

### FEATURES

- $V_{CC}$  Current (Commercial/Industrial)
  - Operating: 55 mA
  - CMOS Standby: 3  $\mu$ A
- Access Times
  - 80/100 (Commercial or Industrial)
  - 90/120 (Military)
- Single 5 Volts  $\pm 10\%$  Power Supply
- Easy Memory Expansion Using  $\overline{CE}_1$ ,  $CE_2$  and  $\overline{OE}$  Inputs
- Common Data I/O
- Three-State Outputs
- Fully TTL Compatible Inputs and Outputs
- Advanced CMOS Technology
- Automatic Power Down
- Packages
  - 28-Pin 300 and 600 mil DIP
  - 28-Pin 330 mil SOP

### DESCRIPTION

The P4C164LL is a 64K density low power CMOS static RAM organized as 8Kx8. 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 $\pm 10\%$  tolerance power supply.

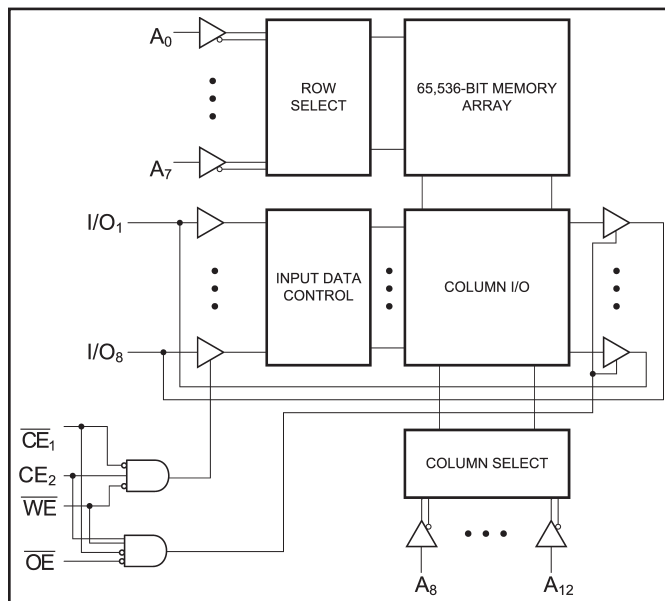
Access times of 80 and 100 ns are available for commercial and industrial temperatures; access times of 90 and 100 ns are available for military temperature. CMOS is utilized to reduce power consumption to a low level.

The P4C164LL device provides asynchronous operation with matching access and cycle times.

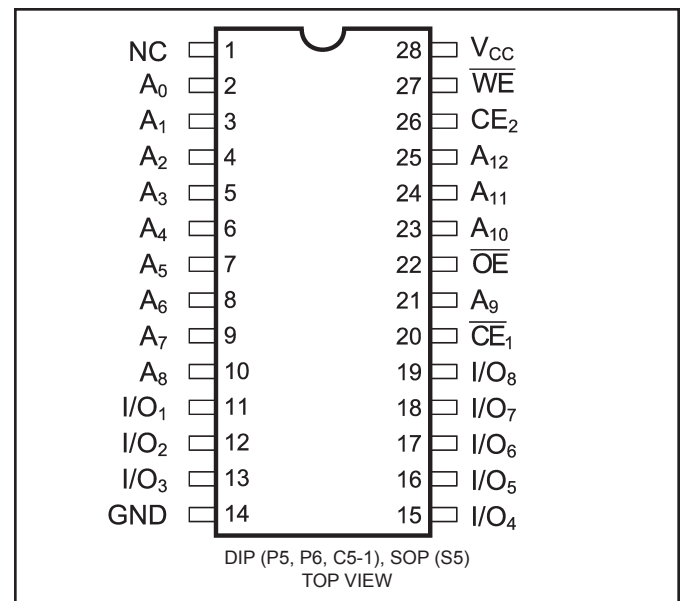
Memory locations are specified on address pins  $A_0$  to  $A_{12}$ . Reading is accomplished by device selection ( $\overline{CE}_1$  LOW,  $CE_2$  HIGH) and output enabling ( $\overline{OE}$ ) while write enable ( $\overline{WE}$ ) remains HIGH. By presenting the address under these conditions, the 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  $\overline{CE}_1$  or  $\overline{OE}$  is HIGH or  $\overline{WE}$  or  $CE_2$  is LOW.

Package options for the P4C164LL include 28-pin 300 and 600 mil DIP and 28-pin 330 mil SOP packages.

