

## FEATURES

- 16K x 4 Static RAM with Common I/O
- Auto-Powerdown™ Design
- Advanced CMOS Technology
- High Speed — to 12 ns maximum
- Low Power Operation
  - Active: 325 mW typical at 25 ns
  - Standby: 400  $\mu$ W typical
- Data Retention at 2 V for Battery Backup Operation
- Available 100% Screened to MIL-STD-883, Class B
- Plug Compatible with IDT 6198/7188 and Cypress CY7C164/166
- Package Styles Available:
  - 24-pin Plastic DIP
  - 22/24-pin Ceramic DIP
  - 24-pin Plastic SOJ
  - 22/28-pin Ceramic LCC

## DESCRIPTION

The L7C164 and L7C166 are high-performance, low-power CMOS static RAMs. The storage cells are organized as 16,384 words by 4 bits per word. Data In and Data Out signals share I/O pins. The L7C164 has a single active-low Chip Enable. The L7C166 has a single Chip Enable and an Output Enable. These devices are available in four speeds with maximum access times from 12 ns to 25 ns.

Inputs and outputs are TTL compatible. Operation is from a single +5 V power supply. Power consumption is 325 mW (typical) at 25 ns. Dissipation drops to 60 mW (typical) when the memory is deselected.

Two standby modes are available. Proprietary Auto-Powerdown™ circuitry reduces power consumption automatically during read or write accesses which are longer than the minimum access time, or when the

memory is deselected. In addition, data may be retained in inactive storage with a supply voltage as low as 2 V. The L7C164 and L7C166 consume only 30  $\mu$ W (typical) at 3 V, allowing effective battery backup operation.

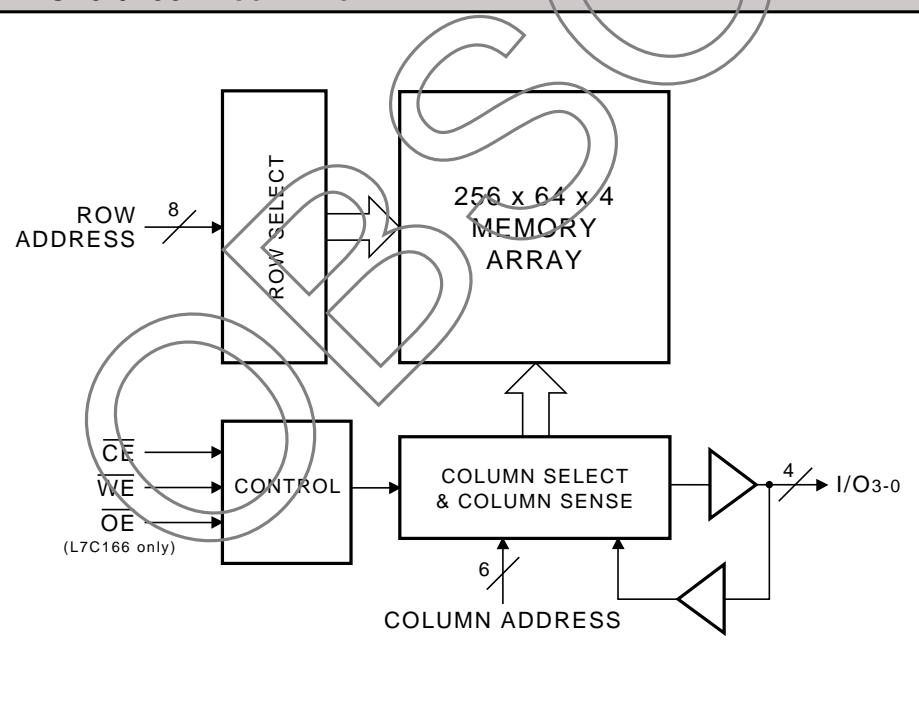
The L7C164 and L7C166 provide asynchronous (unclocked) operation with matching access and cycle times. An active-low Chip Enable and a three-state I/O bus simplify the connection of several chips for increased capacity.

