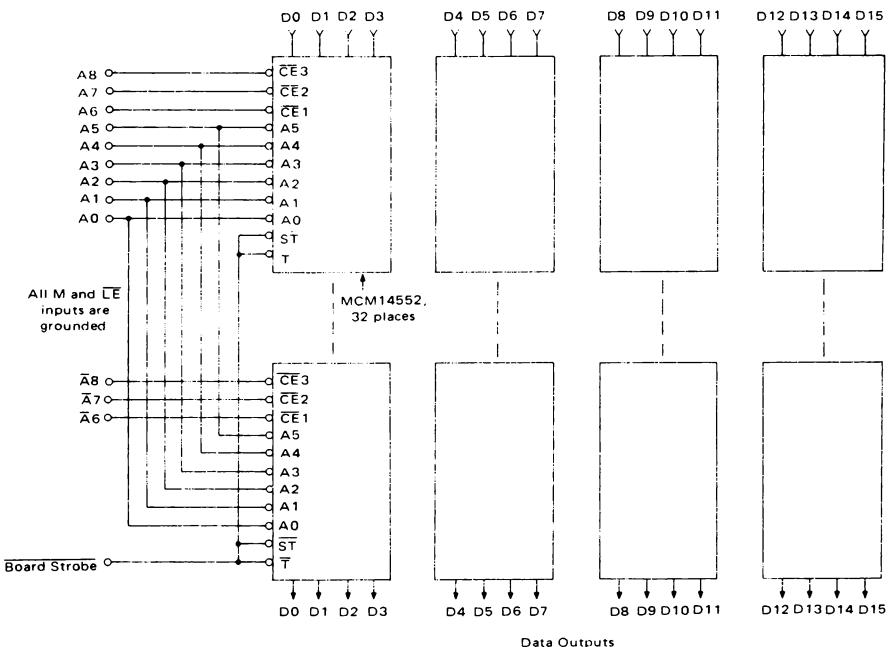
R A = An R or A condition, dependent on the logic function

X = Don't care condition must be in the 'I' or '0' state

1 = A high level at V<sub>DD</sub>

0 = A low level at V<sub>SS</sub>

FIGURE 5 – 512 WORD x 16 BIT MEMORY BOARD Data Inputs





**MOTOROLA**

# MCM5101 MCM51L01

## 256 × 4 BIT STATIC RAM

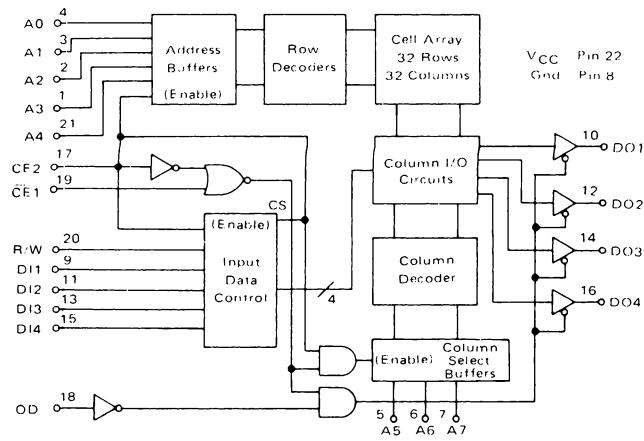
The MCM5101 family of CMOS RAMs offers ultra low power and fully static operation with a single 5-volt supply. The CMOS 1024 bit devices are organized in 256 words by 4 bits. Separate data inputs and data outputs permit maximum flexibility in bus-oriented systems. Data retention at a power supply as low as 2.0 volts over temperature readily allows design into applications using battery backup for nonvolatility. The MCM5101 is fully static and does not require clocking in standby mode.

The MCM5101 is fabricated using the Motorola advanced ion-implanted, silicon-gate technology for high performance and high reliability.

- Low Standby Power
- Fast Access Time
- Single +5.0 Volt Supply
- Fully TTL Compatible - All Inputs and Outputs
- Three-State Output
- Fully Static Operation
- Data Retention to 2.0 Volts
- Direct Replacement for:
  - Intel 5101 Series
  - AMI S5101 Series
  - Hitachi HM435101 Series
- Pin Replacement for Harris HM6501 Series

Type Number	Typical Current @2 V ( $\mu$ A)	Typical Current @ 5 V ( $\mu$ A)	Max Access (ns)
MCM51L01C45, P45	0.14	0.2	450
MCM51L01C65, P65	0.14	0.2	650
MCM5101C65, P65	0.70	1.0	650
MCM5101C80, P80	—	10	800

BLOCK DIAGRAM



## CMOS

(COMPLEMENTARY MOS)

## 1024-BIT STATIC RANDOM ACCESS MEMORY

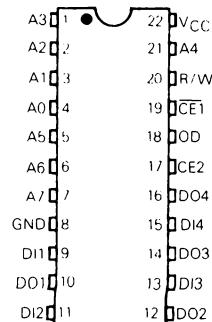


C SUFFIX  
PLASTIC PACKAGE  
CASE 28-12



P SUFFIX  
PLASTIC PACKAGE  
CASE 28K04

## PIN ASSIGNMENT



## TRUTH TABLE

CE1	CE2	OD	R/W	D <sub>in</sub>	Output	Mode
H	X	X	X	X	High-Z	Not Selected
X	L	X	X	X	High-Z	Not Selected
X	X	H	H	X	High-Z	Output Disabled
L	H	H	L	X	High-Z	Write
L	H	L	L	X	D <sub>in</sub>	Write
L	H	L	H	X	D <sub>out</sub>	Read

# MCM5101•MCM51L01

## MAXIMUM RATINGS (Voltages referenced to V<sub>SS</sub> Pin 8)

Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>CC</sub>	-0.5 to +7.0	V
Voltage on Any Pin	V <sub>in</sub>	-0.3 to V <sub>CC</sub> +0.3	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°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 device contains 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 this high-impedance circuit.

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub> V <sub>SS</sub>	4.75 0	5.0 0	5.25 0	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	2.2	--	V <sub>CC</sub> +0.3	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	-0.3	--	0.65	V

### DC CHARACTERISTICS

Characteristic	Symbol	MCM51L01-45 MCM51L01-65			MCM5101-65			MCM5101-80			Unit
		Min	Typ <sup>(1)</sup>	Max	Min	Typ <sup>(1)</sup>	Max	Min	Typ <sup>(1)</sup>	Max	
		-	5.0	-	-	5.0	-	-	5.0	-	nA
Input Current	I <sub>in</sub> <sup>(2)</sup>	-	5.0	-	-	5.0	-	-	5.0	-	nA
Input High Voltage	V <sub>IH</sub>	2.2	-	V <sub>CC</sub> +0.3	2.2	-	V <sub>CC</sub> +0.3	2.2	-	V <sub>CC</sub> +0.3	V
Input Low Voltage	V <sub>IL</sub>	-0.3	--	0.65	-0.3	--	0.65	-0.3	--	0.65	V
Output High Voltage (I <sub>OH</sub> = -1.0 mA)	V <sub>OH</sub>	2.4	-	-	2.4	-	-	2.4	-	-	V
Output Low Voltage (I <sub>OL</sub> = 2.0 mA)	V <sub>OL</sub>	-	-	0.4	-	-	0.4	-	-	0.4	V
Output Leakage Current (CE1 = 2.2 V, V <sub>OL</sub> = 0 V to V <sub>CC</sub> )	I <sub>LO</sub> <sup>(2)</sup>	--	-	±1.0	-	-	±1.0	-	-	±2.0	µA
Operating Current (V <sub>in</sub> = V <sub>CC</sub> , except CE1 ≤ 0.65 V, outputs open)	I <sub>CC1</sub>	-	9.0	22	-	9.0	22	-	11	25	mA
Operating Current (V <sub>in</sub> = 2.2 V, Except CE1 ≤ 0.65 V, outputs open)	I <sub>CC2</sub>	-	13	27	-	13	27	--	15	30	mA
Standby Current (CE2 ≤ 0.2 V, V <sub>in</sub> = 0 V or V <sub>CC</sub> )	I <sub>CCL</sub> <sup>(2)(4)</sup>	-	-	10	-	-	200	-	-	500	µA

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5 V periodically sampled rather than 100% tested)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V)	C <sub>in</sub>	4.0	8.0	pF
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	8.0	12.0	pF

### LOW V<sub>CC</sub> DATA RETENTION CHARACTERISTICS (Excluding MCM5101-80)

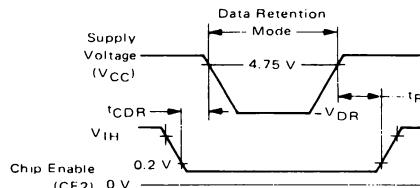
Parameter	Test Conditions	Symbol	Min	Typ <sup>(1)</sup>	Max	Unit
V <sub>CC</sub> for Data Retention	CE2 ≤ 0.2 V	V <sub>DR</sub>	2.0	-	-	V
MCM51L01-45, -65 Data Retention Current		I <sub>CCDR1</sub>	-	0.14	10	µA
MCM5101-65 Data Retention Current		I <sub>CCDR2</sub>	-	0.70	200	µA
Chip Deselect to Data Retention Time		t <sub>CDR</sub>	0	-	-	ns
Operation Recover Time		t <sub>R</sub>	t <sub>RC</sub> <sup>(3)</sup>	-	-	ns

#### Notes:

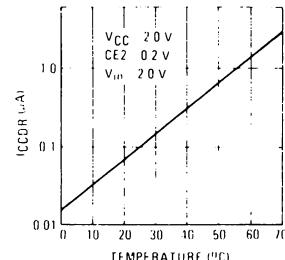
1. Typical values are T<sub>A</sub> = 25°C and nominal supply voltage
2. Current through all inputs and outputs included in I<sub>CCL</sub> measurement
3. t<sub>RC</sub> = Read Cycle Time
4. Low current state is for CE2 = 0 only

# MCM5101•MCM51L01

LOW V<sub>CC</sub> DATA RETENTION WAVEFORM



TYPICAL ICCDR VS TEMPERATURE



## AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted)

Input Pulse Levels	+0.65 V to 2.2 V	Output Load	1 TTL Gate and $C_L = 100\text{ pF}$
Input Rise and Fall Times...	..... 20 ns	Timing Measurement Reference Level	1.5 V

### READ CYCLE

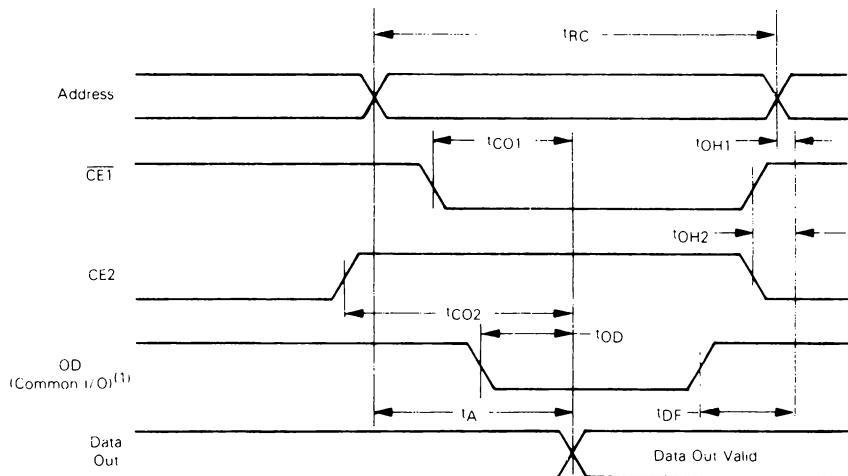
Parameter	Symbol	MCM51L01-45		MCM51L01-65 MCM5101-65		MCM5101-80		Unit
		Min	Max	Min	Max	Min	Max	
Read Cycle	$t_{RC}$	450	-	650	-	800	-	ns
Access Time	$t_A$	-	450	-	650	-	800	ns
Chip Enable ( $CE1$ ) to Output	$t_{CO1}$	-	400	-	600	-	800	ns
Chip Enable ( $CE2$ ) to Output	$t_{CO2}$	-	500	-	700	-	850	ns
Output Disable to Output	$t_{OD}$	-	250	-	350	-	450	ns
Data Output to High-Z State	$t_{DF}$	0	130	0	150	0	200	ns
Previous Read Data Valid with Respect to Address Change	$t_{OH1}$	0	-	0	-	0	-	ns
Previous Read Data Valid with Respect to Chip Enable	$t_{OH2}$	0	-	0	-	0	-	ns

### WRITE CYCLE

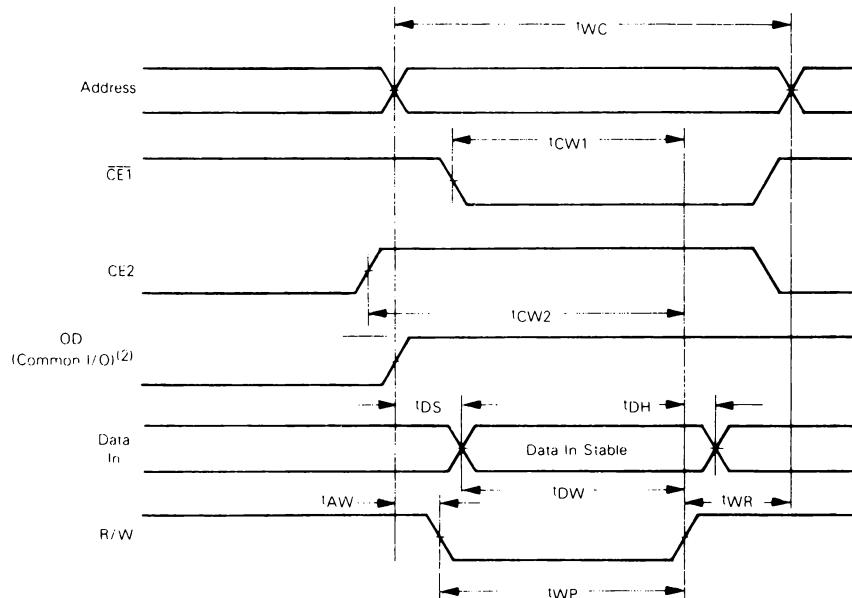
Parameter	Symbol	MCM51L01-45		MCM51L01-65 MCM5101-65		MCM5101-80		Unit
		Min	Max	Min	Max	Min	Max	
Write Cycle	$t_{WC}$	450	-	650	-	800	-	ns
Write Delay	$t_{AW}$	130	-	150	-	200	-	ns
Chip Enable ( $CE1$ ) to Write	$t_{CW1}$	350	-	550	-	650	-	ns
Chip Enable ( $CE2$ ) to Write	$t_{CW2}$	350	-	550	-	650	-	ns
Data Setup	$t_{DW}$	250	-	400	-	450	-	ns
Data Hold	$t_{DH}$	50	-	100	-	100	-	ns
Write Pulse	$t_{WP}$	250	-	400	-	450	-	ns
Write Recovery	$t_{WR}$	50	-	50	-	100	-	ns
Output Disable Setup	$t_{DS}$	130	-	150	-	200	-	ns

# MCM5101•MCM51L01

## READ CYCLE TIMING



## WRITE CYCLE TIMING



### Notes

1  $\bar{OD}$  may be tied low for separate I/O operation

2 During the write cycle,  $\bar{OD}$  is "high" for common I/O and "don't care" for separate I/O operation



**MOTOROLA**

**MCM6508  
MCM6518**

**1024 × 1 BIT STATIC RANDOM ACCESS MEMORY**

The MCM6508 and MCM6518 are fully static  $1024 \times 1$  RAMs fabricated using CMOS silicon gate technology. They offer low power operation from a single +5 V supply with data retention to 2.0 V. The 16-pin MCM6508 has a single active low chip enable. The MCM6518 has two select lines, in addition to the chip enable. Both part types latch addresses with chip enable. The MCM6518 is especially suitable for multiplexed bus microprocessors like the MC146805.

- Low Standby and Operating Power
- Single  $\pm 10\%$  5 V Supply
- Data Retention to 2.0 V
- Fast Access Time
- Address Latches
- Three State Outputs
- Fully TTL Compatible Inputs/Outputs
- Fully Static Operation
- Direct Replacement For  
Harris HM6508/HM6518  
Intersil IM6508/IM6518

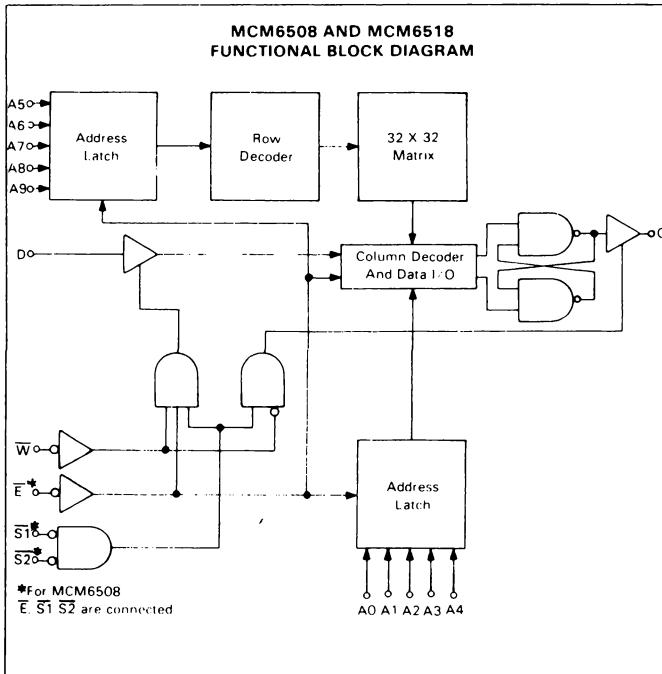
**CMOS**

(COMPLEMENTARY MOS)

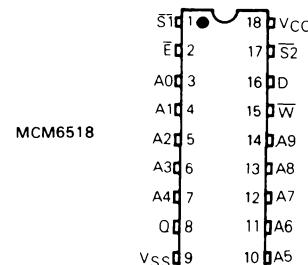
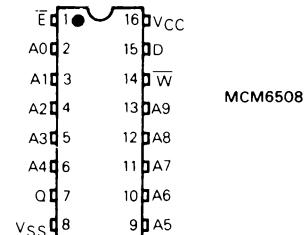
**1024 X 1 BIT STATIC  
RANDOM ACCESS MEMORY**



Type Number	Package Suffixes	Typical Current		Maximum Access Time	Operating Temperature Range
		2 V	5 V		
MCM6508-25/MCM6518-25	C/P	0.1 $\mu$ A	0.1 $\mu$ A	250 ns	0 to 70°C
MCM6508-30/MCM6518-30	C/P	1 $\mu$ A	1 $\mu$ A	300 ns	0 to 70°C
MCM6508-46/MCM6518-46	C/P	1 $\mu$ A	1 $\mu$ A	460 ns	0 to 70°C



**PIN ASSIGNMENTS**



This device contains 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 applications of any voltage higher than maximum rated voltages to this high-impedance circuit.

# MCM6508•MCM6518

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>CC</sub>	- 0.5 to 7.0	V
Voltage on Any Pin	V <sub>in</sub>	- 0.3 to V <sub>CC</sub> + 0.3	V
Operating Temperature Range	T <sub>A</sub>	0 to 70	°C
Storage Temperature Range	T <sub>sig</sub>	- 65 to 150	°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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V
V <sub>SS</sub>	0	0	0	0	V
Logic 1 Voltage, All Inputs	V <sub>IH</sub>	V <sub>CC</sub> - 2.0	-	V <sub>CC</sub>	V
Logic 0 Voltage, All Inputs	V <sub>IL</sub>	- 0.3	-	0.8	V

### DC CHARACTERISTICS

Characteristic	Symbol	MCM6508-25 MCM6518-25			MCM6508-30, -46 MCM6518-30, -46			Unit
		Min	Typ <sup>1</sup>	Max	Min	Typ <sup>1</sup>	Max	
Input Current	I <sub>IN</sub>	5.0	--	--	5.0	--	--	nA
Output High Voltage (I <sub>OH</sub> = - 1.0 mA)	V <sub>OH</sub>	2.4	--	--	2.4	--	--	V
Output Low Voltage (I <sub>OL</sub> = 2.0 mA)	V <sub>OL</sub>	--	0.4	--	--	0.4	--	V
Output Leakage Current (See Note 1) V <sub>O</sub> = 0 V to V <sub>CC</sub>	I <sub>OL</sub>	--	± 1.0	--	--	± 1.0	μA	
Standby Current (V <sub>IH</sub> = E = S <sub>1</sub> = S <sub>2</sub> = V <sub>CC</sub> )	I <sub>DDSB</sub>	0.1	10.0	--	1.0	100	μA	
Data Retention Current (V <sub>DD</sub> = 2.0 V; V <sub>IH</sub> = E = S <sub>1</sub> = S <sub>2</sub> )	I <sub>DDDR</sub>	0.1	10.0	--	1.0	100	μA	
Operating Current (E <sub>LEH</sub> = 1 μs)	I <sub>DDOP</sub>	-	1.5	--	-	1.5	--	mA

Note:

1 Typical values are T<sub>A</sub> = 25°C and nominal supply voltage.

### CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, V<sub>CC</sub> = + 5 V, periodically sampled rather than 100% tested)

Characteristic	Symbol	Typ	Max	Unit
Input Capacitance (V <sub>in</sub> = 0 V)	C <sub>in</sub>	4.0	8.0	pf
Output Capacitance (V <sub>out</sub> = 0 V)	C <sub>out</sub>	8.0	12.0	pf

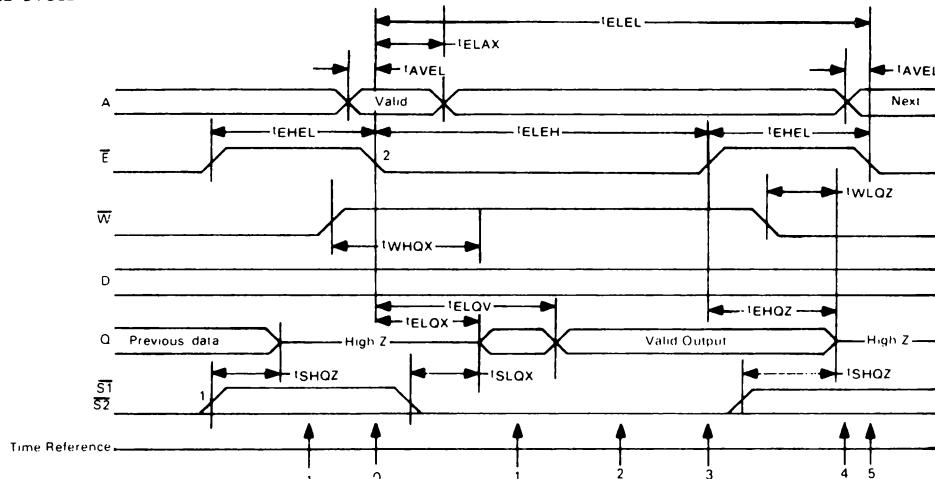
# MCM6508•MCM6518

## AC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature range unless otherwise noted)

Input Pulse Levels ..... 0.8 V to V<sub>CC</sub> – 2.0 V      Output Load ..... 1 TTL Gate and C<sub>L</sub> = 50 pF  
Input Rise and Fall Times ..... 20 ns      Timing Measurement Reference Level ..... 1.5 V

Parameter	Symbol	MCM6508-25 MCM6518-25		MCM6508-30 MCM6518-30		MCM6508-46 MCM6518-46		Units
		Min	Max	Min	Max	Min	Max	
Read or Write Cycle Time	I'EEL	350	—	450	—	730	—	ns
Enable Pulse Width, Low	I'EH <sub>L</sub>	250	—	300	—	460	—	ns
Enable Pulse Width, High	I'EH <sub>H</sub>	100	—	150	—	270	—	ns
Enable Access Time	I'ELQV	—	250	—	300	—	460	ns
Address Setup	I'AVEL	0	—	7	—	15	—	ns
Address Hold	I'ELAX	50	—	70	—	130	—	ns
Data Setup	I'DVWH	110	—	130	—	270	—	ns
Data Hold	I'WHD <sub>X</sub>	0	—	0	—	0	—	ns
Write Pulse Width	I'WLWH	130	—	160	—	270	—	ns
Write Enable to Output Disable	I'WLQZ	—	160	—	180	—	285	ns
Output Disable (6508 Only)	I'EHOZ	—	160	—	180	—	285	ns
Output Disable (6518 Only)	I'SHQZ	—	160	—	180	—	285	ns
Write Disable to Output Enable	I'WHOX	—	160	—	180	—	285	ns
Output Enable (6508 Only)	I'ELQX	—	160	—	180	—	285	ns
Output Enable (6518 Only)	I'SLQX	—	160	—	180	—	285	ns
Select to Write Pulse Setup	I'WL <sub>S</sub> H	130	—	160	—	270	—	ns
Select to Write Pulse Hold	I'SLWH	130	—	160	—	270	—	ns
Enable to Write Pulse Setup	I'WLEH	130	—	160	—	270	—	ns
Enable to Write Pulse Hold	I'ELWH	130	—	160	—	270	—	ns

### READ CYCLE



### TRUTH TABLE

Time Reference	Inputs					Output Q	Function
	E	S	W	A	D		
-1	H	H	X	X	X	Z	Disabled
0		X	H	V	X	Z	Address Latched
1	L	L	H	X	X	X	Output Enabled
2	L	L	H	X	X	V	Output Valid
3		L	H	X	X	V	Output Latched
4	H	H	X	X	X	Z	Disabled (Same As 1)
5		X	H	V	X	Z	Next Cycle (Same As 0)

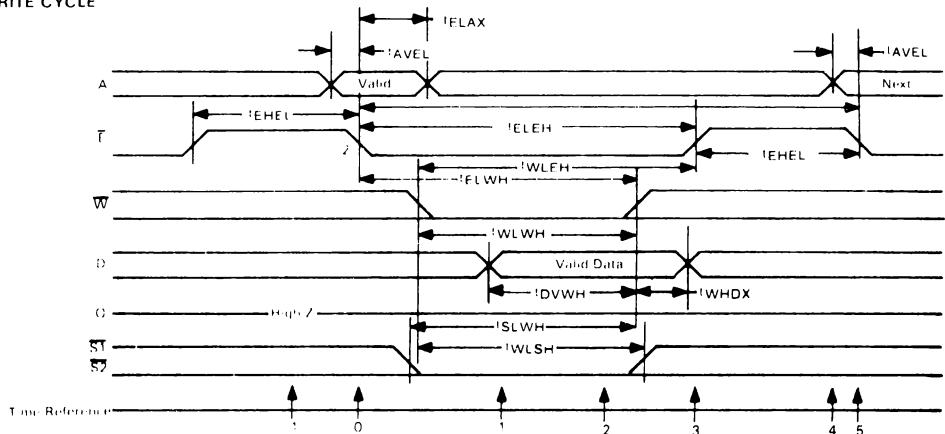
#### Notes:

1 MCM6518 selected only if both S1 and S2 are low and deselected if either S1 or S2 is high. S1 and S2 are connected to E on MCM6508.

2 The address within the memory will change only on falling E.

## MCM6508•MCM6518

WRITE CYCLE



TRUTH TABLE

Time Reference	Inputs					Output Q	Function
	E	S	W	A	D		
1	H	X	X	X	X	Z	Disabled
0	L	X	X	V	X	Z	Address Latched
1	L	L	X	V	Z	Z	Write Mode
2	L	L	X	V	Z	Z	Data Written
3	L	X	X	X	X	Z	Write Completed
4	H	X	X	X	X	Z	Disabled (Same As 1)
5	L	X	X	V	X	Z	Next Cycle (Same As 0)

Notes:

1. MCM6518 sees address A. Both S1 and S2 are low and deselected if either S1 or S2 is high. S1 and S2 are connected to T on MCM6508.

2. The address value in the memory will change only on falling T.



**MOTOROLA**

## MCM65116

### Product Preview

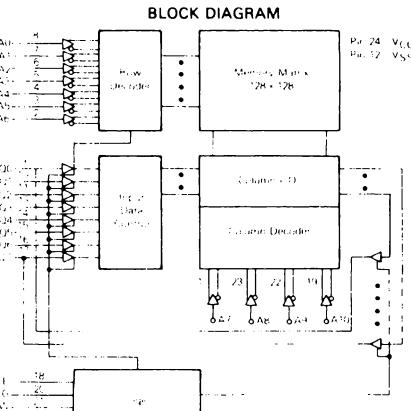
#### 2048 × 8-BIT STATIC RANDOM ACCESS MEMORY

The MCM65116 is a 16,384-bit Static Random Access Memory organized as 2048 words by 8-bits, fabricated using Motorola's high-performance silicon-gate complementary metal oxide semiconductor (HCMOS) technology. It uses a design approach which provides the simple timing features associated with fully static memories and the reduced power associated with CMOS memories. This means low standby power without the need for clocks, nor reduced data rates due to cycle times that exceed access time.

Chip Enable (E) controls the power-down feature. It is not a clock but rather a chip control that affects power consumption. In less than a cycle time after chip enable (E) goes high, the part automatically reduces its power requirements and remains in this low-power standby as long as the chip enable (E) remains high. The automatic power-down feature causes no performance degradation.

The MCM65116 is in a 24-pin dual-in-line package with the industry standard pinout and is pinout compatible with the industry standard 16K EPROM/ROM.

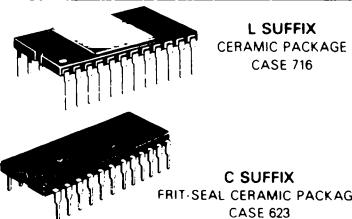
- 2048 Words by 8-Bit Organization
- HCMOS Technology
- Single + 5 V Supply
- Fully Static: No Clock or Timing Strobe Required
- Industry Standard 24-Pin Package
- Maximum Access Time
  - MCM65116-12 – 120 ns
  - MCM65116-15 – 150 ns
  - MCM65116-20 – 200 ns
- Power Dissipation
  - 80 mA Maximum (Active)
  - 15 mA Maximum (Standby)
- Fully TTL Compatible
- Automatic Power-Down
- Pinout Compatible with Industry Standard 2716 16K EPROM and Mask Programmable ROM



#### CMOS

(COMPLEMENTARY MOS)

#### 2,048 × 8 BIT STATIC RANDOM ACCESS MEMORY



#### PIN ASSIGNMENTS

A7	1	24	VCC
A6	2	23	A8
A5	3	22	A9
A4	4	21	W
A3	5	20	G
A2	6	19	A10
A1	7	18	E
A0	8	17	DQ7
DQ0	9	16	DQ6
DQ1	10	15	DQ5
DQ2	11	14	DQ4
VSS	12	13	DQ3

#### PIN NAMES

A0-A10	.....	Address Input
DQ0-DQ7	.....	Data Input/Output
W	.....	Write Enable
G	.....	Output Enable
E	.....	Chip Enable
VCC	.....	.Power (+ 5 V)
VSS	.....	Ground

Motorola reserves the right to make changes to any product herein to improve reliability, functionality or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM65147**

## Product Preview

### 4096-BIT STATIC RANDOM ACCESS MEMORY

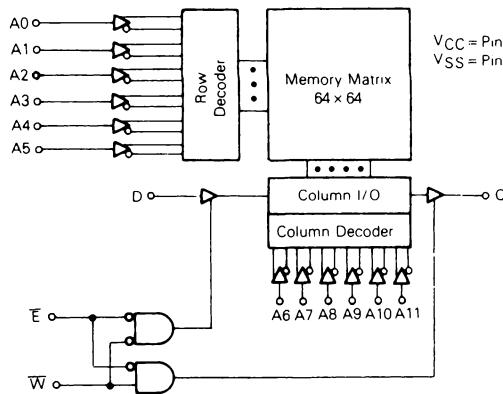
The MCM65147 is a 4096-bit static Random Access Memory organized as 4096 words by 1-bit, fabricated using Motorola's high performance CMOS silicon gate technology (HCMOS). It uses a design approach which provides the simple timing features associated with fully static memories and the reduced power associated with CMOS memories. This means low power without the need for clocks, nor reduced data rates due to cycle times that exceed access times.

Chip enable ( $\bar{E}$ ) controls the power-down feature. It is not a clock, but rather a chip control that affects power consumption. After  $\bar{E}$  goes high, initiating deselect mode, the part automatically reduces its power requirements and remains in this low-power standby mode as long as  $\bar{E}$  remains high.

The MCM65147 is in an 18-pin dual in-line package with the industry standard pinout. It is TTL compatible in all respects. The data out has the same polarity as the input data. A data input and a separate three-state output provide flexibility and allow easy OR-ties.

- Single +5 V Supply
- Fully Static Memory – No Clock or Timing Strobe Required
- Automatic Power Down
- Low Power Dissipation  
    75 mW Typical (Active)  
    500  $\mu$ W Typical (Standby)
- Directly TTL Compatible – All Inputs and Output
- Separate Data Input and Three-State Output
- Equal Access and Cycle Time
- Maximum Access Time  
    MCM65147-55 = 55 ns  
    MCM65147-70 = 70 ns
- High Density 18-Pin Package

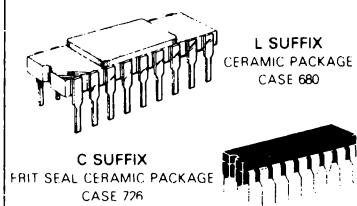
### BLOCK DIAGRAM



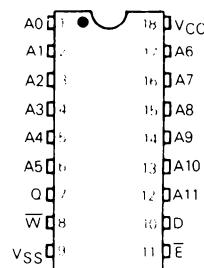
### CMOS

(COMPLIMENTARY MOS)

**4,096 × 1 BIT  
STATIC RANDOM  
ACCESS MEMORY**



### PIN ASSIGNMENTS



### PIN NAMES

A0-A11	... Address
E	... Chip Enable
D	... Data In
Q	... Data Out
W	... Write
VCC	... Power (+5 V)
VSS	... Ground

Motorola reserves the right to make changes to any product herein to improve reliability, function, or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein, neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

## Product Preview

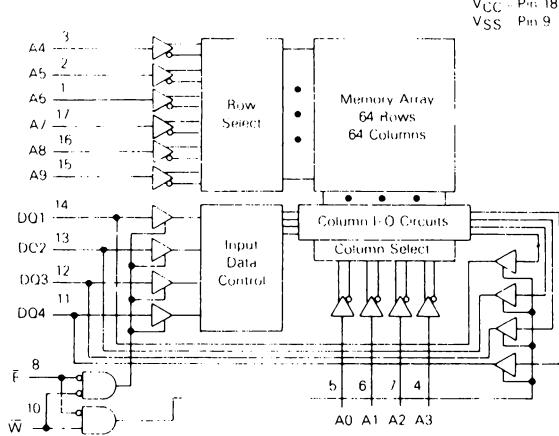
### 4096-BIT STATIC RANDOM ACCESS MEMORY

The MCM65148 is a 4096-bit Random Access Memory organized as 1024 words by 4-bits, fabricated using Motorola's high-performance silicon-gate complementary metal oxide semiconductor (HCMOS) technology. For ease of use, the device operates from a single power supply, is directly compatible with TTL and requires no clocks or refreshing because of its fully static design. Data access is particularly simple, since address setup times are not required. The output data has the same polarity as the input data.

The MCM65148 is designed for memory applications where simple interfacing is the design objective. The MCM65148 is assembled in an 18-pin dual-in-line package with the industry standard pinout. A chip enable ( $\bar{E}$ ) lead allows easy selection of an individual package when the three-state outputs are OR-tied.

- 1024 Words by 4-Bit Organization
- HCMOS Technology
- Single +5 V Supply
- No Clock or Timing Strobe Required
- Industry Standard 18-Pin Configuration
- Maximum Access Time  
MCM65148-70 – 70 ns  
MCM65148-85 – 85 ns
- Automatic Power Down
- Power Dissipation  
200 mW Typical (Active)  
100  $\mu$ W Typical (Standby)
- Fully TTL Compatible
- Common Data Inputs and Outputs
- Three-State Outputs for OR-Ties

BLOCK DIAGRAM

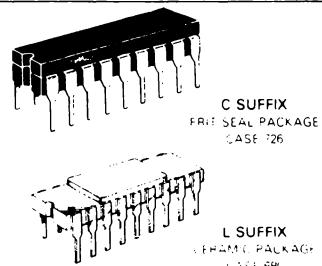


**MCM65148**

### CMOS

(COMPLEMENTARY MOS)

### 4096-BIT STATIC RANDOM ACCESS MEMORY



#### PIN ASSIGNMENT

A6	1	18	V <sub>CC</sub>
A5	2	17	A <sub>+</sub>
A4	1	16	A <sub>8</sub>
A3	4	15	A <sub>9</sub>
A0	7	14	DQ1
A1	6	13	DQ2
A2	5	12	DQ3
$\bar{E}$	8	11	DQ4
VSS	9	10	GND

#### PIN NAMES

A0-A9	Address Input
W	Write Enable
$\bar{E}$	Chip Select
DQ1-DQ4	Data Input/Output
V <sub>CC</sub>	Power (+5 V)
VSS	Ground

Motorola reserves the right to make changes to any product herein to improve reliability, function or design. Motorola does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.



**MOTOROLA**

**MCM14524**

### 1024-BIT READ ONLY MEMORY

The MCM14524 is a complementary MOS mask programmable Read Only Memory (ROM). This device is ordered as a factory special with its unique pattern specified by the user.

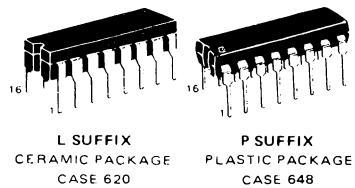
This ROM is organized in a  $256 \times 4$ -bit pattern. The contents of a specified address ( $< A_0, A_1, A_2, A_3, A_4, A_5, A_6, A_7 >$ ) will appear at the four data outputs ( $B_0, B_1, B_2, B_3$ ) following the negative going edge of the clock. When the clock goes high, the data present at the output will be latched. The memory Enable may be taken low asynchronously, forcing the data outputs low and resetting the output latches. This device finds application wherever low power or high noise immunity is a design consideration.

- Diode Protection on All Inputs
- Noise Immunity = 45% of V<sub>DD</sub> typical
- Quiescent Current = 10 nA/package typical @ 5 Vdc
- Single Supply Operation - Either Positive or Negative
- Memory Enable Allows Expansion
- Output Latches Provide a Useful Storage Register
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads, One Low-power Schottky TTL Load to Two HTL Loads Over the Rated Temperature Range

### CMOS LSI

(LOW-POWER COMPLEMENTARY MOS)

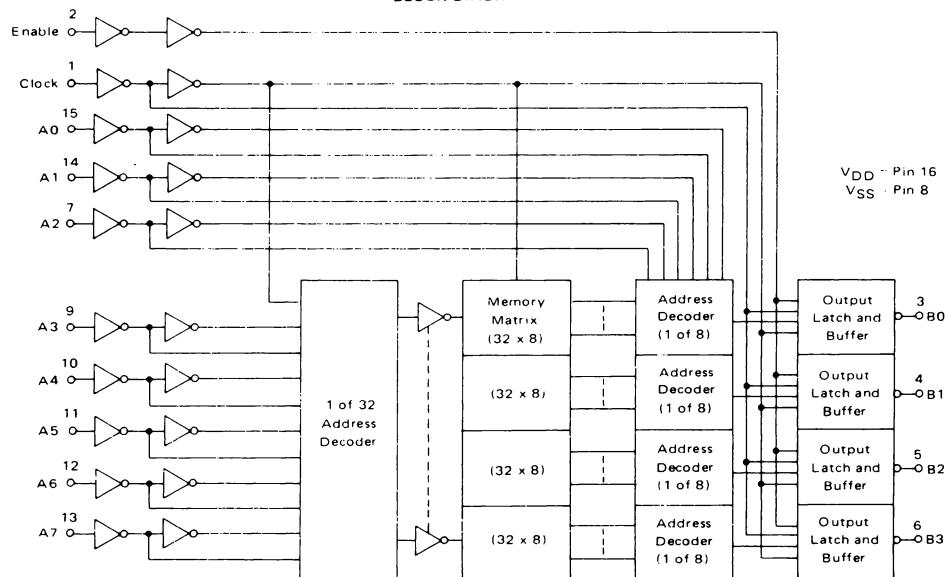
### 1024-BIT (256 x 4) READ ONLY MEMORY



#### ORDERING INFORMATION

MC14XXX	Suffix	Denotes
	L	Ceramic Package
	P	Plastic Package
	A	Extended Operating Temperature Range
	C	Limited Operating Temperature Range

#### BLOCK DIAGRAM



MAXIMUM RATINGS (Voltages referenced to V<sub>SS</sub>)

Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>DD</sub>	0.5 to +3.8	Vdc
Input Voltage, All Inputs	V <sub>IN</sub>	-0.3 to +V <sub>DD</sub> + 0.3	Vdc
DC Current Draw per Pin	I <sub>DD</sub>	—	mAdc
Operating Temperature Range, AL Device	T <sub>A</sub>	-55°C to +125°C	°C
CL/CP Device		40°C to +85°C	
Storage Temperature Range	T <sub>STG</sub>	-65°C to +150°C	°C

This device contains 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 applications of any voltage higher than maximum rated voltages to this high impedance circuit.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>).

