



32-Macrocell MAX® EPLD

Features

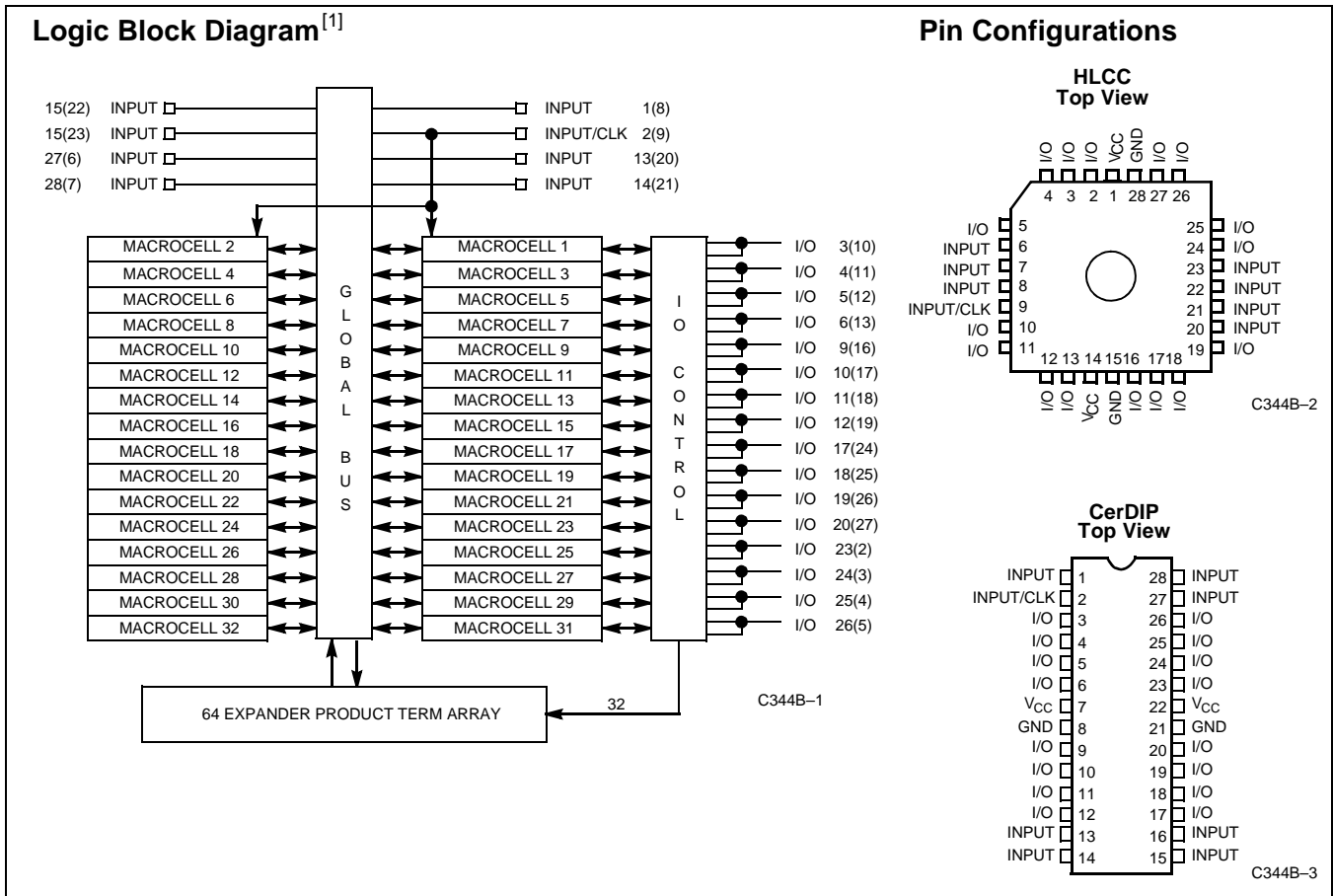
- High-performance, high-density replacement for TTL, 74HC, and custom logic
- 32 macrocells, 64 expander product terms in one LAB
- 8 dedicated inputs, 16 I/O pins
- Advanced 0.65-micron CMOS EPROM technology to increase performance
- 28-pin, 300-mil DIP, cerDIP or 28-pin HLCC, PLCC package

Functional Description

Available in a 28-pin, 300-mil DIP or windowed J-led ceramic chip carrier (HLCC), the CY7C344B represents the

densest EPLD of this size. Eight dedicated inputs and 16 bi-directional I/O pins communicate to one logic array block. In the CY7C344B LAB there are 32 macrocells and 64 expander product terms. When an I/O macrocell is used as an input, two expanders are used to create an input path. Even if all of the I/O pins are driven by macrocell registers, there are still 16 "buried" registers available. All inputs, macrocells, and I/O pins are interconnected within the LAB.

The speed and density of the CY7C344B makes it a natural for all types of applications. With just this one device, the designer can implement complex state machines, registered logic, and combinatorial "glue" logic, without using multiple chips. This architectural flexibility allows the CY7C344B to replace multi-chip TTL solutions, whether they are synchronous, asynchronous, combinatorial, or all three.



Selection Guide

| | 7C344B-15 | 7C344B-20 | 7C344B-25 |
|--------------------------|-----------|-----------|-----------|
| Maximum Access Time (ns) | 15 | 20 | 25 |

Note:

1. Number in () refers to J-led packages.

MAX is a registered trademark of Altera Corporation.

Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature -65°C to +135°C
 Ambient Temperature with Power Applied..... -65°C to +135°C
 Maximum Junction Temperature (Under Bias)..... 150°C
 Supply Voltage to Ground Potential^[2]..... -2.0V to +7.0V

DC Output Current, per Pin^[2]..... -25 mA to +25 mA
 DC Input Voltage^[2]..... -2.0V to +7.0V

Operating Range

| Range | Ambient Temperature | V _{CC} |
|------------|---------------------|-----------------|
| Commercial | -0°C to +70°C | 5V ±5% |
| Industrial | -40°C to +85°C | 5V ±10% |

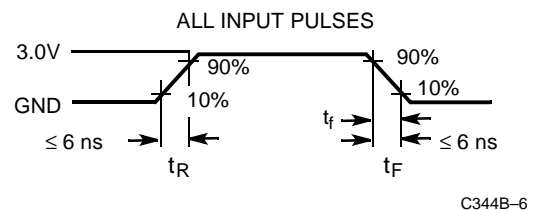
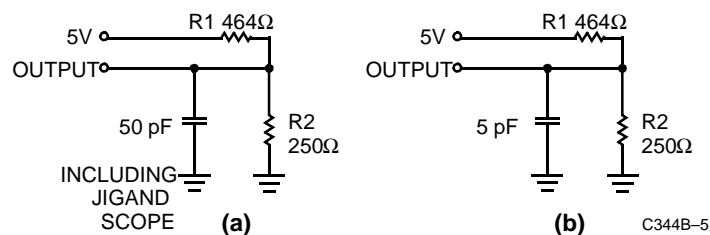
Electrical Characteristics Over the Operating Range

| Parameter | Description | Test Conditions | Min. | Max. | Unit |
|-----------------|-----------------------------|---|-----------|----------------------|------|
| V _{CC} | Supply Voltage | Maximum V _{CC} rise time is 10 ms | 4.75(4.5) | 5.25(5.5) | V |
| V _{OH} | Output HIGH Voltage | I _{OH} = -4.0 mA DC ^[3] | 2.4 | | V |
| V _{OL} | Output LOW Voltage | I _{OL} = 8 mA DC ^[3] | | 0.45 | V |
| V _{IH} | Input HIGH Level | | 2.0 | V _{CC} +0.3 | V |
| V _{IL} | Input LOW Level | | -0.3 | 0.8 | V |
| I _{IX} | Input Current | GND ≤ V _{IN} ≤ V _{CC} | -10 | +10 | μA |
| I _{OZ} | Output Leakage Current | V _O = V _{CC} or GND | -40 | +40 | μA |
| t _R | Recommended Input Rise Time | | | 100 | ns |
| t _F | Recommended Input Fall Time | | | 100 | ns |

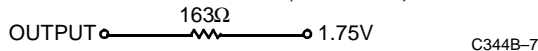
Capacitance

| Parameter | Description | Test Conditions | Max. | Unit |
|------------------|--------------------|------------------------------------|------|------|
| C _{IN} | Input Capacitance | V _{IN} = 0V, f = 1.0 MHz | 10 | pF |
| C _{OUT} | Output Capacitance | V _{OUT} = 0V, f = 1.0 MHz | 12 | pF |

AC Test Loads and Waveforms



Equivalent to: THÉVENIN EQUIVALENT (commercial)



Notes:

- Minimum DC input is -0.3V. During transactions, the inputs may undershoot to -2.0V or overshoot to 7.0V for input currents less than 100 mA and periods shorter than 20 ns.
- The I_{OH} parameter refers to high-level TTL output current; the I_{OL} parameter refers to low-level TTL output current.

Design Recommendations

Operation of the devices described herein with conditions above those listed under "Absolute 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 data sheet is not implied. Exposure to absolute maximum ratings conditions for extended periods of time may affect device reliability. The CY7C344B contains circuitry to protect device pins from high-static voltages or electric fields; however, normal precautions should be taken to avoid applying any voltage higher than maximum rated voltages.

For proper operation, input and output pins must be constrained to the range $GND \leq (V_{IN} \text{ or } V_{OUT}) \leq V_{CC}$. Unused inputs must always be tied to an appropriate logic level (either V_{CC} or GND). Each set of V_{CC} and GND pins must be connected together directly at the device. Power supply decoupling capacitors of at least $0.2 \mu F$ must be connected between V_{CC} and GND . For the most effective decoupling, each V_{CC} pin should be separately decoupled.

Timing Considerations

Unless otherwise stated, propagation delays do not include expanders. When using expanders, add the maximum expander delay t_{EXP} to the overall delay.

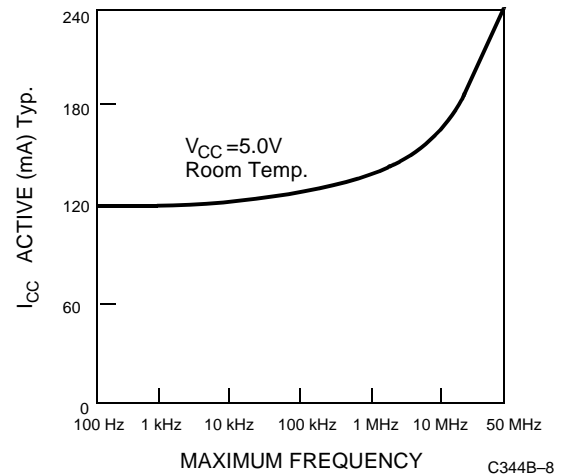
When calculating synchronous frequencies, use t_{SU} if all inputs are on the input pins. When expander logic is used in the data path, add the appropriate maximum expander delay, t_{EXP} to t_{SU} . Determine which of $1/(t_{WH} + t_{WL})$, $1/t_{CO1}$, or $1/(t_{EXP} + t_{SU})$ is the lowest frequency. The lowest of these frequencies is the maximum data-path frequency for the synchronous configuration.