Memory locations are specified on address pins A0 through A13. For the L7C164, reading from a designated location is accomplished by presenting an address and driving  $\overline{CE}$  LOW while  $\overline{WE}$  remains HIGH. For the L7C166,  $\overline{CE}$  and  $\overline{OE}$  must be LOW while  $\overline{WE}$  remains HIGH. The data in the addressed memory location will then appear on the Data Out pins within one access time. The output pins stay in a high-impedance state when  $\overline{CE}$  or  $\overline{OE}$  is HIGH, or  $\overline{WE}$  is LOW.

Writing to an addressed location is accomplished when the active-low  $\overline{CE}$  and  $\overline{WE}$  inputs are LOW. Either signal may be used to terminate the write operation. Data In and Data Out signals have the same polarity.

Latchup and static discharge protection are provided on-chip. The L7C164 and L7C166 can withstand an injection current of up to 200 mA on any pin without damage.

## L7C164/166 BLOCK DIAGRAM



**MAXIMUM RATINGS** *Above which useful life may be impaired (Notes 1, 2)*

Storage temperature .....	-65°C to +150°C
Operating ambient temperature .....	-55°C to +125°C
V <sub>CC</sub> supply voltage with respect to ground .....	-0.5 V to +7.0 V
Input signal with respect to ground .....	-3.0 V to +7.0 V
Signal applied to high impedance output .....	-3.0 V to +7.0 V
Output current into low outputs .....	25 mA
Latchup current .....	> 200 mA

**OPERATING CONDITIONS** *To meet specified electrical and switching characteristics*

Mode	Temperature Range (Ambient)	Supply Voltage
Active Operation, Commercial	0°C to +70°C	4.5 V £ V <sub>CC</sub> £ 5.5 V
Active Operation, Industrial	-40°C to +85°C	4.5 V £ V <sub>CC</sub> £ 5.5 V
Active Operation, Military	-55°C to +125°C	4.5 V £ V <sub>CC</sub> £ 5.5 V
Data Retention, Commercial	0°C to +70°C	2.0 V £ V <sub>CC</sub> £ 5.5 V
Data Retention, Industrial	-40°C to +85°C	2.0 V £ V <sub>CC</sub> £ 5.5 V
Data Retention, Military	-55°C to +125°C	2.0 V £ V <sub>CC</sub> £ 5.5 V

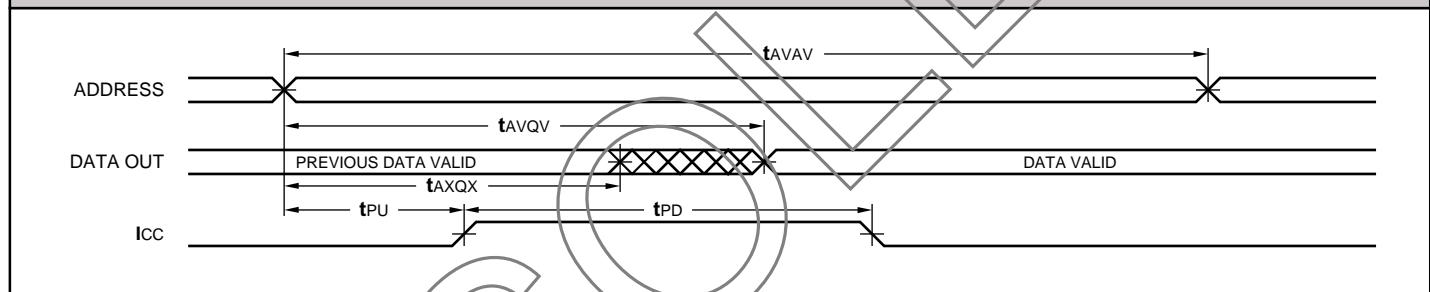
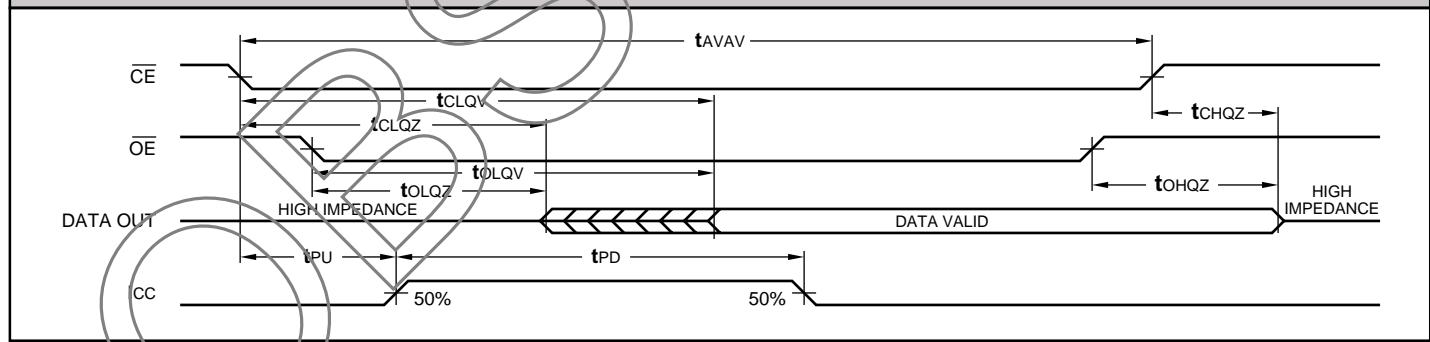
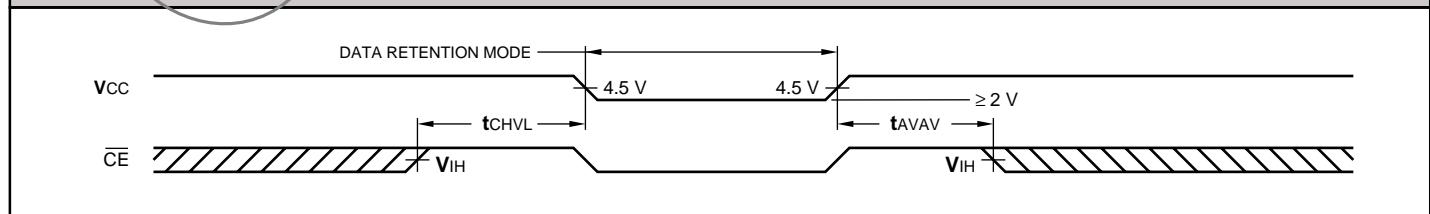
**ELECTRICAL CHARACTERISTICS** *Over Operating Conditions (Note 5)*

