

# DATA SHEET

## **74ALVCH16374**

**2.5V/3.3V 16-bit edge-triggered D-type  
flip-flop (3-State)**

Product specification  
Supersedes data of 1997 Mar 21  
IC24 Data Handbook

1998 Jun 18

## 16-bit edge-triggered D-type flip-flop (3-State)

74ALVCH16374

## FEATURES

- 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  $V_{CC}$  and ground pins for minimum noise and ground bounce
- Direct interface with TTL levels
- All data inputs have bushold
- Output drive capability 50Ω transmission lines @ 85°C
- Current drive  $\pm 24$  mA at 3.0 V

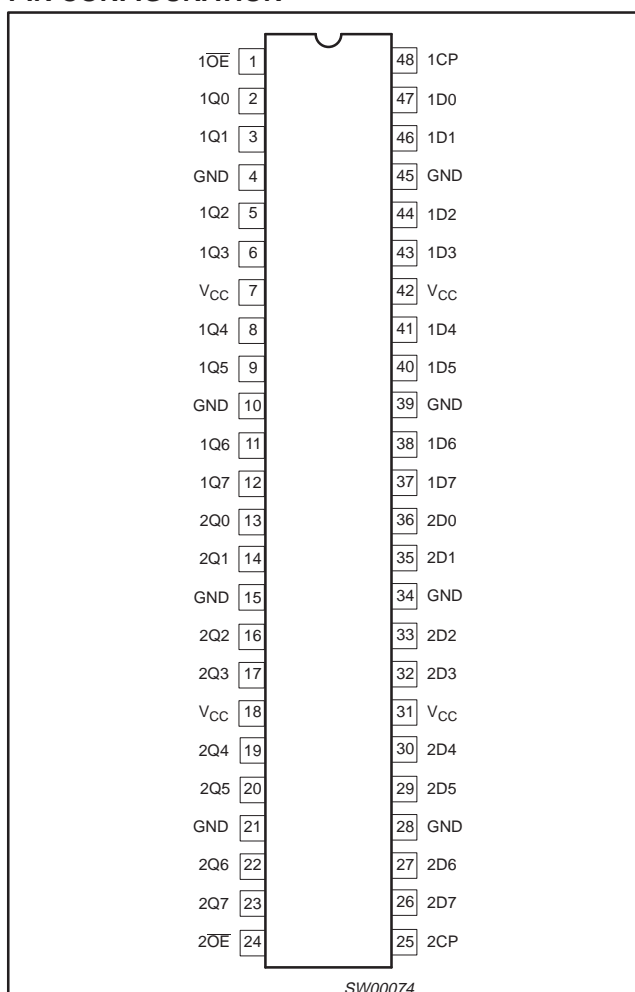
## DESCRIPTION

The 74ALVCH16374 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. Incorporates bus hold data inputs which eliminate the need for external pull-up or pull-down resistors to hold unused inputs. The 74ALVCH16374 consists of 2 sections of eight edge-triggered flip-flops. A clock (CP) input and an output enable ( $\overline{OE}$ ) are provided per 8-bit section.

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.

## 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	$V_{CC} = 2.5\text{V}$ , $C_L = 30\text{pF}$	2.3	ns	
		$V_{CC} = 3.3\text{V}$ , $C_L = 50\text{pF}$	2.4		
$f_{MAX}$	Maximum clock frequency	$V_{CC} = 2.5\text{V}$	300	MHz	
		$V_{CC} = 3.3\text{V}$	350	MHz	
$C_I$	Input capacitance		5.0	pF	
$C_{PD}$	Power dissipation capacitance per flip-flop	$V_I = \text{GND to } V_{CC}^1$	Outputs enabled	16	pF
			Outputs disabled	10	

## NOTE:

- $C_{PD}$  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 capacitance 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	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	74ALVCH16374 DL	ACH16374 DL	SOT370-1
48-Pin Plastic TSSOP Type II	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	74ALVCH16374 DGG	ACH16374 DGG	SOT362-1

