

# 74LVC374A

## Low-Voltage CMOS Octal D-Type Flip-Flop

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

The 74LVC374A is a high performance, non-inverting octal D-type flip-flop operating from a 1.2 to 3.6 V supply. 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 74LVC374A inputs to be safely driven from 5 V devices.

The 74LVC374A consists of 8 edge-triggered flip-flops with individual D-type inputs and 3-state true outputs. The buffered clock and buffered Output Enable ( $\overline{OE}$ ) are common to all flip-flops. The eight 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 eight 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

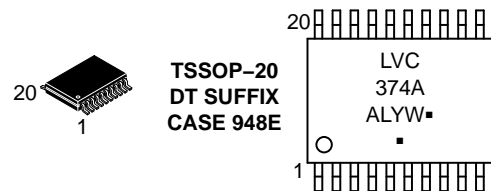
- Designed for 1.2 to 3.6 V  $V_{CC}$  Operation
- 5 V Tolerant – Interface Capability With 5 V TTL Logic
- Supports Live Insertion and Withdrawal
- $I_{OFF}$  Specification Guarantees High Impedance When  $V_{CC} = 0$  V
- 24 mA Output Sink and Source Capability
- Near Zero Static Supply Current in All Three Logic States (10  $\mu$ A) Substantially Reduces System Power Requirements
- ESD Performance:
  - ◆ Human Body Model >2000 V
  - ◆ Machine Model >200 V
- These are Pb-Free Devices



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#### MARKING DIAGRAM



A = Assembly Location  
L, WL = Wafer Lot  
Y, YY = Year  
W, WW = Work Week  
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

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Figure 1. Pinout: 20-Lead (Top View)

## PIN NAMES

Pins	Function
$\overline{OE}$	Output Enable Input
CP	Clock Pulse Input
D0–D7	Data Inputs
O0–O7	3-State Outputs

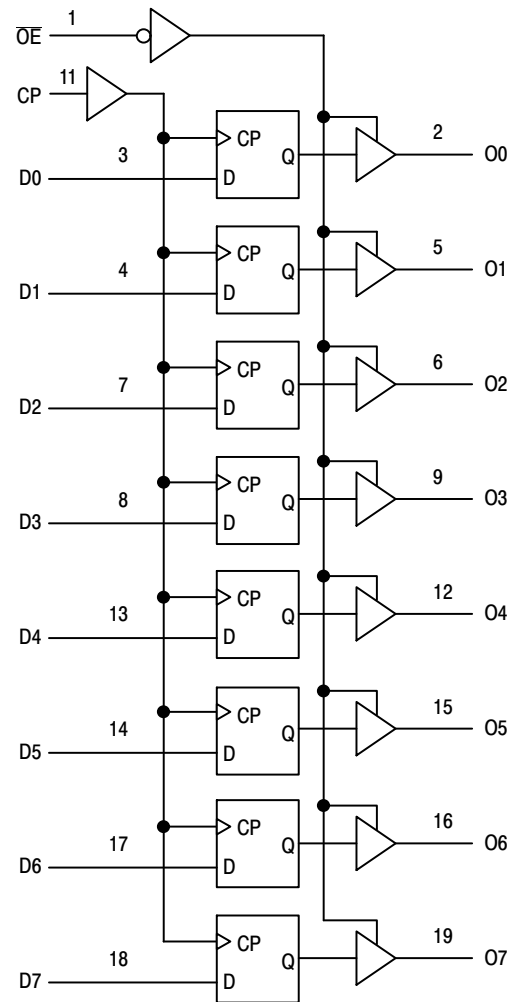


Figure 2. LOGIC DIAGRAM

## TRUTH TABLE

INPUTS			OUTPUTS	OPERATING MODE
$\overline{OE}$	CP	Dn	On	
L	$\uparrow$	l	L	Load and Read Register
L	$\uparrow$	h	H	
L	$\nabla$	X	NC	Hold and Read Register
H	$\nabla$	X	Z	Hold and Disable Outputs
H	$\uparrow$	l	Z	Load Internal Register and Disable Outputs
H	$\uparrow$	h	Z	

