



Is Now Part of



**ON Semiconductor®**

To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## 74LCX16374

### Low Voltage 16-Bit D-Type Flip-Flop with 5V Tolerant Inputs and Outputs

#### General Description

The LCX16374 contains sixteen non-inverting D-type flip-flops with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. A buffered clock (CP) and Output Enable ( $\overline{OE}$ ) are common to each byte and can be shorted together for full 16-bit operation.

The LCX16374 is designed for low voltage (2.5V or 3.3V)  $V_{CC}$  applications with capability of interfacing to a 5V signal environment.

The LCX16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

#### Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 6.2 ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 20  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Uses proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

**Note 1:** To ensure the high-impedance state during power up or down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pull-up resistor; the minimum value or the resistor is determined by the current-sourcing capability of the driver.

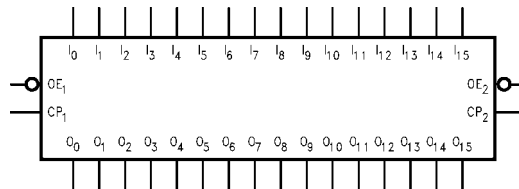
#### Ordering Code:

| Order Number                    | Package Number | Package Description   |
|---------------------------------|----------------|---|
| 74LCX16374G<br>(Note 2)(Note 3) | BGA54A         | 54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide         |
| 74LCX16374MEA<br>(Note 3)       | MS48A          | 48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide      |
| 74LCX16374MTD<br>(Note 3)       | MTD48          | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

**Note 2:** Ordering code "G" indicates Trays.

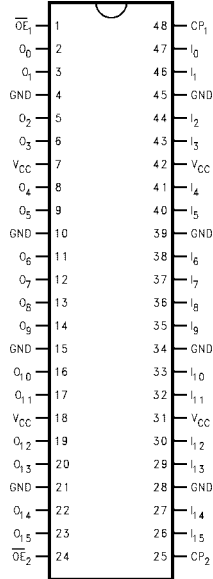
**Note 3:** Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Logic Symbol

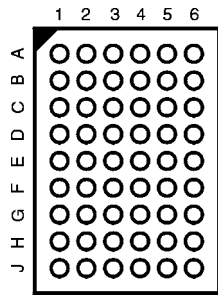


### Connection Diagrams

Pin Assignment for SSOP and TSSOP



Pin Assignment for FBGA



(Top Thru View)

### Pin Descriptions

| Pin Names         | Description                      |
|-------------------|----------------------------------|
| $\overline{OE}_n$ | Output Enable Input (Active LOW) |
| $CP_n$            | Clock Pulse Input                |
| $I_0-I_{15}$      | Inputs                           |
| $O_0-O_{15}$      | Outputs                          |
| NC                | No Connect                       |

### FBGA Pin Assignments

|          | 1        | 2        | 3                 | 4        | 5        | 6        |
|----------|----------|----------|-------------------|----------|----------|----------|
| <b>A</b> | $O_0$    | NC       | $\overline{OE}_1$ | $CP_1$   | NC       | $I_0$    |
| <b>B</b> | $O_2$    | $O_1$    | NC                | NC       | $I_1$    | $I_2$    |
| <b>C</b> | $O_4$    | $O_3$    | $V_{CC}$          | $V_{CC}$ | $I_3$    | $I_4$    |
| <b>D</b> | $O_6$    | $O_5$    | GND               | GND      | $I_5$    | $I_6$    |
| <b>E</b> | $O_8$    | $O_7$    | GND               | GND      | $I_7$    | $I_8$    |
| <b>F</b> | $O_{10}$ | $O_9$    | GND               | GND      | $I_9$    | $I_{10}$ |
| <b>G</b> | $O_{12}$ | $O_{11}$ | $V_{CC}$          | $V_{CC}$ | $I_{11}$ | $I_{12}$ |
| <b>H</b> | $O_{14}$ | $O_{13}$ | NC                | NC       | $I_{13}$ | $I_{14}$ |
| <b>J</b> | $O_{15}$ | NC       | $\overline{OE}_2$ | $CP_2$   | NC       | $I_{15}$ |