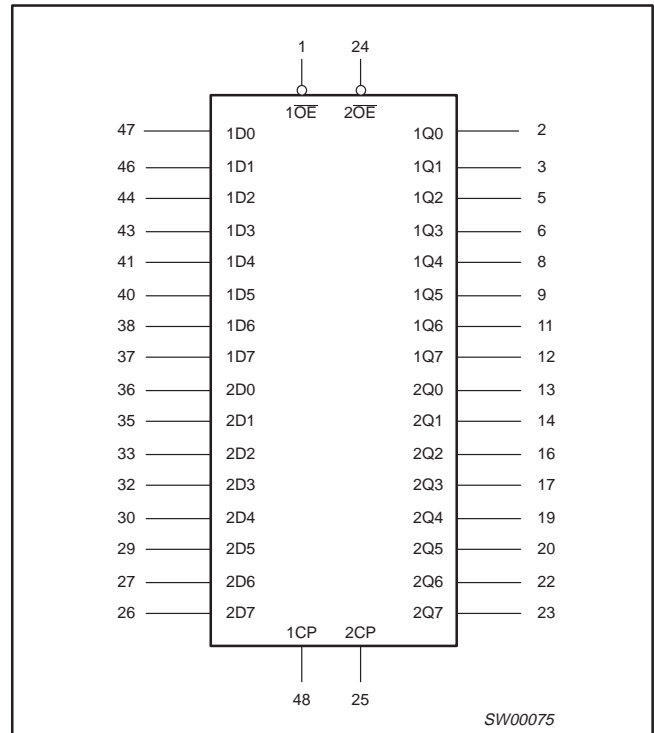
# 16-bit edge-triggered D-type flip-flop (3-State)

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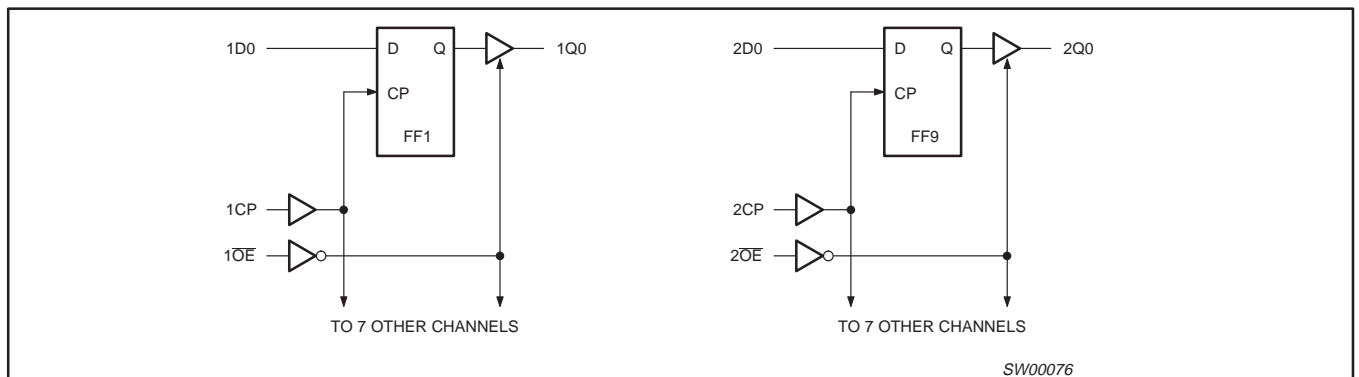
## PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1	1OE	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	2OE	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

