

## 74LCXH16374

### Low Voltage 16-Bit D-Type Flip-Flop with Bushold

#### General Description

The LCXH16374 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 LCXH16374 is designed for low voltage (2.5V or 3.3V)  $V_{CC}$  applications.

The LCXH16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

The LCXH16374 data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

#### Features

- 5V tolerant control 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
- Bushold on inputs eliminating the need for external pull-up/pull-down resistors
- Power down high impedance outputs
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Implements patented noise/EML 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)

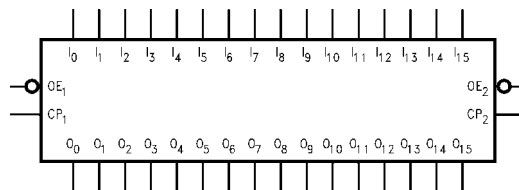
#### Ordering Code:

| Order Number                     | Package Number | Package Description                                                         |
|----------------------------------|----------------|-----------------------------------------------------------------------------|
| 74LCXH16374G<br>(Note 1)(Note 3) | BGA54A         | 54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide         |
| 74LCXH16374MEA<br>(Note 2)       | MS48A          | 48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide      |
| 74LCXH16374MTD<br>(Note 2)       | MTD48          | 48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

**Note 1:** Ordering code "G" indicates Trays.

**Note 2:** Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

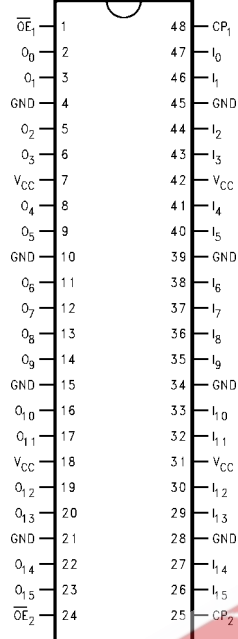
#### Logic Symbol



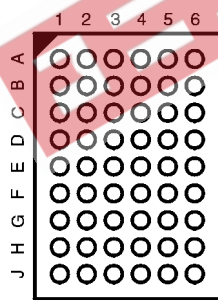
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### Connection Diagrams

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                |
| $I_0-I_{15}$      | Bushold 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            |

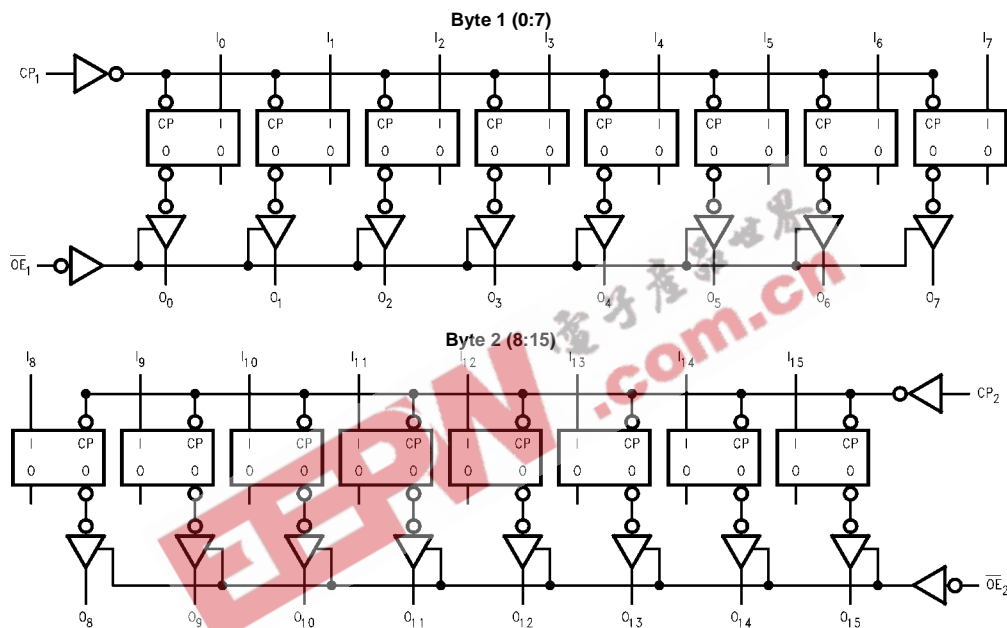
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial  
 Z = High Impedance  
 $O_0$  = Previous  $O_0$  before HIGH-to-LOW of CP

