

# MC74LCX16374

## Low-Voltage CMOS 16-Bit D-Type Flip-Flop

### With 5 V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The MC74LCX16374 is a high performance, non-inverting 16-bit D-type flip-flop operating from a 2.3 V to 3.6 V supply. The device is byte controlled. Each byte has separate Output Enable and Clock Pulse 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  $V_I$  specification of 5.5 V allows MC74LCX16374 inputs to be safely driven from 5.0 V devices.

The MC74LCX16374 consists of 16 edge-triggered flip-flops with individual D-type inputs and 5.0 V-tolerant 3-state true outputs. The buffered clocks (CPn) and buffered Output Enables ( $\overline{OE}n$ ) are common to all flip-flops within the respective byte. The flip-flops will store the state of individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP) transition. With the  $\overline{OE}$  LOW, the contents of the flip-flops are available at the outputs. When the  $\overline{OE}$  is HIGH, the outputs go to the high impedance state. The  $\overline{OE}$  input level does not affect the operation of the flip-flops.

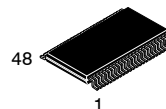
#### Features

- Designed for 2.3 to 3.6 V  $V_{CC}$  Operation
- 6.2 ns Maximum  $t_{pd}$
- 5.0 V Tolerant – Interface Capability With 5.0 V TTL Logic
- Supports Live Insertion and Withdrawal
- $I_{OFF}$  Specification Guarantees High Impedance When  $V_{CC} = 0$  V
- LVTTL Compatible
- LVCMOS Compatible
- 24 mA Balanced Output Sink and Source Capability
- Near Zero Static Supply Current in All Three Logic States (20  $\mu$ A)  
Substantially Reduces System Power Requirements
- Latchup Performance Exceeds 500 mA
- ESD Performance:
  - ♦ Human Body Model >2000 V
  - ♦ Machine Model >200 V
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



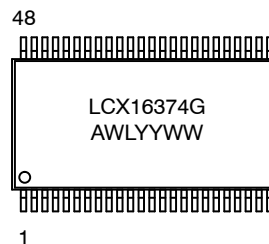
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TSSOP-48  
DT SUFFIX  
CASE 1201

#### MARKING DIAGRAM

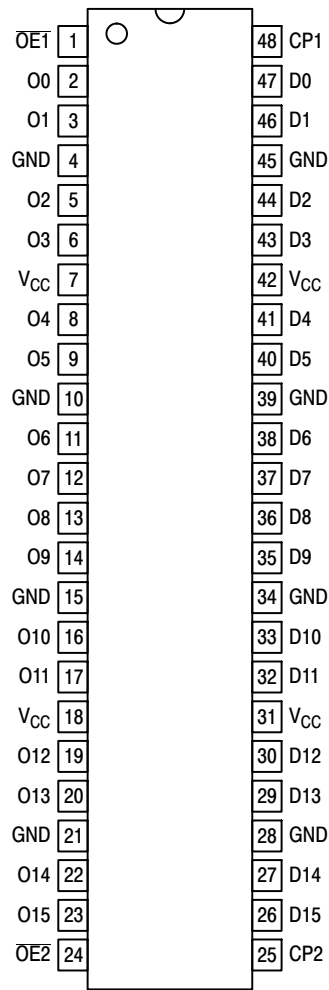


|    |                     |
|----|---------------------|
| A  | = Assembly Location |
| WL | = Wafer Lot         |
| YY | = Year              |
| WW | = Work Week         |
| G  | = Pb-Free Package   |