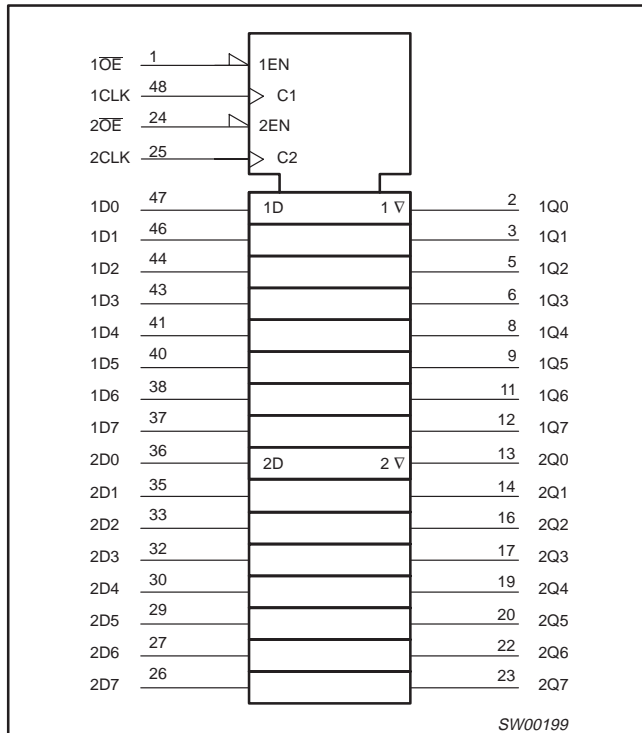
OPERATING MODES	INPUTS			INTERNAL FLIP-FLOPS	OUTPUTS
	OE	CP	Dn		Q0 to Q7
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Load register and disable outputs	H	↑	l	L	Z
	H	↑	h	H	Z

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

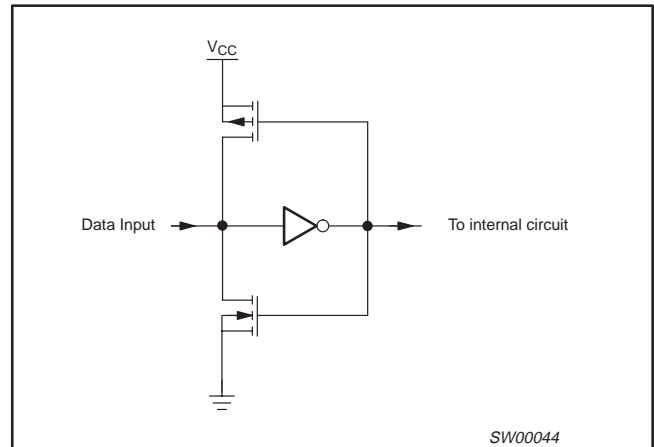
# 16-bit edge-triggered D-type flip-flop (3-State)

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## LOGIC SYMBOL (IEEE/IEC)



## BUS HOLD CIRCUIT



## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
V <sub>CC</sub>	DC supply voltage 2.5V range (for max. speed performance @ 30 pF output load)		2.3	2.7	V
	DC supply voltage 3.3V range (for max. speed performance @ 50 pF output load)		3.0	3.6	
	DC supply voltage (for low-voltage applications)		1.2	3.6	
V <sub>I</sub>	DC Input voltage range	For data input pins	0	V <sub>CC</sub>	V
		For control pins	0	5.5	
V <sub>O</sub>	DC output voltage range		0	V <sub>CC</sub>	V
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> = 2.3 to 3.0V	0	20	ns/V
		V <sub>CC</sub> = 3.0 to 3.6V	0	10	

## 16-bit edge-triggered D-type flip-flop (3-State)

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**ABSOLUTE MAXIMUM RATINGS**

In accordance with the Absolute Maximum Rating System (IEC 134)

Voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
$V_{CC}$	DC supply voltage		-0.5 to +4.6	V
$I_{IK}$	DC input diode current	$V_I < 0$	-50	mA
$V_I$	DC input voltage	For control pins <sup>1</sup>	-0.5 to +4.6	V
		For data inputs <sup>1</sup>	-0.5 to $V_{CC} + 0.5$	
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$	$\pm 50$	mA
$V_O$	DC output voltage	Note 1	-0.5 to $V_{CC} + 0.5$	V
$I_O$	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	For temperature range: -40 to +125 °C above +55°C derate linearly with 11.3 mW/K above +55°C derate linearly with 8 mW/K	850	mW
	-plastic medium-shrink (SSOP) -plastic thin-medium-shrink (TSSOP)		600	

**NOTE:**

1. 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. Voltage are referenced to GND (ground = 0 V).

