

74VCX16373

Low-Voltage 1.8/2.5/3.3V 16-Bit Transparent Latch

With 3.6 V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The 74VCX16373 is an advanced performance, non-inverting 16-bit transparent latch. It is designed for very high-speed, very low-power operation in 1.8 V, 2.5 V or 3.3 V systems. The VCX16373 is byte controlled, with each byte functioning identically, but independently. Each byte has separate Output Enable and Latch Enable inputs. These control pins can be tied together for full 16-bit operation.

When operating at 2.5 V (or 1.8 V) the part is designed to tolerate voltages it may encounter on either inputs or outputs when interfacing to 3.3 V busses. It is guaranteed to be overvoltage tolerant to 3.6 V.

The 74VCX16373 contains 16 D-type latches with 3-state 3.6 V-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, (a latch output will change state each time its D input changes). When LE is LOW, the latch stores 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 (\overline{OE}) inputs. When \overline{OE} is LOW, the outputs are enabled. When \overline{OE} is HIGH, the standard outputs are in the high impedance state, but this does not interfere with new data entering into the latches.

Features

- Designed for Low Voltage Operation: $V_{CC} = 1.65\text{ V} - 3.6\text{ V}$
- 3.6 V Tolerant Inputs and Outputs
- High Speed Operation: 3.0 ns max for 3.0 V to 3.6 V
3.9 ns max for 2.3 V to 2.7 V
6.8 ns max for 1.65 V to 1.95 V
- Static Drive: $\pm 24\text{ mA}$ Drive at 3.0 V
 $\pm 18\text{ mA}$ Drive at 2.3 V
 $\pm 6\text{ mA}$ Drive at 1.65 V
- Supports Live Insertion and Withdrawal
- I_{OFF} Specification Guarantees High Impedance When $V_{CC} = 0\text{ V}$
- Near Zero Static Supply Current in All Three Logic States (20 μA)
Substantially Reduces System Power Requirements
- Latchup Performance Exceeds $\pm 250\text{ mA}$ @ 125°C
- ESD Performance: Human Body Model >2000 V;
Machine Model >200 V
- All Devices in Package TSSOP are Inherently Pb-Free*

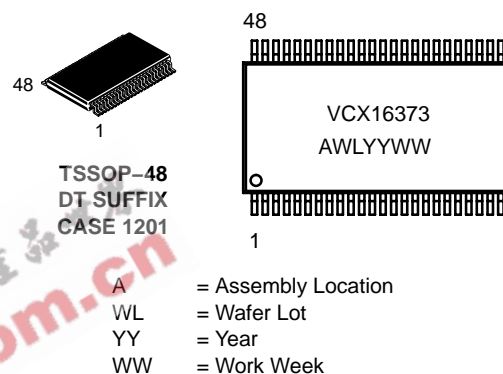
*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



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MARKING DIAGRAM



PIN NAMES

| Pins | Function |
|-----------------|----------------------|
| \overline{OE} | Output Enable Inputs |
| LEn | Latch Enable Inputs |
| D0-D15 | Inputs |
| O0-O15 | Outputs |

ORDERING INFORMATION

| Device | Package | Shipping† |
|---------------|--------------------|-------------|
| 74VCX16373DT | TSSOP (Pb-Free) | 39 / Rail |
| 74VCX16373DTR | TSSOP (Pb-Free) | 2500 / Reel |

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

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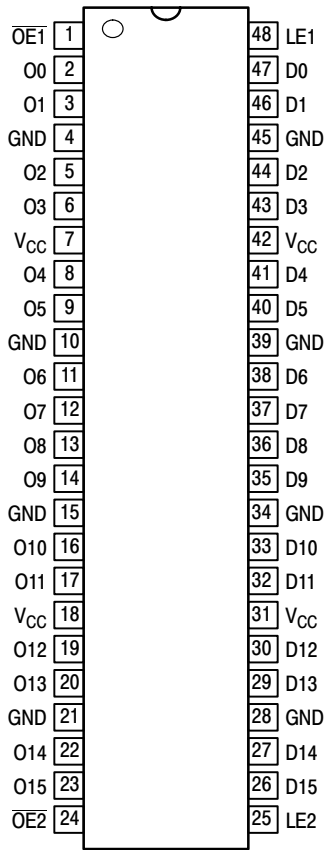