### FUNCTIONAL BLOCK DIAGRAM



### PIN CONFIGURATIONS





## RECOMMENDED OPERATING TEMPERATURE & SUPPLY VOLTAGE

Grade	Ambient Temp	Supply Voltage
Commercial	0°C to 70°C	$4.5V \leq V_{CC} \leq 5.5V$
Industrial	-40°C to +85°C	$4.5V \leq V_{CC} \leq 5.5V$
Military	-55°C to +125°C	$4.5V \leq V_{CC} \leq 5.5V$

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

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	Supply Voltage with Respect to GND	-0.5	7.0	V
$V_{TERM}$	Terminal Voltage with Respect to GND (up to 7.0V)	-0.5	$V_{CC} + 0.5$	V
$T_A$	Operating Ambient Temperature	-55	125	°C
$S_{TG}$	Storage Temperature	-65	150	°C
$I_{OUT}$	Output Current into Low Outputs		25	mA
$I_{LAT}$	Latch-up Current	> 200		mA

## DC ELECTRICAL CHARACTERISTICS

(Over Recommended Operating Temperature & Supply Voltage)<sup>(2)</sup>

Sym	Parameter	Test Conditions	Min	Max	Unit	
$V_{OH}$	Output High Voltage ( $I/O_0 - I/O_7$ )	$I_{OH} = -1mA, V_{CC} = 4.5V$	2.4		V	
$V_{OL}$	Output Low Voltage ( $I/O_0 - I/O_7$ )	$I_{OL} = 2.1mA$		0.4	V	
$V_{IH}$	Input High Voltage		2.2	$V_{CC} + 0.3$	V	
$V_{IL}$	Input Low Voltage		-0.5 <sup>(3)</sup>	0.8	V	
$I_{LI}$	Input Leakage Current	$GND \leq V_{IN} \leq V_{CC}$	Com / Ind	-2	+2	$\mu A$
			Military	-5	+5	
$I_{LO}$	Output Leakage Current	$GND \leq V_{OUT} \leq V_{CC}$ $\overline{CE}_1 \geq V_{IH}$	Com / Ind	-2	+2	$\mu A$
			Military	-10	+10	
$I_{SB}$	$V_{CC}$ Current TTL Standby Current (TTL Input Levels)	$V_{CC} = 5.5V, I_{OUT} = 0 mA$ $\overline{CE}_1 = V_{IH}$ or $CE_2 = V_{IL}$	Com / Ind		100	$\mu A$
			Military		400	
$I_{SB1}$	$V_{CC}$ Current CMOS Standby Current (CMOS Input Levels)	$V_{CC} = 5.5V, I_{OUT} = 0 mA$ $\overline{CE}_1 \geq V_{CC} - 0.2V$ or $CE_2 \leq 0.2V$	Com / Ind		3	$\mu A$
			Military		25	

### Notes:

- 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.
- Extended temperature operation guaranteed with 400 linear feet per minute of air flow.
- Transient inputs with  $V_{IL}$  and  $I_{LI}$  not more negative than -3.0V and -100mA, respectively, are permissible for pulse widths up to 20ns.
- This parameter is sampled and not 100% tested.

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

Symbol	Parameter	Test Conditions	Max	Unit
$C_{IN}$	Input Capacitance	$V_{IN} = 0V$	7	pF
$C_{OUT}$	Output Capacitance	$V_{OUT} = 0V$	9	pF

**POWER DISSIPATION CHARACTERISTICS VS. SPEED**

Symbol	Parameter	Temperature Range	*				Unit
			-80	-90	-100	-120	
$I_{CC}$	Dynamic Operating Current	Com / Ind / Military	55	55	55	55	mA

\* Tested with outputs open and all address and data inputs changing at the maximum write-cycle rate. The device is continuously enabled for writing, i.e.  $\overline{CE}_1$  and  $\overline{WE} \leq V_{IL}$  (max),  $\overline{OE}$  is high. Switching inputs are 0V and 3V.

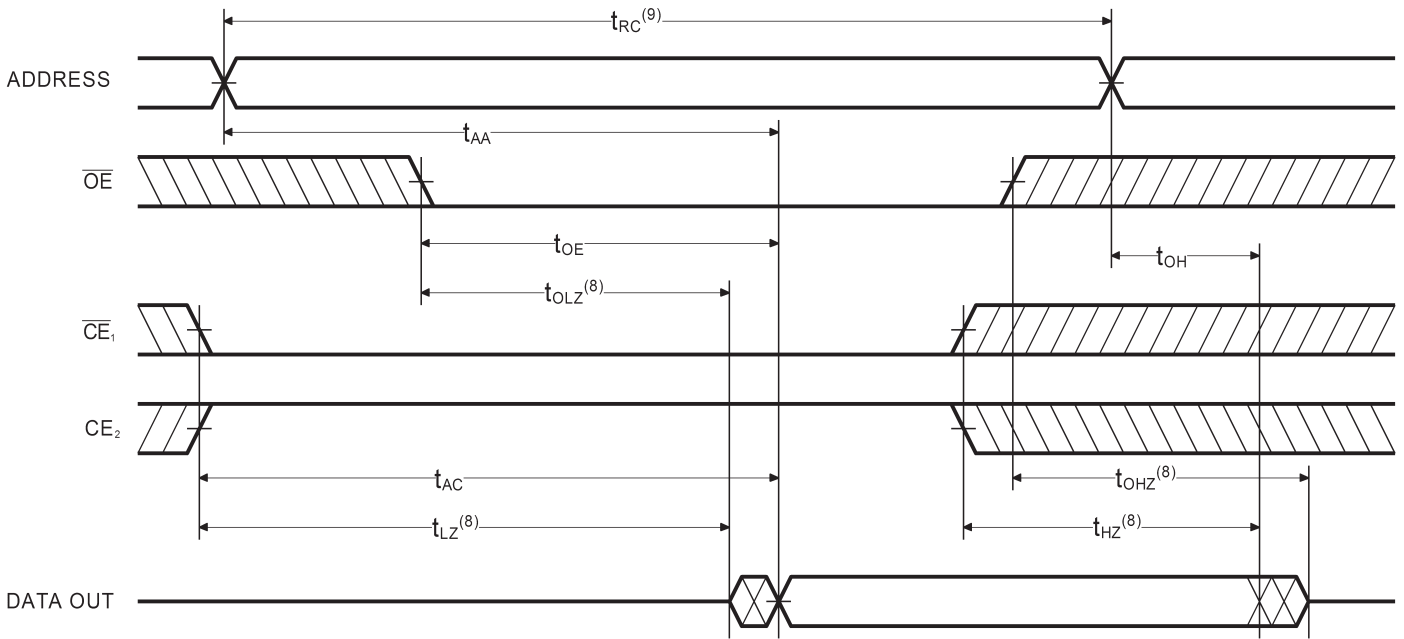
**AC ELECTRICAL CHARACTERISTICS—READ CYCLE**

