

# P4C1049/P4C1049L HIGH SPEED 512K x 8 STATIC CMOS RAM

## FEATURES

- High Speed (Equal Access and Cycle Times)
  - 15/20/25 ns (Commercial)
  - 20/25/35 ns (Industrial)
  - 20/25/35/45/55/70 ns (Military)
- Low Power
- Single 5V±10% Power Supply
- Easy Memory Expansion Using  $\overline{CE}$  and  $\overline{OE}$  Inputs
- Common Data I/O
- Three-State Outputs
- Fully TTL Compatible Inputs and Outputs
- Advanced CMOS Technology
- Automatic Power Down
- Packages
  - 36-Pin SOJ (400 mil)
  - 36-Pin FLATPACK
  - 36-Pin LCC (452 mil x 920 mil)

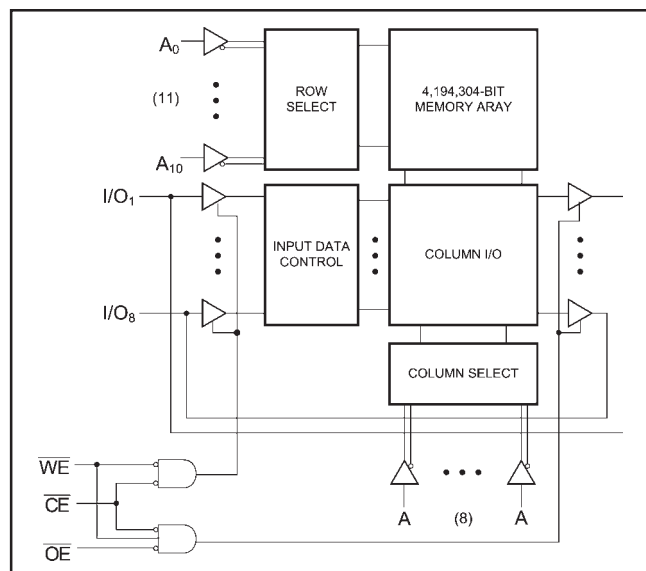
## DESCRIPTION

The P4C1049 is a 4 Megabit high-speed CMOS static RAM organized as 512Kx8. The CMOS memory requires no clocks or refreshing, and has equal access and cycle times. Inputs are fully TTL-compatible. The RAM operates from a single 5V±10% tolerance power supply.

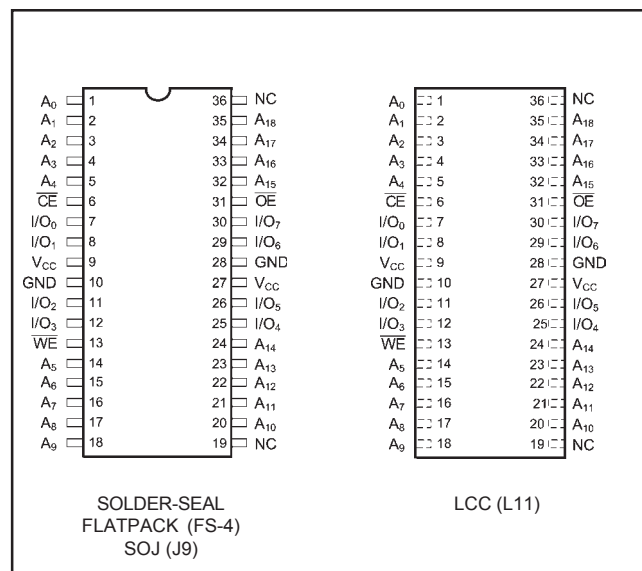
Access times as fast as 15 nanoseconds permit greatly enhanced system operating speeds. CMOS is utilized to reduce power consumption to a low level. The P4C1049 is a member of a family of PACE RAM™ products offering fast access times.

The P4C1049 device provides asynchronous operation with matching access and cycle times. Memory locations are specified on address pins  $A_0$  to  $A_{18}$ . Reading is accomplished by device selection ( $\overline{CE}$ ) and output enabling ( $\overline{OE}$ ) while write enable ( $\overline{WE}$ ) remains HIGH. By presenting the address under these conditions, the data in the addressed memory location is presented on the data input/output pins. The input/output pins stay in the HIGH Z state when either  $\overline{CE}$  or  $\overline{OE}$  is HIGH or  $\overline{WE}$  is LOW.

## FUNCTIONAL BLOCK DIAGRAM



## PIN CONFIGURATIONS



## MAXIMUM RATINGS<sup>(1)</sup>

| Symbol     | Parameter                                         | Value                  | Unit |
|------------|---------------------------------------------------|------------------------|------|
| $V_{CC}$   | Power Supply Pin with Respect to GND              | −0.5 to +7             | V    |
| $V_{TERM}$ | Terminal Voltage with Respect to GND (up to 7.0V) | −0.5 to $V_{CC} + 0.5$ | V    |
| $T_A$      | Operating Temperature                             | −55 to +125            | °C   |

