

# 74VCXH16244

## Low-Voltage 1.8/2.5/3.3V 16-Bit Buffer

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

The 74VCXH16244 is an advanced performance, non-inverting 16-bit buffer. It is designed for very high-speed, very low-power operation in 1.8 V, 2.5 V or 3.3 V systems.

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 over-voltage tolerant to 3.6 V.

The 74VCXH16244 is nibble controlled with each nibble functioning identically, but independently. The control pins may be tied together to obtain full 16-bit operation. The 3-state outputs are controlled by an Output Enable ( $\overline{OEn}$ ) input for each nibble. When  $\overline{OEn}$  is LOW, the outputs are on. When  $\overline{OEn}$  is HIGH, the outputs are in the high impedance state. 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:  $V_{CC} = 1.65\text{--}3.6\text{ V}$
- 3.6 V Tolerant Inputs and Outputs
- High Speed Operation: 2.5 ns max for 3.0 to 3.6 V  
3.0 ns max for 2.3 to 2.7 V  
6.0 ns max for 1.65 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
- 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  $\mu\text{A}$ )  
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

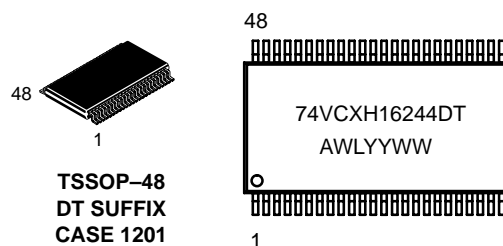
$^\dagger$ NOTE: To ensure the outputs activate in the 3-state condition, the output enable pins should be connected to  $V_{CC}$  through a pull-up resistor. The value of the resistor is determined by the current sinking capability of the output connected to the  $\overline{OE}$  pin.



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#### MARKING DIAGRAM

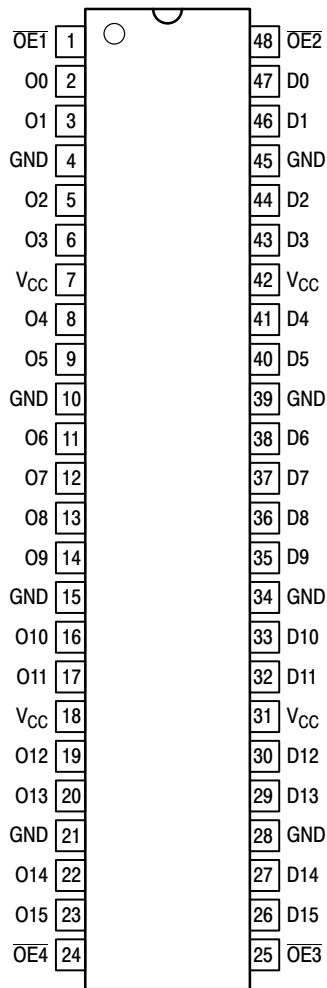


A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week

#### ORDERING INFORMATION

Device	Package	Shipping
74VCXH16244DT	TSSOP	39 / Rail
74VCXH16244DTR	TSSOP	2500 / Reel