(Over Recommended Operating Temperature & Supply Voltage)

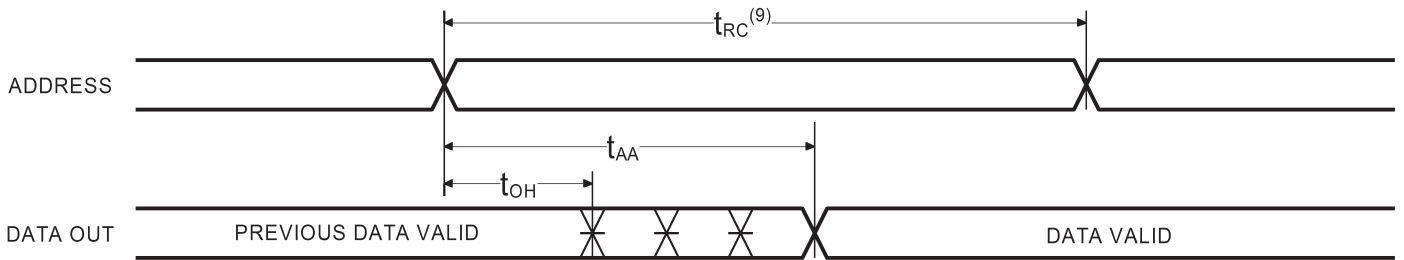
Sym	Parameter	-80		-90		-100		-120		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
$t_{RC}$	Read Cycle Time	80		90		100		120		ns
$t_{AA}$	Address Access Time		80		90		100		120	ns
$t_{AC}$	Chip Enable Access Time		80		90		100		120	ns
$t_{OH}$	Output Hold from Address Change	10		10		10		10		ns
$t_{LZ}$	Chip Enable to Output in Low Z	10		10		10		10		ns
$t_{HZ}$	Chip Disable to Output in High Z		30		30		30		30	ns
$t_{OE}$	Output Enable Low to Data Valid		40		40		40		40	ns
$t_{OLZ}$	Output Enable Low to Low Z	5		5		5		5		ns
$t_{OHZ}$	Output Enable High to High Z		20		20		20		20	ns
$t_{PU}$	Chip Enable to Power Up Time	0		0		0		0		ns
$t_{PD}$	Chip Disable to Power Down Time		80		90		100		120	ns



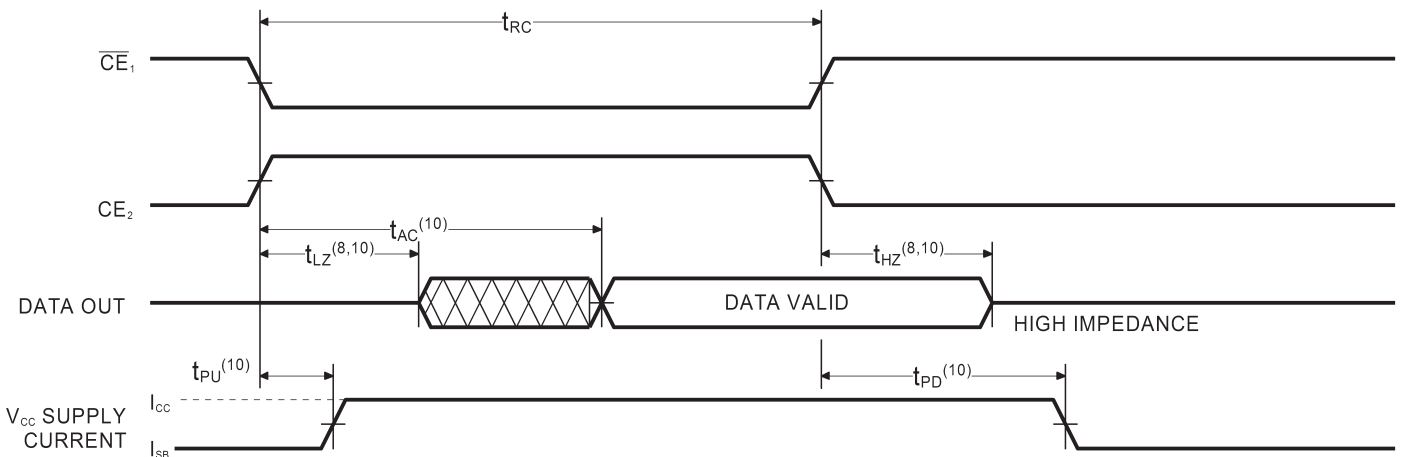
### TIMING WAVEFORM OF READ CYCLE NO. 1 ( $\overline{OE}$ CONTROLLED)<sup>(1)</sup>