Symbol	Parameter	Test Condition	L7C164/166			Unit
			Min	Typ	Max	
V <sub>OH</sub>	Output High Voltage	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -4.0 mA	2.4			V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 8.0 mA			0.4	V
V <sub>IH</sub>	Input High Voltage		2.2		V <sub>CC</sub> +0.3	V
V <sub>IL</sub>	Input Low Voltage	(Note 3)	-3.0		0.8	V
I <sub>IX</sub>	Input Leakage Current	Ground £ V <sub>IN</sub> £ V <sub>CC</sub>	-10		+10	µA
I <sub>OZ</sub>	Output Leakage Current	(Note 4)	-10		+10	µA
I <sub>CC2</sub>	V <sub>CC</sub> Current, TTL Inactive	(Note 7)		12	25	mA
I <sub>CC3</sub>	V <sub>CC</sub> Current, CMOS Standby	(Note 8)		80	300	µA
I <sub>CC4</sub>	V <sub>CC</sub> Current, Data Retention	V <sub>CC</sub> = 3.0 V (Notes 9, 10)		10	150	µA
C <sub>IN</sub>	Input Capacitance	Ambient Temp = 25°C, V <sub>CC</sub> = 5.0 V			5	pF
C <sub>OUT</sub>	Output Capacitance	Test Frequency = 1 MHz (Note 10)			7	pF

Symbol	Parameter	Test Condition	L7C164/166-				
			25	20	15	12	Unit
I <sub>CC1</sub>	V <sub>CC</sub> Current, Active	(Note 6)	100	120	140	165	mA

SWITCHING CHARACTERISTICS *Over Operating Range*READ CYCLE *Notes 5, 11, 12, 22, 23, 24 (ns)*

