

## Advance Information

# 256K/512K Pipelined BurstRAM™ Secondary Cache Module for Pentium™

The MCM64PD32 (256K) and MCM64PD64 (512K) are designed to provide a burstable, high performance, L2 cache for the Pentium microprocessor in conjunction with Intel's Triton II chip set. The MCM64PD32 is configured as 32K x 64 bits and the MCM64PD64 is configured as 64K x 64 bits. Both are packaged in a 160 pin card edge memory module. Each module uses Motorola's 3.3 V 32K x 32 BurstRAMs and two Motorola 3.3 V 32K x 8 FSRAM for the tag RAM.

Bursts can be initiated with either address status processor (ADSP) or cache address status (CADS). Subsequent burst addresses are generated internal to the BurstRAM by the cache burst advance (CADV) input pin.

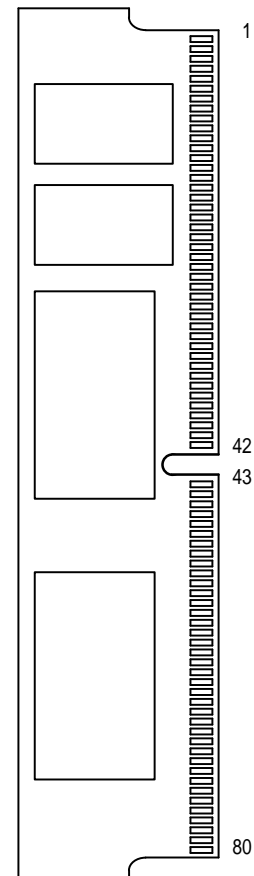
Write cycles are internally self timed and are initiated by the rising edge of the clock (CLK0) input. Eight write enables are provided for byte write control.

PD0 – PD3 map into the Triton II chip set for auto-configuration of the cache control.

- Pentium-Style Burst Counter on Chip
- Pipelined Data Out
- 160 Pin Card Edge Module
- Address Pipeline Supported by ADSP Disabled with  $\bar{E}x$
- All Cache Data and Tag I/Os are TTL Compatible
- Three State Outputs
- Byte Write Capability
- Fast Module Clock Rate: 66 MHz
- Fast SRAM Access Times: 15 ns for Tag RAM  
8 ns for Data RAMs
- One-cycle Deselect Data RAMs
- Decoupling Capacitors for Each Fast Static RAM
- High Quality Multi-Layer FR4 PWB with Separate Power and Ground Planes
- Single 3.3 V +10%, - 5% Power Supply
- Burndy Connector, Part Number: CELP2X80SC3Z48
- Intel COAST 3.0 Option III Compliant
- Burst Order Select (BOSEL) Option

