

NL74VCXH16374

Low-Voltage 1.8/2.5/3.3V 16-Bit D-Type Flip-Flop With 3.6V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The NL74VCXH16374 is an advanced performance, non-inverting 16-bit D-type flip-flop. It is designed for very high-speed, very low-power operation in 1.8V, 2.5V or 3.3V systems. The VCXH16374 is byte controlled, with each byte functioning identically, but independently. Each byte has separate Output Enable and Clock Pulse inputs. These control pins can be tied together for full 16-bit operation.

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

The NL74VCXH16374 consists of 16 edge-triggered flip-flops with individual D-type inputs and 3.6V-tolerant 3-state outputs. The clocks (CPn) and 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. The data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating inputs at a valid logic state.

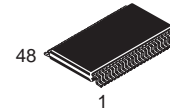
- Designed for Low Voltage Operation: $V_{CC} = 1.65\text{--}3.6\text{V}$
- 3.6V Tolerant Inputs and Outputs
- High Speed Operation: 3.0ns max for 3.0 to 3.6V
3.9ns max for 2.3 to 2.7V
7.8ns max for 1.65 to 1.95V
- Static Drive: $\pm 24\text{mA}$ Drive at 3.0V
 $\pm 18\text{mA}$ Drive at 2.3V
 $\pm 6\text{mA}$ Drive at 1.65V
- Supports Live Insertion and Withdrawal
- Includes Active Bushold to Hold Unused or Floating Inputs at a Valid Logic State
- I_{OFF} Specification Guarantees High Impedance When $V_{CC} = 0\text{V}^\dagger$
- Near Zero Static Supply Current in All Three Logic States (20 μA) Substantially Reduces System Power Requirements
- Latchup Performance Exceeds $\pm 300\text{mA}$ @ 125°C
- ESD Performance: Human Body Model >2000V; Machine Model >200V

\dagger NOTE: To ensure the outputs activate in the 3-state condition, the output enable pins should be connected to V_{CC} through a pull-up resistor. The value of the resistor is determined by the current sinking capability of the output connected to the OE pin.



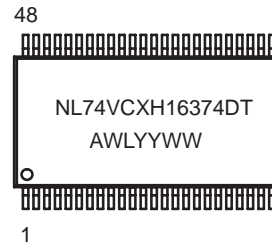
ON Semiconductor

<http://onsemi.com>



TSSOP-48
DT SUFFIX
CASE 1201

MARKING DIAGRAM



A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week

PIN NAMES

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

ORDERING INFORMATION

Device	Package	Shipping
NL74VCXH16374DT	TSSOP	39 / Rail
NL74VCXH16374DTR	TSSOP	2500 / Reel

NL74VCXH16374

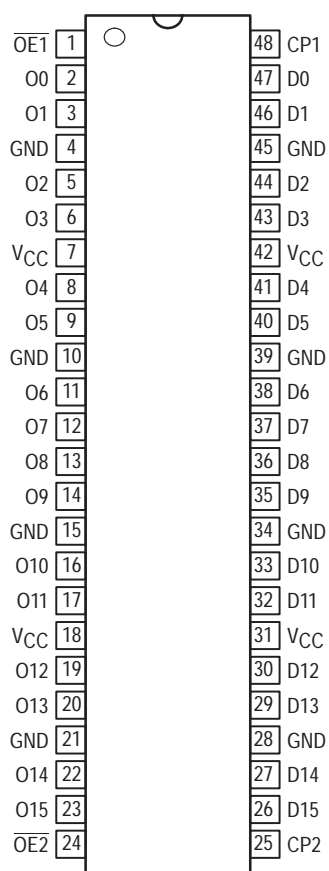


Figure 1. 48-Lead Pinout (Top View)