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
		$V_{CC} = 1.8V$	$0.7 \cdot V_{CC}$	0.9		
		$V_{CC} = 2.3$ to $2.7V$	1.7	1.2		
		$V_{CC} = 2.7$ to $3.6V$	2.0	1.5		
$V_{IL}$	LOW level Input voltage	$V_{CC} = 1.2V$			GND	V
		$V_{CC} = 1.8V$		0.9	$0.2 \cdot V_{CC}$	
		$V_{CC} = 2.3$ to $2.7V$		1.2	0.7	
		$V_{CC} = 2.7$ to $3.6V$		1.5	0.8	
$V_{OH}$	HIGH level output voltage	$V_{CC} = 1.8$ to $3.6V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -100\mu A$	$V_{CC} - 0.2$	$V_{CC}$		V
		$V_{CC} = 1.8V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -6mA$	$V_{CC} - 0.4$	$V_{CC} - 0.10$		
		$V_{CC} = 2.3V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -6mA$	$V_{CC} - 0.3$	$V_{CC} - 0.08$		
		$V_{CC} = 2.3V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -12mA$	$V_{CC} - 0.5$	$V_{CC} - 0.17$		
		$V_{CC} = 2.3V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -18mA$	$V_{CC} - 0.6$	$V_{CC} - 0.26$		
		$V_{CC} = 2.7V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -12mA$	$V_{CC} - 0.5$	$V_{CC} - 0.14$		
		$V_{CC} = 3.0V$ ; $V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -24mA$	$V_{CC} - 1.0$	$V_{CC} - 0.28$		

## 16-bit edge-triggered D-type flip-flop (3-State)

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**DC ELECTRICAL CHARACTERISTICS (Continued)**

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

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			Temp = -40°C to +85°C			
			MIN	TYP <sup>1</sup>	MAX	
V <sub>OL</sub>	LOW level output voltage	V <sub>CC</sub> = 1.8 to 3.6V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100μA		GND	0.20	V
		V <sub>CC</sub> = 1.8V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 6mA		0.09	0.30	
		V <sub>CC</sub> = 2.3V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 6mA		0.07	0.20	
		V <sub>CC</sub> = 2.3V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 12mA		0.15	0.40	
		V <sub>CC</sub> = 2.3V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 12mA		0.23	0.60	
		V <sub>CC</sub> = 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 12mA		0.14	0.40	
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 24mA		0.27	0.55	
I <sub>I</sub>	Input leakage current per control pin	V <sub>CC</sub> = 1.8 to 3.6V; V <sub>I</sub> = 5.5V or GND		0.1	5	μA
	Input leakage current per data pin	V <sub>CC</sub> = 1.8 to 3.6V; V <sub>I</sub> = V <sub>CC</sub> or GND		0.1	5	
I <sub>IHZ</sub> /I <sub>ILZ</sub>	Input current for common I/O pins	V <sub>CC</sub> = 1.8 to 2.7V; V <sub>I</sub> = V <sub>CC</sub> or GND		0.1	10	μA
		V <sub>CC</sub> = 3.6V; V <sub>I</sub> = V <sub>CC</sub> or GND		0.1	15	
I <sub>OZ</sub>	3-State output OFF-state current	V <sub>CC</sub> = 1.8 to 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND		0.1	5	μA
		V <sub>CC</sub> = 2.7 to 3.6V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND		0.1	10	
I <sub>CC</sub>	Quiescent supply current	V <sub>CC</sub> = 1.8 to 2.7V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0		0.1	20	μA
		V <sub>CC</sub> = 2.7 to 3.6V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0		0.2	40	
ΔI <sub>CC</sub>	Additional quiescent supply current given per control pin	V <sub>CC</sub> = 2.7V to 3.6V; V <sub>I</sub> = V <sub>CC</sub> - 0.6V; I <sub>O</sub> = 0		5	500	μA
	Additional quiescent supply current given per data I/O pin			150	750	
I <sub>BHL</sub> <sup>2</sup>	Bus hold LOW sustaining current	V <sub>CC</sub> = 2.3V; V <sub>I</sub> = 0.7V	45	-		μA
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = 0.8V	75	150		
I <sub>BHH</sub> <sup>2</sup>	Bus hold HIGH sustaining current	V <sub>CC</sub> = 2.3V; V <sub>I</sub> = 1.7V	-45			μA
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = 2.0V	-75	-175		
I <sub>BHLO</sub> <sup>2</sup>	Bus hold LOW overdrive current	V <sub>CC</sub> = 2.7V	300			μA
		V <sub>CC</sub> = 3.6V	450			
I <sub>BHHO</sub> <sup>2</sup>	Bus hold HIGH overdrive current	V <sub>CC</sub> = 2.7V	-300			μA
		V <sub>CC</sub> = 3.6V	-450			