**MCM64PD32**  
**MCM64PD64**

160-LEAD CARD EDGE  
CASE TBD, TOP VIEW

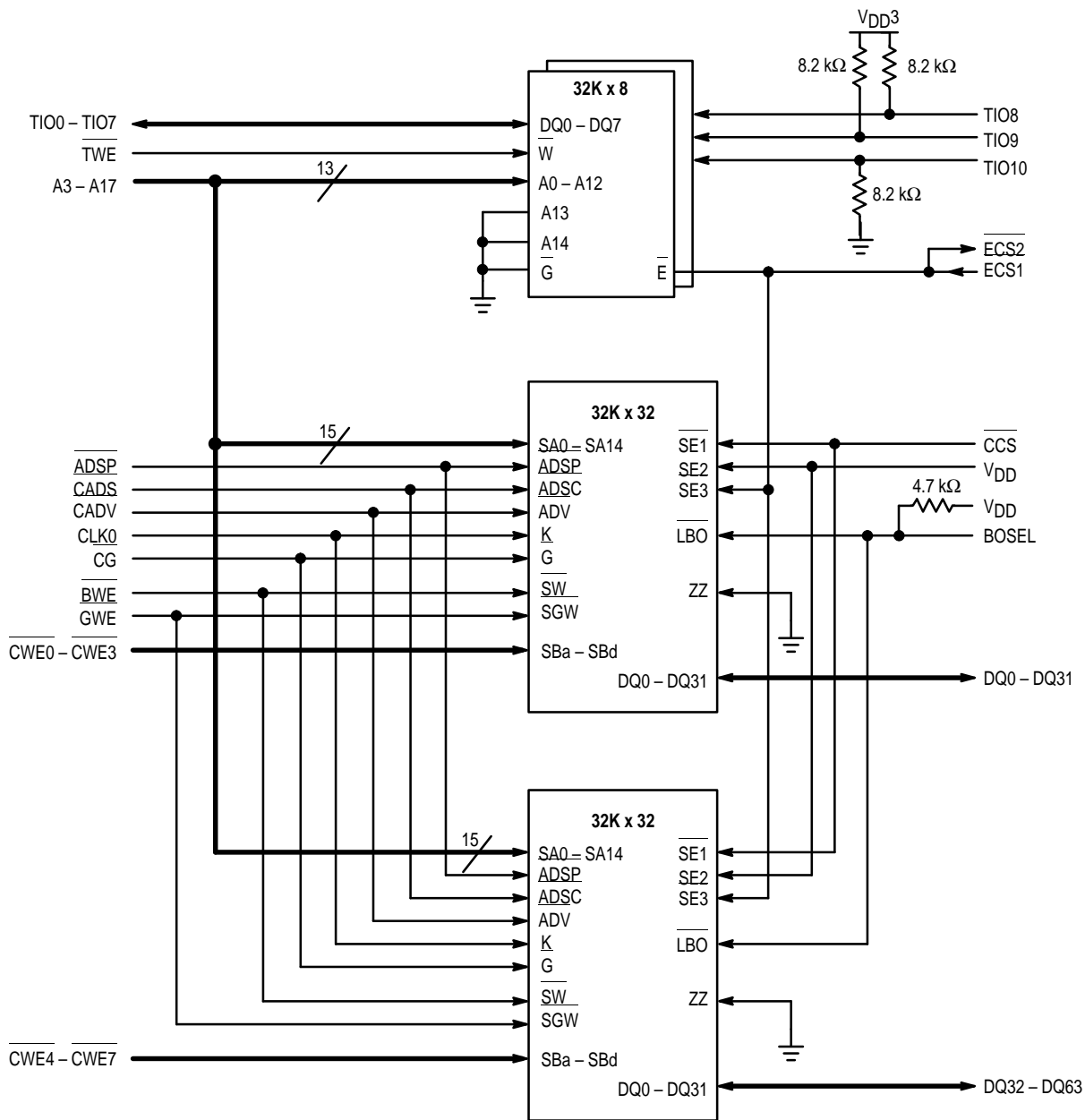


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Pentium is a trademark of Intel Corp.

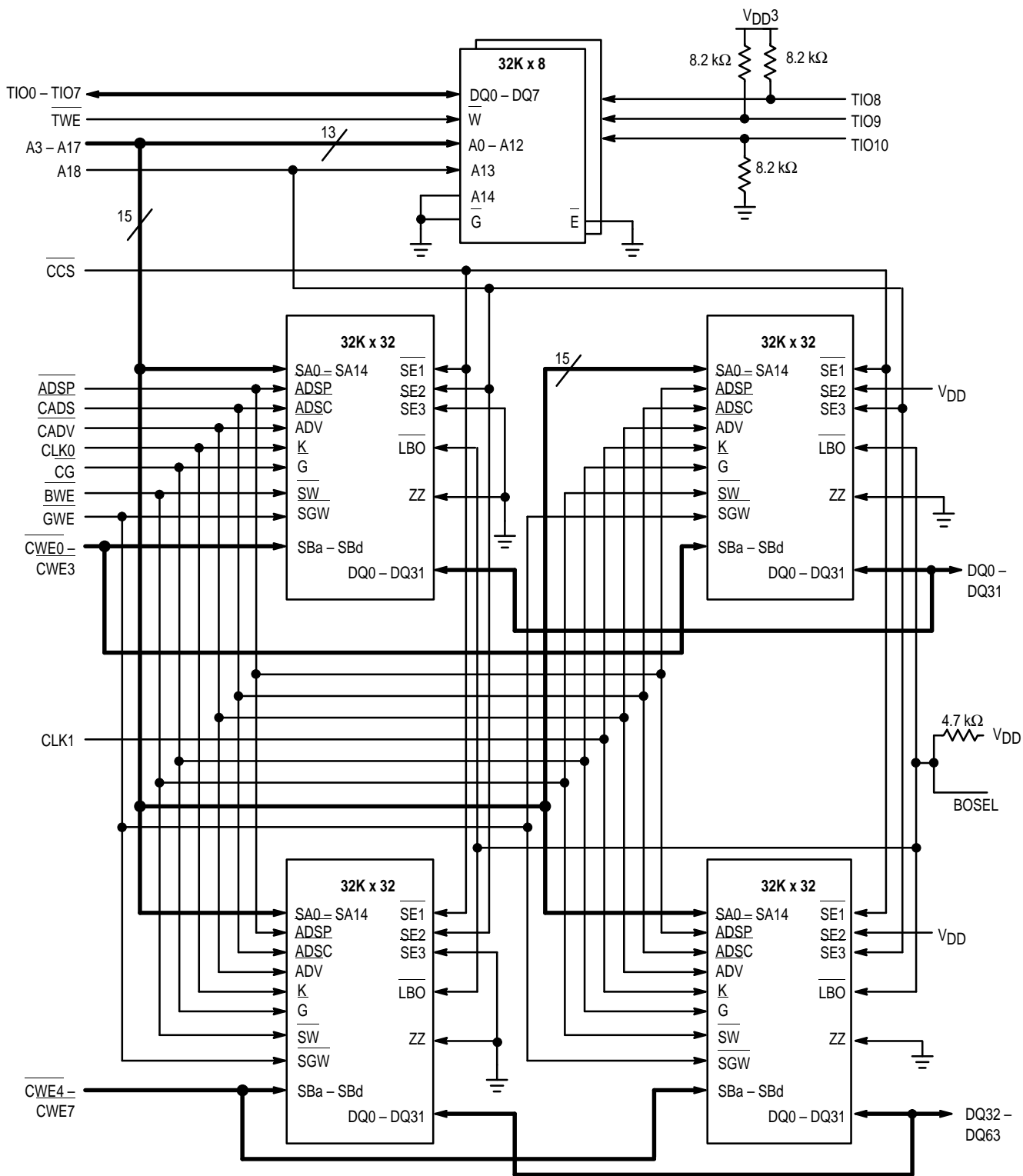
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6/14/96