H = High Voltage Level

h = High Voltage Level One Setup Time Prior to the Low-to-High Clock Transition

L = Low Voltage Level

l = Low Voltage Level One Setup Time Prior to the Low-to-High Clock Transition

NC = No Change, State Prior to Low-to-High Clock Transition

X = High or Low Voltage Level and Transitions are Acceptable

Z = High Impedance State

$\uparrow$  = Low-to-High Transition

$\nabla$  = Not a Low-to-High Transition; For  $I_{CC}$  Reasons, DO NOT FLOAT Inputs

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## MAXIMUM RATINGS

Symbol	Parameter	Condition	Value	Unit
V <sub>CC</sub>	DC Supply Voltage		-0.5 to +6.5	V
V <sub>I</sub>	DC Input Voltage		-0.5 ≤ V <sub>I</sub> ≤ +6.5	V
V <sub>O</sub>	DC Output Voltage	Output in 3-State	-0.5 ≤ V <sub>O</sub> ≤ +6.5	V
		Output in HIGH or LOW State (Note 1)	-0.5 ≤ V <sub>O</sub> ≤ V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	DC Input Diode Current	V <sub>I</sub> < GND	-50	mA
I <sub>OK</sub>	DC Output Diode Current	V <sub>O</sub> < GND	-50	mA
		V <sub>O</sub> > V <sub>CC</sub>	+50	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
T <sub>L</sub>	Lead Temperature, 1 mm from Case for 10 Seconds		T <sub>L</sub> = 260	°C
T <sub>J</sub>	Junction Temperature Under Bias		T <sub>J</sub> = 135	°C
θ <sub>JA</sub>	Thermal Resistance (Note 2) TSSOP		110.7	°C/W
MSL	Moisture Sensitivity	Level 1		

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- I<sub>O</sub> absolute maximum rating must be observed.
- Measured with minimum pad spacing on an FR4 board, using 10 mm-by-1 inch, 2 ounce copper trace no air flow.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>CC</sub>	Supply Voltage Operating Functional	1.65 1.2		3.6 3.6	V
V <sub>I</sub>	Input Voltage	0		5.5	V
V <sub>O</sub>	Output Voltage HIGH or LOW State 3-State	0 0		V <sub>CC</sub> 5.5	V
I <sub>OH</sub>	HIGH Level Output Current V <sub>CC</sub> = 3.0 V – 3.6 V V <sub>CC</sub> = 2.7 V – 3.0 V			-24 -12	mA
I <sub>OL</sub>	LOW Level Output Current V <sub>CC</sub> = 3.0 V – 3.6 V V <sub>CC</sub> = 2.7 V – 3.0 V			24 12	mA
T <sub>A</sub>	Operating Free-Air Temperature	-40		+125	°C
Δt/ΔV	Input Transition Rise or Fall Rate, V <sub>CC</sub> = 1.65 to 2.7 V V <sub>CC</sub> = 2.7 to 3.6 V	0 0		20 10	ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	-40 to +85°C			-40 to +125°C			Unit
			Min	Typ (Note 3)	Max	Min	Typ (Note 3)	Max	
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.2 V	1.08	–	–	1.08	–	–	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 x V <sub>CC</sub>	–	–	0.65 x V <sub>CC</sub>	–	–	
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	–	–	1.7	–	–	
		V <sub>CC</sub> = 2.7 V to 3.6 V	2.0	–	–	2.0	–	–	
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.2 V	–	–	0.12	–	–	0.12	V
		V <sub>CC</sub> = 1.65 V to 1.95 V	–	–	0.35 x V <sub>CC</sub>	–	–	0.35 x V <sub>CC</sub>	
		V <sub>CC</sub> = 2.3 V to 2.7 V	–	–	0.7	–	–	0.7	
		V <sub>CC</sub> = 2.7 V to 3.6 V	–	–	0.8	–	–	0.8	
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>							V
		I <sub>O</sub> = –100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	V <sub>CC</sub> – 0.2	–	–	V <sub>CC</sub> – 0.3	–	–	
		I <sub>O</sub> = –4 mA; V <sub>CC</sub> = 1.65 V	1.2	–	–	1.05	–	–	
		I <sub>O</sub> = –8 mA; V <sub>CC</sub> = 2.3 V	1.8	–	–	1.65	–	–	
		I <sub>O</sub> = –12 mA; V <sub>CC</sub> = 2.7 V	2.2	–	–	2.05	–	–	
		I <sub>O</sub> = –18 mA; V <sub>CC</sub> = 3.0 V	2.4	–	–	2.25	–	–	
		I <sub>O</sub> = –24 mA; V <sub>CC</sub> = 3.0 V	2.2	–	–	2.0	–	–	
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>							V
		I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	–	–	0.2	–	–	0.3	
		I <sub>O</sub> = 4 mA; V <sub>CC</sub> = 1.65 V	–	–	0.45	–	–	0.65	
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	–	–	0.6	–	–	0.8	
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.7 V	–	–	0.4	–	–	0.6	
		I <sub>O</sub> = –24 mA; V <sub>CC</sub> = 3.0 V	–	–	0.55	–	–	0.8	
I <sub>I</sub>	Input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 3.6 V	–	±0.1	±5	–	±0.1	±20	μA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = 5.5 V or GND; V <sub>CC</sub> = 3.6 V	–	±0.1	±5	–	±0.1	±20	μA
I <sub>OFF</sub>	Power-off leakage current	V <sub>I</sub> or V <sub>O</sub> = 5.5 V; V <sub>CC</sub> = 0.0 V	–	±0.1	±10	–	±0.1	±20	μA
I <sub>CC</sub>	Supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 3.6 V	–	0.1	10	–	0.1	40	μA
ΔI <sub>CC</sub>	Additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> – 0.6 V; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 2.7 V to 3.6 V	–	5	500	–	5	5000	μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. All typical values are measured at T<sub>A</sub> = 25°C and V<sub>CC</sub> = 3.3 V, unless stated otherwise.