### Truth Tables

| Inputs |                   |           | Outputs   |
|--------|-------------------|-----------|-----------|
| $CP_1$ | $\overline{OE}_1$ | $I_0-I_7$ | $O_0-O_7$ |
| ↗      | L                 | H         | H         |
| ↗      | L                 | L         | L         |
| L      | L                 | X         | $O_0$     |
| X      | H                 | X         | Z         |

| Inputs |                   |              | Outputs      |
|--------|-------------------|--------------|--------------|
| $CP_2$ | $\overline{OE}_2$ | $I_8-I_{15}$ | $O_8-O_{15}$ |
| ↗      | L                 | H            | H            |
| ↗      | L                 | L            | L            |
| L      | L                 | X            | $O_0$        |
| X      | H                 | X            | Z            |

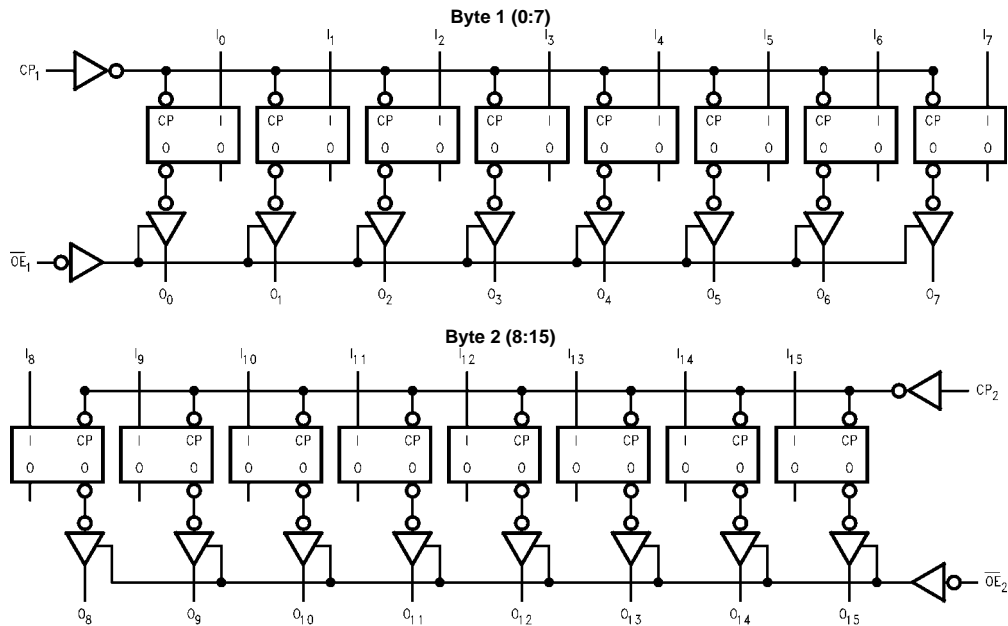
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial  
 Z = High Impedance  
 $O_0$  = Previous  $O_0$  before HIGH-to-LOW of CP

## Functional Description

The LCX16374 consists of sixteen edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. Each byte has a buffered clock and buffered Output Enable common to all flip-flops within that byte. The description which follows applies to each byte. Each flip-flop will store the

state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock ( $CP_n$ ) transition. With the Output Enable ( $\overline{OE}_n$ ) LOW, the contents of the flip-flops are available at the outputs. When  $\overline{OE}_n$  is HIGH, the outputs go to the high impedance state. Operation of the  $\overline{OE}_n$  input does not affect the state of the flip-flops.

## Logic Diagrams



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings** (Note 4)

| Symbol           | Parameter                        | Value   | Conditions   | Units |
|------------------|----------------------------------|---|--|-------|
| V <sub>CC</sub>  | Supply Voltage                   | -0.5 to +7.0                                  |  | V     |
| V <sub>I</sub>   | DC Input Voltage                 | -0.5 to +7.0                                  |  | V     |
| V <sub>O</sub>   | DC Output Voltage                | -0.5 to +7.0<br>-0.5 to V <sub>CC</sub> + 0.5 | 3-STATE<br>Output in HIGH or LOW State (Note 5)          | V     |
| I <sub>IK</sub>  | DC Input Diode Current           | -50   | V <sub>I</sub> < GND                                     | mA    |
| I <sub>OK</sub>  | DC Output Diode Current          | -50<br>+50                                    | V <sub>O</sub> < GND<br>V <sub>O</sub> > V <sub>CC</sub> | mA    |
| I <sub>O</sub>   | DC Output Source/Sink Current    | ±50   |  | mA    |
| I <sub>CC</sub>  | DC Supply Current per Supply Pin | ±100  |  | mA    |
| I <sub>GND</sub> | DC Ground Current per Ground Pin | ±100  |  | mA    |
| T <sub>STG</sub> | Storage Temperature              | -65 to +150                                   |  | °C    |

**Note 4:** The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 5:** I<sub>O</sub> Absolute Maximum Rating must be observed.