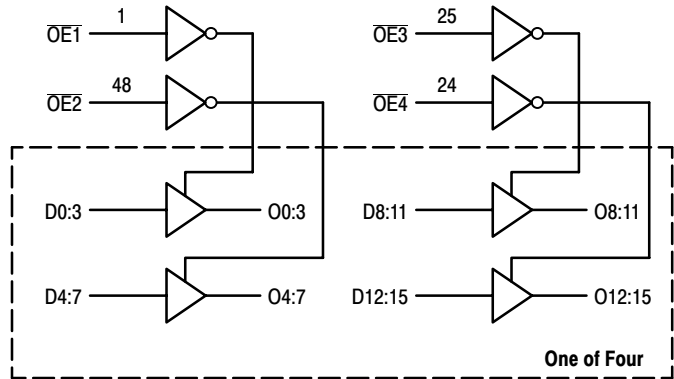
# 74VCXH16244



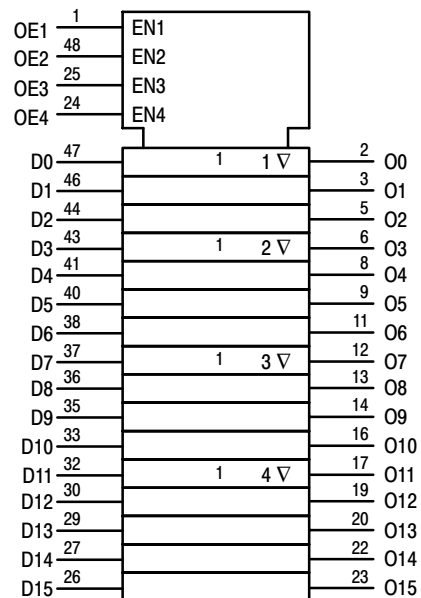
**Figure 1. 48-Lead Pinout**  
(Top View)

## PIN NAMES

Pins	Function
OE <sub>n</sub>	Output Enable Inputs
D0–D15	Inputs
O0–O15	Outputs



**Figure 2. Logic Diagram**



**Figure 3. IEC Logic Diagram**

OE1	D0:3	O0:3	OE2	D4:7	O4:7	OE3	D8:11	O8:11	OE4	D12:15	O12:15
L	L	L	L	L	L	L	L	L	L	L	L
L	H	H	L	H	H	L	H	H	L	H	H
H	X	Z	H	X	Z	H	X	Z	H	X	Z

H = High Voltage Level; L = Low Voltage Level; Z = High Impedance State; X = High or Low Voltage Level and Transitions Are Acceptable, for I<sub>CC</sub> reasons, DO NOT FLOAT Inputs