Figure 1. 48-Lead Pinout (Top View)

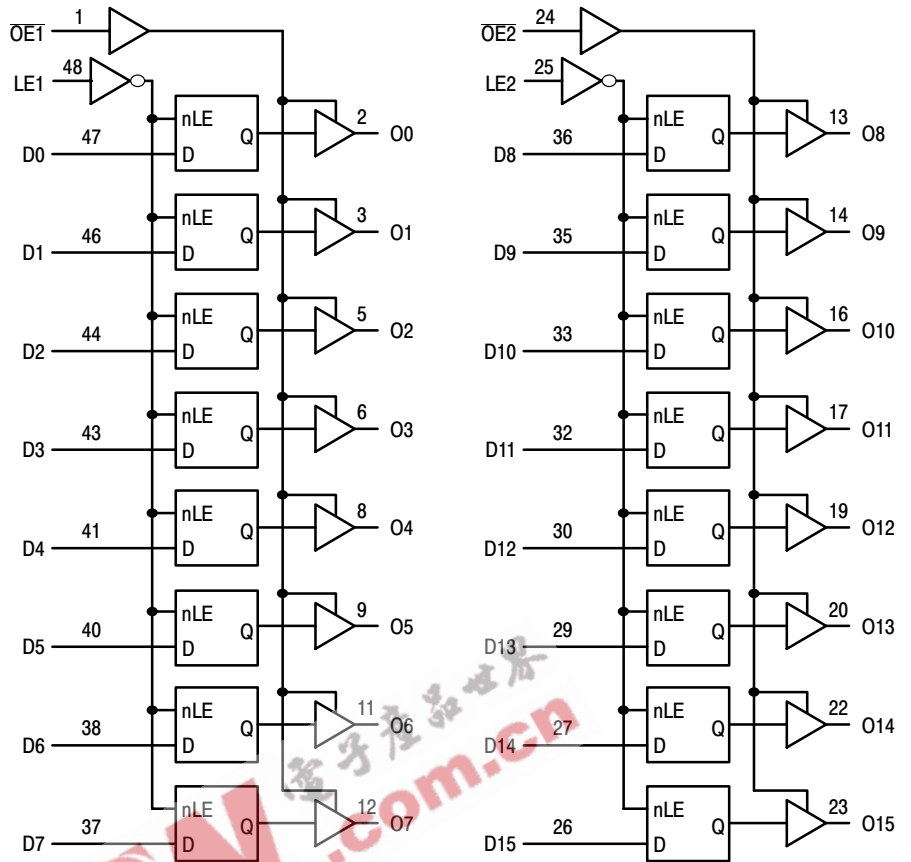


Figure 2. Logic Diagram

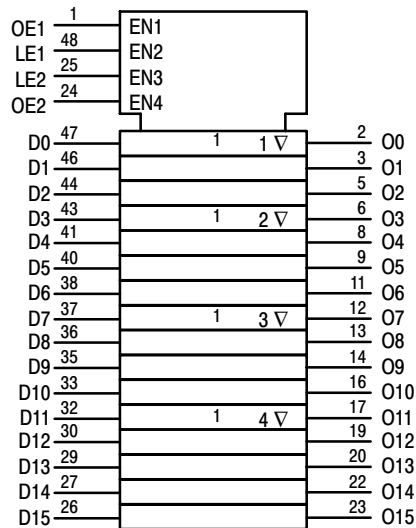


Figure 3. IEC Logic Diagram

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TRUTH TABLE

| Inputs | | | Outputs | Inputs | | | 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 | O0 |