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub> Vdc	T <sub>low</sub> *		25°C		T <sub>high</sub> *		Unit
			Min	Max	Min	Typ	Max	Min	
Output Voltage, 25°C Level	V <sub>OH</sub>	5.0	—	0.01	—	0	0.01	—	0.05 Vdc
		10	—	0.01	—	0	0.01	—	0.05 Vdc
		15	—	0.01	—	0	0.01	—	0.05 Vdc
	V <sub>OL</sub>	5.0	4.99	—	4.99	5.0	—	4.99	— Vdc
		10	9.99	—	9.99	10	—	9.99	— Vdc
		15	14.99	—	14.99	15	—	14.99	— Vdc
Noise Immunity	V <sub>NI</sub>	—	—	—	—	—	—	—	— Vdc
		(+V <sub>DD</sub> , 0.2 Vdc)	5.0	1.5	—	1.5	2.26	—	1.4 Vdc
		(+V <sub>DD</sub> , 1.0 Vdc)	10	3.0	—	3.0	4.50	—	2.9 Vdc
		(+V <sub>DD</sub> , 1.5 Vdc)	15	3.75	—	3.75	6.75	—	3.75 Vdc
		(+V <sub>DD</sub> , 0.8 Vdc)	5.0	1.4	—	1.5	2.26	—	1.5 Vdc
		(+V <sub>DD</sub> , 1.0 Vdc)	10	2.9	—	3.0	4.50	—	3.0 Vdc
Output Drive Current, AL Device	I <sub>OH</sub>	(+V <sub>DD</sub> = Source)	5.0	+1.7	—	+1.0	+1.7	—	+0.7 mAdc
			10	0.25	—	0.2	0.36	—	0.14 mAdc
			15	0.62	—	0.5	0.9	—	0.35 mAdc
		(+V <sub>DD</sub> = Sink)	5.0	+1.3	—	+1.5	+1.3	—	+1.1 mAdc
			10	0.64	—	0.51	0.88	—	0.36 mAdc
			15	1.6	—	1.3	2.26	—	1.0 mAdc
Output Drive Current, CL/CP Device	I <sub>OL</sub>	(+V <sub>DD</sub> = Source)	5.0	+1.7	—	+1.0	+1.7	—	+0.7 mAdc
			10	0.25	—	0.2	0.36	—	0.14 mAdc
			15	0.62	—	0.5	0.9	—	0.35 mAdc
		(+V <sub>DD</sub> = Sink)	5.0	+1.3	—	+1.5	+1.3	—	+1.1 mAdc
			10	0.64	—	0.51	0.88	—	0.36 mAdc
			15	1.6	—	1.3	2.26	—	1.0 mAdc
Input Current (AL Device)	I <sub>IN</sub>	15	—	0.1	—	0.00001	0.1	—	+1.0 μAdc
	I <sub>IN</sub>	15	—	+1.0	—	0.00001	+1.0	—	+1.0 μAdc
Input Capacitance (V <sub>IN</sub> = 0)	C <sub>IN</sub>	—	—	—	—	5.0	—	—	— pF
	I <sub>IN</sub>	—	—	—	—	—	—	—	—
Quiescent Current (AL Device) (Per Package)	I <sub>DD</sub>	5.0	—	5.0	—	0.010	5.0	—	150 μAdc
	I <sub>DD</sub>	10	—	10	—	0.020	10	—	300
	I <sub>DD</sub>	15	—	20	—	0.030	20	—	600
Quiescent Current (CL/CP Device) (Per Package)	I <sub>DD</sub>	5.0	—	50	—	0.010	50	—	375 μAdc
	I <sub>DD</sub>	10	—	100	—	0.020	100	—	750
	I <sub>DD</sub>	15	—	200	—	0.030	200	—	1500
Total Supply Current** (Dynamic plus Quiescent, Per Package)	I <sub>T</sub>	5.0	—	I <sub>T</sub> (1.6 μA/kHz) + I <sub>DD</sub>	—	—	—	—	μAdc
	I <sub>T</sub>	10	—	I <sub>T</sub> (3.2 μA/kHz) + I <sub>DD</sub>	—	—	—	—	
	I <sub>T</sub>	15	—	I <sub>T</sub> (4.8 μA/kHz) + I <sub>DD</sub>	—	—	—	—	
where, I <sub>T</sub> is in μA (per package), C <sub>L</sub> in pF, V <sub>DD</sub> in Vdc, and f in kHz is input frequency									
**The formulas given are for the typical characteristics only at 25°C									

\*T<sub>low</sub> = 55°C for AL Device, -40°C for CL/CP Device

\*\*T<sub>high</sub> = +125°C for AL Device, +85°C for CL/CP Device

#Noise immunity specified for worst case input combination

†To calculate total supply current at loads other than 50 pF

$$I_T(C_L) = I_T(50 \text{ pF}) + 1 \times 10^{-3} (C_L - 50) V_{DD}$$

where, I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V<sub>DD</sub> in Vdc, and f in kHz is input frequency

\*\*The formulas given are for the typical characteristics only at 25°C

## SWITCHING CHARACTERISTICS\* ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ )

Characteristic	Symbol	V <sub>DD</sub>	Min	Typ	Max	Unit
Output Rise Time $t_{TLH}, t_{THL} = (3.0 \text{ ns/pF}) C_L + 30 \text{ ns}$ $t_{TLH}, t_{THL} = (1.5 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{TLH}, t_{THL} = (1.1 \text{ ns/pF}) C_L + 10 \text{ ns}$	$t_{TLH}$	5.0 10 15	— — —	180 90 65	360 180 130	ns
Output Fall Time $t_{TLH}, t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{TLH}, t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{TLH}, t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$	$t_{THL}$	5.0 10 15	— — —	100 50 40	200 100 80	ns
Clock Read Access Delay Time $t_{accC} = (1.7 \text{ ns/pF}) C_L + 1265 \text{ ns}$ $t_{accC} = (0.66 \text{ ns/pF}) C_L + 517 \text{ ns}$ $t_{accC} = (0.5 \text{ ns/pF}) C_L + 325 \text{ ns}$	$t_{accC}$	5.0 10 15	— — —	1350 550 350	4000 1600 1200	ns
Enable Access Delay Time $t_{accEn} = (1.7 \text{ ns/pF}) C_L + 160 \text{ ns}$ $t_{accEn} = (0.66 \text{ ns/pF}) C_L + 77 \text{ ns}$ $t_{accEn} = (0.5 \text{ ns/pF}) C_L + 50 \text{ ns}$	$t_{accEn}$	5.0 10 15	— — —	245 110 75	615 265 190	ns
Clock Pulse Width*	$t_{WH}$	5.0 10 15	450 165 125	150 55 35	— — —	ns
	$t_{WL}$	5.0 10 15	3600 1425 1070	1200 475 300	— — —	ns
Maximum Low Clock Pulse Width #	$t_{WL}$	5.0 10 15	2.0 0.9 0.1	10 3.0 0.3	— — —	ms
Address Setup-Time	$t_{su(A)}$	5.0 10 15	0 0 0	0 0 0	— — —	ns
Address Hold Time	$t_{h(A)}$	5.0 10 15	0 0 0	0 0 0	— — —	ns
Clock to Enable Setup Time	$t_{su(cl)}$	5.0 10 15	4275 1725 1295	1425 575 400	— — —	ns
Clock to Enable Hold Time	$t_{h(cl)}$	5.0 10 15	150 75 55	0 0 0	— — —	ns

\* The clock can remain high indefinitely with the data remaining latched.

# If clock stays low too long, the dynamically stored data will leak off and will have to be recalled.

FIGURE 1 – OUTPUT DRIVE CURRENT TEST CIRCUIT

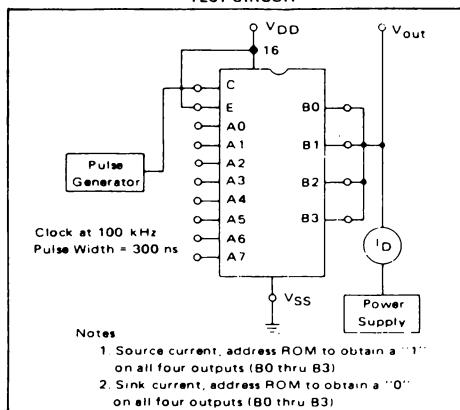
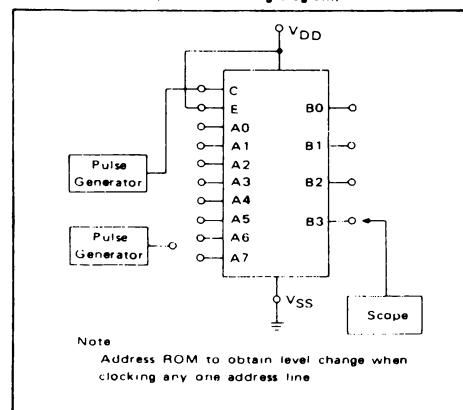
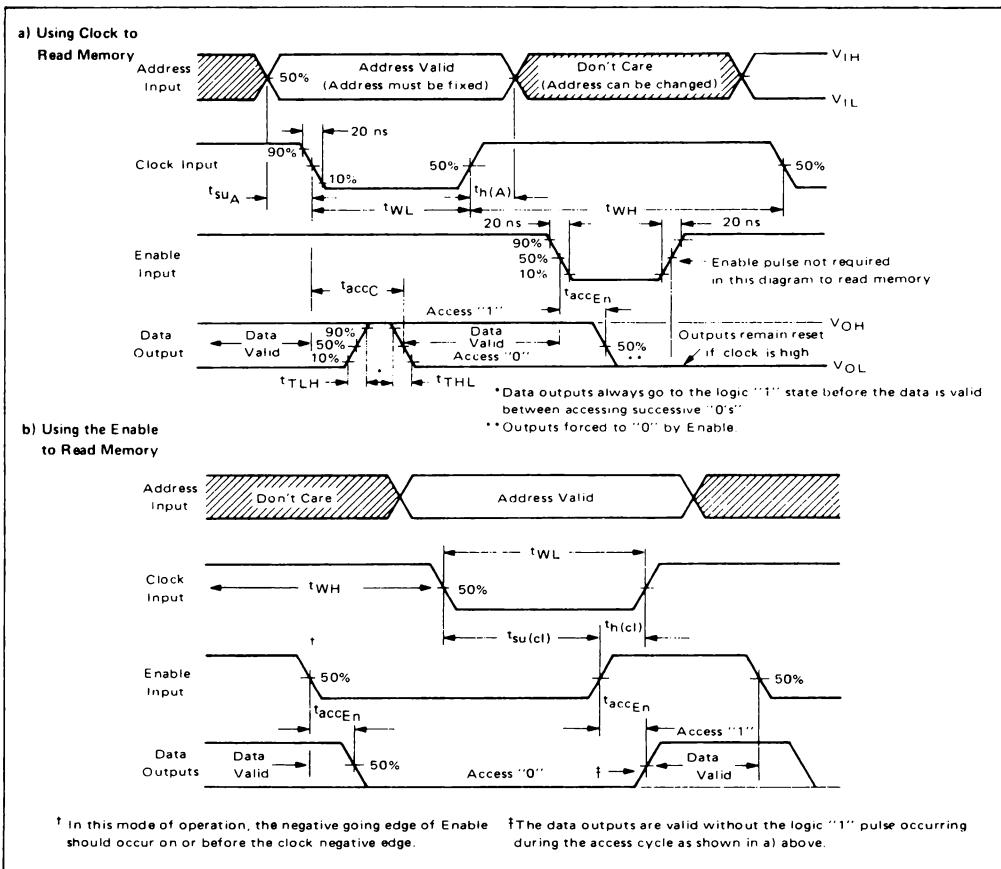


FIGURE 2 – SWITCHING TIME TEST CIRCUIT  
(Refer to timing diagram)



## MEMORY READ CYCLE TIMING DIAGRAMS



## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM14524, the customer may specify the content of the memory.

### Address Inputs:

Words are numbered 0 through 255 and are addressed using sequential addressing of Address leads A0 through A7 with A0 as the least significant digit.

Logic "0" is defined as a "low" Address input ( $V_{IL}$ ).  
Logic "1" is defined as a "high" Address input ( $V_{IH}$ )

MCM14524

### TRUTH TABLE

CLOCK	ENABLE	B0	B1	B2	B3
V <sub>DD</sub> 	1	<Address>	<Address>	<Address>	<Address>
V <sub>SS</sub> 	1	OUTPUT DATA LATCHES			
X	0	0	0	0	0

X = Don't Care

\*Indicates contents of specified Address will appear at outputs as stated above.

Two methods may be used to transmit the custom memory pattern to Motorola

#### METHOD A: PUNCHED COMPUTER CARDS

A binary coded decimal equivalent of each desired output may be punched in standard 8 register cards (four cards are required for all 256 words) in numerical (word number) order. 64 words per card are punched in columns 12-thru 75 using the Binary to Hexadecimal conversion table. Columns 77 and 78 are used to number the cards, which must be in numerical order. Please use characters as shown in the table when punching computer cards.

## BINARY TO HEXA- DECIMAL CON- VERSION TABLE

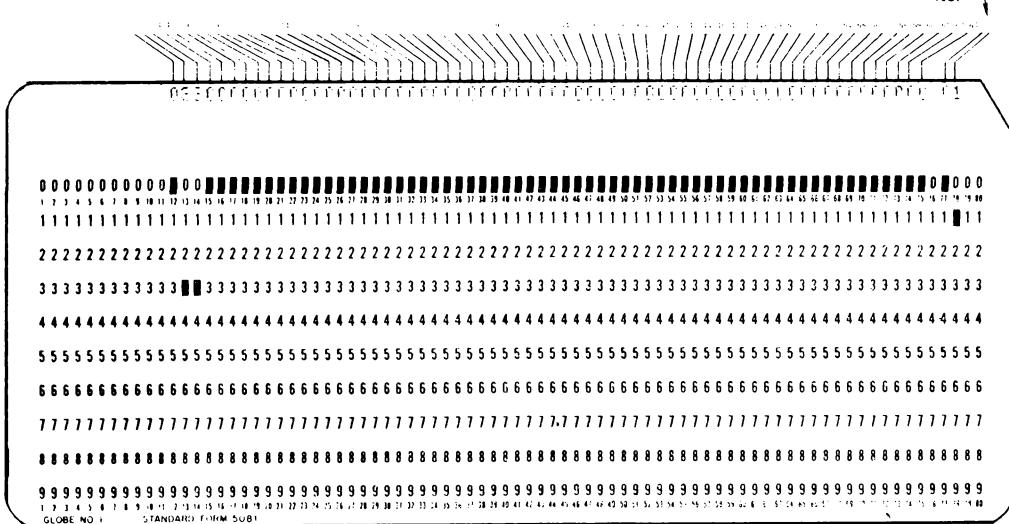
BINARY WORD DESIRED	CARD CHARACTER
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	A
1 0 1 1	B
1 1 0 0	C
1 1 0 1	D
1 1 1 0	E
1 1 1 1	F

BOM SAMPLE WORD PROGRAMMING FOR PUNCHED CARD

WORD NUMBER	ADDRESS INPUTS								SAMPLE WORD OUTPUTS				CARD CHARACTER
	A7	A6	A5	A4	A3	A2	A1	A0	B3	B2	B1	B0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	0	0	1	1	3
2	0	0	0	0	0	0	1	0	0	0	1	1	3
3	0	0	0	0	0	0	1	1	0	0	0	0	0
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
255	1	1	1	1	1	1	1	1	1	0	1	0	A

Shown in columns  
12 15 on card  
below

Card  
No. -



## METHOD B: TRUTH TABLE

For customers who do not have access to punch cards, Motorola will accept Truth Tables. When filling out the table, use the 0 to F hexadecimal character in column "C".

CUSTOM PROGRAM for the MCM14524 Read Only Memory

WORD	C								
0		51		102		153		204	
1		52		103		154		205	
2		53		104		155		206	
3		54		105		156		207	
4		55		106		157		208	
5		56		107		158		209	
6		57		108		159		210	
7		58		109		160		211	
8		59		110		161		212	
9		60		111		162		213	
10		61		112		163		214	
11		62		113		164		215	
12		63		114		165		216	
13		64		115		166		217	
14		65		116		167		218	
15		66		117		168		219	
16		67		118		169		220	
17		68		119		170		221	
18		69		120		171		222	
19		70		121		172		223	
20		71		122		173		224	
21		72		123		174		225	
22		73		124		175		226	
23		74		125		176		227	
24		75		126		177		228	
25		76		127		178		229	
26		77		128		179		230	
27		78		129		180		231	
28		79		130		181		232	
29		80		131		182		233	
30		81		132		183		234	
31		82		133		184		235	
32		83		134		185		236	
33		84		135		186		237	
34		85		136		187		238	
35		86		137		188		239	
36		87		138		189		240	
37		88		139		190		241	
38		89		140		191		242	
39		90		141		192		243	
40		91		142		193		244	
41		92		143		194		245	
42		93		144		195		246	
43		94		145		196		247	
44		95		146		197		248	
45		96		147		198		249	
46		97		148		199		250	
47		98		149		200		251	
48		99		150		201		252	
49		100		151		202		253	
50		101		152		203		254	



**MOTOROLA**

**MCM65516**

## Advance Information

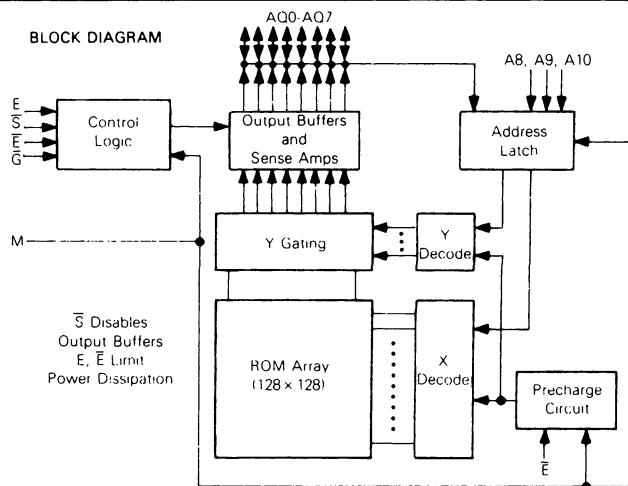
### 2048 × 8 BIT READ ONLY MEMORY

The MCM65516 is a complementary MOS mask programmable byte organized read only memory (ROM). The MCM65516 is organized as 2048 bytes of 8 bits, designed for use in multiplex bus systems. It is fabricated using Motorola's silicon gate CMOS technology, which offers low power operation from a single 5.0 volt supply.

The memory is compatible with CMOS microprocessors that share address and data lines. Compatibility is enhanced by pins 13, 14, 16, and 17 which give the user the versatility of selecting the active levels of each. Pin 17 allows the user to choose active high, active low or a third option of programming which is termed the "MOTEL" mode. If this mode is selected by the user, it provides direct compatibility with either the Motorola MC146805E2 or Intel 8085 type microprocessor series. In the MOTEL operation the ROM can accept either polarity signal on the data strobe input as long as the signal toggles during the cycle. This unique operational feature makes the ROM an extremely versatile part.

- 2K × 8 CMOS ROM
- 3 to 6 Volt Supply
- Access Time
  - 430 ns (5 V) MCM65516-43
  - 550 ns (5 V) MCM65516-55
- Low Power Dissipation
  - 30 mA Maximum (Active)
  - 50  $\mu$ A Maximum (Standby)
- Multiplex Bus Directly Compatible With All CMOS Microprocessors (MC146805E2, NSC800)
- Pins 13, 14, 16, and 17 are Mask Programmable
- MOTEL Mask Option Also Insures Direct Compatibility with NMOS Microprocessors Like MC6803, MC6801, 8085, and 8086
- Standard 18 Pin Package

BLOCK DIAGRAM



### CMOS

(COMPLEMENTARY MOS)

### 2048 × 8 BIT MULTIPLEXED BUS READ ONLY MEMORY



### PIN ASSIGNMENTS

AQ0	1	V <sub>CC</sub>
AQ1	2	G
AQ2	3	16
AQ3	4	15
AQ4	5	14
AQ5	6	13
AQ6	7	12
AQ7	8	11
VSS	9	10
		A10
		A9
		A8

### PIN NAMES

AQ0-AQ7	.....	Address/Data Output
A8-A10	.....	Address
M	.....	Multiplex Address Strobe
E	.....	Chip Enable
S	.....	Chip Select
G	.....	Data Strobe (Output Enable)

This device contains 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 this high-impedance circuit.

# MCM65516

## ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	-0.3 to +7.0	V
Input Voltage	V <sub>in</sub>	-0.3 to +7.0	V
Operating Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°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.

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted.)

### RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage (V <sub>CC</sub> must be applied at least 100 μs before proper device operation is achieved)	V <sub>CC</sub>	4.5	5.0	5.5	V
Input High Voltage	V <sub>IH</sub>	V <sub>CC</sub> - 2.0	-	5.5	V
Input Low Voltage	V <sub>IL</sub>	-0.3	-	0.8	V

### RECOMMENDED OPERATING CHARACTERISTICS

Characteristic	Symbol	MCM65516-43		MCM65516-55		Unit	Test Condition
		Min	Max	Min	Max		
Output High Voltage Source Current - 1.6 mA	V <sub>OH</sub>	V <sub>CC</sub> - 0.4 V	-	V <sub>CC</sub> - 0.4 V	-	V	
Output Low Voltage Sink Current + 1.6 mA	V <sub>OL</sub>	-	0.4	-	0.4	V	
Supply Current (Operating)	I <sub>CC1</sub>	-	30	-	30	mA	C <sub>L</sub> = 130 pF, V <sub>in</sub> = V <sub>IH</sub> to V <sub>IL</sub> t <sub>cyc</sub> = 1.0 μs
Supply Current (DC Active)	I <sub>CC2</sub>	-	100	-	100	μA	V <sub>in</sub> = V <sub>CC</sub> to GND
Standby Current	I <sub>SB</sub>	-	50	-	75	μA	V <sub>in</sub> = V <sub>CC</sub> to GND
Input Leakage	I <sub>in</sub>	-10	+10	-10	+10	μA	
Output Leakage	I <sub>OL</sub>	-10	+10	-10	+10	μA	

CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested)

Characteristic	Symbol	Max	Unit
Input Capacitance	C <sub>in</sub>	5	pF
Output Capacitance	C <sub>out</sub>	12.5	pF

## AC OPERATING CONDITIONS AND CHARACTERISTICS

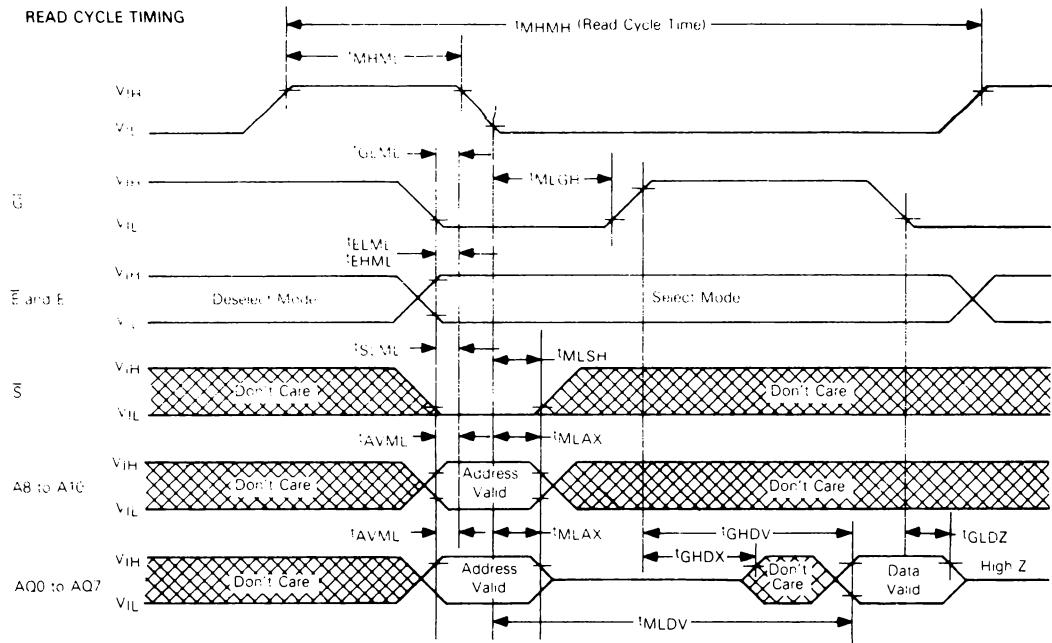
(Full operating voltage and temperature range unless otherwise noted.)

### READ CYCLE

C<sub>L</sub> = 130 pF

Parameter	Symbol	MCM65516-43		MCM65516-55		Unit
		Min	Max	Min	Max	
Address Strobe Access Time	t <sub>MLDV</sub>	-	430	-	550	ns
Read Cycle Time	t <sub>MHMH</sub>	580	-	725	-	ns
Multiplex Address Strobe High to Multiplex Address Strobe Low (Pulse Width)	t <sub>MHML</sub>	150	-	175	-	ns
Data Strobe Low to Multiplex Address Strobe Low	t <sub>GLML</sub>	50	--	50	-	ns
Multiplex Address Strobe Low to Data Strobe High	t <sub>MLGH</sub>	100	--	160	--	ns
Address Valid to Multiplex Address Strobe Low	t <sub>AVML</sub>	50	--	50	-	ns
Chip Select Low to Multiplex Address Strobe Low	t <sub>SLML</sub>	50	--	50	--	ns
Multiplex Address Strobe Low to Chip Select High	t <sub>MLSH</sub>	50	-	80	--	ns
Chip Enable Low/High to Multiplex Address Strobe Low	t <sub>ELML</sub>	50	-	50	--	ns
t <sub>EHML</sub>	50	-	50	-	..	ns
Multiplex Address Strobe Low to Address Don't Care	t <sub>MLAX</sub>	50	-	80	--	ns
Data Strobe High to Data Valid	t <sub>GHDV</sub>	175	-	200	-	ns
Data Strobe Low to High-Z	t <sub>GLDZ</sub>	-	160	-	160	ns
Data Strobe High to Address Don't Care	t <sub>GHDX</sub>	20	-	20	-	ns

# MCM65516



## FUNCTIONAL DESCRIPTION

The 2K  $\times$  8 bit CMOS ROM (MCM65516) shares address and data lines and, therefore, is compatible with the majority of CMOS microprocessors in the industry. The package size is reduced from 24 pins for standard NMOS ROMs to 18 pins because of the multiplexed bus approach. The savings in package size and external bus lines adds up to tighter board packing density which is handy for battery powered hand carried CMOS systems. This ROM is designed with the intention of having very low active as well as standby currents. The active power dissipation of 150 mW (at  $V_{CC} = 5$  V freq = 1 MHz) and standby power of 250  $\mu$ W (at  $V_{CC} = 5$  V) add up to low power for battery operation. The typical access time of the ROM is 280 ns making it acceptable for operation with today's existing CMOS microprocessors.

An example of this operation is shown in Figure 1. Shown is a typical connection with either the Motorola MC146805E2 CMOS microprocessor (M6800 series) or the National NSC800 which is an 8085 or Z80 based system. The main difference between the systems is that the data strobe (DS) on the MC146805E2 and the read bar ( $\overline{RD}$ ) on the 8085 both control the output of data from the ROM but are of opposite polarity. The Motorola 2K  $\times$  8 ROM can accept either polarity signal on the data strobe input as long as the signal toggles during the cycle. This is termed the MOTEI mode of operation. This unique operational feature makes the ROM an extremely versatile part. Further operational features are explained in the following section.

## Operational Features

In order to operate in a multiplexed bus system the ROM latches, for one cycle, the address and chip select input information on the trailing edge of address strobe ( $I_M$ ) so the address signals can be taken off the bus.

Since they are latched, the address and chip select signals have a setup and hold time referenced to the negative edge

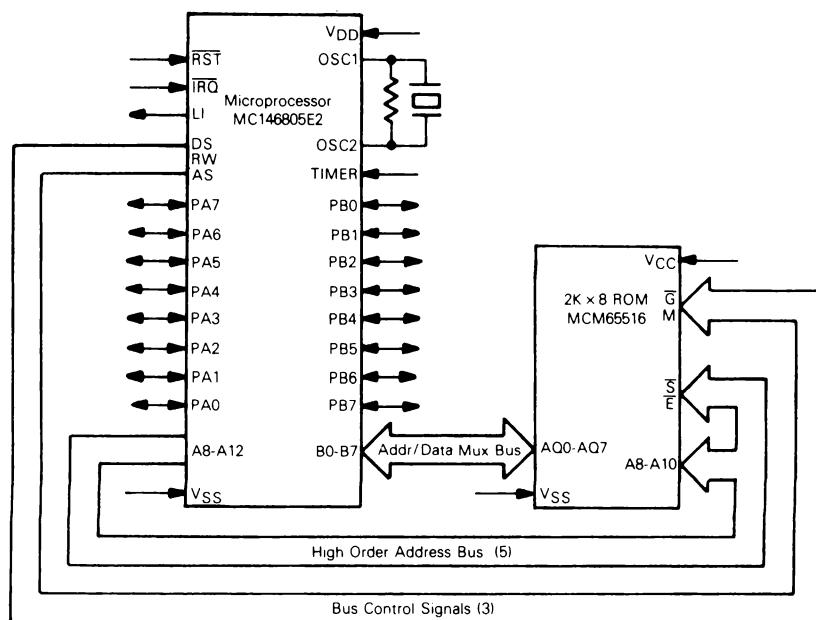
of address strobe. Address strobe has a minimum pulse width requirement since the circuit is internally precharged during this time and is setup for the next cycle on the trailing edge of address strobe. Access time is measured from the negative edge of address strobe.

The part is equipped with a data strobe input ( $G$ ) which controls the output of data onto the bus lines after the addresses are off the bus. The data strobe has three potential modes of operation which are programmable with the ROM array. The first mode is termed the MOTEI mode of operation. In this mode, the circuit can work with either the Motorola or Intel type microprocessor series. The difference between the two series for a ROM peripheral is only the polarity of the data strobe signal. Therefore, in the MOTEI mode the ROM recognizes the state of the data strobe signal at the trailing edge of address strobe (requires a setup and hold time), latches the state into the circuit after address strobe, and turns on the data outputs when an opposite polarity signal appears on the data strobe input. In this manner the data strobe input can work with either polarity signal but that signal must toggle during a cycle to output data on the bus lines. If the data strobe remains at a d.c. level the outputs will remain off. The data strobe input has two other programmable modes of operation and those are the standard static select modes (high or low) where a d.c. input not synchronous with the address strobe will turn the outputs on or off.

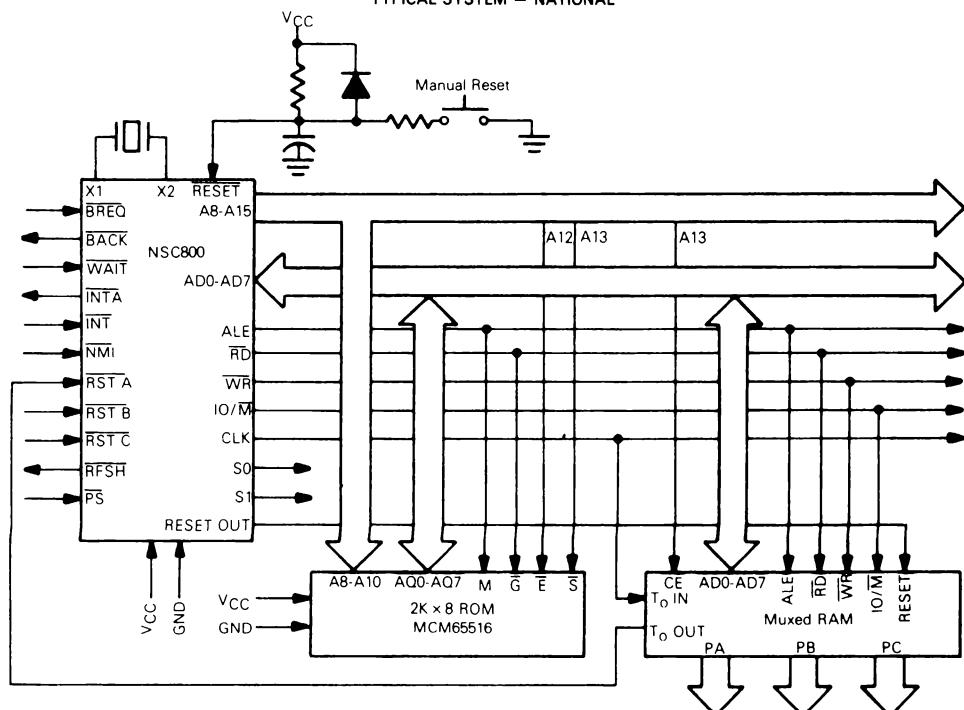
The chip enable and chip select inputs are all programmable with the ROM array to either a high or low select. The chip select acts as an additional address and is latched on the address strobe trailing edge. On deselect the chip select merely turns off the output drivers acting as an output disable. It does not power down the chip. The chip enable inputs, however, do put the chip in a power down standby mode but they are not latched with address strobe and must be maintained in a d.c. state for a full cycle.

# MCM65516

FIGURE 1  
TYPICAL MINIMUM SYSTEM – MOTOROLA



TYPICAL SYSTEM – NATIONAL



# MCM65516

## CUSTOM PROGRAMMING

By the programming of a single photomask for the MCM65516 the customer may specify the content of the memory and the method of enabling the outputs, or selection of the "MOTEL" option (Pin 17).

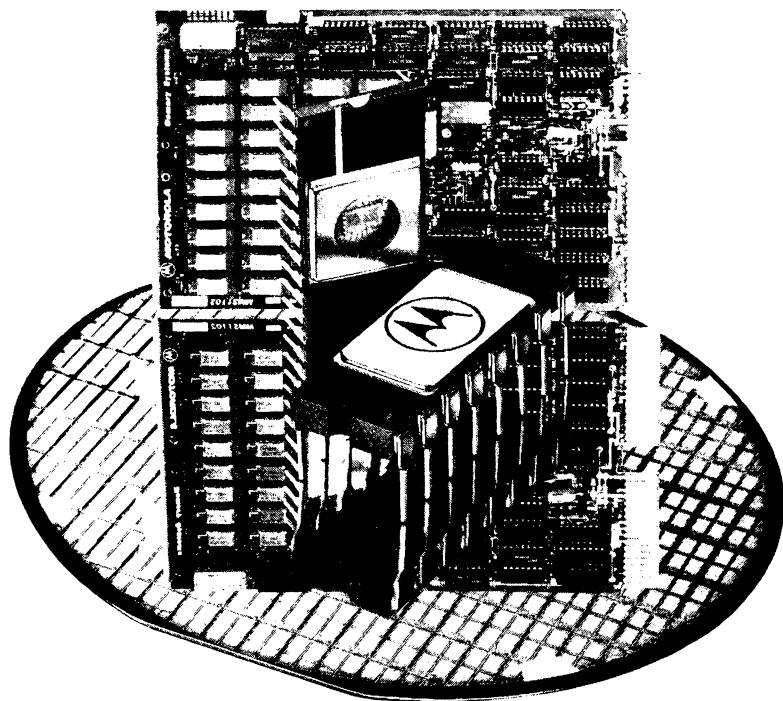
Information on the general options of the MCM65516 should be submitted on an Organizational Data form such as that shown in the below figure.

Information for custom memory content may be sent to Motorola in one of two forms (shown in order of preference):

1. Magnetic Tape  
9 track, 800 bpi, odd parity written in EBCDIC character code. Motorola's R.O.M.S. format.
2. EPROMs  
One 16K (MCM2716, or TMS2716).

### FORMAT FOR PROGRAMMING GENERAL OPTIONS

ORGANIZATIONAL DATA MOS READ ONLY MEMORY				
Customer:				
Company _____				
Part No. _____				
Originator _____				
Phone No. _____				
Motorola Use Only				
Quote. _____				
Part No.: _____				
Specif. No.: _____				
Programmable Pin Options.	13	14	16	17
Active High	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Active Low	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MOTEL <input type="checkbox"/>				



**Bipolar Memories  
TTL, MECL-RAM, PROM**



**MOTOROLA**

**MCM93415**

### 1024-BIT RANDOM ACCESS MEMORY

The MCM93415 is a 1024-bit Read/Write RAM organized 1024 words by 1 bit.

The MCM93415 is designed for buffer control storage and high performance main memory applications, and has a typical access time of 35 ns.

The MCM93415 has full decoding on-chip, separate data input and data output lines, and an active low chip select. The device is fully compatible with standard DTL and TTL logic families and features an uncommitted collector output for ease of memory expansion.

- Uncommitted Collector Output
- TTL Inputs and Output
- Non-Inverting Data Output
- High Speed --
  - Access Time -- 35 ns Typical
  - Chip Select -- 15 ns Typical
- Power Dissipation Decreases with Increasing Temperature
- Power Dissipation 0.5 mW/Bit Typical
- Organized 1024 Words X 1 Bit

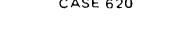
TTL

1024 X 1 BIT  
RANDOM ACCESS MEMORY

F SUFFIX  
CERAMIC PACKAGE  
CASE 650

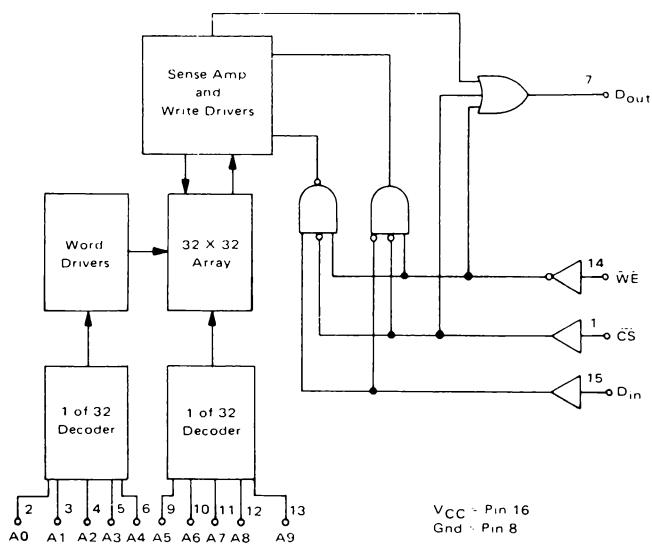


D SUFFIX  
CERAMIC PACKAGE  
CASE 620



P SUFFIX  
PLASTIC PACKAGE  
CASE 648

### BLOCK DIAGRAM



### PIN ASSIGNMENT

1	CS	V <sub>CC</sub>
2	A0	D <sub>in</sub>
3	A1	WE
4	A2	A9
5	A3	A8
6	A4	A7
7	Dout	A6
8	Gnd	A5

#### Pin Designation

- CS Chip Select  
A0--A9 Address Inputs  
WE Write Enable  
D<sub>in</sub> Data Input  
D<sub>out</sub> Data Output

# MCM93415

## FUNCTIONAL DESCRIPTION

The MCM93415 is a fully decoded 1024-bit Random Access Memory organized 1024 words by one bit. Bit selection is achieved by means of a 10-bit address, A0 to A9.