When calculating external asynchronous frequencies, use t_{AS1} if all inputs are on dedicated input pins.

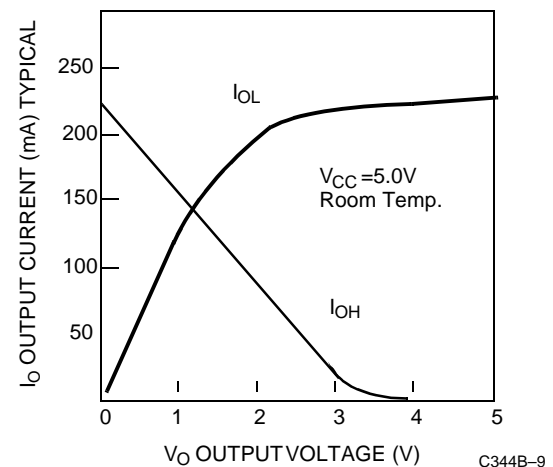
When expander logic is used in the data path, add the appropriate maximum expander delay, t_{EXP} to t_{AS1} . Determine which of $1/(t_{AWH} + t_{AWL})$, $1/t_{ACO1}$, or $1/(t_{EXP} + t_{AS1})$ is the lowest frequency. The lowest of these frequencies is the maximum data-path frequency for the asynchronous configuration.

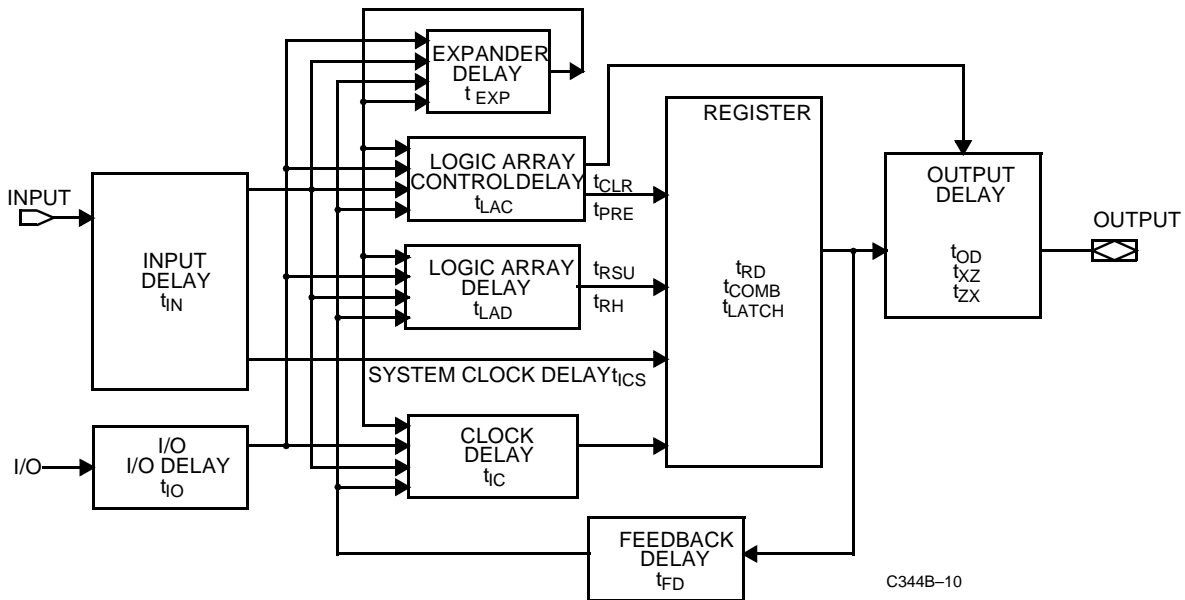
The parameter t_{OH} indicates the system compatibility of this device when driving other synchronous logic with positive input hold times, which is controlled by the same synchronous clock. If t_{OH} is greater than the minimum required input hold time of the subsequent synchronous logic, then the devices are guaranteed to function properly with a common synchronous clock under worst-case environmental and supply voltage conditions.

Typical I_{CC} vs. f_{MAX}



Output Drive Current




Figure 1. CY7C344B Timing Model
External Synchronous Switching Characteristics Over Operating Range