## RECOMMENDED OPERATING TEMPERATURE AND SUPPLY VOLTAGE

| Grade(2)   | Ambient Temperature | GND | $V_{CC}$   |
|------------|---------------------|-----|------------|
| Military   | −55°C to +125°C     | 0V  | 5.0V ± 10% |
| Industrial | −40°C to +85°C      | 0V  | 5.0V ± 10% |
| Commercial | 0°C to +70°C        | 0V  | 5.0V ± 10% |

| Symbol     | Parameter              | Value       | Unit |
|------------|------------------------|-------------|------|
| $T_{BIAS}$ | Temperature Under Bias | −55 to +125 | °C   |
| $T_{STG}$  | Storage Temperature    | −65 to +150 | °C   |
| $P_T$      | Power Dissipation      | 1.0         | W    |
| $I_{OUT}$  | DC Output Current      | 50          | mA   |

## CAPACITANCES<sup>(4)</sup>

$V_{CC} = 5.0V$ ,  $T_A = 25^\circ C$ ,  $f = 1.0MHz$

| Symbol    | Parameter          | Conditions     | Typ. | Unit |
|-----------|--------------------|----------------|------|------|
| $C_{IN}$  | Input Capacitance  | $V_{IN} = 0V$  | 8    | pF   |
| $C_{OUT}$ | Output Capacitance | $V_{OUT} = 0V$ | 8    | pF   |

## DC ELECTRICAL CHARACTERISTICS

Over recommended operating temperature and supply voltage<sup>(2)</sup>

| Symbol    | Parameter                                        | Test Conditions                                                                                                | P4C1049             |                | P4C1049L            |                | Unit    |
|-----------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------|----------------|---------------------|----------------|---------|
|           |                                                  |                                                                                                                | Min                 | Max            | Min                 | Max            |         |
| $V_{IH}$  | Input High Voltage                               |                                                                                                                | 2.2                 | $V_{CC} + 0.3$ | 2.2                 | $V_{CC} + 0.3$ | V       |
| $V_{IL}$  | Input Low Voltage                                |                                                                                                                | −0.3 <sup>(3)</sup> | 0.8            | −0.3 <sup>(3)</sup> | 0.8            | V       |
| $V_{HC}$  | CMOS Input High Voltage                          |                                                                                                                | $V_{CC} - 0.2$      | $V_{CC} + 0.3$ | $V_{CC} - 0.2$      | $V_{CC} + 0.3$ | V       |
| $V_{LC}$  | CMOS Input Low Voltage                           |                                                                                                                | −0.3 <sup>(3)</sup> | 0.2            | −0.3 <sup>(3)</sup> | 0.2            | V       |
| $V_{OL}$  | Output Low Voltage (TTL Load)                    | $I_{OL} = +8\text{ mA}$ , $V_{CC} = \text{Min.}$                                                               |                     | 0.4            |                     | 0.4            | V       |
| $V_{OH}$  | Output High Voltage (TTL Load)                   | $I_{OH} = -4\text{ mA}$ , $V_{CC} = \text{Min.}$                                                               | 2.4                 |                | 2.4                 |                | V       |
| $I_{LI}$  | Input Leakage Current                            | $V_{CC} = \text{Max.}$ Mil.                                                                                    | −10                 | +10            | −5                  | +5             | $\mu A$ |
|           |                                                  | $V_{IN} = \text{GND to } V_{CC}$ Ind./Com'l.                                                                   | −5                  | +5             | n/a                 | n/a            |         |
| $I_{LO}$  | Output Leakage Current                           | $V_{CC} = \text{Max.}$ , Mil.                                                                                  | −10                 | +10            | −5                  | +5             | $\mu A$ |
|           |                                                  | $\overline{CE} = V_{IH}$ , Ind./Com'l.<br>$V_{OUT} = \text{GND to } V_{CC}$                                    | −5                  | +5             | n/a                 | n/a            |         |
| $I_{SB}$  | Standby Power Supply Current (TTL Input Levels)  | $\overline{CE} \geq V_{IH}$ Mil.                                                                               | —                   | 45             | —                   | 40             | mA      |
|           |                                                  | $V_{CC} = \text{Max.}$ , Ind./Com'l.<br>$f = \text{Max.}$ , Outputs Open                                       | —                   | 40             | —                   | n/a            |         |
| $I_{SB1}$ | Standby Power Supply Current (CMOS Input Levels) | $\overline{CE} \geq V_{HC}$ Mil.                                                                               | —                   | 15             | —                   | 10             | mA      |
|           |                                                  | $V_{CC} = \text{Max.}$ , Ind./Com'l.<br>$f = 0$ , Outputs Open<br>$V_{IN} \leq V_{LC}$ or $V_{IN} \geq V_{HC}$ | —                   | 10             | —                   | n/a            |         |

N/A = Not Applicable

**DATA RETENTION CHARACTERISTICS (P4C1049L Military Temperature Only)**

| Symbol        | Parameter                            | Test Conditions                                                                             | Min         | Typ.*<br>$V_{CC} = 3.0V$ | Max<br>$V_{CC} = 3.0V$ | Unit |
|---------------|--------------------------------------|---------------------------------------------------------------------------------------------|-------------|--------------------------|------------------------|------|
| $V_{DR}$      | $V_{CC}$ for Data Retention          |                                                                                             | 3.0         |                          |                        | V    |
| $I_{CCDR}$    | Data Retention Current               | $\overline{CE} \geq V_{CC} - 0.2V,$<br>$V_{IN} \geq V_{CC} - 0.2V$<br>or $V_{IN} \leq 0.2V$ |             | 2                        | 3                      | mA   |
| $t_{CDR}$     | Chip Deselect to Data Retention Time |                                                                                             | 0           |                          |                        | ns   |
| $t_R^\dagger$ | Operation Recovery Time              |                                                                                             | $t_{RC}^\S$ |                          |                        | ns   |