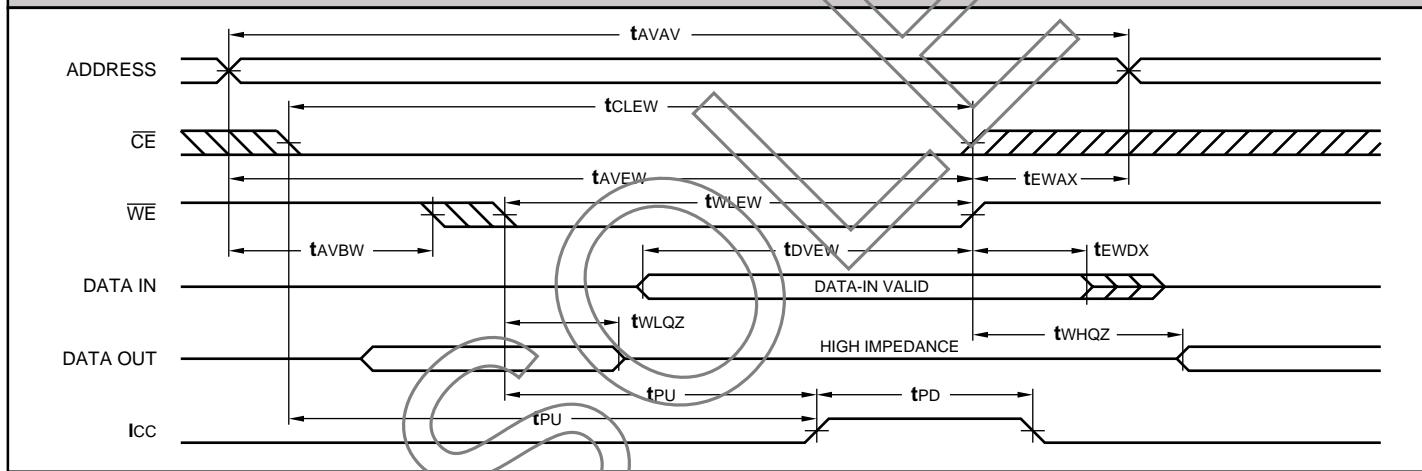
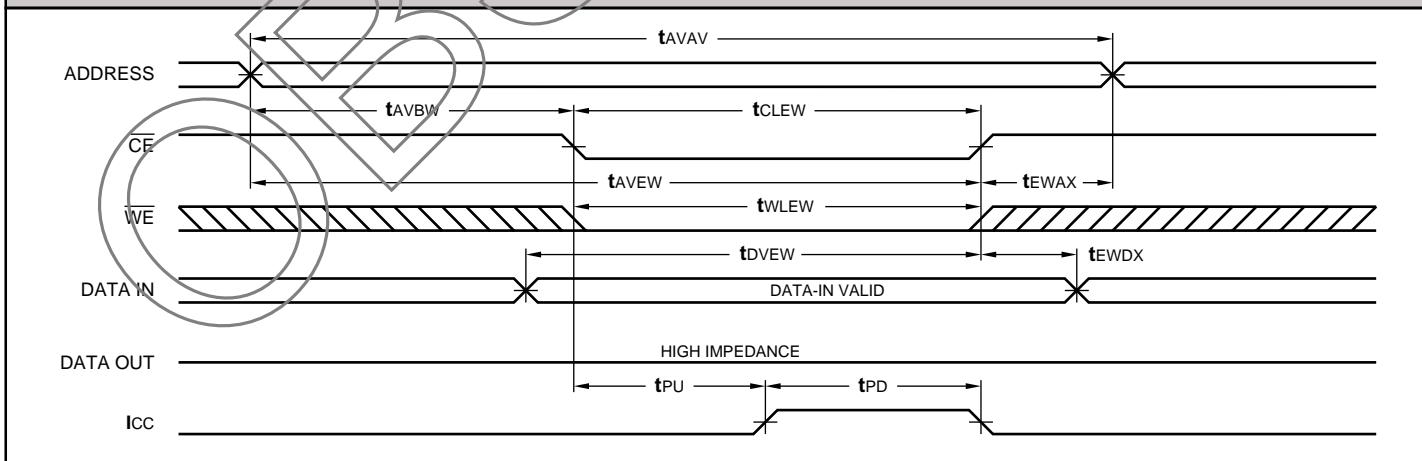
Symbol	Parameter	L7C164/166—							
		25		20		15		12	
		Min	Max	Min	Max	Min	Max	Min	Max
$t_{AVAV}$	Read Cycle Time	25		20		15		12	
$t_{AVQV}$	Address Valid to Output Valid (Notes 13, 14)		25		20		15		12
$t_{AXQX}$	Address Change to Output Change	3		3		3		3	
$t_{CLQV}$	Chip Enable Low to Output Valid (Notes 13, 15)		25		20		15		12
$t_{CLQZ}$	Chip Enable Low to Output Low Z (Notes 20, 21)	3		3		3		3	
$t_{CHQZ}$	Chip Enable High to Output High Z (Notes 20, 21)		10		8		8		5
$t_{OLQV}$	Output Enable Low to Output Valid		12		10		8		6
$t_{OLQZ}$	Output Enable Low to Output Low Z (Notes 20, 21)	0		0		0		0	
$t_{OHQZ}$	Output Enable High to Output High Z (Notes 20, 21)		10		8		5		5
$t_{PU}$	Input Transition to Power Up (Notes 10, 19)	0		0		0		0	
$t_{PD}$	Power Up to Power Down (Notes 10, 19)		25		20		20		20
$t_{CHVL}$	Chip Enable High to Data Retention (Note 10)	0		0		0		0	