**Recommended Operating Conditions** (Note 6)

| Symbol                           | Parameter  | Min                           | Max | Units           |    |
|----------------------------------|--|-------------------------------|-----|-----------------|----|
| V <sub>CC</sub>                  | Supply Voltage   | Operating                     | 2.0 | 3.6             | V  |
|                                  |  | Data Retention                | 1.5 | 3.6             |    |
| V <sub>I</sub>                   | Input Voltage  | 0                             | 5.5 | V               |    |
| V <sub>O</sub>                   | Output Voltage   | HIGH or LOW State             | 0   | V <sub>CC</sub> | V  |
|                                  |  | 3-STATE                       | 0   | 5.5             |    |
| I <sub>OH</sub> /I <sub>OL</sub> | Output Current   | V <sub>CC</sub> = 3.0V - 3.6V |     | ±24             | mA |
|                                  |  | V <sub>CC</sub> = 2.7V - 3.0V |     | ±12             |    |
|                                  |  | V <sub>CC</sub> = 2.3V - 2.7V |     | ±8              |    |
| T <sub>A</sub>                   | Free-Air Operating Temperature   | -40                           | 85  | °C              |    |
| Δt/ΔV                            | Input Edge Rate, V <sub>IN</sub> = 0.8V - 2.0V, V <sub>CC</sub> = 3.0V | 0                             | 10  | ns/V            |    |

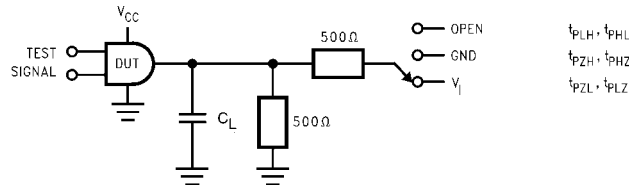
**Note 6:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

| Symbol           | Parameter                 | Conditions   | V <sub>CC</sub><br>(V) | T <sub>A</sub> = -40°C to -85°C |      | Units |
|------------------|---------------------------|--|------------------------|---------------------------------|------|-------|
|                  |                           |  |                        | Min                             | Max  |       |
| V <sub>IH</sub>  | HIGH Level Input Voltage  |  | 2.3 - 2.7              | 1.7                             |      | V     |
|                  |                           |  | 2.7 - 3.6              | 2.0                             |      |       |
| V <sub>IL</sub>  | LOW Level Input Voltage   |  | 2.3 - 2.7              |                                 | 0.7  | V     |
|                  |                           |  | 2.7 - 3.6              |                                 | 0.8  |       |
| V <sub>OH</sub>  | HIGH Level Output Voltage | I <sub>OH</sub> = -100 μA  | 2.3 - 3.6              | V <sub>CC</sub> - 0.2           |      | V     |
|                  |                           | I <sub>OH</sub> = -8 mA  | 2.3                    | 1.8                             |      |       |
|                  |                           | I <sub>OH</sub> = -12 mA   | 2.7                    | 2.2                             |      |       |
|                  |                           | I <sub>OH</sub> = -18 mA   | 3.0                    | 2.4                             |      |       |
|                  |                           | I <sub>OH</sub> = -24 mA   | 3.0                    | 2.2                             |      |       |
| V <sub>OL</sub>  | LOW Level Output Voltage  | I <sub>OL</sub> = 100 μA   | 2.3 - 3.6              |                                 | 0.2  | V     |
|                  |                           | I <sub>OL</sub> = 8 mA   | 2.3                    |                                 | 0.6  |       |
|                  |                           | I <sub>OL</sub> = 12 mA  | 2.7                    |                                 | 0.4  |       |
|                  |                           | I <sub>OL</sub> = 16 mA  | 3.0                    |                                 | 0.4  |       |
|                  |                           | I <sub>OL</sub> = 24 mA  | 3.0                    |                                 | 0.55 |       |
| I <sub>I</sub>   | Input Leakage Current     | 0 ≤ V <sub>I</sub> ≤ 5.5V  | 2.3 - 3.6              |                                 | ±5.0 | μA    |
| I <sub>OZ</sub>  | 3-STATE Output Leakage    | 0 ≤ V <sub>O</sub> ≤ 5.5V<br>V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> | 2.3 - 3.6              |                                 | ±5.0 | μA    |
| I <sub>OFF</sub> | Power-Off Leakage Current | V <sub>I</sub> or V <sub>O</sub> = 5.5V  | 0                      |                                 | 10   | μA    |

