## Low-Voltage CMOS 16-Bit Transparent Latch With 5V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The MC74LCX16373 is a high performance, non-inverting 16-bit transparent latch operating from a 2.7 to 3.6 V supply. The device is byte controlled. Each byte has separate Output Enable and Latch Enable inputs. These control pins can be tied together for full 16-bit operation. High impedance TTL compatible inputs significantly reduce current loading to input drivers while TTL compatible outputs offer improved switching noise performance. A $\mathrm{V}_{\mathrm{I}}$ specification of 5.5 V allows MC74LCX16373 inputs to be safely driven from 5V devices.

The MC74LCX16373 contains 16 D-type latches with 3-state 5V-tolerant outputs. When the Latch Enable (LEn) inputs are HIGH, data on the Dn inputs enters the latches. In this condition, the latches are transparent, i.e., a latch output will change state each time its D input changes. When LE is LOW, the latches store the information that was present on the $D$ inputs a setup time preceding the HIGH-to-LOW transition of LE. The 3-state outputs are controlled by the Output Enable (OEn) inputs. When OE is LOW, the outputs are enabled. When OE is HIGH, the standard outputs are in the high impedance state, but this does not interfere with new data entering into the latches.

- Designed for 2.7 to $3.6 \mathrm{~V} \mathrm{~V}_{\mathrm{CC}}$ Operation
- 5.4ns Maximum tpd
- 5V Tolerant - Interface Capability With 5V TTL Logic
- Supports Live Insertion and Withdrawal
- IOFF Specification Guarantees High Impedance When VCC $=0 \mathrm{~V}$
- LVTTL Compatible
- LVCMOS Compatible
- 24 mA Balanced Output Sink and Source Capability
- Near Zero Static Supply Current in All Three Logic States (20 A A) Substantially Reduces System Power Requirements
- Latchup Performance Exceeds 500 mA
- ESD Performance: Human Body Model >2000V; Machine Model >200V


## MC74LCX16373

LCX

## LOW-VOLTAGE CMOS 16-BIT TRANSPARENT LATCH



PIN NAMES

| Pins | Function |
| :--- | :--- |
| $\overline{\text { OEn }}$ | Output Enable Inputs |
| LEn | Latch Enable Inputs |
| D0-D15 | Inputs |
| O0-O15 | Outputs |

LOGIC DIAGRAM



| Inputs |  |  | Outputs |  | Onputs | Outputs |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| LE1 | OE1 | D0:7 | O0:7 | LE2 | OE2 | D8:15 | O8:15 |
| X | H | X | Z | X | H | X | Z |
| H | L | L | L | H | L | L | L |
| H | L | H | H | H | L | H | H |
| L | L | X | O0 | L | L | X | O |

$\mathrm{H}=$ High Voltage Level; L = Low Voltage Level; Z = High Impedance State; X = High or Low Voltage Level and Transitions Are Acceptable, for ICC reasons, DO NOT FLOAT Inputs

ABSOLUTE MAXIMUM RATINGS*

| Symbol | Parameter | Value | Condition | Unit |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{CC}}$ | DC Supply Voltage | -0.5 to +7.0 |  | V |
| $V_{1}$ | DC Input Voltage | $-0.5 \leq \mathrm{V}_{\mathrm{I}} \leq+7.0$ |  | V |
| $\mathrm{V}_{\mathrm{O}}$ | DC Output Voltage | $-0.5 \leq \mathrm{V}_{\mathrm{O}} \leq+7.0$ | Output in 3-State | V |
|  |  | $-0.5 \leq \mathrm{V}_{\mathrm{O}} \leq \mathrm{V}_{\mathrm{CC}}+0.5$ | Note 1. | V |
| IIK | DC Input Diode Current | -50 | $\mathrm{V}_{1}<\mathrm{GND}$ | mA |
| IOK | DC Output Diode Current | -50 | $\mathrm{V}_{\mathrm{O}}<\mathrm{GND}$ | mA |
|  |  | +50 | $\mathrm{V}_{\mathrm{O}}>\mathrm{V}_{\mathrm{CC}}$ | mA |
| $\mathrm{I}^{\circ}$ | DC Output Source/Sink Current | $\pm 50$ |  | mA |
| ${ }^{\text {ICC }}$ | DC Supply Current Per Supply Pin | $\pm 100$ |  | mA |
| $\mathrm{I}_{\text {GND }}$ | DC Ground Current Per Ground Pin | $\pm 100$ |  | mA |
| TSTG | Storage Temperature Range | -65 to +150 |  | ${ }^{\circ} \mathrm{C}$ |

* Absolute maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute-maximum-rated conditions is not implied.