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## AC ELECTRICAL CHARACTERISTICS ( $t_R = t_F = 2.5$ ns)

Symbol	Parameter	Conditions	-40 to +85°C			-40 to +125°C			Unit
			Min	Typ (Note 4)	Max	Min	Typ (Note 4)	Max	
t <sub>pd</sub>	Propagation Delay (Note 5) CP to On	V <sub>CC</sub> = 1.2 V	–	16.0	–	–	–	–	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	2.2	7.4	16.3	2.2	–	18.8	
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.5	3.9	8.4	1.5	–	9.7	
		V <sub>CC</sub> = 2.7 V	1.5	3.5	8.0	1.5	–	10.0	
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.5	3.3	7.0	1.5	–	9.0	
t <sub>en</sub>	Enable Time (Note 6) OE to On	V <sub>CC</sub> = 1.2 V	–	19.0	–	–	–	–	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	1.5	6.6	16.7	1.5	–	19.3	
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.5	3.7	9.3	1.5	–	10.8	
		V <sub>CC</sub> = 2.7 V	1.5	3.8	8.5	1.5	–	11.0	
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.5	3.0	7.5	1.5	–	9.5	
t <sub>dis</sub>	Disable Time (Note 7) OE to On	V <sub>CC</sub> = 1.2 V	–	8.0	–	–	–	–	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	2.3	4.0	10.1	2.3	–	11.7	
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.0	2.2	5.7	1.0	–	6.7	
		V <sub>CC</sub> = 2.7 V	1.5	3.1	6.5	1.5	–	9.0	
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.5	2.9	6.0	1.5	–	7.5	
t <sub>w</sub>	Pulse Width CP HIGH or LOW	V <sub>CC</sub> = 1.65 V to 1.95 V	5.0	–	–	5.0	–	–	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	4.0	–	–	4.0	–	–	
		V <sub>CC</sub> = 2.7 V	3.0	–	–	4.5	–	–	
		V <sub>CC</sub> = 3.0 V to 3.6 V	3.0	1.5	–	4.5	–	–	
t <sub>su</sub>	Set-up Time Dn to CP	V <sub>CC</sub> = 1.65 V to 1.95 V	4.0	–	–	4.0	–	–	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	3.0	–	–	3.0	–	–	
		V <sub>CC</sub> = 2.7 V	2.0	–	–	2.0	–	–	
		V <sub>CC</sub> = 3.0 V to 3.6 V	2.0	0.0	–	2.0	–	–	
t <sub>h</sub>	Hold Time Dn to CP	V <sub>CC</sub> = 1.65 V to 1.95 V	3.0	–	–	3.0	–	–	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	2.0	–	–	2.0	–	–	
		V <sub>CC</sub> = 2.7 V	1.5	–	–	1.5	–	–	
		V <sub>CC</sub> = 3.0 V to 3.6 V	1.5	0.6	–	1.5	–	–	
f <sub>max</sub>	Maximum Frequency	V <sub>CC</sub> = 1.65 V to 1.95 V	100	–	–	64	–	–	MHz
		V <sub>CC</sub> = 2.3 V to 2.7 V	125	–	–	100	–	–	
		V <sub>CC</sub> = 2.7 V	150	–	–	120	–	–	
		V <sub>CC</sub> = 3.0 V to 3.6 V	150	–	–	120	–	–	
t <sub>sk(0)</sub>	Output Skew Time (Note 8)		–	–	1.0	–	–	1.5	ns