\* $T_A = +25^\circ C$  $^\S t_{RC}$  = Read Cycle Time $^\dagger$  This parameter is guaranteed but not tested.**DATA RETENTION WAVEFORM****POWER DISSIPATION CHARACTERISTICS VS. SPEED**

| Symbol   | Parameter                  | Temperature Range | -15 | -20 | -25 | -35 | -45 | -55 | -70 | Unit |
|----------|----------------------------|-------------------|-----|-----|-----|-----|-----|-----|-----|------|
| $I_{CC}$ | Dynamic Operating Current* | Commercial        | 220 | 185 | 180 | N/A | N/A | N/A | N/A | mA   |
|          |                            | Industrial        | N/A | 190 | 185 | 175 | N/A | N/A | N/A | mA   |
|          |                            | Military          | N/A | 200 | 195 | 185 | 175 | 170 | 165 | mA   |

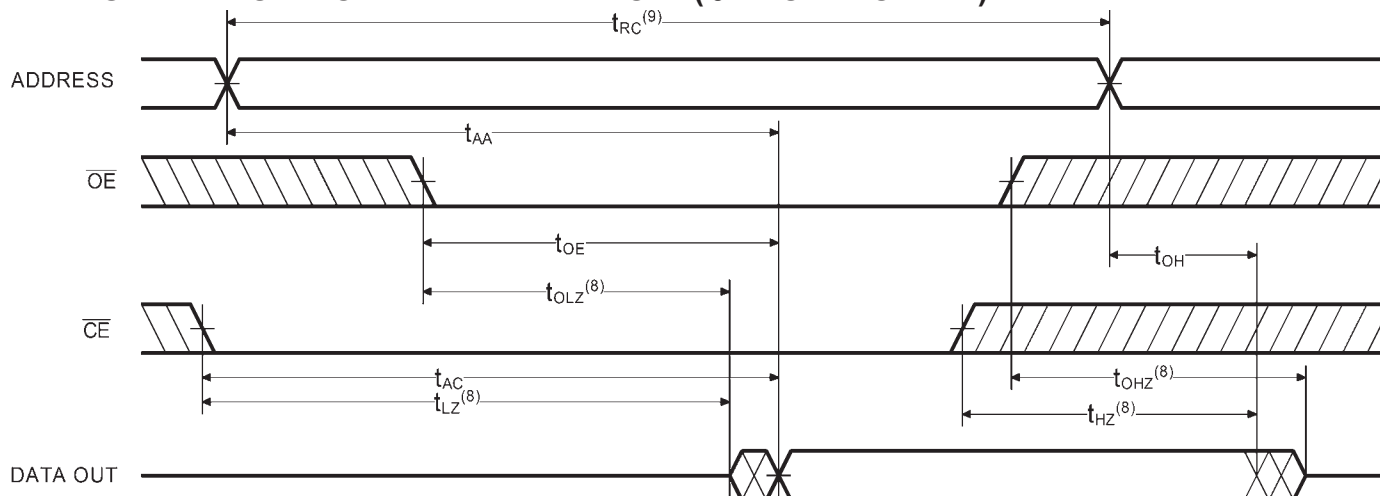
\* $V_{CC} = 5.5V$ . Tested with outputs open.  $f = \text{Max}$ . Switching inputs are 0V and 3V.  $\overline{CE} = V_{IL}$ ,  $\overline{OE} = V_{IH}$ .

## AC ELECTRICAL CHARACTERISTICS—READ CYCLE

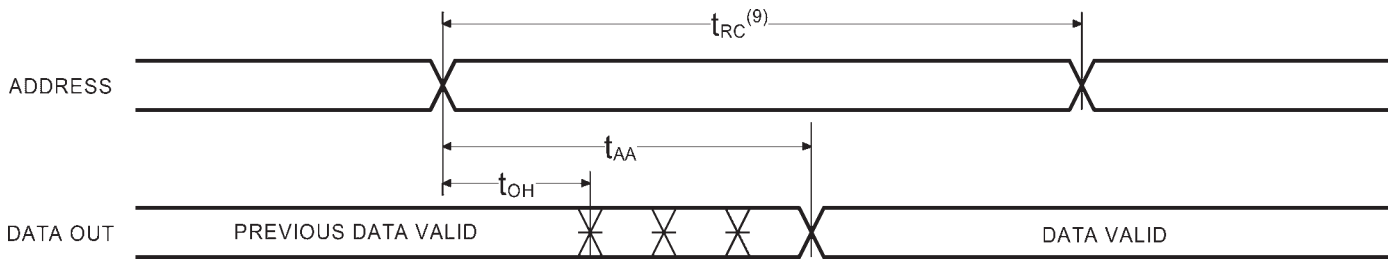
( $V_{CC} = 5V \pm 10\%$ , All Temperature Ranges)<sup>(2)</sup>