H = High Voltage Level

L = Low Voltage Level

Z = High Impedance State

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

O0 = No Change

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Condition | Unit |
|------------------|----------------------------------|---|----------------------------------|------|
| V _{CC} | DC Supply Voltage | -0.5 to +4.6 | | V |
| V _I | DC Input Voltage | -0.5 ≤ V _I ≤ +4.6 | | V |
| V _O | DC Output Voltage | -0.5 ≤ V _O ≤ +4.6 | Output in 3-State | V |
| | | -0.5 ≤ V _O ≤ V _{CC} + 0.5 | Note 1; Outputs Active | |
| I _{IK} | DC Input Diode Current | -50 | V _I < GND | mA |
| I _{OK} | DC Output Diode Current | -50 | V _O < GND | mA |
| | | +50 | V _O > V _{CC} | |
| I _O | DC Output Source/Sink Current | ±50 | | mA |
| I _{CC} | DC Supply Current Per Supply Pin | ±100 | | mA |
| I _{GND} | DC Ground Current Per Ground Pin | ±100 | | mA |
| T _{STG} | Storage Temperature Range | -65 to +150 | | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. I_O absolute maximum rating must be observed.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Typ | Max | Unit | |
|-----------------|--|---------------------|------|-----------------|------|---|
| V _{CC} | Supply Voltage | Operating | 1.65 | 3.3 | 3.6 | V |
| | | Data Retention Only | 1.2 | 3.3 | 3.6 | |
| V _I | Input Voltage | -0.3 | | 3.6 | V | |
| V _O | Output Voltage | (Active State) | 0 | V _{CC} | V | |
| | | (3-State) | 0 | 3.6 | | |
| I _{OH} | HIGH Level Output Current, V _{CC} = 3.0 V – 3.6 V | | | -24 | mA | |
| I _{OL} | LOW Level Output Current, V _{CC} = 3.0 V – 3.6 V | | | 24 | mA | |
| I _{OH} | HIGH Level Output Current, V _{CC} = 2.3 V – 2.7 V | | | -18 | mA | |
| I _{OL} | LOW Level Output Current, V _{CC} = 2.3 V – 2.7 V | | | 18 | mA | |
| I _{OH} | HIGH Level Output Current, V _{CC} = 1.65 V – 1.95 V | | | -6 | mA | |
| I _{OL} | LOW Level Output Current, V _{CC} = 1.65 V – 1.95 V | | | 6 | mA | |
| T _A | Operating Free-Air Temperature | -40 | | +85 | °C | |
| Δt/ΔV | Input Transition Rise or Fall Rate, V _{IN} from 0.8 V to 2.0 V, V _{CC} = 3.0 V | 0 | | 10 | ns/V | |

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DC ELECTRICAL CHARACTERISTICS