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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	$-50$	$V_I < GND$	mA
$I_{OK}$	DC Output Diode Current	$-50$	$V_O < GND$	mA
		$+50$	$V_O > V_{CC}$	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 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	1.65	3.3	3.6	V
		1.2	3.3	3.6	
$V_I$	Input Voltage	$-0.3$		3.6	V
$V_O$	Output Voltage	0		$V_{CC}$	V
		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, $V_{CC} = 1.65V - 1.95V$			$-6$	mA
$I_{OL}$	LOW Level Output Current, $V_{CC} = 1.65V - 1.95V$			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 <sub>A</sub> = -40°C to +85°C		Unit
			Min	Max	
V <sub>IH</sub>	HIGH Level Input Voltage (Note 2.)	1.65V ≤ V <sub>CC</sub> < 2.3V	0.65 x V <sub>CC</sub>		V
		2.3V ≤ V <sub>CC</sub> ≤ 2.7V	1.6		
		2.7V < V <sub>CC</sub> ≤ 3.6V	2.0		
V <sub>IL</sub>	LOW Level Input Voltage (Note 2.)	1.65V ≤ V <sub>CC</sub> < 2.3V		0.35 x V <sub>CC</sub>	V
		2.3V ≤ V <sub>CC</sub> ≤ 2.7V		0.7	
		2.7V < V <sub>CC</sub> ≤ 3.6V		0.8	
V <sub>OH</sub>	HIGH Level Output Voltage	1.65V ≤ V <sub>CC</sub> ≤ 3.6V; I <sub>OH</sub> = -100μA	V <sub>CC</sub> - 0.2		V
		V <sub>CC</sub> = 1.65V; I <sub>OH</sub> = -6mA	1.25		
		V <sub>CC</sub> = 2.3V; I <sub>OH</sub> = -6mA	2.0		
		V <sub>CC</sub> = 2.3V; I <sub>OH</sub> = -12mA	1.8		
		V <sub>CC</sub> = 2.3V; I <sub>OH</sub> = -18mA	1.7		
		V <sub>CC</sub> = 2.7V; I <sub>OH</sub> = -12mA	2.2		
		V <sub>CC</sub> = 3.0V; I <sub>OH</sub> = -18mA	2.4		
		V <sub>CC</sub> = 3.0V; I <sub>OH</sub> = -24mA	2.2		
V <sub>OL</sub>	LOW Level Output Voltage	1.65V ≤ V <sub>CC</sub> ≤ 3.6V; I <sub>OL</sub> = 100μA		0.2	V
		V <sub>CC</sub> = 1.65V; I <sub>OL</sub> = 6mA		0.3	
		V <sub>CC</sub> = 2.3V; I <sub>OL</sub> = 12mA		0.4	
		V <sub>CC</sub> = 2.3V; I <sub>OL</sub> = 18mA		0.6	
		V <sub>CC</sub> = 2.7V; I <sub>OL</sub> = 12mA		0.4	
		V <sub>CC</sub> = 3.0V; I <sub>OL</sub> = 18mA		0.4	
		V <sub>CC</sub> = 3.0V; I <sub>OL</sub> = 24mA		0.55	
I <sub>I</sub>	Input Leakage Current	1.65V ≤ V <sub>CC</sub> ≤ 3.6V; 0V ≤ V <sub>I</sub> ≤ 3.6V		±5.0	μA
I <sub>I(HOLD)</sub>	Minimum Bushold Input Current	V <sub>CC</sub> = 3.0V, V <sub>IN</sub> = 0.8V	75		μA
		V <sub>CC</sub> = 3.0V, V <sub>IN</sub> = 2.0V	-75		
		V <sub>CC</sub> = 2.3V, V <sub>IN</sub> = 0.7V	45		
		V <sub>CC</sub> = 2.3V, V <sub>IN</sub> = 1.6V	-45		
		V <sub>CC</sub> = 1.65V, V <sub>IN</sub> = 0.57V	25		
		V <sub>CC</sub> = 1.65V, V <sub>IN</sub> = 1.07V	-25		
I <sub>I(OD)</sub>	Minimum Bushold Over-Drive Current Needed to Change State	V <sub>CC</sub> = 3.6V, (Note 3.)	450		μA
		V <sub>CC</sub> = 3.6V, (Note 4.)	-450		
		V <sub>CC</sub> = 2.7V, (Note 3.)	300		
		V <sub>CC</sub> = 2.7V, (Note 4.)	-300		
		V <sub>CC</sub> = 1.95V, (Note 3.)	200		
		V <sub>CC</sub> = 1.95V, (Note 4.)	-200		
I <sub>OZ</sub>	3-State Output Current	1.65V ≤ V <sub>CC</sub> ≤ 3.6V; 0V ≤ V <sub>O</sub> ≤ 3.6V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>		±10	μA
I <sub>OFF</sub>	Power-Off Leakage Current	V <sub>CC</sub> = 0V; V <sub>I</sub> or V <sub>O</sub> = 3.6V		10	μA
I <sub>CC</sub>	Quiescent Supply Current (Note 5.)	1.65V ≤ V <sub>CC</sub> ≤ 3.6V; V <sub>I</sub> = GND or V <sub>CC</sub>		20	μA
		1.65V ≤ V <sub>CC</sub> ≤ 3.6V; 3.6V ≤ V <sub>I</sub> , V <sub>O</sub> ≤ 3.6V		±20	μA
ΔI <sub>CC</sub>	Increase in I <sub>CC</sub> per Input	2.7V < V <sub>CC</sub> ≤ 3.6V; V <sub>IH</sub> = V <sub>CC</sub> - 0.6V		750	μA

2. These values of V<sub>I</sub> 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 <sub>A</sub> = −40°C to +85°C						
			V <sub>CC</sub> = 3.0V to 3.6V		V <sub>CC</sub> = 2.3V to 2.7V		V <sub>CC</sub> = 1.65 – 1.95V		
			Min	Max	Min	Max	Min	Max	
t <sub>PLH</sub>	Propagation Delay	1	0.8	2.5	1.0	3.0	1.5	6.0	ns
t <sub>PHL</sub>	Input to Output		0.8	2.5	1.0	3.0	1.5	6.0	
t <sub>PZH</sub>	Output Enable Time to	2	0.8	3.5	1.0	4.1	1.5	8.2	ns
t <sub>PZL</sub>	High and Low Level		0.8	3.5	1.0	4.1	1.5	8.2	
t <sub>PHZ</sub>	Output Disable Time From	2	0.8	3.5	1.0	3.8	1.5	6.8	ns
t <sub>PLZ</sub>	High and Low Level		0.8	3.5	1.0	3.8	1.5	6.8	
t <sub>OSHL</sub>	Output-to-Output Skew			0.5		0.5		0.75	ns
t <sub>OSLH</sub>	(Note 7.)			0.5		0.5		0.75	

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.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	0.8	
$V_{OLV}$	Dynamic LOW Valley Voltage (Note 8.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.25	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.6	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	-0.8	
$V_{OHV}$	Dynamic HIGH Valley Voltage (Note 9.)	$V_{CC} = 1.8\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.5	V
		$V_{CC} = 2.5\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	1.9	
		$V_{CC} = 3.3\text{V}, C_L = 30\text{pF}, V_{IH} = V_{CC}, V_{IL} = 0\text{V}$	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.