1. Output in HIGH or LOW State. IO absolute maximum rating must be observed.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{CC}}$ |  | $\begin{aligned} & 2.0 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 3.3 \\ & 3.3 \end{aligned}$ | $\begin{aligned} & 3.6 \\ & 3.6 \end{aligned}$ | V |
| $V_{1}$ | Input Voltage | 0 |  | 5.5 | V |
| $\mathrm{V}_{\mathrm{O}}$ | Output Voltage <br> (HIGH or LOW State) <br> (3-State) | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ |  | $\begin{gathered} \mathrm{V}_{\mathrm{CC}} \\ 5.5 \end{gathered}$ | V |
| ${ }^{\mathrm{O}} \mathrm{OH}$ | HIGH Level Output Current, $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V}-3.6 \mathrm{~V}$ |  |  | -24 | mA |
| IOL | LOW Level Output Current, $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V}-3.6 \mathrm{~V}$ |  |  | 24 | mA |
| ${ }^{\mathrm{O}} \mathrm{OH}$ | HIGH Level Output Current, $\mathrm{V}_{\mathrm{CC}}=2.7 \mathrm{~V}-3.0 \mathrm{~V}$ |  |  | -12 | mA |
| IOL | LOW Level Output Current, $\mathrm{V}_{\mathrm{CC}}=2.7 \mathrm{~V}-3.0 \mathrm{~V}$ |  |  | 12 | mA |
| $\mathrm{T}_{\mathrm{A}}$ | Operating Free-Air Temperature | -40 |  | +85 | ${ }^{\circ} \mathrm{C}$ |
| $\Delta t / \Delta \mathrm{V}$ | Input Transition Rise or Fall Rate, $\mathrm{V}_{\mathrm{IN}}$ from 0.8 V to 2.0 V , $V_{C C}=3.0 \mathrm{~V}$ | 0 |  | 10 | $\mathrm{ns} / \mathrm{V}$ |

DC ELECTRICAL CHARACTERISTICS

| Symbol | Characteristic | Condition | $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Min | Max |  |
| $\mathrm{V}_{\mathrm{IH}}$ | HIGH Level Input Voltage (Note 2.) | $2.7 \mathrm{~V} \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V}$ | 2.0 |  | V |
| $\mathrm{V}_{\mathrm{IL}}$ | LOW Level Input Voltage (Note 2.) | $2.7 \mathrm{~V} \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V}$ |  | 0.8 | V |
| $\mathrm{V}_{\mathrm{OH}}$ | HIGH Level Output Voltage |  | $\mathrm{V}_{\mathrm{CC}}-0.2$ |  | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.7 \mathrm{~V} ; \mathrm{IOH}=-12 \mathrm{~mA}$ | 2.2 |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V} ; \mathrm{IOH}=-18 \mathrm{~mA}$ | 2.4 |  |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V} ; \mathrm{IOH}=-24 \mathrm{~mA}$ | 2.2 |  |  |
| $\mathrm{V}_{\text {OL }}$ | LOW Level Output Voltage | $2.7 \mathrm{~V} \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V}$; $\mathrm{lOL}=100 \mu \mathrm{~A}$ |  | 0.2 | V |
|  |  | $\mathrm{V}_{\mathrm{CC}}=2.7 \mathrm{~V} ; \mathrm{l}_{\mathrm{OL}}=12 \mathrm{~mA}$ |  | 0.4 |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V} ; \mathrm{loL}=16 \mathrm{~mA}$ |  | 0.4 |  |
|  |  | $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V} ; \mathrm{l}_{\mathrm{OL}}=24 \mathrm{~mA}$ |  | 0.55 |  |

