

# DATA SHEET

## **74LVC16374A/74LVCH16374A**

16-bit edge triggered D-type flip-flop with  
5 Volt tolerant inputs/outputs (3-State)

Product specification  
Supersedes data of 1997 Aug 22  
IC24 Data Handbook

1998 Mar 17

# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

## 74LVC16374A/ 74LVCH16374A

### FEATURES

- 5 volt tolerant inputs/outputs for interfacing with 5V logic
- Wide supply voltage range of 1.2 V to 3.6 V
- Complies with JEDEC standard no. 8-1A
- CMOS low power consumption
- MULTIBYTE™ flow-through standard pin-out architecture
- Low inductance multiple power and ground pins for minimum noise and ground bounce
- Direct interface with TTL levels
- All data inputs have bus hold (74LVCH16374A only)
- High impedance when  $V_{CC} = 0$

### DESCRIPTION

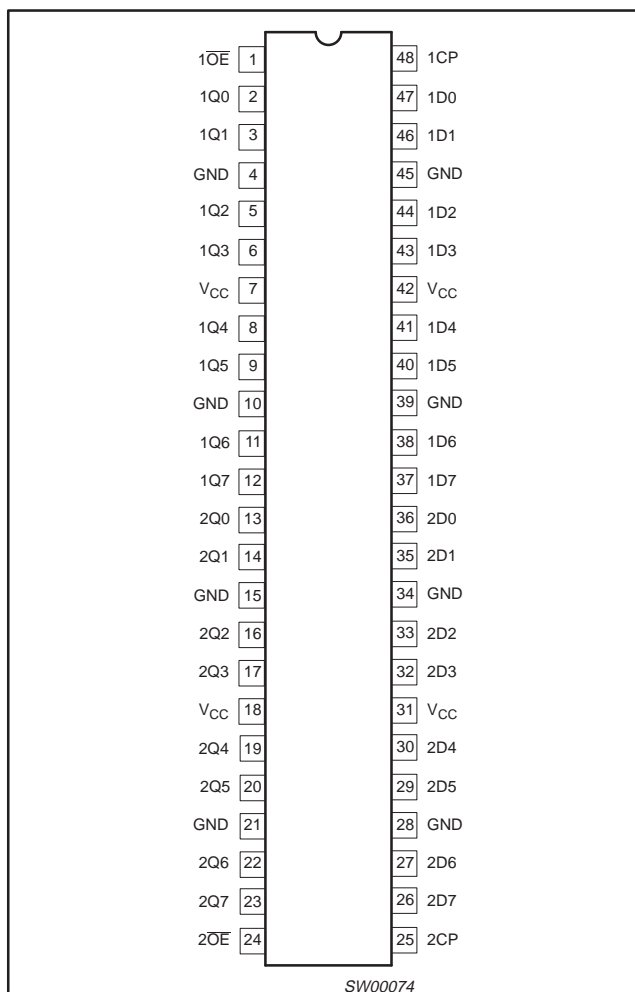
The 74LVC(H)16374A is a 16-bit edge-triggered flip-flop featuring separate D-type inputs for each flip-flop and 3-State outputs for bus oriented applications. The 74LVC16374A consists of 2 sections of eight positive edge-triggered flip-flops. A clock (CP) input and an output enable (OE) are provided for each octal. Inputs can be driven from either 3.3V or 5V devices. In 3-State operation, outputs can handle 5V. These features allow the use of these devices in a mixed 3.3V/5V environment.

The flip-flops will store the state of their individual D-inputs that meet the set-up and hold time requirements on the LOW-to-HIGH CP transition.

When  $\overline{OE}$  is LOW, the contents of the flip-flops are available at the outputs. When  $\overline{OE}$  is HIGH, the outputs go to the high impedance OFF-state. Operation of the  $\overline{OE}$  input does not affect the state of the flip-flops.

The 74LVCH16374A bus hold data inputs eliminates the need for external pull up resistors to hold unused inputs.