### MCM64PD32 BLOCK DIAGRAM



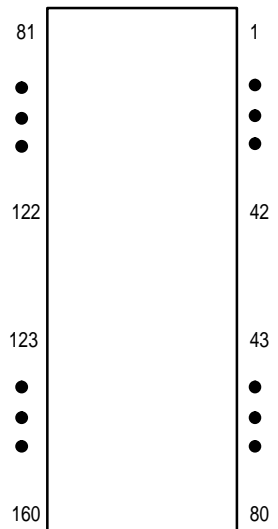
### MCM64PD64 BLOCK DIAGRAM



**PIN ASSIGNMENT 160-LEAD CARD EDGE MODULE (DIMM)**

Pin	Name	Pin	Name	Pin	Name	Pin	Name	Pin	Name
1	VSS	33	PD1	65	DQ22	97	NC	129	DQ47
2	TIO0	34	PD3	66	DQ20	98	NC	130	DQ45
3	TIO2	35	VSS	67	DQ18	99	VSS	131	DQ43
4	TIO6	36	CLK1	68	VDD3	100	RSVD	132	VDD5
5	TIO4	37	VSS	69	DQ16	101	A4	133	DQ41
6	TIO8	38	DQ62	70	DQ14	102	A6	134	DQ39
7	VDD3	39	VDD3	71	DQ12	103	A8	135	DQ37
8	TWE	40	DQ60	72	VSS	104	A10	136	VSS
9	CADS	41	DQ58	73	DQ10	105	VDD5	137	DQ35
10	VSS	42	DQ56	74	DQ8	106	A17	138	DQ33
11	CWE4	43	VSS	75	DQ6	107	VSS	139	DQ31
12	CWE6	44	DQ54	76	VDD3	108	A9	140	VDD5
13	CWE0	45	DQ52	77	DQ4	109	A14	141	DQ29
14	CWE2	46	DQ50	78	DQ2	110	A15	142	DQ27
15	VDD3	47	DQ48	79	DQ0	111	RSVD	143	DQ25
16	CCS	48	VSS	80	VSS	112	PD0	144	VSS
17	GWE	49	DQ46	81	VSS	113	PD2	145	DQ23
18	BWE	50	DQ44	82	TIO1	114	BOSEL	146	DQ21
19	VSS	51	DQ42	83	TIO7	115	VSS	147	DQ19
20	A3	52	VDD3	84	TIO5	116	CLK0	148	VDD5
21	A7	53	DQ40	85	TIO3	117	VSS	149	DQ17
22	A5	54	DQ38	86	TIO9	118	DQ63	150	DQ15
23	A11	55	DQ36	87	VDD5	119	VDD5	151	DQ13
24	A16	56	VSS	88	TIO10	120	DQ61	152	VSS
25	VDD3	57	DQ34	89	CADV	121	DQ59	153	DQ11
26	A18	58	DQ32	90	VSS	122	DQ57	154	DQ9
27	VSS	59	DQ30	91	CG	123	VSS	155	DQ7
28	A12	60	VDD3	92	CWE5	124	DQ55	156	VDD5
29	A13	61	DQ28	93	CWE7	125	DQ53	157	DQ5
30	ADSP	62	DQ26	94	CWE1	126	DQ51	158	DQ3
31	ECS1	63	DQ24	95	VDD5	127	DQ49	159	DQ1
32	ECS2	64	VSS	96	CWE3	128	VSS	160	VSS

**TOP VIEW – CASE TBD**



**PRESENCE DETECT TABLE**

Cache Size and Functionality	PD0	PD1	PD2	PD3
256K Pipe Burst	NC	NC	VSS	NC
512K Pipe Burst	VSS	VSS	NC	VSS

## PIN DESCRIPTIONS

160-Lead Card Edge Pin Locations	Symbol	Type	Description
20, 21, 22, 23, 24, 26, 28, 29, 101, 102, 103, 104, 106, 108, 109, 110	A3 – A18	Input	Address Inputs: These inputs are registered into data RAMs and must meet setup and hold times. The tag RAM addresses are not registered.
30	ADSP	Input	Address Status Processor: Initiates READ, WRITE, or chip deselect cycle. (Exception—chip deselect dGs not occur when ADSP is asserted and CCS is high.
114	BOSEL	Input	Burst Order Select: NC for interleaved burst counter. Tie to ground for linear burst counter.
18	BWE	Input	Byte Write Enable: To be used in future modules.
9	CADS	Input	Cache Address Status: Initiates READ, WRITE, or chip deselect cycle.
89	CADV	Input	Cache Burst Advance: Increments address count in accordance with interleaved count style.
16	CCS	Input	Chip Select: Active low chip enable for data RAMs.
91	CG	Input	Cache Output Enable: Active low asynchronous input. Low – enables output buffers (DQ pins) High – DQx pins are high impedance.
36, 116	CLK0, CLK1	Input	Clock: This signal registers the address, data in, and all control signals except CG.
11, 12, 13, 14, 92, 93, 94, 96	CWE0 – CWE7	Input	Cache Data Byte Write Enable: Active low write signal for data RAMs.
38, 40, 41, 42, 44, 45, 46, 47, 49, 50, 51, 53, 54, 55, 57, 58, 59, 61, 62, 63, 65, 66, 67, 69, 70, 71, 73, 74, 75, 77, 78, 79, 118, 120, 121, 122, 124, 125, 126, 127, 129, 130, 131, 133, 134, 135, 137, 138, 139, 141, 142, 143, 145, 146, 147, 149, 150, 151, 153, 154, 155, 157, 158, 159	DQ0 – DQ63	I/O	Synchronous Data I/O: Drives data out of data RAMs during READ cycles. Stores data to data RAMs during WRITE cycles.
31, 32	ECS1, ECS2	Input	Expansion Chip Select
17	GWE	Input	Global Write Enable: To be used in future modules.
33, 34, 112, 113	PD0 – PD3	—	Presence Detect: See Presence Detect Table
2, 3, 4, 5, 6, 82, 83, 84, 85, 86, 88	TIO0 – TIO10	I/O	Tag RAM I/O: Drives data out during tag compare cycles. Stores data to tag RAM during tag WRITE cycles.
8	TWE	Input	Tag Write Enable: Active low write signal for tag RAMs.
7, 15, 25, 39, 52, 60, 68, 76	VDD3	Supply	Power Supply: 3.3 V + 10%, – 5%.
87, 95, 105, 119, 132, 140, 148, 156	VDD5	Supply	Power Supply: 5.0 V ± 5%.
1, 10, 19, 27, 35, 37, 43, 48, 56, 64, 72, 80, 81, 90, 99, 107, 115, 117, 123, 128, 136, 144, 152, 160	VSS	Supply	Ground.
100, 111	RSVD	—	No Connection: Reserved for future use.
97, 98	NC	—	No Connection: There is no connection to the module.