[^0]DC ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Characteristic | Condition | $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Min | Max |  |
| I | Input Leakage Current | $2.7 \mathrm{~V} \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V} ; 0 \mathrm{~V} \leq \mathrm{V}_{1} \leq 5.5 \mathrm{~V}$ |  | $\pm 5.0$ | $\mu \mathrm{A}$ |
| IOZ | 3-State Output Current | $\begin{gathered} 2.7 \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V} ; 0 \mathrm{~V} \leq \mathrm{V}_{\mathrm{O}} \leq 5.5 \mathrm{~V} ; \\ \mathrm{V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{IH}} \text { or } \mathrm{V}_{\text {IL }} \end{gathered}$ |  | $\pm 5.0$ | $\mu \mathrm{A}$ |
| IOFF | Power-Off Leakage Current | $\mathrm{V}_{\mathrm{CC}}=0 \mathrm{~V}$; $\mathrm{V}_{\text {I }}$ or $\mathrm{V}_{\mathrm{O}}=5.5 \mathrm{~V}$ |  | 10 | $\mu \mathrm{A}$ |
| ${ }^{\text {ICC }}$ | Quiescent Supply Current | $2.7 \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V}$; $\mathrm{V}_{\mathrm{I}}=\mathrm{GND}$ or $\mathrm{V}_{\mathrm{CC}}$ |  | 20 | $\mu \mathrm{A}$ |
|  |  | $2.7 \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V} ; 3.6 \leq \mathrm{V}_{\text {I }}$ or $\mathrm{V}_{\mathrm{O}} \leq 5.5 \mathrm{~V}$ |  | $\pm 20$ | $\mu \mathrm{A}$ |
| $\Delta_{\text {l }} \mathrm{CC}$ | Increase in ICC per Input | $2.7 \leq \mathrm{V}_{\mathrm{CC}} \leq 3.6 \mathrm{~V} ; \mathrm{V}_{\mathrm{IH}}=\mathrm{V}_{\mathrm{CC}}-0.6 \mathrm{~V}$ |  | 500 | $\mu \mathrm{A}$ |

AC CHARACTERISTICS ( $\mathrm{t} R=\mathrm{t}_{\mathrm{F}}=2.5 \mathrm{~ns} ; \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF} ; \mathrm{R}_{\mathrm{L}}=500 \Omega$ )

| Symbol | Parameter | Waveform | Limits |  |  |  | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |  |  |  |  |
|  |  |  | $\mathrm{V}_{\mathrm{CC}}=3.0 \mathrm{~V}$ to 3.6 V |  | $\mathrm{V}_{\mathrm{CC}}=2.7 \mathrm{~V}$ |  |  |
|  |  |  | Min | Max | Min | Max |  |
| $\begin{aligned} & \text { tPLH } \\ & \text { tPHL } \end{aligned}$ | Propagation Delay $\mathrm{D}_{\mathrm{n}}$ to $\mathrm{O}_{\mathrm{n}}$ | 1 | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 5.4 \\ & 5.4 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 5.9 \\ & 5.9 \end{aligned}$ | ns |
| tpLH tPHL | Propagation Delay LE to $\mathrm{O}_{\mathrm{n}}$ | 3 | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 5.5 \\ & 5.5 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 6.4 \\ & 6.4 \end{aligned}$ | ns |
| $\begin{aligned} & \text { tpZH } \\ & \text { tpZL } \end{aligned}$ | Output Enable Time to HIGH and LOW Level | 2 | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 6.1 \\ & 6.1 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 6.5 \\ & 6.5 \end{aligned}$ | ns |
| $\begin{aligned} & \text { tPHZ } \\ & \text { tPLZ } \end{aligned}$ | Output Disable Time from HIGH and LOW Level | 2 | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 6.0 \\ & 6.0 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \end{aligned}$ | $\begin{aligned} & 6.3 \\ & 6.3 \end{aligned}$ | ns |
| $\mathrm{t}_{\text {S }}$ | Setup TIme, HIGH or LOW $\mathrm{D}_{\mathrm{n}}$ to LE | 3 | 2.5 |  | 2.5 |  | ns |
| $t_{\text {h }}$ | Hold TIme, HIGH or LOW $\mathrm{D}_{\mathrm{n}}$ to LE | 3 | 1.5 |  | 1.5 |  | ns |
| $\mathrm{t}_{\mathrm{w}}$ | LE Pulse Width, HIGH | 3 | 3.0 |  | 3.0 |  | ns |
| $\begin{aligned} & \text { toshl } \\ & \text { tOSLH } \end{aligned}$ | Output-to-Output Skew (Note 3.) |  |  | $\begin{aligned} & 1.0 \\ & 1.0 \end{aligned}$ |  |  | ns |

3. 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 (tOSHL) or LOW-to-HIGH (tOSLH); parameter guaranteed by design.