### PIN CONFIGURATION



### QUICK REFERENCE DATA

GND = 0V;  $T_{amb} = 25^{\circ}\text{C}$ ;  $t_r = t_f \leq 2.5$  ns

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
$t_{PHL}/t_{PLH}$	Propagation delay Cp to Qn	$C_L = 50\text{pF}$ $V_{CC} = 3.3\text{V}$	3.8	ns
$f_{MAX}$	Maximum clock frequency		150	MHz
$C_I$	Input capacitance		5.0	pF
$C_{PD}$	Power dissipation capacitance per flip-flop	$V_{CC} = 3.3\text{V}^1$	30	pF

### NOTES:

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ):

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

$f_i$  = input frequency in MHz;  $C_L$  = output load capacity in pF;

$f_o$  = output frequency in MHz;  $V_{CC}$  = supply voltage in V;

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

### ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	DWG NUMBER
48-Pin Plastic SSOP Type III	-40°C to +85°C	74LVC16374A DL	VC16374A DL	SOT370-1
48-Pin Plastic TSSOP Type II	-40°C to +85°C	74LVC16374A DGG	VC16374A DGG	SOT362-1
48-Pin Plastic SSOP Type III	-40°C to +85°C	74LVCH16374A DL	VCH16374A DL	SOT370-1
48-Pin Plastic TSSOP Type II	-40°C to +85°C	74LVCH16374A DGG	VCH16374A DGG	SOT362-1

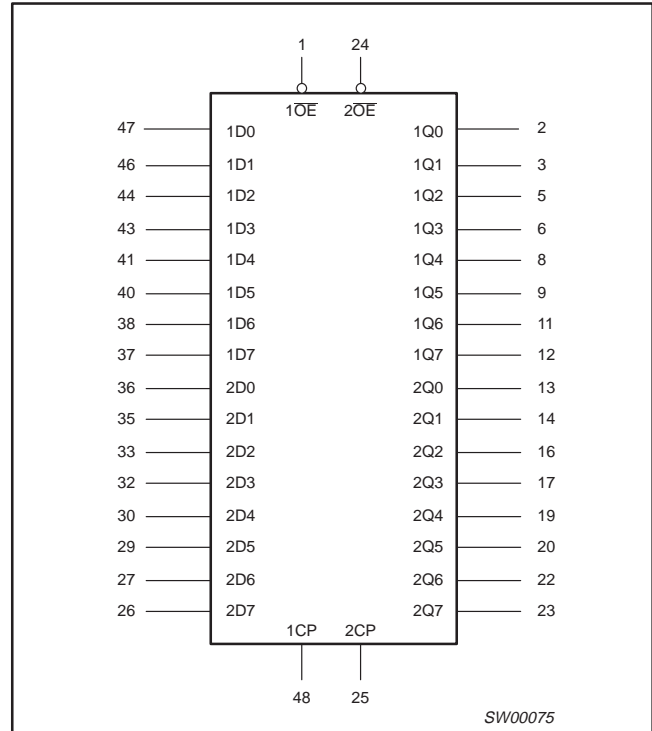
# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/  
74LVCH16374A

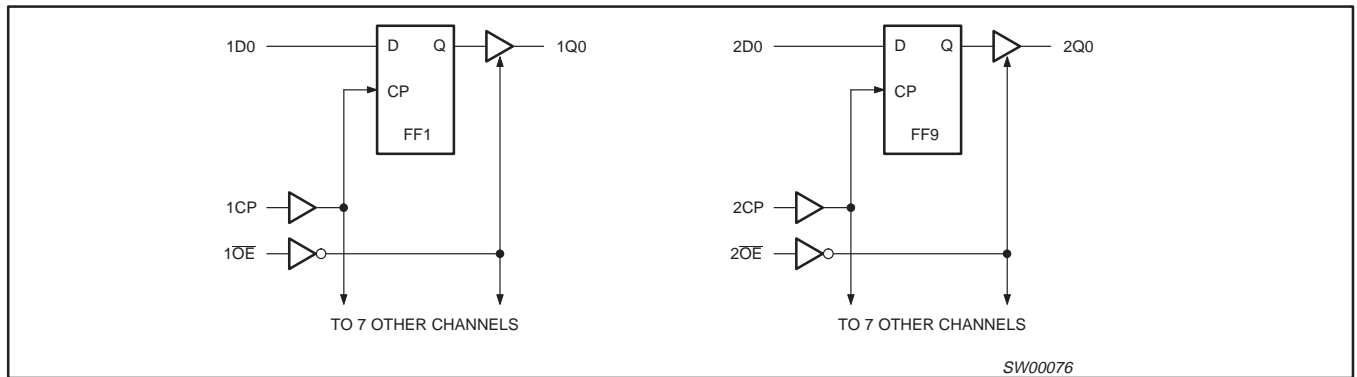
## PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1	1 $\overline{OE}$	Output enable input (active LOW)
2, 3, 5, 6, 8, 9, 11, 12	1Q0 to 1Q7	3-State flip-flop outputs
4, 10, 15, 21, 28, 34, 39, 45	GND	Ground (0V)
7, 18, 31, 42	V <sub>CC</sub>	Positive supply voltage
13, 14, 16, 17, 19, 20, 22, 23	2Q0 to 2Q7	3-State flip-flop outputs
24	2 $\overline{OE}$	Output enable input (active LOW)
25	2CP	Clock input
36, 35, 33, 32, 30, 29, 27, 26	2D0 to 2D7	Data inputs
47, 46, 44, 43, 41, 40, 38, 37	1D0 to 1D7	Data inputs
48	1CP	Clock input