| Sym.      | Parameter                        | -15 |     | -20 |     | -25 |     | -35 |     | -45 |     | -55 |     | -70 |     | Unit |
|-----------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|           |                                  | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |      |
| $t_{RC}$  | Read Cycle Time                  | 15  |     | 20  |     | 25  |     | 35  |     | 45  |     | 55  |     | 70  |     | ns   |
| $t_{AA}$  | Address Access Time              |     | 15  |     | 20  |     | 25  |     | 35  |     | 45  |     | 55  |     | 70  | ns   |
| $t_{AC}$  | Chip Enable Access Time          |     | 15  |     | 20  |     | 25  |     | 35  |     | 45  |     | 55  |     | 70  | ns   |
| $t_{OH}$  | Output Hold from Address Change  | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | ns   |
| $t_{LZ}$  | Chip Enable to Output in Low Z   | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | 3   |     | ns   |
| $t_{HZ}$  | Chip Disable to Output in High Z |     | 8   |     | 9   |     | 11  |     | 15  |     | 20  |     | 25  |     | 30  | ns   |
| $t_{OE}$  | Output Enable Low to Data Valid  |     | 7   |     | 9   |     | 10  |     | 15  |     | 20  |     | 25  |     | 30  | ns   |
| $t_{OLZ}$ | Output Enable Low to Low Z       | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | ns   |
| $t_{OHZ}$ | Output Enable High to High Z     |     | 7   |     | 9   |     | 10  |     | 15  |     | 20  |     | 25  |     | 30  | ns   |
| $t_{PU}$  | Chip Enable to Power Up Time     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | ns   |
| $t_{PD}$  | Chip Disable to Power Down Time  |     | 15  |     | 20  |     | 25  |     | 35  |     | 45  |     | 55  |     | 70  | ns   |

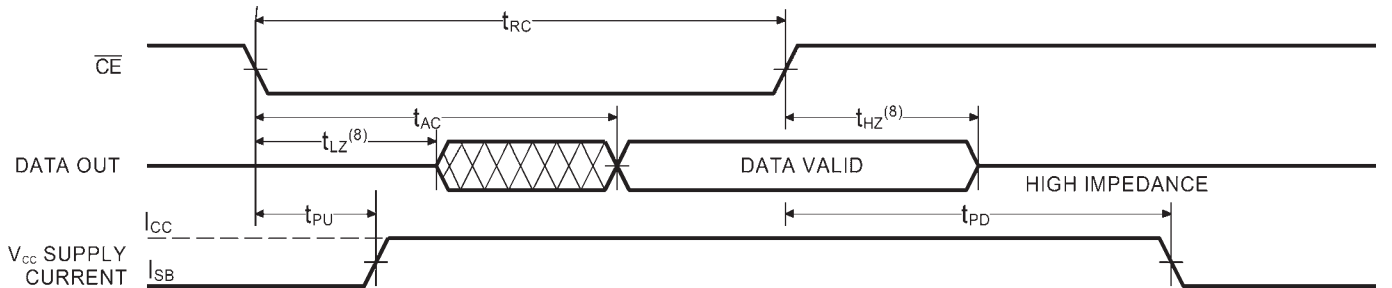
### TIMING WAVEFORM OF READ CYCLE NO. 1 ( $\overline{OE}$ CONTROLLED)<sup>(5)</sup>



## TIMING WAVEFORM OF READ CYCLE NO. 2 (ADDRESS CONTROLLED)<sup>(5,6)</sup>



## TIMING WAVEFORM OF READ CYCLE NO. 3 ( $\overline{CE}$ CONTROLLED)<sup>(5,7)</sup>



### Notes:

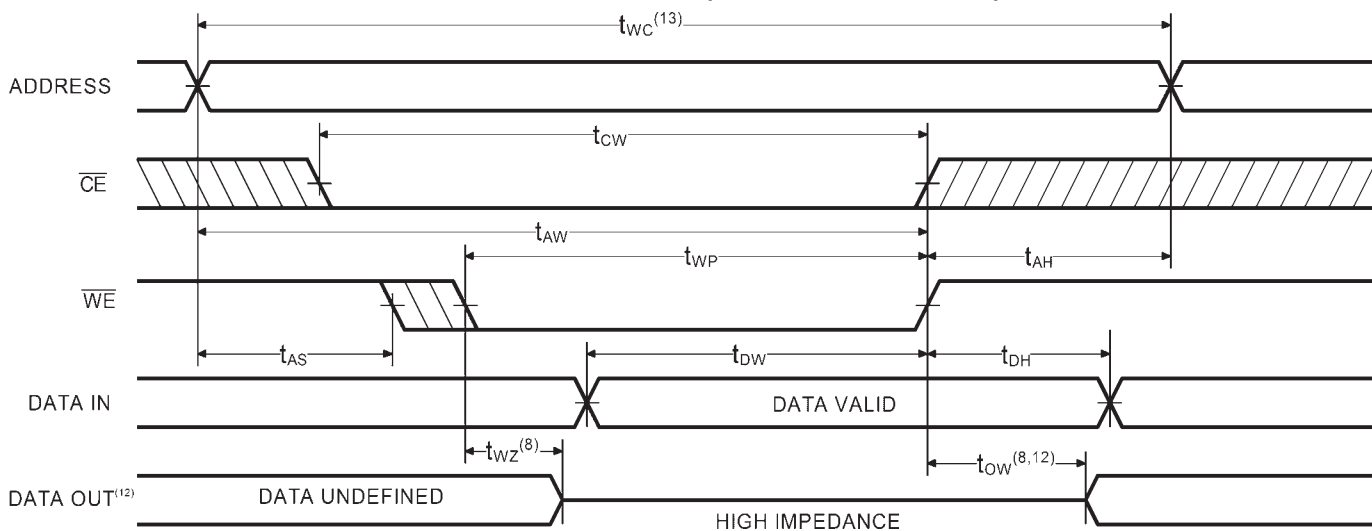
1. Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to MAXIMUM rating conditions for extended periods may affect reliability.
2. Extended temperature operation guaranteed with 400 linear feet per minute of air flow.
3. Transient inputs with  $V_{IL}$  and  $I_{IL}$  not more negative than  $-2.0V$  and  $-100mA$ , respectively, are permissible for pulse widths up to 20 ns.
4. This parameter is sampled and not 100% tested.
5.  $\overline{WE}$  is HIGH for READ cycle.
6.  $\overline{CE}$  is LOW and  $\overline{OE}$  is LOW for READ cycle.
7. ADDRESS must be valid prior to, or coincident with  $\overline{CE}$  transition LOW.
8. Transition is measured  $\pm 200$  mV from steady state voltage prior to change, with loading as specified in Figure 1. This parameter is sampled and not 100% tested.
9. Read Cycle Time is measured from the last valid address to the first transitioning address.