**SYNCHRONOUS TRUTH TABLE** (See Notes 1, 2, and 3)

CCS	ADSP	CADS	CADV	CWEx	CLK0	Address Used	Operation
H	X	L	X	X	L-H	N/A	Deselected
L	L	X	X	X	L-H	External Address	Read Cycle, Begin Burst
L	H	L	X	L	L-H	External Address	Write Cycle, Begin Burst
L	H	L	X	H	L-H	External Address	Read Cycle, Begin Burst
X	H	H	L	L	L-H	Next Address	Write Cycle, Continue Burst
X	H	H	L	H	L-H	Next Address	Read Cycle, Continue Burst
X	H	H	H	L	L-H	Current Address	Write Cycle, Suspend Burst
X	H	H	H	H	L-H	Current Address	Read Cycle, Suspend Burst
H	X	H	L	L	L-H	Next Address	Write Cycle, Continue Burst
H	X	H	L	H	L-H	Next Address	Read Cycle, Continue Burst
H	X	H	H	L	L-H	Current Address	Write Cycle, Suspend Burst
H	X	H	H	H	L-H	Current Address	Read Cycle, Suspend Burst

NOTES:

1. X means Don't Care.
2. All inputs except CG must meet setup and hold times for the low-to-high transition of clock (CLK0/1).
3. Wait states are inserted by suspending burst.

**ASYNCHRONOUS TRUTH TABLE** (See Notes 1 and 2)

Operation	CG	I/O Status
Read	L	Data Out
Read	H	High-Z
Write	X	High-Z — Data In
Deselected	X	High-Z

NOTES:

1. X means Don't Care.
2. For a write operation following a read operation, G must be high before the input data required setup time and held high through the input data hold time.

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

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{DD3}$	- 0.5 to + 4.6	V
Voltage Relative to $V_{SS}$	$V_{in}, V_{out}$	$V_{SS} - 0.5$ to $V_{DD3} + 0.5$	V
Output Current (per I/O)	$I_{out}$	$\pm 20$	mA
Temperature Under Bias	$T_{bias}$	- 10 to + 85	°C
Operating Temperature	$T_A$	0 to +70	°C
Storage Temperature	$T_{stg}$	- 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.

This BiCMOS memory circuit has been designed to meet the dc and ac specifications shown in the tables, after thermal equilibrium has been established.

This device contains circuitry that will ensure the output devices are in High-Z at power up.

**DC OPERATING CONDITIONS AND CHARACTERISTICS**  
 ( $V_{DD} = 3.3\text{ V} + 10\%, -5\%$ ,  $T_J = 20\text{ to }+110^\circ\text{C}$ , Unless Otherwise Noted)

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

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage (Operating Voltage Range)	$V_{DD}$	3.135	3.6	V	1
Input High Voltage	$V_{IH}$	2.0	$V_{DD} + 0.3$	V	2
Input Low Voltage	$V_{IL}$	-0.5	0.8	V	3

NOTES:

- JEDEC specification 8-1A specifies  $\pm 0.3\text{ V}$  tolerance for  $V_{DD}$ .
- $V_{IH}(\text{max}) = V_{DD} + 0.3\text{ V}$  dc;  $V_{IH}(\text{max}) = V_{DD} + 2.0\text{ V}$  ac (pulse width  $\leq 20\text{ ns}$ ) for  $I \leq 20.0\text{ mA}$ .
- $V_{IL}(\text{min}) = -0.5\text{ V}$  dc;  $V_{IL}(\text{min}) = -2.0\text{ V}$  ac (pulse width  $\leq 20\text{ ns}$ ) for  $I \leq 20.0\text{ mA}$ .

**DC CHARACTERISTICS**

Parameter	Symbol	Min	Max	Unit	Notes
Input Leakage Current (All Inputs, $V_{in} = 0\text{ to }V_{DD3}$ )	$I_{lkg(I)}$	—	$\pm 1.0$	$\mu\text{A}$	
Output Leakage Current ( $CG = V_{IH}$ )	$I_{lkg(O)}$	—	$\pm 1.0$	$\mu\text{A}$	
TTL Output Low Voltage ( $I_{OL} = +8.0\text{ mA}$ )	$V_{OL}$	—	0.4	V	1
TTL Output High Voltage ( $I_{OH} = -4.0\text{ mA}$ )	$V_{OH}$	2.4	—	V	1

NOTES:

- Champing diodes exist to  $V_{SS}$  and  $V_{DD}$ .