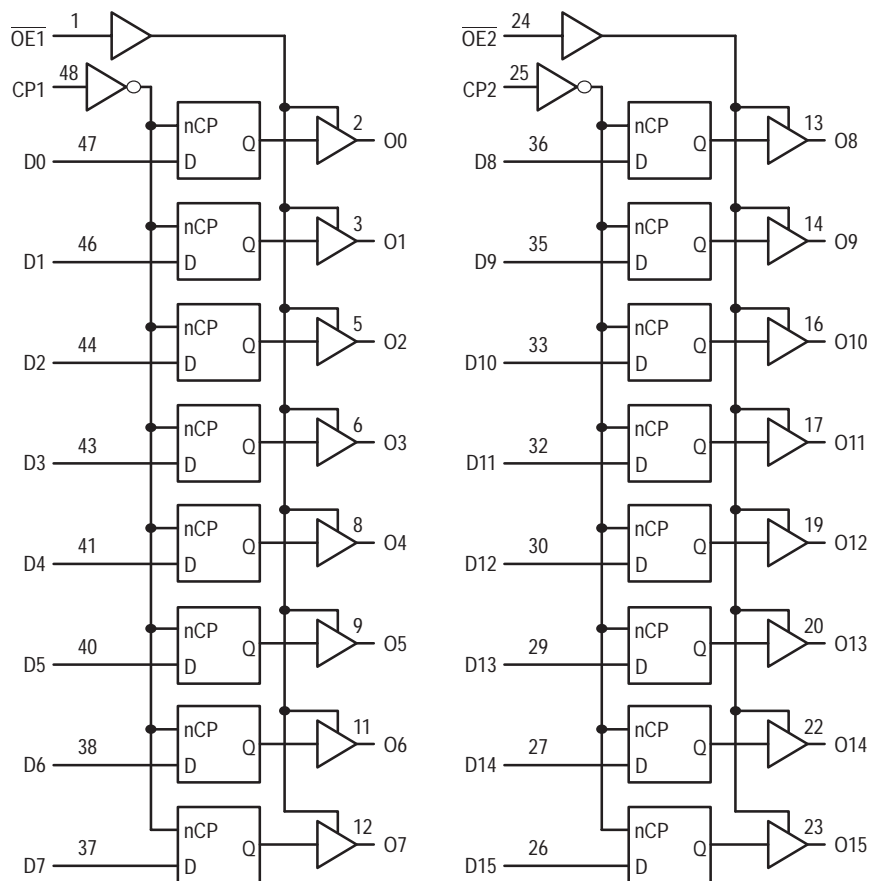
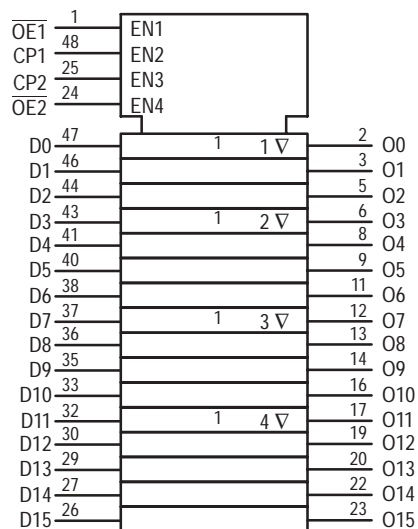


Figure 2. Logic Diagram



Inputs			Outputs	Inputs			Outputs
CP1	$\overline{OE1}$	D0:7	O0:7	CP2	$\overline{OE2}$	D8:15	O8:15
↑	L	H	H	↑	L	H	H
↑	L	L	L	↑	L	L	L
X	L	X	O0	X	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. O0 = No Change.