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Typical values are measured at T<sub>A</sub> = 25°C and V<sub>CC</sub> = 3.3 V, unless stated otherwise.

5. t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

6. t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>.

7. t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.

8. Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

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## DYNAMIC SWITCHING CHARACTERISTICS

Symbol	Characteristic	Condition	T <sub>A</sub> = +25°C			Unit
			Min	Typ	Max	
V <sub>OLP</sub>	Dynamic LOW Peak Voltage (Note 9)	V <sub>CC</sub> = 3.3 V, C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V V <sub>CC</sub> = 2.5 V, C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V		0.8 0.6		V
V <sub>OLV</sub>	Dynamic LOW Valley Voltage (Note 9)	V <sub>CC</sub> = 3.3 V, C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V V <sub>CC</sub> = 2.5 V, C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V		-0.8 -0.6		V

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 LOW state.

## CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Condition	Typical	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>CC</sub> = 3.3 V, V <sub>I</sub> = 0 V or V <sub>CC</sub>	5.0	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>CC</sub> = 3.3 V, V <sub>I</sub> = 0 V or V <sub>CC</sub>	6.0	pF
C <sub>PD</sub>	Power Dissipation Capacitance (Note 10)	Per flip-flop; V <sub>I</sub> = GND or V <sub>CC</sub>		pF
		V <sub>CC</sub> = 1.65 V to 1.95 V	11.6	
		V <sub>CC</sub> = 2.3 V to 2.7 V	13.6	
		V <sub>CC</sub> = 3.0 V to 3.6 V	15.4	

10. C<sub>PD</sub> is used to determine the dynamic power dissipation (PD in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz; f<sub>o</sub> = output frequency in MHz

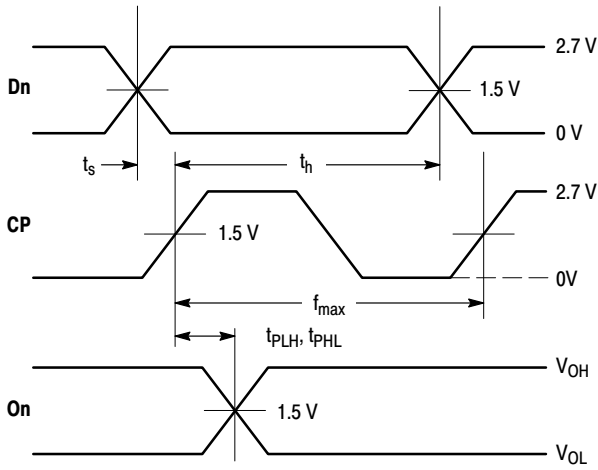
C<sub>L</sub> = output load capacitance in pF