## Functional Description

The LCXH16374 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

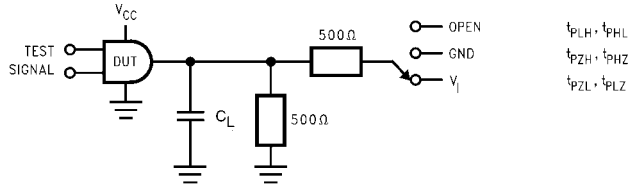


Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

| Absolute Maximum Ratings (Note 3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |                                                |                                                          |                                 |      |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------|----------------------------------------------------------|---------------------------------|------|-------|
| Symbol                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Parameter                                                              | Value                                          | Conditions                                               | Units                           |      |       |
| V <sub>CC</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Supply Voltage                                                         | -0.5 to +7.0                                   |                                                          | V                               |      |       |
| V <sub>I</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | DC Input Voltage<br>$I_0 - I_{15}$<br>$\overline{OE}_1, CP_n$          | -0.5 to V <sub>CC</sub> + 0.5<br>-0.5V to 7.0V |                                                          | 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 4)          | 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                              |      |       |
| Recommended Operating Conditions (Note 5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |                                                |                                                          |                                 |      |       |
| 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                                              | V <sub>CC</sub>                                          | 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                            |      |       |
| <p><b>Note 3:</b> 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.</p> <p><b>Note 4:</b> I<sub>O</sub> Absolute Maximum Rating must be observed.</p> <p><b>Note 5:</b> Floating or unused control inputs must be HIGH or LOW.</p> |                                                                        |                                                |                                                          |                                 |      |       |
| 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                                                  | Data                                           | V <sub>I</sub> = V <sub>CC</sub> or GND                  | 2.3 - 3.6                       | ±5.0 | μA    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        | Control                                        | 0V ≤ V <sub>I</sub> ≤ 5.5                                | 2.3 - 3.6                       | ±5.0 |       |