**POWER SUPPLY CURRENTS**

Parameter	Symbol	Max	Unit
AC Supply Current ( $CG = V_{IH}$ , $CCS = V_{IL}$ , $I_{out} = 0\text{ mA}$ , All Inputs = $V_{IL}$ or $V_{IH}$ , $V_{IL} = 0.0\text{ V}$ and $V_{IH} \geq 3.0\text{ V}$ , Cycle Time $\geq t_{KHKH}$ min)	MCM64PD32 MCM64PD64 $I_{DDA}$	720 880	mA
AC Standby Current ( $CG = V_{IH}$ , $CCS = V_{IL}$ , $I_{out} = 0\text{ mA}$ , All Inputs = $V_{IL}$ or $V_{IH}$ , $V_{IL} = 0.0\text{ V}$ and $V_{IH} \geq 3.0\text{ V}$ , Cycle Time $\geq t_{KHKH}$ min)	MCM64PD32 MCM64PD64 $I_{SB1}$	200 490	mA

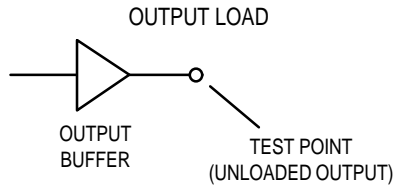
**CAPACITANCE** ( $f = 1.0\text{ MHz}$ ,  $dV = 3.0\text{ V}$ ,  $T_J = 20\text{ to }110^\circ\text{C}$ , Periodically Sampled Rather Than 100% Tested)

Parameter	Symbol	Max	Unit
Input Capacitance	MCM64PD32 MCM64PD64 $C_{in}$	22 32	pF
Input/Output Capacitance (DQ0 – DQ63)	MCM64PD32 MCM64PD64 $C_{I/O}$	8 16	pF

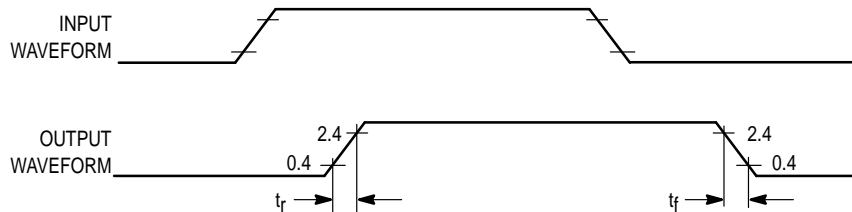
## DATA RAMs AC OPERATING CONDITIONS AND CHARACTERISTICS

( $V_{DD} = 3.3\text{ V} + 10\%, -5\%$   $T_J = 20\text{ to } +110^\circ\text{C}$ , Unless Otherwise Noted)

Input Timing Measurement Reference Level . . . . . 1.5 V	Output Timing Reference Level . . . . . 1.5 V
Input Pulse Levels . . . . . 0 to 3.0 V	Output Load . . . . . See Figure 3 Unless Otherwise Noted
Input Rise/Fall Time . . . . . 2 ns	



### UNLOADED RISE AND FALL TIME MEASUREMENT



**NOTES:**

1. Input waveform has a slew rate of 1 V/ns.
2. Rise time is measured from 0.4 V to 2.4 V unloaded.
3. Fall time is measured from 2.4 V to 0.4 V unloaded.

**Figure 1. Unloaded Rise and Fall Time Characterization**



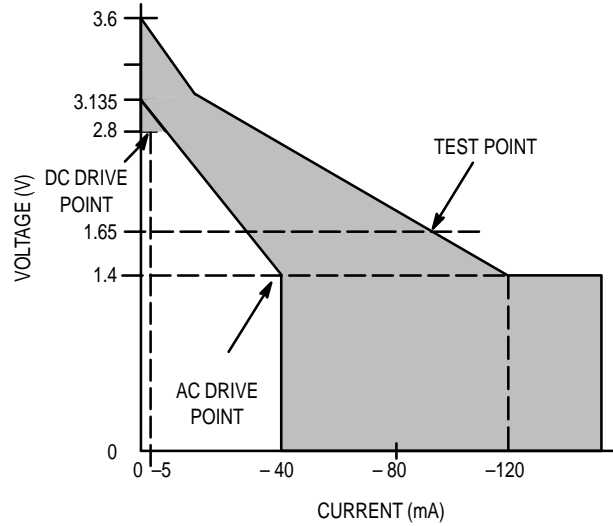
**DATA RAMs READ/WRITE CYCLE TIMING** (See Notes 1, 2, and 3)

Parameter	Symbol	MCM64PD32-66		Unit	Notes	
		Min	Max			
Cycle Time	t <sub>KHKH</sub>	15	—	ns		
Clock Access Time	t <sub>KHQV</sub>	—	8	ns	5	
Output Enable to Output Valid	t <sub>GLQV</sub>	—	6	ns	5	
Clock High to Output Active	t <sub>KHQX1</sub>	0	—	ns	5, 7	
Clock High to Output Change	t <sub>KHQX2</sub>	2	—	ns	5, 7	
Output Enable to Output Active	t <sub>GLQX</sub>	0	—	ns	5, 7	
Output Disable to Q High-Z	t <sub>GHQZ</sub>	—	8	ns	6, 7	
Clock High to Q High-Z	t <sub>KHQZ</sub>	2	8	ns	6, 7	
Clock High Pulse Width	t <sub>KHKL</sub>	5	—	ns		
Clock Low Pulse Width	t <sub>KLKH</sub>	5	—	ns		
Setup Times:	Address Address Status Data In Write Address Advance Chip Enable	t <sub>AVKH</sub> t <sub>ADSVKH</sub> t <sub>DVKH</sub> t <sub>WVKH</sub> t <sub>ADVVKH</sub> t <sub>EVKH</sub>	2.5	—	ns	4
Hold Times:	Address Address Status Data In Write Address Advance Chip Enable	t <sub>KHAX</sub> t <sub>KHADSX</sub> t <sub>KHDX</sub> t <sub>KHWX</sub> t <sub>KHADVX</sub> t <sub>KHEX</sub>	0.5	—	ns	4

**NOTES:**

1. Write applies to all SBx, SW, and SGW signals when the chip is selected and ADSP high.
2. Chip Enable applies to all SE1, SE2 and SE3 signals whenever ADSP or ADSC is asserted.
3. All read and write cycle timings are referenced from K or G.
4. G is a don't care after write cycle begins. To prevent bus contention, G should be negated prior to start of write cycle.
5. Tested per AC Test Load.
6. Measured at ± 200 mV from steady state. Tested per High-Z Test Load.
7. This parameter is sampled and is not 100% tested.