## AC CHARACTERISTICS—WRITE CYCLE

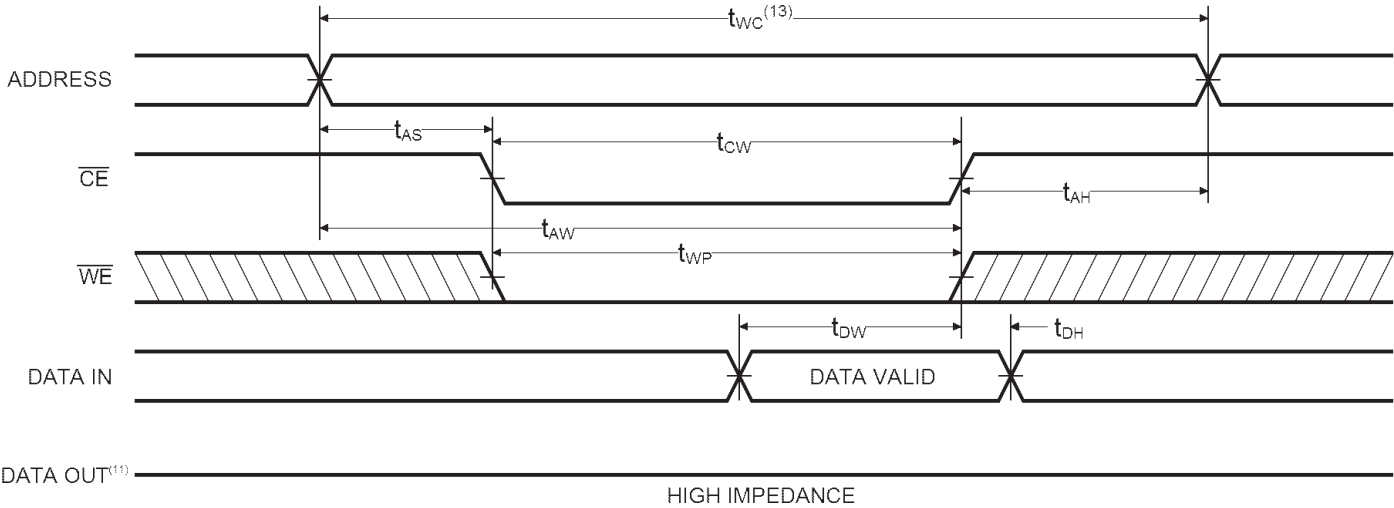
( $V_{CC} = 5V \pm 10\%$ , All Temperature Ranges)<sup>(2)</sup>

| Sym.     | Parameter                        | -15 |     | -20 |     | -25 |     | -35 |     | -45 |     | -55 |     | -70 |     | Unit |
|----------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|          |                                  | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |      |
| $t_{WC}$ | Write Cycle Time                 | 15  |     | 20  |     | 25  |     | 35  |     | 45  |     | 55  |     | 70  |     | ns   |
| $t_{CW}$ | Chip Enable Time to End of Write | 12  |     | 14  |     | 18  |     | 22  |     | 30  |     | 35  |     | 40  |     | ns   |
| $t_{AW}$ | Address Valid to End of Write    | 12  |     | 14  |     | 16  |     | 20  |     | 25  |     | 35  |     | 40  |     | ns   |
| $t_{AS}$ | Address Set-up Time              | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | ns   |
| $t_{WP}$ | Write Pulse Width                | 12  |     | 14  |     | 16  |     | 22  |     | 25  |     | 30  |     | 35  |     | ns   |
| $t_{AH}$ | Address Hold Time                | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | ns   |
| $t_{DW}$ | Data Valid to End of Write       | 9   |     | 11  |     | 13  |     | 15  |     | 20  |     | 25  |     | 30  |     | ns   |
| $t_{DH}$ | Date Hold Time                   | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | 0   |     | ns   |
| $t_{WZ}$ | Write Enable to Output in High Z |     | 8   |     | 10  |     | 11  |     | 15  |     | 18  |     | 25  |     | 30  | ns   |
| $t_{OW}$ | Output Active from End of Write  | 3   |     | 3   |     | 3   |     | 5   |     | 5   |     | 5   |     | 5   |     | ns   |