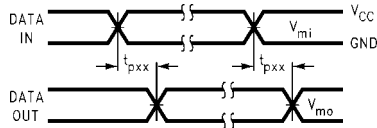
| DC Electrical Characteristics (Continued)                                                                                                                                                                                                                                                                                                               |                                                  |                                                                             |                        |                                 |      |                               |     |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------|------------------------|---------------------------------|------|-------------------------------|-----|-------|
| Symbol                                                                                                                                                                                                                                                                                                                                                  | Parameter                                        | Conditions                                                                  | V <sub>CC</sub><br>(V) | T <sub>A</sub> = -40°C to +85°C |      | Units                         |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  |                                                                             |                        | Min                             | Max  |                               |     |       |
| I <sub>I(HOLD)</sub>                                                                                                                                                                                                                                                                                                                                    | Bushold Input Minimum Drive Hold Current         | V <sub>IN</sub> = 0.7V                                                      | 2.3                    | 45                              |      | μA                            |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | V <sub>IN</sub> = 1.7V                                                      |                        | -45                             |      |                               |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | V <sub>IN</sub> = 0.8V                                                      | 3.0                    | 75                              |      |                               |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | V <sub>IN</sub> = 2.0V                                                      |                        | -75                             |      |                               |     |       |
| I <sub>I(OD)</sub>                                                                                                                                                                                                                                                                                                                                      | Bushold Input Over-Drive Current to Change State | (Note 7)                                                                    | 2.7                    | 300                             |      | μA                            |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | (Note 8)                                                                    |                        | -300                            |      |                               |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | (Note 7)                                                                    | 3.6                    | 450                             |      |                               |     |       |
|                                                                                                                                                                                                                                                                                                                                                         |                                                  | (Note 8)                                                                    |                        | -450                            |      |                               |     |       |
| I <sub>OZ</sub>                                                                                                                                                                                                                                                                                                                                         | 3-STATE Output Leakage                           | 0 ≤ V <sub>O</sub> ≤ 5.5V                                                   | 2.3 – 3.6              |                                 | ±5.0 | μA                            |     |       |
| I <sub>OFF</sub>                                                                                                                                                                                                                                                                                                                                        | Power-Off Leakage Current                        | V <sub>O</sub> = V <sub>CC</sub>                                            | 0                      |                                 | 10   | μA                            |     |       |
| 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>O</sub> ≤ 5.5V (Note 6)                                       | 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                            |     |       |
| <p><b>Note 6:</b> Outputs disabled or 3-STATE only.</p> <p><b>Note 7:</b> An external driver must source at least the specified current to switch from LOW-to-HIGH.</p> <p><b>Note 8:</b> An external driver must sink at least the specified current to switch from HIGH-to-LOW.</p>                                                                   |                                                  |                                                                             |                        |                                 |      |                               |     |       |
| 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 CP to O <sub>n</sub>           | 1.5                                                                         | 6.2                    | 1.5                             | 6.5  | 1.5                           | 7.4 | ns    |
| t <sub>PLH</sub>                                                                                                                                                                                                                                                                                                                                        |                                                  | 1.5                                                                         | 6.2                    | 1.5                             | 6.5  | 1.5                           | 7.4 | ns    |
| 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>OSSL</sub>                                                                                                                                                                                                                                                                                                                                       | Output to Output Skew (Note 9)                   |                                                                             | 1.0                    |                                 |      |                               |     | ns    |
| t <sub>OSLH</sub>                                                                                                                                                                                                                                                                                                                                       |                                                  |                                                                             | 1.0                    |                                 |      |                               |     |       |
| <p><b>Note 9:</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>OSSL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>). Parameter guaranteed by design.</p> |                                                  |                                                                             |                        |                                 |      |                               |     |       |
| 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

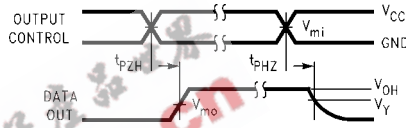


**FIGURE 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)**

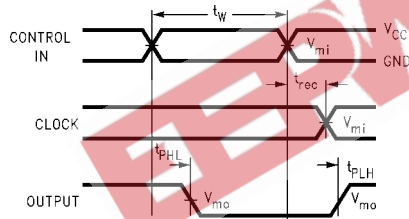
| Test                  | Switch                                                                                   |
|-----------------------|------------------------------------------------------------------------------------------|
| $t_{PLH}$ , $t_{PHL}$ | Open                                                                                     |
| $t_{PZL}$ , $t_{PLZ}$ | 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                                                                                      |



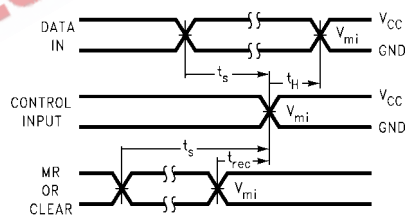
**Waveform for Inverting and Non-Inverting Functions**



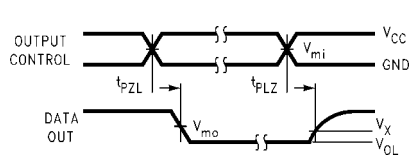
**3-STATE Output High Enable and Disable Times for Logic**



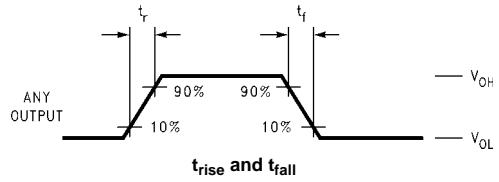
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