PULL-UP		
VOLTAGE (V)	I (mA) Min	I (mA) Max
-0.5	-40	-120
0	-40	-120
1.4	-40	-120
1.65	-37	-104
2	-28	-81
3.135	0	-20
3.6	0	0

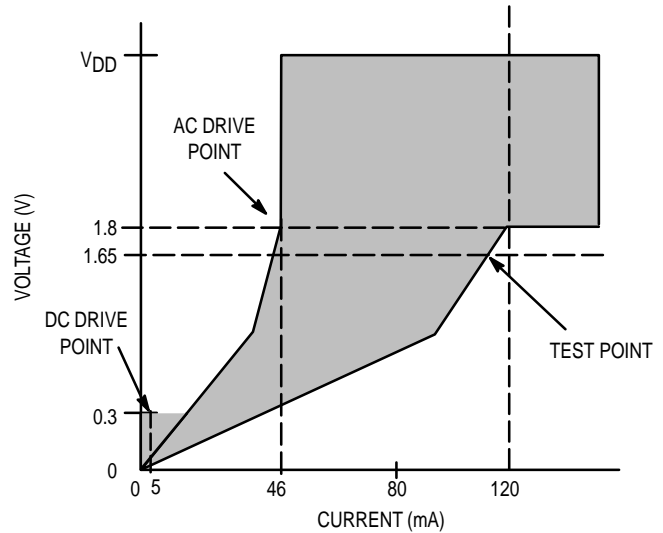


NOTES:

1. Driver impedance @ 1.65 V = 15.9 to 44.6  $\Omega$ .
2. Meets the temperature and voltage range specified in DC Characteristics tables.
3. This drawing is not to scale. Comparisons should be made to the table in Figure 2a.

(a) Pull-Up

PULL-DOWN		
VOLTAGE (V)	I (mA) Min	I (mA) Max
-0.5	-34	-126
0	0	0
0.5	17	47
1	35	90
1.65	45	114
1.8	46	120
3.6	46	120
4	46	120



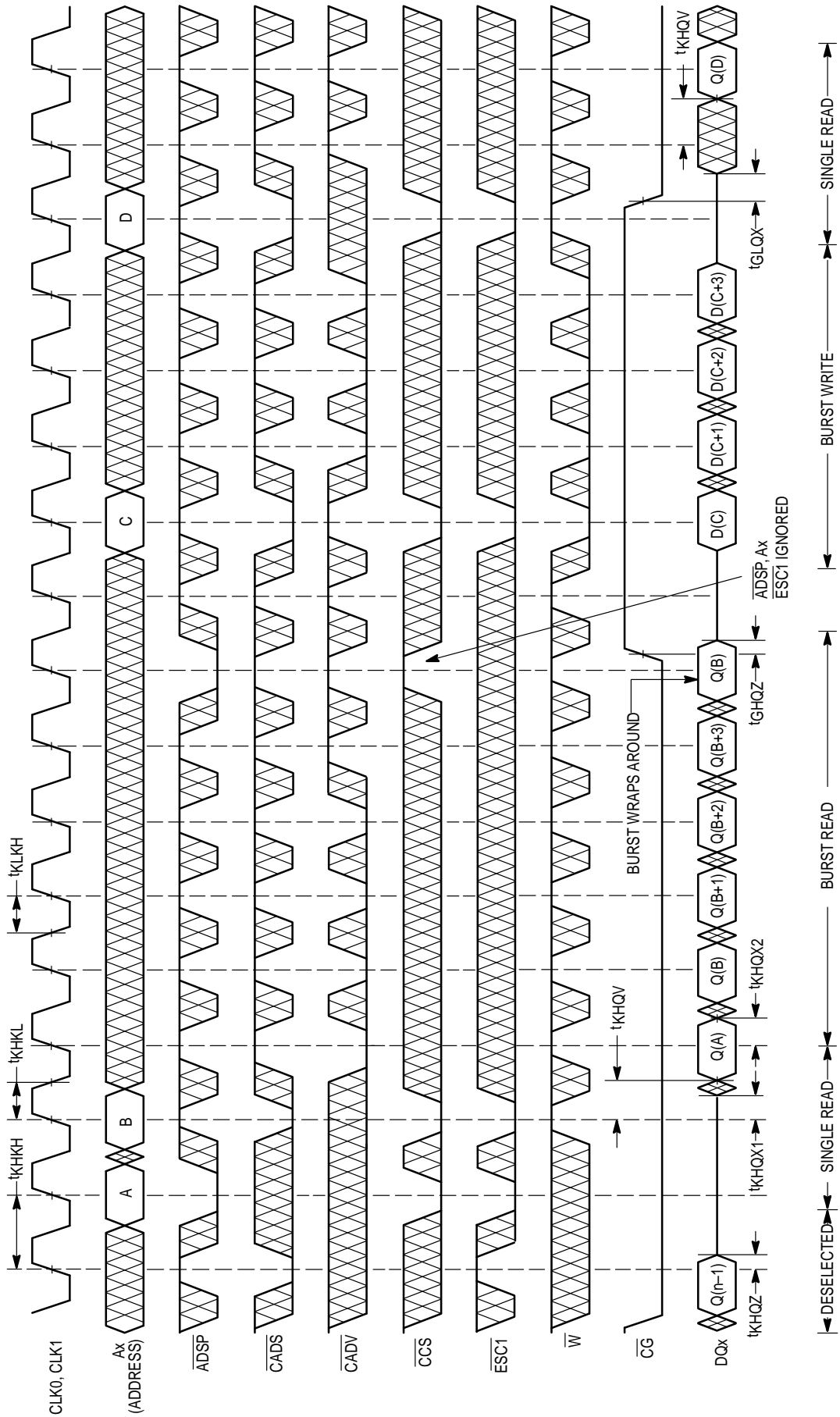
NOTES:

1. Driver impedance @ 1.65 V = 15.9 to 44.6  $\Omega$ .
2. Meets the temperature and voltage range specified in DC Characteristics tables.
3. This drawing is not to scale. Comparisons should be made to the table in Figure 2b.