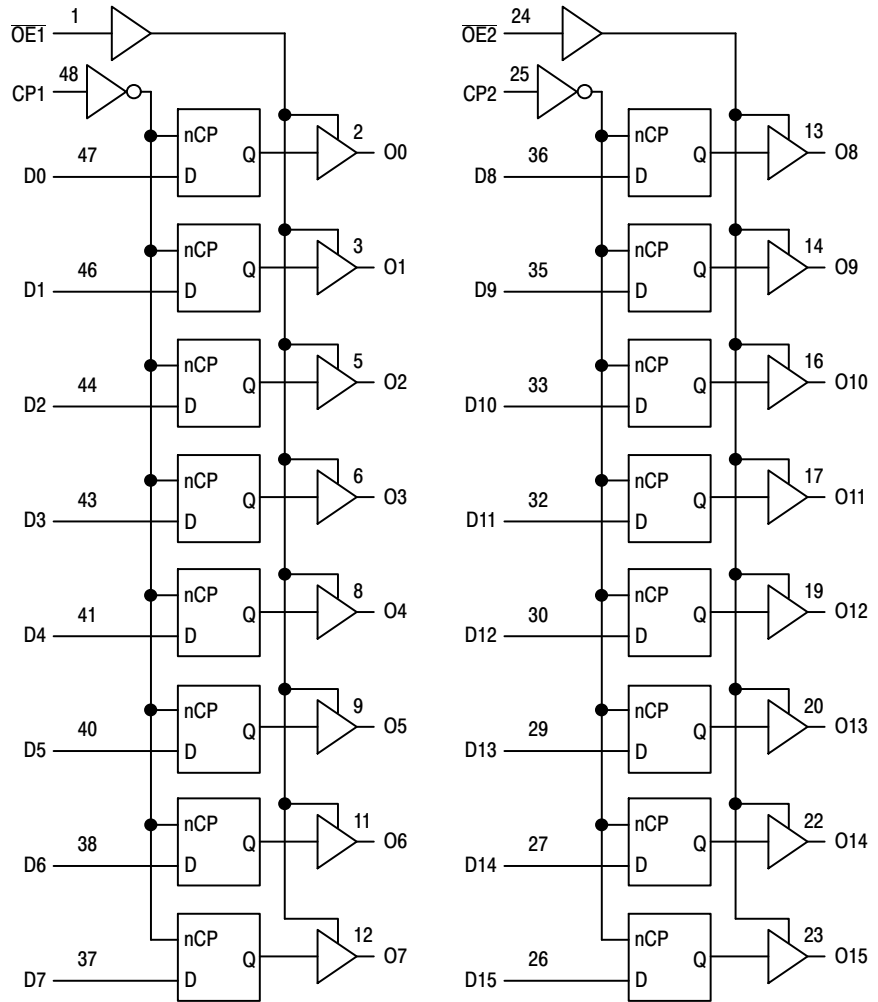
#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

# MC74LCX16374



**Figure 1. Pinout: 48-Lead**  
(Top View)



**Figure 2. Logic Diagram**

**Table 1. PIN NAMES**

| Pins             | Function             |
|------------------|----------------------|
| $\overline{OE}n$ | Output Enable Inputs |
| CPn              | Clock Pulse Inputs   |
| D0-D15           | Inputs               |
| O0-O15           | Outputs              |

## TRUTH TABLE

| Inputs |                  |      | Outputs | Inputs |                  |       | Outputs |
|--------|------------------|------|---------|--------|------------------|-------|---------|
| CP1    | $\overline{OE}1$ | D0:7 | O0:7    | CP2    | $\overline{OE}2$ | D8:15 | O8:15   |
| ↑      | L                | H    | H       | ↑      | L                | H     | H       |
| ↑      | L                | L    | L       | ↑      | L                | L     | L       |
| L      | L                | X    | O0      | L      | L                | X     | O0      |
| X      | H                | X    | Z       | X      | H                | X     | Z       |

H = High Voltage Level

L = Low Voltage Level

Z = High Impedance State

↑ = Low-to-High Transition

X = High or Low Voltage Level and Transitions Are Acceptable; for  $I_{CC}$  reasons, DO NOT FLOAT Inputs

# MC74LCX16374

## ORDERING INFORMATION

| Device           | Package               | Shipping <sup>†</sup> |
|------------------|-----------------------|-----------------------|
| MC74LCX16374DTG  | TSSOP-48<br>(Pb-Free) | 39 Units / Rail       |
| M74LCX16374DTR2G | TSSOP-48<br>(Pb-Free) | 2500 / Tape & Reel    |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## MAXIMUM RATINGS