| Parameter | Description | | 7C344B-15 | | 7C344B-20 | | 7C344B-25 | | Unit |
|-----------|--|------------|-----------|------|-----------|------|-----------|------|------|
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| t_{PD1} | Dedicated Input to Combinatorial Output Delay ^[4] | Com'/I/Ind | | 15 | | 20 | | 25 | ns |
| t_{PD2} | I/O Input to Combinatorial Output Delay ^[4] | Com'/I/Ind | | 15 | | 20 | | 25 | ns |
| t_{SU} | Global Clock Set-up Time | Com'/I/Ind | 9 | | 12 | | 15 | | ns |
| t_{CO1} | Synchronous Clock Input to Output Delay ^[4] | Com'/I/Ind | | 10 | | 12 | | 15 | ns |
| t_H | Input Hold Time from Synchronous Clock Input | Com'/I/Ind | 0 | | 0 | | 0 | | ns |
| t_{WH} | Synchronous Clock Input HIGH Time | Com'/I/Ind | 6 | | 7 | | 8 | | ns |
| t_{WL} | Synchronous Clock Input LOW Time | Com'/I/Ind | 6 | | 7 | | 8 | | ns |
| f_{MAX} | Maximum Register Toggle Frequency ^[5] | Com'/I/Ind | 83.3 | | | 71.4 | | 62.5 | MHz |
| t_{CNT} | Minimum Global Clock Period | Com'/I/Ind | | 13 | | 16 | | 20 | ns |
| t_{ODH} | Output Data Hold Time After Clock | Com'/I/Ind | 1 | | 1 | | 1 | | ns |
| f_{CNT} | Maximum Internal Global Clock Frequency ^[6] | Com'/I/Ind | 76.9 | | 62.5 | | 50 | | MHz |

Notes:

4. $C1 = 35 \text{ pF}$
5. The f_{MAX} values represent the highest frequency for pipeline data.
6. This parameter is measured with a 32-bit counter programmed into each LAB.

External Asynchronous Switching Characteristics Over Operating Range

| Parameter | Description | | 7C344B-15 | | 7C344B-20 | | 7C344B-25 | | Unit |
|------------|---|-----------|-----------|------|-----------|------|-----------|------|------|
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| t_{ACO1} | Asynchronous Clock Input to Output Delay ^[4] | Com'l/Ind | | 15 | | 18 | | 22 | ns |
| t_{AS1} | Dedicated Input or Feedback Set-Up Time to Asynchronous Clock Input | Com'l/Ind | 5 | | 6 | | 8 | | ns |
| t_{AH} | Input Hold Time from Asynchronous Clock Input | Com'l/Ind | 5 | | 6 | | 8 | | ns |
| t_{AWH} | Asynchronous Clock Input HIGH Time ^[7] | Com'l/Ind | 6 | | 7 | | 9 | | ns |
| t_{AWL} | Asynchronous Clock Input LOW Time ^[7] | Com'l/Ind | 7 | | 9 | | 11 | | ns |
| t_{ACNT} | Minimum Internal Array Clock Frequency | Com'l/Ind | | 13 | | 16 | | 20 | ns |
| f_{ACNT} | Maximum Internal Array Clock Frequency ^[6] | Com'l/Ind | 76.9 | | 62.5 | | 50 | | MHz |

Typical Internal Switching Characteristics Over Operating Range

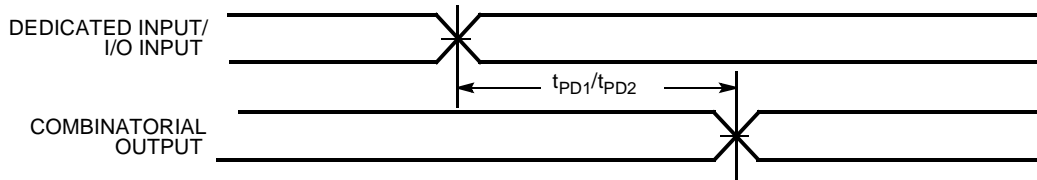
| Parameter | Description | | 7C344B-15 | | 7C344B-20 | | 7C344B-25 | | Unit |
|-------------|---|------------|-----------|------|-----------|------|-----------|------|------|
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| t_{IN} | Dedicated Input Pad and Buffer Delay | Com'l/Ind | | 3 | | 5 | | 7 | ns |
| t_{IO} | I/O Input Pad and Buffer Delay | Com'l/Ind | | 3 | | 5 | | 7 | ns |
| t_{EXP} | Expander Array Delay | Com'l/Ind | | 8 | | 10 | | 15 | ns |
| t_{LAD} | Logic Array Data Delay | Com'l/Ind | | 7 | | 10 | | 13 | ns |
| t_{LAC} | Logic Array Control Delay | Com'l/Ind | | 4 | | 4 | | 4 | ns |
| t_{OD} | Output Buffer and Pad Delay ^[4] | Com'l/Ind | | 4 | | 4 | | 4 | ns |
| t_{ZX} | Output Buffer Enable Delay ^[4] | Com'l /Ind | | 7 | | 7 | | 7 | ns |
| t_{XZ} | Output Buffer Disable Delay ^[4] | Com'l/Ind | | 7 | | 7 | | 7 | ns |
| t_{RSU} | Register Set-Up Time Relative to Clock Signal at Register | Com'l/Ind | 4 | | 4 | | 5 | | ns |
| t_{RH} | Register Hold Time Relative to Clock Signal at Register | Com'l/Ind | 5 | | 8 | | 10 | | ns |
| t_{LATCH} | Flow-Through Latch Delay | Com'l/Ind | | 1 | | 1 | | 1 | ns |
| t_{RD} | Register Delay | Com'l/Ind | | 1 | | 1 | | 1 | ns |
| t_{COMB} | Transparent Mode Delay | Com'l/Ind | | 1 | | 1 | | 1 | ns |
| t_{IC} | Asynchronous Clock Logic Delay | Com'l/Ind | | 7 | | 8 | | 10 | ns |
| t_{ICS} | Synchronous Clock Delay | Com'l/Ind | | 2 | | 2 | | 3 | ns |
| t_{FD} | Feedback Delay | Com'l/Ind | | 1 | | 1 | | 1 | ns |
| t_{PRE} | Asynchronous Register Preset Time | Com'l/Ind | | 5 | | 6 | | 9 | ns |
| t_{CLR} | Asynchronous Register Clear Time | Com'l/Ind | | 5 | | 6 | | 9 | ns |

Notes:

7. This parameter is measured with a positive-edge-triggered clock at the register. For the negative-edge clocking, the t_{ACH} and t_{ACL} parameter must be swapped.