(b) Pull-Down

Figure 2. Output Buffer Characteristics

DATA RAMs READ/WRITE CYCLES



Note:  $\overline{W}$  low =  $\overline{GWE}$  low and/or  $\overline{BWE}$  and  $\overline{CWEX}$  low.

## TAG RAM AC OPERATING CONDITIONS AND CHARACTERISTICS

( $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$ ,  $T_J = 20 \text{ to } +110^\circ\text{C}$ , Unless Otherwise Noted)

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

Output Timing Measurement Reference Level ..... 1.5 V  
 Output Load ..... Figure 3a Unless Otherwise Noted

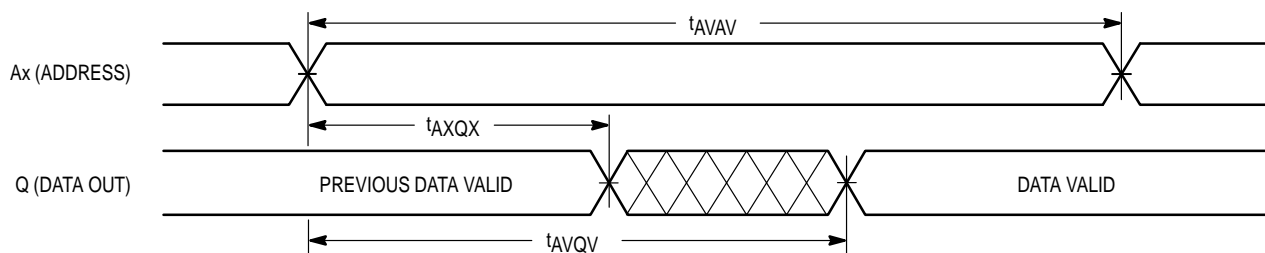
### TAG RAM READ CYCLE (See Note 1 and 5)

Parameter	Symbol	- 15		Unit	Notes
		Min	Max		
Read Cycle Time	$t_{AVAV}$	15	—	ns	2
Address Access Time	$t_{AVQV}$	—	15	ns	
Output Hold from Address Change	$t_{AXQX}$	4	—	ns	3, 4

#### NOTES:

1.  $CWE$  is high for read cycle.
2. All timings are referenced from the last valid address to the first address transition.
3. Transition is measured  $\pm 500 \text{ mV}$  from steady-state voltage with load of Figure 3b.
4. This parameter is sampled and not 100% tested.
5. Device is continuously selected ( $CG = V_{IL}$ ).

### TAG RAM READ CYCLE (See Note 5)



#### 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.

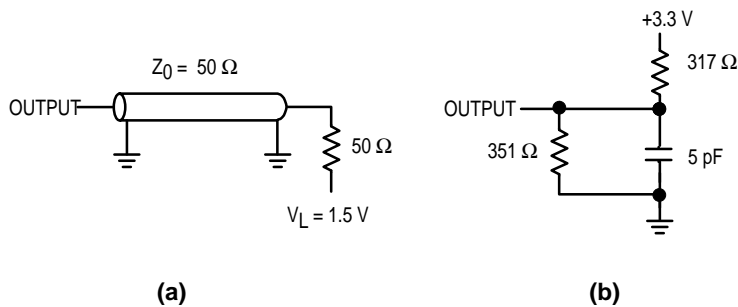


Figure 3. AC Test Loads

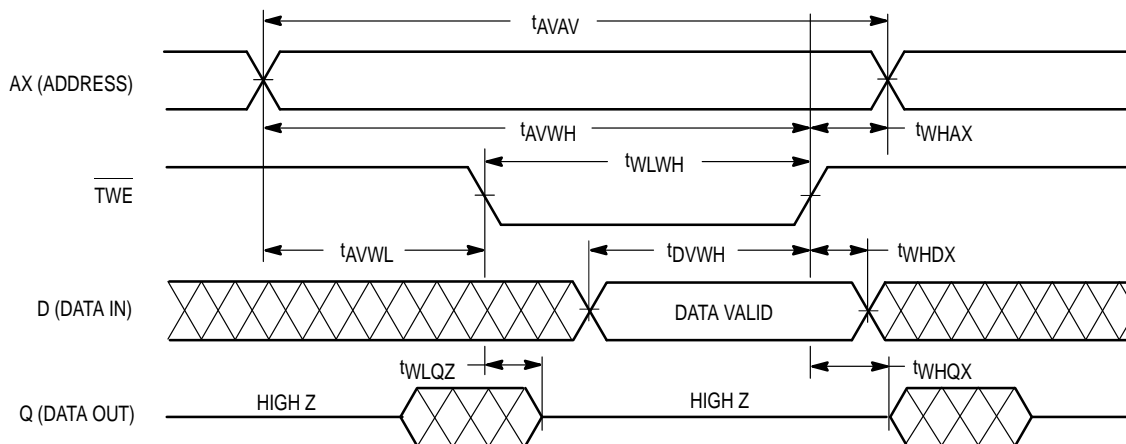
**TAG RAM WRITE CYCLE** (See Notes 1 and 2)