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ABSOLUTE MAXIMUM RATINGS*

Symbol	Parameter	Value	Condition	Unit
V_{CC}	DC Supply Voltage	-0.5 to +4.6		V
V_I	DC Input Voltage	$-0.5 \leq V_I \leq +4.6$		V
V_O	DC Output Voltage	$-0.5 \leq V_O \leq +4.6$	Output in 3-State	V
		$-0.5 \leq V_O \leq V_{CC} + 0.5$	Note 1.; Outputs Active	V
I_{IK}	DC Input Diode Current	-50	$V_I < \text{GND}$	mA
I_{OK}	DC Output Diode Current	-50	$V_O < \text{GND}$	mA
		+50	$V_O > V_{CC}$	mA
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
TSTG	Storage Temperature Range	-65 to +150		°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. 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, $V_{CC} = 3.0V - 3.6V$			-24	mA	
I_{OL}	LOW Level Output Current, $V_{CC} = 3.0V - 3.6V$			24	mA	
I_{OH}	HIGH Level Output Current, $V_{CC} = 2.3V - 2.7V$			-18	mA	
I_{OL}	LOW Level Output Current, $V_{CC} = 2.3V - 2.7V$			18	mA	
I_{OH}	HIGH Level Output Current, $V_{CC} = 1.65 - 1.95V$			-6	mA	
I_{OL}	LOW Level Output Current, $V_{CC} = 1.65 - 1.95V$			6	mA	
T_A	Operating Free-Air Temperature	-40		+85	°C	
$\Delta t/\Delta V$	Input Transition Rise or Fall Rate, V_{IN} from 0.8V to 2.0V, $V_{CC} = 3.0V$	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.)	1.65V ≤ V _{CC} < 2.3V	0.65 x V _{CC}		V
		2.3V ≤ V _{CC} ≤ 2.7V	1.6		
		2.7V < V _{CC} ≤ 3.6V	2.0		
V _{IL}	LOW Level Input Voltage (Note 2.)	1.65V ≤ V _{CC} < 2.3V		0.35 x V _{CC}	V
		2.3V ≤ V _{CC} ≤ 2.7V		0.7	
		2.7V < V _{CC} ≤ 3.6V		0.8	
V _{OH}	HIGH Level Output Voltage	1.65V ≤ V _{CC} ≤ 3.6V; I _{OH} = -100μA	V _{CC} - 0.2		V
		V _{CC} = 1.65V; I _{OH} = -6mA	1.25		
		V _{CC} = 2.3V; I _{OH} = -6mA	2.0		
		V _{CC} = 2.3V; I _{OH} = -12mA	1.8		
		V _{CC} = 2.3V; I _{OH} = -18mA	1.7		
		V _{CC} = 2.7V; I _{OH} = -12mA	2.2		
		V _{CC} = 3.0V; I _{OH} = -18mA	2.4		
V _{OL}	LOW Level Output Voltage	1.65V ≤ V _{CC} ≤ 3.6V; I _{OL} = 100μA		0.2	V
		V _{CC} = 1.65V; I _{OL} = 6mA		0.3	
		V _{CC} = 2.3V; I _{OL} = 12mA		0.4	
		V _{CC} = 2.3V; I _{OL} = 18mA		0.6	
		V _{CC} = 2.7V; I _{OL} = 12mA		0.4	
		V _{CC} = 3.0V; I _{OL} = 18mA		0.4	
		V _{CC} = 3.0V; I _{OL} = 24mA		0.55	
I _I	Input Leakage Current	1.65V ≤ V _{CC} ≤ 3.6V; 0V ≤ V _I ≤ 3.6V		±5.0	μA
I _I (HOLD)	Minimum Bushold Input Current	V _{CC} = 3.0V, V _{IN} = 0.8V	75		μA
		V _{CC} = 3.0V, V _{IN} = 2.0V	-75		
		V _{CC} = 2.3V, V _{IN} = 0.7V	45		
		V _{CC} = 2.3V, V _{IN} = 1.6V	-45		
		V _{CC} = 1.65V, V _{IN} = 0.57V	25		
		V _{CC} = 1.65V, V _{IN} = 1.07V	-25		
I _I (OD)	Minimum Bushold Over-Drive Current Needed to Change State	V _{CC} = 3.6V, (Note 3.)	450		μA
		V _{CC} = 3.6V, (Note 4.)	-450		
		V _{CC} = 2.7V, (Note 3.)	300		
		V _{CC} = 2.7V, (Note 4.)	-300		
		V _{CC} = 1.95V, (Note 3.)	200		
		V _{CC} = 1.95V, (Note 4.)	-200		
I _{OZ}	3-State Output Current	1.65V ≤ V _{CC} ≤ 3.6V; 0V ≤ V _O ≤ 3.6V; V _I = V _{IH} or V _{IL}		±10	μA
I _{OFF}	Power-Off Leakage Current	V _{CC} = 0V; V _I or V _O = 3.6V		10	μA
I _{CC}	Quiescent Supply Current (Note 5.)	1.65V ≤ V _{CC} ≤ 3.6V; V _I = GND or V _{CC}		20	μA
		1.65V ≤ V _{CC} ≤ 3.6V; 3.6V ≤ V _I , V _O ≤ 3.6V		±20	μA
ΔI _{CC}	Increase in I _{CC} per Input	2.7V < V _{CC} ≤ 3.6V; V _{IH} = V _{CC} - 0.6V		750	μA

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

3. An external driver must source at least the specified current to switch from LOW-to-HIGH

4. An external driver must source at least the specified current to switch from HIGH-to-LOW

5. Outputs disabled or 3-state only.

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AC CHARACTERISTICS (Note 6.; $t_R = t_F = 2.0\text{ns}$; $C_L = 30\text{pF}$; $R_L = 500\Omega$)

Symbol	Parameter	Waveform	Limits						Unit
			$T_A = -40^\circ\text{C to } +85^\circ\text{C}$						
			$V_{CC} = 3.0\text{V to } 3.6\text{V}$		$V_{CC} = 2.3\text{V to } 2.7\text{V}$		$V_{CC} = 1.65 \text{ to } 1.95\text{V}$		
			Min	Max	Min	Max	Min	Max	
f_{max}	Clock Pulse Frequency	1	250		200		100		MHz
t_{PLH} t_{PHL}	Propagation Delay CP 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 CP	3	1.5		1.5		2.5		ns
t_h	Hold Time, High or Low Dn to CP	3	1.0		1.0		1.0		ns
t_w	CP Pulse Width, High	3	1.5		1.5		4.0		ns
t_{OSHL} t_{OSLH}	Output-to-Output Skew (Note 7.)			0.5 0.5		0.5 0.5		0.75 0.75	ns

6. For $C_L = 50\text{pF}$, add approximately 300ps to the AC maximum specification.

7. 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.

DYNAMIC SWITCHING CHARACTERISTICS

Symbol	Characteristic	Condition	$T_A = +25^\circ\text{C}$	Unit
			Typ	
V_{OLP}	Dynamic LOW Peak Voltage (Note 8.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	0.8	
V_{OLV}	Dynamic LOW Valley Voltage (Note 8.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	-0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	-0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	-0.8	
V_{OHV}	Dynamic HIGH Valley Voltage (Note 9.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	1.5	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	1.9	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{\text{IH}} = V_{CC}, V_{\text{IL}} = 0\text{V}$	2.2	

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 LOW state.