| DC Electrical Characteristics (Continued)  |   |   |                        |                                 |     |                               |     |       |
|--|---|---|------------------------|---------------------------------|-----|-------------------------------|-----|-------|
| Symbol   | Parameter                                   | Conditions  | V <sub>CC</sub><br>(V) | T <sub>A</sub> = -40°C to +85°C |     | Units                         |     |       |
|  |   |   |                        | Min                             | Max |                               |     |       |
| I <sub>CC</sub>  | Quiescent Supply Current                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                     | 2.3 – 3.6              |                                 | 20  | μA                            |     |       |
|  |   | 3.6V ≤ V <sub>I</sub> , V <sub>O</sub> ≤ 5.5V (Note 7)                      | 2.3 – 3.6              |                                 | ±20 |                               |     |       |
| ΔI <sub>CC</sub>   | Increase in I <sub>CC</sub> per Input       | V <sub>IH</sub> = V <sub>CC</sub> - 0.6V                                    | 2.3 – 3.6              |                                 | 500 | μA                            |     |       |
| <b>Note 7:</b> Outputs disabled or 3-STATE only.   |   |   |                        |                                 |     |                               |     |       |
| AC Electrical Characteristics  |   |   |                        |                                 |     |                               |     |       |
| Symbol   | Parameter                                   | T <sub>A</sub> = -40° to +85°C, R <sub>L</sub> = 500Ω                       |                        |                                 |     |                               |     | Units |
|  |   | V <sub>CC</sub> = 3.3V ± 0.3V   |                        | V <sub>CC</sub> = 2.7V          |     | V <sub>CC</sub> = 2.5V ± 0.2V |     |       |
|  |   | C <sub>L</sub> = 50 pF  |                        | C <sub>L</sub> = 50 pF          |     | C <sub>L</sub> = 30 pF        |     |       |
|  |   | Min   | Max                    | Min                             | Max | Min                           | Max |       |
| f <sub>MAX</sub>   | Maximum Clock Frequency                     | 170   |                        |                                 |     |                               |     | MHz   |
| t <sub>PHL</sub>   | Propagation Delay                           | 1.5   | 6.2                    | 1.5                             | 6.5 | 1.5                           | 7.4 | ns    |
| t <sub>PLH</sub>   | CP to O <sub>n</sub>                        | 1.5   | 6.2                    | 1.5                             | 6.5 | 1.5                           | 7.4 |       |
| t <sub>PZL</sub>   | Output Enable time                          | 1.5   | 6.1                    | 1.5                             | 6.3 | 1.5                           | 7.9 | ns    |
| t <sub>PZH</sub>   |   | 1.5   | 6.1                    | 1.5                             | 6.3 | 1.5                           | 7.9 |       |
| t <sub>PLZ</sub>   | Output Disable Time                         | 1.5   | 6.0                    | 1.5                             | 6.2 | 1.5                           | 7.2 | ns    |
| t <sub>PHZ</sub>   |   | 1.5   | 6.0                    | 1.5                             | 6.2 | 1.5                           | 7.2 |       |
| t <sub>S</sub>   | Setup Time                                  | 2.5   |                        | 2.5                             |     | 3.0                           |     | ns    |
| t <sub>H</sub>   | Hold Time                                   | 1.5   |                        | 1.5                             |     | 2.0                           |     | ns    |
| t <sub>W</sub>   | Pulse Width                                 | 3.0   |                        | 3.0                             |     | 3.5                           |     | ns    |
| t <sub>OSHL</sub>  | Output to Output Skew (Note 8)              |   | 1.0                    |                                 |     |                               |     | ns    |
| t <sub>OSLH</sub>  |   |   | 1.0                    |                                 |     |                               |     |       |
| <b>Note 8:</b> Skew is defined as the absolute value of the differences between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t <sub>OSHL</sub> ) or LOW-to-HIGH (t <sub>OSLH</sub> ). Parameter guaranteed by design. |   |   |                        |                                 |     |                               |     |       |
| Dynamic Switching Characteristics  |   |   |                        |                                 |     |                               |     |       |
| Symbol   | Parameter                                   | Conditions  | V <sub>CC</sub><br>(V) | T <sub>A</sub> = 25°C           |     | Units                         |     |       |
|  |   |   |                        | Typical                         |     |                               |     |       |
| V <sub>OLP</sub>   | Quiet Output Dynamic Peak V <sub>OL</sub>   | C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V        | 3.3                    | 0.8                             |     | V                             |     |       |
|  |   | C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V        | 2.5                    | 0.6                             |     |                               |     |       |
| V <sub>OLV</sub>   | Quiet Output Dynamic Valley V <sub>OL</sub> | C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V        | 3.3                    | -0.8                            |     | V                             |     |       |
|  |   | C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V        | 2.5                    | 0.6                             |     |                               |     |       |
| Capacitance  |   |   |                        |                                 |     |                               |     |       |
| Symbol   | Parameter                                   | Conditions  | Typical                | Units                           |     |                               |     |       |
| C <sub>IN</sub>  | Input Capacitance                           | V <sub>CC</sub> = Open, V <sub>I</sub> = 0V or V <sub>CC</sub>              | 7                      | pF                              |     |                               |     |       |
| C <sub>OUT</sub>   | Output Capacitance                          | V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub>              | 8                      | pF                              |     |                               |     |       |
| C <sub>PD</sub>  | Power Dissipation Capacitance               | V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub> , f = 10 MHz | 20                     | pF                              |     |                               |     |       |