| Symbol | Characteristic | Condition | T _A = -40°C to +85°C | | Unit |
|------------------|---------------------------------------|--|---------------------------------|------------------------|------|
| | | | Min | Max | |
| V _{IH} | HIGH Level Input Voltage (Note 2) | 1.65 V ≤ V _{CC} < 2.3 V | 0.65 x V _{CC} | | V |
| | | 2.3 V ≤ V _{CC} ≤ 2.7 V | 1.6 | | |
| | | 2.7 V < V _{CC} ≤ 3.6 V | 2.0 | | |
| V _{IL} | LOW Level Input Voltage (Note 2) | 1.65 V ≤ V _{CC} < 2.3 V | | 0.35 x V _{CC} | V |
| | | 2.3 V ≤ V _{CC} ≤ 2.7 V | | 0.7 | |
| | | 2.7 V < V _{CC} ≤ 3.6 V | | 0.8 | |
| V _{OH} | HIGH Level Output Voltage | 1.65 V ≤ V _{CC} ≤ 3.6 V; I _{OH} = -100 μA | V _{CC} - 0.2 | | V |
| | | V _{CC} = 1.65 V; I _{OH} = -6 mA | 1.25 | | |
| | | V _{CC} = 2.3 V; I _{OH} = -6 mA | 2.0 | | |
| | | V _{CC} = 2.3 V; I _{OH} = -12 mA | 1.8 | | |
| | | V _{CC} = 2.3 V; I _{OH} = -18 mA | 1.7 | | |
| | | V _{CC} = 2.7 V; I _{OH} = -12 mA | 2.2 | | |
| | | V _{CC} = 3.0 V; I _{OH} = -18 mA | 2.4 | | |
| V _{OL} | LOW Level Output Voltage | 1.65 V ≤ V _{CC} ≤ 3.6 V; I _{OL} = 100 μA | | 0.2 | V |
| | | V _{CC} = 1.65 V; I _{OL} = 6 mA | | 0.3 | |
| | | V _{CC} = 2.3 V; I _{OL} = 12 mA | | 0.4 | |
| | | V _{CC} = 2.3 V; I _{OL} = 18 mA | | 0.6 | |
| | | V _{CC} = 2.7 V; I _{OL} = 12 mA | | 0.4 | |
| | | V _{CC} = 3.0 V; I _{OL} = 18 mA | | 0.4 | |
| | | V _{CC} = 3.0 V; I _{OL} = 24 mA | | 0.55 | |
| I _I | Input Leakage Current | 1.65 V ≤ V _{CC} ≤ 3.6 V; 0 V ≤ V _I ≤ 3.6 V | | ±5.0 | μA |
| I _{OZ} | 3-State Output Current | 1.65 V ≤ V _{CC} ≤ 3.6 V; 0 V ≤ V _O ≤ 3.6 V; V _I = V _{IH} or V _{IL} | | ±10 | μA |
| I _{OFF} | Power-Off Leakage Current | V _{CC} = 0 V; V _I or V _O = 3.6 V | | 10 | μA |
| I _{CC} | Quiescent Supply Current (Note 3) | 1.65 V ≤ V _{CC} ≤ 3.6 V; V _I = GND or V _{CC} | | 20 | μA |
| | | 1.65 V ≤ V _{CC} ≤ 3.6 V; 3.6 V ≤ V _I , V _O ≤ 3.6 V | | ±20 | μA |
| ΔI _{CC} | Increase in I _{CC} per Input | 2.7 V < V _{CC} ≤ 3.6 V; V _{IH} = V _{CC} - 0.6 V | | 750 | μA |

2. These values of V_I are used to test DC electrical characteristics only.

3. Outputs disabled or 3-state only.

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AC CHARACTERISTICS (Note 4; $t_R = t_F = 2.0$ ns; $C_L = 30$ pF; $R_L = 500$ Ω)

| Symbol | Parameter | Waveform | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ | | | | | | Unit |
|--------------------------|--|----------|---|------------|---------------------------|------------|-----------------------------|--------------|------|
| | | | $V_{CC} = 3.0$ V to 3.6 V | | $V_{CC} = 2.3$ V to 2.7 V | | $V_{CC} = 1.65$ V to 1.95 V | | |
| | | | Min | Max | Min | Max | Min | Max | |
| t_{PLH} t_{PHL} | Propagation Delay Dn-to-On | 1 | 0.8 0.8 | 3.0 3.0 | 1.0 1.0 | 3.4 3.4 | 1.5 1.5 | 6.8 6.8 | ns |
| t_{PLH} t_{PHL} | Propagation Delay LE-to-On | 1 | 0.8 0.8 | 3.0 3.0 | 1.0 1.0 | 3.9 3.9 | 1.5 1.5 | 7.8 7.8 | ns |
| t_{PZH} t_{PZL} | Output Enable Time to High and Low Level | 2 | 0.8 0.8 | 3.5 3.5 | 1.0 1.0 | 4.6 4.6 | 1.5 1.5 | 9.2 9.2 | ns |
| t_{PHZ} t_{PLZ} | Output Disable Time From High and Low Level | 2 | 0.8 0.8 | 3.5 3.5 | 1.0 1.0 | 3.8 3.8 | 1.5 1.5 | 6.8 6.8 | ns |
| t_s | Setup Time, High or Low Dn-to-LE | 3 | 1.5 | | 1.5 | | 2.5 | | ns |
| t_h | Hold Time, High or Low Dn-to-LE | 3 | 1.0 | | 1.0 | | 1.0 | | ns |
| t_w | LE Pulse Width, High | 3 | 1.5 | | 1.5 | | 4.0 | | ns |
| t_{OSHL} t_{OSLH} | Output-to-Output Skew (Note 5) | | | 0.5 0.5 | | 0.5 0.5 | | 0.75 0.75 | ns |

4. For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.
5. 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}); parameter guaranteed by design.