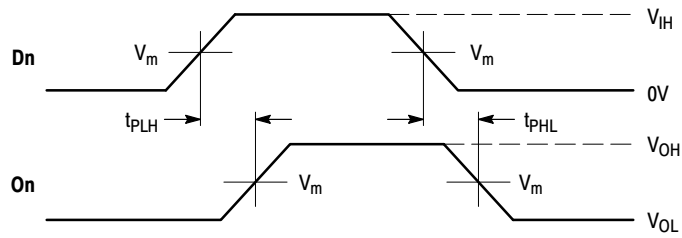
9. Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the HIGH state.

## 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

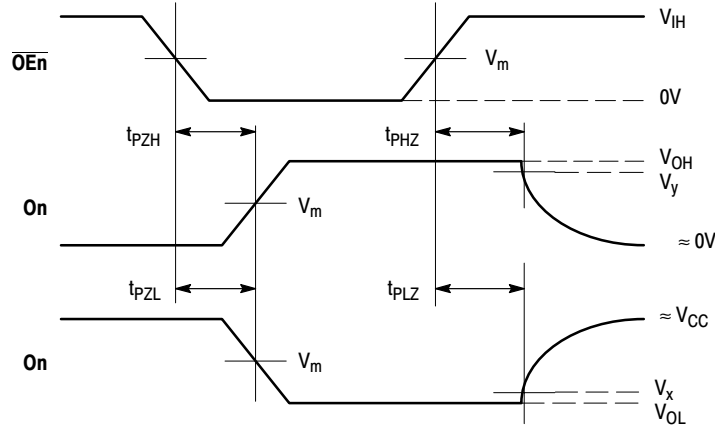
10.  $V_{CC} = 1.8, 2.5$  or  $3.3\text{V}$ ;  $V_I = 0\text{V}$  or  $V_{CC}$ .

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**WAVEFORM 1 - PROPAGATION DELAYS**

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

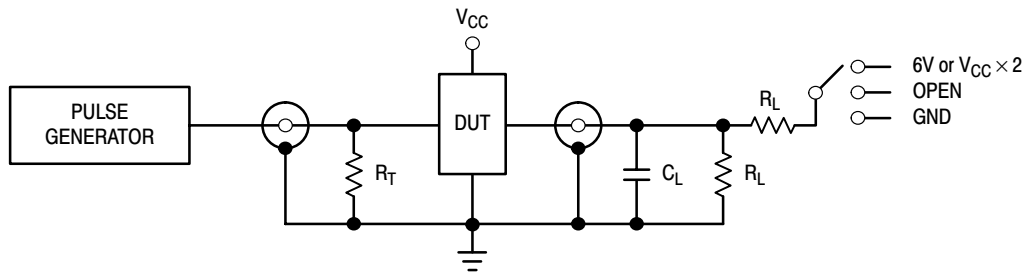


**WAVEFORM 2 - OUTPUT ENABLE AND DISABLE TIMES**

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

**Figure 4. AC Waveforms**

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



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 $V_{CC} = 2.5 \pm 0.2\text{V}$ ; $1.8 \pm 0.15\text{V}$
$t_{PZH}$ , $t_{PHZ}$	GND

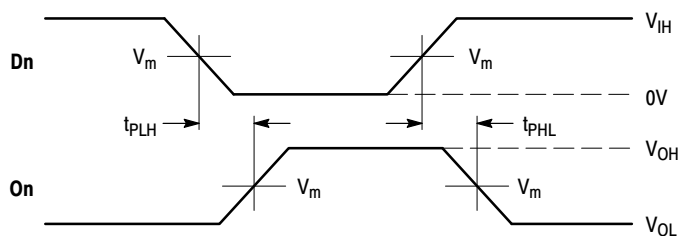
$C_L = 30\text{pF}$  or equivalent (Includes jig and probe capacitance)