### TIMING WAVEFORM OF READ CYCLE NO. 2 (ADDRESS CONTROLLED)



### TIMING WAVEFORM OF READ CYCLE NO. 3 ( $\overline{CE}_1, CE_2$ CONTROLLED)



**Notes:**

- 5.  $\overline{WE}$  is HIGH for READ cycle.
- 6.  $\overline{CE}_1$  is LOW,  $CE_2$  is HIGH and  $\overline{OE}$  is LOW for READ cycle.
- 7. ADDRESS must be valid prior to, or coincident with  $\overline{CE}_1$  transition LOW and  $CE_2$  transition HIGH.
- 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.
- 10. Transitions caused by a chip enable control have similar delays irrespective of whether  $\overline{CE}_1$  or  $CE_2$  causes them.

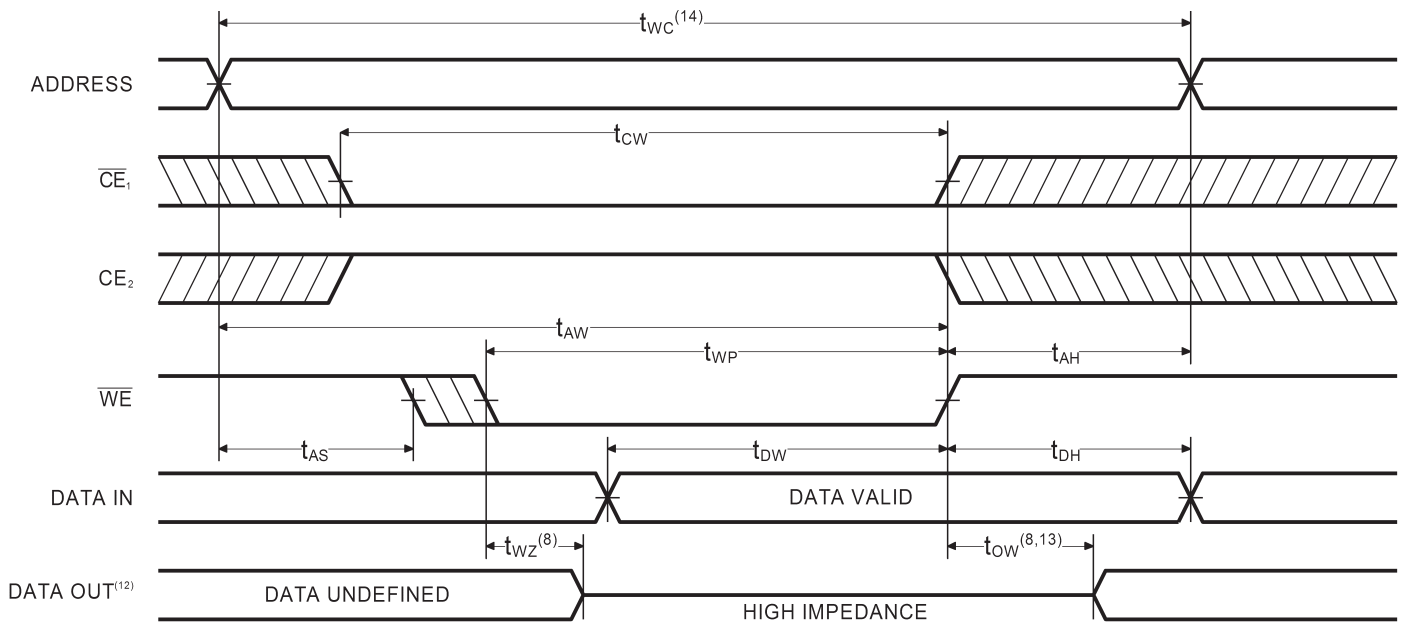


## AC CHARACTERISTICS—WRITE CYCLE

(Over Recommended Operating Temperature & Supply Voltage)