READ CYCLE — ADDRESS CONTROLLED *Notes 13, 14*READ CYCLE —  $\overline{CE}/\overline{OE}$  CONTROLLED *Notes 13, 15*DATA RETENTION *Notes 9, 10*

SWITCHING CHARACTERISTICS *Over Operating Range*

## WRITE CYCLE Notes 5, 11, 12, 22, 23, 24 (ns)

Symbol	Parameter	L7C164/166—							
		25		20		15		12	
		Min	Max	Min	Max	Min	Max	Min	Max
$t_{AVAV}$	Write Cycle Time	20		20		15		12	
$t_{CLEW}$	Chip Enable Low to End of Write Cycle	15		15		12		10	
$t_{AVBW}$	Address Valid to Beginning of Write Cycle	0		0		0		0	
$t_{AIEW}$	Address Valid to End of Write Cycle	15		15		12		10	
$t_{EWAX}$	End of Write Cycle to Address Change	0		0		0		0	
$t_{WLEW}$	Write Enable Low to End of Write Cycle	15		15		12		10	
$t_{DVEW}$	Data Valid to End of Write Cycle	10		10		7		6	
$t_{EWDX}$	End of Write Cycle to Data Change	0		0		0		0	
$t_{WHQZ}$	Write Enable High to Output Low Z (Notes 20, 21)	0		0		0		0	
$t_{WLQZ}$	Write Enable Low to Output High Z (Notes 20, 21)			7		7		5	
									4

WRITE CYCLE —  $\overline{WE}$  CONTROLLED Notes 16, 17, 18, 19WRITE CYCLE —  $\overline{CE}$  CONTROLLED Notes 16, 17, 18, 19