$R_L = 500\Omega$  or equivalent

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

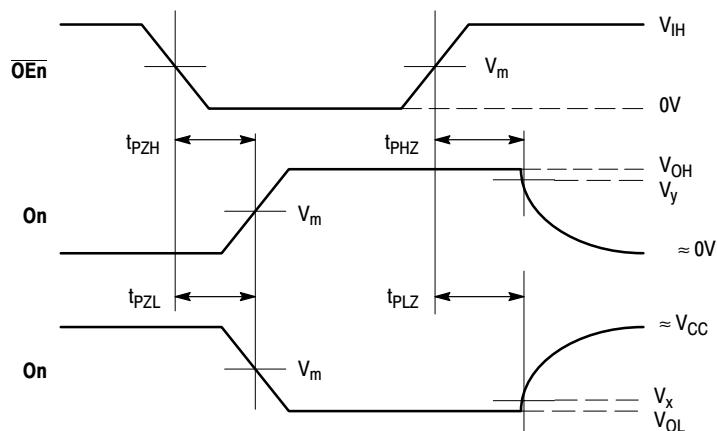
**Figure 5. Test Circuit**

## 74VCXH16244



**WAVEFORM 3 - PROPAGATION DELAYS**

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

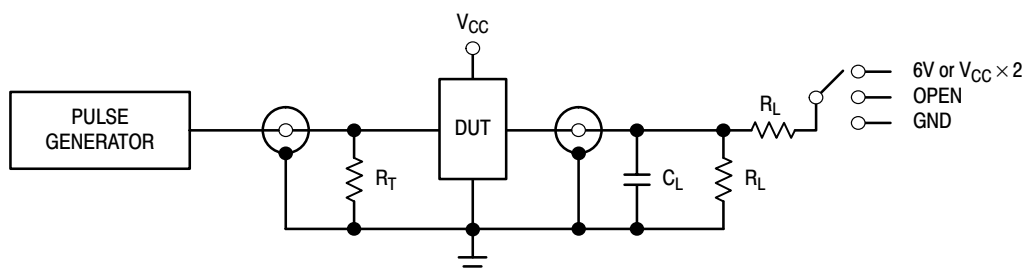


**WAVEFORM 4 - OUTPUT ENABLE AND DISABLE TIMES**

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

**Figure 6. AC Waveforms**

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



TEST	SWITCH
$t_{PLH}$ , $t_{PHL}$	Open
$t_{PZL}$ , $t_{PLZ}$	$6\text{V}$ 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

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

$R_L = 500\Omega$  or equivalent

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

**Figure 7. Test Circuit**

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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 <sub>A</sub> = −40°C to +85°C				
			V <sub>CC</sub> = 3.0V to 3.6V		V <sub>CC</sub> = 2.7V		
			Min	Max	Min	Max	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Input to Output	3	1.0 1.0	3.0 3.0		3.6 3.6	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time to High and Low Level	4	1.0 1.0	4.4 4.4		5.4 5.4	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time From High and Low Level	4	1.0 1.0	4.1 4.1		4.6 4.6	ns
t <sub>OSHL</sub> t <sub>OSLH</sub>	Output-to-Output Skew (Note 11.)			0.5 0.5		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.