| Symbol           | Parameter                        | Value                                         | Condition                             | Units |
|------------------|----------------------------------|-----------------------------------------------|---------------------------------------|-------|
| V <sub>CC</sub>  | DC Supply Voltage                | -0.5 to +7.0                                  |                                       | V     |
| V <sub>I</sub>   | DC Input Voltage                 | -0.5 ≤ V <sub>I</sub> ≤ +7.0                  |                                       | V     |
| V <sub>O</sub>   | DC Output Voltage                | -0.5 ≤ V <sub>O</sub> ≤ +7.0                  | Output in 3-State                     | V     |
|                  |                                  | -0.5 ≤ V <sub>O</sub> ≤ V <sub>CC</sub> + 0.5 | Output in HIGH or LOW State. (Note 1) | 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                                           | V <sub>O</sub> < GND                  | mA    |
|                  |                                  | +50                                           | 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 Range        | -65 to +150                                   |                                       | °C    |
| MSL              | Moisture Sensitivity             |                                               | Level 1                               |       |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. I<sub>O</sub> absolute maximum rating must be observed.

## RECOMMENDED OPERATING CONDITIONS

| Symbol          | Parameter                                                                                                                          | Min        | Typ                  | Max                    | Units |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|------------|----------------------|------------------------|-------|
| V <sub>CC</sub> | Supply Voltage<br>Operating<br>Data Retention Only                                                                                 | 2.0<br>1.5 | 2.5, 3.3<br>2.5, 3.3 | 3.6<br>3.6             | V     |
| V <sub>I</sub>  | Input Voltage                                                                                                                      | 0          |                      | 5.5                    | V     |
| V <sub>O</sub>  | Output Voltage<br>(HIGH or LOW State)<br>(3-State)                                                                                 | 0<br>0     |                      | V <sub>CC</sub><br>5.5 | V     |
| I <sub>OH</sub> | HIGH Level Output Current<br>V <sub>CC</sub> = 3.0 V – 3.6 V<br>V <sub>CC</sub> = 2.7 V – 3.0 V<br>V <sub>CC</sub> = 2.3 V – 2.7 V |            |                      | -24<br>-12<br>-8       | mA    |
| I <sub>OL</sub> | LOW Level Output Current<br>V <sub>CC</sub> = 3.0 V – 3.6 V<br>V <sub>CC</sub> = 2.7 V – 3.0 V<br>V <sub>CC</sub> = 2.3 V – 2.7 V  |            |                      | +24<br>+12<br>+8       | mA    |
| T <sub>A</sub>  | Operating Free-Air Temperature                                                                                                     | -55        |                      | +125                   | °C    |
| Δt/ΔV           | Input Transition Rise or Fall Rate, V <sub>IN</sub> from 0.8 V to 2.0 V, V <sub>CC</sub> = 3.0 V                                   | 0          |                      | 10                     | ns/V  |