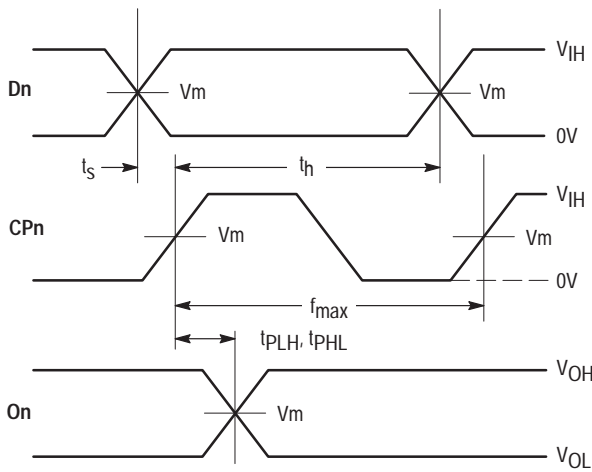
9. Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the HIGH state.

CAPACITIVE CHARACTERISTICS

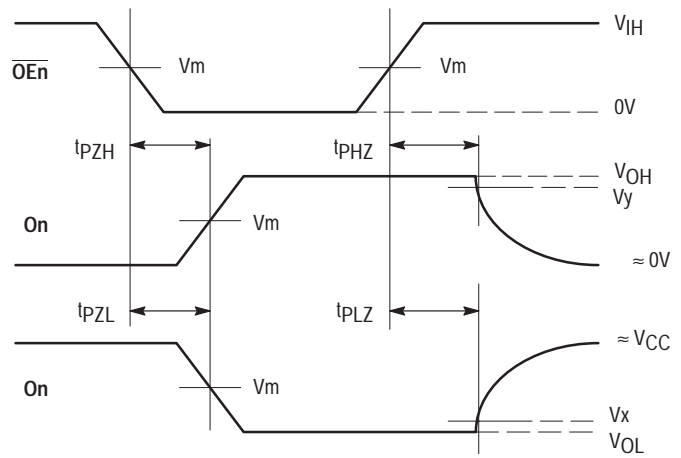
Symbol	Parameter	Condition	Typical	Unit
C_{IN}	Input Capacitance	Note 10.	6	pF
C_{OUT}	Output Capacitance	Note 10.	7	pF
C_{PD}	Power Dissipation Capacitance	Note 10., 10MHz	20	pF

10. $V_{CC} = 1.8, 2.5 \text{ or } 3.3\text{V}$; $V_I = 0\text{V}$ or V_{CC} .

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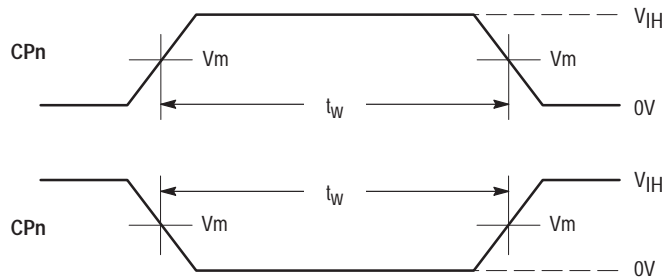


WAVEFORM 1 – PROPAGATION DELAYS, SETUP AND HOLD TIMES
 $t_R = t_F = 2.0\text{ns}$, 10% to 90%; $f = 1\text{MHz}$; $t_W = 500\text{ns}$



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

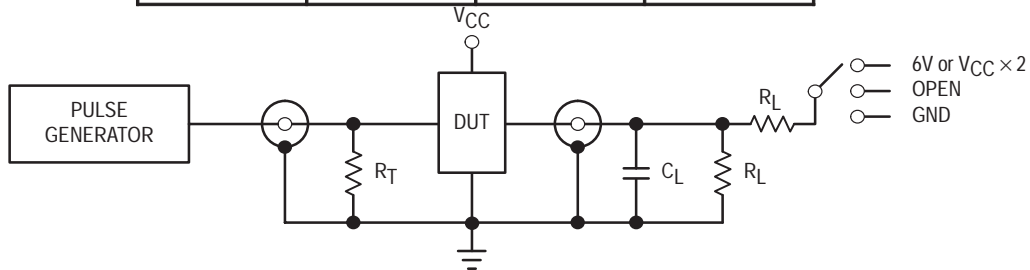
Figure 3. AC Waveforms



WAVEFORM 3 – PULSE WIDTH
 $t_R = t_F = 2.0\text{ns}$ (or fast as required) from 10% to 90%

Figure 4. AC Waveforms

Symbol	VCC		
	3.3V ±0.3V	2.5V ±0.2V	1.8V ±0.15V
VIH	2.7V	VCC	VCC
Vm	1.5V	VCC/2	VCC/2
Vx	VOL + 0.3V	VOL + 0.15V	VOL + 0.15V
Vy	VOH - 0.3V	VOH - 0.15V	VOH - 0.15V