The Chip Select input provides for memory array expansion. For large memories, the fast chip select access time permits the decoding of Chip Select (CS) from the address without affecting system performance.

The read and write operations are controlled by the state of the active low Write Enable (WE, Pin 14). With WE held low and the chip selected, the data at D<sub>in</sub> is written into the addressed location. To read, WE is held high and the chip selected. Data in the specified location is presented at D<sub>out</sub> and is non-inverted.

Uncommitted collector outputs are provided to allow wired-OR applications. In any application an external pull-up resistor of R<sub>L</sub> value must be used to provide a high at the output when it is off. Any R<sub>L</sub> value within the range specified below may be used.

$$V_{CC}(\text{Min}) > R_L > V_{CC}(\text{Min}) - V_{OH}$$

$$I_{OL} = FO(1.6) \quad n(CEX) + FO(0.04)$$

R<sub>L</sub> is in kΩ

n = number of wired-OR outputs tied together

FO = number of TTL Unit Loads (UL) driven

I<sub>CEX</sub> = Memory Output Leakage Current

V<sub>OH</sub> = Required Output High Level at Output Node

I<sub>OL</sub> = Output Low Current

The minimum R<sub>L</sub> value is limited by output current sinking ability. The maximum R<sub>L</sub> value is determined by the output and input leakage current which must be supplied to hold the output at V<sub>OH</sub>. One Unit Load = 40 μA High/1.6 mA Low.

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Storage Temperature	
Ceramic Package (D and F Suffix)	-55°C to +165°C
Plastic Package (P Suffix)	-55°C to +125°C
Operating Junction Temperature, T <sub>J</sub>	
Ceramic Package (D and F Suffix)	165°C
Plastic Package (P Suffix)	125°C
V <sub>CC</sub> Pin Potential to Ground Pin	-0.5 V to +7.0 V
Input Voltage (dc)	-0.5 V to +5.5 V
Voltage Applied to Outputs (Output High)	-0.5 V to +5.5 V
Output Current (dc) (Output Low)	+20 mA
Input Current (dc)	-12 mA to +5.0 mA

## TRUTH TABLE

Inputs			Output	Mode
CS	WE	D <sub>in</sub>	Open Collector	
H	X	X	H	Not Selected
L	L	L	H	Write "0"
L	L	H	H	Write "1"
L	H	X	D <sub>out</sub>	Read

H = High Voltage Level

L = Low Voltage Level

X = Don't Care (High or Low)

NOTE 1: Device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded.

## GUARANTEED OPERATING RANGES (Note 2)

Part Number	Supply Voltage (V <sub>CC</sub> )			Ambient Temperature (T <sub>A</sub> )
	Min	Nom	Max	
MCM93415DC, PC	4.75 V	5.0 V	5.25 V	0°C to +75°C
MCM93415FM, DM	4.50 V	5.0 V	5.50 V	-55°C to +125°C

## DC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

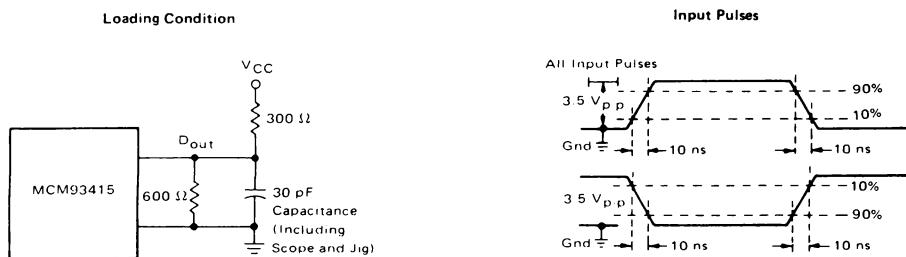
Symbol	Characteristic	Limits		Unit	Conditions	
		Min	Max		T <sub>A</sub> = Max,	T <sub>A</sub> = Min,
V <sub>OL</sub>	Output Low Voltage		0.45	V <sub>dc</sub>	V <sub>CC</sub> = Min, I <sub>OL</sub> = 16 mA	
V <sub>IH</sub>	Input High Voltage	2.1		V <sub>dc</sub>	Guaranteed Input High Voltage for All Inputs	
V <sub>IL</sub>	Input Low Voltage		0.8	V <sub>dc</sub>	Guaranteed Input Low Voltage for All Inputs	
I <sub>IL</sub>	Input Low Current	-400	μA/dc	V <sub>CC</sub> = Max, V <sub>in</sub> = 0.4 V		
I <sub>IIH</sub>	Input High Current	40	μA/dc	V <sub>CC</sub> = Max, V <sub>in</sub> = 4.5 V		
		1.0	mA/dc	V <sub>CC</sub> = Max, V <sub>in</sub> = 5.25 V		
I <sub>CEX</sub>	Output Leakage Current	100	μA/dc	V <sub>CC</sub> = Max, V <sub>out</sub> = 4.5 V		
V <sub>CD</sub>	Input Diode Clamp Voltage	-1.5	V <sub>dc</sub>	V <sub>CC</sub> = Max, I <sub>in</sub> = -10 mA		
I <sub>CC</sub>	Power Supply Current	130	mAdc	T <sub>A</sub> = Max	V <sub>CC</sub> = Max, All Inputs Grounded	
		155	mAdc	T <sub>A</sub> = 0°C		
		170	mAdc	T <sub>A</sub> = Min		

# MCM93415

## AC OPERATING CONDITIONS AND CHARACTERISTICS

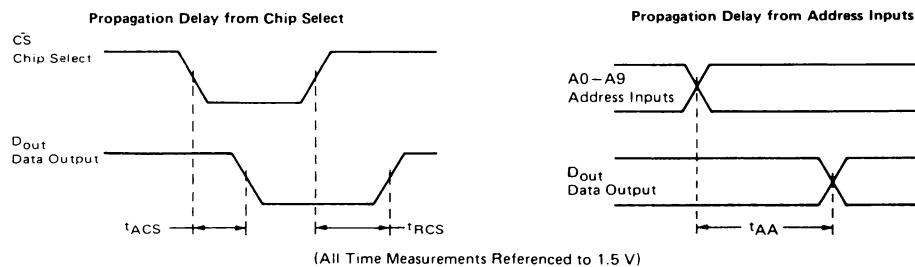
(Full operating voltage and temperature unless otherwise noted)

### AC TEST LOAD AND WAVEFORM



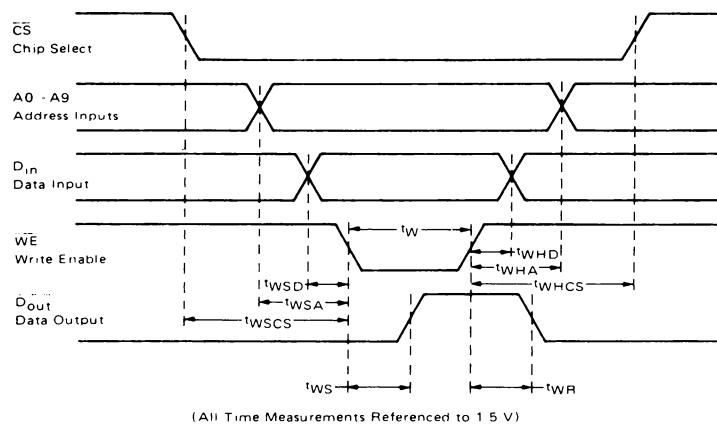
Symbol	Characteristic (Notes 2, 3)	MCM93415DC, PC		MCM93415DM, FM		Unit	Conditions
		Min	Max	Min	Max		
READ MODE	DELAY TIMES					ns	See Test Circuit and Waveforms
	t <sub>ACS</sub> Chip Select Time		35		45		
	t <sub>RCS</sub> Chip Select Recovery Time		35		50		
	t <sub>AA</sub> Address Access Time		45		60		
WRITE MODE	DELAY TIMES					ns	See Test Circuit and Waveforms
	t <sub>WS</sub> Write Disable Time		35		45		
	t <sub>WR</sub> Write Recovery Time		40		50		
	INPUT TIMING REQUIREMENTS						
	t <sub>W</sub> Write Pulse Width (to guarantee write)	30		40			
	t <sub>WSD</sub> Data Setup Time Prior to Write	5		5			
	t <sub>WHD</sub> Data Hold Time After Write	5		5			
	t <sub>WSA</sub> Address Setup Time (at t <sub>W</sub> Min)	10		15			
	t <sub>WHA</sub> Address Hold Time	10		10			
	t <sub>WSCS</sub> Chip Select Setup Time	5		5			
	t <sub>WHCS</sub> Chip Select Hold Time	5		5			

### READ OPERATION TIMING DIAGRAM



# MCM93415

## WRITE CYCLE TIMING



(All Time Measurements Referenced to 1.5 V)

NOTE 2: DC and AC specifications limits guaranteed with 500 linear feet per minute blown air. Contact your Motorola Sales Representative if extended temperature or modified operating conditions are desired.

Package	$\theta_{JA}$ (Junction to Ambient)		$\theta_{JC}$ (Junction to Case)
	Blown	Still	
D Suffix	50°C/W	85°C/W	15°C/W
F Suffix	55°C/W	90°C/W	15°C/W
P Suffix	65°C/W	100°C/W	25°C/W

NOTE 3: The AC limits are guaranteed to be the worst case bit in the memory.



**MOTOROLA**

**MCM93425**

### 1024-BIT RANDOM ACCESS MEMORY

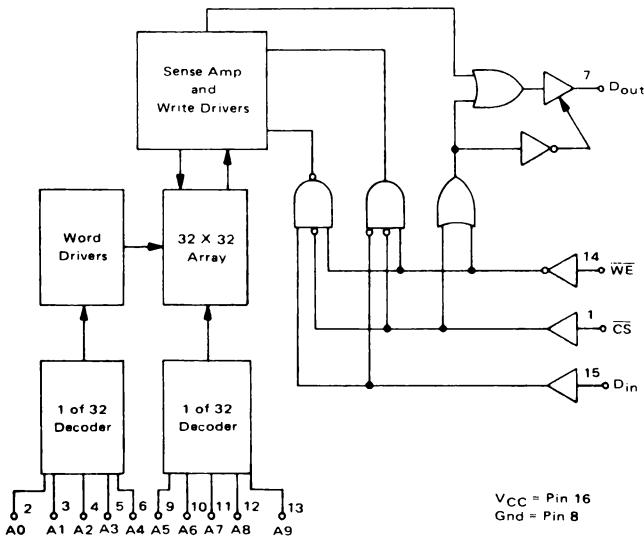
The MCM93425 is a 1024-bit Read/Write RAM, organized 1024 words by 1 bit.

The MCM93425 is designed for high performance main memory and control storage applications and has a typical address time of 35 ns.

The MCM93425 has full decoding on-chip, separate data input and data output lines, and an active low-chip select and write enable. The device is fully compatible with standard DTL and TTL logic families. A three-state output is provided to drive bus-organized systems and/or highly capacitive loads.

- Three-State Output
- TTL Inputs and Output
- Non-Inverting Data Output
- High Speed –
  - Access Time – 35 ns Typical
  - Chip Select – 15 ns Typical
- Power Dissipation – 0.5 mW/Bit Typical
- Power Dissipation Decreases With Increasing Temperature

BLOCK DIAGRAM

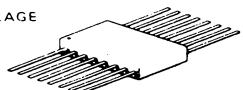


V<sub>CC</sub> = Pin 16  
Gnd = Pin 8

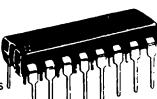
NOTE: Logic driving sense amp/write drivers depicts negative only write used on C4m

**TTL  
1024 X 1 BIT  
RANDOM ACCESS MEMORY**

F SUFFIX  
CERAMIC PACKAGE  
CASE 650

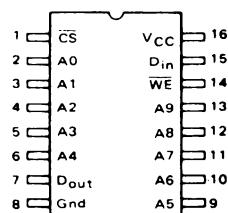


D SUFFIX  
CERAMIC PACKAGE  
CASE 620



P SUFFIX  
PLASTIC PACKAGE  
CASE 648

PIN ASSIGNMENT



Pin Description

CS	Chip Select
A0-A9	Address Inputs
WE	Write Enable
D <sub>in</sub>	Data Input
D <sub>out</sub>	Data Output

# MCM93425

## FUNCTIONAL DESCRIPTION

The MCM93425 is a fully decoded 1024-bit Random Access Memory organized 1024 words by one bit. Word selection is achieved by means of a 10-bit address, A0-A9.

The Chip Select (CS) input provides for memory array expansion. For large memories, the fast chip select time permits the decoding of chip select from the address without increasing address access time.

The read and write operations are controlled by the state of the active low Write Enable (WE, Pin 14). With WE and CS held

low, the data at  $D_{in}$  is written into the addressed location. To read, WE is held high and CS held low. Data in the specified location is presented at  $D_{out}$  and is non-inverted.

The three-state output provides drive capability for higher speeds with capacitive load systems. The third state (high impedance) allows bus organized systems where multiple outputs are connected to a common bus.

During writing, the output is held in the high-impedance state.

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Storage Temperature	
Ceramic Package (D and F Suffix)	-55°C to +165°C
Plastic Package (P Suffix)	55°C to +125°C
Operating Junction Temperature, $T_J$	
Ceramic Package (D and F Suffix)	165°C
Plastic Package (P Suffix)	125°C
$V_{CC}$ Pin Potential to Ground Pin	-0.5 V to +7.0 V
Input Voltage (dc)	-0.5 V to +5.5 V
Voltage Applied to Outputs (Output High)	-0.5 V to +5.5 V
Output Current (dc) (Output Low)	+20 mA
Input Current (dc)	-12 mA to +5.0 mA

NOTE 1: Device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded.

## TRUTH TABLE

Inputs		Output		Mode
CS	WE	$D_{in}$	$D_{out}$	
H	X	X	High Z	Not Selected
L	L	L	High Z	Write "0"
L	L	H	High Z	Write "1"
L	H	X	$D_{out}$	Read

H = High Voltage Level

L = Low Voltage Level

X = Don't Care (High or Low)

## GUARANTEED OPERATING RANGES (Notes 2 and 3)

Part Number	Supply Voltage ( $V_{CC}$ )			Ambient Temperature ( $T_A$ )
	Min	Nom	Max	
MCM93425DC, PC	4.75 V	5.0 V	5.25 V	0°C to +75°C
MCM93425FM, DM	4.50 V	5.0 V	5.50 V	-55°C to +125°C

## DC OPERATING CONDITIONS AND CHARACTERISTICS

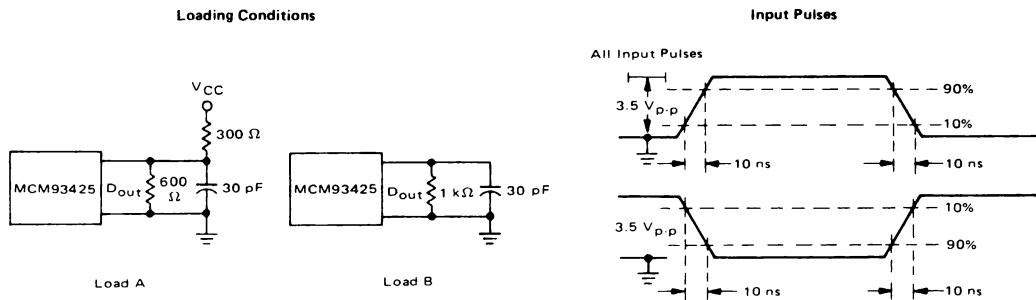
(Full operating voltage and temperature range unless otherwise noted)

Symbol	Characteristic	Limits		Units	Conditions
		Min	Max		
$V_{OL}$	Output Low Voltage		0.45	Vdc	$V_{CC}$ Min, $I_{OL}$ - 16 mA
$V_{IH}$	Input High Voltage	2.1		Vdc	Guaranteed Input High Voltage for all Inputs
$V_{IL}$	Input Low Voltage		0.8	Vdc	Guaranteed Input Low Voltage for all Inputs
$I_{IL}$	Input Low Current		-400	$\mu$ Adc	$V_{CC}$ Max, $V_{in}$ - 0.4 V
$I_{IH}$	Input High Current		40	$\mu$ Adc	$V_{CC}$ Max, $V_{in}$ - 4.5 V
			1.0	$\mu$ Adc	$V_{CC}$ Max, $V_{in}$ - 5.25 V
			50	$\mu$ Adc	$V_{CC}$ Max, $V_{out}$ - 2.4 V
$I_{off}$	Output Current (High Z)		-50	$\mu$ Adc	$V_{CC}$ Max, $V_{out}$ - 0.5 V
$I_{OS}$	Output Current Short Circuit to Ground	100		$\mu$ Adc	$V_{CC}$ Max
$V_{OH}$	Output High Voltage	2.4		Vdc	$I_{OH}$ - 10.3 mA, $V_{CC}$ - 5.0 V - 5%
				Vdc	$I_{OH}$ - 5.2 mA
$V_{CD}$	Input Diode Clamp Voltage		-1.5	Vdc	$V_{CC}$ Max, $I_{in}$ - 10 mA
$I_{CC}$	Power Supply Current		130	$\mu$ Adc	$T_A$ Max
			155	$\mu$ Adc	$T_A$ 0°C
			170	$\mu$ Adc	$T_A$ Min
					All Inputs Grounded

# MCM93425

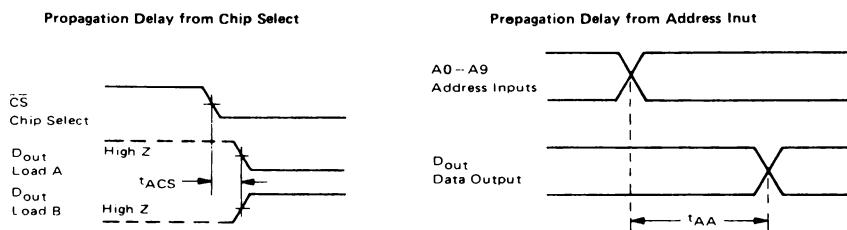
## AC OPERATING CONDITIONS AND CHARACTERISTICS (Full operating voltage and temperature unless otherwise noted)

### AC TEST LOAD AND WAVEFORMS



Symbol	Characteristic (Notes 2, 4)	MCM93425DC, PC		MCM93425DM, FM		Units	Conditions
		Min	Max	Min	Max		
READ MODE	DELAY TIMES					ns	
$t_{ACS}$	Chip Select Time			35			
$t_{ZRCs}$	Chip Select to High Z			35	50		
$t_{AA}$	Address Access Time			45	60		
WRITE MODE	DELAY TIMES					ns	
$t_{ZWS}$	Write Disable to High Z			35			
$t_{WR}$	Write Recovery Time			40	50		
	INPUT TIMING REQUIREMENTS					ns	
$t_W$	Write Pulse Width (to guarantee write)	30		40			
$t_{WSD}$	Data Setup Time Prior to Write	5		5			
$t_{WHD}$	Data Hold Time After Write	5		5			
$t_{WSA}$	Address Setup Time (at $t_W = \text{Min}$ )	10		15			
$t_{WHA}$	Address Hold Time	10		10			
$t_{WSCS}$	Chip Select Setup Time	5		5			
$t_{WHCS}$	Chip Select Hold Time	5		5			

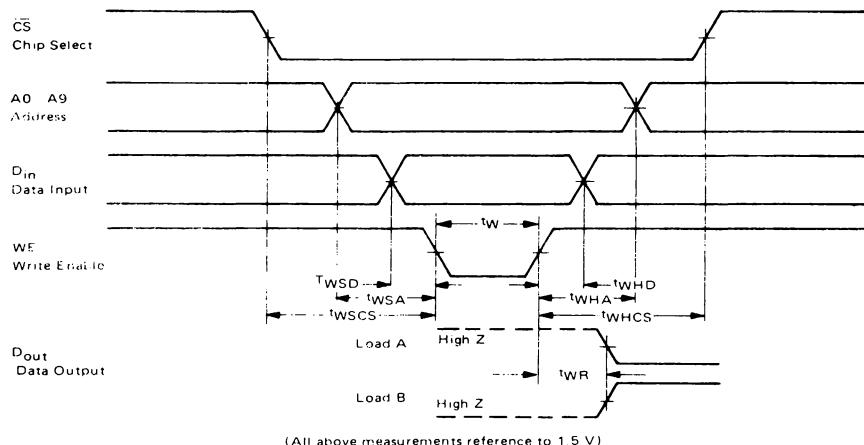
### READ OPERATION TIMING DIAGRAM



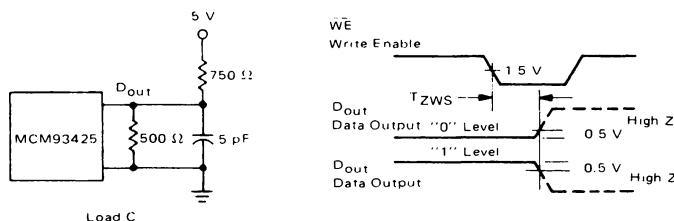
(All time measurements referenced to 1.5 V)

# MCM93425

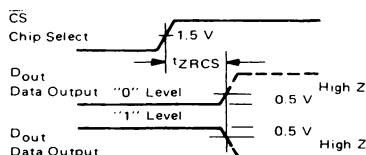
## WRITE CYCLE TIMING



## WRITE ENABLE TO HIGH Z DELAY



## Propagation Delay from Chip Select to High Z



(All t\_ZXXX parameters are measured at a delta of 0.5 V from the logic level and using Load C)

NOTE 2: DC and AC specifications limits guaranteed with 500 linear feet per minute blown air. Contact your Motorola Sales Representative if extended temperature or modified operating conditions are desired.

Package	$\theta_{JA}$ (Junction to Ambient)		$\theta_{JC}$ (Junction to Case)
	Blown	Still	
D Suffix	50°C/W	85°C/W	15°C/W
F Suffix	55°C/W	90°C/W	15°C/W
P Suffix	65°C/W	100°C/W	25°C/W

NOTE 3: Output short circuit conditions must not exceed 1 second duration.

NOTE 4: The maximum address access time is guaranteed to be the worst case bit in the memory.



## MOTOROLA

# MCM7680 MCM7681

### 8192-BIT PROGRAMMABLE READ ONLY MEMORY

The MCM7680/81 together with the MCM7620/21, MCM7640/43 comprise a complete, compatible family having common dc electrical characteristics and identical programming requirements. They are fully decoded, high-speed, field-programmable ROMs and are available in commonly used organizations, with both open-collector and three-state outputs. All bits are manufactured storing a logical "1" (outputs high), and can be selectively programmed for logical "0" (outputs low).

The field-programmable PROM can be custom-programmed to any pattern using a simple programming procedure. Schottky bipolar circuitry provides fast access time, and features temperature and voltage compensation to minimize access time variations.

Pinouts are compatible to industry-standard PROMs and ROMs. In addition, the MCM7680 and 81 are pin compatible replacement for the 512 X 8 with pin 2 connected as A9 on the 1024 X 8.

In addition to the conventional storage array, extra test rows and columns are included to assure high programmability, and guarantee parametric and ac performance. Fuses in these test rows and columns are blown prior to shipment.

- Common dc Electrical Characteristics and Programming Procedure
- Simple, High-Speed Programming Procedure (0.1 second per 1024 Bits, Typical)
- Expandable – Open-Collector or Three-State Outputs and Chip Enable Inputs
- Inputs and Outputs TTL-Compatible
  - Low Input Current – 250  $\mu$ A Logic "0", 40  $\mu$ A Logic "1"
  - Full Output Drive – 16 mA Sink, 2.0 mA Source
- Fast Access Time – Guaranteed for Worst-Case N<sup>2</sup> Sequencing, Over Commercial and Military Temperature Ranges
- Pin-Compatible with Industry-Standard PROMs and ROMs

### ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Supply Voltage (operating)	V <sub>CC</sub>	+7.0	Vdc
Input Voltage	V <sub>in</sub>	+5.5	Vdc
Output Voltage (operating)	V <sub>OH</sub>	+7.0	Vdc
Supply Current	I <sub>CC</sub>	650	mAdc
Input Current	I <sub>in</sub>	-20	mAdc
Output Sink Current	I <sub>o</sub>	100	mAdc
Operating Temperature Range MCM76xxDM MCM76xxDC	T <sub>A</sub>	-55 to +125 0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +150	°C
Maximum Junction Temperature	T <sub>J</sub>	+175	°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. (While programming, follow the programming specifications.)

### MTTL

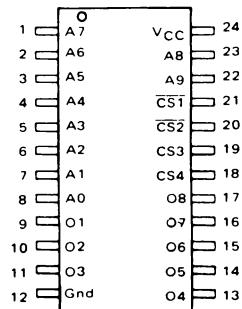
### 8192-BIT PROGRAMMABLE READ ONLY MEMORIES

MCM7680 – 1024 X 8 – Open-Collector  
MCM7681 – 1024 X 8 – Three-State



CERAMIC PACKAGE  
CASE 623

### PIN ASSIGNMENT



# MCM7680, MCM7681

## DC OPERATING CONDITIONS AND CHARACTERISTICS

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage MCM76xxDM MCM76xxDC	V <sub>CC</sub>	4.50 4.75	5.0 5.0	5.50 5.25	V <sub>dc</sub>
Input High Voltage	V <sub>IH</sub>	2.0	-	--	V <sub>dc</sub>
Input Low Voltage	V <sub>IL</sub>	-	-	0.8	V <sub>dc</sub>

### DC CHARACTERISTICS

Symbol	Parameter	Test Conditions	Open-Collector Output			Three-State Output			Unit
			Min	Typ	Max	Min	Typ	Max	
I <sub>RA</sub> , I <sub>RE</sub>	Address/Enable "1"	V <sub>IH</sub> , V <sub>CC</sub> Max	-	40	-	-	40	-	μA/dc
I <sub>FA</sub> , I <sub>FE</sub>	Input Current "0"	V <sub>IL</sub> 0.45 V	-	-0.1	-0.25	-	-0.1	-0.25	mADC
V <sub>OH</sub> , V <sub>OL</sub>	Output Voltage "1" "0"	I <sub>OH</sub> -2.0 mA, V <sub>CC</sub> - V <sub>CC</sub> Min I <sub>OL</sub> +16 mA, V <sub>CC</sub> V <sub>CC</sub> Min	N/A -	0.35	0.45	2.4 ...	3.4 0.35	0.45	V <sub>dc</sub> V <sub>dc</sub>
I <sub>OHE</sub> , I <sub>OLE</sub>	Output Disabled "1" Current "0"	V <sub>OH</sub> , V <sub>CC</sub> V <sub>CC</sub> Max V <sub>OL</sub> +0.3 V, V <sub>CC</sub> V <sub>CC</sub> Max	-	-	-	100 N/A	-	100 -100	μA/dc μA/dc
I <sub>OH</sub>	Output Leakage "1"	V <sub>OH</sub> , V <sub>CC</sub> V <sub>CC</sub> Max	-	100	-	-	-	N/A	μA/dc
V <sub>CCL</sub>	Input Clamp Voltage	I <sub>in</sub> -10 mA	-	-	-1.5	-	-	-1.5	V <sub>dc</sub>
I <sub>OS</sub>	Output Short Circuit Current	V <sub>CC</sub> - V <sub>CC</sub> Max, V <sub>out</sub> 0.0 V One Output Only for 1 s Max	N/A	-	N/A	15	-	70	mADC
I <sub>CC</sub>	Power Supply Current MCM7680/MCM7681DC MCM7680/MCM7681DM	V <sub>CC</sub> - V <sub>CC</sub> Max All Inputs Grounded	-	110 110	150 170	-	110 110	150 170	mADC mADC

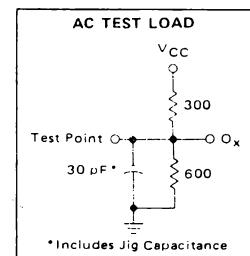
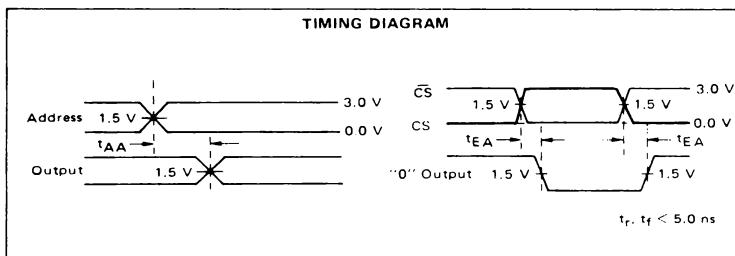
CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Unit
Input Capacitance	C <sub>in</sub>	8.0	pF
Output Capacitance	C <sub>out</sub>	8.0	pF

### AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted)

Characteristic	Symbol	Typ	Max	Typ	Max	Unit
Address to Output Access Time	t <sub>AA</sub>	45	70	45	85	ns
Chip Enable Access Time	t <sub>EA</sub>	30	40	30	50	ns



# MCM7680, MCM7681

## PROGRAMMING

The PROMs are manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build

## PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed. Address inputs are TTL-compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying inputs highs ( $V_{IH}$ ) to the  $\bar{CS}$  inputs. CS inputs must remain at  $V_{IH}$  for program and verify. The chip select is TTL-compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than  $V_{OPD}$  to the output of the PROM. The output may be left open to achieve the disable.
4. Raise  $V_{CC}$  to  $V_{PH}$  with rise time equal to  $t_r$ .
5. After a delay equal to or greater than  $t_d$ , apply a pulse with amplitude of  $V_{OPE}$  and duration of  $t_p$  to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed

his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. These PROMs can be programmed automatically or by the manual procedure shown below.

- while the  $V_{CC}$  input is raised to  $V_{PH}$  by applying output enable pulses to each output which is to be programmed. The output enable pulses must be separated by a minimum interval of  $t_d$ .
7. Lower  $V_{CC}$  to 4.5 Volts following a delay of  $t_d$  from the last programming enable pulse applied to an output.
  8. Enable the PROM for verification by applying a logic "0" ( $V_{IL}$ ) to the  $\bar{CS}$  inputs.
  9. If any bit does not verify as programmed, repeat Steps 2 through 8 until the bit has received a total of 1.0 ms of programming time. Bits which do not program within 1.0 ms may be considered programming rejects. Multiple pulses of durations shorter than 1.0 ms may be used to enhance programming speed.
  10. Repeat Steps 1 through 9 for all other bits to be programmed in the PROM.
  11. Programming rejects returned to the factory must be accompanied by data giving address with desired and actual output data of a location in which a programming failure has occurred.

TABLE 1  
PROGRAMMING SPECIFICATIONS

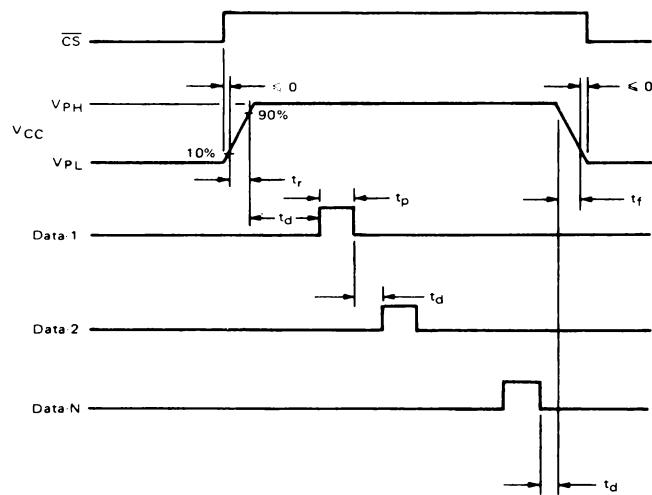
Symbol	Parameter	Min	Typ	Max	Unit
$V_{IH}$	Address Input Voltage(1)	2.4	5.0	5.0	V
$V_{IL}$		0.0	0.4	0.8	V
$V_{PH}$	Programming/Verify Voltage to $V_{CC}$	11.75	12.0	12.25	V
$V_{PL}$		4.5	4.5	5.5	V
$I_{CCP}$	Programming Voltage Current Limit Programming ( $V_{CC}$ )	600	600	650	mA
$t_r$	Voltage Rise and Fall Time	1	1	10	$\mu s$
$t_f$		1	1	10	$\mu s$
$t_d$	Programming Delay	10	10	100	$\mu s$
$t_p$	Programming Pulse Width	100	-	1000	$\mu s$
DC	Programming Duty Cycle	-	50	90	%
$V_{OPE}$	Output Voltage Enable	10.0	10.5	11.0	V
$V_{OPD}$	Disable(2)	4.5	5.0	5.5	V
$I_{OPE}$	Output Voltage Enable Current	2	4	10	mA
$T_C$	Case Temperature	-	25	75	$^{\circ}C$

(1) Address and chip select should not be left open for  $V_{IH}$ .

(2) Disable condition will be met with output open circuit.

## MCM7680, MCM7681

FIGURE 1 – TYPICAL PROGRAMMING WAVEFORMS





**MOTOROLA**

## Advance Information

### 8192-BIT PROGRAMMABLE READ ONLY MEMORY

The MCM7684/85 together with the MCM7620/21/40/41/42/43/80/81 comprise a complete, compatible family having common dc electrical characteristics and identical programming requirements. They are fully decoded, high-speed, field-programmable ROMs and are available in commonly used organizations, with both open-collector and three-state outputs. All bits are manufactured storing a logical "1" (outputs high), and can be selectively programmed for logical "0" (outputs low).

The field-programmable PROM can be custom-programmed to any pattern using a simple programming procedure. Schottky bipolar circuitry provides fast access time, and features temperature and voltage compensation to minimize access time variations.

Pinouts are compatible to industry-standard PROMs and ROMs. In addition, the MCM7684 and 85 are pin compatible replacement for the 1024 X 4 with pin 8 connected as A10 on the 2048 X 4.

In addition to the conventional storage array, extra test rows and columns are included to assure high programmability, and guarantee parametric and ac performance. Fuses in these test rows and columns are blown prior to shipment.

- Common dc Electrical Characteristics and Programming Procedure
- Simple, High-Speed Programming Procedure (0.1 second per 1024 Bits, Typical)
- Expandable – Open-Collector or Three-State Outputs and Chip Enable Input
- Inputs and Outputs TTL-Compatible
  - Low Input Current – 250  $\mu$ A Logic "0", 40  $\mu$ A Logic "1"
  - Full Output Drive – 16 mA Sink, 2.0 mA Source
- Fast Access Time – Guaranteed for Worst-Case  $N^2$  Sequencing, Over Commercial and Military Temperature Ranges
- Pin-Compatible with Industry-Standard PROMs and ROMs

### ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Value	Unit
Supply Voltage (operating)	V <sub>CC</sub>	+7.0	Vdc
Input Voltage	V <sub>in</sub>	+5.5	Vdc
Output Voltage (operating)	V <sub>OH</sub>	+7.0	Vdc
Supply Current	I <sub>CC</sub>	650	mAdc
Input Current	I <sub>in</sub>	-20	mAdc
Output Sink Current	I <sub>O</sub>	100	mAdc
Operating Temperature Range MCM76xxDM MCM76xxDC	T <sub>A</sub>	-55 to +125 0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +150	°C
Maximum Junction Temperature	T <sub>J</sub>	+175	°C

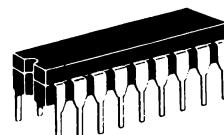
NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability. (While programming, follow the programming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

**MCM7684  
MCM7685**

### MTL

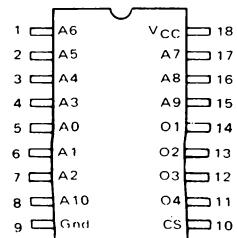
#### 8192-BIT PROGRAMMABLE READ ONLY MEMORIES

MCM7684 – 2048 X 4 – Open-Collector  
MCM7685 – 2048 X 4 – Three-State



D SUFFIX  
CERAMIC PACKAGE  
CASE 726

#### PIN ASSIGNMENT



# MCM7684, MCM7685

## DC OPERATING CONDITIONS AND CHARACTERISTICS

### RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage MCM76xxDM MCM76xxDC	V <sub>CC</sub>	4.50 4.75	5.0 5.0	5.50 5.25	V <sub>dC</sub>
Input High Voltage	V <sub>IH</sub>	2.0	—	—	V <sub>dC</sub>
Input Low Voltage	V <sub>IL</sub>	—	—	0.8	V <sub>dC</sub>

### DC CHARACTERISTICS

(Over Recommended Operating Temperature Range)

Symbol	Parameter	Test Conditions	Open-Collector Output			Three-State Output			Unit
			Min	Typ	Max	Min	Typ	Max	
I <sub>RA</sub> , I <sub>RE</sub>	Address/Enable "1"	V <sub>IH</sub> = V <sub>CC</sub> Max	—	—	40	—	—	40	μA <sub>dC</sub>
I <sub>FA</sub> , I <sub>FE</sub>	Input Current "0"	V <sub>IL</sub> = 0.45 V	—	-0.1	-0.25	—	-0.1	-0.25	mA <sub>dC</sub>
V <sub>OH</sub> V <sub>OL</sub>	Output Voltage "1" "0"	I <sub>OH</sub> = -2.0 mA, V <sub>CC</sub> Min I <sub>OL</sub> = +16 mA, V <sub>CC</sub> Min	N/A —	— 0.35	— 0.45	2.4 —	3.4 0.35	— 0.45	V <sub>dC</sub> V <sub>dC</sub>
I <sub>OHZ</sub> I <sub>OLZ</sub>	Output Disabled "1" Current "0"	V <sub>OH</sub> , V <sub>CC</sub> Max V <sub>OL</sub> = +0.3 V, V <sub>CC</sub> Max	— —	— —	100 N/A	— —	— —	100 -100	μA <sub>dC</sub> μA <sub>dC</sub>
I <sub>OH</sub>	Output Leakage "1"	V <sub>OH</sub> , V <sub>CC</sub> Max	—	—	100	—	—	N/A	μA <sub>dC</sub>
V <sub>IC</sub>	Input Clamp Voltage	I <sub>in</sub> = -10 mA	—	—	-1.5	—	—	-1.5	V <sub>dC</sub>
I <sub>OS</sub>	Output Short Circuit Current	V <sub>CC</sub> Max, V <sub>out</sub> = 0.0 V One Output Only for 1 s Max	N/A	—	N/A	15	—	70	mA <sub>dC</sub>
I <sub>CC</sub>	Power Supply Current MCM7684/MCM7685 DC MCM7684/MCM7685 DM	V <sub>CC</sub> Max All Inputs Grounded	— —	80 80	120 140	— —	80 80	120 140	mA <sub>dC</sub> mA <sub>dC</sub>

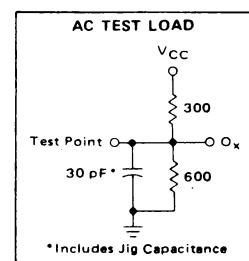
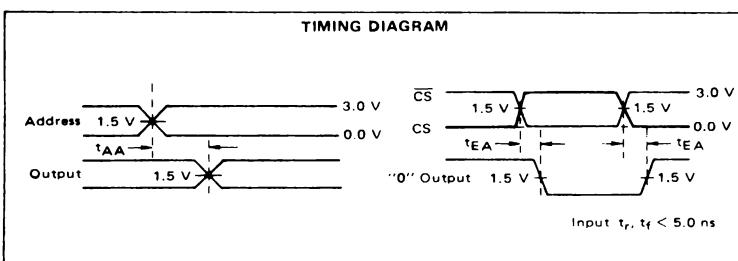
CAPACITANCE (f = 1.0 MHz, T<sub>A</sub> = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Typ	Unit
Input Capacitance	C <sub>in</sub>	8.0	pF
Output Capacitance	C <sub>out</sub>	8.0	pF

### AC OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted)

Characteristic	Symbol	Typ	Max	Typ	Max	Unit
Address to Output Access Time	t <sub>AA</sub>	45	70	45	85	ns
Chip Enable Access Time	t <sub>EA</sub>	15	25	15	30	ns



# MCM7684, MCM7685

## PROGRAMMING

The PROMs are manufactured with all bits/outputs Logical "1" (Output High). Any desired bit/output can be programmed to a Logical "0" (Output Low) by following the simple procedure shown below. One may build

## PROGRAMMING PROCEDURE

1. Address the PROM with the binary address of the selected word to be programmed. Address inputs are TTL-compatible. An open circuit should not be used to address the PROM.
2. Disable the chip by applying an input high ( $V_{IH}$ ) to the  $\bar{CS}$  input. The chip select is TTL-compatible. An open circuit should not be used to disable the chip.
3. Disable the programming circuitry by applying an Output Voltage Disable of less than  $V_{OPD}$  to the output of the PROM. The output may be left open to achieve the disable.
4. Raise  $V_{CC}$  to  $V_{PH}$  with rise time equal to  $t_r$ .
5. After a delay equal to or greater than  $t_d$ , apply a pulse with amplitude of  $V_{OPE}$  and duration of  $t_p$  to the output selected for programming. Note that the PROM is supplied with fuses intact generating an output high. Programming a fuse will cause the output to go low in the verify mode.
6. Other bits in the same word may be programmed

his own programmer to satisfy the specifications described in Table 1, or buy any of the commercially available programmers which meet these specifications. These PROMs can be programmed automatically or by the manual procedure shown below.