# MC74LCX16374

## DC ELECTRICAL CHARACTERISTICS

| Symbol           | Characteristic                        | Condition                                                                                                        | T <sub>A</sub> = -55°C to +125°C |      | Units |
|------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------|------|-------|
|                  |                                       |                                                                                                                  | Min                              | Max  |       |
| V <sub>IH</sub>  | HIGH Level Input Voltage (Note 2)     | 2.3 V ≤ V <sub>CC</sub> ≤ 2.7 V                                                                                  | 1.7                              |      | V     |
|                  |                                       | 2.7 V ≤ V <sub>CC</sub> ≤ 3.6 V                                                                                  | 2.0                              |      |       |
| V <sub>IL</sub>  | LOW Level Input Voltage (Note 2)      | 2.3 V ≤ V <sub>CC</sub> ≤ 2.7 V                                                                                  |                                  | 0.7  | V     |
|                  |                                       | 2.7 V ≤ V <sub>CC</sub> ≤ 3.6 V                                                                                  |                                  | 0.8  |       |
| V <sub>OH</sub>  | HIGH Level Output Voltage             | 2.3 V ≤ V <sub>CC</sub> ≤ 3.6 V; I <sub>OL</sub> = 100 μA                                                        | V <sub>CC</sub> - 0.2            |      | V     |
|                  |                                       | V <sub>CC</sub> = 2.3 V; I <sub>OH</sub> = -8 mA                                                                 | 1.8                              |      |       |
|                  |                                       | V <sub>CC</sub> = 2.7 V; I <sub>OH</sub> = -12 mA                                                                | 2.2                              |      |       |
|                  |                                       | V <sub>CC</sub> = 3.0 V; I <sub>OH</sub> = -18 mA                                                                | 2.4                              |      |       |
|                  |                                       | V <sub>CC</sub> = 3.0 V; I <sub>OH</sub> = -24 mA                                                                | 2.2                              |      |       |
| V <sub>OL</sub>  | LOW Level Output Voltage              | 2.3 V ≤ V <sub>CC</sub> ≤ 3.6 V; I <sub>OL</sub> = 100 μA                                                        |                                  | 0.2  | V     |
|                  |                                       | V <sub>CC</sub> = 2.3 V; I <sub>OL</sub> = 8 mA                                                                  |                                  | 0.6  |       |
|                  |                                       | V <sub>CC</sub> = 2.7 V; I <sub>OL</sub> = 12 mA                                                                 |                                  | 0.4  |       |
|                  |                                       | V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 16 mA                                                                 |                                  | 0.4  |       |
|                  |                                       | V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 24 mA                                                                 |                                  | 0.55 |       |
| I <sub>OZ</sub>  | 3-State Output Current                | V <sub>CC</sub> = 3.6 V, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> ,<br>V <sub>OUT</sub> = 0 to 5.5 V |                                  | ±5   | μA    |
| I <sub>OFF</sub> | Power Off Leakage Current             | V <sub>CC</sub> = 0, V <sub>IN</sub> = 5.5 V or V <sub>OUT</sub> = 5.5 V                                         |                                  | 10   | μA    |
| I <sub>IN</sub>  | Input Leakage Current                 | V <sub>CC</sub> = 3.6 V, V <sub>IN</sub> = 5.5 V or GND                                                          |                                  | ±5   | μA    |
| I <sub>CC</sub>  | Quiescent Supply Current              | V <sub>CC</sub> = 3.6 V, V <sub>IN</sub> = 5.5 V or GND                                                          |                                  | 10   | μA    |
| ΔI <sub>CC</sub> | Increase in I <sub>CC</sub> per Input | 2.3 ≤ V <sub>CC</sub> ≤ 3.6 V; V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V                                         |                                  | 500  | μA    |

2. These values of V<sub>I</sub> are used to test DC electrical characteristics only.

## AC CHARACTERISTICS (t<sub>R</sub> = t<sub>F</sub> = 2.5 ns; C<sub>L</sub> = 50 pF; R<sub>L</sub> = 500 Ω)

| Symbol                                 | Parameter                                       | Waveform | T <sub>A</sub> = -55°C to +125°C                          |            |                                                   |            |                                                           |            | Units |
|----------------------------------------|-------------------------------------------------|----------|-----------------------------------------------------------|------------|---------------------------------------------------|------------|-----------------------------------------------------------|------------|-------|
|                                        |                                                 |          | V <sub>CC</sub> = 3.3 V ± 0.3 V<br>C <sub>L</sub> = 50 pF |            | V <sub>CC</sub> = 2.7 V<br>C <sub>L</sub> = 50 pF |            | V <sub>CC</sub> = 2.5 V ± 0.2 V<br>C <sub>L</sub> = 30 pF |            |       |
|                                        |                                                 |          | Min                                                       | Max        | Min                                               | Max        | Min                                                       | Max        |       |
| f <sub>max</sub>                       | Clock Pulse Frequency                           | 1        | 170                                                       |            |                                                   |            |                                                           |            | MHz   |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay<br>CP to O <sub>n</sub>       | 1        | 1.5<br>1.5                                                | 6.2<br>6.2 | 1.5<br>1.5                                        | 6.5<br>6.5 | 1.5<br>1.5                                                | 7.4<br>7.4 | ns    |
| t <sub>PZH</sub><br>t <sub>PZL</sub>   | Output Enable Time to<br>High and Low Level     | 2        | 1.5<br>1.5                                                | 6.1<br>6.1 | 1.5<br>1.5                                        | 6.3<br>6.3 | 1.5<br>1.5                                                | 7.9<br>7.9 | ns    |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub>   | Output Disable Time From<br>High and Low Level  | 2        | 1.5<br>1.5                                                | 6.0<br>6.0 | 1.5<br>1.5                                        | 6.2<br>6.2 | 1.5<br>1.5                                                | 7.2<br>7.2 | ns    |
| t <sub>s</sub>                         | Setup Time, HIGH or LOW D <sup>n</sup> to<br>CP | 1        | 2.5                                                       |            | 2.5                                               |            | 3.0                                                       |            | ns    |
| t <sub>h</sub>                         | Hold Time, HIGH or LOW D <sup>n</sup> to CP     | 1        | 1.5                                                       |            | 1.5                                               |            | 2.0                                                       |            | ns    |
| t <sub>w</sub>                         | CP Pulse Width, HIGH                            | 3        | 3.0                                                       |            | 3.0                                               |            | 3.5                                                       |            | ns    |
| t <sub>OSHL</sub><br>t <sub>OSLH</sub> | Output-to-Output Skew<br>(Note 3)               |          |                                                           | 1.0<br>1.0 |                                                   |            |                                                           |            | 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 (t<sub>OSHL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>); parameter guaranteed by design.