## LOGIC SYMBOL



## LOGIC DIAGRAM



## FUNCTION TABLE

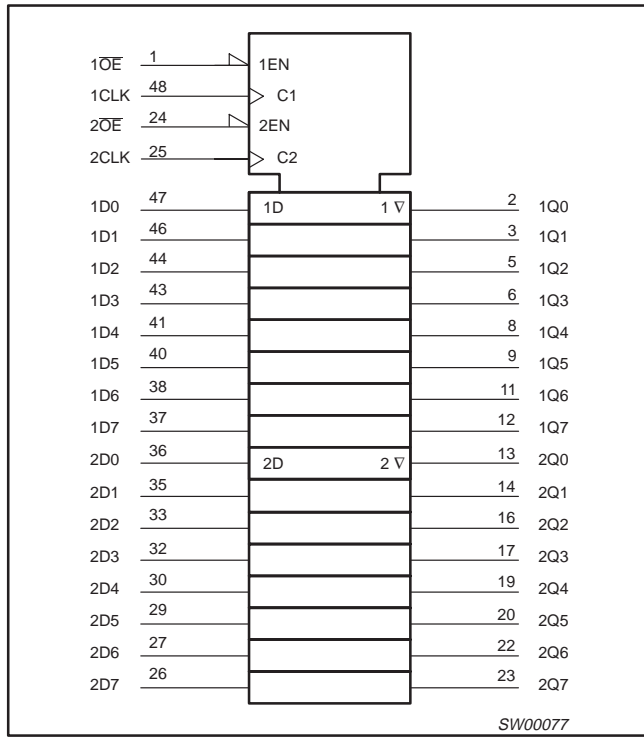
OPERATING MODES	INPUTS			INTERNAL FLIP-FLOPS	OUTPUTS
	n $\overline{OE}$	nCP	nDx		Q0 to Q7
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Load register and disable outputs	H	↑	l	L	Z
	H	↑	h	H	Z

H = HIGH voltage level  
 h = HIGH voltage level one set-up time prior to the HIGH-to-LOW LE transition  
 L = LOW voltage level  
 l = LOW voltage level one set-up time prior to the HIGH-to-LOW LE transition  
 Z = high impedance OFF-state  
 ↑ = LOW-to-HIGH CP transition

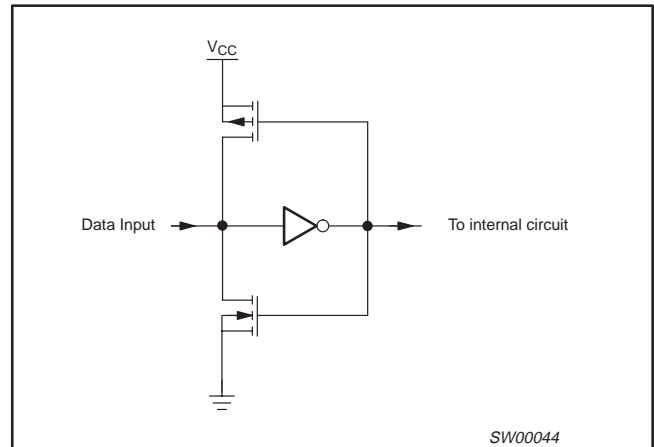
# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/  
74LVCH16374A