**NOTES:**

1. All typical values are at T<sub>amb</sub> = 25°C.
2. Valid for data inputs of bus hold parts.

## 16-bit edge-triggered D-type flip-flop (3-State)

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**AC CHARACTERISTICS FOR  $V_{CC} = 2.3V$  TO  $2.7V$  RANGE AND  $V_{CC} < 2.3V$** GND = 0V;  $t_r = t_f \leq 2.0ns$ ;  $C_L = 30pF$ 

SYMBOL	PARAMETER	WAVEFORM	LIMITS							UNIT
			$V_{CC} = 2.3$ to $2.7V$			$V_{CC} = 1.8V$			$V_{CC} = 1.2V$	
			MIN	TYP <sup>1, 2</sup>	MAX	MIN	TYP <sup>1</sup>	MAX	TYP <sup>1</sup>	
$t_{PHL}/t_{PLH}$	Propagation delay nCP to nQn	1, 4	1.0	2.3	4.3	1.5	3.6	6.5	7.7	ns
$t_{PZH}/t_{PZL}$	3-State output enable time nOE to nQn	2, 4	1.0	2.6	4.8	1.5	4.0	7.2	8.7	ns
$t_{PHZ}/t_{PLZ}$	3-State output disable time nOE to nQn	2, 4	1.0	2.1	4.0	1.5	3.1	5.4	6.2	ns
$t_W$	nCP pulse width HIGH or LOW	1	3.0	1.6	–	4.0	2.0	–	–	ns
$t_{su}$	Set-up time Dn to nCP	3	1.2	0.2	–	1.5	0.2	–	–	ns
$t_h$	Hold time Dn to nCP	3	0.8	–0.1	–	0.6	–0.2	–	–	ns
$f_{max}$	Maximum clock pulse frequency	1	150	300	–	125	250	–	–	MHz

**NOTES:**

- All typical values are measured at  $T_{amb} = 25^\circ C$ .
- Typical value is measured at  $V_{CC} = 2.5V$ .

**AC CHARACTERISTICS FOR  $V_{CC} = 3.0V$  TO  $3.6V$  RANGE AND  $V_{CC} = 2.7V$** GND = 0V;  $t_r = t_f \leq 2.5ns$ ;  $C_L = 50pF$ 

SYMBOL	PARAMETER	WAVEFORM	LIMITS						UNIT
			$V_{CC} = 2.3$ to $2.7V$			$V_{CC} = 2.7V$			
			MIN	TYP <sup>1, 2</sup>	MAX	MIN	TYP <sup>1</sup>	MAX	
$t_{PHL}/t_{PLH}$	Propagation delay nCP to nQn	1, 4	1.0	2.4	3.4	1.0	2.3	3.8	ns
$t_{PZH}/t_{PZL}$	3-State output enable time nOE to nQn	2, 4	1.0	2.3	4.0	1.0	2.9	4.8	ns
$t_{PHZ}/t_{PLZ}$	3-State output disable time nOE to nQn	2, 4	1.0	2.6	4.1	1.0	2.9	4.5	ns
$t_W$	nCP pulse width HIGH or LOW	1	2.5	1.4	–	3.0	1.6	–	ns
$t_{su}$	Set-up time Dn to nCP	3	1.2	0.2	–	1.5	0.4	–	ns
$t_h$	Hold time Dn to nCP	3	0.8	0.0	–	0.6	–0.2	–	ns
$f_{max}$	Maximum clock pulse frequency	1	200	350	–	150	300	–	MHz

**NOTES:**

- All typical values are measured at  $T_{amb} = 25^\circ C$ .
- Typical value is measured at  $V_{CC} = 3.3V$ .