Symbol	Parameter	-80		-90		-100		-120		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
$t_{WC}$	Write Cycle Time	80		90		100		120		ns
$t_{CW}$	Chip Enable Time to End of Write	70		80		80		100		ns
$t_{AW}$	Address Valid to End of Write	70		80		80		100		ns
$t_{AS}$	Address Setup Time	0		0		0		0		ns
$t_{WP}$	Write Pulse Width	60		60		60		60		ns
$t_{AH}$	Address Hold Time	0		0		0		0		ns
$t_{DW}$	Data Valid to End of Write	40		40		40		40		ns
$t_{DH}$	Data Hold Time	0		0		0		0		ns
$t_{WZ}$	Write Enable to Output in High Z		30		30		30		30	ns
$t_{OW}$	Output Active from End of Write	10		10		10		10		ns

### TIMING WAVEFORM OF WRITE CYCLE NO. 1 ( $\overline{WE}$ CONTROLLED)<sup>(6)</sup>



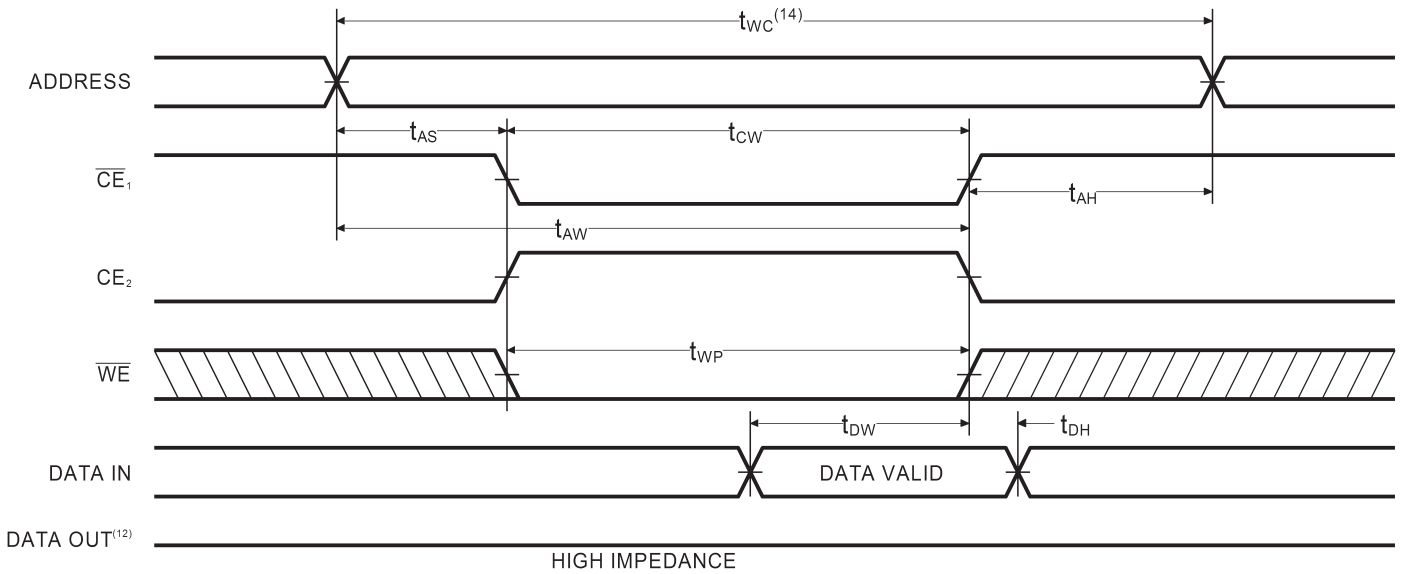
#### Notes:

11.  $\overline{CE}_1$  and  $\overline{WE}$  must be LOW, and  $\overline{CE}_2$  HIGH for WRITE cycle.
12.  $\overline{OE}$  is LOW for this WRITE cycle to show  $t_{WZ}$  and  $t_{OW}$ .
13. If  $\overline{CE}_1$  goes HIGH, or  $\overline{CE}_2$  goes LOW, simultaneously with  $\overline{WE}$  HIGH, the output remains in a high impedance state.

14. Write Cycle Time is measured from the last valid address to the first transitioning address.



### TIMING WAVEFORM OF WRITE CYCLE NO. 2 (CE CONTROLLED)<sup>(6)</sup>



### 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	$\overline{CE}_1$	$CE_2$	$\overline{OE}$	$\overline{WE}$	I/O	Power
Standby	H	X	X	X	High Z	Standby
Standby	X	L	X	X	High Z	Standby
$D_{OUT}$ Disabled	L	H	H	H	High Z	Active
Read	L	H	L	H	$D_{OUT}$	Active
Write	L	H	X	L	High Z	Active

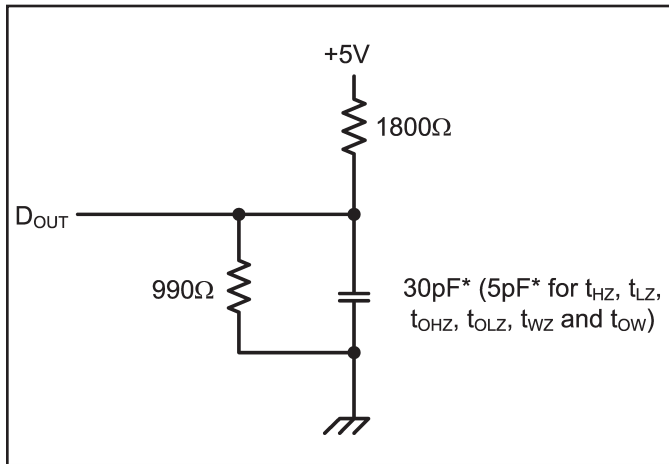


Figure 1. Output Load

\* including scope and test fixture.