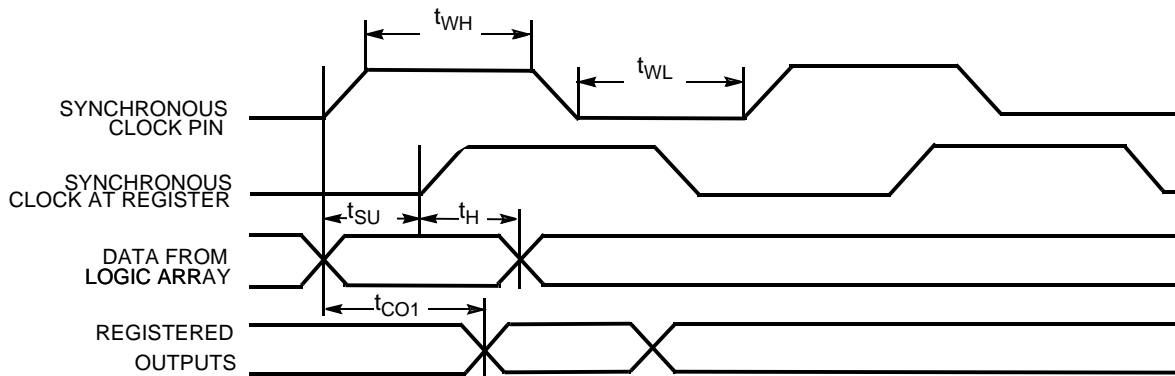
Switching Waveforms

External Combinatorial



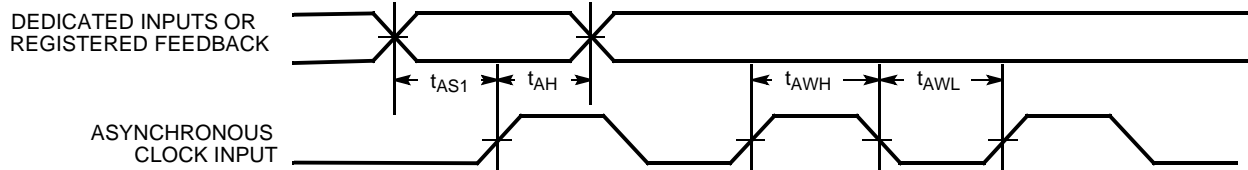
C344B-11

External Synchronous



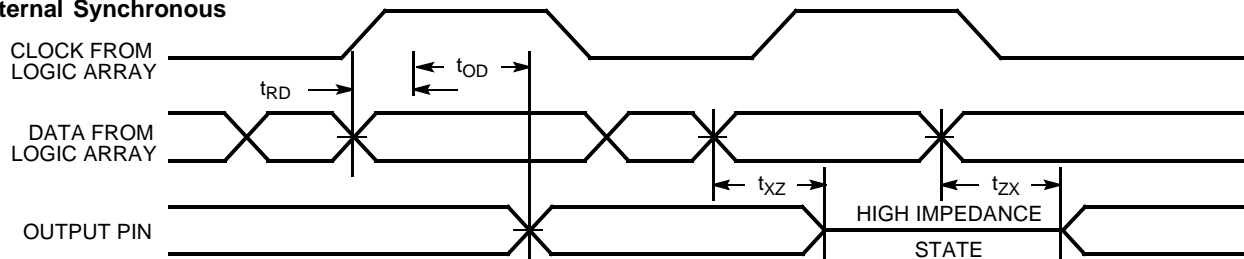
C344B-12

External Asynchronous

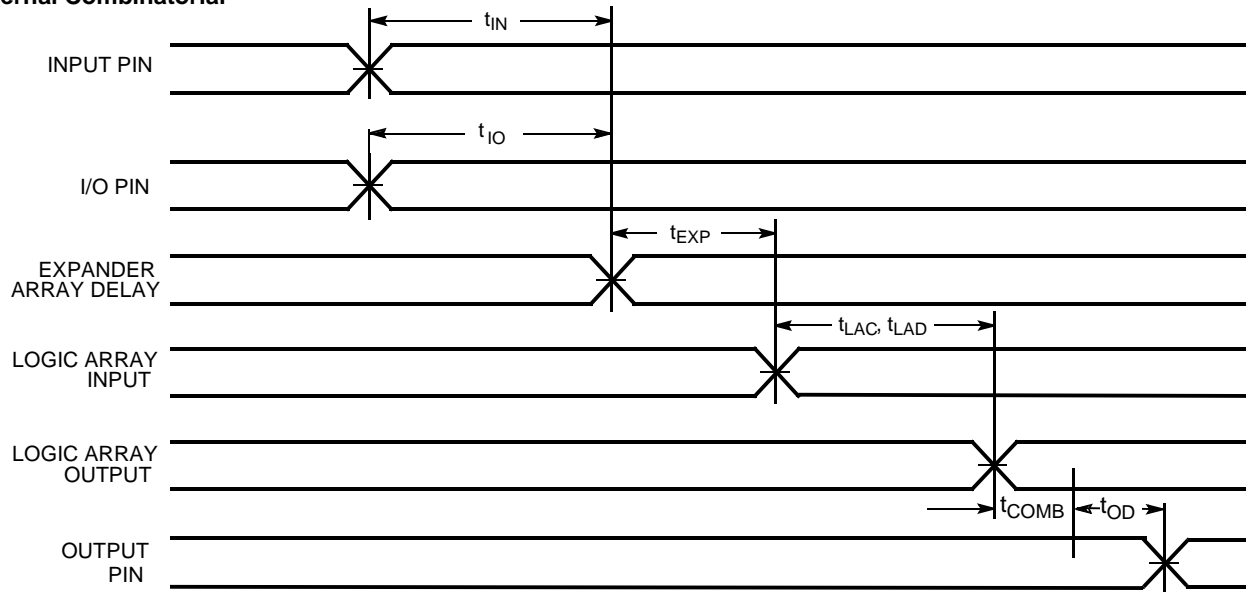