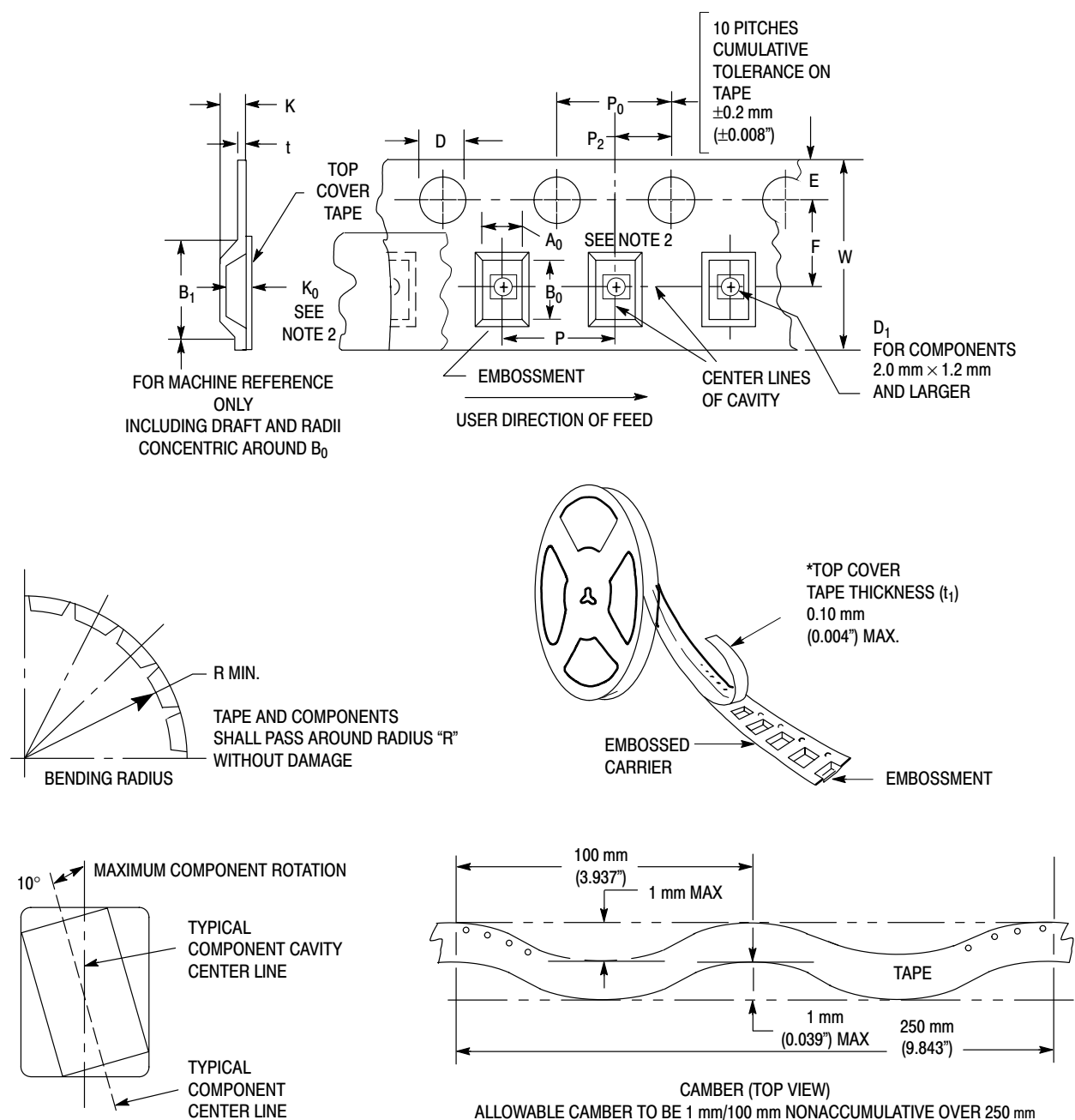


Figure 8. Carrier Tape Specifications

#### 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 $\pm 0.1$ mm (0.069 $\pm 0.004$ " )	11.5 $\pm 0.10$ mm (0.453 $\pm 0.004$ " )	11.9 mm Max (0.468")	16.0 $\pm 0.1$ mm (0.63 $\pm 0.004$ " )	4.0 $\pm 0.1$ mm (0.157 $\pm 0.004$ " )	2.0 $\pm 0.1$ mm (0.079 $\pm 0.004$ " )	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.  $A_0$ ,  $B_0$ , and  $K_0$  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.

