

## 74LCX04

### Low Voltage Hex Inverter with 5V Tolerant Inputs

#### General Description

The LCX04 contains six inverters. The inputs tolerate voltages up to 7V allowing the interface of 5V systems to 3V systems.

The 74LCX04 is fabricated with advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

#### Features

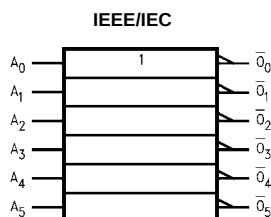
- 5V tolerant inputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 5.2 ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 10  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

#### Ordering Code:

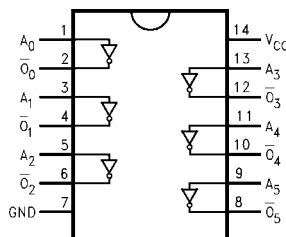
| Order Number | Package Number | Package Description                                                          |
|--------------|----------------|------------------------------------------------------------------------------|
| 74LCX04M     | M14A           | 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow |
| 74LCX04SJ    | M14D           | 14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide                |
| 74LCX04MTC   | MTC14          | 14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  |

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

#### Logic Symbol



#### Connection Diagram



#### Pin Descriptions

| Pin Names        | Description |
|------------------|-------------|
| $A_n$            | Inputs      |
| $\overline{O}_n$ | Outputs     |

**Absolute Maximum Ratings** (Note 1)

| Symbol    | Parameter                        | Value                  | Conditions                           | Units |
|-----------|----------------------------------|------------------------|--------------------------------------|-------|
| $V_{CC}$  | Supply Voltage                   | -0.5 to +7.0           |                                      | V     |
| $V_I$     | DC Input Voltage                 | -0.5 to +7.0           |                                      | V     |
| $V_O$     | DC Output Voltage                | -0.5 to $V_{CC} + 0.5$ | Output in HIGH or LOW State (Note 2) | V     |
| $I_{IK}$  | DC Input Diode Current           | -50                    | $V_I < \text{GND}$                   | mA    |
| $I_{OK}$  | DC Output Diode Current          | -50<br>+50             | $V_O < \text{GND}$<br>$V_O > V_{CC}$ | mA    |
| $I_O$     | DC Output Source/Sink Current    | $\pm 50$               |                                      | mA    |
| $I_{CC}$  | DC Supply Current per Supply Pin | $\pm 100$              |                                      | mA    |
| $I_{GND}$ | DC Ground Current per Ground Pin | $\pm 100$              |                                      | mA    |
| $T_{STG}$ | Storage Temperature              | -65 to +150            |                                      | °C    |

**Recommended Operating Conditions** (Note 3)

| Symbol              | Parameter                                                 | Min                                                                        | Max                             | Units |
|---------------------|-----------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------|-------|
| $V_{CC}$            | Supply Voltage                                            | Operating<br>2.0<br>Data Retention<br>1.5                                  | 3.6<br>3.6                      | V     |
| $V_I$               | Input Voltage                                             | 0                                                                          | 5.5                             | V     |
| $V_O$               | Output Voltage                                            | 0                                                                          | $V_{CC}$                        | V     |
| $I_{OH}/I_{OL}$     | Output Current                                            | $V_{CC} = 3.0V - 3.6V$<br>$V_{CC} = 2.7V - 3.0V$<br>$V_{CC} = 2.3V - 2.7V$ | $\pm 24$<br>$\pm 12$<br>$\pm 8$ | mA    |
| $T_A$               | Free-Air Operating Temperature                            | -40                                                                        | 85                              | °C    |
| $\Delta t/\Delta V$ | Input Edge Rate, $V_{IN} = 0.8V - 2.0V$ , $V_{CC} = 3.0V$ | 0                                                                          | 10                              | ns/V  |