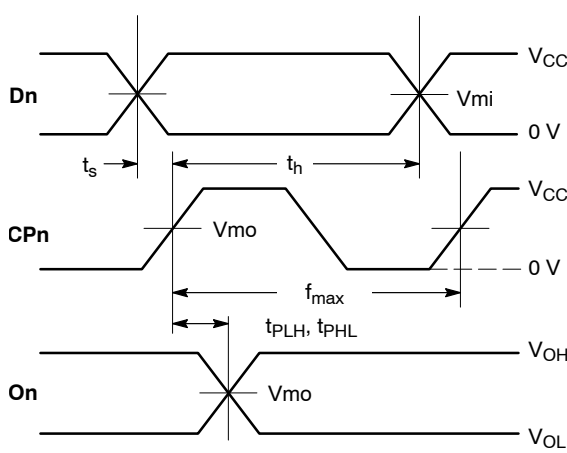
## DYNAMIC SWITCHING CHARACTERISTICS

| Symbol    | Characteristic                         | Condition                                                                                                                                                                          | $T_A = +25^\circ\text{C}$ |              |     | Units |
|-----------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------|-----|-------|
|           |                                        |                                                                                                                                                                                    | Min                       | Typ          | Max |       |
| $V_{OLP}$ | Dynamic LOW Peak Voltage<br>(Note 4)   | $V_{CC} = 3.3\text{ V}, C_L = 50\text{ pF}, V_{IH} = 3.3\text{ V}, V_{IL} = 0\text{ V}$<br>$V_{CC} = 2.5\text{ V}, C_L = 30\text{ pF}, V_{IH} = 2.5\text{ V}, V_{IL} = 0\text{ V}$ |                           | 0.8<br>0.6   |     | V     |
| $V_{OLV}$ | Dynamic LOW Valley Voltage<br>(Note 4) | $V_{CC} = 3.3\text{ V}, C_L = 50\text{ pF}, V_{IH} = 3.3\text{ V}, V_{IL} = 0\text{ V}$<br>$V_{CC} = 2.5\text{ V}, C_L = 30\text{ pF}, V_{IH} = 2.5\text{ V}, V_{IL} = 0\text{ V}$ |                           | -0.8<br>-0.6 |     | V     |