7. Lower  $V_{CC}$  to 4.5 Volts following a delay of  $t_d$  from the last programming enable pulse applied to an output.
8. Enable the PROM for verification by applying a logic "0" ( $V_{IL}$ ) to the  $\bar{CS}$  inputs.
9. If any bit does not verify as programmed, repeat Steps 2 through 8 until the bit has received a total of 1.0 ms of programming time. Bits which do not program within 1.0 ms may be considered programming rejects. Multiple pulses of durations shorter than 1.0 ms may be used to enhance programming speed.
10. Repeat Steps 1 through 9 for all other bits to be programmed in the PROM.
11. Programming rejects returned to the factory must be accompanied by data giving address with desired and actual output data of a location in which a programming failure has occurred.

TABLE 1  
PROGRAMMING SPECIFICATIONS

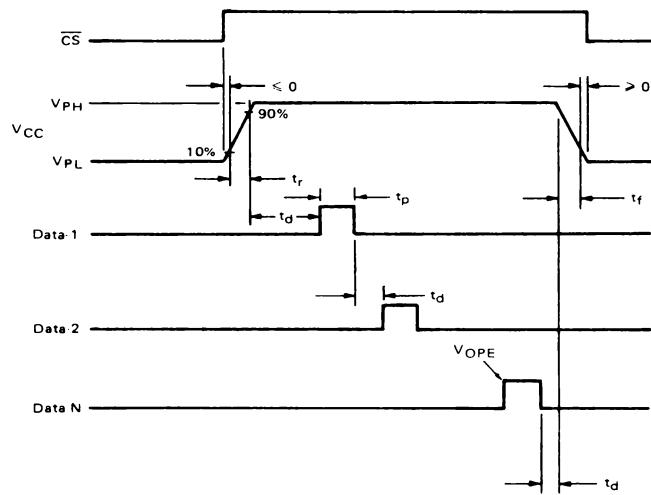
Symbol	Parameter	Min	Typ	Max	Unit
$V_{IH}$	Address Input Voltage(1)	2.4	5.0	5.0	V
$V_{IL}$		0.0	0.4	0.8	V
$V_{PH}$	Programming/Verify Voltage to $V_{CC}$	11.75	12.0	12.25	V
$V_{PL}$		4.5	4.5	5.5	V
$I_{CCP}$	Programming Voltage Current Limit Programming ( $V_{CC}$ )	600	600	650	mA
$t_r$	Voltage Rise and Fall Time	1	1	10	$\mu s$
$t_f$		1	1	10	$\mu s$
$t_d$	Programming Delay	10	10	100	$\mu s$
$t_p$	Programming Pulse Width	100	--	1000	$\mu s$
DC	Programming Duty Cycle	--	50	90	%
$V_{OPE}$	Output Voltage Enable	10.0	10.5	11.0	V
$V_{OPD}$	Disable(2)	4.5	5.0	5.5	V
$I_{OPE}$	Output Voltage Enable Current	2	4	10	mA
$T_C$	Case Temperature	--	25	75	$^{\circ}C$

(1) Address and chip select should not be left open for  $V_{IH}$ .

(2) Disable condition will be met with output open circuit.

## MCM7684, MCM7685

FIGURE 1 – TYPICAL PROGRAMMING WAVEFORMS



# MECL MEMORIES

## GENERAL INFORMATION

Complete information is available in the MECL Data Book. Contact your sales representative or authorized distributor for information.

**TABLE 1 – LIMITS BEYOND WHICH DEVICE LIFE MAY BE IMPAIRED**

Characteristic	Symbol	Rating	Unit
Supply Voltage	$V_{EE}$	-8.0 to 0	V
Input Voltage ( $V_{CC} = 0$ )	$V_{in}$	0 to $V_{EE}$	V
Output Source Current – Continuous Surge	$I_{out}$	50 100	mA
Junction Temperature – Ceramic Package <sup>①</sup> Plastic Package	$T_J$	165 150	°C
Storage Temperature	$T_{stg}$	-55 to +150	°C

- <sup>①</sup> Maximum  $T_J$  may be exceeded ( $\leq 250^{\circ}\text{C}$ ) for short periods of time ( $\leq 240$  hours) without significant reduction in device life.

**TABLE 2 – LIMITS BEYOND WHICH PERFORMANCE MAY BE DEGRADED**

Characteristic	Symbol	Rating	Unit
Supply Voltage ( $V_{CC} = 0$ ) <sup>②</sup>	$V_{EE}$	-4.94 to -5.46	V
Output Drive – MCM10100 Series MCM10500 Series	—	50 Ω to -2.0 V 100 Ω to -2.0 V	Ω
Operating Temperature Range <sup>③</sup> MCM10100 Series MCM10500 Series	$T_A$	0 to 75 -55 to +125	°C

- <sup>②</sup> Functionality only. Data sheet limits are specified for -5.19 to -5.21 V.

- <sup>③</sup> With airflow  $\geq 500$  Ifpm.

## MECL MEMORIES (continued)

TABLE 3 – DC TEST PARAMETERS

Each MECL 10,000 series device has been designed to meet the dc specifications shown in the test table, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 linear feet per minute is maintained.  $V_{EE} = -5.2 V \pm 0.010 V$ .

Forcing Function	Parameter	-55°C	0°C	25°C		75°C	125°C
		MCM10500*	MCM10100**	MCM10100**	MCM10500*	MCM10100**	MCM10500*
$V_{IHmax}$	$= V_{OHmax}$	-0.880	-0.840	-0.810	-0.780	-0.720	-0.630
	$V_{OHmin}$	-1.080	-1.000	-0.960	-0.930	-0.900	-0.825
	$V_{OHAmmin}$	-1.100	-1.020	-0.980	-0.950	-0.920	-0.845
$V_{IHAmmin}$		-1.255	-1.145	-1.105	-1.105	-1.045	-1.000
$V_{ILAmmin}$		-1.510	-1.490	-1.475	-1.475	-1.450	-1.400
	$V_{OLAmmin}$	-1.635	-1.645	-1.630	-1.600	-1.605	-1.525
	$V_{OLAmmax}$	-1.655	-1.665	-1.650	-1.620	-1.625	-1.545
$V_{ILmin}$	$= V_{OLmin}$	-1.920	-1.870	-1.850	-1.850	-1.830	-1.820
	$V_{ILmin}$	0.5	0.5	0.5	0.5	0.3	0.3

\*Driving 100  $\Omega$  to -2.0 V.

\*\*Driving 50  $\Omega$  to -2.0 V.

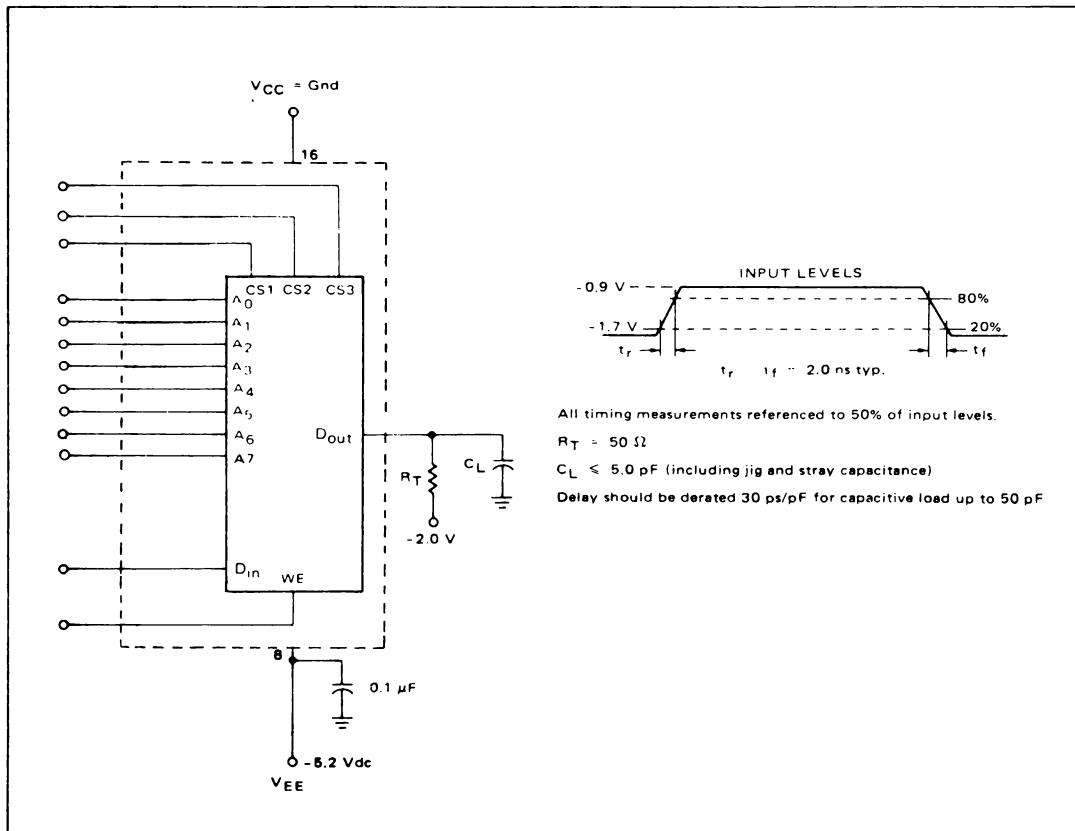


FIGURE 1 – SWITCHING TIME TEST CIRCUIT

## MECL MEMORIES (continued)

FIGURE 2 -- CHIP SELECT ACCESS TIME WAVEFORM

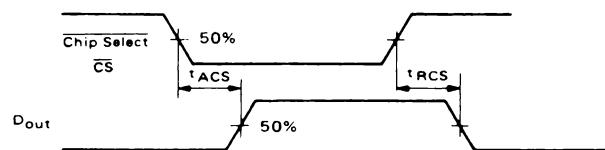


FIGURE 3 – ADDRESS ACCESS TIME WAVEFORM

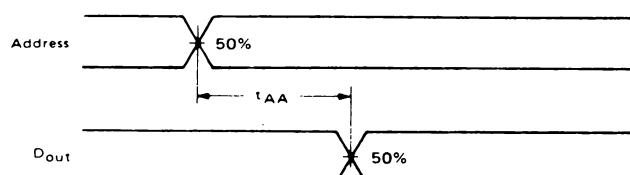
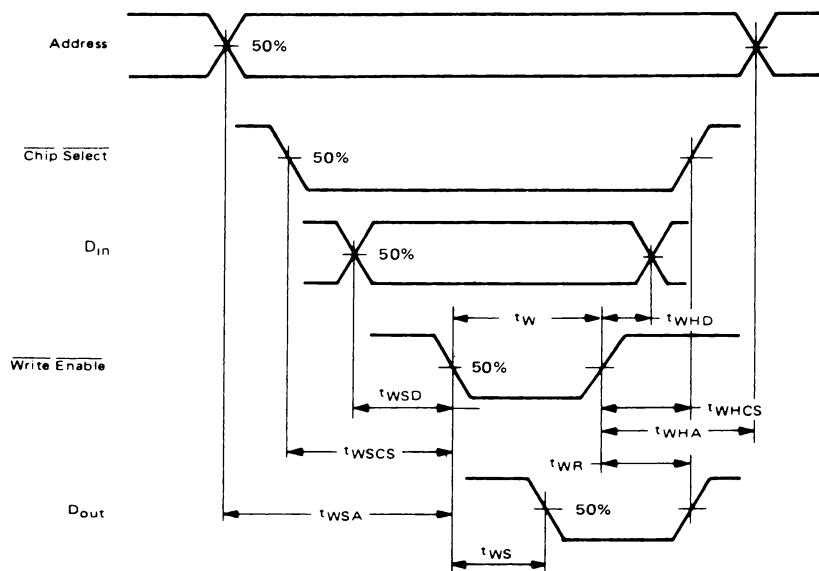


FIGURE 4 – SETUP AND HOLD WAVEFORMS (WRITE MODE)





**MOTOROLA**

**MCM10143**

**8 X 2 MULTIPORT REGISTER FILE (RAM)**

### 8 x 2 MULTIPORT REGISTER FILE (RAM)

The MCM10143 is an 8 word by 2 bit multiport register file (RAM) capable of reading two locations and writing one location simultaneously. Two sets of eight latches are used for data storage in this LSI circuit.

#### WRITE

The word to be written is selected by addresses A<sub>0</sub> - A<sub>2</sub>. Each bit of the word has a separate write enable to allow more flexibility in system design. A write occurs on the positive transition of the clock. Data is enabled by having the write enables at a low level when the clock makes the transition. To inhibit a bit from being written, the bit enable must be at a high level when the clock goes low and not change until the clock goes high. Operation of the clock and the bit enables can be reversed. While the clock is low a positive transition of the bit enable will write that bit into the address selected by A<sub>0</sub>-A<sub>2</sub>.

#### READ

When the clock is high any two words may be read out simultaneously, as selected by addresses B<sub>0</sub> - B<sub>2</sub> and C<sub>0</sub> - C<sub>2</sub>, including the word written during the preceding half clock cycle. When the clock goes low the addressed data is stored in the slaves. Level changes on the read address lines have no effect on the output until the clock again goes high. Read out is accomplished at any time by enabling output gates (B<sub>0</sub> - B<sub>1</sub>), (C<sub>0</sub> - C<sub>1</sub>).

t<sub>pd</sub>:

Clock to Data out 5 ns (typ)

(Read Selected)

Address to Data out 10 ns (typ)

(Clock High)

Read Enable to Data out 28 ns (typ)

(Clock high, Addresses present)

P<sub>D</sub> 610 mW/pkg (typ no load)



**L SUFFIX**  
CERAMIC PACKAGE  
CASE 623

#### PIN ASSIGNMENT

1	V <sub>CC0</sub>	V <sub>CC</sub>	24
2	QB <sub>1</sub>	V <sub>CC1</sub>	23
3	QB <sub>0</sub>	QC <sub>1</sub>	22
4	RE <sub>B</sub>	QC <sub>0</sub>	21
5	B <sub>2</sub>	RE <sub>C</sub>	20
6	B <sub>0</sub>	Clock	19
7	B <sub>1</sub>	C <sub>2</sub>	18
8	WE <sub>1</sub>	C <sub>0</sub>	17
9	WE <sub>0</sub>	C <sub>1</sub>	16
10	D <sub>0</sub>	A <sub>1</sub>	15
11	D <sub>1</sub>	A <sub>0</sub>	14
12	VEE	A <sub>2</sub>	13

#### TRUTH TABLE

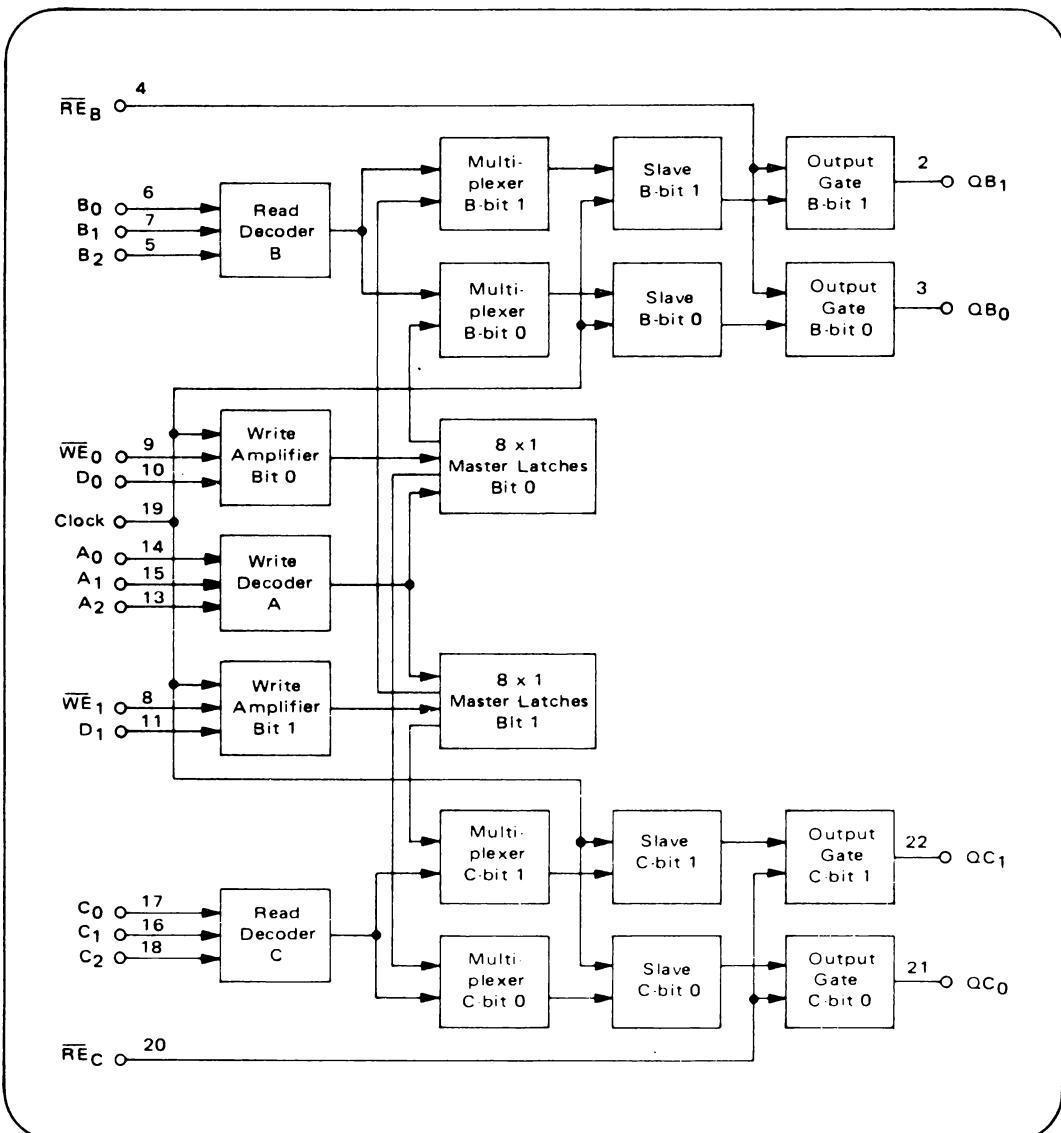
**MODE	INPUT						OUTPUT				
	**Clock	WE <sub>0</sub>	WE <sub>1</sub>	D <sub>0</sub>	D <sub>1</sub>	RE <sub>B</sub>	RE <sub>C</sub>	QB <sub>0</sub>	QB <sub>1</sub>	QC <sub>0</sub>	QC <sub>1</sub>
Write	L "H	L	L	H	H	H	H	L	L	L	L
Read	H	L	L	L	L	L	L	H	H	H	H
Read	H "L	H	L	L	L	L	L	H	H	H	H
Read	L "H "L	H	H	L	L	L	L	H	H	H	H
Write	L "H	L	L	L	H	H	H	L	L	L	L
Read	H	L	H	L	L	L	L	H	L	H	H

\*Note Clock occurs sequentially through Truth Table

\*Note A<sub>0</sub> A<sub>2</sub>, B<sub>0</sub> B<sub>2</sub>, and C<sub>0</sub> C<sub>2</sub> are all set to same address location throughout Table

○ Don't Care

BLOCK DIAGRAM

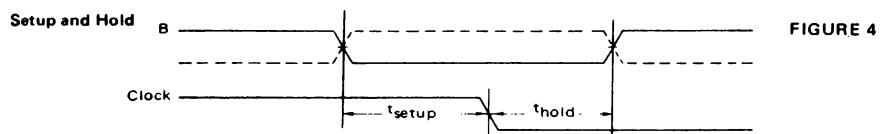
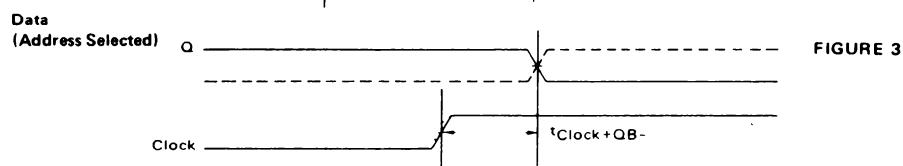
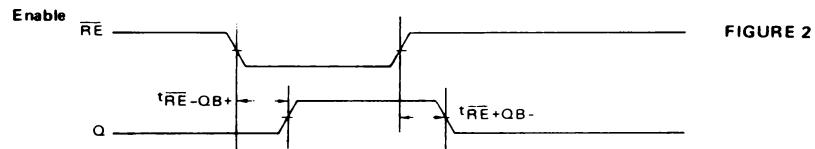
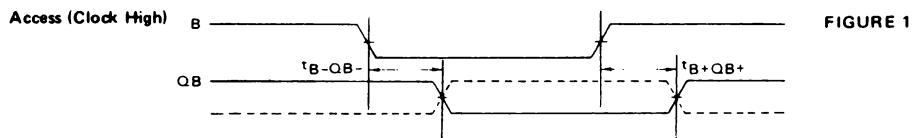


## ELECTRICAL CHARACTERISTICS

Characteristics	Symbol	0°C		+25°C			+75°C		Unit
		Min	Max	Min	Typ	Max	Min	Max	
Power Supply Drain Current	I <sub>E</sub>	—	150	—	118	150	—	150	mAdc
Input Current Pins 10, 11, 19 All other pins	I <sub>inH</sub>	—	245	—	—	245	—	245	μAdc
Switching Times ①									ns
Read Mode									
Address Input	t <sub>B</sub> ± QB ±	4.0	15.3	4.5	10	14.5	4.5	15.5	
Read Enable	t <sub>RE</sub> - QB +	1.1	5.3	1.2	3.5	5.0	1.2	5.5	
Data	t <sub>Clock</sub> + QB -	1.7	7.3	2.0	5.0	7.0	2.0	7.6	
Setup									
Address	t <sub>setup</sub> (B - Clock -)	—	—	8.5	5.5	—	—	—	
Hold									
Address	t <sub>hold</sub> (Clock - B +)	—	—	-1.5	-4.5	—	—	—	
Write Mode									
Setup									
Write Enable	t <sub>setup</sub> (WE - Clock +)	—	—	7.0	4.0	—	—	—	
	t <sub>setup</sub> (WE + Clock -)	—	—	1.0	-2.0	—	—	—	
Address	t <sub>setup</sub> (A - Clock +)	—	—	8.0	5.0	—	—	—	
Data	t <sub>setup</sub> (D - Clock +)	—	—	5.0	2.0	—	—	—	
Hold									
Write Enable	t <sub>hold</sub> (Clock + WE +)	—	—	5.5	2.5	—	—	—	
	t <sub>hold</sub> (Clock + WE -)	—	—	1.0	-2.0	—	—	—	
Address	t <sub>hold</sub> (Clock + A +)	—	—	1.0	-3.0	—	—	—	
Data	t <sub>hold</sub> (Clock + D +)	—	—	1.0	-2.0	—	—	—	
Write Pulse Width	PW <sub>WE</sub>	—	—	8.0	5.0	—	—	—	
Rise Time, Fall Time (20% to 80%)	t <sub>r</sub> , t <sub>f</sub>	1.1	4.2	1.1	2.5	4.0	1.1	4.5	

① AC timing figures do not show all the necessary presetting conditions.

READ TIMING DIAGRAMS



**WRITE TIMING DIAGRAM**

Enable Setup

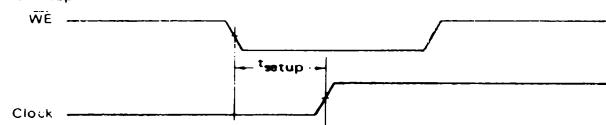


FIGURE 5

Enable Hold

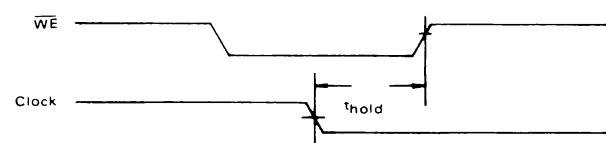


FIGURE 6

Disable

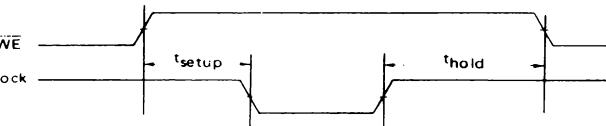


FIGURE 7

Pulse Width

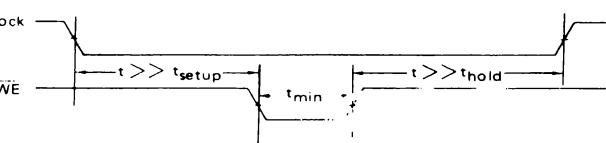


FIGURE 8

Address

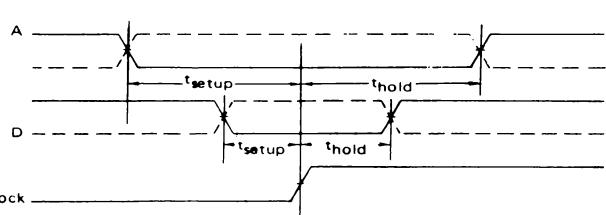


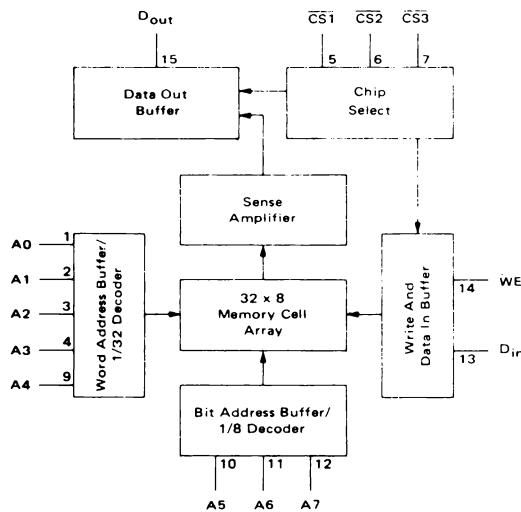
FIGURE 9



**MOTOROLA**

# MCM10144/MCM10544

**256 X 1-BIT RANDOM  
ACCESS MEMORY**



The MCM10144/10544 is a 256 word X 1-bit RAM. Bit selection is achieved by means of an 8-bit address A0 through A7.

The active-low chip select allows memory expansion up to 2048 words. The fast chip select access time allows memory expansion without affecting system performance.

The operating mode of the RAM ( $\overline{CS}$  inputs low) is controlled by the  $\overline{WE}$  input. With  $\overline{WE}$  low the chip is in the write mode—the output is low and the data present at  $D_{in}$  is stored at the selected address. With  $\overline{WE}$  high the chip is in the read mode—the data state at the selected memory location is presented non-inverted at  $D_{out}$ .

- Typical Address Access Time = 17 ns
- Typical Chip Select Access Time = 4.0 ns
- 50 k $\Omega$  Input Pulldown Resistors on Chip Select
- Power Dissipation (470 mW typ @ 25°C)  
Decreases with Increasing Temperature
- Pin-for-Pin Replacement for F10410

TRUTH TABLE

MODE	INPUT			OUTPUT
	$\overline{CS}^*$	$\overline{WE}$	$D_{in}$	$D_{out}$
Write "0"	L	L	L	L
Write "1"	L	L	H	L
Read	L	H	$\phi$	Q
Disabled	H	$\phi$	$\phi$	L

\* $\overline{CS} = \overline{CS}_1 + \overline{CS}_2 + \overline{CS}_3$

$\phi$  = Don't Care.



PIN ASSIGNMENT

1	A0	V <sub>CC</sub>	16
2	A1	$\overline{D}_{out}$	15
3	A2	$\overline{WE}$	14
4	A3	$D_{in}$	13
5	$\overline{CS}_1$	A7	12
6	$\overline{CS}_2$	A6	11
7	$\overline{CS}_3$	A5	10
8	V <sub>EE</sub>	A4	9

# MCM10144/MCM10544

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I <sub>EE</sub>	—	140	—	135	—	130	—	125	—	125	mAdc
Input Current High	I <sub>inH</sub>	—	375	—	220	—	220	—	220	—	220	μAdc

-55°C and +125°C test values apply to MC105xx devices only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10144		MCM10544		Unit	Conditions
		T <sub>A</sub> = 0 to +75°C, V <sub>EE</sub> = -5.2 Vdc ± 5%	T <sub>A</sub> = -55 to +125°C, V <sub>EE</sub> = -5.2 Vdc ± 5%	Min	Max		
Read Mode							
Chip Select Access Time	t <sub>ACS</sub>	2.0	10	2.0	10	ns	Measured from 50% of input to 50% of output. See Note 2.
Chip Select Recovery Time	t <sub>RCS</sub>	2.0	10	2.0	10		
Address Access Time	t <sub>AA</sub>	7.0	26	7.0	26		
Write Mode							
Write Pulse Width	t <sub>W</sub>	25	—	25	—	ns	t <sub>WSA</sub> = 8.0 ns Measured at 50% of input to 50% of output. t <sub>W</sub> = 25 ns.
Data Setup Time Prior to Write	t <sub>WSD</sub>	2.0	—	2.0	—		
Data Hold Time After Write	t <sub>WHD</sub>	2.0	—	2.0	—		
Address Setup Time Prior to Write	t <sub>WSA</sub>	8.0	—	8.0	—		
Address Hold Time After Write	t <sub>WHA</sub>	2.0	—	0.0	—		
Chip Select Setup Time Prior to Write	t <sub>WSCS</sub>	2.0	—	2.0	—		
Chip Select Hold Time After Write	t <sub>WHCS</sub>	2.0	—	2.0	—		
Write Disable Time	t <sub>WS</sub>	2.5	10	2.5	10		
Write Recovery Time	t <sub>WR</sub>	2.5	10	2.5	10		
Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>					ns	Measured between 20% and 80% points.
Address to Output CS or WE to Output		1.5	7.0	1.5	7.0		
		1.5	5.0	1.5	5.0		
Capacitance						pF	Measured with a pulse technique.
Input Capacitance	C <sub>in</sub>	—	5.0	—	5.0		
Output Capacitance	C <sub>out</sub>	—	8.0	—	8.0		

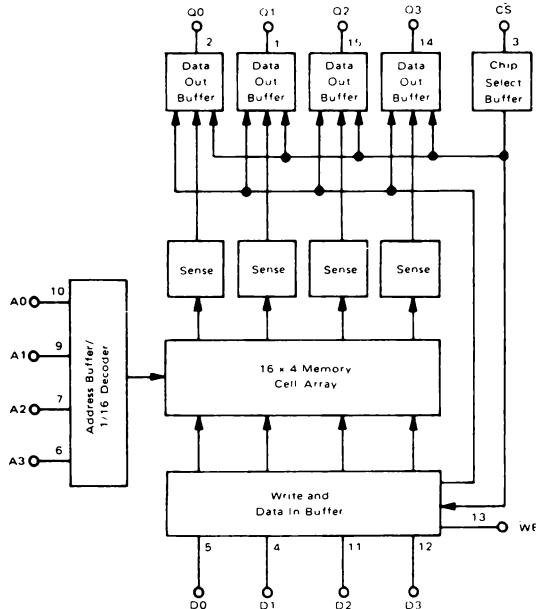
- NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10144; 100 Ω, MCM10544. C<sub>L</sub> ≤ 5.0 pF (including jig and stray capacitance). Delay should be derated 30 ps/pF for capacitive load up to 50 pF.  
 2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.  
 3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.



**MOTOROLA**

# MCM10145/MCM10545

**16 X 4-BIT REGISTER FILE  
(RAM)**



The MCM10145/10545 is a 16 word X 4-bit RAM. Bit selection is achieved by means of a 4-bit address A0 through A3.

The active-low chip select allows memory expansion up to 32 words. The fast chip select access time allows memory expansion without affecting system performance.

The operating mode of the RAM (CS input low) is controlled by the  $\overline{WE}$  input. With  $\overline{WE}$  low the chip is in the write mode—the output is low and the data present at  $D_n$  is stored at the selected address. With  $\overline{WE}$  high the chip is in the read mode—the data state at the selected memory location is presented non-inverted at  $Q_n$ .

- Typical Address Access Time = 10 ns
- Typical Chip Select Access Time = 4.5 ns
- 50 k $\Omega$  Pulldown Resistors on All Inputs
- Power Dissipation (470 mW typ @ 25°C)  
Decreases with Increasing Temperature



**L SUFFIX**  
**CERAMIC PACKAGE**  
**CASE 620**



**F SUFFIX**  
**CERAMIC PACKAGE**  
**CASE 650**

## PIN ASSIGNMENT

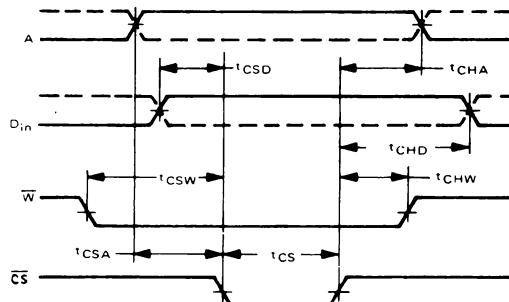
1	Q1	V <sub>CC</sub>	16
2	Q0	Q2	15
3	$\overline{CS}$	Q3	14
4	D1	$\overline{WE}$	13
5	D0	D3	12
6	A3	D2	11
7	A2	A0	10
8	VEE	A1	9

## TRUTH TABLE

MODE	INPUT			OUTPUT
	$\overline{CS}$	$\overline{WE}$	$D_n$	
Write "0"	L	L	L	L
Write "1"	L	L	H	L
Read	L	H	$\phi$	Q
Disabled	H	$\phi$	$\phi$	L

$\phi$  = Don't Care.

**FIGURE 1 – CHIP ENABLE STROBE MODE**



# MCM10145/MCM10545

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I <sub>EE</sub>	—	135	—	130	—	125	—	120	—	120	mA
Input Current High	I <sub>inH</sub>	—	375	—	220	—	220	—	220	—	220	μA

55°C and +125°C test values apply to MC105xx devices only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10145		MCM10545		Unit	Conditions
		T <sub>A</sub> = 0 to +75°C, V <sub>EE</sub> = -5.2 Vdc ± 5%	T <sub>A</sub> = -55 to +125°C, V <sub>EE</sub> = -5.2 Vdc ± 5%	Min	Max		
Read Mode						ns	Measured from 50% of input to 50% of output. See Note 2.
Chip Select Access Time	t <sub>ACS</sub>	2.0	8.0	2.0	10		
Chip Select Recovery Time	t <sub>RCS</sub>	2.0	8.0	2.0	10		
Address Access Time	t <sub>AA</sub>	4.0	15	4.0	18		
Write Mode						ns	t <sub>WSA</sub> = 5 ns Measured at 50% of input to 50% of output. t <sub>W</sub> = 8 ns.
Write Pulse Width	t <sub>W</sub>	8.0	—	8.0	—		
Data Setup Time Prior to Write	t <sub>WSD</sub>	0	—	0	—		
Data Hold Time After Write	t <sub>WHD</sub>	3.0	—	4.0	—		
Address Setup Time Prior to Write	t <sub>WSA</sub>	5.0	—	5.0	—		
Address Hold Time After Write	t <sub>WHA</sub>	1.0	—	3.0	—		
Chip Select Setup Time Prior to Write	t <sub>WSCS</sub>	0	—	5.0	—		
Chip Select Hold Time After Write	t <sub>WHCS</sub>	0	—	0	—		
Write Disable Time	t <sub>WS</sub>	2.0	8.0	2.0	10		
Write Recovery Time	t <sub>WR</sub>	2.0	8.0	2.0	10		
Chip Enable Strobe Mode						ns	Guaranteed but not tested on standard product. See Figure 1.
Data Setup Prior to Chip Select	t <sub>CSD</sub>	0	—	—	—		
Write Enable Setup Prior to Chip Select	t <sub>CSP</sub>	0	—	—	—		
Address Setup Prior to Chip Select	t <sub>CSCA</sub>	0	—	—	—		
Data Hold Time After Chip Select	t <sub>CHD</sub>	2.0	—	—	—		
Write Enable Hold Time After Chip Select	t <sub>CHW</sub>	0	—	—	—		
Address Hold Time After Chip Select	t <sub>CHA</sub>	4.0	—	—	—		
Chip Select Minimum Pulse Width	t <sub>CS</sub>	18	—	—	—		
Rise and Fall Time	t <sub>r, tf</sub>					ns	Measured between 20% and 80% points.
Address to Output		1.5	7.0	1.5	7.0		
CS to Output		1.5	5.0	1.5	5.0		
Capacitance						pF	Measured with a pulse technique.
Input Capacitance	C <sub>in</sub>	—	6.0	—	6.0		
Output Capacitance	C <sub>out</sub>	—	8.0	—	8.0		

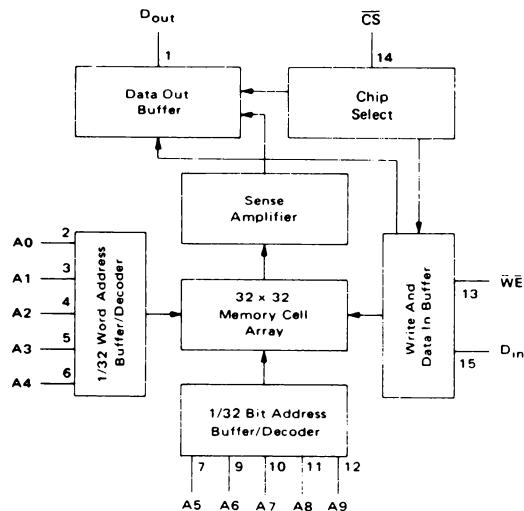
- NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10145; 100 Ω, MCM10545. C<sub>L</sub> ≤ 5.0 pF (including jig and Stray Capacitance). Delay should be derated 30 ps/pF for capacitive loads up to 50 pF.
2. The maximum Address Access Time is guaranteed to be the worst-case bit in the memory.
3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.



**MOTOROLA**

# MCM10146/MCM10546

1024 X 1-BIT RANDOM  
ACCESS MEMORY



The MCM10146/10546 is a 1024 X 1-bit RAM. Bit selection is achieved by means of a 10-bit address, A0 to A9.

The active-low chip select is provided for memory expansion up to 2048 words.

The operating mode of the RAM ( $\overline{CS}$  input low) is controlled by the  $\overline{WE}$  input. With  $\overline{WE}$  low, the chip is in the write mode, the output,  $D_{out}$ , is low and the data state present at  $D_{in}$  is stored at the selected address. With  $\overline{WE}$  high, the chip is in the read mode and the data stored at the selected memory location will be presented non-inverted at  $D_{out}$ . (See Truth Table.)