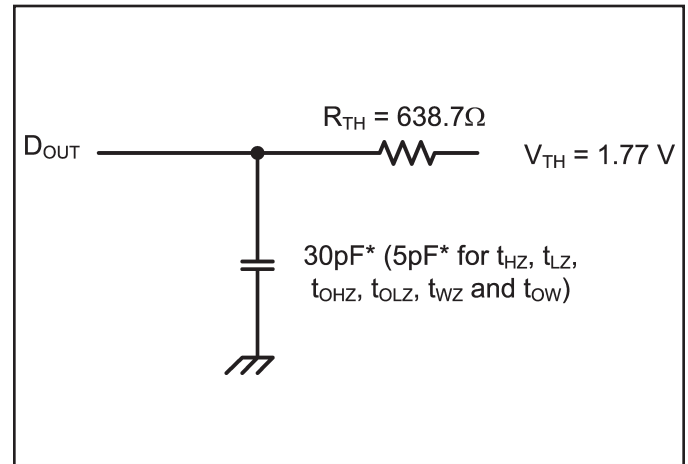


Figure 2. Thevenin Equivalent

**Note:**

Because of the ultra-high speed of the P4C164LL, 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  $V_{CC}$  and ground planes directly up to the contactor fingers. A 0.01  $\mu$ F high frequency capacitor

is also required between  $V_{CC}$  and ground. To avoid signal reflections, proper termination must be used; for example, a 50 $\Omega$  test environment should be terminated into a 50 $\Omega$  load with 1.77V (Thevenin Voltage) at the comparator input, and a 589 $\Omega$  resistor must be used in series with  $D_{OUT}$  to match 639 $\Omega$  (Thevenin Resistance).



## DATA RETENTION CHARACTERISTICS

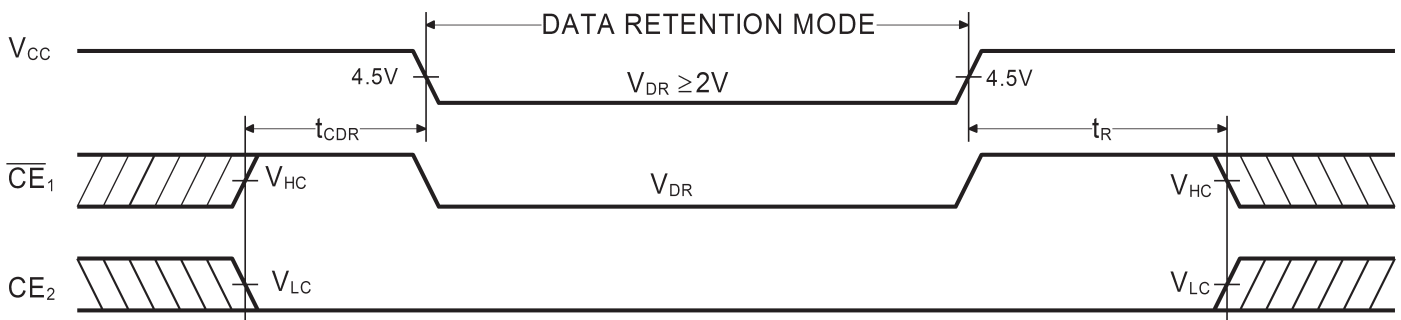
Symbol	Parameter	Test Condition	Min	Typ. * $V_{CC} =$		Max $V_{CC} =$		Unit
				2.0V	3.0V	2.0V	3.0V	
$V_{DR}$	$V_{CC}$ for Data Retention		2.0					V
$I_{CCDR}$	Data Retention Current	$\overline{CE}_1 \geq V_{CC} - 0.2V$ or		1	2	3	4	$\mu A$
$t_{CDR}$	Chip Deselect to Data Retention Time	$CE_2 \leq 0.2V, V_{IN} \geq V_{CC} - 0.2V$ or	0					ns
$t_R^\dagger$	Operation Recovery Time	$V_{IN} \leq 0.2V$	$t_{RC}^\S$					ns

\*  $T_A = +25^\circ C$

$\S t_{RC}$  = Read Cycle Time

$\dagger$  This parameter is guaranteed but not tested.