Parameter	Symbol	- 15		Unit	Notes
		Min	Max		
Write Cycle Time	$t_{AVAV}$	15	—	ns	3
Address Setup Time	$t_{AVWL}$	0	—	ns	
Address Valid to End of Write	$t_{AVWH}$	12	—	ns	
Data Valid to End of Write	$t_{DVWH}$	7	—	ns	
Data Hold Time	$t_{WHDX}$	0	—	ns	
Write Low to Output High-Z	$t_{WLQZ}$	0	7	ns	5,6,7
Write High to Output Active	$t_{WHQX}$	4	—	ns	5,6,7
Write Recovery Time	$t_{WHAX}$	0	—	ns	

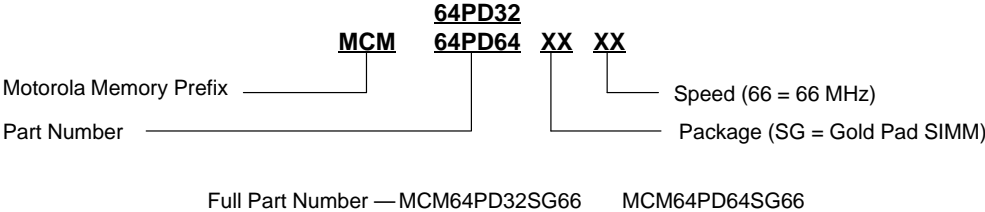
NOTES:

1. A write occurs when  $\overline{CWE}$  is low.
2. If CG goes low coincident with or after  $\overline{CWE}$  goes low, the output will remain in a high impedance state.
3. All timings are referenced from the last valid address to the first address transition.
4. If  $CG \geq V_{IH}$ , the output will remain in a high impedance state.
5. At any given voltage and temperature,  $t_{WLQZ}$  (max) is less than  $t_{WHQX}$  (min), both for a given device and from device to device.
6. Transition is measured  $\pm 500$  mV from steady-state voltage with load of Figure 3B.
7. This parameter is sampled and not 100% tested.

**TAG RAM WRITE CYCLE** (See Notes 1 and 2)

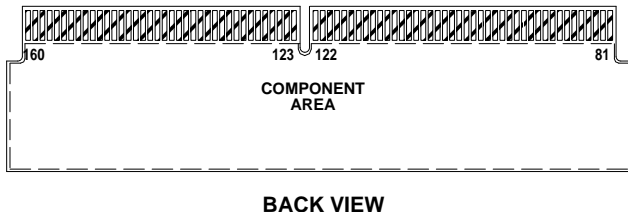
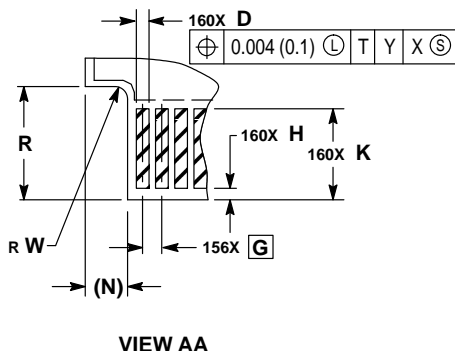
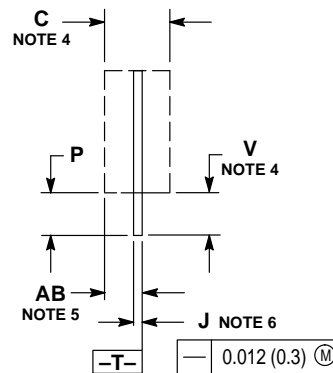
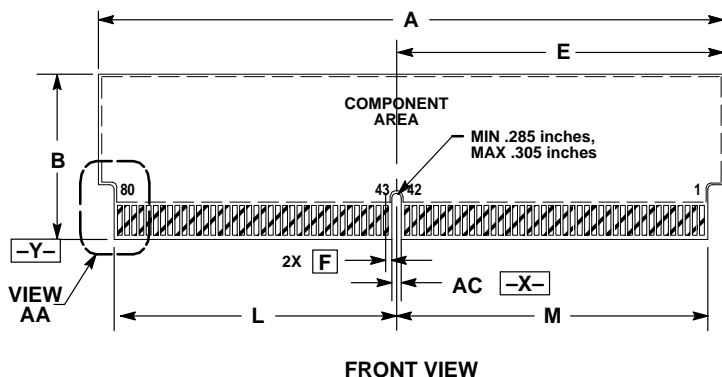


**ORDERING INFORMATION**  
(Order by Full Part Number)



# PACKAGE DIMENSIONS

160-LEAD  
CARD EDGE MODULE  
CASE TBD



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. CARD THICKNESS APPLIES ACROSS TABS AND INCLUDES PLATING AND/OR METALLIZATION.
  4. DIMENSIONS C AND V DEFINE A DOUBLE-SIDED MODULE.
  5. DIMENSION AB DEFINES OPTIONAL SINGLE-SIDED MODULE.
  6. STRAIGHTNESS CALLOUT APPLIES TO TAB AREA ONLY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	4.330	4.350	109.98	110.49
B	1.120	1.140	28.45	28.96
C	—	0.454	—	11.53
D	0.033	0.037	0.84	0.94
E	2.265	2.275	57.53	57.79
F	0.075 BSC		1.91 BSC	
G	0.050 BSC		1.27 BSC	
H	—	0.030	—	0.51
J	0.055	0.069	1.40	1.75
K	0.210	—	5.33	—
L	1.955	1.965	49.66	49.91
M	2.155	2.165	54.74	54.99
N	0.110 REF		2.79 REF	
P	0.300	—	7.62	—
R	0.492	0.512	7.24	7.75
V	0.300	—	7.62	—
W	0.040	0.060	1.02	1.52
AB	—	0.262	—	6.66
AC	0.072	0.076	1.83	1.93

NOTE: Case Outline number to be determined.

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