4. Number of outputs defined as “n”. Measured with “n-1” outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

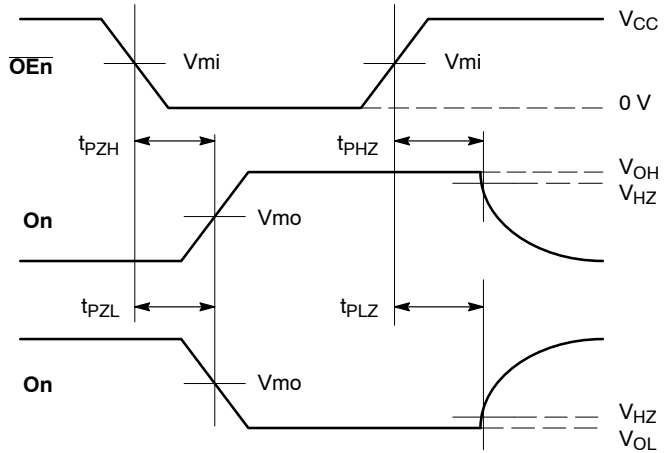
## CAPACITIVE CHARACTERISTICS

| Symbol    | Parameter                     | Condition                                                    | Typical | Units |
|-----------|-------------------------------|--------------------------------------------------------------|---------|-------|
| $C_{IN}$  | Input Capacitance             | $V_{CC} = 3.3\text{ V}, V_I = 0\text{ V or } V_{CC}$         | 7       | pF    |
| $C_{OUT}$ | Output Capacitance            | $V_{CC} = 3.3\text{ V}, V_I = 0\text{ V or } V_{CC}$         | 8       | pF    |
| $C_{PD}$  | Power Dissipation Capacitance | 10 MHz, $V_{CC} = 3.3\text{ V}, V_I = 0\text{ V or } V_{CC}$ | 20      | pF    |



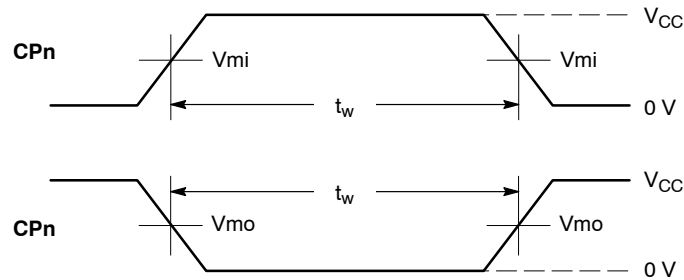
WAVEFORM 1 – PROPAGATION DELAYS, SETUP AND HOLD TIMES

$t_R = t_F = 2.5\text{ ns}$ , 10% to 90%;  $f = 1\text{ MHz}$ ;  $t_W = 500\text{ ns}$



WAVEFORM 2 – OUTPUT ENABLE AND DISABLE TIMES

$t_R = t_F = 2.5\text{ ns}$ , 10% to 90%;  $f = 1\text{ MHz}$ ;  $t_W = 500\text{ ns}$



WAVEFORM 3 – PULSE WIDTH

$t_R = t_F = 2.5\text{ ns}$  (or fast as required) from 10% to 90%;  
Output requirements:  $V_{OL} \leq 0.8\text{ V}$ ,  $V_{OH} \geq 2.0\text{ V}$

Figure 3. AC Waveforms

Table 2. AC WAVEFORMS

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

## MC74LCX16374

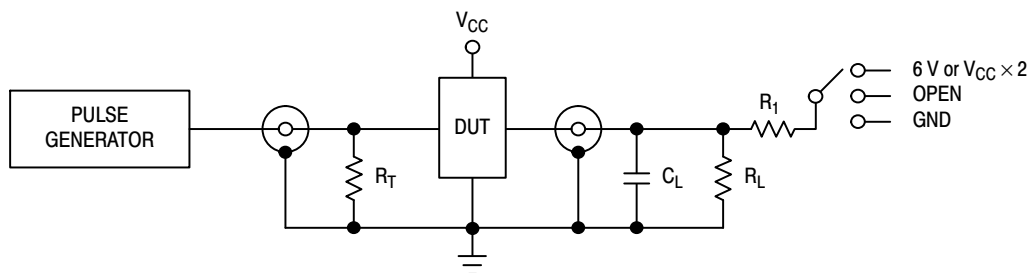


Figure 4. Test Circuit

Table 3. TEST CIRCUIT

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

$C_L = 50$  pF at  $V_{CC} = 3.3 \pm 0.3$  V or equivalent (includes jig and probe capacitance)

$C_L = 30$  pF at  $V_{CC} = 2.5 \pm 0.2$  V or equivalent (includes jig and probe capacitance)

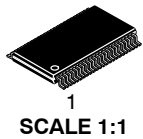
$R_L = R_1 = 500 \Omega$  or equivalent

$R_T = Z_{OUT}$  of pulse generator (typically  $50 \Omega$ )