**Note 1:** 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 2:**  $I_O$  Absolute Maximum Rating must be observed.

**Note 3:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

| Symbol          | Parameter                      | Conditions                                                                                                                              | $V_{CC}$<br>(V)                       | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |                | Units   |
|-----------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------------------------|----------------|---------|
|                 |                                |                                                                                                                                         |                                       | Min                                             | Max            |         |
| $V_{IH}$        | HIGH Level Input Voltage       |                                                                                                                                         | 2.3 - 2.7<br>2.7 - 3.6                | 1.7<br>2.0                                      |                | V       |
| $V_{IL}$        | LOW Level Input Voltage        |                                                                                                                                         | 2.3 - 2.7<br>2.7 - 3.6                |                                                 | 0.7<br>0.8     | V       |
| $V_{OH}$        | HIGH Level Output Voltage      | $I_{OH} = -100 \mu A$<br>$I_{OH} = -8 \text{ mA}$<br>$I_{OH} = -12 \text{ mA}$<br>$I_{OH} = -18 \text{ mA}$<br>$I_{OH} = 24 \text{ mA}$ | 2.3 - 3.6<br>2.3<br>2.7<br>3.0<br>3.0 | $V_{CC} - 0.2$<br>1.8<br>2.2<br>2.4<br>2.2      |                | V       |
| $V_{OL}$        | LOW Level Output Voltage       | $I_{OL} = -100 \mu A$<br>$I_{OL} = 8 \text{ mA}$<br>$I_{OL} = 12 \text{ mA}$<br>$I_{OL} = 16 \text{ mA}$<br>$I_{OL} = 24 \text{ mA}$    | 2.3 - 3.6<br>2.3<br>2.7<br>3.0<br>3.0 | 0.2<br>0.6<br>0.4<br>0.4<br>0.55                |                | V       |
| $I_I$           | Input Leakage Current          | $0 \leq V_I \leq 5.5V$                                                                                                                  | 2.3 - 3.6                             |                                                 | $\pm 5.0$      | $\mu A$ |
| $I_{OFF}$       | Power-Off Leakage Current      | $V_I$ or $V_O = 5.5V$                                                                                                                   | 0                                     |                                                 | 10             | $\mu A$ |
| $I_{CC}$        | Quiescent Supply Current       | $V_I = V_{CC}$ or GND<br>$3.6V \leq V_I \leq 5.5V$                                                                                      | 2.3 - 3.6<br>2.3 - 3.6                |                                                 | 10<br>$\pm 10$ | $\mu A$ |
| $\Delta I_{CC}$ | Increase in $I_{CC}$ per Input | $V_{IH} = V_{CC} - 0.6V$                                                                                                                | 2.3 - 3.6                             |                                                 | 500            | $\mu A$ |

## AC Electrical Characteristics

| Symbol            | Parameter              | T <sub>A</sub> = -40°C 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 |       |
| t <sub>PHL</sub>  | Propagation Delay Time | 1.5                                                    | 5.2 | 1.5                    | 6.0 | 1.5                           | 6.2 | ns    |
| t <sub>PLH</sub>  |                        | 1.5                                                    | 5.2 | 1.5                    | 6.0 | 1.5                           | 6.2 |       |
| t <sub>OSHL</sub> | Output to Output Skew  |                                                        | 1.0 |                        |     |                               |     | ns    |
| t <sub>OSLH</sub> | (Note 4)               |                                                        | 1.0 |                        |     |                               |     |       |

**Note 4:** Skew is defined as the absolute value of the difference 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 ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ).

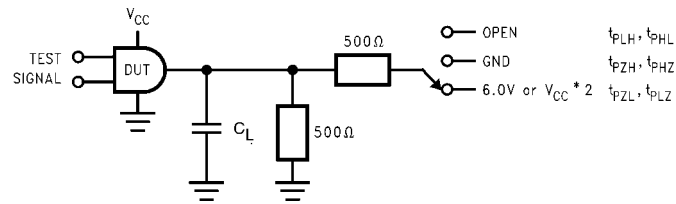
## Dynamic Switching Characteristics

| Symbol    | Parameter                            | Conditions                                                                                           | $V_{CC}$<br>(V) | $T_A = 25^{\circ}\text{C}$ | Units |
|-----------|--------------------------------------|------------------------------------------------------------------------------------------------------|-----------------|----------------------------|-------|
|           |                                      |                                                                                                      |                 | Typical                    |       |
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$   | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$<br>$C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 3.3<br>2.5      | 0.8<br>0.6                 | V     |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$<br>$C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 3.3<br>2.5      | -0.8<br>-0.6               | V     |