**AC LOADING and WAVEFORMS** Generic for LCX Family



**FIGURE 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)**

| Test                  | Switch   |
|-----------------------|--|
| $t_{PLH}$ , $t_{PHL}$ | Open   |
| $t_{PZL}$ , $t_{PLZ}$ | 6V at $V_{CC} = 3.3 \pm 0.3V$ , and 2.7V<br>$V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$ |
| $t_{PZH}$ , $t_{PHZ}$ | GND  |



**Waveform for Inverting and Non-Inverting Functions**



**3-STATE Output High Enable and Disable Times for Logic**



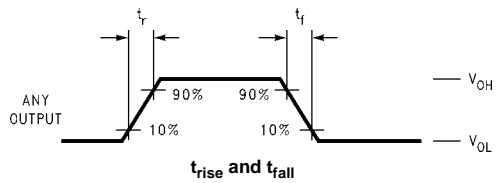
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



**Setup Time, Hold Time and Recovery Time for Logic**



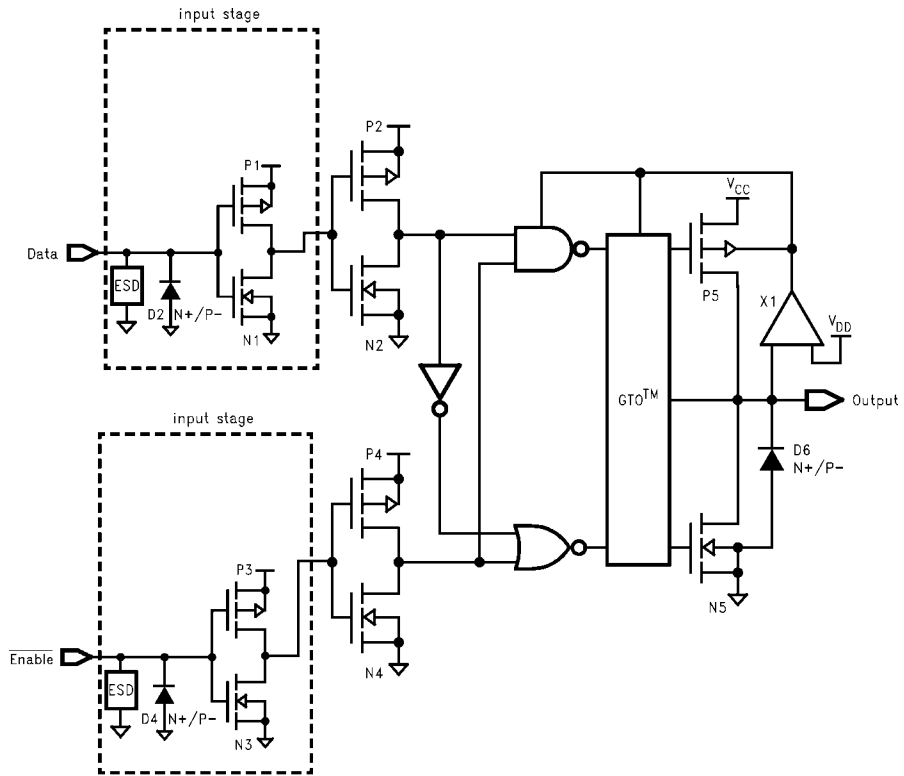
**3-STATE Output Low Enable and Disable Times for Logic**