# 16-bit edge-triggered D-type flip-flop (3-State)

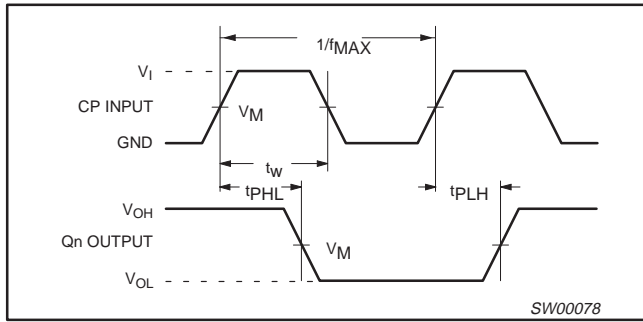
74ALVCH16374

## AC WAVEFORMS FOR $V_{CC} = 2.3V$ TO $2.7V$ AND $V_{CC} < 2.3V$ RANGE

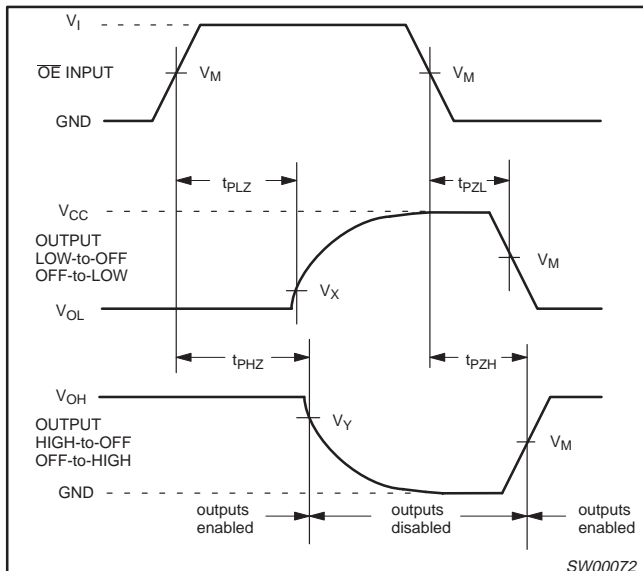
$V_M = 0.5 V_{CC}$   
 $V_X = V_{OL} + 0.15V$   
 $V_Y = V_{OH} - 0.15V$   
 $V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load.  
 $V_I = V_{CC}$

## AC WAVEFORMS FOR $V_{CC} = 3.0V$ TO $3.6V$ AND $V_{CC} = 2.7V$ RANGE

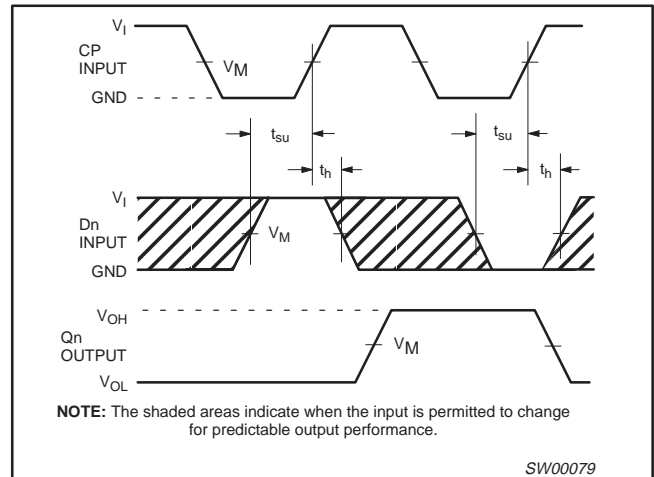
$V_M = 1.5 V$   
 $V_X = V_{OL} + 0.3V$   
 $V_Y = V_{OH} - 0.3V$   
 $V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load.  
 $V_I = 2.7V$



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

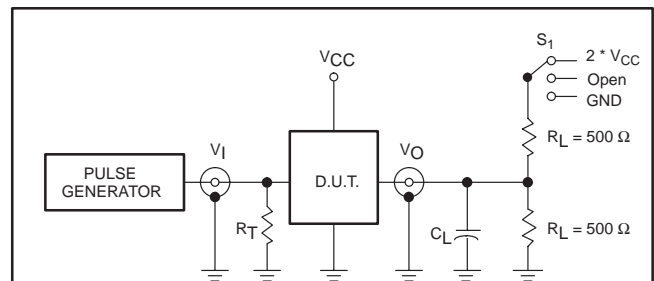


Waveform 2. 3-State enable and disable times



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

## TEST CIRCUIT



Test Circuit for switching times

### 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.

### SWITCH POSITION

TEST	S <sub>1</sub>
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	$2 * V_{CC}$
$t_{PHZ}/t_{PZH}$	GND