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



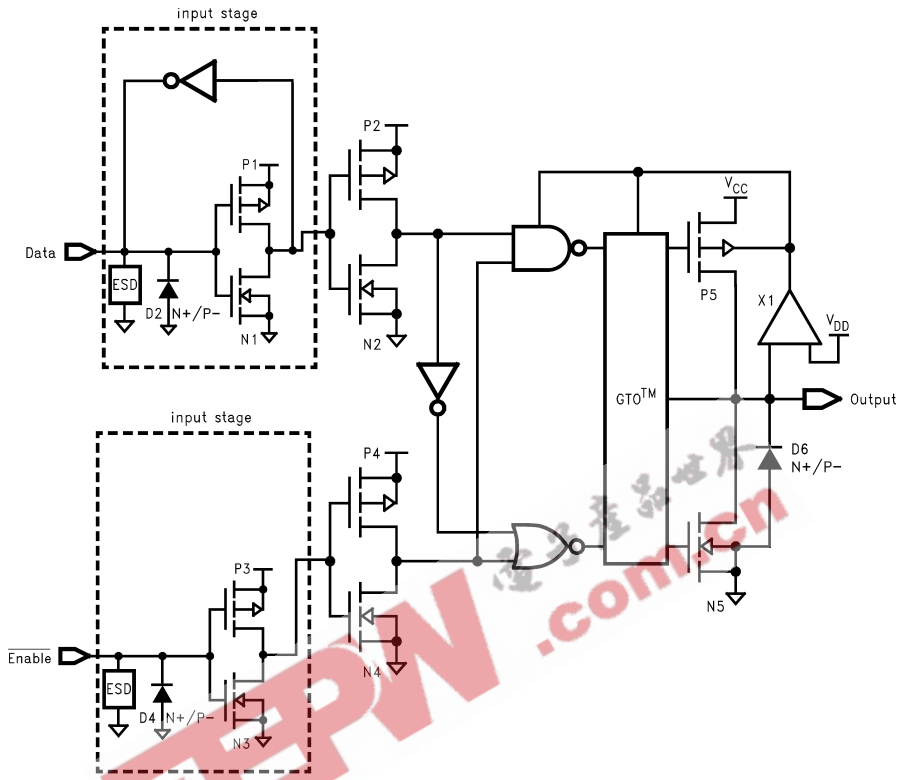
**3-STATE Output Low Enable and Disable Times for Logic**



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

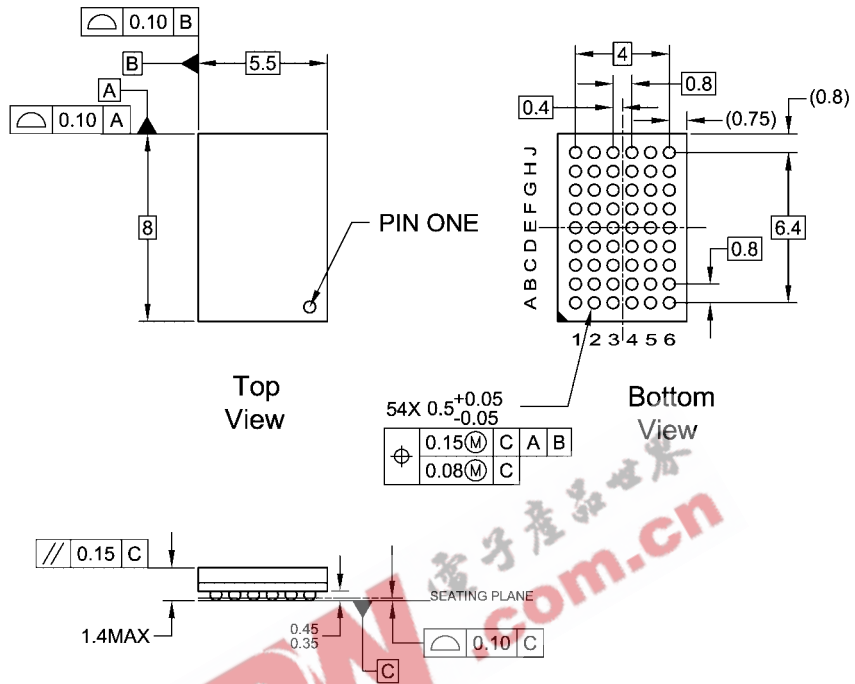
| Symbol   | $V_{CC}$        |                 |                  |
|----------|-----------------|-----------------|------------------|
|          | $3.3V \pm 0.3V$ | 2.7V            | $2.5V \pm 0.2V$  |
| $V_{mi}$ | 1.5V            | 1.5V            | $V_{CC}/2$       |
| $V_{mo}$ | 1.5V            | 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 LCXH Family (with Bushold)