## LOGIC SYMBOL (IEEE/IEC)



## BUS HOLD CIRCUIT



## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
V <sub>CC</sub>	DC supply voltage (for max. speed performance)		2.7	3.6	V
	DC supply voltage (for low-voltage applications)		1.2	3.6	
V <sub>I</sub>	DC input voltage range		0	5.5	V
V <sub>O</sub>	DC input voltage range; output HIGH or LOW state		0	V <sub>CC</sub>	V
	DC output voltage range; output 3-State		0	5.5	
T <sub>amb</sub>	Operating free-air temperature range		-40	+85	°C
t <sub>r</sub> , t <sub>f</sub>	Input rise and fall times	V <sub>CC</sub> = 1.2 to 2.7V	0	20	ns/V
		V <sub>CC</sub> = 2.7 to 3.6V	0	10	

# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

## 74LVC16374A/ 74LVCH16374A

### ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

In accordance with the Absolute Maximum Rating System (IEC 134).  
Voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
$V_{CC}$	DC supply voltage		-0.5 to +6.5	V
$I_{IK}$	DC input diode current	$V_I < 0$	-50	mA
$V_I$	DC input voltage	Note 2	-0.5 to +6.5	V
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$	$\pm 50$	mA
$V_O$	DC output voltage; output HIGH or LOW state	Note 2	-0.5 to $V_{CC} + 0.5$	V
	DC output voltage; output 3-State	Note 2	-0.5 to 6.5	
$I_O$	DC output source or sink current	$V_O = 0$ to $V_{CC}$	$\pm 50$	mA
$I_{GND}, I_{CC}$	DC $V_{CC}$ or GND current		$\pm 100$	mA
$T_{stg}$	Storage temperature range		-65 to +150	°C
$P_{TOT}$	Power dissipation per package – plastic mini-pack (SO)	above +70°C derate linearly with 8 mW/K	500	mW
	– plastic shrink mini-pack (SSOP and TSSOP)	above +60°C derate linearly with 5.5 mW/K	500	

#### NOTES:

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

### DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			Temp = -40°C to +85°C			
			MIN	TYP <sup>1</sup>	MAX	
$V_{IH}$	HIGH level Input voltage	$V_{CC} = 1.2V$	$V_{CC}$			V
		$V_{CC} = 2.7$ to $3.6V$	2.0			
$V_{IL}$	LOW level Input voltage	$V_{CC} = 1.2V$			GND	V
		$V_{CC} = 2.7$ to $3.6V$			0.8	
$V_{OH}$	HIGH level output voltage	$V_{CC} = 2.7V; V_I = V_{IH}$ or $V_{IL}; I_O = -12mA$	$V_{CC} - 0.5$			V
		$V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -100\mu A$	$V_{CC} - 0.2$	$V_{CC}$		
		$V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -18mA$	$V_{CC} - 0.6$			
		$V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -24mA$	$V_{CC} - 0.8$			
$V_{OL}$	LOW level output voltage	$V_{CC} = 2.7V; V_I = V_{IH}$ or $V_{IL}; I_O = 12mA$			0.40	V
		$V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = 100\mu A$			0.20	
		$V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = 24mA$			0.55	
$I_I$	Input leakage current	$V_{CC} = 3.6V; V_I = 5.5V$ or GND <sup>6</sup>		$\pm 0.1$	$\pm 5$	$\mu A$
$I_{OZ}$	3-State output OFF-state current	$V_{CC} = 3.6V; V_I = V_{IH}$ or $V_{IL}; V_O = 5.5V$ or GND		0.1	$\pm 5$	$\mu A$
$I_{off}$	Power off leakage supply	$V_{CC} = 0.0V; V_I$ or $V_O = 5.5V$			$\pm 10$	$\mu A$
$I_{CC}$	Quiescent supply current	$V_{CC} = 3.6V; V_I = V_{CC}$ or GND; $I_O = 0$		0.1	20	$\mu A$
$\Delta I_{CC}$	Additional quiescent supply current per input pin	$V_{CC} = 2.7V$ to $3.6V; V_I = V_{CC} - 0.6V; I_O = 0$		5	500	$\mu A$

# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

## 74LVC16374A/ 74LVCH16374A

### DC ELECTRICAL CHARACTERISTICS (Continued)

Over recommended operating conditions voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			Temp = -40°C to +85°C			
			MIN	TYP <sup>1</sup>	MAX	
I <sub>BHL</sub>	Bus hold LOW sustaining current	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = 0.8V <sup>2, 3, 4</sup>	75			μA
I <sub>BHH</sub>	Bus hold HIGH sustaining current	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = 2.0V <sup>2, 3, 4</sup>	-75			μA
I <sub>BHLO</sub>	Bus hold LOW overdrive current	V <sub>CC</sub> = 3.6V <sup>2, 3, 5</sup>	500			μA
I <sub>BHHO</sub>	Bus hold HIGH overdrive current	V <sub>CC</sub> = 3.6V <sup>2, 3, 5</sup>	-500			μA

#### NOTES:

- All typical values are at V<sub>CC</sub> = 3.3V and T<sub>amb</sub> = 25°C.
- Valid for data inputs of bus hold parts (LVCH16-A) only.
- For data inputs only, control inputs do not have a bus hold circuit.
- The specified sustaining current at the data input holds the input below the specified V<sub>I</sub> level.
- The specified overdrive current at the data input forces the data input to the opposite logic input state.
- For bus hold parts, the bus hold circuit is switched off when V<sub>I</sub> exceeds V<sub>CC</sub> allowing 5.5V on the input terminal.

### AC CHARACTERISTICS

GND = 0V; t<sub>R</sub> = t<sub>F</sub> = 2.5ns; C<sub>L</sub> = 50pF; R<sub>L</sub> = 500Ω; T<sub>amb</sub> = -40°C to +85°C.

SYMBOL	PARAMETER	WAVEFORM	LIMITS						UNIT
			V <sub>CC</sub> = 3.3V ±0.3V			V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 1.2V	
			MIN	TYP <sup>1</sup>	MAX	MIN	MAX	MAX	
t <sub>PHL</sub> t <sub>PLH</sub>	Propagation delay CP to Qn	1, 4	1.5	3.8	5.4	1.5	6.4	17	ns
t <sub>PZH</sub> t <sub>PZL</sub>	3-State output enable time OE to Qn	2, 4	1.5	3.6	5.6	1.5	6.6	20	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	3-State output disable time OE to Qn	2, 4	1.5	3.9	5.5	1.5	6.5	12	ns
t <sub>W</sub>	CP pulse width HIGH or LOW	1	3.0	1.5	–	3.0	–	–	ns
t <sub>SU</sub>	Set-up time Dn to CP	3	2.0	0.3	–	1.9	–	–	ns
t <sub>H</sub>	Hold time Dn to CP	3	1.5	-0.3	–	1.1	–	–	ns
f <sub>max</sub>	Maximum clock pulse frequency	1	100	–	–	80	–	–	MHz

#### NOTE:

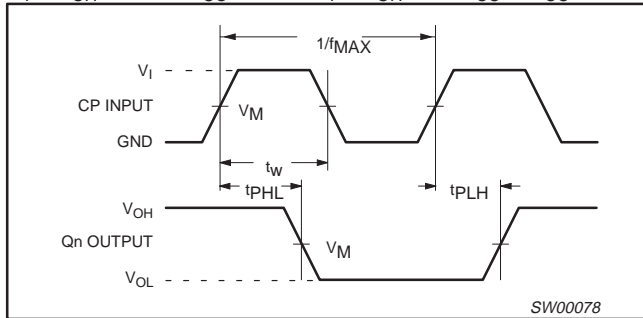
- All typical values are at V<sub>CC</sub> = 3.3V and T<sub>amb</sub> = 25°C.

# 16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

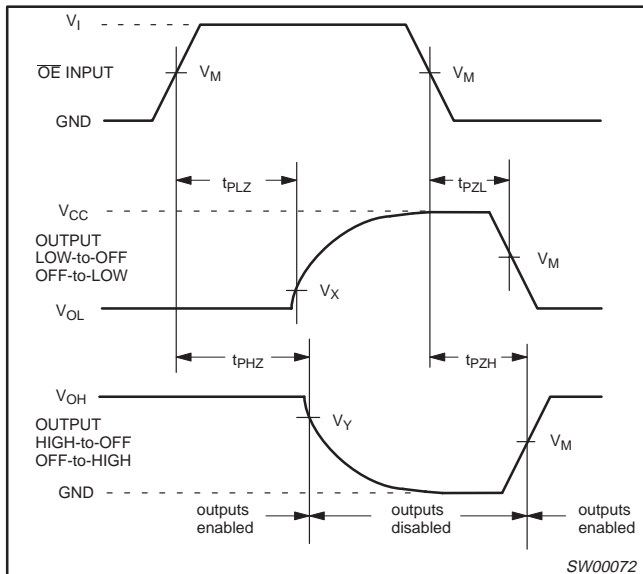
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## AC WAVEFORMS