- Pin-for-Pin Compatible with the 10415
- Power Dissipation (520 mW typ @ 25°C)  
Decreases with Increasing Temperature
- Typical Address Access of 24 ns
- Typical Chip Select Access of 4.0 ns
- 50 k $\Omega$  Pulldown Resistor on Chip Select Input

TRUTH TABLE

MODE	INPUT			OUTPUT
	$\overline{CS}$	$\overline{WE}$	$D_{in}$	
Write "0"	L	L	L	L
Write "1"	L	L	H	L
Read	L	H	$\phi$	Q
Disabled	H	$\phi$	$\phi$	L

$\phi$  = Don't Care

PIN ASSIGNMENT

1	$D_{out}$	V <sub>CC</sub>	16
2	A0	$D_{in}$	15
3	A1	$\overline{CS}$	14
4	A2	$\overline{WE}$	13
5	A3	A9	12
6	A4	A8	11
7	A5	A7	10
8	VEE	A6	9



L SUFFIX  
CERAMIC PACKAGE  
CASE 620



F SUFFIX  
CERAMIC PACKAGE  
CASE 650 03

# MCM10146/MCM10546

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max									
Power Supply Drain Current	$I_{EE}$	—	155	—	150	—	145	—	125	—	125	mAdc
Input Current High	$I_{inH}$	—	375	—	220	—	220	—	220	—	220	$\mu$ Adc
Logic "0" Output Voltage	$V_{OL}$	-1.970	-1.655	-1.920	-1.665	-1.900	-1.650	-1.880	-1.625	-1.870	-1.545	Vdc

NOTE: -55°C and +125°C test values apply to MCM105XX only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10146		MCM10546		Unit	Conditions		
		$T_A = 0 \text{ to } +75^\circ\text{C}$ , $V_{EE} = -5.2 \text{ Vdc} \pm 5\%$		$T_A = -55 \text{ to } +125^\circ\text{C}$ , $V_{EE} = -5.2 \text{ Vdc} \pm 5\%$					
		Min	Max	Min	Max				
Read Mode									
Chip Select Access Time	$t_{ACS}$	2.0	7.0	2.0	8.0	ns	Measured at 50% of input to 50% of output. See Note 2.		
Chip Select Recovery Time	$t_{RCS}$	2.0	7.0	2.0	8.0				
Address Access Time	$t_{AA}$	8.0	29	8.0	40				
Write Mode						ns			
Write Pulse Width (To guarantee writing)	$t_W$	25	—	25	—				
Data Setup Time Prior to Write	$t_{WSD}$	5.0	—	5.0	—				
Data Hold Time After Write	$t_{WHD}$	5.0	—	5.0	—				
Address Setup Time Prior to Write	$t_{WSA}$	8.0	—	10	—				
Address Hold Time After Write	$t_{WHA}$	2.0	—	8.0	—				
Chip Select Setup Time Prior to Write	$t_{WSCS}$	5.0	—	5.0	—				
Chip Select Hold Time After Write	$t_{WHCS}$	5.0	—	5.0	—				
Write Disable Time	$t_{WS}$	2.8	7.0	2.8	12				
Write Recovery Time	$t_{WR}$	2.8	7.0	2.8	12				
Rise and Fall Time $\bar{CS}$ or $\bar{WE}$ to Output	$t_r, t_f$	1.5	4.0	1.5	4.0	ns	Measured between 20% and 80% points.		
Address to Output		1.5	8.0	1.5	8.0				
Capacitance						pF	Measured with a pulse technique.		
Input Capacitance	$C_{in}$	—	5.0	—	5.0				
Output Capacitance	$C_{out}$	—	8.0	—	8.0				

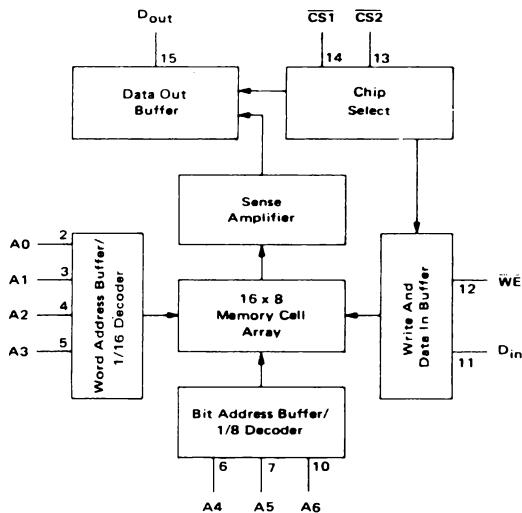
- NOTES: 1. Test circuit characteristics:  $R_T = 50 \Omega$ , MCM10146;  $100 \Omega$ , MCM10546.  $C_L \leq 5.0 \text{ pF}$  including jig and stray capacitance. For Capacitance Loading  $\leq 50 \text{ pF}$ , delay should be derated by 30 ps/pF.
2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.
3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.



**MOTOROLA**

# MCM10147/MCM10547

128 X 1-BIT  
RANDOM ACCESS MEMORY



## PIN ASSIGNMENT

1	V <sub>CC1</sub>	V <sub>CC2</sub>	16
2	A <sub>0</sub>	D <sub>out</sub>	15
3	A <sub>1</sub>	CS <sub>1</sub>	14
4	A <sub>2</sub>	CS <sub>2</sub>	13
5	A <sub>3</sub>	WE	12
6	A <sub>4</sub>	D <sub>in</sub>	11
7	A <sub>5</sub>	A <sub>6</sub>	10
8	V <sub>EE</sub>	N.C.	9



L SUFFIX  
CERAMIC PACKAGE  
CASE 620

## TRUTH TABLE

MODE	INPUT		OUTPUT
	CS*	WE	
Write "0"	L	L	L
Write "1"	L	L	H
Read	L	H	φ
Disabled	H	φ	φ
			L

\*CS = CS<sub>1</sub> + CS<sub>2</sub>

φ = Don't Care.



F SUFFIX  
CERAMIC PACKAGE  
CASE 650

# MCM10147/MCM10547

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I <sub>EE</sub>	-	115	-	105	-	100	-	95	-	95	mAdc
Input Current High	I <sub>inH</sub>	-	375	-	220	-	220	-	220	-	220	μAdc

-55°C and +125°C test values apply to MC105xx devices only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10147		MCM10547		Unit	Conditions		
		TA = 0 to +75°C, VEE = -5.2 Vdc ± 5%		TA = -55 to +125°C, VEE = -5.2 Vdc ± 5%					
		Min	Max	Min	Max				
Read Mode									
Chip Select Access Time	t <sub>ACS</sub>	2.0	8.0	*	*	ns	Measured from 50% of input to 50% of output. See Note 2.		
Chip Select Recovery Time	t <sub>RCS</sub>	2.0	8.0	*	*				
Address Access Time	t <sub>AA</sub>	5.0	15	*	*				
Write Mode						ns	t <sub>WSA</sub> = 4.0 ns Measured at 50% of input to 50% of output. t <sub>W</sub> = 8.0 ns.		
Write Pulse Width	t <sub>W</sub>	8.0	-	*	-				
Data Setup Time Prior to Write	t <sub>WSD</sub>	1.0	-	*	-				
Data Hold Time After Write	t <sub>WHD</sub>	3.0	-	*	-				
Address Setup Time Prior to Write	t <sub>WSA</sub>	4.0	-	*	-				
Address Hold Time After Write	t <sub>WHA</sub>	3.0	-	*	-				
Chip Select Setup Time Prior to Write	t <sub>WSCS</sub>	1.0	-	*	-				
Chip Select Hold Time After Write	t <sub>WHCS</sub>	1.0	-	*	-				
Write Disable Time	t <sub>WS</sub>	2.0	8.0	*	*				
Write Recovery Time	t <sub>WR</sub>	2.0	8.0	*	*				
Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>	1.5	5.0	*	*	ns	Measured between 20% and 80% points.		
Capacitance						pF	Measured with a pulse technique.		
Input Capacitance	C <sub>in</sub>	-	5.0	-	*				
Output Capacitance	C <sub>out</sub>	-	8.0	-	*				

NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10147; 100 Ω, MCM10547.

C<sub>L</sub> ≤ 5.0 pF (including jig and stray capacitance).

Delay should be derated 30 ps/pF for capacitive load up to 50 pF.

2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.

3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.

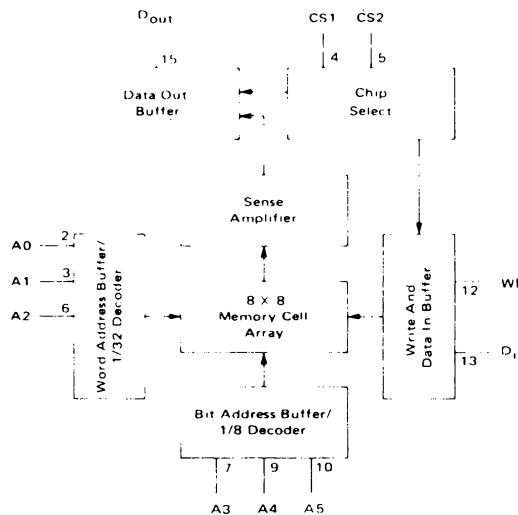
\*To be determined; contact your Motorola representative for up-to-date information.



**MOTOROLA**

# MCM10148/MCM10548

64 X 1-BIT  
RANDOM ACCESS MEMORY



## PIN ASSIGNMENT

1	V <sub>CC1</sub>	V <sub>CC2</sub>	16
2	A0	D <sub>out</sub>	15
3	A1	N.C.	14
4	CS1	D <sub>in</sub>	13
5	CS2	WE	12
6	A2	N.C.	11
7	A3	A5	10
8	VEE	A4	9

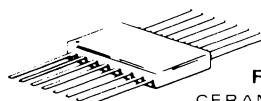


L SUFFIX  
CERAMIC PACKAGE  
CASE 620

## TRUTH TABLE

MODE	INPUT		OUTPUT	
	CS*	WE	D <sub>in</sub>	D <sub>out</sub>
Write '0'	L	L	L	L
Write '1'	L	L	H	L
Read	L	H	φ	Q
Disabled	H	φ	φ	L

\*CS = CS1 + CS2 + CS3 φ = Don't Care



F SUFFIX  
CERAMIC PACKAGE  
CASE 650

# MCM10148/MCM10548

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I <sub>EE</sub>	--	115	--	105	--	100	--	95	--	95	mAdc
Input Current High	I <sub>inH</sub>	--	375	--	220	--	220	--	220	--	220	μAdc

-55°C and +125°C test values apply to MC105xx devices only

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10148		MCM10548		Unit	Conditions		
		TA = 0 to +75°C, VEE = -5.2 Vdc ± 5%		TA = -55 to +125°C, VEE = -5.2 Vdc ± 5%					
		Min	Max	Min	Max				
Read Mode						ns	Measured from 50% of input to 50% of output. See Note 2.		
Chip Select Access Time	t <sub>AWS</sub>			7.5		*			
Chip Select Recovery Time	t <sub>RCS</sub>	--		7.5	--	*			
Address Access Time	t <sub>AA</sub>	--		15	--	*			
Write Mode						ns	t <sub>WSA</sub> = 5.0 ns Measured at 50% of input to 50% of output. t <sub>W</sub> = 8.0 ns.		
Write Pulse Width	t <sub>W</sub>	8.0			*	--			
Data Setup Time Prior to Write	t <sub>WSD</sub>	3.0		--	*	--			
Data Hold Time After Write	t <sub>WHD</sub>	2.0			*	--			
Address Setup Time Prior to Write	t <sub>WSA</sub>	5.0		--	*	--			
Address Hold Time After Write	t <sub>WHA</sub>	3.0		--	*	--			
Chip Select Setup Time Prior to Write	t <sub>WSCS</sub>	3.0		--	*	--			
Chip Select Hold Time After Write	t <sub>WHCS</sub>	0		--	*	--			
Write Disable Time	t <sub>WS</sub>	2.0		7.5	--	*			
Write Recovery Time	t <sub>WR</sub>	2.0		7.5	--	*			
Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>	1.5		5.0	*	*	Measured between 20% and 80% points.		
Capacitance						pF	Measured with a pulse technique.		
Input Capacitance	C <sub>in</sub>	--		5.0	--	*			
Output Capacitance	C <sub>out</sub>	--		8.0	--	*			

NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10148; 100 Ω, MCM10548.

C<sub>L</sub> ≤ 5.0 pF (including jig and stray capacitance)

Delay should be derated 30 ps/pF for capacitive load up to 50 pF.

2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.

3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.

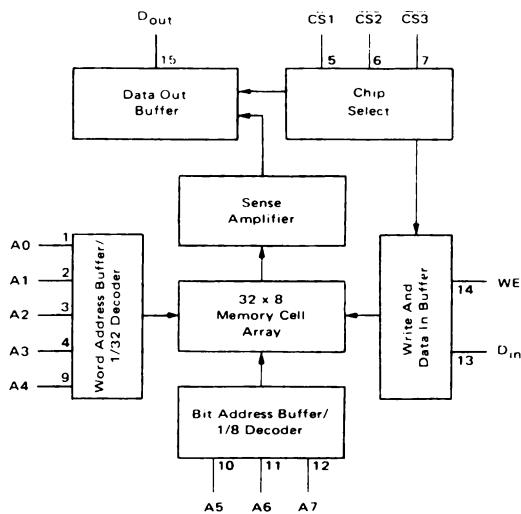
\* To be determined; contact your Motorola representative for up-to-date information.



**MOTOROLA**

# MCM10152/MCM10552

**256 X 1-BIT  
RANDOM ACCESS MEMORY**



## PIN ASSIGNMENT

1	A0	V <sub>CC</sub>	16
2	A1	D <sub>out</sub>	15
3	A2	WE	14
4	A3	D <sub>in</sub>	13
5	CS1	A7	12
6	CS2	A6	11
7	CS3	A5	10
8	VEE	A4	9



L SUFFIX  
CERAMIC PACKAGE  
CASE 620

MODE	INPUT		OUTPUT
	CS*	WE	
Write "0"	L	L	L
Write "1"	L	L	L
Read	L	H	Q
Disabled	H	φ	φ

\*CS = CS1 + CS2 + CS3      φ = Don't Care



F SUFFIX  
CERAMIC PACKAGE  
CASE 650

# MCM10152/MCM10552

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	$I_{EE}$	140		135		130		125		125		mAdc
Input Current High	$I_{IH}$	375		220		220		220		220		$\mu$ Adc

55°C and +125°C test values apply to MC105xx devices only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10152		MCM10552		Unit	Conditions		
		$T_A = 0 \text{ to } +75^\circ\text{C}, V_{EE} = -5.2 \text{ Vdc } \pm 5\%$		$T_A = -55 \text{ to } +125^\circ\text{C}, V_{EE} = -5.2 \text{ Vdc } \pm 5\%$					
		Min	Max	Min	Max				
Read Mode									
Chip Select Access Time	$t_{ACS}$	2.0	7.5						
Chip Select Recovery Time	$t_{RCS}$	2.0	7.5						
Address Access Time	$t_{AA}$	7.0	15						
Write Mode						ns			
Write Pulse Width	$t_W$	10					$t_{WSA} = 5 \text{ ns}$		
Data Setup Time Prior to Write	$t_{WSD}$	2.0					Measured at 50% of input to 50% of output.		
Data Hold Time After Write	$t_{WHD}$	2.0					See Note 2.		
Address Setup Time Prior to Write	$t_{WSA}$	5.0							
Address Hold Time After Write	$t_{WHA}$	3.0							
Chip Select Setup Time Prior to Write	$t_{WCS}$	2.0							
Chip Select Hold Time After Write	$t_{WHCS}$	2.0							
Write Disable Time	$t_{WDS}$	2.5	7.5						
Write Recovery Time	$t_{WR}$	2.5	7.5						
Rise and Fall Time	$t_r, t_f$	1.5	5.0			ns	Measured between 20% and 80% points.		
Capacitance						pF			
Input Capacitance	$C_{in}$		5.0				Measured with a pulse technique.		
Output Capacitance	$C_{out}$		8.0						

NOTES 1. Test circuit characteristics:  $R_T = 50 \Omega$ , MCM10152;  $100 \Omega$ , MCM10552.

$C_L = 5.0 \text{ pF}$  (including jig and stray capacitance).

Delay should be derated 30 ps/pF for capacitive load up to 50 pF.

2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.

3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.

\* To be determined, contact your Motorola representative for up-to-date information.



**MOTOROLA**

# **MCM10139/MCM10539**

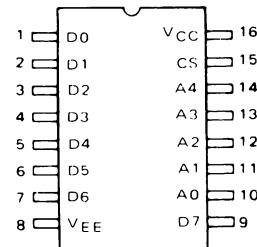
**32 x 8-BIT PROGRAMMABLE  
READ-ONLY MEMORY**



**L SUFFIX**  
CERAMIC PACKAGE  
CASE 620



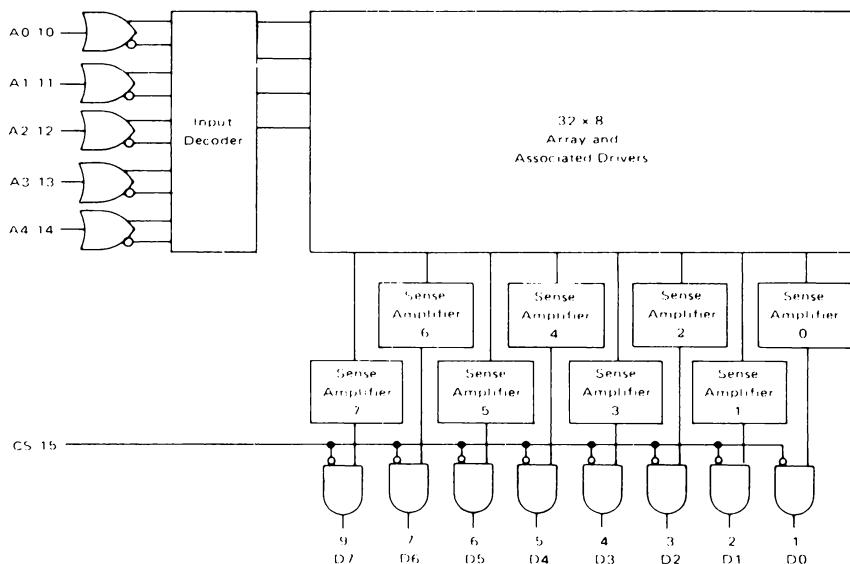
**F SUFFIX**  
CERAMIC PACKAGE  
CASE 650



The MCM10139/10539 is a 256-bit field programmable read only memory (PROM). Prior to programming, all stored bits are at logic 0 (low) levels. The logic state of each bit can then be changed by on-chip programming circuitry. The memory has a single negative logic chip enable. When the chip is disabled ( $\overline{CS}$  = high), all outputs are forced to a logic 0 (low).

- Typical Address Access Time = 15 ns
- Typical Chip Select Access Time = 10 ns
- 50 k $\Omega$  Input Pulldown Resistors on all inputs
- Power Dissipation (520 mW typ @ 25°C)  
Decreases with Increasing Temperature

**BLOCK DIAGRAM**



# MCM10139/MCM10539

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		-0°C		+25°C		+75°C		+125°C		Unit
		Min	Max									
Power Supply Drain Current	I <sub>EE</sub>	—	160	—	150	—	145	—	140	—	160	mAdc
Input Current High	I <sub>inH</sub>	—	450	—	265	—	265	—	265	—	265	μAdc
Logic "0" Output Voltage MCM10139 MCM10539	V <sub>OL</sub>	—	—	-2.010	-1.665	-1.990	-1.650	-1.970	-1.625	—	—	Vdc
		-2.060	-1.655	—	—	-1.990	-1.620	—	—	-1.960	-1.545	

## SWITCHING CHARACTERISTICS (Note 1)

Characteristic	Symbol	MCM10139	MCM10539	Conditions
		(V <sub>EE</sub> = -5.2 Vdc ± 5%; T <sub>A</sub> = 0°C to +75°C)	(V <sub>EE</sub> = -5.2 Vdc ± 5%; T <sub>A</sub> = -55°C to +125°C)	
Chip Select Access Time	t <sub>TCS</sub>	15 ns Max	•	
Chip Select Recovery Time	t <sub>RC</sub>	15 ns Max	•	
Address Access Time	t <sub>AA</sub>	20 ns Max	•	Measured from 50% of input to 50% of output. See Note 2
Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>	3.0 ns Typ	•	Measured between 20% and 80% points.
Input Capacitance	C <sub>in</sub>	5.0 pF Max	•	
Output Capacitance	C <sub>out</sub>	8.0 pF Max	•	Measured with a pulse technique.

NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10139; 100 Ω, MCM10539. C<sub>L</sub> ≤ 5.0 pF including jig and stray capacitance.  
For Capacitance Loading ≤ 50 pF, delay should be derated by 30 ps/pF.  
2. The maximum Address Access Time is guaranteed to be the Worst Case Bit in the Memory.  
3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.

\*To be determined; contact your Motorola representative for up-to-date information.

## MCM10139/MCM10539

FIGURE 1 – MANUAL PROGRAMMING CIRCUIT

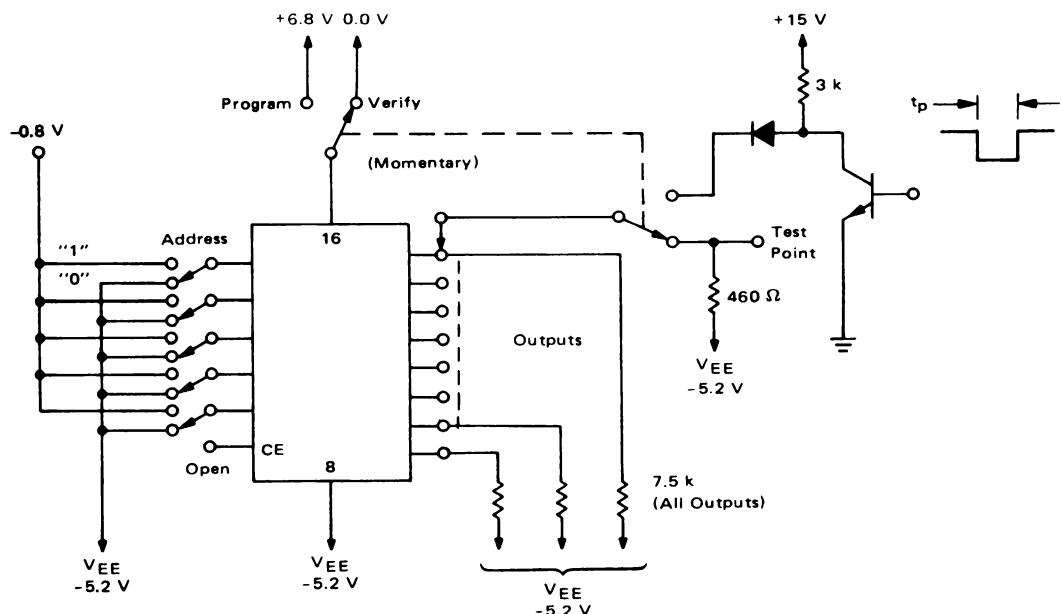
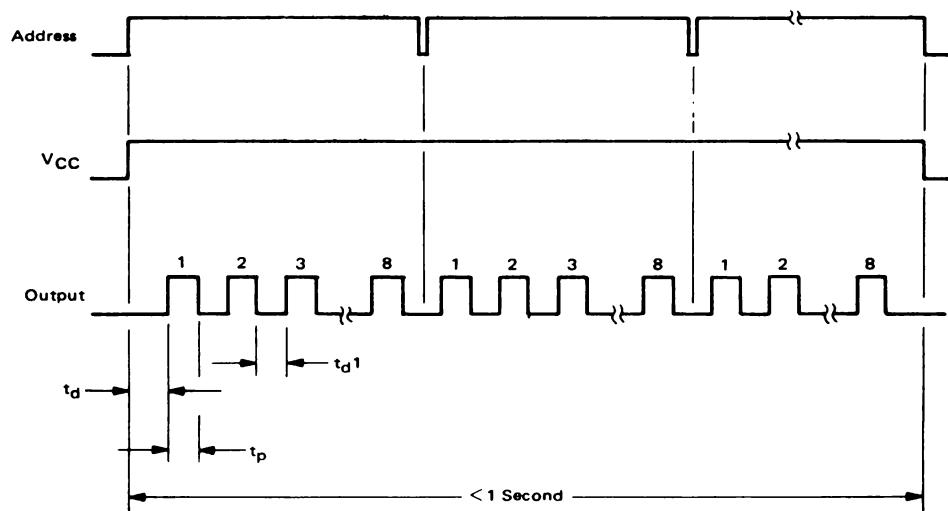


FIGURE 2 – AUTOMATIC PROGRAMMING CIRCUIT



# MCM10139/MCM10539

## RECOMMENDED PROGRAMMING PROCEDURE\*

The MCM10139 is shipped with all bits at logical "0" (low). To write logical "1s", proceed as follows.

### MANUAL (See Figure 1)

**Step 1** Connect V<sub>EE</sub> (Pin 8) to -5.2 V and V<sub>CC</sub> (Pin 16) to 0.0 V. Address the word to be programmed by applying -1.2 to -0.6 volts for a logic "1" and -5.2 to -4.2 volts for a logic "0" to the appropriate address inputs.

**Step 2** Raise V<sub>CC</sub> (Pin 16) to +6.8 volts.

**Step 3** After V<sub>CC</sub> has stabilized at +6.8 volts (including any ringing which may be present on the V<sub>CC</sub> line), apply a current pulse of 2.5 mA to the output pin corresponding to the bit to be programmed to a logic "1".

**Step 4** Return V<sub>CC</sub> to 0.0 Volts.

#### CAUTION

To prevent excessive chip temperature rise, V<sub>CC</sub> should not be allowed to remain at +6.8 volts for more than 1 second.

**Step 5** Verify that the selected bit has programmed by connecting a 460  $\Omega$  resistor to -5.2 volts and measuring the voltage at the output pin. If a logic "1" is not detected at the output, the procedure should be repeated once. During verification V<sub>IH</sub> should be -1.0 to -0.6 volts.

**Step 6** If verification is positive, proceed to the next bit to be programmed.

\*NOTE: For devices that program incorrectly—return serialized units with individual truth tables. Noncompliance voids warranty.

### PROGRAMMING SPECIFICATIONS

Characteristic	Symbol	Limits			Units	Conditions
		Min	Typ	Max		
Power Supply Voltage To Program	V <sub>EE</sub>	-5.46	-5.2	-4.94	Vdc	
To Verify	V <sub>CCP</sub>	+6.04	+6.8	+7.56	Vdc	
	V <sub>CCV</sub>	0	0	0	Vdc	
Programming Supply Current	I <sub>CCP</sub>	—	200	600	mA	V <sub>CC</sub> = +6.8 Vdc
Address Voltage Logical "1" Logical "0"	V <sub>IH</sub> Program V <sub>IH</sub> Verify V <sub>IL</sub>	-1.2 -1.0 -5.2	— — —	-0.6 -0.6 -4.2	Vdc Vdc Vdc	
Maximum Time at V <sub>CC</sub> = V <sub>CCP</sub>	—	—	—	1.0	sec	
Output Programming Current	I <sub>OP</sub>	2.0	2.5	3.0	mAdc	
Output Program Pulse Width	t <sub>p</sub>	0.5	—	1.0	ms	
Output Pulse Rise Time	—	—	—	10	$\mu$ s	
Programming Pulse Delay (1) Following V <sub>CC</sub> change Between Output Pulses	t <sub>d</sub> t <sub>d1</sub>	0.1 0.01	— —	1.0 1.0	ms ms	

NOTE 1. Maximum is specified to minimize the amount of time V<sub>CC</sub> is at +6.8 volts.

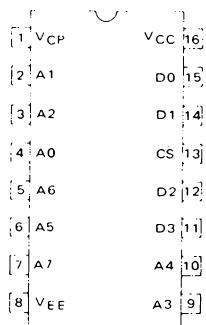


**MOTOROLA**

# MCM10149/MCM10549

**256 X 4-BIT PROGRAMMABLE  
READ-ONLY MEMORY**

## PIN ASSIGNMENT

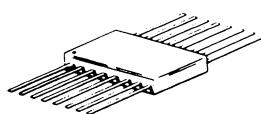


The MCM10149/10549 is a 256 word X 4 bit field programmable read only memory (PROM). Prior to programming, all stored bits are at logic 1 (high) levels. The logic state of each bit can then be changed by on-chip programming circuitry. The memory has a single negative logic chip enable. When the chip is disabled ( $\bar{CS}$  = high), all outputs are forced to a logic 0 (low).

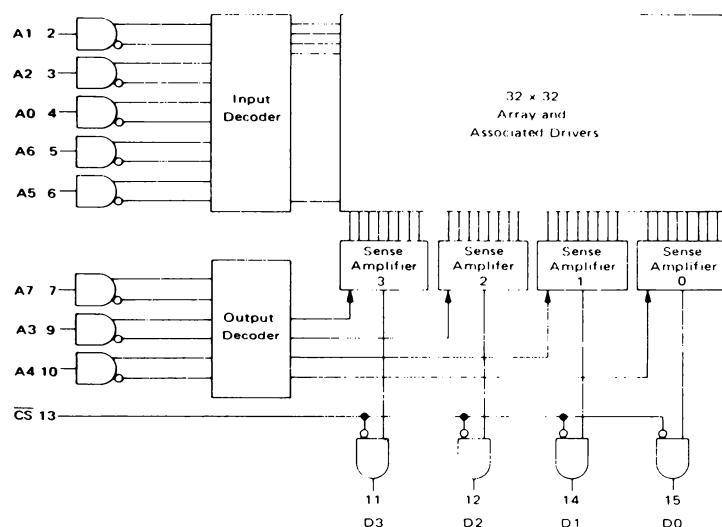
- Typical Address Access Time of 20 ns
- Typical Chip Select Access Time of 8.0 ns
- 50 k $\Omega$  Input Pulldown Resistors on All Inputs
- Power Dissipation (540 mW typ @ 25°C)  
Decreases with Increasing Temperature



**L SUFFIX**  
CERAMIC PACKAGE  
CASE 620



**F SUFFIX**  
CERAMIC PACKAGE  
CASE 650



# MCM10149/MCM10549

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	-55°C		0°C		+25°C		+75°C		+125°C		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I <sub>EE</sub>	--	140	--	135	--	130	--	125	--	125	mAdc
Input Current High	I <sub>INH</sub>	--	450	--	265	--	265	--	265	--	265	μAdc

55°C and +125°C test values apply to MC105xx devices only.

## SWITCHING CHARACTERISTICS (Note 1)

Characteristics	Symbol	MCM10149		MCM10549		Unit	Conditions		
		TA = 0 to +75°C, V <sub>EE</sub> = -5.2 Vdc ± 5%		TA = -55 to +125°C, V <sub>EE</sub> = -5.2 Vdc ± 5%					
		Min	Max	Min	Max				
Read Mode									
Chip Select Access Time	t <sub>ACS</sub>	2.0	10	•	•	ns	Measured from 50% of input to 50% of output. See Note 1.		
Chip Select Recovery Time	t <sub>RCS</sub>	2.0	10	•	•				
Address Access Time	t <sub>AA</sub>	7.0	25	•	•				
Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>	1.5	7.0	•	•	ns	Measured between 20% and 80% points.		
Capacitance									
Input Capacitance	C <sub>in</sub>	—	5.0	—	5.0	pF	Measured with a pulse technique.		
Output Capacitance	C <sub>out</sub>	—	8.0	—	8.0				

NOTES: 1. Test circuit characteristics: R<sub>T</sub> = 50 Ω, MCM10149; 100 Ω, MCM10549.

C<sub>L</sub> ≤ 5.0 pF (including jig and stray capacitance)

Delay should be derated 30 ps/pF for capacitive load up to 50 pF

2. The maximum Address Access Time is guaranteed to be the Worst-Case Bit in the Memory.

3. For proper use of MECL Memories in a system environment, consult MECL System Design Handbook.

4. V<sub>CP</sub> = V<sub>CC</sub> = Gnd for normal operation.

\*To be determined; contact your Motorola representative for up-to-date information.

## PROGRAMMING THE MCM10149 †

During programming of the MCM10149, input pins 7, 9, and 10 are addressed with standard MECL 10K logic levels. However, during programming input pins 2, 3, 4, 5, and 6 are addressed with 0 V ≤ V<sub>IH</sub> ≤ + 0.25 V and V<sub>EE</sub> ≤ V<sub>IL</sub> ≤ -3.0 V. It should be stressed that this deviation from standard input levels is required only during the programming mode. During normal operation, standard MECL 10,000 input levels must be used.

With these requirements met, and with V<sub>CP</sub> = V<sub>CC</sub> = 0 V and V<sub>EE</sub> = -5.2 V ± 5%, the address is set up. After a minimum of 100 ns delay, V<sub>CP</sub> (pin 1) is ramped up to +12 V ± 0.5 V (total voltage V<sub>CP</sub> to V<sub>EE</sub> is now 17.2 V, +12 V - [-5.2 V]). The rise time of this V<sub>CP</sub> voltage pulse should be in the 1-10 μs range, while its pulse width (t<sub>w1</sub>) should be greater than 100 μs but less than 1 ms. The V<sub>CP</sub> supply current at +12 V will be approximately 525 mA while current drain from V<sub>CC</sub> will be approximately 175 mA. A current limit should therefore be set on both of these supplies. The current limit on the V<sub>CP</sub> supply should be set at 700 mA while the V<sub>CC</sub> supply should be limited to 250 mA. It should be noted that the V<sub>EE</sub> supply must be capable of sinking the combined current of the V<sub>CC</sub> and V<sub>CP</sub> supplies while maintaining a voltage of -5.2 V ± 5%.

Coincident with, or at some delay after the V<sub>CP</sub> pulse has reached its 100% level, the desired bit to be fused can be selected. This is done by taking the corresponding output pin to a voltage of +2.85 V ± 5%. It is to be noted that only one bit is to be fused at a time. The other three unselected outputs should remain terminated through their 50 ohm load resistor (100 ohm for MCM10549) to -2.0 V. Current into the selected output is 5 mA maximum.

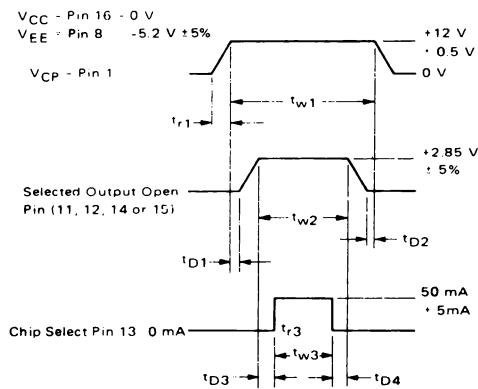
After the bit select pulse has been applied to the appropriate output, the fusing current is sourced out of the chip select pin 13. The 0% to 100% rise time of this current pulse should be 250 ns max. Its pulse width should be greater than 100 μs. Pulse magnitude is 50 mA ± 5.0 mA. The voltage clamp on this current source is to be -6.0 V.

After the fusing current source has returned 0 mA, the bit select pulse is returned to its initial level, i.e., the output is returned through its load to -2.0 V. Thereafter, V<sub>CP</sub> is returned to 0 V. Strobing of the outputs to determine success in programming should occur no sooner than 100 ns after V<sub>CP</sub> has returned to 0 V. The remaining bits are programmed in a similar fashion.

† NOTE: For devices that program incorrectly, return serialized units with individual truth tables.  
Non compliance voids warranty.

### PROGRAMMING SPECIFICATIONS

The following timing diagrams and fusing information represent programming specifications for the MCM10149.



The timing diagram is shown for programming one bit. Note that only one bit is blown at a time. All addressing must be done 100 ns prior to the beginning of the  $V_{CP}$  pulse, i.e.,  $V_{CP} = 0$  V. Likewise, strobing of the outputs to determine success in programming should occur no sooner than 100 ns after  $V_{CP}$  returns to 0 V.

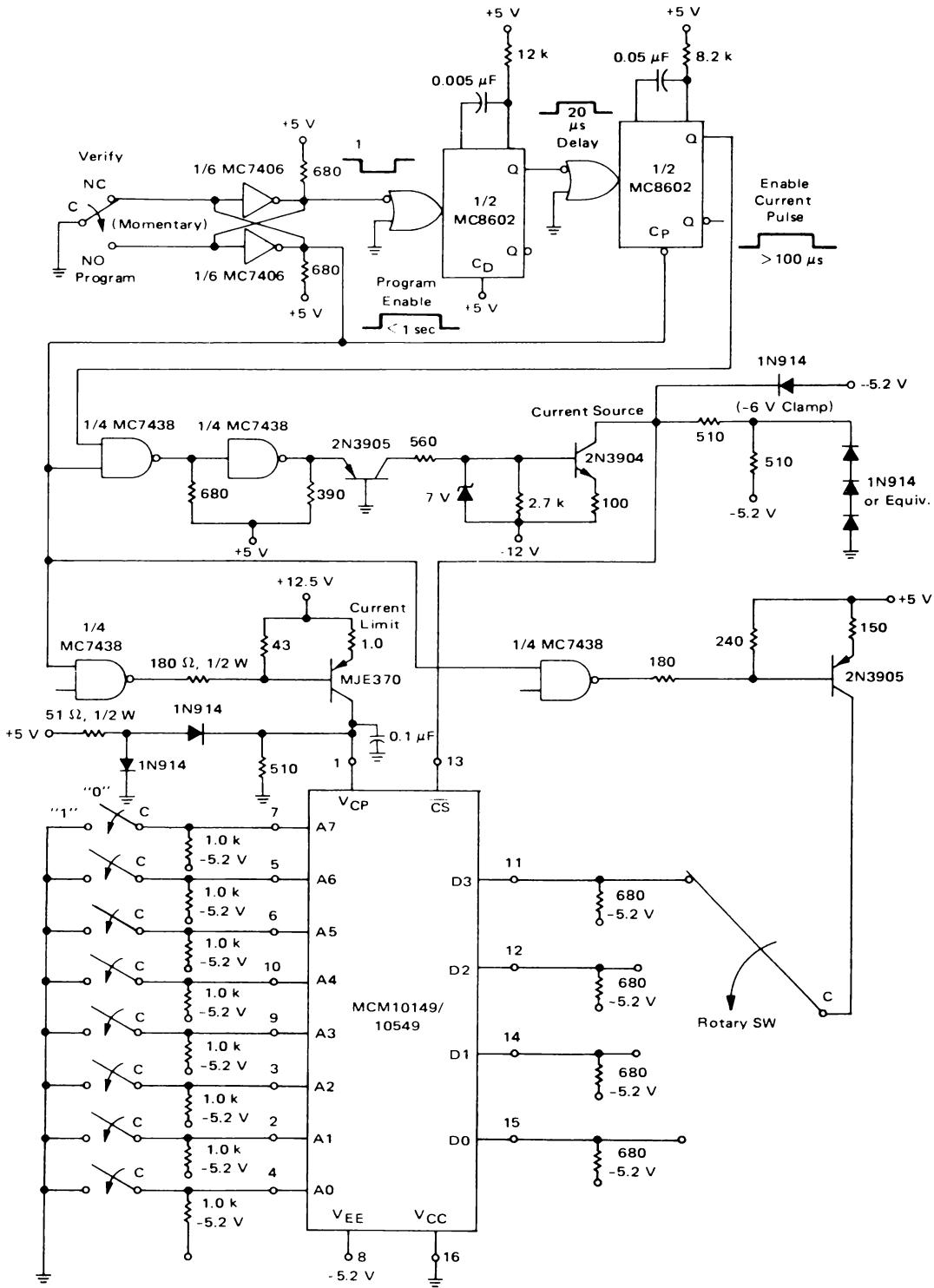
Note that the fusing current is defined as a positive current out of the chip select, pin 13. A programming duty cycle of  $\leq 15\%$  is to be observed.