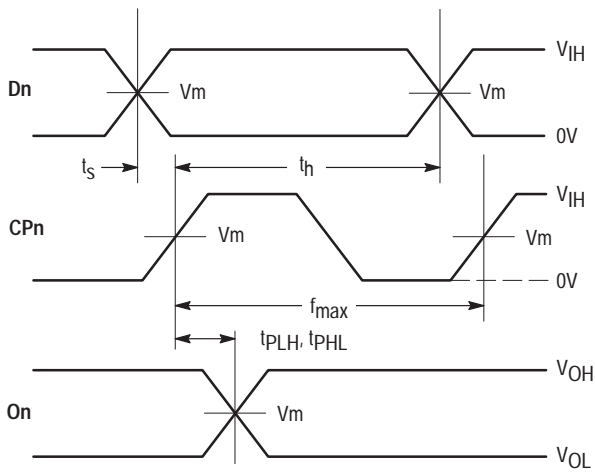


TEST	SWITCH
tPLH, tPHL	Open
tPZL, tPLZ	6V at VCC = 3.3 ±0.3V; VCC × 2 at VCC = 2.5 ±0.2V; 1.8V ±0.15V
tPZH, tPHZ	GND

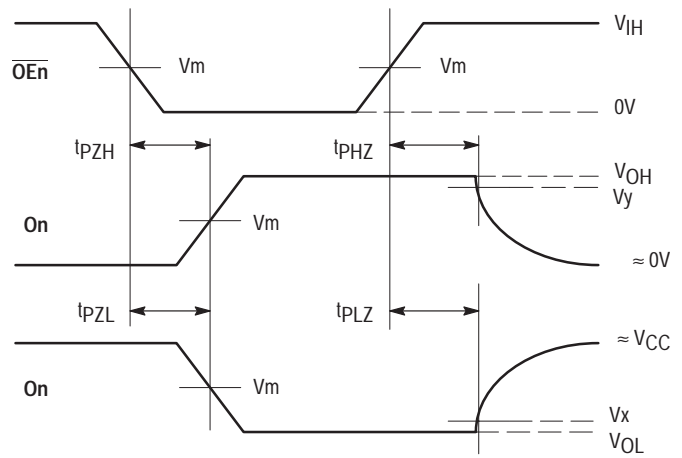
CL = 30pF or equivalent (Includes jig and probe capacitance)
 RL = 500Ω or equivalent
 RT = ZOUT of pulse generator (typically 50Ω)

Figure 5. Test Circuit

NL74VCXH16374

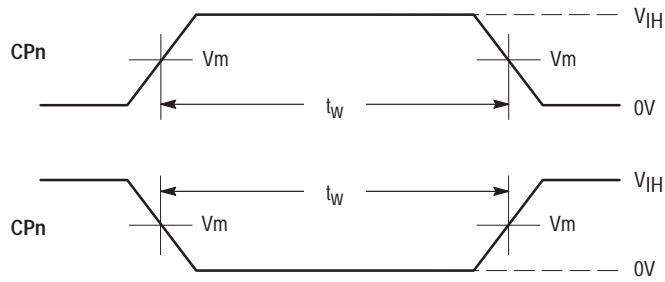


WAVEFORM 4 – PROPAGATION DELAYS, SETUP AND HOLD TIMES
 $t_R = t_F = 2.0\text{ns}$, 10% to 90%; $f = 1\text{MHz}$; $t_W = 500\text{ns}$



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

Figure 6. AC Waveforms



WAVEFORM 6 – PULSE WIDTH
 $t_R = t_F = 2.0\text{ns}$ (or fast as required) from 10% to 90%

Figure 7. AC Waveforms

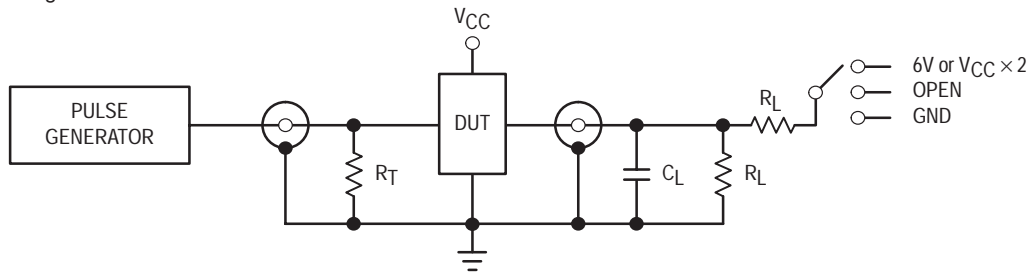
Symbol	V _{CC}	
	3.3V ±0.3V	2.7V
V _{IH}	2.7V	2.7V
V _m	1.5V	1.5V
V _x	V _{OL} + 0.3V	V _{OL} + 0.3V
V _y	V _{OH} - 0.3V	V _{OH} - 0.3V

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AC CHARACTERISTICS ($t_R = t_F = 2.0\text{ns}$; $C_L = 50\text{pF}$; $R_L = 500\Omega$)

Symbol	Parameter	Waveform	Limits				Unit
			$T_A = -40^\circ\text{C to } +85^\circ\text{C}$				
			$V_{CC} = 3.0\text{V to } 3.6\text{V}$		$V_{CC} = 2.7\text{V}$		
			Min	Max	Min	Max	
f_{max}	Clock Pulse Frequency	4	150		150		MHz
t_{PLH} t_{PHL}	Propagation Delay CP to On	4	1.0	4.2		4.9	ns
t_{PZH} t_{PZL}	Output Enable Time to High and Low Level	5	1.0	4.8		5.9	ns
t_{PHZ} t_{PLZ}	Output Disable Time From High and Low Level	5	1.0	4.3		4.7	ns
t_{OSHL} t_{OSLH}	Output-to-Output Skew (Note 11.)			0.5		0.5	ns

11. 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.