### TIMING WAVEFORM OF WRITE CYCLE NO. 1 ( $\overline{WE}$ CONTROLLED)<sup>(10,11)</sup>



**TIMING WAVEFORM OF WRITE CYCLE NO. 2 ( $\overline{\text{CE}}$  CONTROLLED)<sup>(10)</sup>**



**Notes:**

- 10.  $\overline{\text{CE}}$  and  $\overline{\text{WE}}$  must be LOW for WRITE cycle.
- 11.  $\overline{\text{OE}}$  is LOW for this WRITE cycle to show  $t_{\text{WZ}}$  and  $t_{\text{OW}}$ .
- 12. If  $\overline{\text{CE}}$  goes HIGH simultaneously with  $\overline{\text{WE}}$  HIGH, the output remains in a high impedance state
- 13. Write Cycle Time is measured from the last valid address to the first transitioning address.

## AC TEST CONDITIONS

|                               |                     |
|-------------------------------|---------------------|
| Input Pulse Levels            | GND to 3.0V         |
| Input Rise and Fall Times     | 3ns                 |
| Input Timing Reference Level  | 1.5V                |
| Output Timing Reference Level | 1.5V                |
| Output Load                   | See Figures 1 and 2 |

## TRUTH TABLE

| Mode                      | $\overline{CE}$ | $\overline{OE}$ | $\overline{WE}$ | I/O              | Power   |
|---------------------------|-----------------|-----------------|-----------------|------------------|---------|
| Standby                   | H               | X               | X               | High Z           | Standby |
| Standby                   | X               | X               | X               | High Z           | Standby |
| D <sub>OUT</sub> Disabled | L               | H               | H               | High Z           | Active  |
| Read                      | L               | L               | H               | D <sub>OUT</sub> | Active  |
| Write                     | L               | X               | L               | High Z           | Active  |

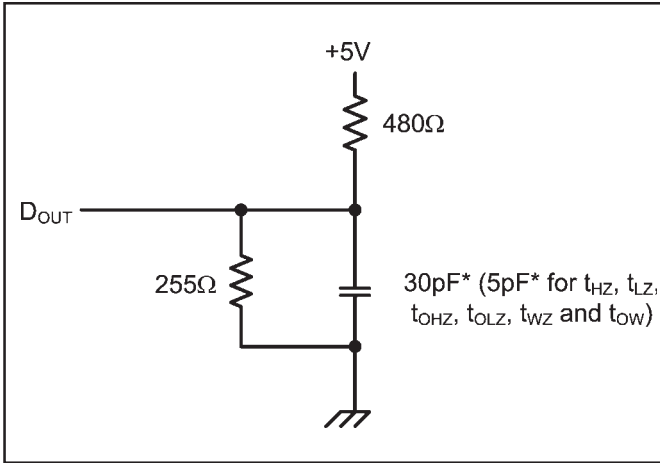


Figure 1. Output Load

\* including scope and test fixture.

### Note:

Because of the ultra-high speed of the P4C1049, care must be taken when testing this device; an inadequate setup can cause a normal functioning part to be rejected as faulty. Long high-inductance leads that cause supply bounce must be avoided by bringing the V<sub>CC</sub> and ground planes directly up to the contactor fingers. A 0.01 μF high frequency capacitor is also required between V<sub>CC</sub> and ground. To avoid