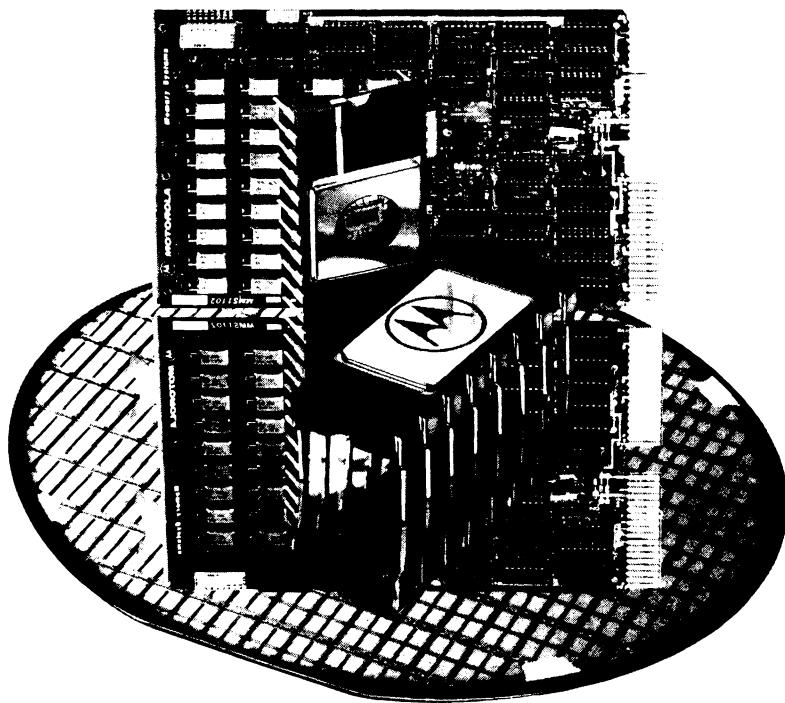
Definitions and values of timing symbols are as follows.

Symbol	Definition	Value
$t_{r1}$	Rise Time, Programming Voltage	$\geq 1 \mu s$
$t_{w1}$	Pulse Width, Programming Voltage	$\geq 100 \mu s < 1 ms$
$t_{D1}$	Delay Time, Programming Voltage Pulse to Bit Select Pulse	$\geq 0$
$t_{w2}$	Pulse Width, Bit Select	$\geq 100 \mu s$
$t_{D2}$	Delay Time, Bit Select Pulse to Programming Voltage Pulse	$\geq 0$
$t_{D3}$	Delay Time, Bit Select Pulse to Programming Current Pulse	$\geq 1 \mu s$
$t_{r3}$	Rise Time, Programming Current Pulse	250 ns max
$t_{w3}$	Pulse Width, Programming Current Pulse	$\geq 100 \mu s$
$t_{D4}$	Delay Time, Programming Current Pulse to Bit Select Pulse	$\geq 1 \mu s$

MCM10149/MCM10549

## **MANUAL PROGRAMMING CIRCUIT**





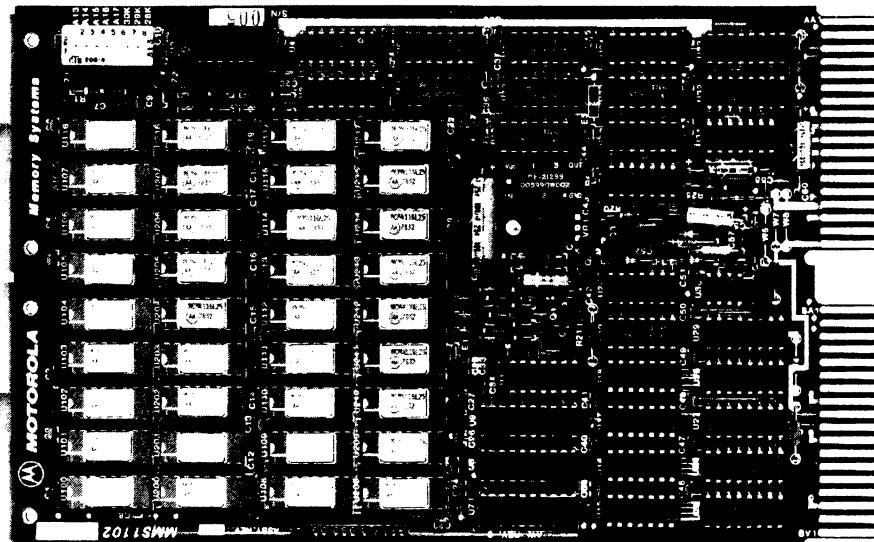
## Memory Boards

**MOTOROLA****MMS1102**

## Advance Information

### ADD-ON MEMORY CARD FOR THE LSI-11 FAMILY

The MMS1102 is a dual height (5.187" x 8.94") add-on memory card for the LSI-11 family of computers. It is compatible with the LSI-11/2 and LSI-11 processors as well as the PDP 11V03 computer systems. It incorporates byte parity storage as well as generation and detection logic.



#### Specification Highlights

INTERFACE	LSI-11, "Q" Bus-Plus.
CAPACITY	8K words x 16 bits, 16K words x 16 bits, 32K words x 16 bits.
PARITY	Optional on-board storage, generation and detection logic for both upper and lower byte. Parity option does not degrade access times.
SPEED	The MMS1102-3X has a read access time under 300 ns. Read access time is defined here as the time from receipt of SYNC H to the transmission of RPLY H, assuming that the SYNC H to DIN H time is no greater than 160 ns.
ADDRESSING	Switch-selectable, to start on any 4K word boundary between 0 and 128K.
I/O PAGE USE	Three switches allow any one of the lowest three kilowords of the I/O page to be used as Read/Write memory.
BATTERY BACKUP	Jumper selectable; allows the MMS1102 to be operated from a separate uninterrupted power source (+5 BBU and +12 BBU).
REFRESH	Implemented internal to the MMS1102 and totally transparent to the system.

# MMS1102

## MMS1102-XX ORDERING INFORMATION

Storage Capacity	Part Number (With Parity and Controller)	Part Number (No Parity)
16 Kilobytes	MMS1102-31PC	MMS1102-31
32 Kilobytes	MMS1102-32PC	MMS1102-32
64 Kilobytes	MMS1102-34PC	MMS1102-34

## MMS1102-3X — AC OPERATING CHARACTERISTICS

Access Time*	Read Access (ns)		Write Access (ns)	
	Typical	Worst Case	Typical	Worst Case
	250	300	125	175
Cycle Time**	470	500	350	400
Refresh Latency***	175	400	175	400

\*As measured from receipt of RSYNC H to transmission of TRPLY H.

\*\*This is the reciprocal of the maximum continuous transfer rate, assuming no refresh interference.

\*\*\*Occurs approximately once every 16 microseconds.

## MMS1102 POWER REQUIREMENTS

Nominal Voltage	Min	Max	Current Requirements (mA)				Input Pins	
			Standby		Active			
			Typical	Worst Case	Typical	Worst Case		
+5 VDC (Total)	4.75	5.25	725 925*	800 1000*	775 1000*	850 1100*	AA2, BA2	
+12 VDC	11.40	12.60	100	150	250	400	AD2, BD2	
+5 VDC (BBU)	4.75	5.25	400	500	450	550	AV1**	
+12 VDC (BBU)	11.40	12.60	100	150	250	400	AS1***	

\*Parity version only.

\*\*In systems without battery backup this voltage is obtained from the regular +5 V rail via an on-board jumper.

\*\*\*The +12 V supply requirement can be met via an on-board jumper from the regular +12 V rail.

## MMS1102 BACKPLANE CONNECTOR PIN ASSIGNMENT

Row	A		B		
	Side	1	2	1	2
Pin					
A	—	+5 V	BDCOK H	+5 V	—
B	—	—	—	GND	—
C	BAD16 L**	GND	—	+12 V	BDAL 2 L
D	BAD17 L	+12 V	—	BDAL 3 L	BDAL 4 L
E	—	BDOUT L	—	BDAL 5 L	BDAL 6 L
F	—	BRPLY L	—	BDAL 7 L	BDAL 8 L
H	—	BDIN L	—	BDAL 9 L	BDAL 10 L
J	GND	BSYNC L	GND	BDAL 11 L	BDAL 12 L
K	•	BWTBT L	•	BDAL 13 L	BDAL 14 L
L	—	—	—	BDAL 15 L	—
M	GND	BAIKI L } ***	GND		
N	—	BAIKO L }	—		
P	—	BBS7 L	—		
R	BREF L	BDMGI L } ***	—		
S	+12 V BBU	BDMGO L }	—		
T	GND	—	GND		
U	—	BDAL 0 L	—		
V	+5 V BBU	BDAL 1 L	+5 V		

\*Must be hardwired on backplane or damage to MOS devices may result.

\*\*Or PRTYER or PRTYCK.

\*\*\*Hardwired on MMS1102.

**MOTOROLA****MMS1122**

## Product Preview

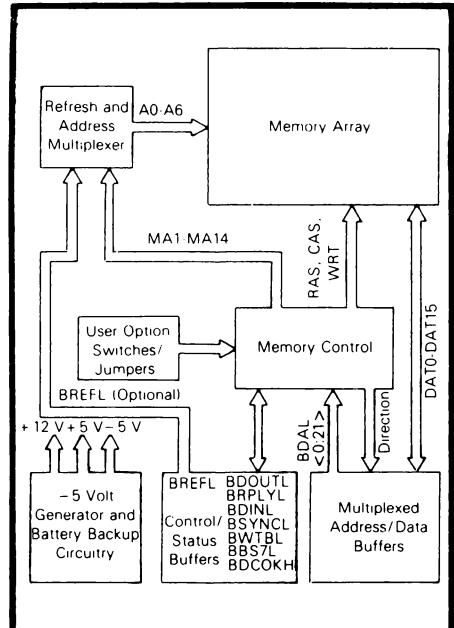
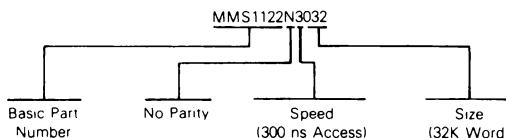
### ADD-IN MEMORY CARD FOR THE LSI-11 FAMILY

The MMS1122 is a dual height (5.19" x 8.94") add-on memory card for the LSI 11 family of computers. It is compatible with LSI-11, LSI-11/2, and LSI-11/23 processors as well as PDP 11V03\* computer systems. It utilizes MCM4132L 32K RAM modules.

#### FEATURES

- Capacity of 32K Words, Each 16-Bits Long
- Effective Capacity is Switch Selectable at any 1K Word Increment
- Addressing is Switch Selectable to Start on Any 1K Word Boundary From 0 to 127K
- Read Access Time of 300 ns (max.)
- Cycle Time 500 ns (max.)
- Refresh Implemented Internal to the Card (Transparent to the System). On-Board Jumpers Permit Synchronization of Refresh if Desired.
- Jumper Selectable Battery Backup Provisions Allow Use of Separate Power Source
- LSI-11 (Q-Bus and Q-Bus Plus) Interface Compatible

#### ORDERING INFORMATION



#### SIMILAR PRODUCTS

Other Add-In memory cards for the LSI-11 family include the MMS1102 and MMS1132.

#### ENVIRONMENTAL RATINGS

Rating	Symbol	Limit	Units
Operating Temperature	T <sub>A</sub>	0 to +50	°C
Storage Temperature	T <sub>stg</sub>	-40 to +80	°C
Relative Humidity (Without Condensation)	RH	5 to 90	%

\*PDP is a trademark of Digital Equipment Corporation.

# MMS1122

## PHYSICAL DIMENSIONS

Dimension	Millimeters	Inches
Width	227.08	8.94
Height	131.75	5.19
PC Board Thickness	1.575	0.062
Clearance Required (Component Side)*	0.826	0.325
Clearance Required (Solder Side)*	1.524	0.060

\*Measured from surface of PC Board.

## POWER REQUIREMENTS (+ 5 Volts)

Mode	Pin	Current Required		Units
		Typical	Worst-Case	
Active	**	0.775	0.850	Adc
Standby	**	0.725	0.800	Adc
Battery Backup	AV1	0.400	0.500	Adc

## POWER REQUIREMENTS (+ 12 Volts)

Mode	Pin	Current Required		Units
		Typical	Worst-Case	
Active	***	0.250	0.400	Adc
Standby	***	0.100	0.150	Adc
Battery Backup	AS1	0.100	0.150	Adc

\*\*AA2, BA2, BV1, AV1 (Jumper option allows all + 5 V current to be supplied by AA2, BA2, and BV1 if battery backup operation is not required).

\*\*\*AD2, BD2, AS1 (Jumper option allows all + 12 V current to be supplied by AD2 and BD2 if battery backup operation is not required).

## AC OPERATING CHARACTERISTICS

Characteristic	Typical	Worst-Case	Unit
Cycle Time -- Read or Write	500	525	ns
Access Time -- Read Write	250 125	300 175	ns

## BACKPLANE CONNECTOR PIN ASSIGNMENT

Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
AA2	+ 5 V	AL1	(Note 1)	AU2	BDAL (0)	BF1	BDAL (21)	BN2	BDAL (9)
AC1	BDAL (16)	AK2	BWTBT L	AV1	+ 5 V BBU <sup>2</sup>	BF2	BDAL (3)	BP2	BDAL (10)
AC2	GND	AM1	GND	AV2	BDAL (1)	BH2	BDAL (4)	BR2	BDAL (11)
AD1	BDAL (17)	AM2	BIAKI L	BA1	BDCOK H	BJ1	GND	BS2	BDAL (12)
AD2	+ 12 V	AN2	BIAKO L	BA2	+ 5 V	BJ2	BDAL (5)	BT1	GND
AE2	BDDOUT L	AP2	BBS7 L	BC1	BDAL (18)	BK1	(Note 3)	BT2	BDAL (3)
AF2	BRPLY L	AR1	BREF L	BC2	GND	BL1	(Note 3)	BU2	BDAL (14)
AH2	BDIN L	AR2	BDMGI L	BD1	BDAL (19)	BK2	BDAL (6)	BV1	+ 5 V
AJ1	GND	AS2	BDMGO L	BD2	+ 12 V	BL2	BDAL (7)	BV2	BDAL (15)
AJ2	BSYNC L	AS1	+ 12 V BBU <sup>2</sup>	BE1	BDAL (20)	BM1	GND		
AK1	(Note 1)	AT1	GND	BE2	BDAL (2)	BM2	BDAL (8)	BV2	BDAL (15)

Notes: (1) AK1 and AL1 normally connected together at backplane. User jumper option allows negative 5 V supply to be connected through AL1 if desired.

(2) + 12 V BBU and + 5 V BBU may be driven by normal + 5 V and + 12 V if desired.

(3) User jumper options allow BK1 and BL1 to be used for synchronous refresh.



**MOTOROLA**

**MMS1132**

## Product Preview

### ADD-IN MEMORY CARD FOR THE LSI-11 FAMILY

The MMS1132 is a dual height (5.19" x 8.94") add-on memory card for the LSI-11 family of computers. It is compatible with LSI-11, LSI-11/2, and LSI-11/23 processors as well as PDP-11V03\* computer systems. It utilizes MCM6633L 32K RAM or MCM6665L 64K RAM chips.

#### FEATURES

- Capacity of up to 128K Words, Each 16-Bits Long Without Parity, 18-Bits with Parity
- Effective Capacity is Switch Selectable at any 1K Word Increment
- Addressing is Switch Selectable to Start on Any 1K Word Boundary From 0 to 127K
- Optional Parity and On-Board Parity Controller
- Read Access Time of 300 ns (max.)
- Cycle Time 500 ns (max.)
- Refresh Implemented Internal to the Card (Transparent to the System). On-Board Jumpers Permit Synchronization of Refresh if Desired.
- Single +5 V Power Supply
- Jumper Selectable Battery Backup Provisions Allow Use of Separate Power Source
- LSI-11 (Q-Bus and Q-Bus Plus) Interface Compatible

#### ORDERING INFORMATION

MMS1132 X 3 Z <sub>2</sub> Z <sub>1</sub> Z <sub>0</sub>				
Basic Part Number	X	Option	Z <sub>2</sub>	Z <sub>1</sub>
	P	Parity	0	3
	N	No Parity	0	6
			1	2
			2	4
			8	128K Words

Speed  
(300 ns Access)

Note: K = 1024, Word = 16 Bits W/O, 18 Bits With Parity

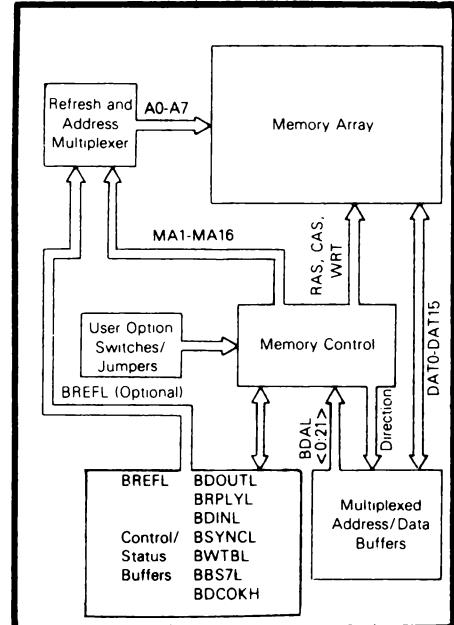
#### SIMILAR PRODUCTS

Other Add-In memory cards for the LSI-11 family include the MMS1102 and MMS1122.

#### ENVIRONMENTAL RATINGS

Rating	Symbol	Limit	Units
Operating Temperature	T <sub>A</sub>	0 to +50	°C
Storage Temperature	T <sub>STG</sub>	-40 to +80	°C
Relative Humidity (Without Condensation)	RH	5 to 90	%

\*PDP is a trademark of Digital Equipment Corporation.



# MMS1132

## PHYSICAL DIMENSIONS

Dimension	Millimeters	Inches
Width	227.08	8.94
Height	131.75	5.19
PC Board Thickness	1.575	0.062
Clearance Required (Component Side)*	0.826	0.325
Clearance Required (Solder Side)*	1.524	0.060

\*Measured from surface of PC Board

## POWER REQUIREMENTS (+ 5 V Only Required)

Mode	Pins	Total Required Current				Units	
		32K Word Capacity		64 or 128K Word Capacity			
		Typical	Worst-Case	Typical	Worst-Case		
Active	AA2, BA2, BV1, AV1**	1.375	1.80	1.50	1.95	Adc	
Standby	AA2, BA2, BV1, AV1**	0.965	1.15	1.05	1.25	Adc	
Battery Backup	AV1	0.640	0.86	0.70	0.93	Adc	

\*\* Jumper option allows all current to be supplied by AA2, BA2, and BV1 if battery backup operation is not required.

## AC OPERATING CHARACTERISTICS

Characteristic		Typical	Worst-Case	Units
Cycle Time – Read		470	500	
Write		350	400	ns
Access Time – Read		250	300	
Write		125	175	ns

## BACKPLANE CONNECTOR PIN ASSIGNMENT

Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
AA2	+5 V	AL1	(Note 1)	AU2	BDAL (0)	BF1	BDAL (21)	BN2	BDAL (9)
AC1	BDAL (16)	AK2	BWTBT L	AV1	+ 5 V BBU <sup>2</sup>	BF2	BDAL (3)	BP2	BDAL (10)
AC2	GND	AM1	GND	AV2	BDAL (1)	BH2	BDAL (4)	BR2	BDAL (11)
AD1	BDAL (17)	AM2	BIAKI L	BA1	BDCOK H	BJ1	GND	BS2	BDAL (12)
AD2	+ 12 V	AN2	BIAKO L	BA2	+ 5 V	BJ2	BDAL (5)	BT1	GND
AE2	BDOOT L	AP2	BBS7 L	BC1	BDAL (18)	BK1	(Note 3)	BT2	BDAL (3)
AF2	BRPLY L	AR1	BREF L	BC2	GND	BL1	(Note 3)	BU2	BDAL (14)
AH2	BDIN L	AR2	BDMGI L	BD1	BDAL (19)	BK2	BDAL (6)	BV1	+ 5 V
AJ1	GND	AS2	BDMGO L	BD2	+ 12 V	BL2	BDAL (7)	BV2	BDAL (15)
AJ2	BSYNC L	AS1	+ 12 V BBU <sup>2</sup>	BE1	BDAL (20)	BM1	GND		
AK1	(Note 1)	AT1	GND	BE2	BDAL (2)	BM2	BDAL (8)	BV2	BDAL (15)

Notes: (1) + 5 V BBU may be driven by normal + 5 V if desired.

(2) User jumper options allow BK1 and BL1 to be used for synchronous refresh.



**MOTOROLA**

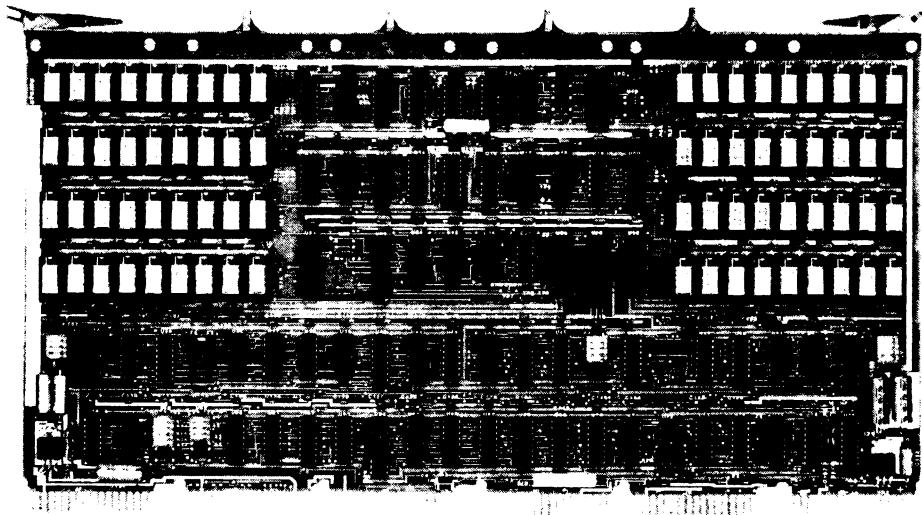
**MMS1117**

## **Advance Information**

### **PDP-11\* UNIBUS\* COMPATIBLE RANDOM ACCESS MEMORIES, UP TO 128 KILOBYTES OF STORAGE CAPACITY PLUS OPTIONAL PARITY CONTROLLER ON A SINGLE CARD**

The MMS1117 family of memory systems offers owners of PDP-11\* computers an opportunity to easily add storage capacity and parity features to their system. Each member of the family is contained on a single plug-in circuit card that interfaces mechanically and electrically with the following models of UNIBUS\* PDP-11\* processors: 11/04, 11/05, 11/10, 11/34, 11/35, 11/40, 11/45, 11/50, 11/55, and 11/60. It plugs into a single hex SPC slot in any of the following backplanes: DD11-B, DD11-C, DD11-D and DD11-P.

The MMS1117 can provide up to 128K 8-bit bytes of main memory on a single module. Quick address select changes are possible via onboard switches. In addition, 1 or 2 kilowords of I/O page can selectively be made available for random access storage. Optional parity as well as full parity generation, detection, and exception control circuits can be provided on the same card with the memory. No additional bus loading is imposed on the system by the addition of the fully compatible parity controller option.



#### **MMS1117 FEATURES**

- High Density
- Low Cost
- Fast Access and Cycle Times
- Low Power
- Fully UNIBUS Compatible
- High Reliability
- One UNIBUS Load

\*Trademark of Digital Equipment Corporation

# MMS1117

## MMS1117 OPTION DESIGNATOR SUFFIX

Typical Read Access Time	Parity Options	Total Storage Capacity (in Kilobytes)			
		32K	64K	96K	128K
290 ns	Parity + Controller	.32-PC	.34-PC	.36-PC	.38-PC
	Parity Data Only	.32-P	.34-P	.36-P	.38-P
	No Parity	.32	.34	.36	.38
360 ns	Parity + Controller	.42-PC	.44-PC	.46-PC	.48-PC
	Parity Data Only	.42-P	.44-P	.46-P	.48-P
	No Parity	.42	.44	.46	.48
390 ns	Parity + Controller	.52-PC	.54-PC	.56-PC	.58-PC
	Parity Data Only	.52-P	.54-P	.56-P	.58-P
	No Parity	.52	.54	.56	.58

## ACCESS AND CYCLE TIMES

Option Designator Suffix	Write		Read		Cycle	
	Typical	Worst Case	Typical	Worst Case	Typical	Worst Case
.3X	105	125	290	315	375	390
.4X	115	135	360	390	480	500
.5X	115	135	390	420	560	585

## MMS1117 POWER REQUIREMENTS

Nominal Voltage	Voltage Tolerance		Current Requirements		Input Pins
			Standby-Typ/WC (Amps)	Active-Typ/WC (Amps)	
	Min	Max			
+5 Vdc	4.75	5.25	2.0/2.5	2.0/2.5	DA2, EA2, FA2
+15 Vdc	15	20	0.15/0.20	0.35/0.70	AV1, AR1, CE1, CU1
-15 Vdc	-7.0	-20	0.015/0.030	0.015/0.030	FB2

## MMS1117 BACK PLANE CONNECTOR PIN ASSIGNMENT

Row Side	A		B		C		D		E		F	
	1	2	1	2	1	2	1	2	1	2	1	2
Pin A					[ .. ]				+5 V		+5 V	+5 V
Pin B					[ .. ]							-15V
Pin C	Gnd		Gnd		PA	Gnd			Gnd	A12	Gnd	Gnd
Pin D		+5BB				D15				A17	A15	
Pin E		*SSyn	*PA DE	***VDD	D14					MSyn	A16	
Pin F						D13				A02	C1	
Pin H					D11	D12				A01	A00	
Pin J						D10				SSyn	C0	
Pin K						D09			[ .. ]	A14	A13	
Pin L						D08	Init	[ .. ]		A11		
Pin M						D07			[ .. ]			
Pin N	*P1				DCL0	D04			[ .. ]		A08	
Pin P	*P0					D05			[ .. ]	A10	A07	
Pin R	***VDD					D01			[ .. ]	A09		
Pin S					PB	D00			[ .. ]			
Pin T	Gnd		Gnd		Gnd	D03	Gnd		[ .. ]	Gnd		Gnd
Pin U					***VDD	D02				A06	A04	
Pin V	***VDD					D06				A05	A03	

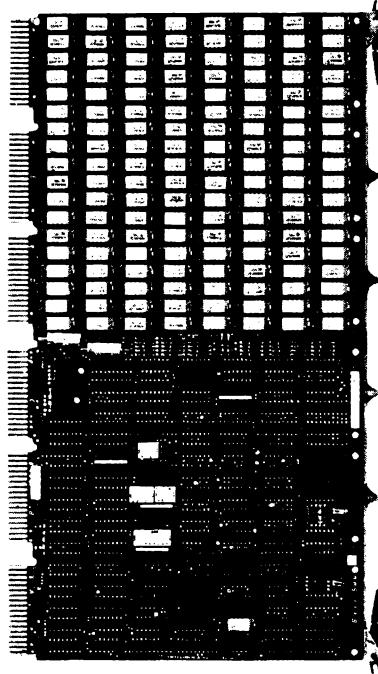
\*Options for use with External Parity Controller.

\*\*Grant Continuity Jumpers

\*\*\*VDD is any voltage between +15 Vdc and +20 Vdc on any one of the four listed pins

**MOTOROLA****MMS1119****Advance Information****PDP-11\* MODIFIED UNIBUS\*/EXTENDED UNIBUS COMPATIBLE MEMORY SYSTEM**

- Uses 16K or 64K Dynamic RAM Chips
- Available in 64K, 96K, 128K, 256K, and 512K Word Capacities
- Read Access Time Typically 300 ns (Measured Inside Buffers)
- Cycle Times as Low as 390 ns Typical
- Two Speed Options Available
- Worst-Case AC Limits Specified at Card Edge
- On-Board Parity and Parity Controller Standard
- Also Available Without Parity
- Starting Address Configurable at Any 4K Boundary
- Optional Selection of I/O Page Size; 2K, 4K, or 8K Words
- Automatic Internal Refresh
- Provisions for External Refresh Control
- Battery Backup Capability Standard
- Single 5-Volt Power Supply Required for 256K and 512K Word Versions

**ORDERING INFORMATION**M M S 1 1 1 9 X Y Z<sub>2</sub> Z<sub>1</sub> Z<sub>0</sub>

Basic Product Designation

X	Option
P	Parity + Controller
N	No Parity**

Y	Read Access
3	300 ns (Typ)
4	350 ns (Typ)

Z <sub>2</sub>	Z <sub>1</sub>	Z <sub>0</sub>	Capacity
0	6	4	64K Words
0	9	6	96K Words
1	2	8	128K Words
2	5	6	256K Words
5	1	2	512K Words

\*\*Available on special order

NOTE: K = 1024, Word = 16 Bits W/O, 18 Bits With Parity

\*PDP-11 and UNIBUS are trademarks of Digital Equipment Corporation

# MMS1119

## ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Limit		Units
		Min	Max	
Supply Voltage (Relative to Ground)	V <sub>DD</sub>	-0.3	20.0	Vdc
	V <sub>CC</sub>	-0.3	7.0	
	V <sub>BB</sub>	-20.0	+0.3	
Input Voltage (Any input relative to Ground)	V <sub>in</sub>	-0.7	+5.5	Vdc

- NOTES: 1. Permanent damage may occur if Absolute Maximum Ratings are exceeded. Functional operation shall be restricted to Recommended Operating Conditions.  
 2. Permanent damage may also occur if V<sub>DD</sub> is applied for more than one second while V<sub>BB</sub> is outside its Recommended Operating Range.

## ENVIRONMENTAL RATINGS

Rating	Symbol	Limit		Units
		Min	Max	
Operating Temperature	T <sub>A</sub>	0 to +70	°C	
Storage Temperature	T <sub>Stg</sub>	-40 to +85	°C	
Relative Humidity (Without Condensation)	RH	0 to 90	%	

## RECOMMENDED DC OPERATION CONDITIONS

Parameter	Symbol	Limit		Units	Note
		Min	Max		
Supply Voltage	V <sub>DD</sub>	14.50	16.50	Vdc	1, 3
		11.40	12.60		
	V <sub>CC</sub>	4.75	5.25		2
	V <sub>CC/BBU</sub>	4.75	5.25		3
	V <sub>BB</sub>	-7.00	-20.00		3, 4

- NOTES: 1. + 15 V or + 12 V is jumper selectable on all modules populated with 16K RAMs.  
 2. Pins AA2, BA2, and CA2 are connected together on the MMS1119.  
 3. These voltages must be present on cards populated with 16K RAMs if Battery Backup is required. Only V<sub>CC/BBU</sub> need be present for cards populated with 32K or 64K RAMs.  
 4. V<sub>DD</sub> and V<sub>BB</sub> not required for cards populated with 32K or 64K RAMs.

## DC OPERATING CHARACTERISTICS (0°C < T<sub>A</sub> < 70°C)

Characteristic	Capacity (K Words)	Mode	Symbol	Limit			Units	Notes
				Min	Typ	Max		
Supply Current – Nominal + 15 V or + 12 V Supply	64, 96, 128	Active	I <sub>DD</sub>	–	0.25	0.50	Adc	1, 2
	64, 96, 128	Standby	I <sub>DD</sub>	–	0.16	0.30	Adc	1, 2
Supply Current – Nominal + 5 V Supply and + 5 V BBU	64, 96, 128	Active/Standby	I <sub>DD</sub>	–	3.30	3.90	Adc	1, 2
Supply Current – Nominal + 5 V BBU	64, 96, 128	BBU	I <sub>CC</sub>	–	1.10	1.30	Adc	1
Supply Current – Nominal + 5 V Supply and + 5 V BBU	256	Active/Standby	I <sub>CC</sub>	–	3.30	4.60	Adc	1
Supply Current – Nominal + 5 V BBU	256	BBU	I <sub>CC</sub>	–	1.00	1.50	Adc	1
Supply Current – Nominal + 5 V Supply and + 5 V BBU	512	Active/Standby	I <sub>CC</sub>	–	3.80	5.1	Adc	1
Supply Current – Nominal + 15 V BBU	512	BBU	I <sub>CC</sub>	–	1.50	2.00	Adc	1
Supply Current – Nominal – 15 V or – 12 V Supply	64, 96, 128	All	I <sub>BB</sub>	–	12	20	mAdc	1, 2
Logic "1" Input Current – Any Input, V <sub>IH</sub> = 2.4 Vdc	Any	All	I <sub>IH</sub>	–	15	50	µAdc	3
Logic "0" Input Current – Any Input, V <sub>IL</sub> = 0.4 Vdc	Any	All	I <sub>IL</sub>	–	-1.0	-50	µAdc	3
Logic "1" Leakage Current – Any Output, V Bus = 4.0 Vdc	Any	All	V <sub>OH</sub>	–	20	100	µAdc	3
Logic "0" Output Voltage – Any Output, I <sub>OL</sub> = 50 mAdc	Any	All	V <sub>OL</sub>	–	0.40	0.70	Vdc	3
Input Threshold Voltage – Any Input – High Logic State			V <sub>IHL</sub>	1.80	2.25	2.50	Vdc	
Input Threshold Voltage – Any Input – Low Logic State			V <sub>IHL</sub>	1.05	1.30	1.55	Vdc	

- NOTES: 1. Active Mode = Memory accesses at maximum continuous rates; Standby Mode = Internal Refresh Cycles only; Battery Backup (BBU) = Standby Mode with + 5 V applied only through Pin BD1.  
 2. + 15 / + 12 V and – 15 / – 12 V supplies not required for products populated with 64K RAMs.  
 3. Negative sign = Current out of pin. Min/Max Limits refer to absolute values of current.

# MMS1119

## AC OPERATING CONDITIONS

Parameter	Symbol	Limit		Unit	Note
		Min	Max		
Address Hold Time – MSYN↓ to A <0:21> Invalid	tAH	25	–	ns	1
Address Setup Time – A <0:21> Valid to MSYN↓	tAS	75	–	ns	1
Processor Handshake Time – SSYN↓ to MSYN↑	tPH	–	0	ns	1, 2
Data Hold Time (Write Cycle/DATO) – MSYN↓ to D <0:15> Invalid	tDHW	40	–	ns	1
Data Setup Time (Write Cycle/DATO) – D <0:15> Valid to MSYN↓	tDSW	15	–	ns	1

NOTES: 1. All timing is referenced at card edge. Operation is assumed to be in a properly terminated backplane, with memory not busy and no refresh arbitration.

2. Assumes handshaking occurs immediately.

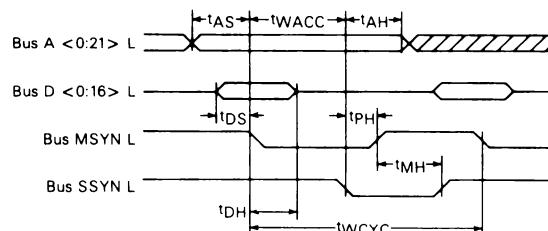
## AC OPERATING CHARACTERISTICS (0°C ≤ TA ≤ 70°C)

Characteristics	Symbol	MMS1119X3XXX			MMS1119X4XXX			Unit	Note
		Min	Typ	Max	Min	Typ	Max		
Cycle Time – Read (DATI) Cycle	tRCYC	390	360	–	440	425	–	ns	1
Read Access Time – MSYN↓ to SSYN↓	tRACC	–	330	360	–	380	430	ns	1
Data Hold Time – Read (DATI) Cycle MSYN↑ to Data Invalid	tDH	70	–	–	70	–	–	ns	1
Data Setup Time – Read (DATI) Cycle D <0:15> Valid to SSYN↓	tDS	0	–	–	0	–	–	ns	1
Memory Handshake Time – Read (DATI) or Write (DATO) Cycle – MSYN↑ to SSYN↓	tMH	–	–	75	–	–	75	ns	1
Write Access Time – MSYN↓ to SSYN↓	tWACC	–	125	165	–	125	165	ns	1
Cycle Time – Write (DATO) Cycle	tWCYC	340	–	–	440	–	–	ns	1

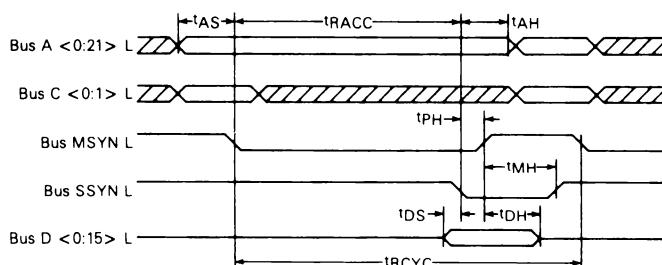
NOTES: 1. All timing is referenced at card edge. Operation is assumed to be in a properly terminated backplane, with memory not busy and no refresh arbitration.

2. Assumes handshaking occurs immediately.

### WRITE CYCLE TIMING



### READ CYCLE TIMING



# MMS1119

## TIMING

The MMS1119 is fully compatible with the PDP-11 Modified and Extended UNIBUS protocol and timing. Limits are specified in the AC Conditions/Characteristics Tables in conjunction with the DATI/DATO waveforms.

## REFRESH

The storage cells in the MMS1119 are implemented with dynamic MOS RAM's. The charge stored in the cells must be refreshed every 2 milliseconds, requiring a single refresh cycle to be initiated approximately once every 16 M Seconds. The latency induced to bus cycles concurrent with refresh cycles is no greater than the specified minimum cycle time for the MMS1119 version chosen.

The MMS1119 contains circuitry to automatically refresh the memory cells. An option is also provided to allow the User to control the refresh externally. In this case, the Refresh Latency will be no greater than the refresh cycle time defined by the external circuitry. Note that any external refresh circuitry must conform to the requirements previously mentioned, i.e., each cell refreshed at a 2 millisecond rate and a refresh cycle time not less than the minimum Read Cycle time.

## AVAILABLE OPTIONS

The MMS1119 features a variety of options, allowing its configuration into a wide range of applications. Several of these options are installed at the factory, with most of these specified by the part number as shown in the "Ordering Information" on Page 1. Others are chosen by the User prior to installation of the product.

## MEMORY CAPACITY

The MMS1119 utilizes either 16K or 64K RAM components to allow optional storage capacities of 64K, 96K, 128K, 256K, or 512K Words. As noted on Page 1 (Ordering Information), the last three digits of the full part number identifies the total memory capacity in K Words.

## BUS INTERFACE

The MMS1119 is provided with a switch to select the type of Bus to be used. With this switch closed, the interface is to an Extended UNIBUS backplane (22 bit address). The memory operates with a Modified UNIBUS system (18 bit address) with this switch open.

## STARTING ADDRESS

The MMS1119 utilizes a set of switches to allow the starting address to be selected at any 4K boundary. This feature is available regardless of the Bus Interface or Memory Capacity option chosen. In cases where the sum of the starting address and the memory capacity exceeds the host machine addressing capability, the capability is automatically reduced. (No wraparound to starting address locations occurs.)

## I/O PAGE SIZE

When the MMS1119 is located in high memory, the User may select part of the I/O page as Read/Write memory. This is implemented via three switches, resulting in optional I/O page sizes of 2K, 4K, or 8K words.

## PARITY OPTIONS

The MMS1119PXXXX contains parity control circuitry which is fully compatible with the DEC parity module. This circuitry does not degrade access or cycle times, and the Parity Control Status Register (CSR) address can be switch selected to any standard pre-assigned bus address. (772100g thru 772136g for Modified UNIBUS, 1772100g thru 1772136g for Extended UNIBUS. In any case, the CSR occupies a single two-byte address space). The on-board parity circuitry does not impose any additional bus loading on the system.

The MMS1119PXXXX can also be used in systems which utilize the DEC Parity Module. The User selects this mode of operation by opening a switch (provided on the MMS1119P) prior to installation of the memory. The parity generation and detection circuitry of the MMS1119P is fully compatible with the DEC Parity Module.

The MMS1119NXXXX version is available for those systems not requiring parity. This product is supplied as a 16-bit word memory with the Internal/External Parity Control switch open (External).