## DATA RETENTION WAVEFORM



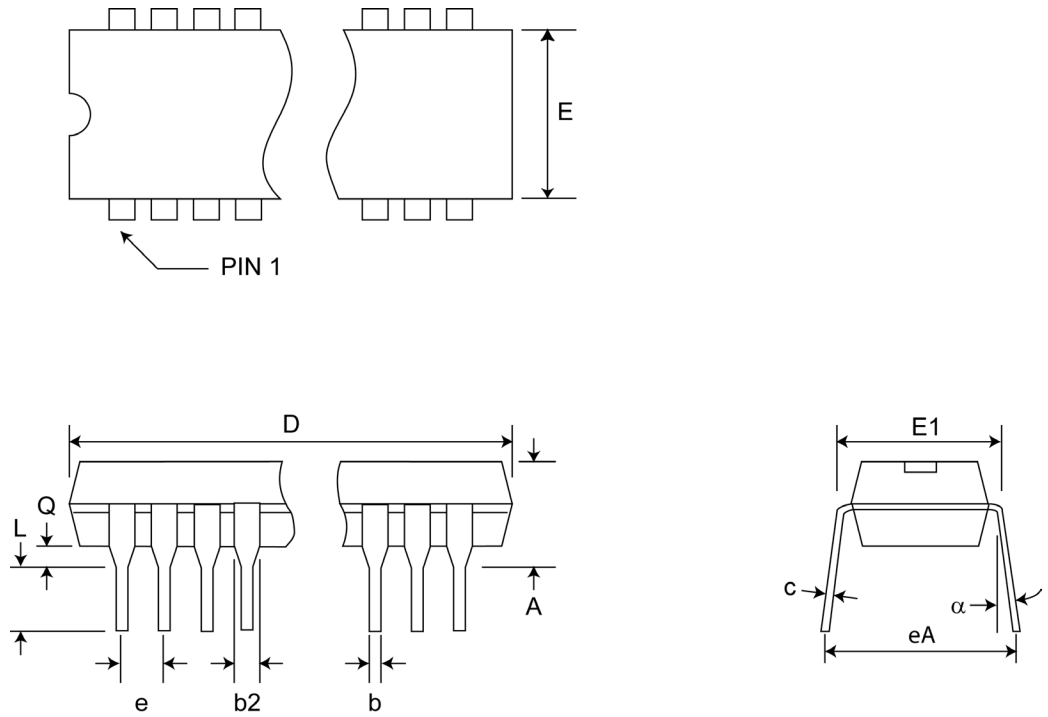
## ORDERING INFORMATION

P4C164LL	xx	x	x	LF	
Device Type	Speed	Package	Processing	Lead Free	
					Lead Free Designation (LF=RoHS compliant (Plastic only); Blank=Standard)
					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
					S Plastic SOP, 330 mil
					P3 Plastic DIP, 300 mil
					P6 Plastic DIP, 600 mil
					CW Ceramic DIP, 600 mil
					80, 90, 100, 120 ns
					8K x 8 VERY LOW POWER SRAM



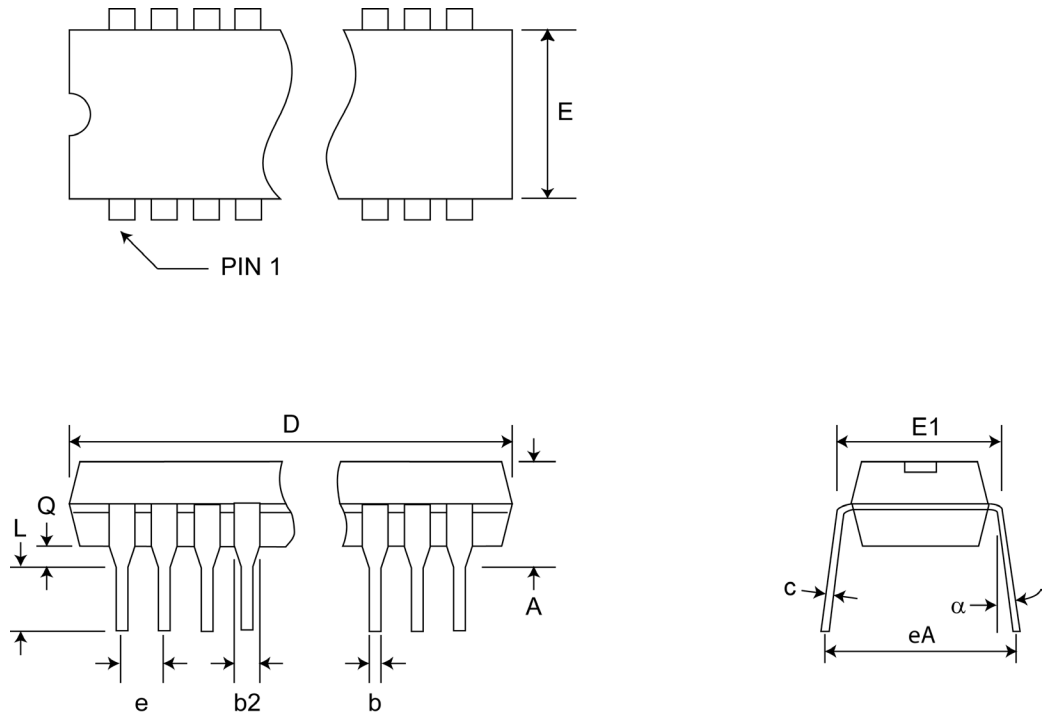
Pkg #	P5	
# Pins	28 (300 mil)	
Symbol	Min	Max
A	-	0.210
A1	-	-
b	0.014	0.023
b2	0.045	0.070
C	0.008	0.014
D	1.345	1.400
E1	0.270	0.300
E	0.300	0.380
e	0.100 BSC	
eB	-	0.430
L	0.115	0.150
$\alpha$	0°	15°