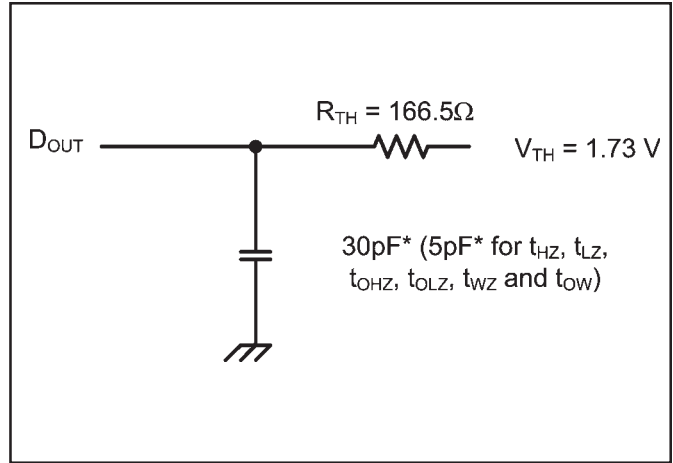


Figure 2. Thevenin Equivalent

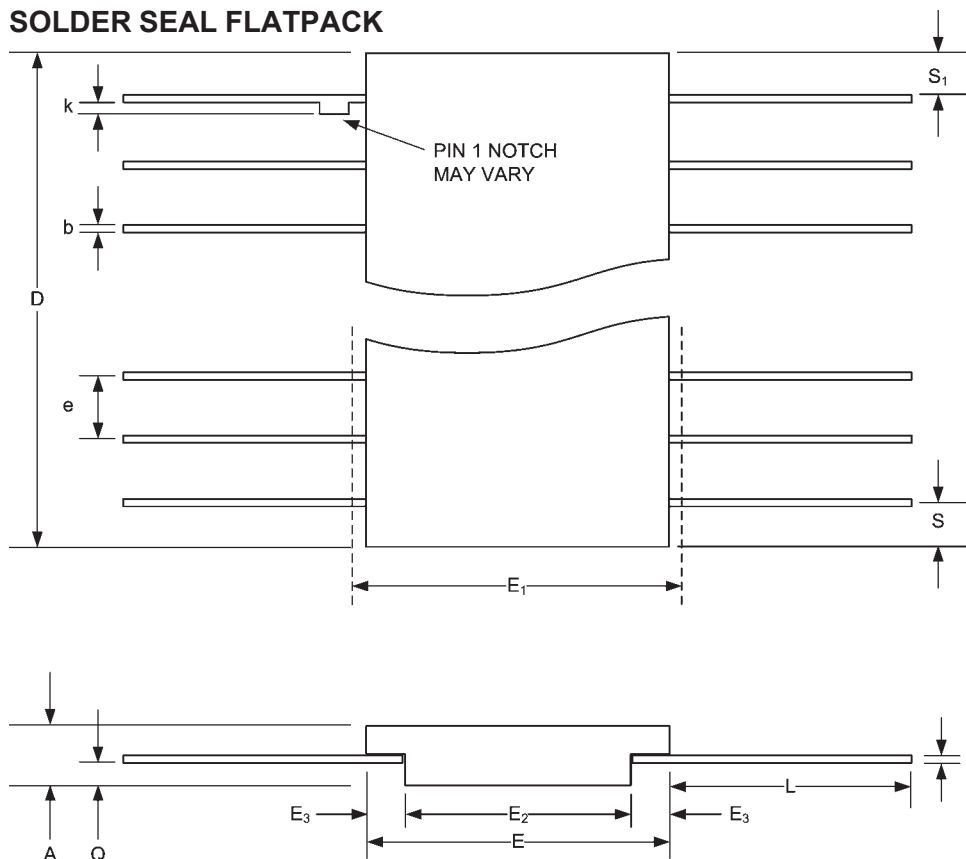
signal reflections, proper termination must be used; for example, a 50Ω test environment should be terminated into a 50Ω load with 1.73V (Thevenin Voltage) at the comparator input, and a 116Ω resistor must be used in series with D<sub>OUT</sub> to match 166Ω (Thevenin Resistance).

ORDERING INFORMATION

| P4C1049     | L         | — | xx    | x       | x          |                                                  |
|-------------|-----------|---|-------|---------|------------|--------------------------------------------------|
| Device Type | Low Power |   | Speed | Package | Processing |                                                  |
|             |           |   |       |         |            | C 0°C to +70°C                                   |
|             |           |   |       |         |            | I -40°C to +85°C                                 |
|             |           |   |       |         |            | M -55°C TO +125°C                                |
|             |           |   |       |         |            | MB Mil. Temp with MIL-STD-883 Class B Compliance |
|             |           |   |       |         |            | J SOJ                                            |
|             |           |   |       |         |            | L36 36-Pin Ceramic LCC (452 x 920 mil)           |
|             |           |   |       |         |            | FS36 36-Pin Solder Seal Flat Pack                |
|             |           |   |       |         |            | 15, 20, 25, 35, 45, 55, 70 ns                    |
|             |           |   |       |         |            | Low Power Designation (L=Low Power; Blank=None)  |
|             |           |   |       |         |            | <b>[Military Temperature Only]</b>               |
|             |           |   |       |         |            | 512K x 8 SRAM                                    |

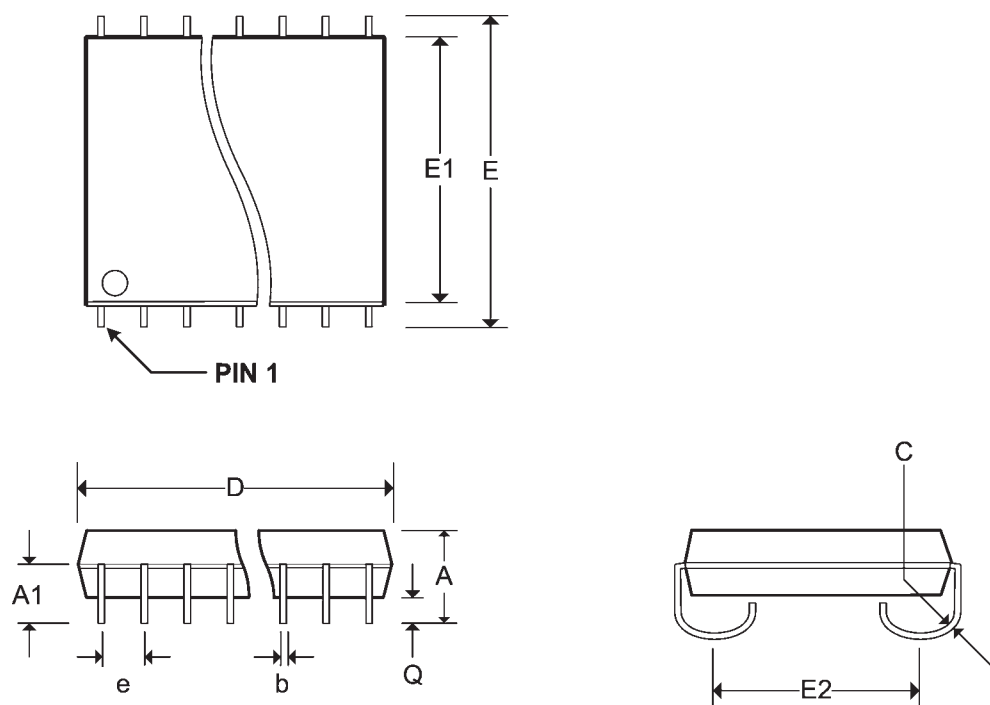
| Pkg #  | FS-4      |        |
|--------|-----------|--------|
| # Pins | 36        |        |
| Symbol | Min       | Max    |
| A      | 0.089     | 0.125  |
| b      | 0.015     | 0.019  |
| c      | 0.003     | 0.007  |
| D      | 0.910     | 0.930  |
| E      | 0.505     | 0.515  |
| E1     | -         | 0.530  |
| E2     | 0.385     | 0.395  |
| E3     | 0.055     | 0.065  |
| e      | 0.050 BSC |        |
| L      | 0.300     | 0.350  |
| Q      | 0.015     | 0.038  |
| S      | -         | 0.045  |
| M      | -         | 0.0015 |
| N      | 36        |        |