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

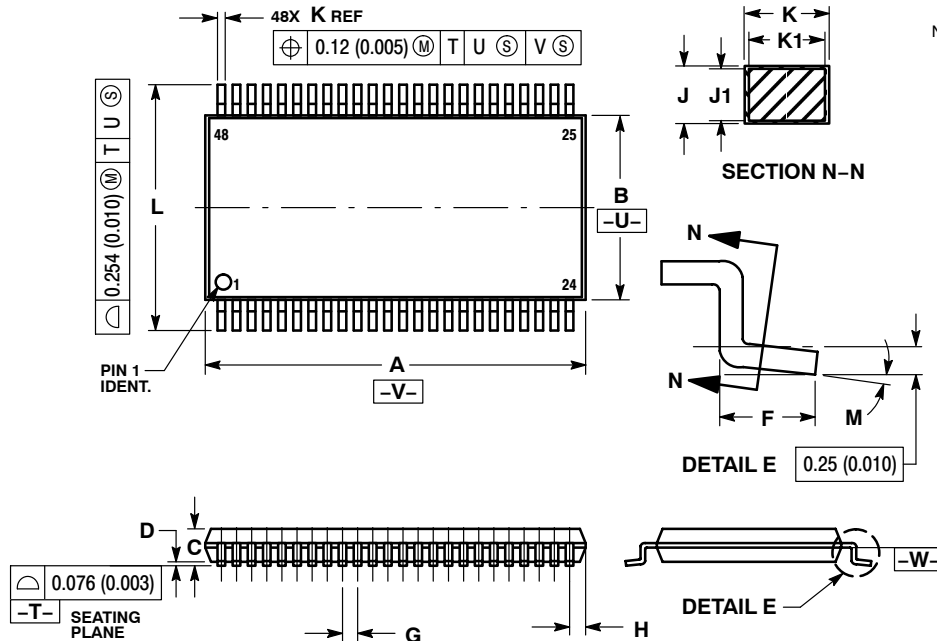
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## TSSOP-48 CASE 1201-01 ISSUE B

DATE 06 JUL 2010



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION 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-.

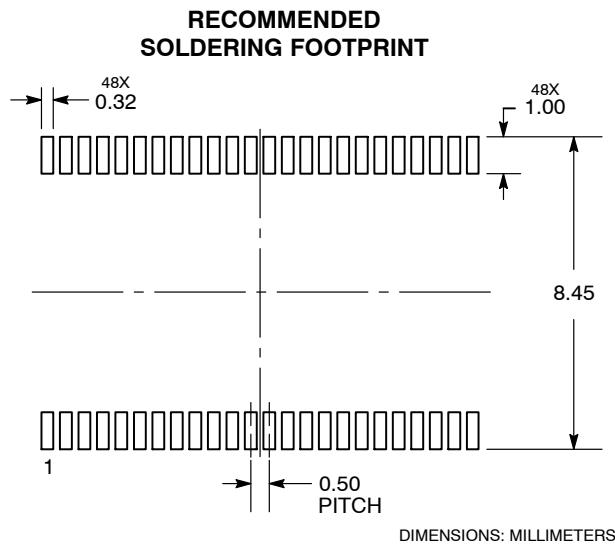
| DIM | MILLIMETERS |       | INCHES     |       |
|-----|-------------|-------|------------|-------|
|     | MIN         | MAX   | MIN        | MAX   |
| A   | 12.40       | 12.60 | 0.488      | 0.496 |
| B   | 6.00        | 6.20  | 0.236      | 0.244 |
| C   | ---         | 1.10  | ---        | 0.043 |
| D   | 0.05        | 0.15  | 0.002      | 0.006 |
| F   | 0.50        | 0.75  | 0.020      | 0.030 |
| G   | 0.50 BSC    |       | 0.0197 BSC |       |
| H   | 0.37        | ---   | 0.015      | ---   |
| J   | 0.09        | 0.20  | 0.004      | 0.008 |
| J1  | 0.09        | 0.16  | 0.004      | 0.006 |
| K   | 0.17        | 0.27  | 0.007      | 0.011 |
| K1  | 0.17        | 0.23  | 0.007      | 0.009 |
| L   | 7.95        | 8.25  | 0.313      | 0.325 |
| M   | 0°          | 8°    | 0°         | 8°    |

### GENERIC MARKING DIAGRAM\*



XXXXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking.



|                  |             |                                                                                                                                                                                     |
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