C344B-13

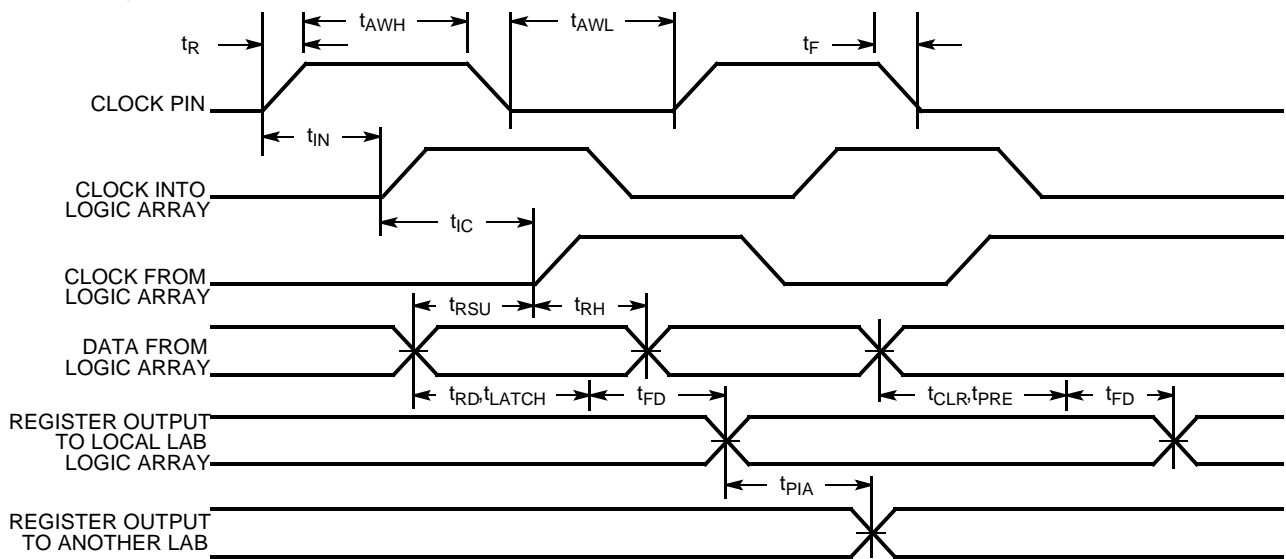
Internal Synchronous



C344B-14

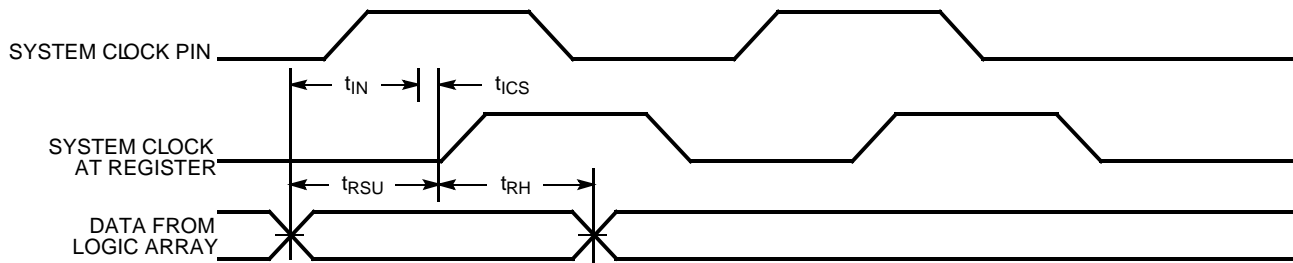
Switching Waveforms (continued)
Internal Combinatorial


C344B-15

Internal Asynchronous


C344B-16

Switching Waveforms (continued)