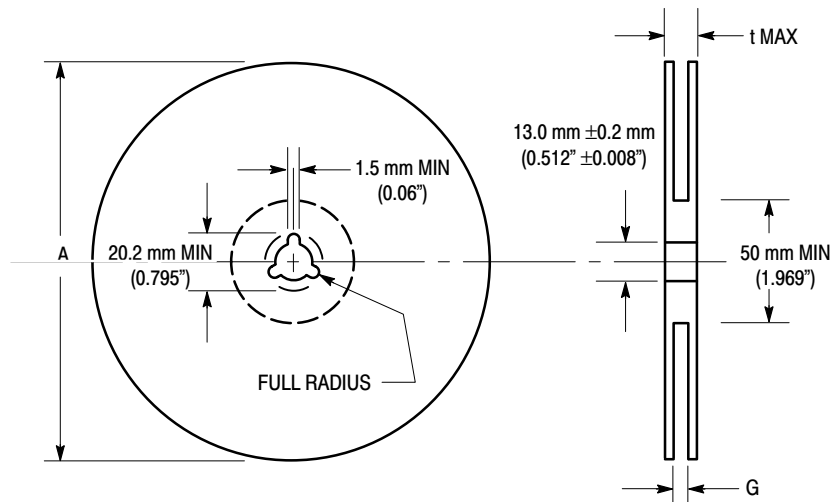


Figure 9. Reel Dimensions

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")