## Capacitance

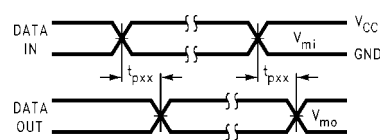
| Symbol    | Parameter                     | Conditions                                                      | Typical | Units |
|-----------|-------------------------------|-----------------------------------------------------------------|---------|-------|
| $C_{IN}$  | Input Capacitance             | $V_{CC} = \text{Open}, V_I = 0V \text{ or } V_{CC}$             | 7       | pF    |
| $C_{OUT}$ | Output Capacitance            | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}$                    | 8       | pF    |
| $C_{PD}$  | Power Dissipation Capacitance | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}, f = 10\text{ MHz}$ | 25      | pF    |

## AC Loading and Waveforms Generic for LCX Family

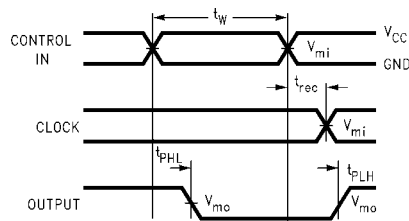


**FIGURE 1. AC Test Circuit**  
( $C_L$  includes probe and jig capacitance)

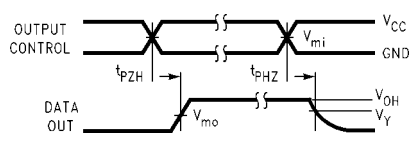
| Test                  | Switch                                                                        |
|-----------------------|-------------------------------------------------------------------------------|
| $t_{PLH}$ , $t_{PHL}$ | Open                                                          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



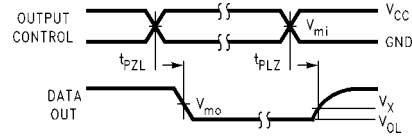
**Waveform for Inverting and Non-Inverting Functions**



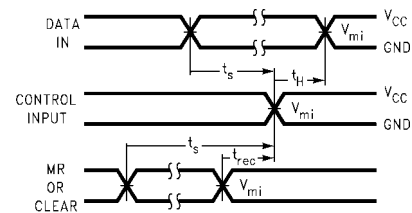
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



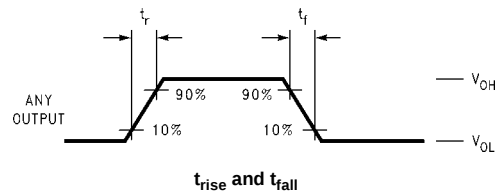
**3-STATE Output High Enable and Disable Times for Logic**