V<sub>CC</sub> = supply voltage in Volts

N = number of outputs switching

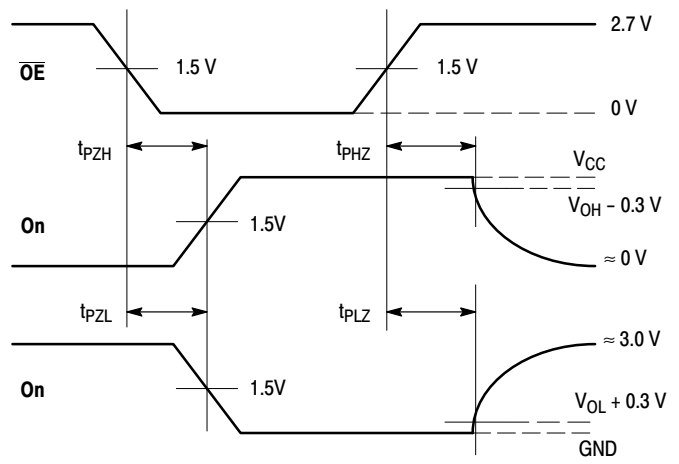
∑(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs

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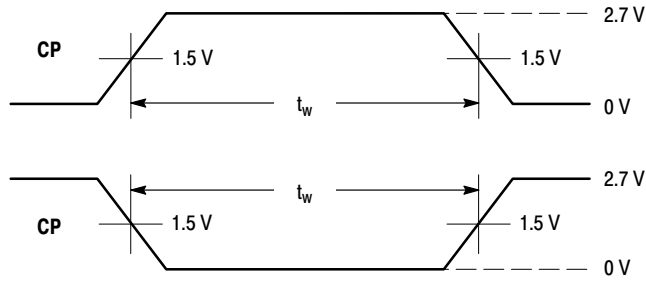
**WAVEFORM 1 – PROPAGATION DELAYS, SETUP AND HOLD TIMES**

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



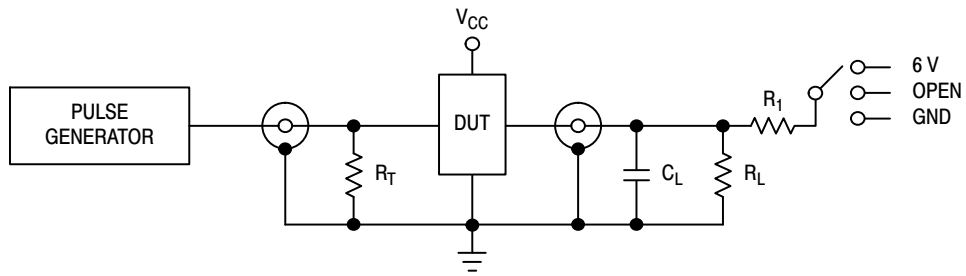
**WAVEFORM 3 – PULSE WIDTH**

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

Symbol	Vcc		
	3.3 V ± 0.3 V	2.7 V	VCC < 2.7 V
Vmi	1.5 V	1.5 V	VCC/2
Vmo	1.5 V	1.5 V	VCC/2
VHZ	VOL + 0.3 V	VOL + 0.3 V	VOL + 0.15 V
VLZ	VOH - 0.3 V	VOH - 0.3 V	VOH - 0.15 V

**Figure 3. AC Waveforms**

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Supply Voltage	Input		Load		V <sub>EXT</sub>		
	V <sub>I</sub>	t <sub>p</sub> , t <sub>f</sub>	C <sub>L</sub>	R <sub>L</sub>	t <sub>PLH</sub> , t <sub>PHL</sub>	t <sub>PLZ</sub> , t <sub>PZL</sub>	t <sub>PHZ</sub> , t <sub>PZH</sub>
1.2	V <sub>CC</sub>	≤ 2 ns	30 pF	1 kΩ	Open	2 x V <sub>CC</sub>	GND
1.65 – 1.95	V <sub>CC</sub>	≤ 2 ns	30 pF	1 kΩ	Open	2 x V <sub>CC</sub>	GND
2.3 – 2.7	V <sub>CC</sub>	≤ 2 ns	30 pF	500 Ω	Open	2 x V <sub>CC</sub>	GND
2.7	2.7 V	≤ 2.5 ns	50 pF	500 Ω	Open	2 x V <sub>CC</sub>	GND
3.0 – 3.6	2.7 V	≤ 2.5 ns	50 pF	500 Ω	Open	2 x V <sub>CC</sub>	GND