## I/O SIGNAL DESCRIPTION

Signal	Type	Description
A<0:21>	Input	Address lines to select memory locations. A0 selects byte in DATOB
D<0:15>	Bidir.	Data lines used to communicate with Master
C<0:1>	Input	Control lines to specify type of cycle
MSYN	Input	Timing control from Master. Used to start cycle
SSYN	Output	Timing control used to notify Master that cycle is complete
INIT	Input	System Reset
DCLO	Input	Power monitoring
PB	Output	Signal to Master that parity error has occurred
P<0:1>	Bidir.	Data Parity Bits
PAR DET	Input	Indicates external parity module is in use
INT SSYN	Output	Slave Sync used with external parity module only

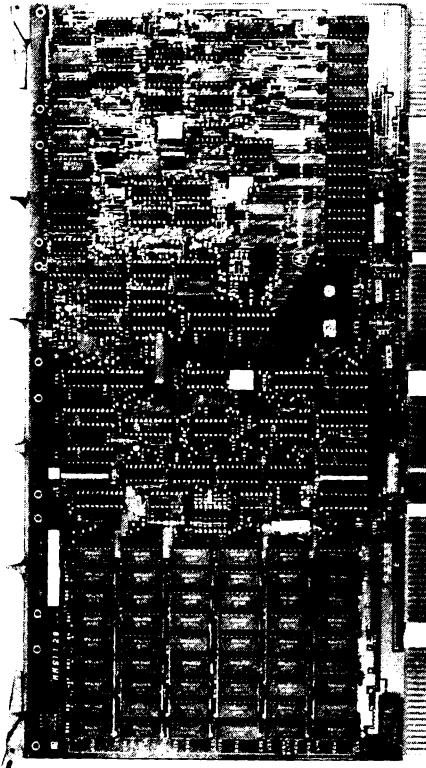
NOTE: All signals are low assertion level.

**MOTOROLA****MMS1128**

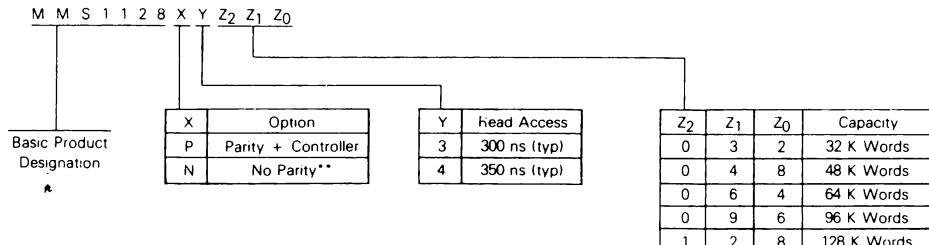
## Advance Information

### \*PDP-11 MODIFIED UNIBUS\* COMPATIBLE MEMORY SYSTEM

- Uses 16K, 32K, or 64K Dynamic RAM Chips
- Available in 32K, 48K, 64K, 96K, and 128K Word Capacities
- Read Access Time Typically 300 ns (Measured Inside Buffers)
- Cycle Times as Low as 460 ns Typical
- Two Speed Options Available
- Worst-Case AC Limits Specified at Card Edge
- On-Board Parity and Parity Controller Standard
- Also Available Without Parity
- Starting Address Configurable at any 4K Boundary
- Automatic Internal Refresh
- Provisions for External Refresh Control
- Battery Backup Capability Standard
- Single 5-Volt Power Supply Required for 64K, 96K, 128K, Word Versions



#### ORDERING INFORMATION



\*\*Available on special order

NOTE: K = 1024, Word = 16 Bits W/O, 18 Bits With Parity

# MMS1128

## I/O SIGNAL DESCRIPTION

Signal	Type	Description
A <0:17>	Input	Address lines to select memory locations. A0 selects byte in DATOB.
D <0:15>	Bidirectional	Data lines used to communicate with Master.
C <0:1>	Input	Control lines to specify type of cycle.
MSYN	Input	Timing control from Master. Used to start cycle.
SSYN	Output	Timing control used to notify Master that cycle is complete.
INIT	Input	System Reset.
DCLO	Input	Power monitoring
PB	Output	Signal to Master that parity error has occurred.
P <0:1>	Bidirectional	Data Parity Bits.
PAR DET	Input	Indicates extend parity module in use.
INT SSYN	Output	Slave Sync used with external parity module only.

NOTE: All signals are low assertion level.

## ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Limit		Units
		Min	Max	
Supply Voltage (Relative to Ground)	VDD	-0.3	20.0	Vdc
	VCC	-0.3	7.0	
	VBB	-20.0	0.3	
Input Voltage (Any input relative to GND)	V <sub>in</sub>	-0.7	5.5	Vdc

NOTES: 1. Permanent damage may occur if Absolute Maximum Ratings are exceeded. Functional operation shall be restricted to Recommended Operating Conditions.  
 2. Permanent damage may also occur if V<sub>DD</sub> is applied for more than one second while V<sub>BB</sub> is outside its Recommended Operating Range.

## ENVIRONMENTAL RATINGS

Rating	Symbol	Limit	Units
Operating Temperature	T <sub>A</sub>	0 to 55	°C
Storage Temperature	T <sub>stg</sub>	-40 to +85	°C
Relative Humidity (Without Condensation)	RH	0 to 90	%

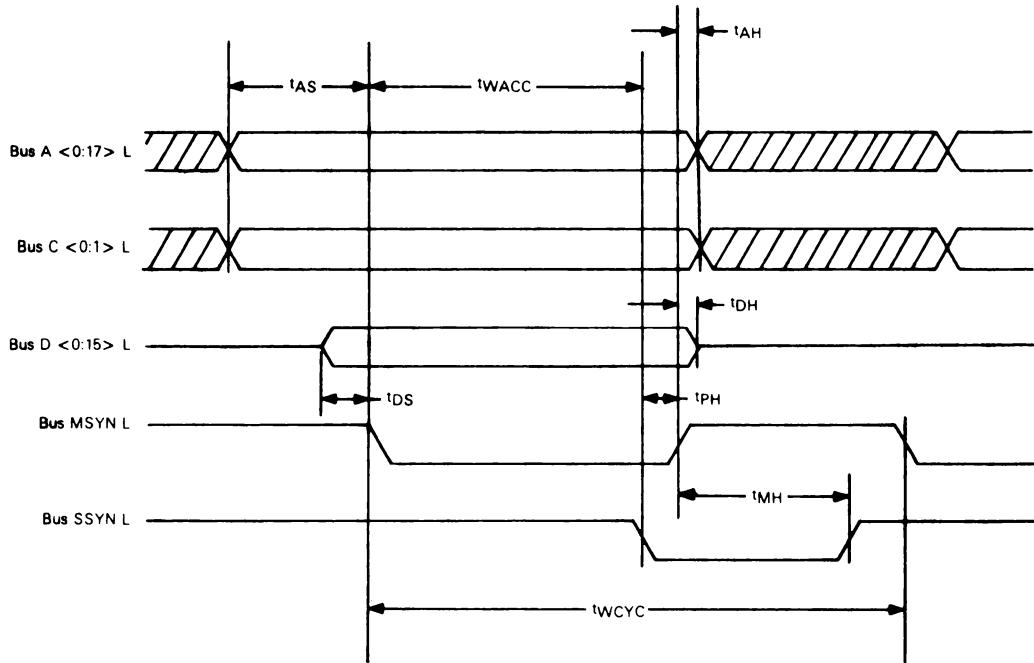
## RECOMMENDED DC OPERATION CONDITIONS

Parameter	Symbol	Limit		Units	Note
		Min	Max		
Supply Voltage	V <sub>DD</sub>	14.50	16.50	Vdc	1, 3
		11.40	12.60		
		4.75	5.25		2
		4.75	5.25		3
		-7.00	-20.00		3, 4
NOTES: 1. +15 V or +12 V is jumper selectable on all modules populated with 16K RAMs.					

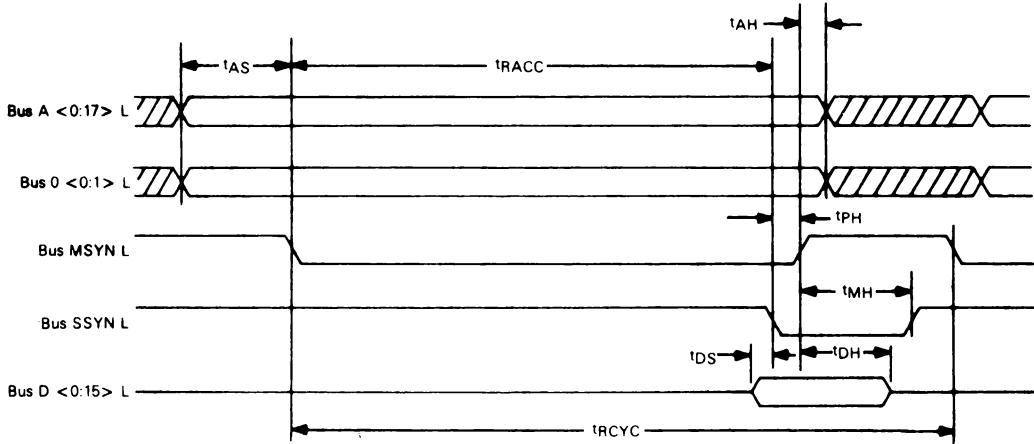
2. Pins AA2, BA2, and CA2 are connected together on the MMS1128.
3. These voltages must be present on cards populated with 16K RAMs if Battery Back Up is required. Only V<sub>CC</sub>/BBU need be present for cards populated with 32K or 64K RAMs.
4. V<sub>DD</sub> and V<sub>BB</sub> not required for cards populated with 32K or 64K RAMs.

## MMS1128

### WRITE CYCLE TIMING (DATA)



### READ CYCLE TIMING (DATA)



# MMS1128

## DC OPERATING CHARACTERISTICS ( $0^\circ < T_A < 55^\circ C$ )

Characteristic	Capacity (K Words)	Mode	Symbol	Limit			Units	Notes
				Min	Typ	Max		
Supply Current								
– Nominal +15 V or +12 V Supply BBU	32, 48	Active	I <sub>DD</sub>		0.25	0.50		
	32, 48	Standby	I <sub>DD</sub>		0.16	0.30		
– Nominal +5 V Supply	32, 48	Act/Stby	I <sub>CC</sub>		1.20	1.50	Adc	1
– Nominal +5 V BBU	32, 48	BBU	I <sub>CC</sub>		0.55	0.80	Adc	1
– Nominal +5 V Supply	64, 96, 128	Act/Stby	I <sub>CC</sub>		1.60	2.25	Adc	1
– Nominal +5 V BBU	64, 96, 128	BBU	I <sub>CC</sub>		0.80	1.15	Adc	1
– Nominal –15 V or –12 V Supply BBU	32, 48	All	I <sub>BB</sub>		12	20	mAdc	1, 2
Logic "1" Input Current – Any Input, $V_{IH} = 4.0$ Vdc			I <sub>IH</sub>		15	50	$\mu$ Adc	3
Logic "0" Input Current – Any Input, $V_{IL} = 0.4$ Vdc			I <sub>IL</sub>			-1.6	mAdc	3
Logic "1" Output Current – Any Output, V Bus = 4.0 Vdc			V <sub>OH</sub>		20	100	$\mu$ Adc	3
Logic "0" Output Voltage – Any Output, $I_{OL} = 50$ mAdc			V <sub>OL</sub>		0.4	0.70	Vdc	3
Input Threshold Voltage – Any Input – High Logic State			V <sub>ILH</sub>	1.80	2.25	2.50	Vdc	
Input Threshold Voltage – Any Input – Low Logic State			V <sub>IHL</sub>	1.05	1.30	1.55	Vdc	

NOTES: 1. Active Mode = Memory accesses at maximum continuous rates; Standby Mode = Internal Refresh Cycles only; Battery Back Up (BBU) = Standby Mode with +5 V applied only through Pin BD1.

2. +15 V / +12 V and –15 V / –12 V supplies not required for products populated with 64K RAMs.

3. Negative Sign = Current out of pin. Min/Max Limits refer to absolute values of current.

## AC OPERATING CONDITIONS

Parameter	Symbol	Limit		Unit	Note
		Min	Max		
Address Hold Time – MSYN to A <0.17> Invalid	t <sub>AH</sub>	50		ns	1
Address Setup Time – A <0.17> Valid to MSYN	t <sub>AS</sub>	75		ns	1
Processor Handshake Time – SSYN to MSYN	t <sub>PH</sub>		0	ns	1, 2
Data Hold Time (Write Cycle/DATO) – MSYN to D <0.15> Invalid	t <sub>DHW</sub>	40		ns	1
Data Setup Time (Write Cycle/DATO) – <0.15> Valid to MSYN	t <sub>DSW</sub>	15		ns	1

NOTES: 1. All timing is referenced at card edge. Operation is assumed to be in a properly terminated backplane, with memory not busy and no refresh arbitration.

2. Assumes handshaking occurs immediately.

## AC OPERATING CHARACTERISTICS ( $0^\circ C < T_A < 70^\circ C$ )

Characteristics	Symbol	MMS1128X3XXX			MMS1128X4XXX			Unit	Note
		Min	Typ	Max	Min	Typ	Max		
Cycle Time – Read (DATI) Cycle	t <sub>RCYC</sub>	460	515		510	565		ns	1
Read Access Time – MSYN to SSYN	t <sub>RACC</sub>	330	380		380	430		ns	1
Data Hold Time – Read (DATI) Cycle MSYN to Data Invalid	t <sub>DH</sub>		70			70		ns	1
Data Setup Time – Read (DATI) Cycle D <0.15> Valid to SSYN	t <sub>DS</sub>	0			0			ns	2
Memory Handshake Time – Read (DATI) or Write (DATA) Cycle – MSYN to SSYN	t <sub>MH</sub>	25		75	25		75	ns	1
Write Access Time – MSYN to SSYN	t <sub>WACC</sub>		125	165		125	165	ns	1
Cycle Time – Write (DATA) Cycle	t <sub>WCYC</sub>	325	340		425	440		ns	1

NOTES: 1. All timing is referenced at card edge. Operation is assumed to be in a properly terminated backplane, with memory not busy and no refresh arbitration.

2. Timing is referenced inside Bus Drivers.

# MMS1128

## TIMING

The MMS1128 is fully compatible with the PDP-11 Modified UNIBUS protocol and timing. Limits are specified in the A.C. Conditions/Characteristics Tables in conjunction with the DATI/DATO waveforms.

## REFRESH

The storage cells in the MMS1128 are implemented with dynamic MOS RAM's. The charge stored in the cells must be refreshed every 2 milliseconds, requiring a single refresh cycle to be initiated approximately once every 16 milliseconds. The latency induced to bus cycles concurred with refresh cycles is no greater than the specified minimum cycle time for the MMS1128 version chosen.

The MMS1128 contains circuitry to automatically refresh the memory cells. An option is also provided to allow the User to control the refresh externally. In this case, the Refresh Latency will be no greater than the refresh cycle time defined by the external circuitry. Note that any external refresh circuitry must conform to the requirements previously mentioned, i.e., each cell refreshed at a 2 millisecond rate and a refresh cycle time not less than the minimum Read Cycle time.

## AVAILABLE OPTIONS

The MMS1128 features a variety of options, allowing its configuration into a wide range of applications. Several of these options are installed at the factory, with most of these specified by the part number as shown in the "Ordering Information" on Page 1. Others are chosen by the User prior to installation of the product.

## MEMORY CAPACITY

The MMS1128 utilizes 16K, 32K, or 64K RAM components to allow optional storage capacities of 32K, 48K, 64K, 96K, or 128K Words. As noted on Page 1 (Ordering Information),

the last three digits of the full part number identifies the total memory capacity in K Words.

## STARTING ADDRESS

The MMS1128 utilizes a set of switches to allow the starting address to be selected at any 4K boundary. This feature is available regardless of the Memory Capacity option chosen. In cases where the sum of the starting address and the memory capacity exceeds the host machine addressing capability, the capability is automatically reduced. (No wraparound to starting address location occurs.)

## I/O PAGE SIZE

When the MMS2118 is located in high memory, the User may select part of the I/O page as Read/Write memory. This is implemented via three switches, resulting in optional I/O page sizes of 2K, 4K, or 8K words.

## PARITY OPTIONS

The MMS2118PXXXX contains parity control circuitry which is fully compatible with the DEC parity module. This circuitry does not degrade access or cycle times, and the Parity Control Status Register (CSR) address can be switch selected to any standard pre-assigned bus address. (772100g through 772136g.) In any case, the CSR occupies a single two-byte address space. The on-board parity circuitry does not impose any additional bus loading on the system.

The MMS1128PXXXX can also be used in systems which utilize the DEC Parity Module. The User selects this mode of operation by inserting a jumper prior to installation of the memory. The parity generation and detection circuitry of the MMS1128P is fully compatible with the DEC Parity Module.

The MMS1128PXXXX version is available for those systems not requiring parity. This product is supplied as a 16-bit word memory with the Internal/External Parity Control switch open (External).



**MOTOROLA**

**MMS1170**

## **Product Preview**

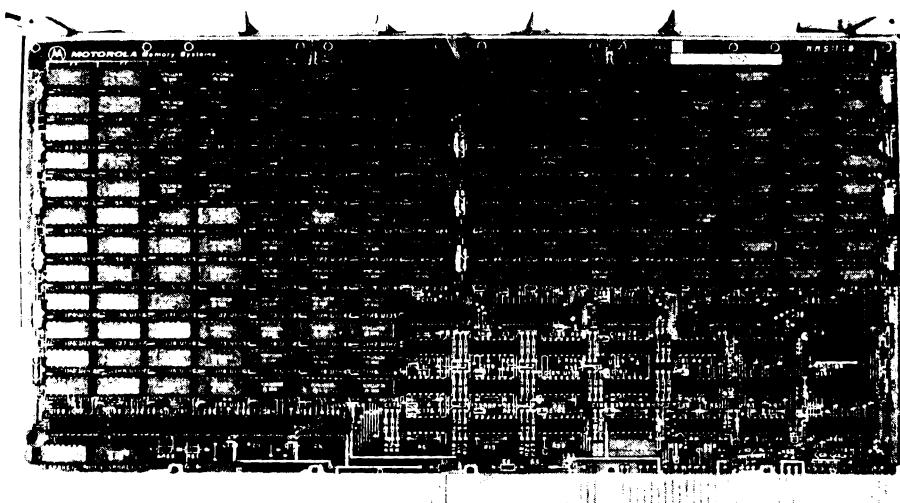
### **MEMORY ARRAY CARD FOR PDP\*-11/70**

The MMS1170 is a dynamic memory array system specifically designed for use in PDP-11/70 minicomputers from Digital Equipment Corporation. The array has a capacity of 64K double words (256K bytes) using 16K RAM chips. It is hardware and software compatible with the PDP-11/70 memory controller module and DEC diagnostics.

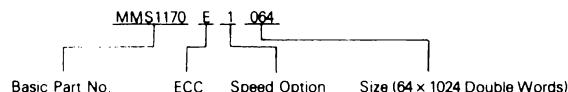
The MMS1170 is designed to occupy a single hex slot of the DEC MK-11 Memory System chassis. It features an On

Line/Off Line switch (with an LED indicator) to facilitate trouble-shooting. A separate LED indicates when battery backup voltage is available via the backplane connector.

All RAMs used on the MMS1170 are socketed. Two spare 16K x 1 RAMs are provided on the board. The product is fully burned-in and covered by the Motorola Memory System One-Year Limited Warranty.



#### **ORDERING INFORMATION**



NOTE: Double Word = 32 Date and 7 ECC Bits

\*PDP is a trademark of Digital Equipment Corporation

# MMS1170

## ENVIRONMENTAL RATINGS

Rating	Symbol	Limit	Units
Operating Temperature	T <sub>A</sub>	0 to +50	°C
Storage Temperature	T <sub>stg</sub>	-40 to +80	°C
Relative Humidity (Without Condensation)	RH	0 to 90	%

## PHYSICAL DIMENSIONS

Dimension	Millimeters	Inches
Width	39.85	15.688
Height	22.225	8.75
PC Board Thickness	0.142	0.056
Clearance Required (Component Side)*	0.952	0.375
Clearance Required (Solder Side)*	0.254	0.10

\*Measured from surface of PC Board.

## POWER REQUIREMENTS

Input Voltage	Maximum Current Requirements			Units
	Operating	Standby	Battery Backup	
+12 B	1.5	0.25	0.25	Adc
+5 V	0.4	0.35	0	Adc
-12 B	0.04	0.02	0.02	Adc
+5 V B	0.9	0.8	0.8	Adc

## AC OPERATING CHARACTERISTICS

Characteristic	Nominal**	Units
Cycle Time — Read Write	650 680	ns
Access Time — Read Write	320 70	ns

\*\*The actual response times are determined by DEC MK-11 Memory System Controller design. Nominal values shown are for reference only.



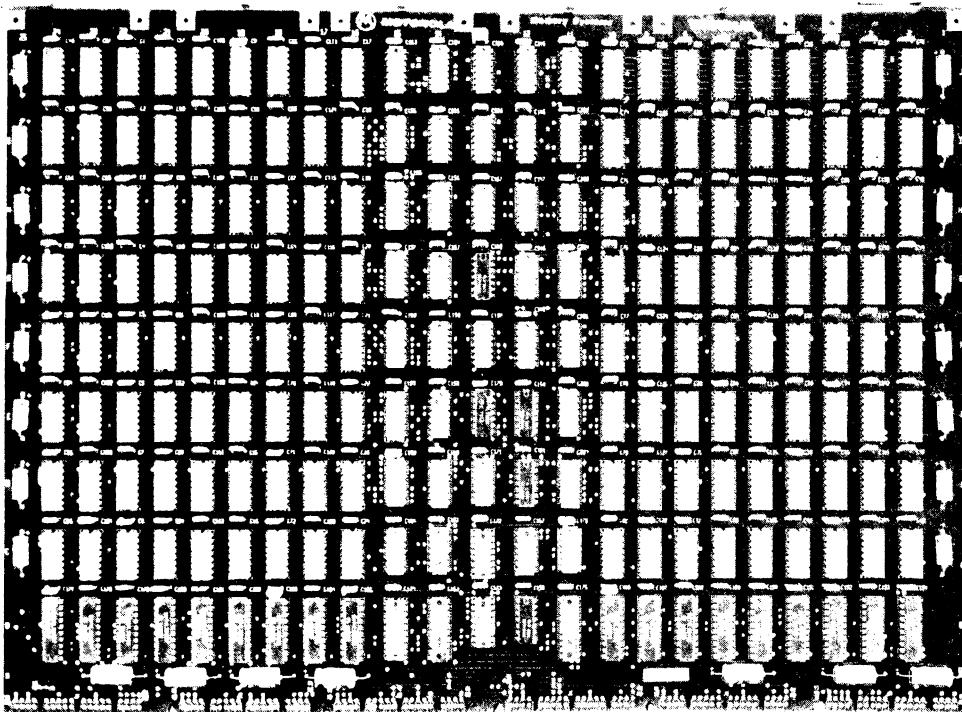
**MOTOROLA**

**MMS780**

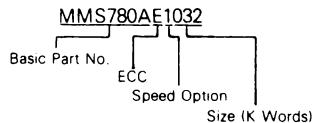
## **Advance Information**

### **MEMORY ARRAY CARD FOR VAX-11/780\***

The MMS780 is a dynamic memory array system specifically designed for use in VAX-11/780 minicomputers from Digital Equipment Corporation. The array has a capacity of 32K words (256K Bytes) using 16K RAM chips. It is fully compatible with the VAX-11/780 memory controller module.



#### **ORDERING INFORMATION**



\*VAX is a trademark of Digital Equipment Corporation.

# MMS780

## ENVIRONMENTAL RATINGS

Rating	Symbol	Limit	Units
Operating Temperature	$T_A$	0 to +55	°C
Storage Temperature	$T_{stg}$	-40 to +80	°C
Relative Humidity (Without Condensation)	RH	0 to 90	%

## PHYSICAL DIMENSIONS

Dimension	Millimeters	Inches
Width	39.85	15.688
Height	30.48	12.0
PC Board Thickness	0.142	0.056
Clearance Required (Component Side)*	0.952	0.375
Clearance Required (Solder Side)*	0.254	0.10

\*Measured from surface of PC Board.

## POWER REQUIREMENTS

Input Voltage	Maximum Current Requirements			Units
	Operating	Standby	Battery Backup	
+ 12 V	1.5	0.25	0.25	Adc
+ 5 V	0.7	0.6	0	Adc
- 5 V	0.04	0.02	0.02	Adc
+ 5 V Battery	0.9	0.8	0.8	Adc

## AC OPERATING CHARACTERISTICS

Characteristic	Nominal**	Units
Cycle Time – Read, Refresh, or Init. – Read/Modify/Write	530 1100	ns
Access Time – Read – Write	250 750	ns

\*\*The actual response times are determined by VAX-11/780 Memory Subsystem Controller design. Nominal values shown are for reference only.

## OPERATING PRINCIPLES

The MSM780 is based on  $16K \times 1$  dynamic RAMs arranged in two banks, each containing 72 chips. The 72-bit word thus formed is subdivided into two 32-bit long words (Upper and Lower) and eight ECC bits. All memory array accesses correspond to a Read from, or write to, the selected 72-bit word. (All 8, 16, and 32 bit memory operations are transformed into 72 bit accesses by the memory controller.)

The memory array selection is accomplished via address lines (ADR19:ADR16) and four select signals at the Memory Subsystem Backplane. This Backplane has 16 slots dedicated for memory array cards, with the select signals uniquely specified for each slot. This arrangement eliminates the need for special jumpers and address switches. The MMS780 is merely inserted in the next available backplane slot. A total of 4 Megabytes of memory can be accommodated by one Memory Subsystem.

## USAGE RECOMMENDATIONS

The MMS780 is recommended for use with any VAX-11/780 memory subsystem set up for operation with the DEC M8210 array card. It is hardware and software compatible with the VAX-11/780, including DEC diagnostics which allow failure isolation at the chip level. The MMS780 is also compatible with DEC battery backup provisions.

## INTERFACE

The VAX-11/780 computer system is normally configured with either one or two memory subsystems, as shown in Figure 1. The normal interface signals utilized within each subsystem are depicted in Figure 2. The MMS780 Array Module functions in any slot of either subsystem, with no modifications required.

# MMS780

FIGURE 1 – NORMAL VAX-11/780 MEMORY CONFIGURATION

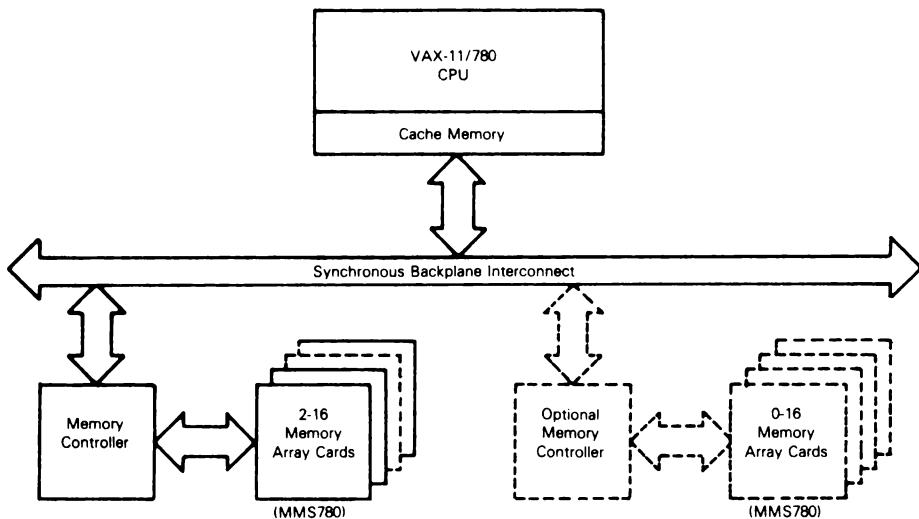
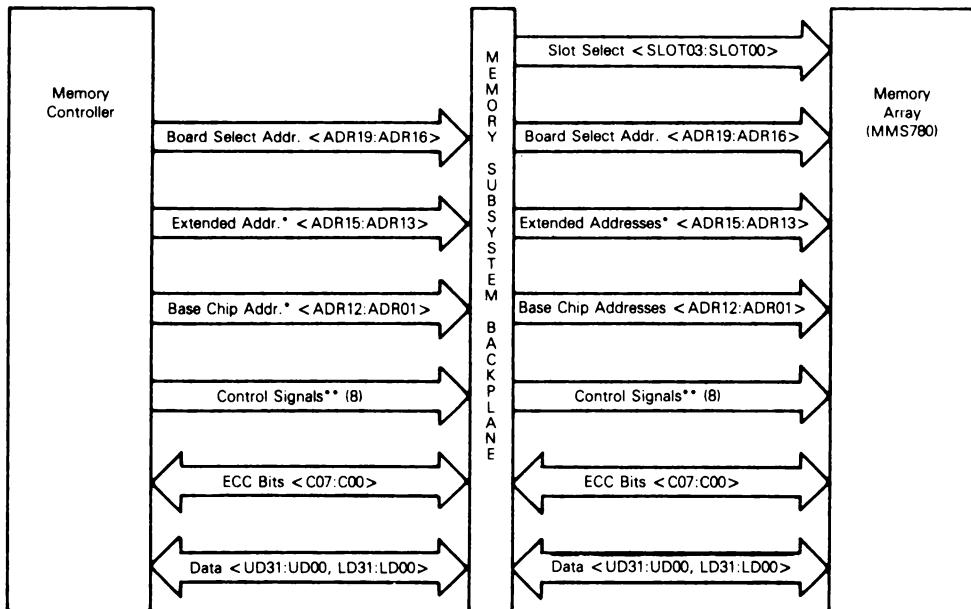


FIGURE 2 – MEMORY SUBSYSTEM INTERFACE



\*Extended Addresses are labeled ADR13, ADRCS, and ADREXT. During normal operation, they correspond to >ADR15:ADR13<.

\*\*Control signals are: Read, Column Address Strobe (CAS), Row Address Strobe (RAS), Multiplexer Control, Refresh Cycle, Bus Select, Bus Output Enable, and Initiate.

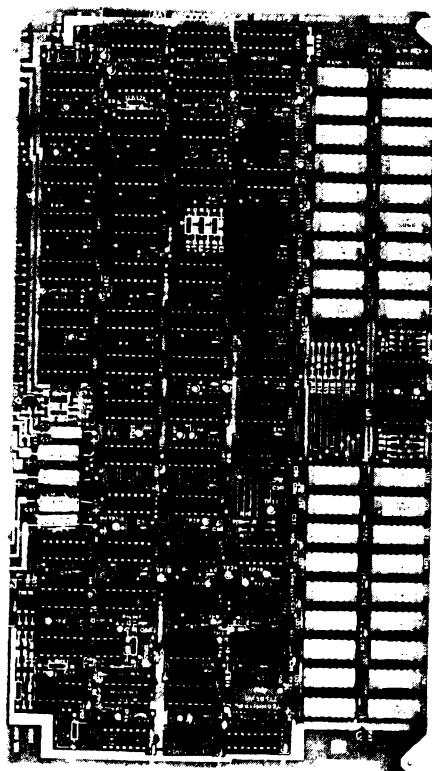
**MOTOROLA****MMS8064(P)  
MMS8048(P)  
MMS8032(P)  
MMS8016(P)**

## Advance Information

### SBC-COMPATIBLE MEMORY SYSTEMS

The MMS80XX family of memory systems is designed for use with the Intel SBC 80 Series computers, System 80 microcomputers, MDS systems, and the 16-bit SBC 86/12. The modules employ 16K dynamic RAM's mounted on a single 6 3/4" X 12" PC board along with timing, control, and bus interface logic. Eight models are available, all having the same access and cycle times. All electrical connections are made via two edge connectors.

- Pin, Function, and Form-Factor Compatible with MULTIBUS® Systems
- Even/Odd Bank Address Allows 16-Bit or 8-Bit Operation
- Addresses Selectable in Independent 8K Blocks
- 20 Address Lines — Operates in 1M Byte System
- Handles Early or Late Inhibits
- Operates in Delayed Write, Advance Write, and Read Modes
- Battery Backup Capability through use of Memory Protect Signal on P2 Connector
- On-Board Refresh Control Circuitry
- Programmable Advanced Acknowledge (AACK-) Signal
- On-board V<sub>BB</sub> Generation (-5 V) Allows Operation from -12 V, +5 V, and -12 V, -10 V, or -5 V Supplies
- Cycle Times of 700 ns (Read, Delayed, Write) and 1240 ns (Advanced Write)
- Available in 16K, 32K, 48K, and 64K Byte Configurations



### ORDERING INFORMATION

No Parity	Parity	Capacity
MMS8064	MMS8064P	64K Bytes
MMS8048	MMS8048P	48K Bytes
MMS8032	MMS8032P	32K Bytes
MMS8016	MMS8016P	16K Bytes

### PHYSICAL CHARACTERISTICS

Characteristic	Limit
Width	30.48 cm (12.00 inches)
Depth	17.15 cm (6.75 inches)
Thickness	1.27 cm (0.50 inches)
Weight	397 grams (14.0 ounces)

\*Trademark of Intel, Inc.

## MMS8064(P)•MMS8048(P)•MMS8032(P)•MMS8016(P)

### AC OPERATING CONDITIONS

Parameter		Symbol	Limit		Units	Notes
			Min	Max		
Cycle Time	Read or Delayed Write Cycle Advanced Write Cycle	tCYC tCYC(A)	700 1240		ns	1, 2 1, 2, 3
Address Setup Time	Address Valid to MRDC/I or MWRC/I	tAS	50		ns	
Address Hold Time	MRDC/I or MWRC/I to Address Invalid	tAH	0		ns	
Write Data Setup Time (Delayed Write)	Data Valid to MWRC/I	tDSW	-100		ns	
Write Data Delay Time (Advanced Write)	MWRC/I to Data Invalid	tDDAW		500	ns	3
Write Data Hold Time		tDHW	0		ns	
Inhibit Setup Time	Early Inhibit INHI/ Valid to MRDC/I or MWRC/I	tIS1 tIS2	10 -50		ns	
Inhibit Hold Time	MRDC/I or MWRC/I to INH1 Invalid	tIH	100		ns	
Byte High Enable Setup Time	BHEN/ Valid to MRDC/I or MWRC/I	tBS	50		ns	
Byte High Enable Hold Time	MRDC/I or MWRC/I to BHEN/ Invalid	tBH	0		ns	
Memory Protect Setup Time	MPRO/I to VCC < 4.75 Vdc	tMPS	15		μs	
Memory Protect Hold Time	VCC ≥ 4.75 Vdc to MPRO/I	tMPH	0		ns	
Refresh Interval		tRI	12.7	15.6	ms	

NOTES: 1) Add Refresh Delay Time (tRD) to these parameters when Asynchronous Refresh occurs.

2) Add 40 ns (Typ), 50 ns (Max) to these parameters if Late Inhibit Option is installed.

3) Applicable only if Advanced Write Cycle option is installed

### AC OPERATING CHARACTERISTICS (0°C ≤ TA ≤ 55°C)

Parameter		Symbol	Limit			Units	Notes
			Min	Typ	Max		
Read Access Time	MRDC/I to Data Valid	tACC		400	450	ns	1, 3
Read Data Setup Time	Read Data Valid to XACK/I	tDSR	0			ns	
Read Data Hold Time	XACK/I to Data Invalid	tDHR	0		65	ns	
Advance Acknowledge Delay Time	MRDC/I or MWTC/I to AACK/I	tAAK	—	—	—	ns	1, 4, 5
Transfer Acknowledge Delay Time	MRDC/I or MWTC/I to XACK/I	tACK			50	ns	1, 2
Acknowledge Turn-Off Time	MRDC/I or MWTC/I to AACK/I or XACK/I	tTO	15		55	ns	
Parity Error Setup Time	PAR ERR/ Valid to XACK/I	tPS	0			ns	
Parity Error Hold Time	XACK/I to PAR ERR/ Invalid	tPH	50			ns	
Refresh Delay Time		tDR			550	ns	

NOTES: 1) Add 40 ns (Typ), 50 ns (Max) to these parameters if Late Inhibit option is installed.

2) Add 450 ns (Typ), 500 ns (Max) to these parameters for Advanced Write Cycle operations.

3) Add Refresh Delay Time (tRD) to these parameters when Asynchronous Refresh occurs.

4) See Advance Acknowledge options table for Delay Time.

5) Advance Acknowledge is delayed until Transfer Acknowledge Time if Asynchronous Refresh occurs

### ADVANCE ACKNOWLEDGE OPTIONS

The MMS8060 Series can be programmed to provide an ADV ACK Delay (tAAK) of 100 to 450 ns. Available options are as noted in table at right. Selection is made via installation of a single jumper between two terminals of a 16 pin DIP socket. (Jumper between pins 8 & 9 - 100 ns Typ, between 1 & 16 - 150 ns, etc.)		Option Selected								Units	
		Limit	8-9	1-16	7-10	2-15	3-14	5-12	4-13	6-11	
	Min	70	120	165	215	260	310	360	400	ns	
	Typ	100	150	200	250	300	350	400	450	ns	
	Max	125	175	230	285	335	400	450	500	ns	

# MMS8064(P)•MMS8048(P)•MMS8032(P)•MMS8016(P)

## ABSOLUTE MAXIMUM RATINGS

Rating	Limit			
	Symbol	Min	Max	Units
Power Supply Voltage (Measured at Connector P1 or P2 With Respect to GND)	V <sub>CC</sub>	-0.3	+7.0	Vdc
	V <sub>DD</sub>	-0.3	+15.0	Vdc
	V <sub>BB</sub>	-0.3 +0.3	-7.0 -15.0	Vdc Vdc
Nominal -5 Vdc (Negative voltage regulator disabled) Nominal -10 Vdc or -12 Vdc (Negative voltage regulator enabled)	V <sub>IN</sub>	-0.3	+5.5	Vdc
Input Voltage, Any Input (Measured at P1 or P2 Conn With Respect to GND)				

NOTES: 1) Permanent damage may occur if Absolute Maximum Ratings are exceeded. Functional operation should be restricted to Recommended Operating Conditions.  
 2) Permanent damage may also occur if V<sub>DD</sub> is applied for more than one second while V<sub>BB</sub> is outside its Recommended Operating Range.