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



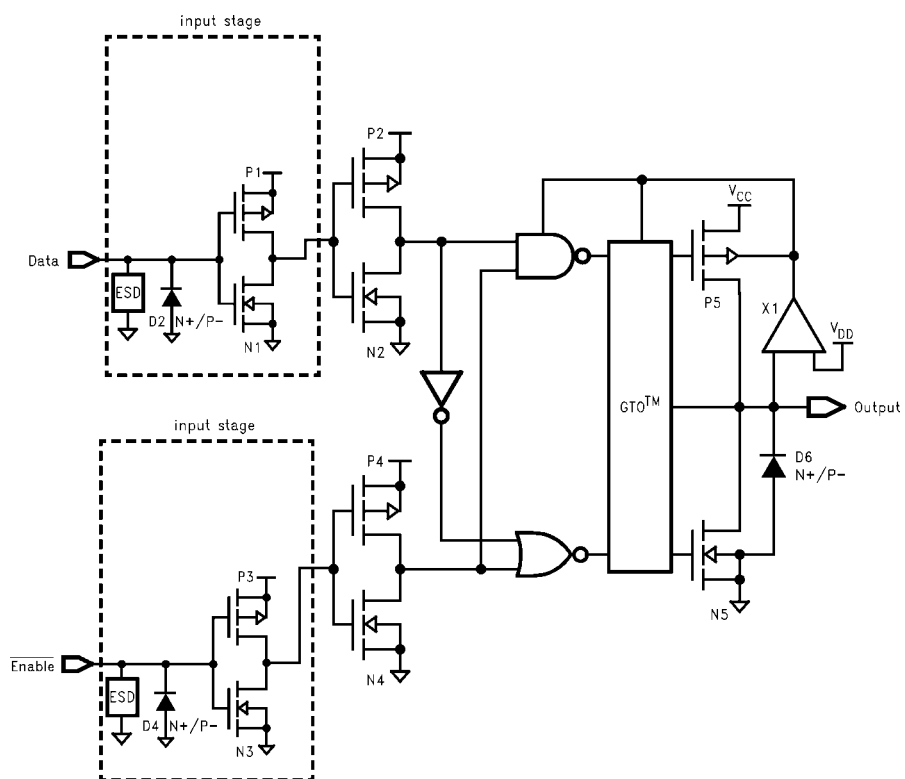
**Setup Time, Hold Time and Recovery Time for Logic**



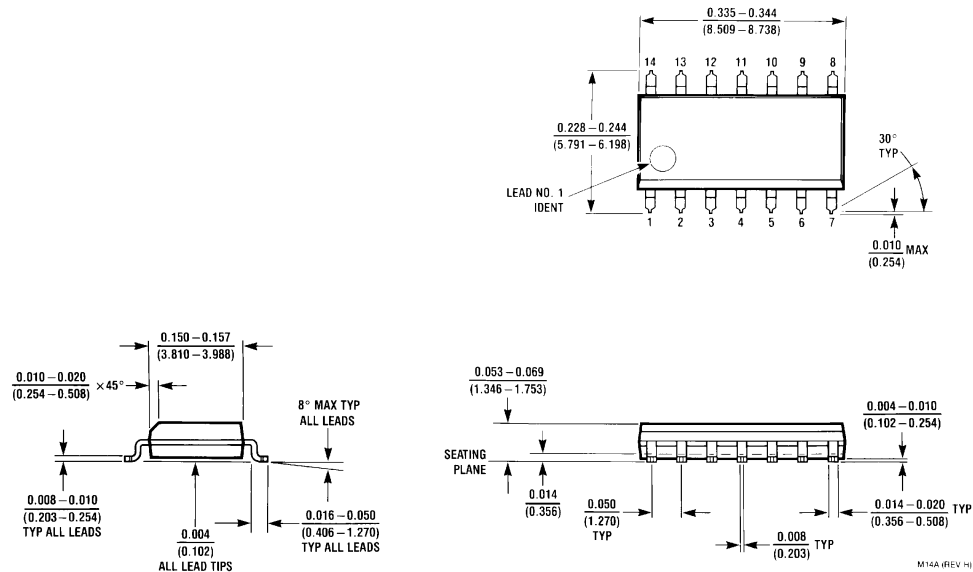
**FIGURE 2. Waveforms**  
(Input Pulse Characteristics;  $f=1MHz$ ,  $t_r=t_f=3ns$ )

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

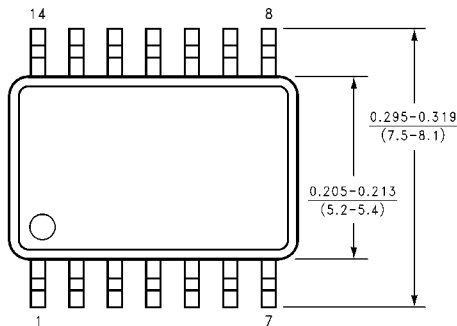
# Schematic Diagram Generic for LCX Family