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

$C_L = 50\text{pF}$ or equivalent (Includes jig and probe capacitance)

$R_L = 500\Omega$ or equivalent

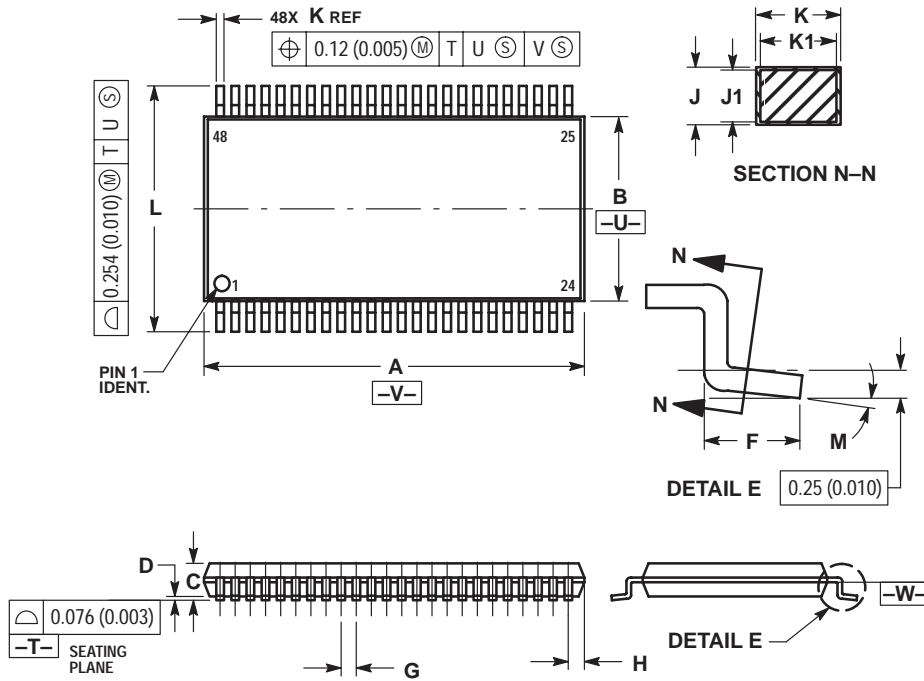
$R_T = Z_{\text{OUT}}$ of pulse generator (typically 50Ω)