AC CHARACTERISTICS ($t_R = t_F = 2.0$ ns; $C_L = 50$ pF; $R_L = 500$ Ω)

| Symbol | Parameter | Waveform | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ | | | | Unit |
|--------------------------|--|----------|---|------------|------------------|------------|------|
| | | | $V_{CC} = 3.0$ V to 3.6 V | | $V_{CC} = 2.7$ V | | |
| | | | Min | Max | Min | Max | |
| t_{PLH} t_{PHL} | Propagation Delay Dn-to-On | 4 | 1.0 1.0 | 3.6 3.6 | | 4.3 4.3 | ns |
| t_{PLH} t_{PHL} | Propagation Delay LE-to-On | 4 | 1.0 1.0 | 3.9 3.9 | | 4.6 4.6 | ns |
| t_{PZH} t_{PZL} | Output Enable Time to High and Low Level | 5 | 1.0 1.0 | 4.7 4.7 | | 5.7 5.7 | ns |
| t_{PHZ} t_{PLZ} | Output Disable Time From High and Low Level | 5 | 1.0 1.0 | 4.1 4.1 | | 4.5 4.5 | ns |
| t_{OSHL} t_{OSLH} | Output-to-Output Skew (Note 6) | | | 0.5 0.5 | | 0.5 0.5 | ns |

6. 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}); parameter guaranteed by design.

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DYNAMIC SWITCHING CHARACTERISTICS

| Symbol | Characteristic | Condition | T _A = +25°C | |
|------------------|---|--|------------------------|------|
| | | | Typ | Unit |
| V _{OLP} | Dynamic LOW Peak Voltage (Note 7) | V _{CC} = 1.8 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 0.25 | V |
| | | V _{CC} = 2.5 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 0.6 | |
| | | V _{CC} = 3.3 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 0.8 | |
| V _{OLV} | Dynamic LOW Valley Voltage (Note 7) | V _{CC} = 1.8 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | -0.25 | V |
| | | V _{CC} = 2.5 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | -0.6 | |
| | | V _{CC} = 3.3 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | -0.8 | |
| V _{OHV} | Dynamic HIGH Valley Voltage (Note 8) | V _{CC} = 1.8 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 1.5 | V |
| | | V _{CC} = 2.5 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 1.9 | |
| | | V _{CC} = 3.3 V, C _L = 30 pF, V _{IH} = V _{CC} , V _{IL} = 0 V | 2.2 | |

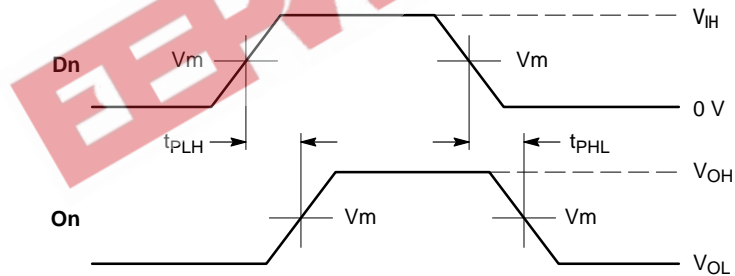
7. Number of outputs defined as “n”. Measured with “n-1” outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

8. 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 HIGH state.

