

## 74ALVCH16374

### Low Voltage 16-Bit D-Type Flip-Flop with Bushold

#### General Description

The ALVCH16374 contains sixteen non-inverting D-type flip-flops with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. A buffered clock (CP) and output enable ( $\overline{OE}$ ) are common to each byte and can be shorted together for full 16-bit operation.

The ALVCH16374 data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

The 74ALVCH16374 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with output compatibility up to 3.6V.

The 74ALVCH16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

#### Features

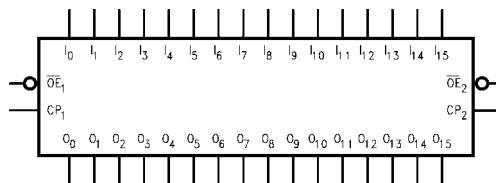
- 1.65V to 3.6V  $V_{CC}$  supply operation
- 3.6V tolerant control inputs and outputs
- Bushold on data inputs eliminates the need for external pull-up/pull-down resistors
- $t_{PD}$ 
  - 4.2 ns max for 3.0V to 3.6V  $V_{CC}$
  - 5.3 ns max for 2.3V to 2.7V  $V_{CC}$
  - 7.8 ns max for 1.65V to 1.95V  $V_{CC}$
- Uses patented noise/EMI reduction circuitry
- Latch-up conforms to JEDEC JED78
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

#### Ordering Code:

Order Number	Package Number	Package Descriptions
74ALVCH16374T (Note 1)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

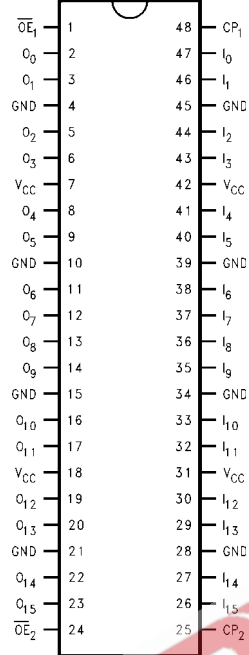
**Note 1:** Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

#### Logic Symbol

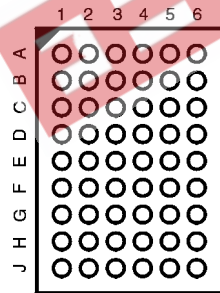


### Connection Diagrams

Pin Assignment for TSSOP



Pin Assignment for FBGA



(Top Thru View)

### Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
CP <sub>n</sub>	Clock Pulse Input
I <sub>0</sub> -I <sub>15</sub>	Bushold Inputs
O <sub>0</sub> -O <sub>15</sub>	Outputs
NC	No Connect

### FBGA Pin Assignments

	1	2	3	4	5	6
A	O <sub>0</sub>	NC	$\overline{OE}_1$	CP <sub>1</sub>	NC	I <sub>0</sub>
B	O <sub>2</sub>	O <sub>1</sub>	NC	NC	I <sub>1</sub>	I <sub>2</sub>
C	O <sub>4</sub>	O <sub>3</sub>	V <sub>CC</sub>	V <sub>CC</sub>	I <sub>3</sub>	I <sub>4</sub>
D	O <sub>6</sub>	O <sub>5</sub>	GND	GND	I <sub>5</sub>	I <sub>6</sub>
E	O <sub>8</sub>	O <sub>7</sub>	GND	GND	I <sub>7</sub>	I <sub>8</sub>
F	O <sub>10</sub>	O <sub>9</sub>	GND	GND	I <sub>9</sub>	I <sub>10</sub>
G	O <sub>12</sub>	O <sub>11</sub>	V <sub>CC</sub>	V <sub>CC</sub>	I <sub>11</sub>	I <sub>12</sub>
H	O <sub>14</sub>	O <sub>13</sub>	NC	NC	I <sub>13</sub>	I <sub>14</sub>
J	O <sub>15</sub>	NC	$\overline{OE}_2$	CP <sub>2</sub>	NC	I <sub>15</sub>