## NOTES

1. Maximum Ratings indicate stress specifications only. Functional operation of these products at values beyond those indicated in the Operating Conditions table is not implied. Exposure to maximum rating conditions for extended periods may affect reliability of the tested device.
2. The products described by this specification include internal circuitry designed to protect the chip from damaging substrate injection currents and accumulations of static charge. Nevertheless, conventional precautions should be observed during storage, handling, and use of these circuits in order to avoid exposure to excessive electrical stress values.
3. This product provides hard clamping of transient undershoot. Input levels below ground will be clamped beginning at -0.6 V. A current in excess of 100 mA is required to reach -2.0 V. The device can withstand indefinite operation with inputs as low as -3 V subject only to power dissipation and bond wire fusing constraints.
4. Tested with  $GND \leq VOUT \leq VCC$ . The device is disabled, i.e.,  $\overline{CE} = VCC$ .
5. A series of normalized curves is available to supply the designer with typical DC and AC parametric information for Logic Devices Static RAMs. These curves may be used to determine device characteristics at various temperatures and voltage levels.
6. Tested with all address and data inputs changing at the maximum cycle rate. The device is continuously enabled for writing, i.e.,  $\overline{CE} \leq VI_L$ ,  $\overline{WE} \leq VI_L$ . Input pulse levels are 0 to 3.0 V.
7. Tested with outputs open and all address and data inputs changing at the maximum read cycle rate. The device is continuously disabled, i.e.,  $\overline{CE} \geq VI_H$ .
8. Tested with outputs open and all address and data inputs stable. The device is continuously disabled, i.e.,  $\overline{CE} = VCC$ . Input levels are within 0.2 V of VCC or GND.
9. Data retention operation requires that VCC never drop below 2.0 V. CE must be  $\geq VCC - 0.2$  V. All other inputs must meet  $VIN \geq VCC - 0.2$  V or  $VIN \leq 0.2$  V to ensure full powerdown. For low power version (if applicable), this requirement applies only to CE and WE; there are no restrictions on data and address.
10. These parameters are guaranteed but not 100% tested.
11. Test conditions assume input transition times of less than 3 ns, reference levels of 1.5 V, output loading for specified IOL and IOH plus 30 pF (Fig. 1a), and input pulse levels of 0 to 3.0 V (Fig. 2).
12. Each parameter is shown as a minimum or maximum value. Input requirements are specified from the point of view of the external system driving the chip. For example, tAVEW is specified as a minimum since the external system must supply at least that much time to meet the worst-case requirements of all parts. Responses from the internal circuitry are specified from the point of view of the device. Access time, for example, is specified as a maximum since worst-case operation of any device always provides data within that time.
13. WE is high for the read cycle.
14. The chip is continuously selected (CE low).
15. All address lines are valid prior-to or coincident-with the  $\overline{CE}$  transition to active.
16. The internal write cycle of the memory is defined by the overlap of  $\overline{CE}$  active and WE low. All three signals must be active to initiate a write. Any signal can terminate a write by going inactive. The address, data, and control input setup and hold times should be referenced to the signal that becomes active last or becomes inactive first.
17. If WE goes low before or concurrent with the latter of  $\overline{CE}$  going active, the output remains in a high impedance state.
18. If  $\overline{CE}$  goes inactive before or concurrent with WE going high, the output remains in a high impedance state.
19. Powerup from  $ICC_2$  to  $ICC_1$  occurs as a result of any of the following conditions:
  - Falling edge of  $\overline{CE}$ .
  - Falling edge of WE ( $\overline{CE}$  active).
  - Transition on any address line ( $\overline{CE}$  active).
  - Transition on any data line ( $\overline{CE}$ , and WE active).
20. At any given temperature and voltage condition, output disable time is less than output enable time for any given device.
21. Transition is measured  $\pm 200$  mV from steady state voltage with specified loading in Fig. 1b. This parameter is sampled and not 100% tested.
22. All address timings are referenced from the last valid address line to the first transitioning address line.
23.  $\overline{CE}$  or  $\overline{WE}$  must be inactive during address transitions.
24. This product is a very high speed device and care must be taken during testing in order to realize valid test information. Inadequate attention to setups and procedures can cause a good part to be rejected as faulty. Long high inductance leads that cause supply bounce must be avoided by bringing the VCC and ground planes directly up to the contactor fingers. A 0.01  $\mu$ F high frequency capacitor is also required between VCC and ground. To avoid signal reflections, proper terminations must be used.

FIGURE 1a.

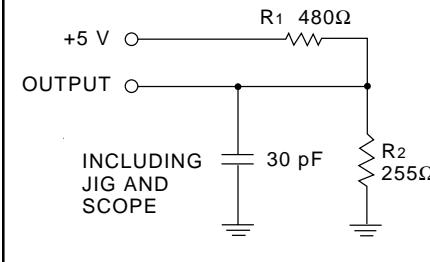


FIGURE 1b.

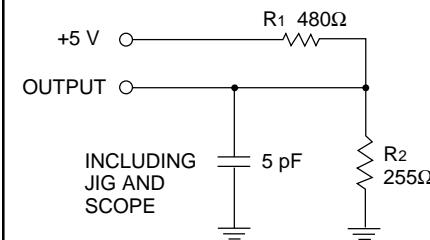
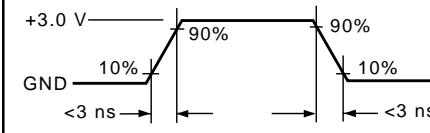
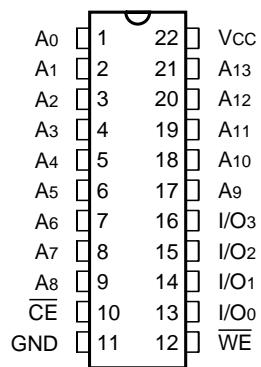


FIGURE 2.