Internal Synchronous


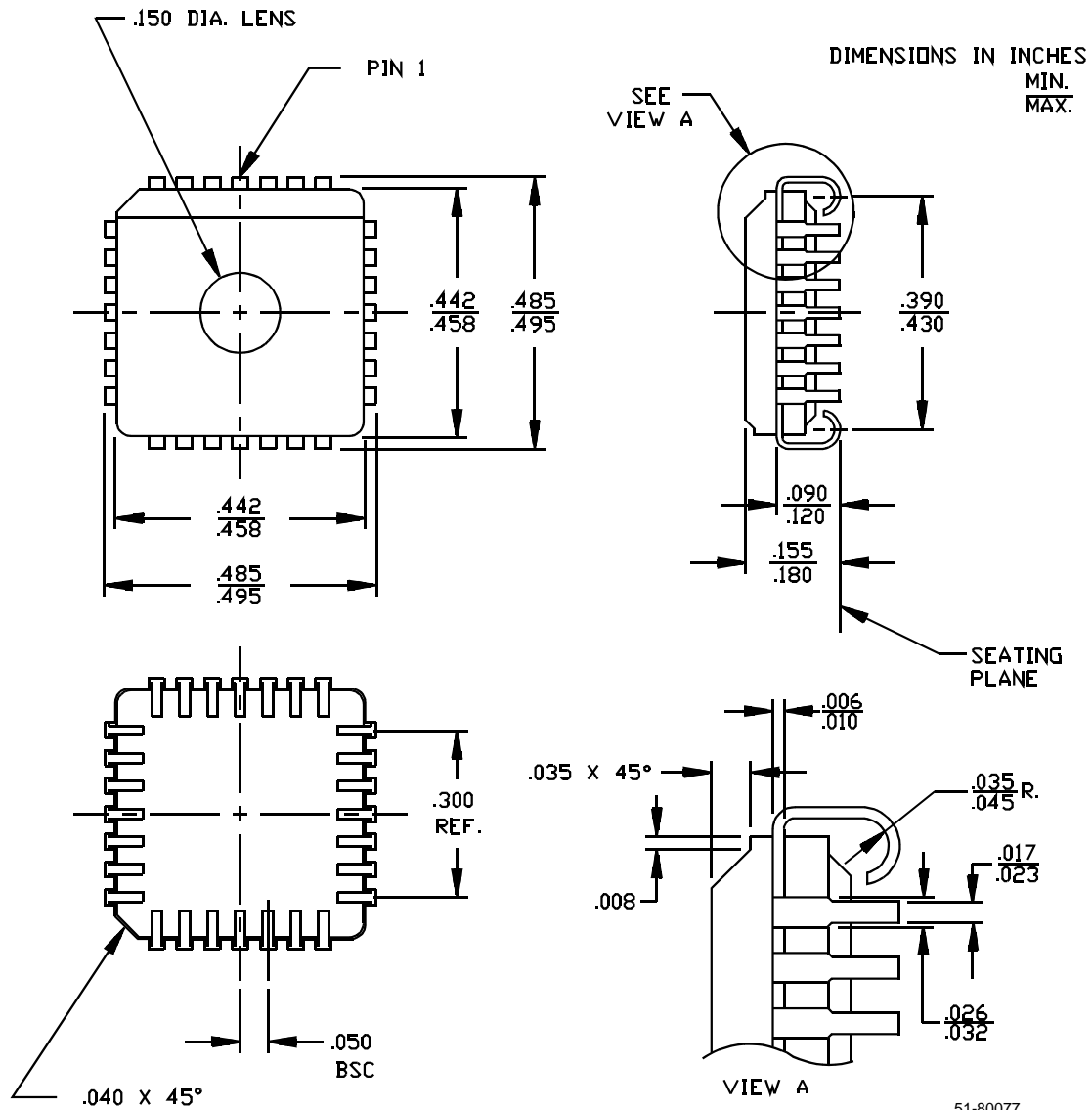
C344B-17

Ordering Information

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|------------------|--------------|--------------------------------------|-----------------------|
| 15 | CY7C344B-15HC/HI | H64 | 28-Lead Windowed Leaded Chip Carrier | Commercial/Industrial |
| | CY7C344B-15JC/JI | J64 | 28-Lead Plastic Leaded Chip Carrier | |
| | CY7C344B-15PC/PI | P21 | 28-Lead (300-Mil) Molded DIP | |
| | CY7C344B-15WC/WI | W22 | 28-Lead Windowed CerDIP | |
| 20 | CY7C344B-20HC/HI | H64 | 28-Lead Windowed Leaded Chip Carrier | Commercial/Industrial |
| | CY7C344B-20JC/JI | J64 | 28-Lead Plastic Leaded Chip Carrier | |
| | CY7C344B-20PC/PI | P21 | 28-Lead (300-Mil) Molded DIP | |
| | CY7C344B-20WC/WI | W22 | 28-Lead Windowed CerDIP | |
| 25 | CY7C344B-25HC/HI | H64 | 28-Lead Windowed Leaded Chip Carrier | Commercial/Industrial |
| | CY7C344B-25JC/JI | J64 | 28-Lead Plastic Leaded Chip Carrier | |
| | CY7C344B-25PC/PI | P21 | 28-Lead (300-Mil) Molded DIP | |