### Truth Tables

Inputs			Outputs
CP <sub>1</sub>	$\overline{OE}_1$	I <sub>0</sub> -I <sub>7</sub>	O <sub>0</sub> -O <sub>7</sub>
↗	L	H	H
↗	L	L	L
L	L	X	O <sub>0</sub>
X	H	X	Z

Inputs			Outputs
CP <sub>2</sub>	$\overline{OE}_2$	I <sub>8</sub> -I <sub>15</sub>	O <sub>8</sub> -O <sub>15</sub>
↗	L	H	H
↗	L	L	L
L	L	X	O <sub>0</sub>
X	H	X	Z

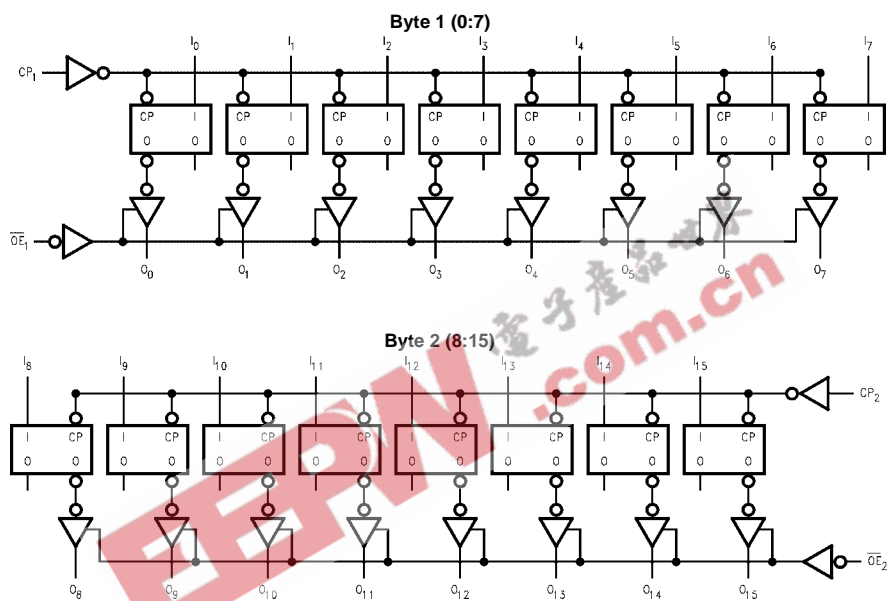
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial (HIGH or LOW, control inputs may not float)  
 Z = High Impedance  
 O<sub>0</sub> = Previous O<sub>0</sub> before HIGH-to-LOW of CP

## Functional Description

The 74ALVCH16374 consists of sixteen edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. Each clock has a buffered clock and buffered Output Enable common to all flip-flops within that byte. The description which follows applies to each byte. Each

flip-flop will store the state of their individual I inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock ( $CP_n$ ) transition. With the Output Enable ( $\overline{OE}_n$ ) LOW, the contents of the flip-flops are available at the outputs. When  $\overline{OE}_n$  is HIGH, the outputs go to the high impedance state. Operations of the  $\overline{OE}_n$  input does not affect the state of the flip-flops.

## Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings (Note 2)		Recommended Operating Conditions (Note 4)	
Supply Voltage ( $V_{CC}$ )	-0.5V to +4.6V	Power Supply	
DC Input Voltage ( $V_I$ )	-0.5V to 4.6V	Operating	1.65V to 3.6V
Output Voltage ( $V_O$ ) (Note 3)	-0.5V to $V_{CC} + 0.5V$	Input Voltage ( $V_I$ )	0V to $V_{CC}$
DC Input Diode Current ( $I_{IK}$ )		Output Voltage ( $V_O$ )	0V to $V_{CC}$
$V_I < 0V$	-50 mA	Free Air Operating Temperature ( $T_A$ )	-40°C to +85°C
DC Output Diode Current ( $I_{OK}$ )		Minimum Input Edge Rate ( $\Delta t/\Delta V$ )	
$V_O < 0V$	-50 mA	$V_{IN} = 0.8V$ to $2.0V$ , $V_{CC} = 3.0V$	10 ns/V
DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ )	$\pm 50$ mA	<b>Note 2:</b> The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.	
DC $V_{CC}$ or GND Current per Supply Pin ( $I_{CC}$ or GND)	$\pm 100$ mA	<b>Note 3:</b> $I_O$ Absolute Maximum Rating must be observed.	
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C	<b>Note 4:</b> Floating or unused control inputs must be held HIGH or LOW.	

DC Electrical Characteristics						
Symbol	Parameter	Conditions	$V_{CC}$ (V)	Min	Max	Units
$V_{IH}$	HIGH Level Input Voltage		1.65 - 1.95 2.3 - 2.7 2.7 - 3.6	$0.65 \times V_{CC}$ 1.7 2.0		V
$V_{IL}$	LOW Level Input Voltage		1.65 - 1.95 2.3 - 2.7 2.7 - 3.6		$0.35 \times V_{CC}$ 0.7 0.8	V
$V_{OH}$	HIGH Level Output Voltage	$I_{OH} = 100 \mu A$ $I_{OH} = -4 \text{ mA}$ $I_{OH} = -6 \text{ mA}$ $I_{OH} = -12 \text{ mA}$ $I_{OH} = -24 \text{ mA}$	1.65 - 3.6 1.65 2.3 2.7 3.0 3.0	$V_{CC} - 0.2$ 1.2 2.0 1.7 2.2 2.4		V
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$ $I_{OL} = 4 \text{ mA}$ $I_{OL} = 6 \text{ mA}$ $I_{OL} = 12 \text{ mA}$ $I_{OL} = 24 \text{ mA}$	1.65 - 3.6 1.65 2.3 2.7 3.0		0.2 0.45 0.4 0.7 0.4 0.55	V
$I_I$	Input Leakage Current	$0 \leq V_I \leq 3.6V$	3.6		$\pm 5.0$	$\mu A$
$I_{I(HOLD)}$	Bushold Input Maximum Drive Hold Current	$V_{IN} = 0.58V$ $V_{IN} = 1.07V$ $V_{IN} = 0.7V$ $V_{IN} = 1.7V$ $V_{IN} = 0.8V$ $V_{IN} = 2.0V$ $0 < V_O \leq 3.6V$	1.65 1.65 2.3 2.3 3.0 3.0 3.6	25 -25 45 -45 75 -75		$\mu A$
$I_{OZ}$	3-STATE Output Leakage	$0 \leq V_O \leq 3.6V$	3.6		$\pm 10$	$\mu A$
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND, $I_O = 0$	3.6		40	$\mu A$
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	3 - 3.6		750	$\mu A$