Figure 8. Test Circuit

NL74VCXH16374

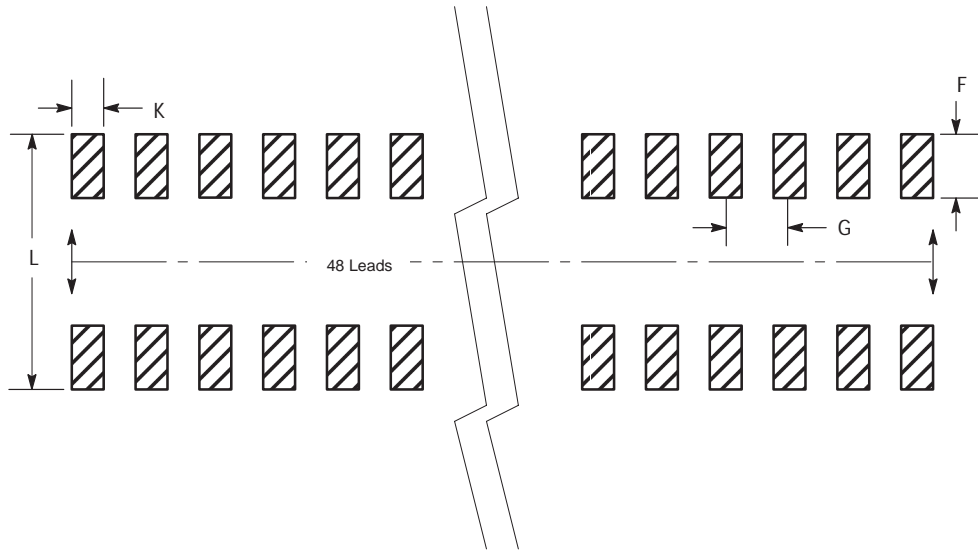
PACKAGE DIMENSIONS

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°



Package Footprint

NL74VCXH16374

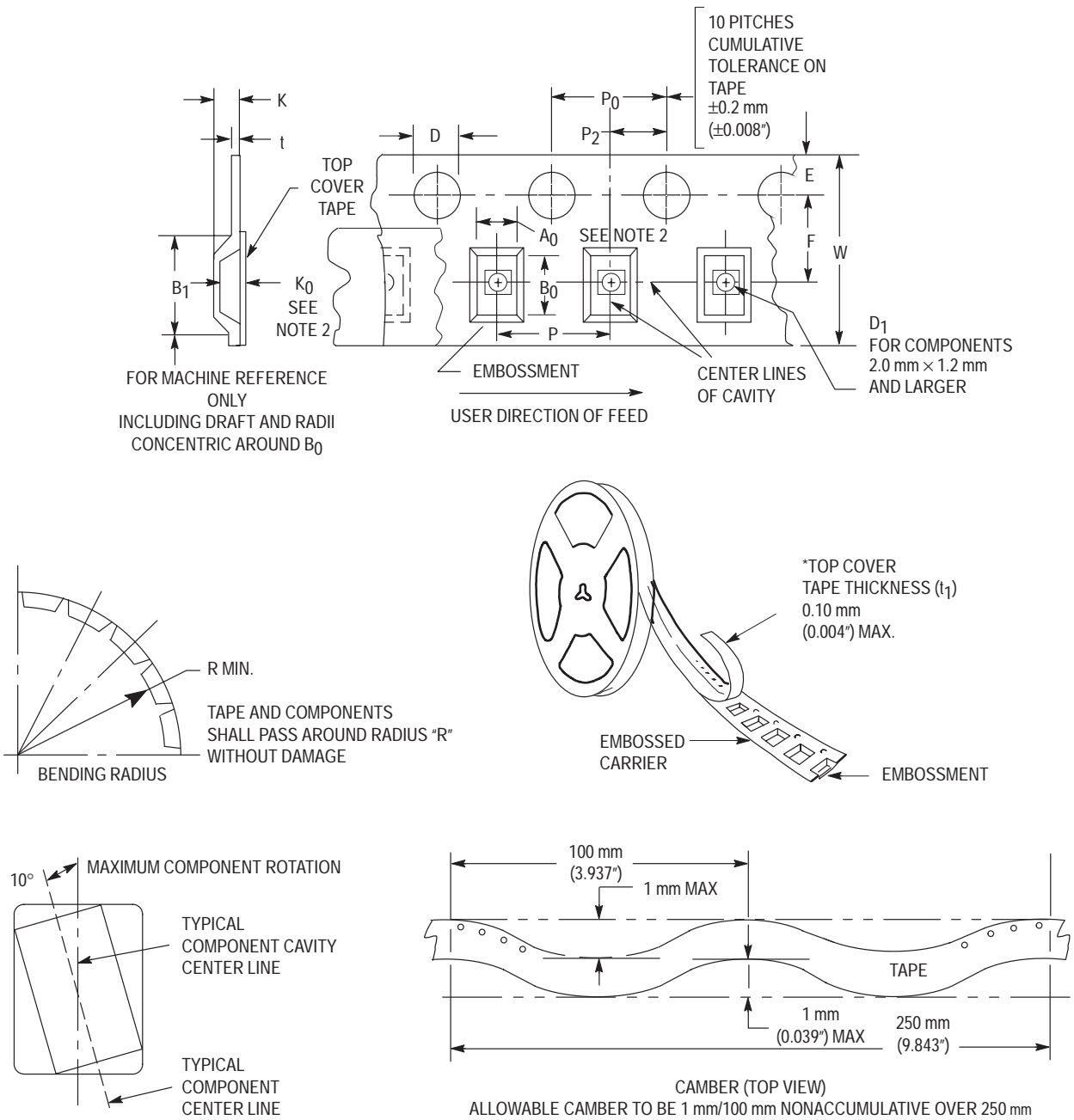


Figure 9. Carrier Tape Specifications

EMBOSSED CARRIER DIMENSIONS (See Notes 1 and 2)

Tape Size	B ₁ Max	D	D ₁	E	F	K	P	P ₀	P ₂	R	T	W
24mm	20.1mm (0.791")	1.5 + 0.1mm -0.0 (0.059 +0.004" -0.0)	1.5mm Min (0.060")	1.75 ±0.1 mm (0.069 ±0.004")	11.5 ±0.10 mm (0.453 ±0.004")	11.9 mm Max (0.468")	16.0 ±0.1 mm (0.63 ±0.004")	4.0 ±0.1 mm (0.157 ±0.004")	2.0 ±0.1 mm (0.079 ±0.004")	30 mm (1.18")	0.6 mm (0.024")	24.3 mm (0.957")

1. Metric Dimensions Govern—English are in parentheses for reference only.
2. A₀, B₀, and K₀ are determined by component size. The clearance between the components and the cavity must be within 0.05 mm min to 0.50 mm max. The component cannot rotate more than 10° within the determined cavity