**PLASTIC DUAL IN-LINE PACKAGE (300 mil)**



Pkg #	P6	
# Pins	28 (600 mil)	
Symbol	Min	Max
A	0.090	0.200
A1	0.000	0.070
b	0.014	0.020
b2	0.015	0.065
C	0.008	0.012
D	1.380	1.480
E1	0.485	0.550
E	0.600	0.625
e	0.100 BSC	
eB	0.600 TYP	
L	0.100	0.200
$\alpha$	0°	15°

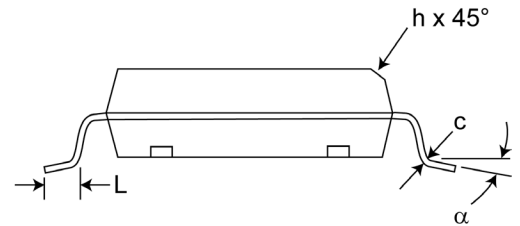
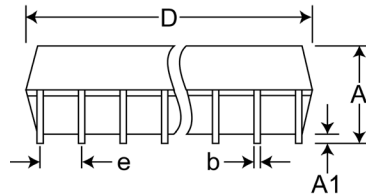
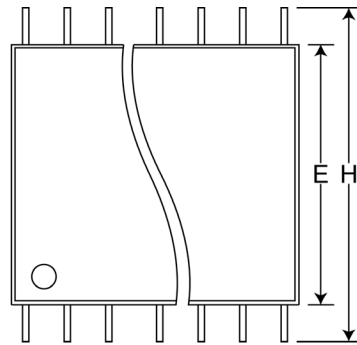
**PLASTIC DUAL IN-LINE PACKAGE (600 mil)**





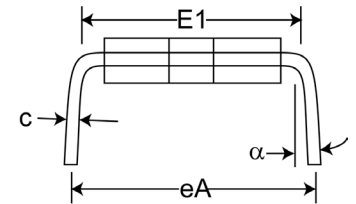
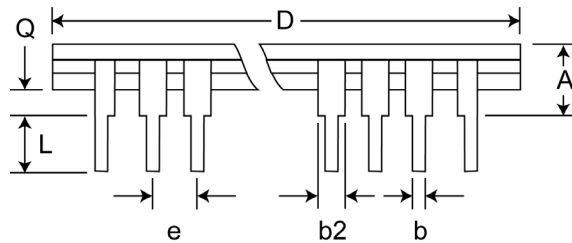
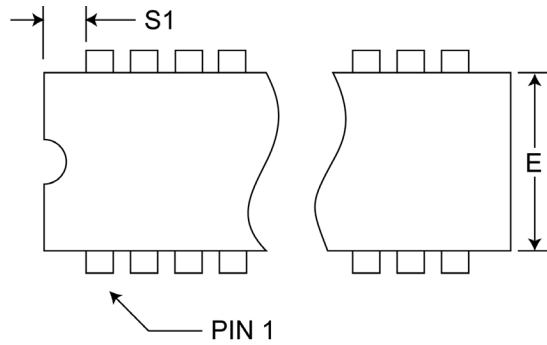
Pkg #	<b>S5</b>	
# Pins	28 (330 mil)	
Symbol	<b>Min</b>	<b>Max</b>
A	0.079	0.102
A1	0.000	0.008
B	0.012	0.020
C	0.004	0.008
D	0.701	0.717
e	0.050 BSC	
E	0.331	0.346
H	0.457	0.488
L	0.016	0.050
$\alpha$	0°	8°

**SOIC/SOP SMALL OUTLINE IC PACKAGE**



Pkg #	<b>C5-1</b>	
# Pins	28 (600 mil)	
Symbol	<b>Min</b>	<b>Max</b>
A	-	0.232
b	0.014	0.026
b2	0.045	0.065
C	0.008	0.018
D	-	1.490
E	0.500	0.610
eA	0.600 BSC	
e	0.100 BSC	
L	0.125	0.200
Q	0.015	0.060
S1	0.005	-
S2	0.005	-

**CERAMIC DUAL IN-LINE PACKAGE (600 mil)**



**REVISIONS**

<b>DOCUMENT NUMBER</b>	SRAM116
<b>DOCUMENT TITLE</b>	P4C164LL - VERY LOW POWER 8Kx8 STATIC CMOS RAM

<b>REV</b>	<b>ISSUE DATE</b>	<b>ORIGINATOR</b>	<b>DESCRIPTION OF CHANGE</b>
OR	Oct-2005	JDB	New Data Sheet
A	Aug-2006	JDB	Added Lead Free Designation
B	Jun-2007	JDB	Corrected SOP package details
C	Mar-2010	JDB	Added Military temperature range