AC Electrical Characteristics										
Symbol	Parameter	$T_A = -40^\circ\text{C to } +85^\circ\text{C}, R_L = 500\Omega$								Units
		$C_L = 50\text{ pF}$				$C_L = 30\text{ pF}$				
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		$V_{CC} = 2.5V \pm 0.2V$		$V_{CC} = 1.8V \pm 0.15V$		
		Min	Max	Min	Max	Min	Max	Min	Max	
$f_{\text{CLOCK}}$	Clock Frequency		150		150		150		100	MHz
$t_W$	Pulse Width	3.3		3.3		3.3		4.0		ns
$t_S$	Setup Time	1.9		2.2		2.1		2.5		ns
$t_H$	Hold Time	0.5		0.5		0.6		1.0		ns
$f_{\text{MAX}}$	Maximum Clock Frequency	150		150		150		100		MHz
$t_{\text{PHL}}, t_{\text{PLH}}$	Propagation Delay	1.0	4.2		4.9	1.0	5.3	1.5	7.8	ns
$t_{\text{PZL}}, t_{\text{PZH}}$	Output Enable Time	1.0	4.8		5.9	1.0	6.2	1.5	9.2	ns
$t_{\text{PLZ}}, t_{\text{PHZ}}$	Output Disable Time	1.0	4.3		4.7	1.0	5.3	1.5	6.8	ns
Capacitance										
Symbol	Parameter	Conditions	$T_A = +25^\circ\text{C}$		Units					
			$V_{CC}$	Typical						
$C_{\text{IN}}$	Input Capacitance	Control	$V_I = 0V$ or $V_{CC}$	3.3	3	pF				
		Data	$V_I = 0V$ or $V_{CC}$	3.3	6					
$C_{\text{OUT}}$	Output Capacitance		$V_I = 0V$ or $V_{CC}$	3.3	7	pF				
$C_{\text{PD}}$	Power Dissipation Capacitance	Outputs Enabled	$f = 10\text{ MHz}, C_L = 50\text{ pF}$	3.3	30	pF				
				2.5	31					
		Outputs Disabled	$f = 10\text{ MHz}, C_L = 50\text{ pF}$	3.3	18					
				2.5	16					

## AC Loading and Waveforms

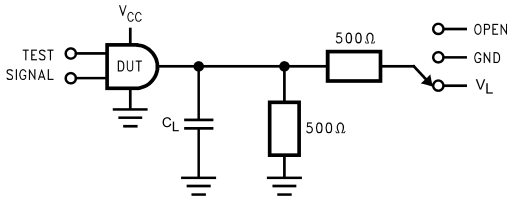


FIGURE 1. AC Test Circuit

TABLE 1. Values for Figure 1

TEST	SWITCH
$t_{PLH}, t_{PHL}$	Open
$t_{PZL}, t_{PLZ}$	$V_L$
$t_{PZH}, t_{PHZ}$	GND

TABLE 2. Variable Matrix  
(Input Characteristics:  $f = 1\text{MHz}$ ;  $t_r = t_f = 2\text{ns}$ ;  $Z_0 = 50\Omega$ )

Symbol	$V_{CC}$			
	$3.3\text{V} \pm 0.3\text{V}$	2.7V	$2.5\text{V} \pm 0.2\text{V}$	$1.8\text{V} \pm 0.15\text{V}$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3\text{V}$	$V_{OL} + 0.3\text{V}$	$V_{OL} + 0.15\text{V}$	$V_{OL} + 0.15\text{V}$
$V_Y$	$V_{OH} - 0.3\text{V}$	$V_{OH} - 0.3\text{V}$	$V_{OH} - 0.15\text{V}$	$V_{OH} - 0.15\text{V}$
$V_L$	6V	6V	$V_{CC} * 2$	$V_{CC} * 2$