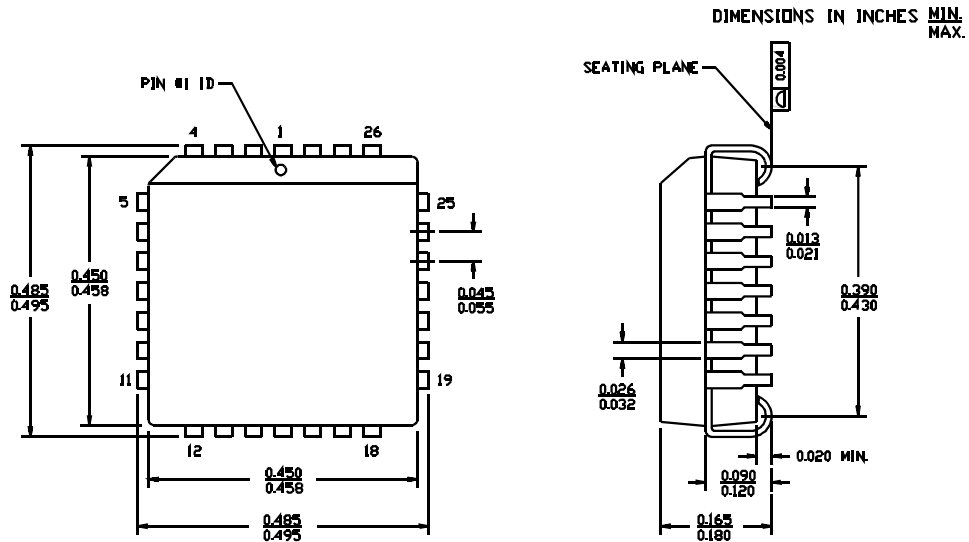
Package Diagrams

28-Pin Windowed Leaded Chip Carrier H64

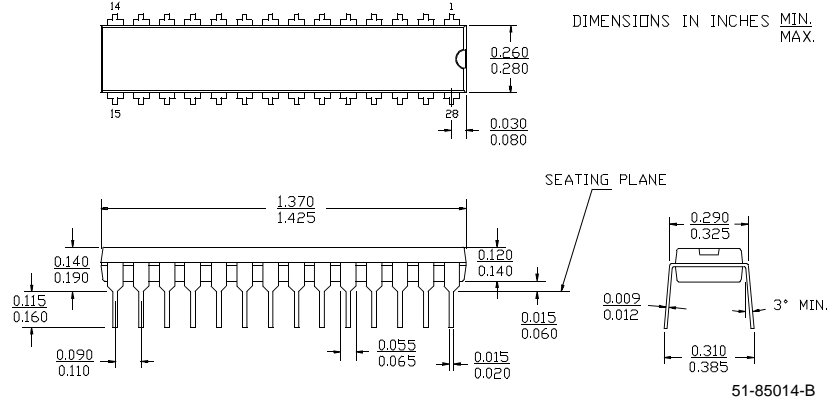


Package Diagrams (continued)

28-Lead Plastic Leaded Chip Carrier J64

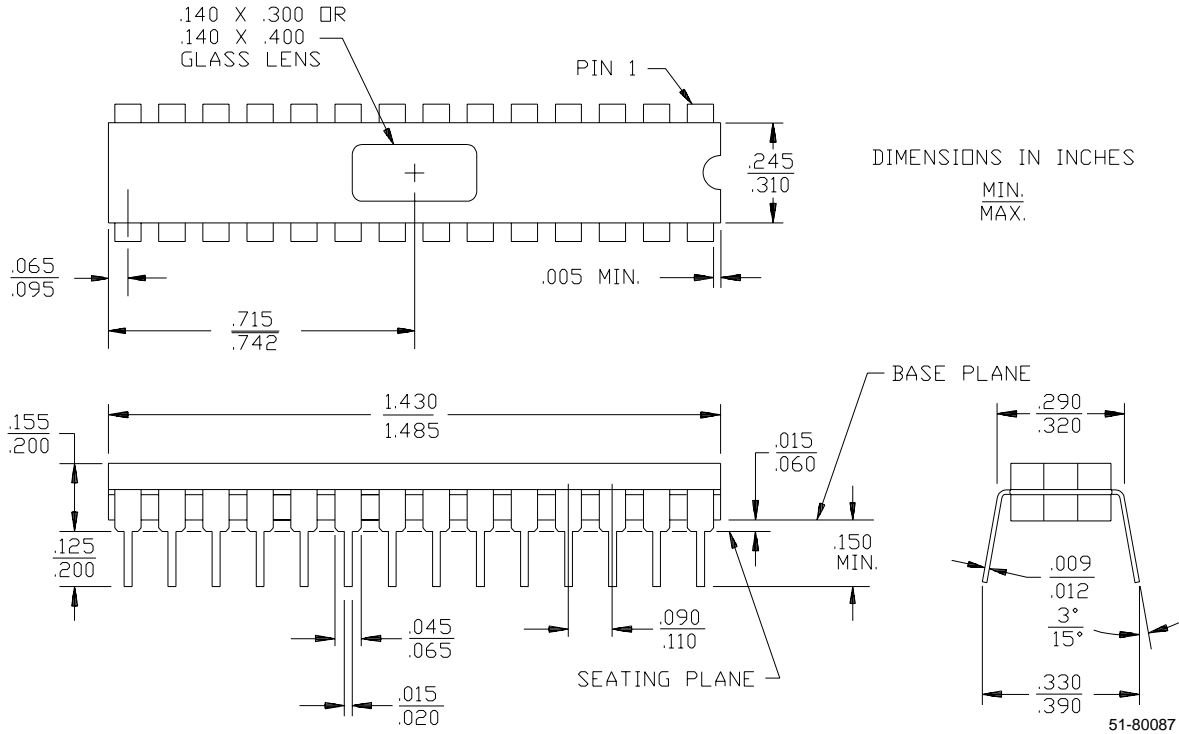


28-Lead (300-Mil) Molded DIP P21



Package Diagrams (continued)

28-Lead (300-Mil) Windowed CerDIP W22
MIL-STD-1835 D-15 Config. A



| Document Title: CY7C344B 32-Macrocell MAX® EPLD Document Number: 38-03036 | | | | |
|--|----------------|-------------------|------------------------|--|
| REV. | ECN NO. | Issue Date | Orig. of Change | Description of Change |
| ** | 106381 | 06/15/01 | SZV | Change from Spec #: 38-00860 to 38-03036 |