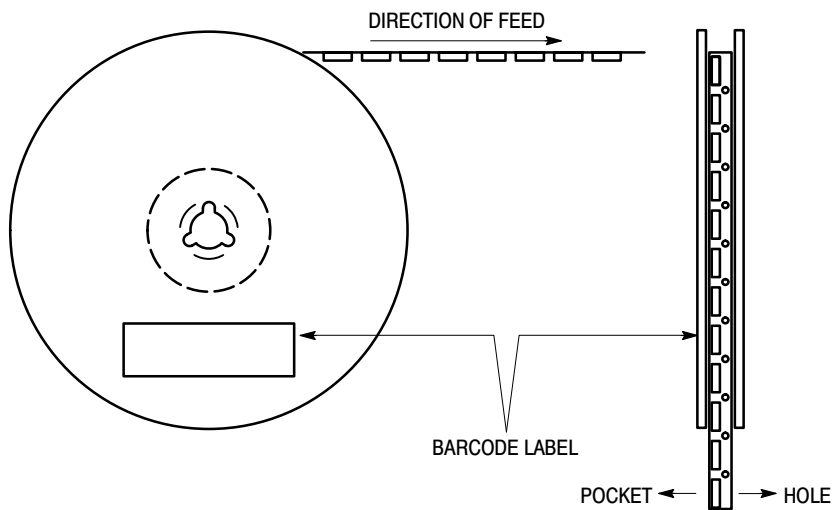


Figure 10. Reel Winding Direction

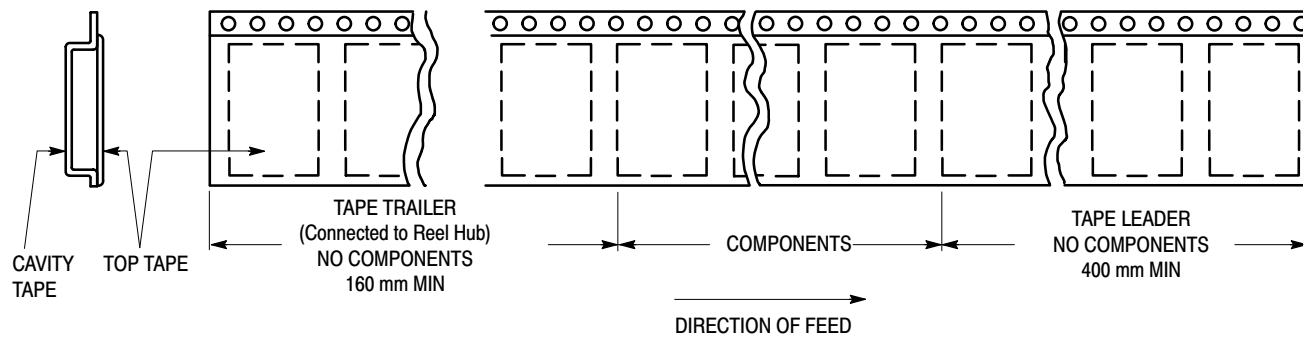


Figure 11. Tape Ends for Finished Goods

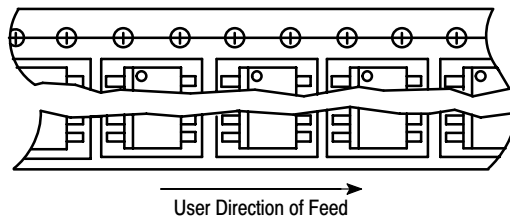


Figure 12. Reel Configuration

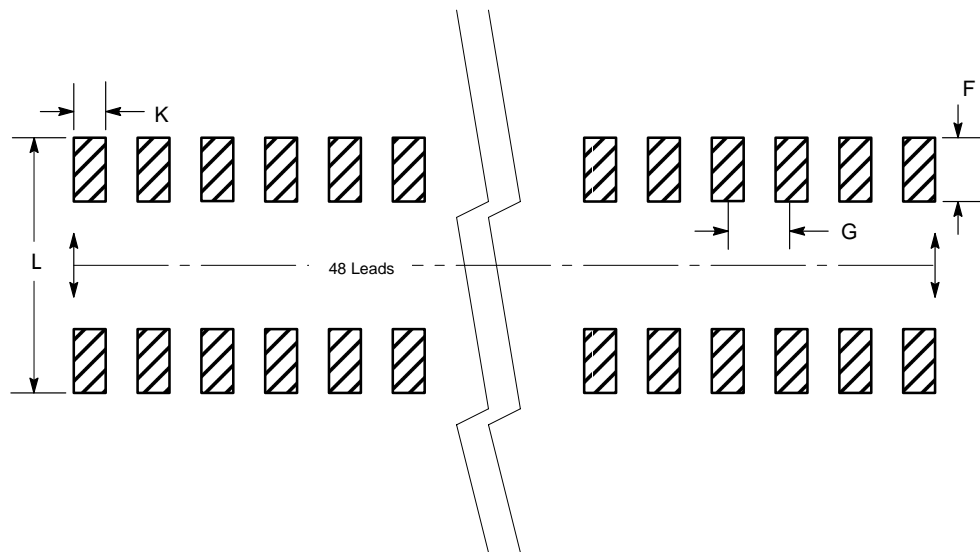
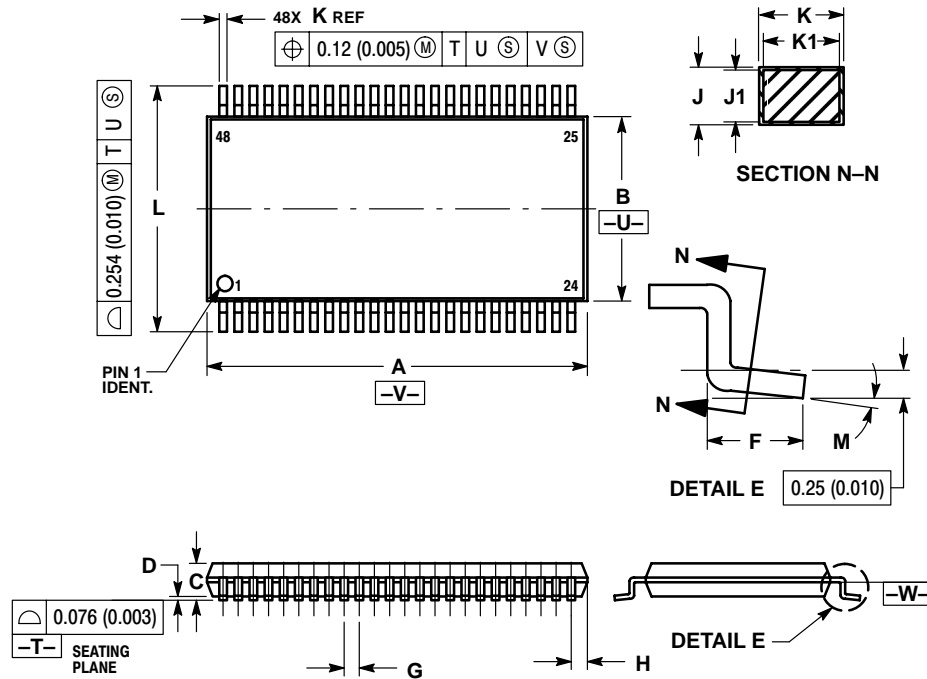


Figure 13. Package Footprint

## 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-.

	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 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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