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Condition | Typical | Unit |
|------------------|-------------------------------|----------------|---------|------|
| C _{IN} | Input Capacitance | Note 9 | 6 | pF |
| C _{OUT} | Output Capacitance | Note 9 | 7 | pF |
| C _{PD} | Power Dissipation Capacitance | Note 9, 10 MHz | 20 | pF |

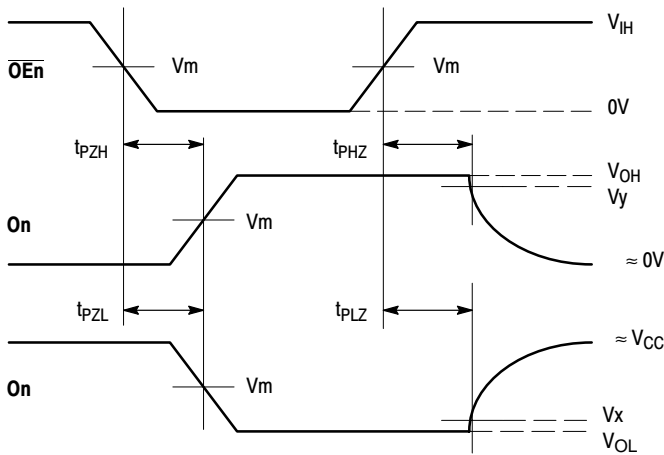
9. V_{CC} = 1.8 V, 2.5 V or 3.3 V; V_I = 0 V or V_{CC}.



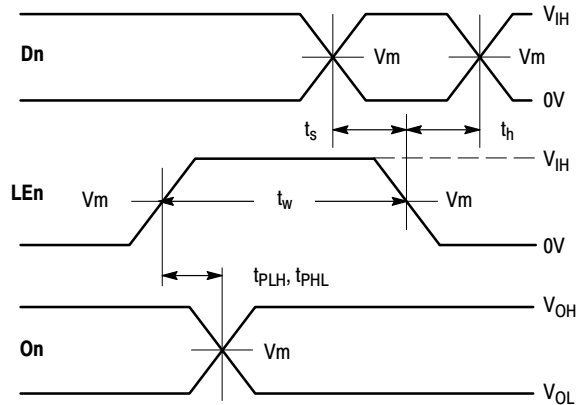
WAVEFORM 1 – PROPAGATION DELAYS
 $t_R = t_F = 2.0$ ns, 10% to 90%; $f = 1$ MHz; $t_W = 500$ ns

Figure 4. AC Waveforms

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WAVEFORM 2 - OUTPUT ENABLE AND DISABLE TIMES
 $t_R = t_F = 2.0$ ns, 10% to 90%; $f = 1$ MHz; $t_W = 500$ ns



WAVEFORM 3 - LE to On PROPAGATION DELAYS, LE MINIMUM PULSE WIDTH, Dn to LE SETUP AND HOLD TIMES
 $t_R = t_F = 2.0$ ns, 10% to 90%; $f = 1$ MHz; $t_W = 500$ ns except when noted

Figure 5. AC Waveforms

Table 1. AC WAVEFORMS

| Symbol | V_{CC} | | |
|----------|-----------------------------------|-----------------------------------|------------------------------------|
| | $3.3 \text{ V} \pm 0.3 \text{ V}$ | $2.5 \text{ V} \pm 0.2 \text{ V}$ | $1.8 \text{ V} \pm 0.15 \text{ V}$ |
| V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| V_m | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| V_x | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ |
| V_y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |

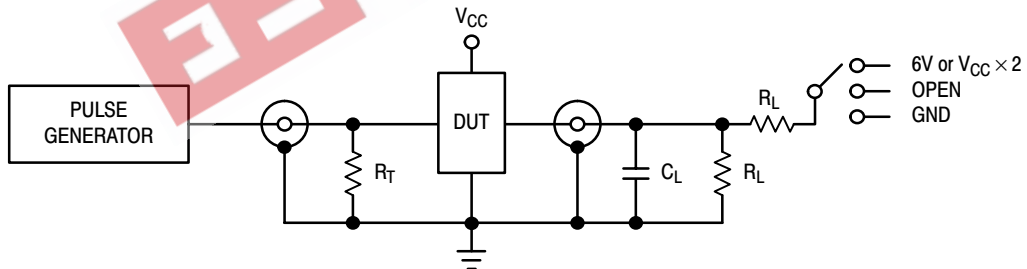


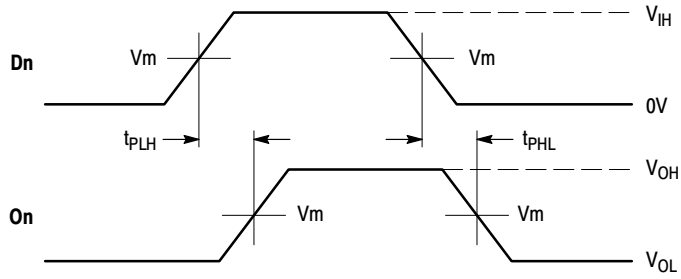
Figure 6. Test Circuit

Table 2. TEST CIRCUIT

| TEST | SWITCH |
|-----------------------|---|
| t_{PLH} , t_{PHL} | Open |
| t_{PZL} , t_{PLZ} | 6 V at $V_{CC} = 3.3 \pm 0.3 \text{ V}$; $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2 \text{ V}$; $1.8 \pm 0.15 \text{ V}$ |
| t_{PZH} , t_{PHZ} | GND |

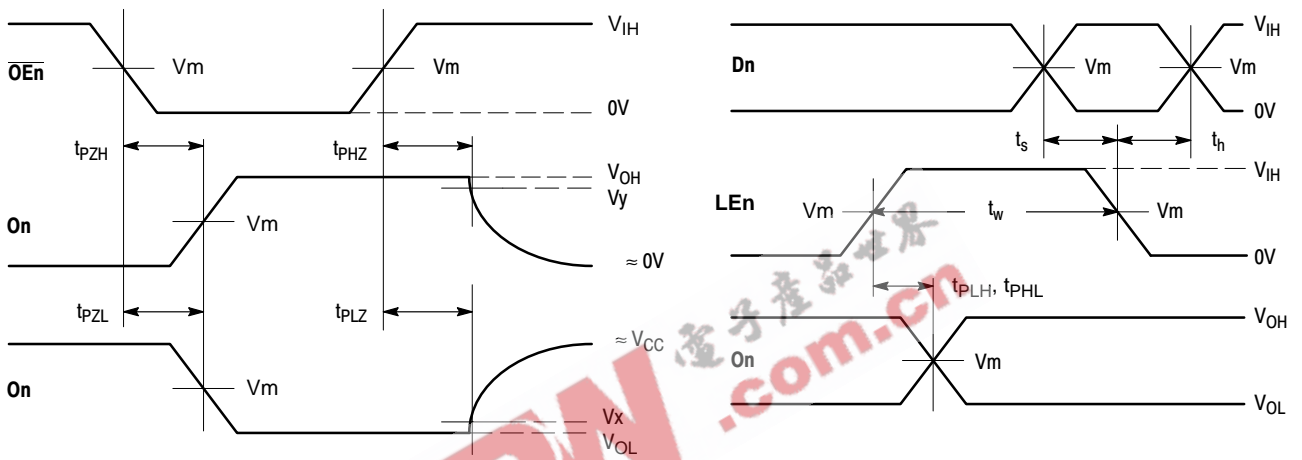
$C_L = 30$ pF or equivalent (Includes jig and probe capacitance)
 $R_L = 500 \Omega$ or equivalent
 $R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

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WAVEFORM 4 – PROPAGATION DELAYS
 $t_R = t_F = 2.0 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$

Figure 7. AC Waveforms



WAVEFORM 5 – OUTPUT ENABLE AND DISABLE TIMES
 $t_R = t_F = 2.0 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$

WAVEFORM 6 – LE to On PROPAGATION DELAYS, LE MINIMUM PULSE WIDTH, Dn to LE SETUP AND HOLD TIMES
 $t_R = t_F = 2.0 \text{ ns}$, 10% to 90%; $f = 1 \text{ MHz}$; $t_W = 500 \text{ ns}$ except when noted