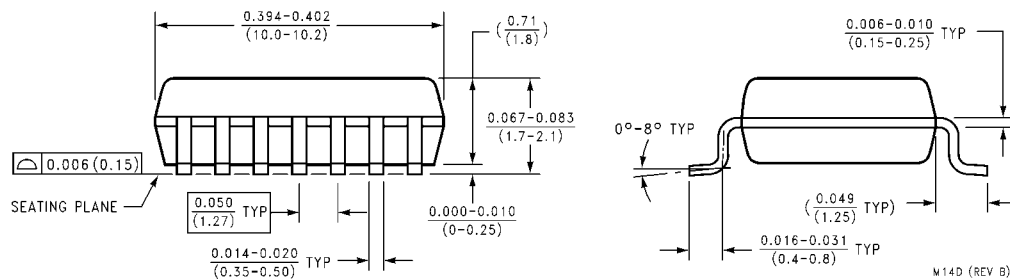
# Physical Dimensions inches (millimeters) unless otherwise noted



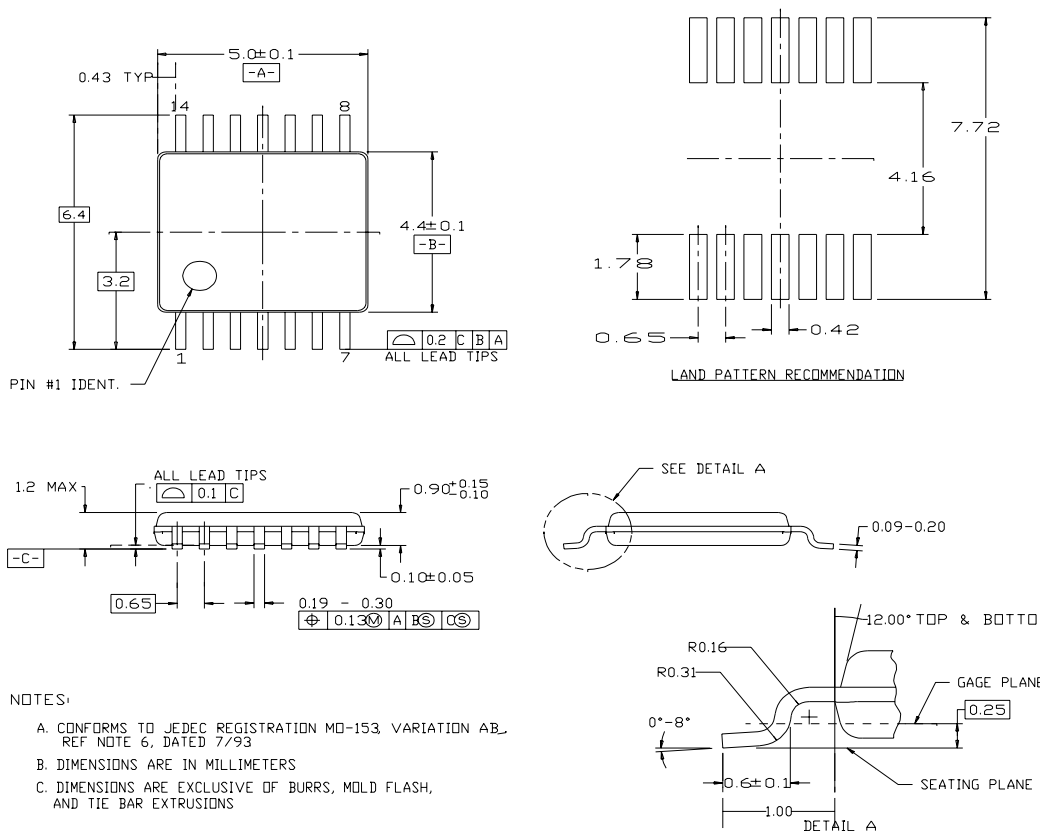
**14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow  
Package Number M14A**



**14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M14D**



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



14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
Package Number MTC14

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