## SOLDER SEAL FLATPACK



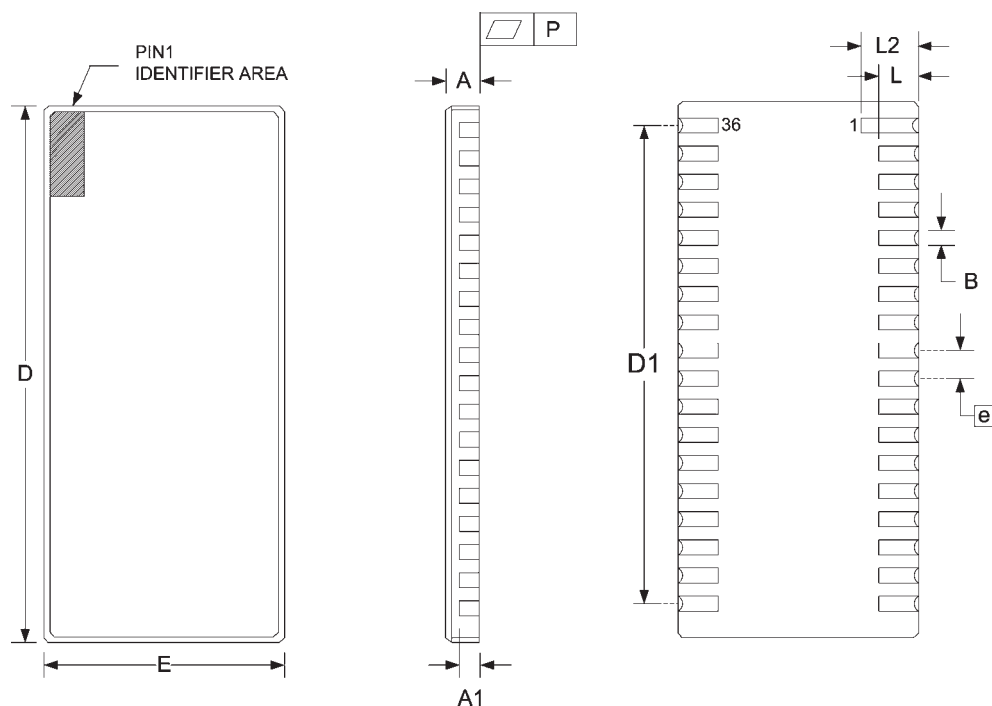
| Pkg #  | J9        |       |
|--------|-----------|-------|
| # Pins | 36        |       |
| Symbol | Min       | Max   |
| A      | 0.130     | 0.145 |
| A1     | 0.082     | -     |
| b      | 0.015     | 0.020 |
| C      | 0.007     | 0.013 |
| D      | 0.920     | 0.930 |
| e      | 0.050 BSC |       |
| E      | 0.435     | 0.445 |
| E1     | 0.395     | 0.405 |
| E2     | 0.370 BSC |       |
| Q      | 0.045     | 0.055 |

## SOJ SMALL OUTLINE IC PACKAGE



|        |            |       |
|--------|------------|-------|
| Pkg #  | <b>L11</b> |       |
| # Pins | 36         |       |
| Symbol | Min        | Max   |
| A      | 0.080      | 0.100 |
| A1     | 0.054      | 0.066 |
| B      | 0.022      | 0.028 |
| D      | 0.910      | 0.930 |
| D1     | 0.840      | 0.860 |
| E      | 0.445      | 0.460 |
| e      | .050 BSC   |       |
| L      | .100 TYP   |       |
| L2     | 0.115      | 0.135 |
| P      | -          | 0.006 |
| R      | .009 TYP   |       |

# RECTANGULAR LEADLESS CHIP CARRIER



# REVISIONS

| <b>DOCUMENT NUMBER:</b> |            | SRAM128                                                |                       |
|-------------------------|------------|--------------------------------------------------------|-----------------------|
| <b>DOCUMENT TITLE:</b>  |            | P4C1049 / P4C1049L HIGH SPEED 512K x 8 STATIC CMOS RAM |                       |
| REV.                    | ISSUE DATE | ORIG. OF CHANGE                                        | DESCRIPTION OF CHANGE |
| OR                      | Oct-05     | JDB                                                    | New Data Sheet        |
|                         |            |                                                        |                       |
|                         |            |                                                        |                       |
|                         |            |                                                        |                       |
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