Figure 8. AC Waveforms

Table 3. AC WAVEFORMS

| Symbol | Vcc | |
|----------|--------------------------|--------------------------|
| | 3.3 V ± 0.3 V | 2.7 V |
| V_{IH} | 2.7 V | 2.7 V |
| V_m | 1.5 V | 1.5 V |
| V_x | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.3 \text{ V}$ |
| V_y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.3 \text{ V}$ |

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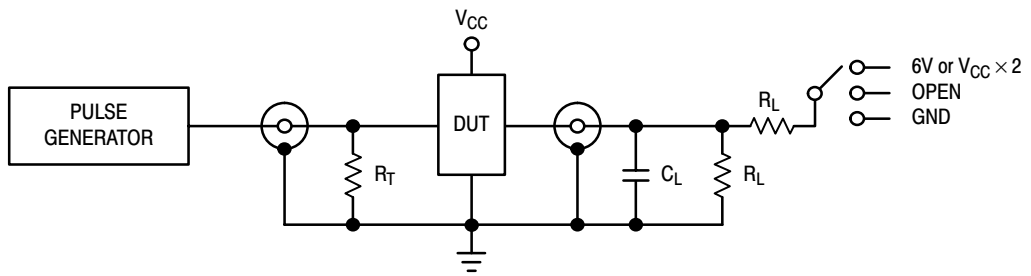


Figure 9. Test Circuit

Table 4. TEST CIRCUIT

| TEST | SWITCH |
|-----------------------|---|
| t_{PLH} , t_{PHL} | Open |
| t_{PZL} , t_{PLZ} | 6 V at $V_{CC} = 3.3 \pm 0.3$ V; $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2$ V; 1.8 ± 0.15 V |
| t_{PZH} , t_{PHZ} | GND |

$C_L = 50$ pF or equivalent (Includes jig and probe capacitance)

$R_L = 500 \Omega$ or equivalent

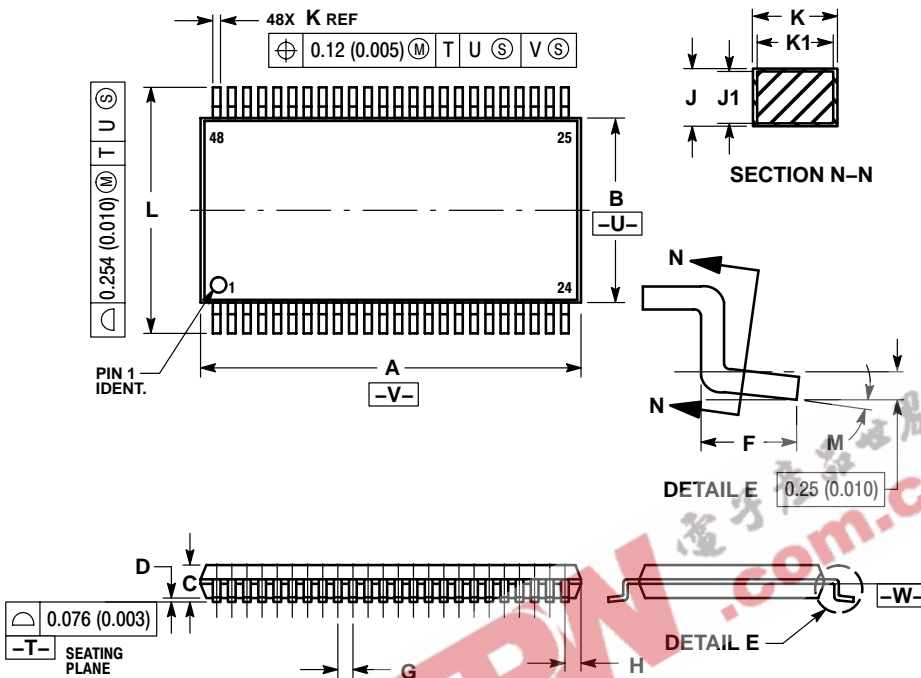
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

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74VCX16373

PACKAGE DIMENSIONS

TSSOP
DT SUFFIX
CASE 1201-01
ISSUE A



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° |

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