## ENVIRONMENTAL RATINGS

Rating	Limit			
	Symbol	Min	Max	Unit
Operating Temperature	T <sub>A</sub>	0	+55	°C
Storage Temperature	T <sub>Stg</sub>	-40	+85	°C
Relative Humidity (Without Condensation)	R.H.	0	90	%

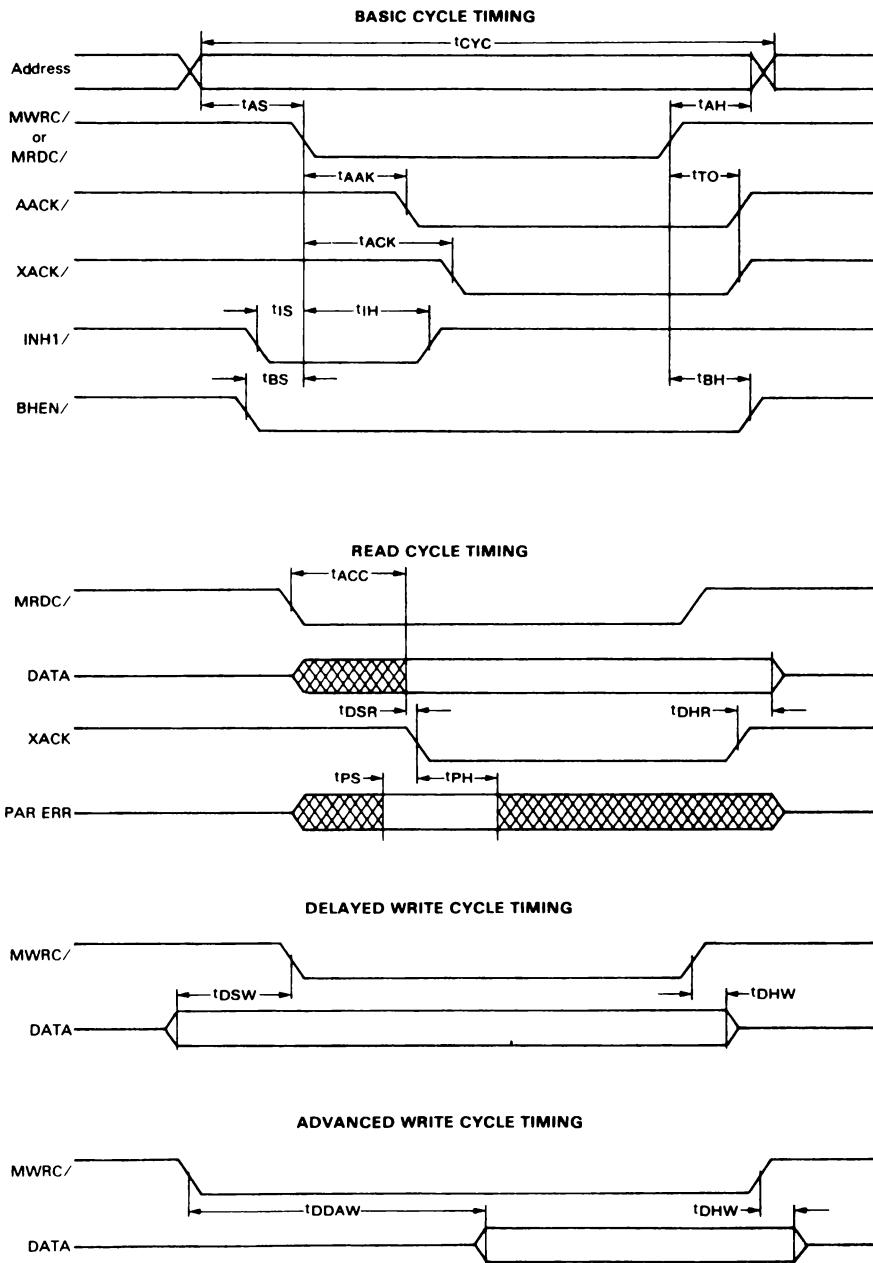
## RECOMMENDED DC OPERATING CONDITIONS

Condition	Limit			
	Symbol	Min	Max	Units
Supply Voltage	V <sub>CC</sub>	4.75	5.25	Vdc
	V <sub>DD</sub>	11.4	12.6	Vdc
	V <sub>BB</sub>	-4.75 -9.5	-5.25 -12.6	Vdc
Nominal -5 Vdc (Negative voltage regulator disabled) Nominal -10 Vdc or -12 Vdc (Negative voltage regulator enabled)	V <sub>IL</sub>	-0.3	+0.8	Vdc
Logic Zero Input Voltage, Any Input	V <sub>IH</sub>	+2.0	+5.25	Vdc
Logic One, Input Voltage, Any Input				

## DC OPERATING CHARACTERISTICS (0°C ≤ T<sub>A</sub> ≤ 55°C)

Parameter	Symbol	Limit			Units
		Min	Typ	Max	
Supply Current (Normal Mode)	I <sub>CC</sub>			3.0	μAdc
	I <sub>DD</sub>			260	mAdc
	I <sub>BB</sub>			14 30	mAdc mAdc
Supply Current (Battery Backup Mode)	I <sub>CC</sub>			1.1	μAdc
	I <sub>DD</sub>			90	mAdc
	I <sub>BB</sub>			7.2 14	mAdc mAdc
Logic One Input Current (V <sub>CC</sub> = 4.75 Vdc, V <sub>IH</sub> = 2.4 Vdc)	I <sub>IH</sub>			250 40	μAdc μAdc
Logic Zero Input Current (V <sub>CC</sub> = 5.25 Vdc, V <sub>IL</sub> = 0.4 Vdc)	I <sub>IL</sub>			-600 -400	μAdc μAdc
Logic One Output Voltage (V <sub>CC</sub> = 4.75 Vdc, I <sub>OH</sub> = -5 mAdc)	V <sub>OH</sub>	2.4			Vdc
Logic Zero Output Voltage (V <sub>CC</sub> = 4.75 Vdc, I <sub>OL</sub> = 48 mAdc)	V <sub>OL</sub>			0.5	Vdc

**MMS8064(P)•MMS8048(P)•MMS8032(P)•MMS8016(P)**



# MMS8064(P)•MMS8048(P)•MMS8032(P)•MMS8016(P)

## P1 CONNECTOR PIN ASSIGNMENTS

Signal Name	Symbol	Pin No.	Signal Name	Symbol	Pin No.	Signal Name	Symbol	Pin No.
Ground	VSS	1, 2	Address Line 0	ADR0/	57	Memory Read Command	MRDC/	19
Ground	VSS	11, 12	Address Line 1	ADR1/	58	Memory Write Command	MWTC/	20
Ground	VSS	75, 76	Address Line 2	ADR2/	55			
Ground	VSS	85, 86	Address Line 3	ADR3/	56			
+12 V Supply	VDD	7, 8	Address Line 4	ADR4/	53	Data Line 0	DAT0/	73
+5 V Supply	VCC	3, 4	Address Line 5	ADR5/	54	Data Line 1	DAT1/	74
+5 V Supply	VCC	5, 6	Address Line 6	ADR6/	51	Data Line 2	DAT2/	71
+5 V Supply	VCC	81, 82	Address Line 7	ADR7/	52	Data Line 3	DAT3/	72
+5 V Supply	VCC	83, 84	Address Line 8	ADR8/	49	Data Line 4	DAT4/	69
-5 V Supply	VBB	9, 10	Address Line 9	ADR9/	50	Data Line 5	DAT5/	70
-10 V Supply	VBB1	77, 78	Address Line A	ADRA/	47	Data Line 6	DAT6/	67
-12 V Supply	VBB2	79, 80	Address Line B	ADRB/	48	Data Line 7	DAT7/	68
Transfer	XACK/	23	Address Line C	ADRC/	45	Data Line 8	DAT8/	65
Acknowledge			Address Line D	ADRD/	46	Data Line 9	DAT9/	66
Advance	AACK/	25	Address Line E	ADRE/	43	Data Line A	DATA/	63
Acknowledge			Address Line F	ADRF/	44	Data Line B	DATB/	64
Command	INH1/	24	Address Line 10	ADR10/	28	Data Line C	DATC/	61
Inhibit			Address Line 11	ADR11/	30	Data Line D	DATD/	62
Byte High	BHEN/	27	Address Line 12	ADR12/	32	Data Line E	DATE/	59
Enable			Address Line 13	ADR13/	34	Data Line F	DATF/	60

NOTE: Pins not listed are not connected to Memory System circuitry.

## P2 CONNECTOR PIN ASSIGNMENTS

Signal Name	Symbol	Pin No.	Signal Name	Symbol	Pin No.
Memory Protect	MPRO/	20	Test Point — Parity 2 & 3	TP-PART 2 & 3	44
Parity Error	PAR ERR/	29	Ground	VSS	1, 2
Test Point — Advanced Write	TP-ADVW	38	+5 V (Battery)	VCC (BATT)	3, 4
Test Point — Refresh Clock	TP-REFCLK	40	+12 V (Battery)	VDD (BATT)	
Test Point — Parity 0 & 1	TP-PART 0 & 1	42	-5 V (Battery)	VBB (BATT)	9, 10

NOTE: Pins not listed are not connected to Memory System circuitry.

## MMS80XX SYSTEM

Signal (P1)	Description
ADRO/-ADRF/	Lower Order Address used to select 1 location out of 64K* block
ADR10-ADR-13/	High Order Address used to select one 64K block out of 1024K
DATO/-DAT7/	Data signals for 8-bit mode or lower byte of data signals for 16-bit mode
DAT8/-DATF/	High order byte data signals for 16-bit mode
AACK/	(Programmable — 8 timing selections) Advanced Acknowledgement Signal from Memory Card in response to MWTC/ or MRDC/
XACK/	Acknowledgement Signal from Memory Card indicating that Data Transfer has occurred
MRDC/	Signal to Memory Card requesting to read RAM memory
MWTC/	Signal to Memory Card requesting to write data into RAM memory
INH1/	Signal disabling response of the Memory card to MWTC/ and MRDC/
BHEN/	Signal used to enable the 16-bit mode of operation
Signal (P2)	Description
MPRO/	Signal used to enable the transfer from normal voltages to battery back-up voltages by disabling all circuits except refresh. Can also be used separately from battery back-up to do same thing
PAR ERR/	Signal used to indicate a Parity Error
TP-ADVW	Test Point Signal used to select Advanced Write Mode
TP-REF C/K	Test Point Signal used to clock refresh flip-flop externally (used only for evaluation purposes)
TP-PART 0 AND 1	Test Point Signal used to force a Parity Error on Reading Banks 0 or 1
TP-PART 2 AND 3	Test Point Signal used to force a Parity Error on Reading Banks 2 or 3

\*K = 1024 Bytes

## MMS8064(P)•MMS8048(P)•MMS8032(P)•MMS8016(P)

### GENERAL DESCRIPTION

The MSM80XX series is designed for operation with SBC/BLC 80 Series Single-Board Computers (including the SBC 86/12 16-bit computer), System 80 Series Microcomputers, and Intel MDS Systems. The four configurations are plug-in replacements for Intel/National SBC/BLC 016, 032, 048, 064 memory cards.

### OPTIONS

The MMS80XX series is available in four population options. Each of these configurations can be obtained with or without parity. (See Ordering Information on Page 1.) In addition to the population and parity options, provisions are made to allow the user to configure the memory card to meet system requirements. The primary user options are Address Selection, Advance-Acknowledge Response time, Early/Late Inhibit options, Advanced/Delayed Write selection, and -5 Vdc derivation.

Address Selection options allow the user to locate the memory card in any one of sixteen memory segments — with each of these segments defined as a 64K memory space. If the MMS8064 is chosen, the memory system responds to all addresses within the selected memory segment. When depopulated modules (8016/8032/8048) are used, address selection for independent 8K Byte blocks is provided. The MMS8048, for example, can be configured to respond to 6 of the eight 8K blocks in the chosen segment.

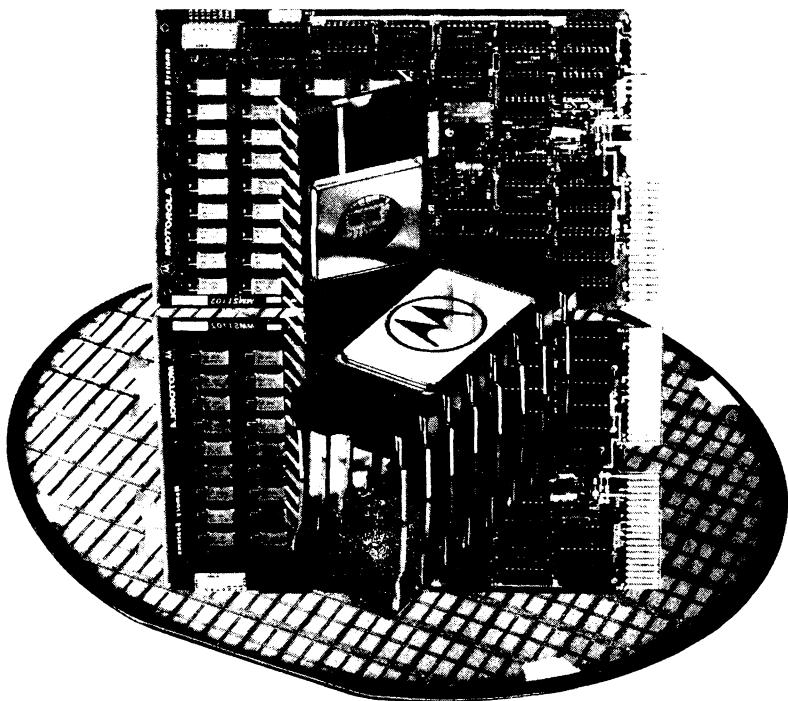
Advance Acknowledge is utilized to prevent initiation of unnecessary processor "Wait" states. (In effect, the signal indicates that the memory transfer will be completed during the current cycle). The MMS80XX

series allows the user to select an Advance-Acknowledge Delay Time of 100 to 450 ns (in 50 ns increments). This facilitates tailoring of the memory response time to the system speed.

An Inhibit input is provided with the MMS80XX series to allow the Bus Master to turn off the memory for certain operations. In general, the system activates this signal prior to a Memory Read (MRDC/) or Write (MWRC/) command. In certain types of systems, however, the Inhibit signal arrives after the Read/Write command. A jumper option is provided with the MMS80XX Series, allowing the Inhibit input to respond to a "Late Inhibit" signal. This option should be installed only if the system requires it, since it slows the Memory System response by approximately 50 ns.

Most SBC systems utilize a "Delayed Write" command wherein the Data is available coincident with activation of MWRC/. Some systems, however, utilize an "Advanced Write" technique, with the data becoming valid some 500 ns after the Write Command. A jumper option is provided with the MMS80XX series to allow operation in the Write Cycle. Transfer Acknowledge (XACK/) is inhibited during the dummy cycle, but Advance Acknowledge (AACK/) occurs if programmed to do so. XACK/ then occurs during the actual Write Cycle unless the system has responded to the AACK/ signal. (In this case, system response to the AACK/ signal is defined as a deactivation of the MWRC/ input). Selection of the "Advanced Write" option does not affect Read Cycle operations.

In general, SBC backplanes provide -5 volts at pins 9 and 10 of connector P1. Some systems, however, provide only -10 volts at pins 77 and 78 and/or -12 volts of pins 79 and 80. The MMS80XX Series contain an on-board negative 5 volt regulator to allow operation with such systems.



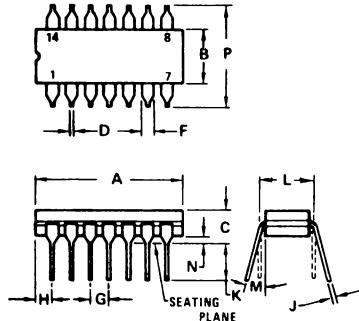
## Mechanical Data

## MECHANICAL DATA

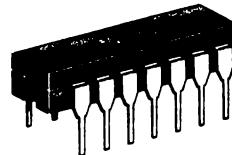
The packaging availability for each device is indicated on the individual data sheets. Dimensions for the packages are given in this section.

### 14-PIN PACKAGES

FRIT-SEAL CERAMIC PACKAGE  
CASE 632



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.94	0.750	0.785
B	6.10	7.49	0.240	0.295
C	—	5.08	—	0.200
D	0.38	0.58	0.015	0.023
F	1.40	1.77	0.055	0.070
G	2.54 BSC		0.100 BSC	
H	1.91	2.29	0.075	0.080
J	0.20	0.38	0.008	0.015
K	3.18	5.08	0.125	0.200
L	7.62 BSC		0.300 BSC	
M	—	1.69	—	15°
N	0.51	1.02	0.020	0.040

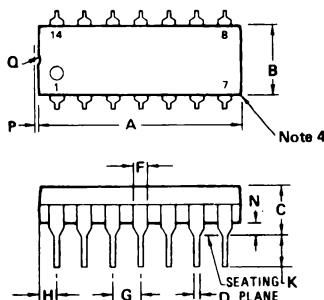


NOTES:

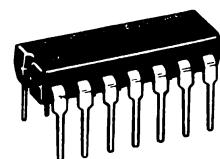
1. ALL RULES AND NOTES ASSOCIATED WITH MO-001 AA OUTLINE SHALL APPLY.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "A" AND "B" (632-06) DO NOT INCLUDE GLASS RUN-OUT.
4. LEADS WITHIN 0.25 mm (0.010) OIA OF TRUE POSITION AT SEATING PLANE AND MAXIMUM MATERIAL CONDITION.

CASE 632-06

PLASTIC PACKAGE  
CASE 646



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.16	19.56	0.715	0.770
B	6.10	6.60	0.240	0.260
C	4.06	5.08	0.160	0.200
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.32	2.41	0.052	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	100°	0°	100°
N	0.51	1.02	0.020	0.040



NOTES:

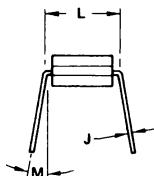
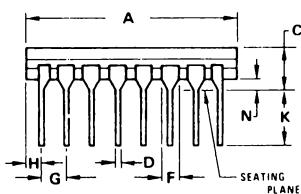
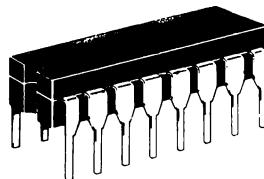
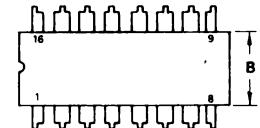
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

CASE 646-05

## MECHANICAL DATA (Continued)

### 16-PIN PACKAGES

FRIT-SEAL CERAMIC PACKAGE  
CASE 620

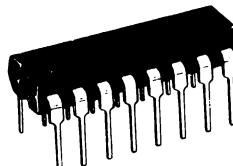
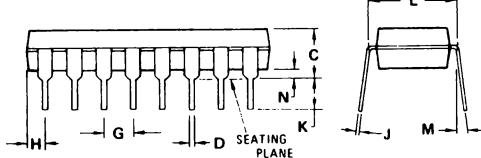
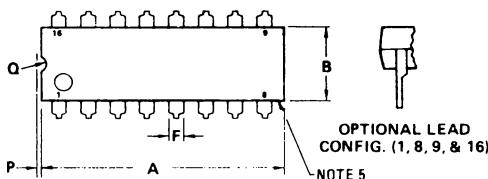


1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. PACKAGE INDEX: NOTCH IN LEAD NOTCH IN CERAMIC OR INK DOT.
3. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIM "A" AND "B" DO NOT INCLUDE GLASS RUN-OUT.
5. DIM "F" MAY NARROW TO 0.76 mm (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.94	0.750	0.785
B	6.10	7.49	0.240	0.295
C	—	5.08	—	0.200
D	0.38	0.53	0.015	0.021
F	1.40	1.78	0.055	0.070
G	2.54 BSC		0.100 BSC	
H	0.51	1.14	0.020	0.045
J	0.20	0.30	0.008	0.012
K	3.18	5.08	0.125	0.200
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°
N	0.51	1.02	0.020	0.040

CASE 620-06

PLASTIC PACKAGE  
CASE 648



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.80	21.34	0.740	0.840
B	6.10	6.60	0.240	0.260
C	4.06	5.08	0.160	0.200
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.38	2.41	0.015	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	100°	0°	100°
N	0.51	1.02	0.020	0.040

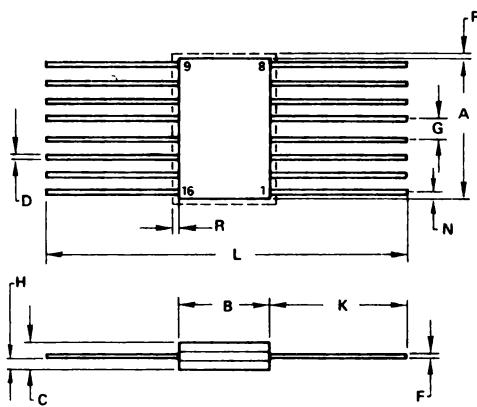
CASE 648-05

- NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
  2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
  3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
  4. "F" DIMENSION IS FOR FULL LEADS. "HALF" LEADS ARE OPTIONAL AT LEAD POSITIONS 1, 8, 9, and 16.
  5. ROUNDED CORNERS OPTIONAL.

## MECHANICAL DATA (Continued)

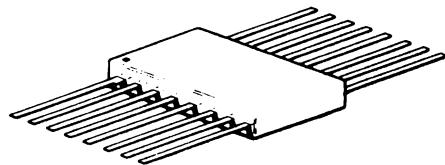
### 16-PIN PACKAGES (Continued)

CERAMIC PACKAGE  
CASE 650



NOTES:

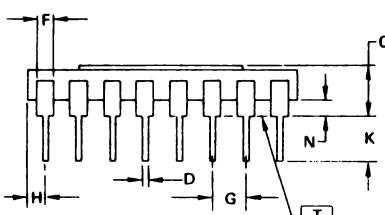
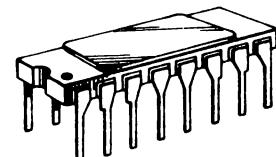
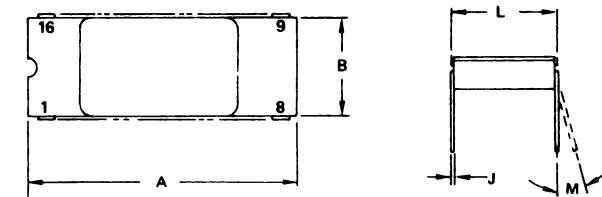
1. LEAD NO. 1 IDENTIFIED BY TAB ON LEAD OR DOT ON COVER.
2. LEADS WITHIN 0.13 mm (0.005) TOTAL OF TRUE POSITION AT MAXIMUM MATERIAL CONDITION.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.22	7.24	0.245	0.285
C	1.52	2.03	0.060	0.080
D	0.41	0.48	0.016	0.019
F	0.08	0.15	0.003	0.006
G	1.27 BSC		0.050 BSC	
H	0.64	0.89	0.025	0.035
K	6.35	9.40	0.250	0.370
L	18.92	-	0.745	-
N	-	0.51	-	0.020
R	-	0.38	-	0.015

CASE 650-03

CERAMIC PACKAGE  
CASE 690



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	7.11	7.62	0.280	0.300
C	2.67	4.19	0.105	0.165
D	0.38	0.53	0.015	0.021
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.78	0.030	0.070
J	0.20	0.30	0.008	0.012
K	3.18	5.08	0.125	0.200
L	7.62 BSC		0.300 BSC	
M	-	10°	-	10°
N	0.38	1.52	0.015	0.060

NOTES:

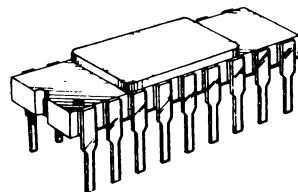
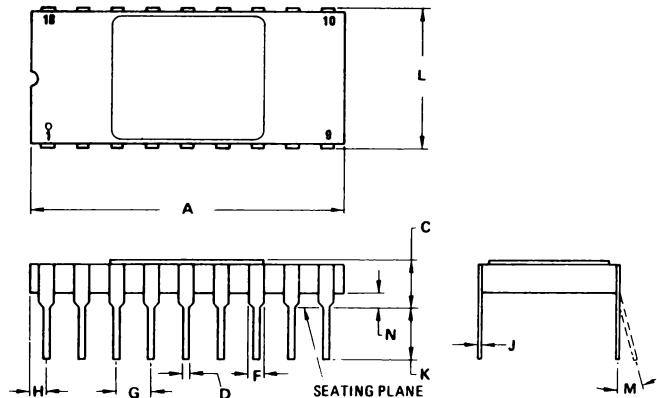
1. -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE
3. POSITIONAL TOLERANCE FOR LEADS (D).
4. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.
6. 690-11 AND 690-12 OBSOLETE.  
NEW STANDARD 690-13.

CASE 690-13

## MECHANICAL DATA (Continued)

### 18-PIN PACKAGES

CERAMIC PACKAGE  
CASE 680

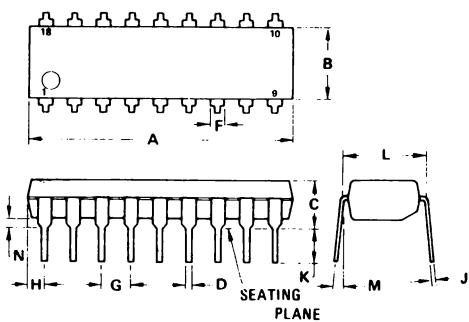


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.48	23.24	0.885	0.915
B	7.16	7.57	0.282	0.298
C	3.18	4.27	0.125	0.168
D	0.38	0.58	0.015	0.023
F	0.76	1.40	0.030	0.055
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.30	0.008	0.012
K	2.68	4.44	0.105	0.175
L	7.37	7.87	0.290	0.310
M	—	10°	—	10°
N	0.38	1.40	0.015	0.055

- NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RAD OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
  2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.

CASE 680-06

PLASTIC PACKAGE  
CASE 701-01



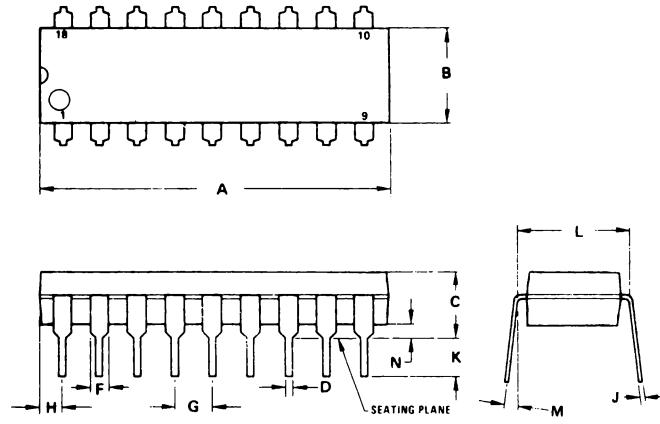
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	23.11	23.88	0.910	0.940
B	6.10	6.60	0.240	0.260
C	4.06	4.57	0.160	0.180
D	0.38	0.51	0.015	0.020
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	1.32	1.83	0.052	0.072
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.37	7.87	0.290	0.310
M	0°	10°	0°	10°
N	0.51	1.02	0.020	0.040

CASE 701-01

## MECHANICAL DATA (Continued)

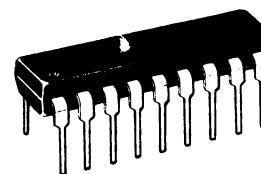
### 18-PIN PACKAGES (Continued)

PLASTIC PACKAGE  
CASE 707



NOTES:

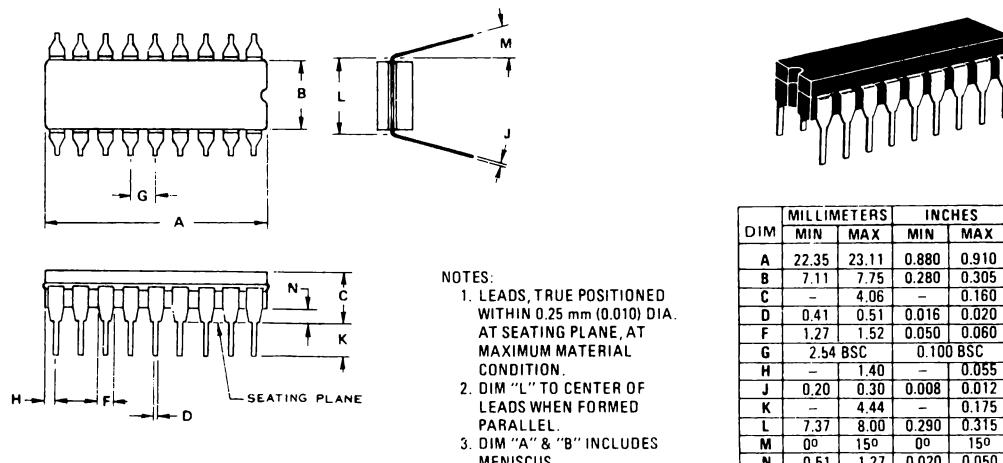
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25mm(0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.22	23.24	0.875	0.915
B	6.10	6.60	0.240	0.260
C	3.94	4.57	0.155	0.180
D	0.36	0.56	0.014	0.022
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

CASE 707-02

FRIT SEAL CERAMIC PACKAGE  
CASE 726



NOTES:

1. LEADS, TRUE POSITIONED WITHIN 0.25 mm (0.010) DIA. AT SEATING PLANE, AT MAXIMUM MATERIAL CONDITION.
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIM "A" & "B" INCLUDES MENISCUS.

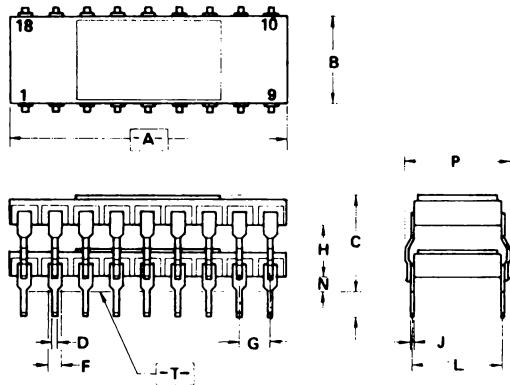
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.35	23.11	0.880	0.910
B	7.11	7.75	0.280	0.305
C	-	4.06	-	0.160
D	0.41	0.51	0.016	0.020
F	1.27	1.52	0.050	0.060
G	2.54 BSC		0.100 BSC	
H	-	1.40	-	0.055
J	0.20	0.30	0.008	0.012
K	-	4.44	-	0.175
L	7.37	8.00	0.290	0.315
M	0°	15°	0°	15°
N	0.51	1.27	0.020	0.050

CASE 726-02

## MECHANICAL DATA (Continued)

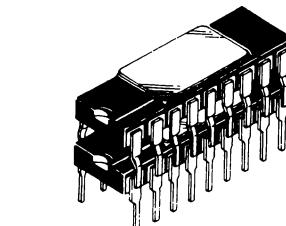
### 18-PIN PACKAGES (Continued)

CERAMIC PACKAGE  
CASE 749



NOTES:

1. DIMENSION **A** IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:  
 $\pm 0.25$  (0.010)  $\text{MIN MAX}$
3. **T** IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER  
ANSI Y14.5, 1973.

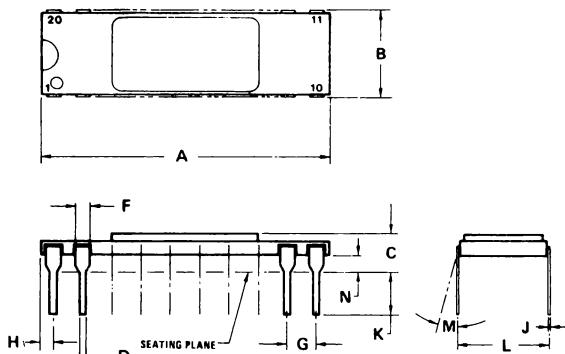


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	7.24	7.75	0.285	0.305
C	—	8.64	—	0.340
D	0.36	0.61	0.014	0.024
F	0.89	1.40	0.035	0.055
G	2.54	BSC	0.100	BSC
H	3.30	—	0.130	—
J	0.23	0.30	0.009	0.012
K	—	2.92	—	0.115
L	7.37	7.87	0.290	0.310
N	0.64	1.14	0.025	0.045
P	—	9.14	—	0.360

CASE 749-01

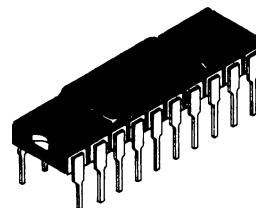
### 20-PIN PACKAGE

CERAMIC PACKAGE  
CASE 729



NOTE:

1. LEADS WITHIN 0.13 mm (0.005)  
RADIUS OF TRUE POSITION AT  
SEATING PLANE, AT MAXIMUM  
MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF  
LEADS WHEN FORMED  
PARALLEL.



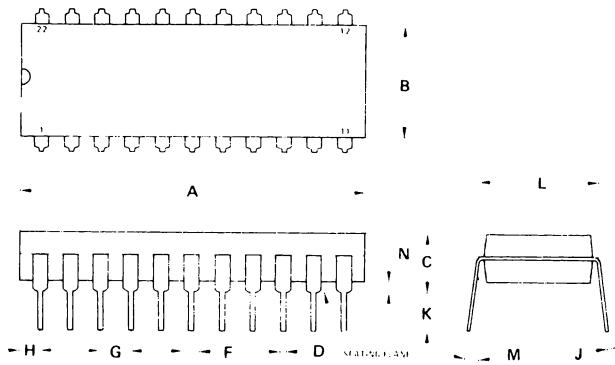
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	25.91	0.970	1.020
B	7.06	8.13	0.278	0.320
C	2.79	4.70	0.110	0.185
D	0.38	0.51	0.015	0.020
F	1.14	1.40	0.045	0.055
G	2.54	BSC	0.100	BSC
H	0.89	1.52	0.035	0.060
J	0.20	0.30	0.008	0.012
K	3.18	4.57	0.125	0.180
L	7.62	BSC	0.300	BSC
M	0°	10°	0°	10°
N	0.51	1.52	0.020	0.060

CASE 729-02

## MECHANICAL DATA (Continued)

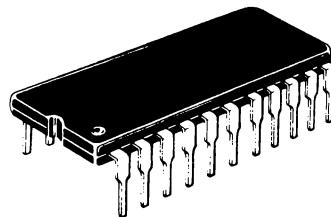
### 22-PIN PACKAGES

PLASTIC PACKAGE  
CASE 708



NOTES:

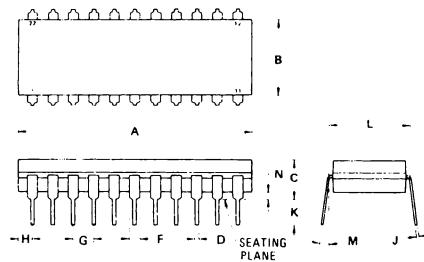
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25mm(0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	27.56	28.32	1.085	1.115
B	8.64	9.14	0.340	0.360
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	10.16 BSC		0.400 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

CASE 708-04

FRIT-SEAL CERAMIC PACKAGE  
CASE 736



NOTES

1. LEADS TRUE POSITIONED WITHIN 0.25 mm (0.010) DIA AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION (DIM "D").
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.



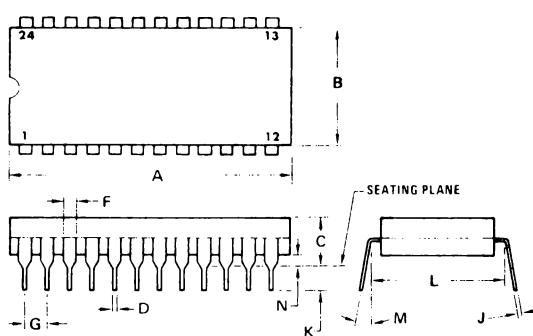
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	26.80	27.81	1.055	1.095
B	9.14	9.91	0.360	0.390
C	3.81	5.46	0.150	0.215
D	0.38	0.53	0.015	0.021
F	1.27	1.65	0.050	0.065
G	2.54 BSC		0.100 BSC	
H	0.51	1.27	0.020	0.050
J	0.20	0.30	0.008	0.012
K	2.54	4.32	0.100	0.170
L	9.91	10.41	0.390	0.410
M	15°		15°	
N	0.25	0.89	0.010	0.035

CASE 736-01

## MECHANICAL DATA (Continued)

### 24-PIN PACKAGES

FRIT-SEAL CERAMIC PACKAGE  
CASE 623



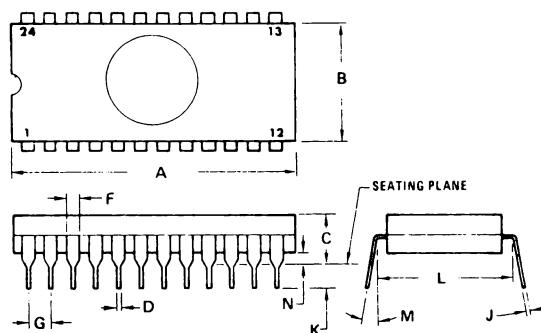
NOTES:

1. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
2. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION. (WHEN FORMED PARALLEL).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.24	32.77	1.230	1.290
B	12.70	15.49	0.500	0.610
C	4.06	5.59	0.160	0.220
D	0.41	0.51	0.016	0.020
F	1.27	1.52	0.050	0.060
G	2.54 BSC		0.100 BSC	
J	0.20	0.30	0.008	0.012
K	2.29	4.06	0.090	0.160
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.27	0.020	0.050

CASE 623-04

FRIT-SEAL CERAMIC PACKAGE  
CASE 623A



NOTES:

1. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
2. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION. (WHEN FORMED PARALLEL).

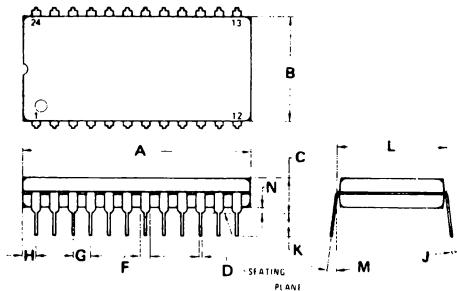
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.24	32.77	1.230	1.290
B	12.70	15.49	0.500	0.610
C	4.06	5.84	0.160	0.230
D	0.41	0.51	0.016	0.020
F	1.27	1.52	0.050	0.060
G	2.54 BSC		0.100 BSC	
J	0.20	0.30	0.008	0.012
K	2.29	4.06	0.090	0.160
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.27	0.020	0.050

CASE 623A-02

## MECHANICAL DATA (Continued)

### 24-PIN PACKAGES (Continued)

PLASTIC PACKAGE  
CASE 709



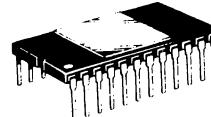
NOTES:

1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 mm (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.37	32.13	1.235	1.265
B	13.72	14.22	0.540	0.560
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.02	1.52	0.040	0.060
G	2.54	BSC	0.100	BSC
H	1.65	2.03	0.065	0.080
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	15.24	BSC	0.600	BSC
M	0 <sup>o</sup>	15 <sup>o</sup>	0 <sup>o</sup>	15 <sup>o</sup>
N	0.51	1.02	0.020	0.040

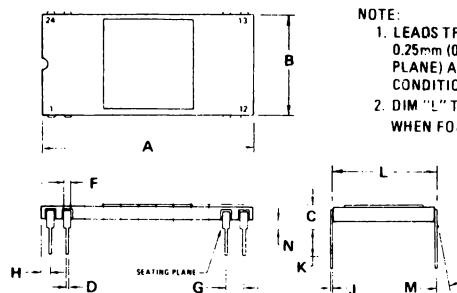
CASE 709-02

CERAMIC PACKAGE  
CASE 716



NOTE:

1. LEADS TRUE POSITIONED WITHIN 0.25mm (0.010) DIA (AT SEATING PLANE) AT MAXIMUM MATERIAL CONDITION.
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.



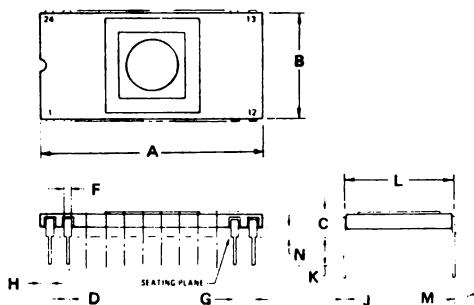
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	27.64	30.99	1.088	1.220
B	14.94	15.34	0.588	0.604
C	2.67	4.32	0.105	0.170
D	0.38	0.53	0.015	0.021
F	0.76	1.40	0.030	0.055
G	2.54	BSC	0.100	BSC
H	0.76	1.78	0.030	0.070
J	0.20	0.30	0.008	0.012
K	2.54	4.19	0.100	0.165
L	14.99	15.49	0.590	0.610
M	-	10 <sup>o</sup>	-	10 <sup>o</sup>
N	1.02	1.52	0.040	0.060

CASE 716-06

## MECHANICAL DATA (Continued)

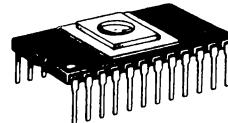
### 24-PIN PACKAGES (Continued)

CERAMIC PACKAGE  
CASE 716



**NOTE:**

1. LEADS TRUE POSITIONED WITHIN 0.25mm (0.010) DIA (AT SEATING PLANE) AT MAXIMUM MATERIAL CONDITION.
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	27.64	30.99	1.088	1.220
B	14.73	15.34	0.580	0.604
C	3.18	5.08	0.125	0.200
D	0.38	0.53	0.015	0.021
F	0.76	1.40	0.030	0.055
G	2.54 BSC		0.100 BSC	
H	0.76	1.78	0.030	0.070
J	0.20	0.30	0.008	0.012
K	2.54	4.57	0.100	0.180
L	14.99	15.49	0.590	0.610
M	-	10°	-	10°
N	1.02	1.52	0.040	0.060

CASE 716-07