**FIGURE 2. Waveforms (Input Characteristics;  $f = 1MHz$ ,  $t_r = t_f = 3ns$ )**

| Symbol   | $V_{CC}$        |                 |                  |
|----------|-----------------|-----------------|------------------|
|          | $3.3V \pm 0.3V$ | 2.7V            | $2.5V \pm 0.2V$  |
| $V_{mi}$ | 1.5V            | 1.5V            | $V_{CC}/2$       |
| $V_{mo}$ | 1.5V            | 1.5V            | $V_{CC}/2$       |
| $V_x$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ |
| $V_y$    | $V_{OH} - 0.3V$ | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ |

**Schematic Diagram** Generic for LCX Family



74LCX16374



**Physical Dimensions** inches (millimeters) unless otherwise noted



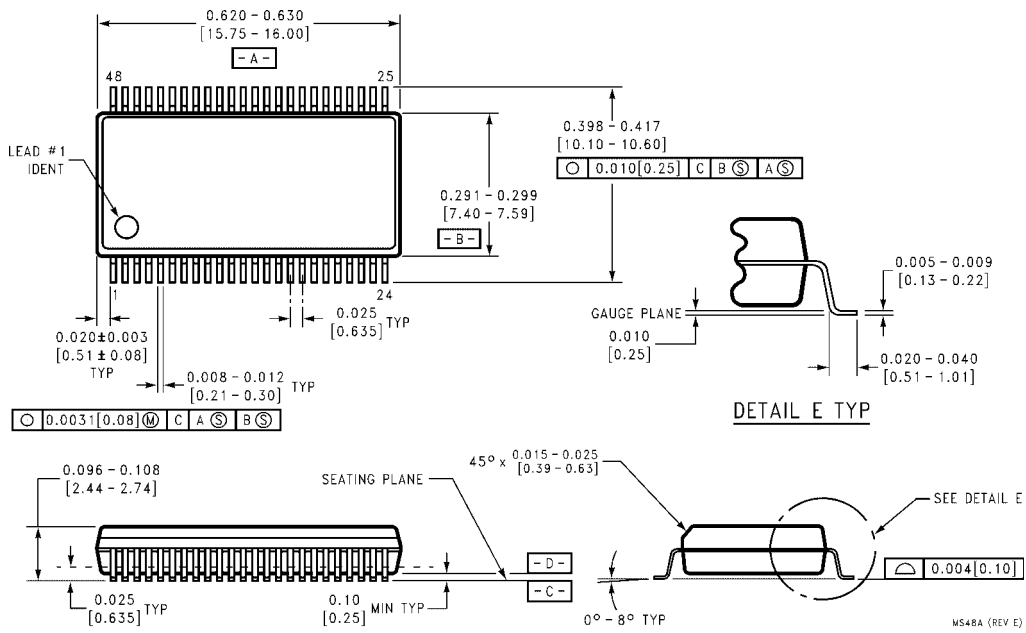
**NOTES:**

- A. THIS PACKAGE CONFORMS TO JEDEC M0-205
- B. ALL DIMENSIONS IN MILLIMETERS
- C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)  
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
- D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA54ArevD

**54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide  
Package Number BGA54A**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide  
Package Number MS48A**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



MTD48REV C

**48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide Package Number MTD48**

Fairchild does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and Fairchild reserves the right at any time without notice to change said circuitry and specifications.

**LIFE SUPPORT POLICY**

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

[www.fairchildsemi.com](http://www.fairchildsemi.com)