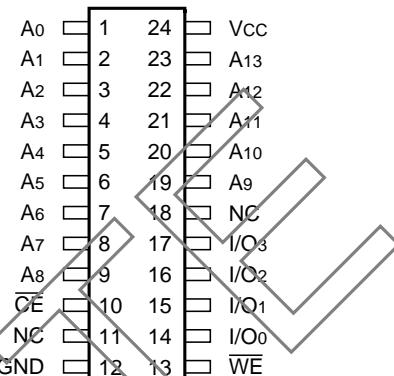


## L7C164 — ORDERING INFORMATION

22-pin — 0.3" wide



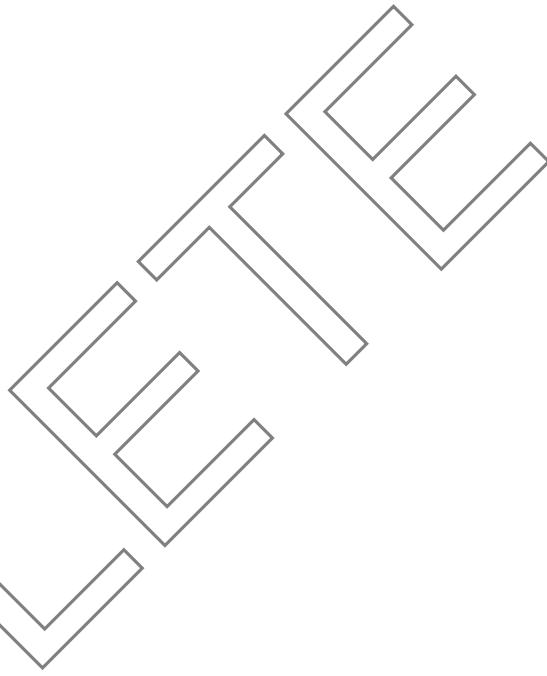
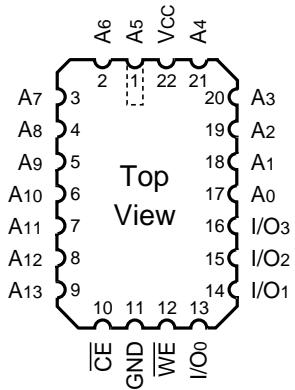
24-pin — 0.3" wide



Speed	Ceramic DIP (C3)	Plastic SOJ (W1)
	<b>0°C to +70°C — COMMERCIAL SCREENING</b>	
20 ns	L7C164CC20	L7C164WC20
15 ns	L7C164CC15	L7C164WC15
12 ns	L7C164CC12	L7C164WC12
	<b>-40°C to +85°C — COMMERCIAL SCREENING</b>	
20 ns		L7C164WI20
15 ns		L7C164WI15
12 ns		L7C164WI12
	<b>-55°C to +125°C — COMMERCIAL SCREENING</b>	
25 ns	L7C164CM25	
20 ns	L7C164CM20	
15 ns	L7C164CM15	
	<b>-55°C to +125°C — MIL-STD-883 COMPLIANT</b>	
25 ns	L7C164CMB25	
20 ns	L7C164CMB20	
15 ns	L7C164CMB15	

## L7C164 — ORDERING INFORMATION

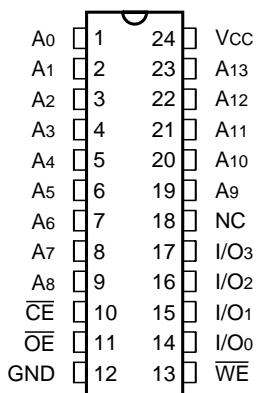
22-pin



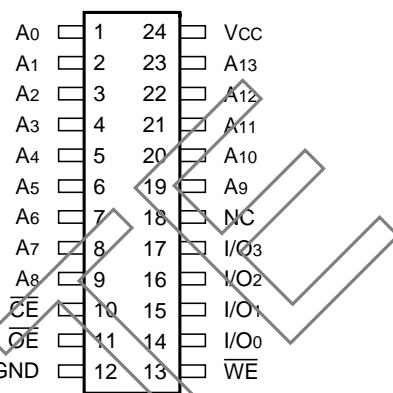
Speed	Ceramic Leadless Chip Carrier (K4)
	<b>0°C to +70°C — COMMERCIAL SCREENING</b>
20 ns	L7C164KC20
15 ns	L7C164KC15
12 ns	L7C164KC12
	<b>-40°C to +85°C — COMMERCIAL SCREENING</b>
20 ns	
15 ns	
12 ns	
	<b>-55°C to +125°C — COMMERCIAL SCREENING</b>
25 ns	L7C164KM25
20 ns	L7C164KM20
15 ns	L7C164KM15
	<b>-55°C to +125°C — MIL-STD-883 COMPLIANT</b>
25 ns	L7C164KMB25
20 ns	L7C164KMB20
15 ns	L7C164KMB15