DYNAMIC SWITCHING CHARACTERISTICS

| Symbol | Characteristic | Condition | $\mathrm{T}_{\mathrm{A}}=+25^{\circ} \mathrm{C}$ |  |  | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Min | Typ | Max |  |
| VOLP | Dynamic LOW Peak Voltage (Note 4.) | $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{CL}=50 \mathrm{pF}, \mathrm{V}_{\text {IH }}=3.3 \mathrm{~V}, \mathrm{~V}_{\text {IL }}=0 \mathrm{~V}$ |  | 0.8 |  | V |
| V OLV | Dynamic LOW Valley Voltage (Note 4.) | $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{C}_{\mathrm{L}}=50 \mathrm{pF}, \mathrm{V}_{\mathrm{IH}}=3.3 \mathrm{~V}, \mathrm{~V}_{\mathrm{IL}}=0 \mathrm{~V}$ |  | 0.8 |  | V |

4. Number of outputs defined as " $n$ ". Measured with " $\mathrm{n}-1$ " outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Condition | Typical | Unit |
| :--- | :--- | :---: | :---: | :---: |
| $\mathrm{C}_{\mathrm{IN}}$ | Input Capacitance | $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{~V}_{\mathrm{I}}=0 \mathrm{~V}$ or $\mathrm{V}_{\mathrm{CC}}$ | 7 | pF |
| $\mathrm{C}_{\mathrm{OUT}}$ | Output Capacitance | $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{~V}_{\mathrm{I}}=0 \mathrm{~V}$ or $\mathrm{V}_{\mathrm{CC}}$ | pF |  |
| CPD | Power Dissipation Capacitance | $10 \mathrm{MHz}, \mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{~V}_{\mathrm{I}}=0 \mathrm{~V}$ or $\mathrm{V}_{\mathrm{CC}}$ | 8 | 20 |



WAVEFORM 1 - PROPAGATION DELAYS
$t_{R}=t_{F}=2.5 \mathrm{~ns}, 10 \%$ to $90 \% ; f=1 \mathrm{MHz} ; \mathrm{t}_{\mathrm{w}}=500 \mathrm{~ns}$


Figure 1. AC Waveforms


| TEST | SWITCH |
| :--- | :---: |
| ${ }^{\text {tPLH, }}$ tPHL | Open |
| tPZL, tPLZ | 6 V |
| Open Collector/Drain tPLH and tPHL | 6 V |
| tPZH, tPHZ | GND |

$C_{L}=50 \mathrm{pF}$ or equivalent (Includes jig and probe capacitance)
$R_{L}=R_{1}=500 \Omega$ or equivalent
$\mathrm{R}_{\mathrm{T}}=\mathrm{Z}_{\mathrm{OUT}}$ of pulse generator (typically $50 \Omega$ )
Figure 2. Test Circuit

OUTLINE DIMENSIONS

DT SUFFIX
PLASTIC TSSOP PACKAGE
CASE 1201-01
ISSUE A


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANS Y14.5M, 1982.
2. CONTROLLING DIMENSION:MILIMETER
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE MOLD FLASH, PROTRUSIONS OR GATE SHALL NOT EXCEED 0.15 ( 0.006 ) PER SIDE
SIIMENSION K DOES NOT INCLUDE DAMBAR
4. DIMENSION K DOES NOT INCLUDE DAM

PROTRUSION. ALLOWABLE DAMBAR
PROTRUSION SHALL BE 0.08 (0.003) TOTALIN
EXCESS OF THE KDIMENSION AT MAXIMUM MATERIAL CONDITION.
5. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
6. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-

|  | MILLIMETERS |  | INCHES |  |  |  |
| :---: | ---: | ---: | ---: | ---: | :---: | :---: |
| DIM | MIN | MAX | MIN | MAX |  |  |
| A | 12.40 | 12.60 | 0.488 | 0.496 |  |  |
| B | 6.00 | 6.20 | 0.236 | 0.244 |  |  |
| C | - | 1.10 | - | 0.043 |  |  |
| D | 0.05 | 0.15 | 0.002 | 0.006 |  |  |
| F | 0.50 | 0.75 | 0.020 | 0.030 |  |  |
| G | 0.50 |  | BSC | 0.0197 |  |  |
| HSC |  |  |  |  |  |  |
| J | 0.37 | - | 0.015 | - |  |  |
| J1 | 0.09 | 0.20 | 0.004 | 0.008 |  |  |
| K | 0.09 | 0.16 | 0.004 | 0.006 |  |  |
| K1 | 0.17 | 0.27 | 0.007 | 0.011 |  |  |
| L | 7.95 | 8.23 | 0.007 | 0.009 |  |  |
| M | $0^{\circ}$ | $8^{\circ}$ | 0.313 | 0.325 |  |  |

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[^0]:    2. These values of $\mathrm{V}_{\mathrm{I}}$ are used to test DC electrical characteristics only.