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

SV00906

Waveform 4. Load circuitry for switching times

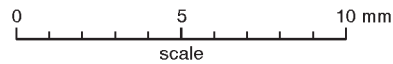
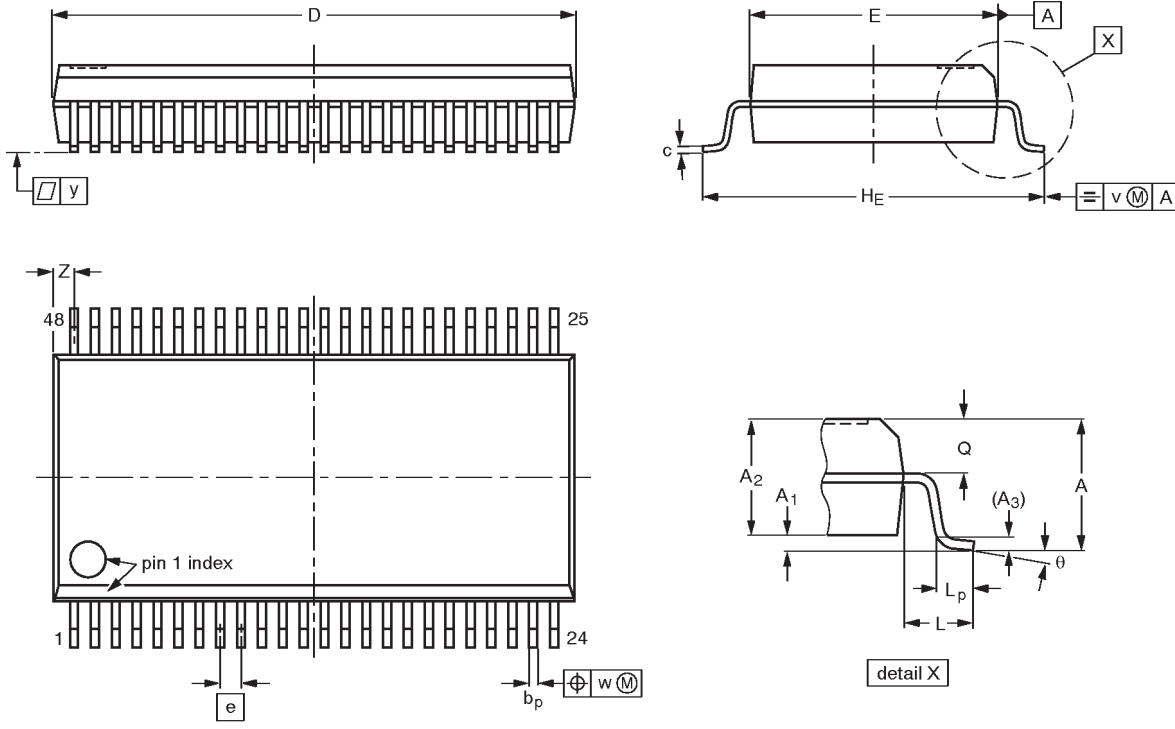


2.5V/3.3V 16-bit edge-triggered D-type flip-flop  
(3-State)

74ALVCH16374

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.