**Figure 4. Test Circuit**

### ORDERING INFORMATION

Device	Package	Shipping†
74LVC374ADTR2G	TSSOP-20 (Pb-Free)	2500 / Tape & Reel

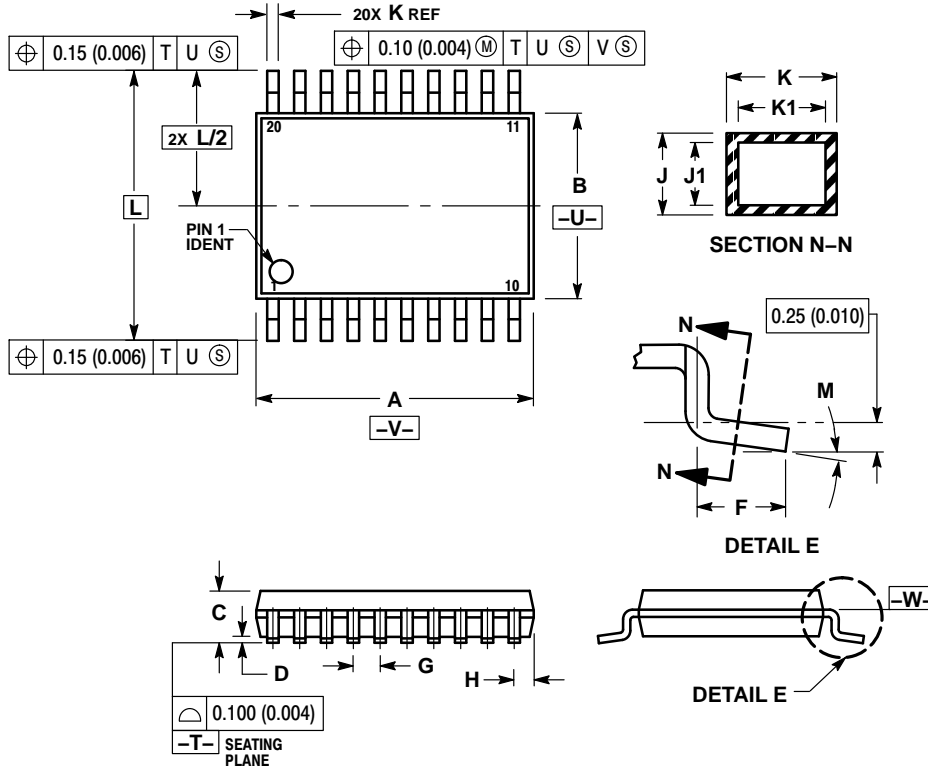
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



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## PACKAGE DIMENSIONS

TSSOP-20  
DT SUFFIX  
CASE 948E-02  
ISSUE C

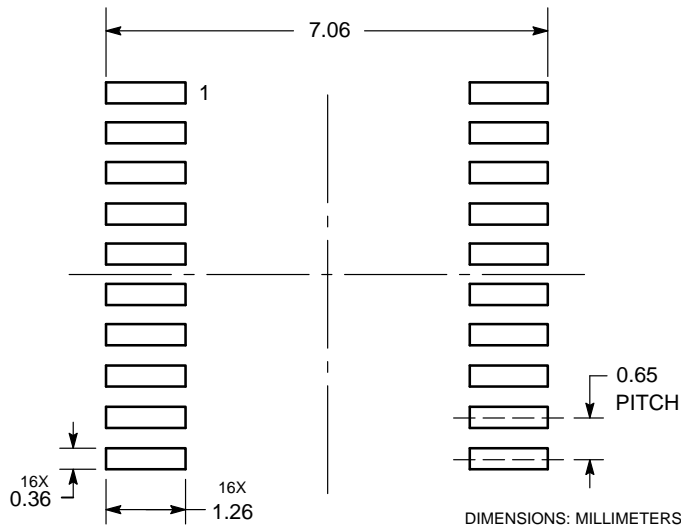


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. 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.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE  $-W-$ .

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

### SOLDERING FOOTPRINT\*



\*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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