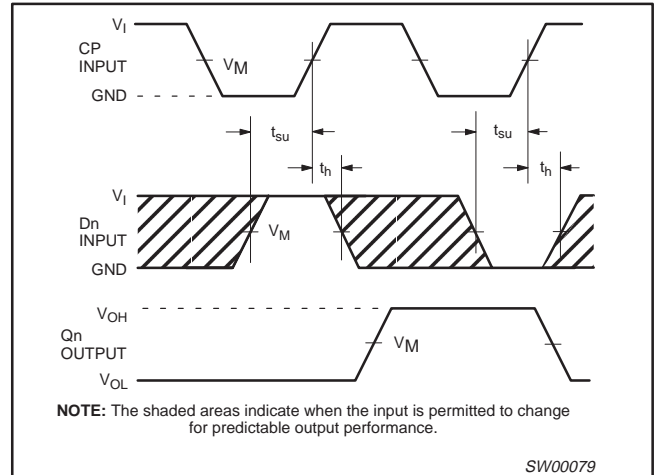
$V_M = 1.5V$  at  $V_{CC} \geq 2.7V$ ;  $V_M = 0.5 V_{CC}$  at  $V_{CC} < 2.7V$ .  
 $V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load.  
 $V_X = V_{OL} + 0.3V$  at  $V_{CC} \geq 2.7V$ ;  $V_X = V_{OL} + 0.1 V_{CC}$  at  $V_{CC} < 2.7V$   
 $V_Y = V_{OH} - 0.3V$  at  $V_{CC} \geq 2.7V$ ;  $V_Y = V_{OH} - 0.1 V_{CC}$  at  $V_{CC} < 2.7V$



Waveform 1. Clock (CP) to output (Qn) propagation delays, the clock pulse width and the maximum clock pulse frequency

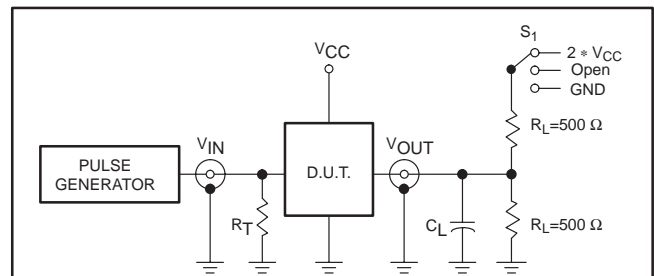


Waveform 2. 3-State enable and disable times



Waveform 3. Data set-up and hold times for the Dn input to the CP input

## TEST CIRCUIT



Test Circuit for 3-State Outputs

### SWITCH POSITION

TEST	SWITCH
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	$2 * V_{CC}$
$t_{PHZ}/t_{PZH}$	GND

$V_{CC}$	$V_{IN}$
$< 2.7V$	$V_{CC}$
$2.7 - 3.6V$	$2.7V$

### DEFINITIONS

$R_L$  = Load resistor  
 $C_L$  = Load capacitance includes jig and probe capacitance  
 $R_T$  = Termination resistance should be equal to  $Z_{OUT}$  of pulse generators.

SW00047

Waveform 4. Load circuitry for switching times

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/  
74LVCH16374A

SSOP48: plastic shrink small outline package; 48 leads; body width 7.5 mm

SOT370-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2.8	0.4 0.2	2.35 2.20	0.25	0.3 0.2	0.22 0.13	16.00 15.75	7.6 7.4	0.635	10.4 10.1	1.4	1.0 0.6	1.2 1.0	0.25	0.18	0.1	0.85 0.40	8° 0°

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT370-1		MO-118AA				93-11-02- 95-02-04



16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/  
74LVCH16374A

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1mm

SOT362-1



16-bit edge triggered D-type flip-flop with 5 Volt  
tolerant inputs/outputs (3-State)

74LVC16374A/  
74LVCH16374A

## DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	<b>Formative or in Design</b>	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	<b>Preproduction Product</b>	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
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