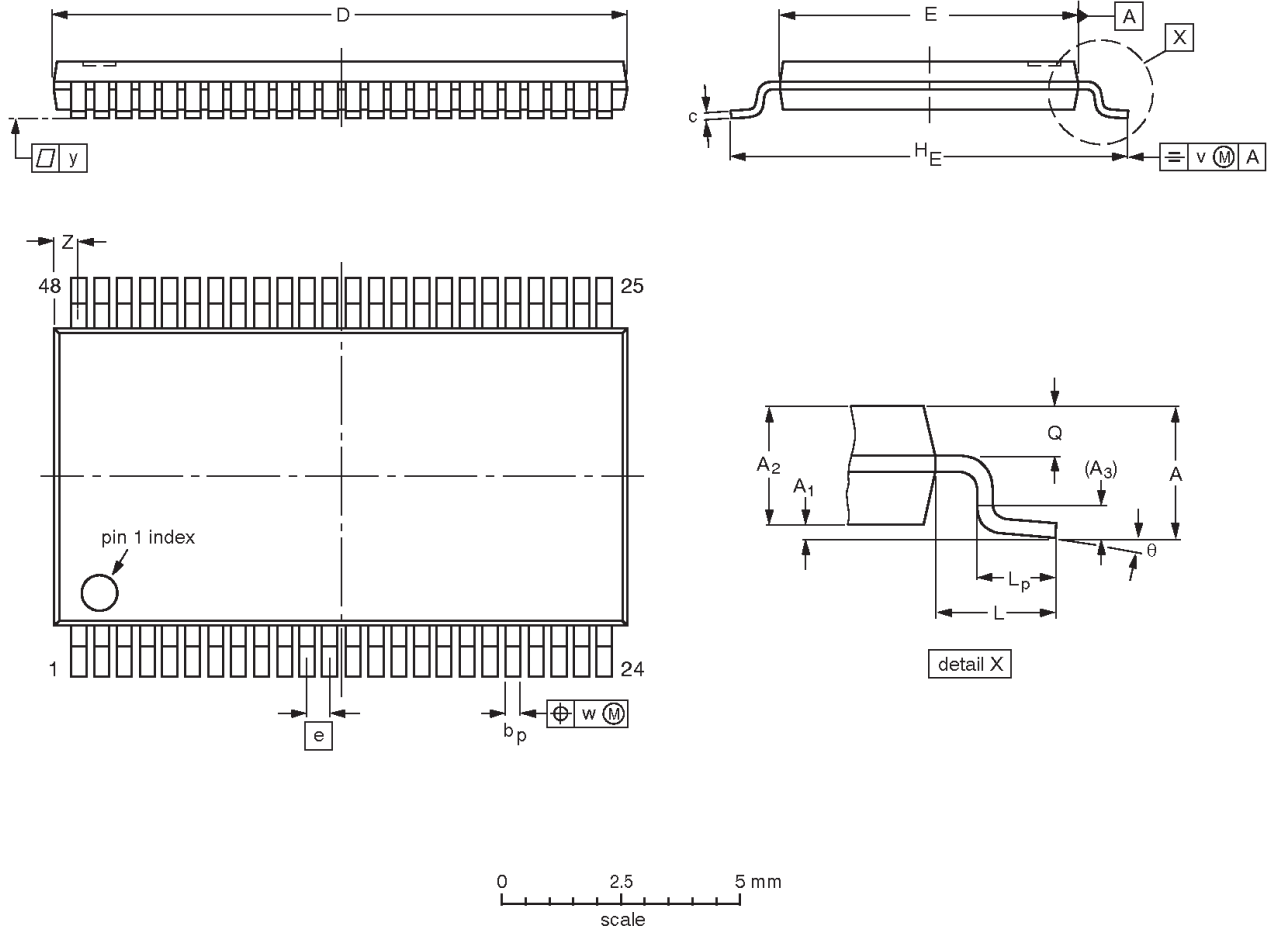
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT370-1		MO-118AA				93-11-02- 95-02-04

2.5V/3.3V 16-bit edge-triggered D-type flip-flop  
(3-State)

74ALVCH16374

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

SOT362-1



**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>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z	θ
mm	1.2	0.15 0.05	1.05 0.85	0.25	0.28 0.17	0.2 0.1	12.6 12.4	6.2 6.0	0.5	8.3 7.9	1	0.8 0.4	0.50 0.35	0.25	0.08	0.1	0.8 0.4	8° 0°

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT362-1		MO-153ED				93-02-03 95-02-10

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2.5V/3.3V 16-bit edge-triggered D-type flip-flop  
(3-State)

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74ALVCH16374

**NOTES**

2.5V/3.3V 16-bit edge-triggered D-type flip-flop  
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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.
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