## L7C166 — ORDERING INFORMATION

24-pin — 0.3" wide



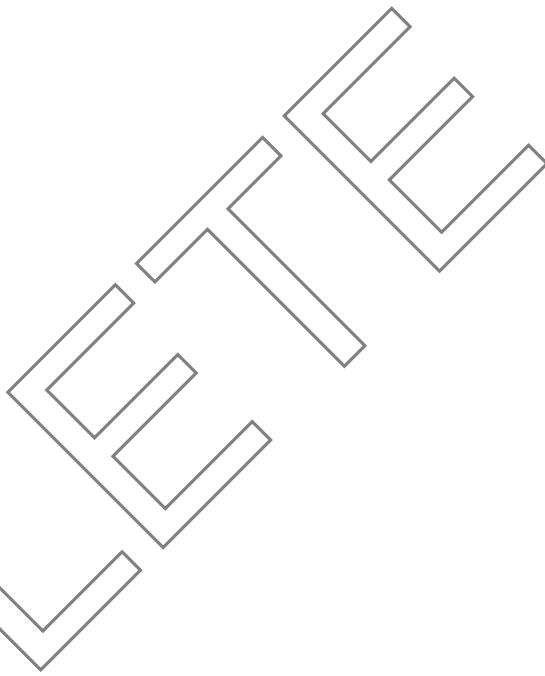
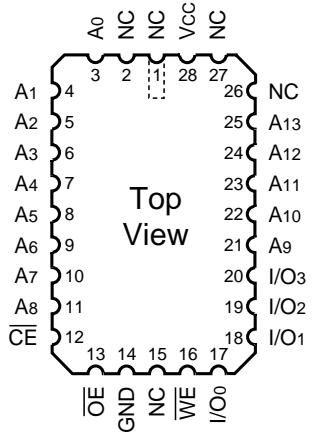
24-pin — 0.3" wide



Speed	Plastic DIP (P2)	Ceramic DIP (C1)	Plastic SOJ (W1)
<b>0°C to +70°C — COMMERCIAL SCREENING</b>			
20 ns	L7C166PC20	L7C166CC20	L7C166WC20
15 ns	L7C166PC15	L7C166CC15	L7C166WC15
12 ns	L7C166PC12	L7C166CC12	L7C166WC12
<b>-40°C to +85°C — COMMERCIAL SCREENING</b>			
20 ns	L7C166PI20		L7C166WI20
15 ns	L7C166PI15		L7C166WI15
12 ns	L7C166PI12		L7C166WI12
<b>-55°C to +125°C — COMMERCIAL SCREENING</b>			
25 ns		L7C166CM25	
20 ns		L7C166CM20	
15 ns		L7C166CM15	
<b>-55°C to +125°C — MIL-STD-883 COMPLIANT</b>			
25 ns		L7C166CMB25	
20 ns		L7C166CMB20	
15 ns		L7C166CMB15	

## L7C166 — ORDERING INFORMATION

28-pin



Speed	Ceramic Leadless Chip Carrier (K5)
	<b>0°C to +70°C — COMMERCIAL SCREENING</b>
20 ns	L7C166KC20
15 ns	L7C166KC15
12 ns	L7C166KC12
	<b>-40°C to +85°C — COMMERCIAL SCREENING</b>
20 ns	
15 ns	
12 ns	
	<b>-55°C to +125°C — COMMERCIAL SCREENING</b>
25 ns	L7C166KM25
20 ns	L7C166KM20
15 ns	L7C166KM15
	<b>-55°C to +125°C — MIL-STD-883 COMPLIANT</b>
25 ns	L7C166KMB25
20 ns	L7C166KMB20
15 ns	L7C166KMB15