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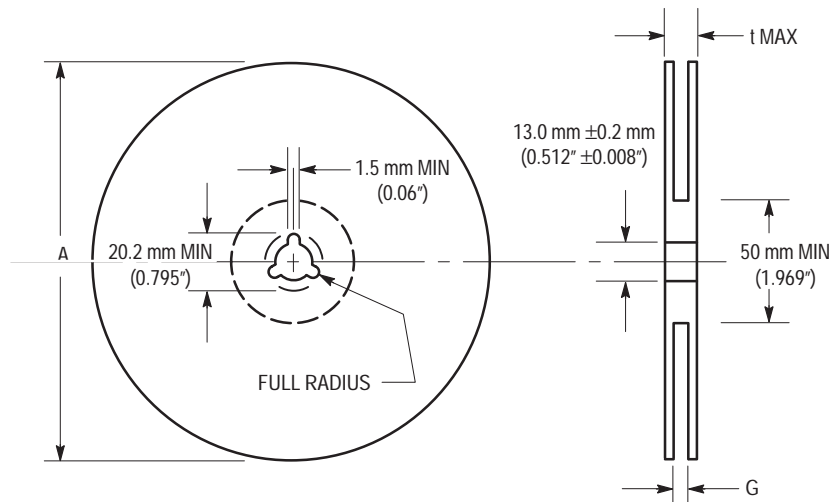


Figure 10. Reel Dimensions

REEL DIMENSIONS

Tape Size	A Max	G	t Max
24 mm	360 mm (14.173")	24.4 mm + 2.0 mm, -0.0 (0.961" + 0.078", -0.00)	30.4 mm (1.197")

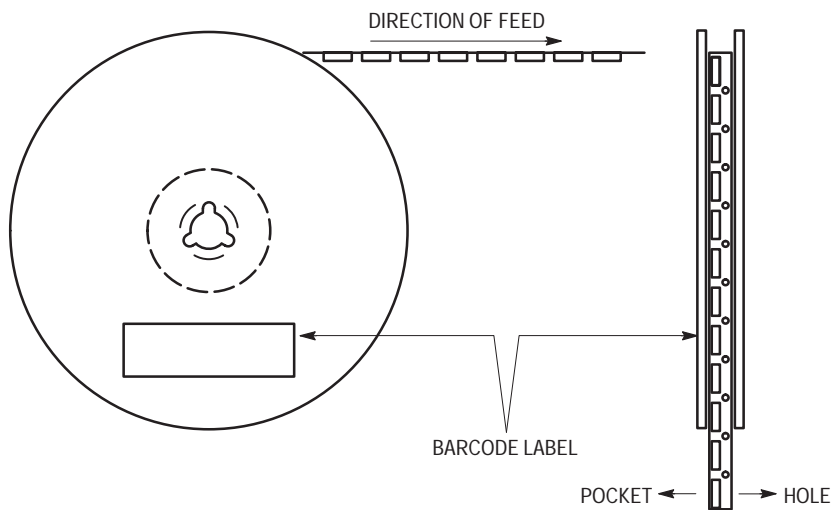


Figure 11. Reel Winding Direction

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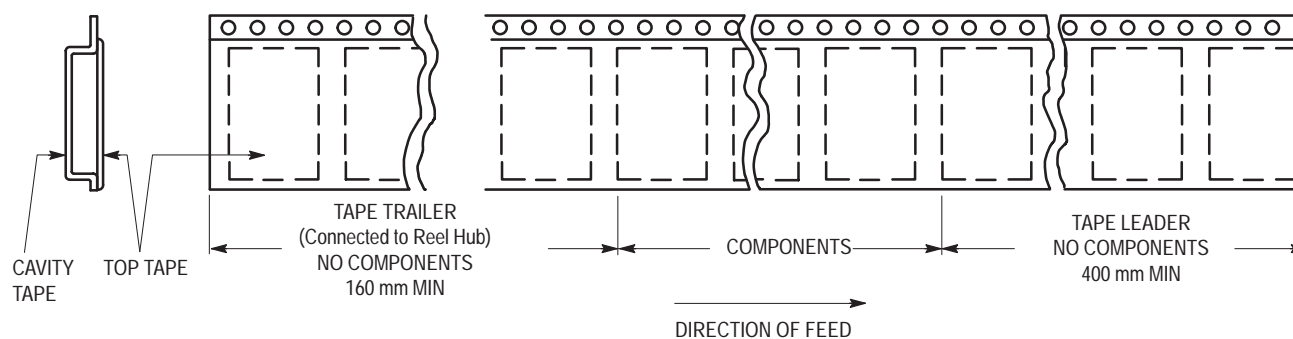


Figure 12. Tape Ends for Finished Goods

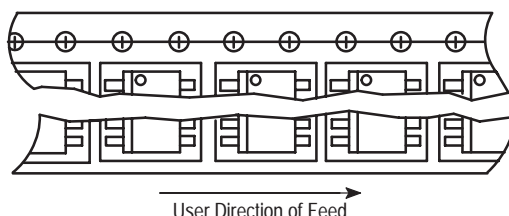



Figure 13. Reel Configuration

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