74LCXH16374

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



**NOTES:**

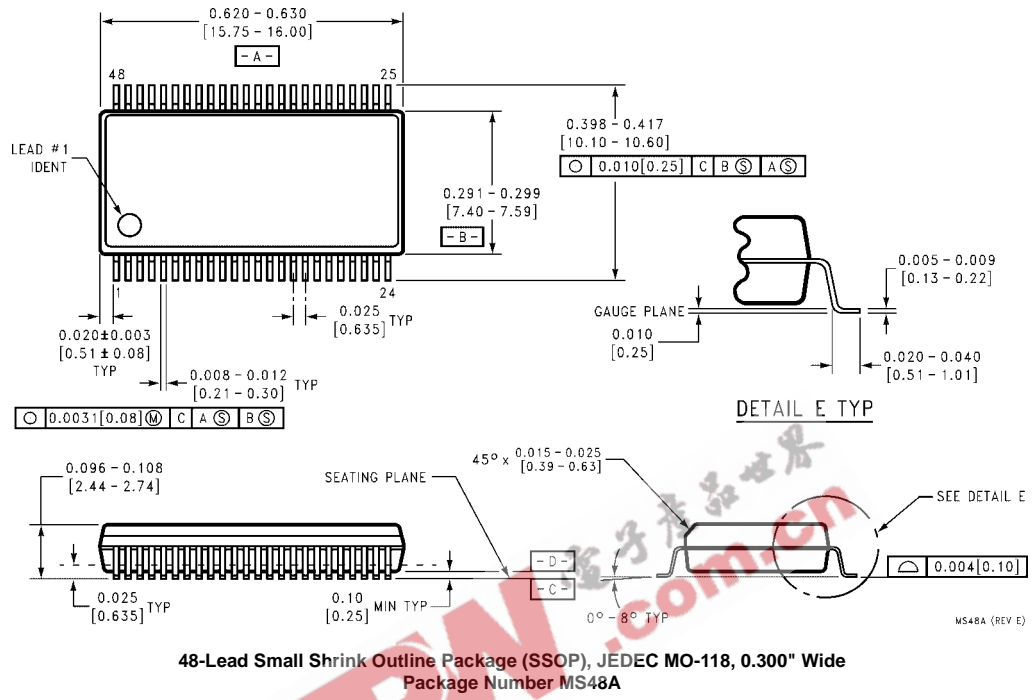
- A. THIS PACKAGE CONFORMS TO JEDEC M0-205
- B. ALL DIMENSIONS IN MILLIMETERS
- C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)  
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
- D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA54ArevD

**54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC M0-205, 5.5mm Wide  
Package Number BGA54A**



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



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

PIN #1 IDENT. 1 6 19 24 30 43 48

12.50±0.10 -A-

0.40 TYP

8.10

4.05

6.10±0.10 -B-

0.2 C B A

ALL LEAD TIPS

LAND PATTERN RECOMMENDATION

SEE DETAIL A

0.13 M A B C S

0.1 C

ALL LEAD TIPS

1.2 MAX

0.50

0.17-0.27

0.10±0.05

0.90±0.15

0.10

0.09-0.20

12.00° TOP & BOTTOM

R0.16

R0.31

GAGE PLANE

1.25

SEATING PLANE

0°-8°

0.60±0.10

1.00

DETAIL A

DIMENSIONS ARE IN MILLIMETERS

NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6, DATE 7/93.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTD48RevB1

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

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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.

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