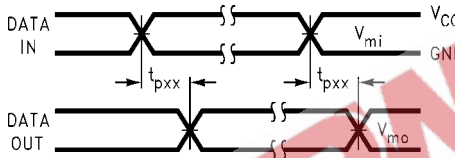


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

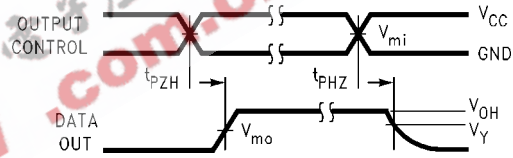


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

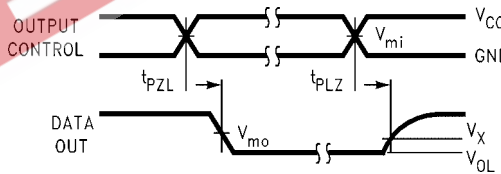


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

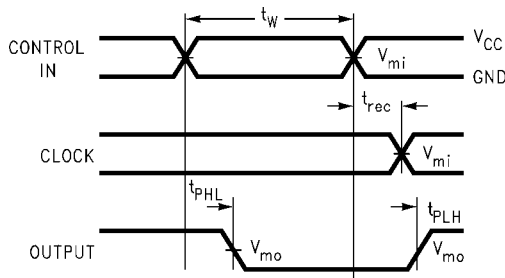


FIGURE 5. Propagation Delay, Pulse Width and  $t_{REC}$  Waveforms

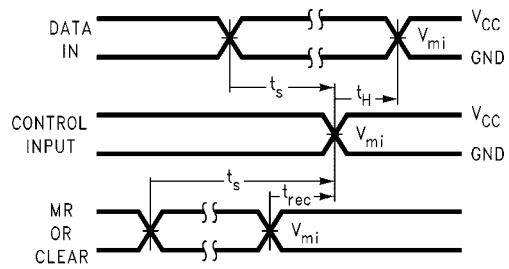
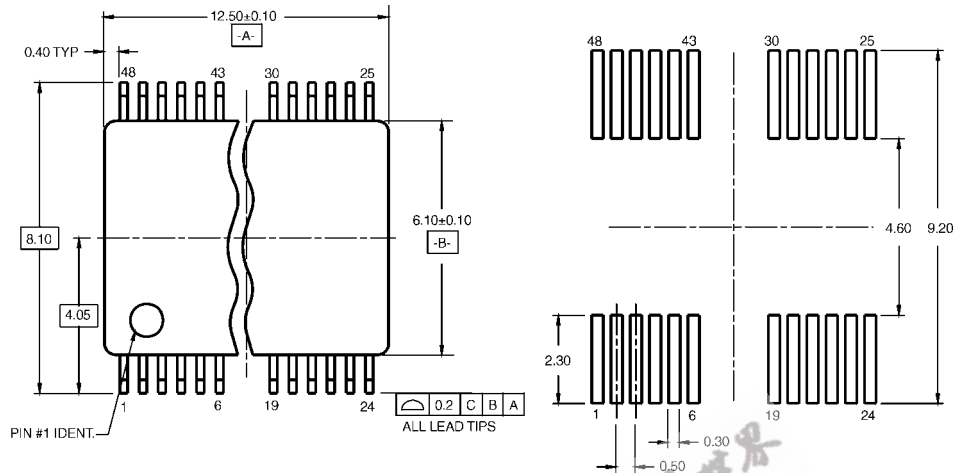
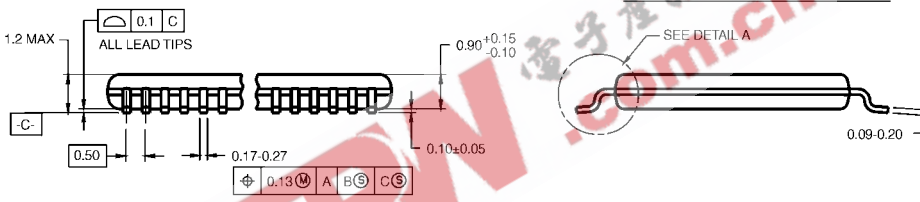


FIGURE 6. Setup Time, Hold Time and Recovery Time for Low Voltage Logic

**Physical Dimensions** inches (millimeters) unless otherwise noted

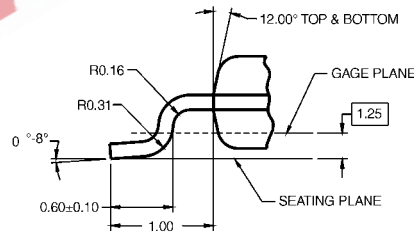


**LAND PATTERN RECOMMENDATION**



- NOTES:
- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6, DATE 7/93.
  - B. DIMENSIONS ARE IN MILLIMETERS.
  - C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
  - D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTD48RevB1



**DETAIL A**

**48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide Package Number MTD48**

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