

## 74ALVC16374

### Low Voltage 16-Bit D-Type Flip-Flop with 3.6V Tolerant Inputs and Outputs

#### General Description

The ALVC16374 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 74ALVC16374 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with I/O compatibility up to 3.6V.

The 74ALVC16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

#### Features

- 1.65V - 3.6V  $V_{CC}$  supply operation
- 3.6V tolerant inputs and outputs
- $t_{PD}$ 
  - 3.5 ns max for 3.0V to 3.6V  $V_{CC}$
  - 4.4 ns max for 2.3V to 2.7V  $V_{CC}$
  - 7.8 ns max for 1.65V to 1.95V  $V_{CC}$
- Power-off high impedance inputs and outputs
- Supports live insertion and withdrawal (Note 1)
- Uses patented noise/EMI reduction circuitry
- Latchup conforms to JEDEC JED78
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

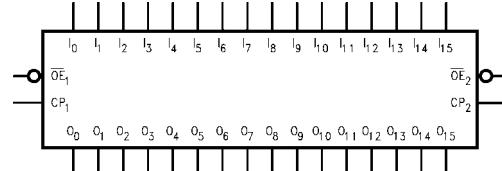
**Note 1:** To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pull-up resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

#### Ordering Code:

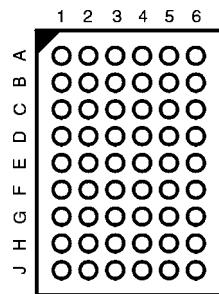
Order Number	Package Number	Package Descriptions
74ALVC16374GX (Note 2)	BGA54A	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
74ALVC16374MTD (Note 3)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

**Note 2:** BGA package available in Tape and Reel only.

**Note 3:** 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**

OE <sub>1</sub>	1	48	CP <sub>1</sub>
O <sub>0</sub>	2	47	I <sub>0</sub>
O <sub>1</sub>	3	46	I <sub>1</sub>
GND	4	45	GND
O <sub>2</sub>	5	44	I <sub>2</sub>
O <sub>3</sub>	6	43	I <sub>3</sub>
V <sub>CC</sub>	7	42	V <sub>CC</sub>
O <sub>4</sub>	8	41	I <sub>4</sub>
O <sub>5</sub>	9	40	I <sub>5</sub>
GND	10	39	GND
O <sub>6</sub>	11	38	I <sub>6</sub>
O <sub>7</sub>	12	37	I <sub>7</sub>
O <sub>8</sub>	13	36	I <sub>8</sub>
O <sub>9</sub>	14	35	I <sub>9</sub>
GND	15	34	GND
O <sub>10</sub>	16	33	I <sub>10</sub>
O <sub>11</sub>	17	32	I <sub>11</sub>
V <sub>CC</sub>	18	31	V <sub>CC</sub>
O <sub>12</sub>	19	30	I <sub>12</sub>
O <sub>13</sub>	20	29	I <sub>13</sub>
GND	21	28	GND
O <sub>14</sub>	22	27	I <sub>14</sub>
O <sub>15</sub>	23	26	I <sub>15</sub>
OE <sub>2</sub>	24	25	CP <sub>2</sub>

**Pin Assignment for FBGA****(Top Thru View)****Pin Descriptions**

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

**FBGA Pin Assignments**

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

**Truth Tables**

Inputs			Outputs
CP <sub>1</sub>	OE <sub>1</sub>	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>	OE <sub>2</sub>	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, inputs may not float)

Z = High Impedance

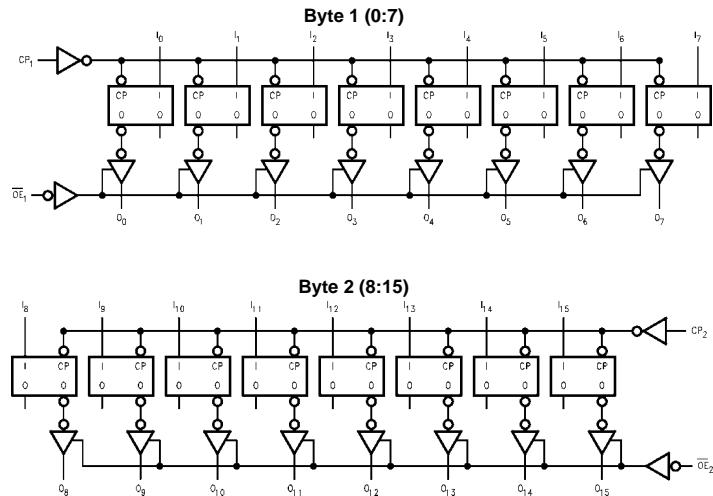
O<sub>0</sub> = Previous O<sub>0</sub> before HIGH-to-LOW of CP

## Functional Description

The 74ALVC16374 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.

<b>Absolute Maximum Ratings</b> <sup>(Note 4)</sup>		<b>Recommended Operating Conditions</b> <sup>(Note 6)</sup>							
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 5)	-0.5V to $V_{CC}$ +0.5V	Input Voltage ( $V_I$ )	0V to $V_{CC}$						
DC Input Diode Current ( $I_{IK}$ ) $V_I < 0V$	-50 mA	Output Voltage ( $V_O$ )	0V to $V_{CC}$						
DC Output Diode Current ( $I_{OK}$ ) $V_O < 0V$	-50 mA	Free Air Operating Temperature ( $T_A$ )	-40°C to +85°C						
DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ )	±50 mA	Minimum Input Edge Rate ( $\Delta t/\Delta V$ )							
DC $V_{CC}$ or GND Current per Supply Pin ( $I_{CC}$ or GND)	±100 mA	$V_{IN} = 0.8V$ to 2.0V, $V_{CC} = 3.0V$	10 ns/V						
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C	<b>Note 4:</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.							
<b>Note 5:</b> $I_O$ Absolute Maximum Rating must be observed.									
<b>Note 6:</b> Floating or unused inputs must be held HIGH or LOW.									
<b>DC Electrical Characteristics</b>									
Symbol	Parameter	Conditions	$V_{CC}$ (V)	Min	Max				
$V_{IH}$	HIGH Level Input Voltage		1.65 -1.95 2.3 - 2.7 2.7 - 3.6	0.65 x $V_{CC}$ 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 x $V_{CC}$ 0.7 0.8		V			
$V_{OH}$	HIGH Level Output Voltage	$I_{OH} = -100 \mu A$	1.65 - 3.6	$V_{CC} - 0.2$		V			
		$I_{OH} = -4 mA$	1.65	1.2					
		$I_{OH} = -6 mA$	2.3	2					
		$I_{OH} = -12 mA$	2.3 2.7 3.0	1.7 2.2 2.4					
		$I_{OH} = -24 mA$	3.0	2					
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$	1.65 - 3.6		0.2	V			
		$I_{OL} = 4 mA$	1.65		0.45				
		$I_{OL} = 6 mA$	2.3		0.4				
		$I_{OL} = 12mA$	2.3 2.7		0.7 0.4				
		$I_{OL} = 24 mA$	3		0.55				
$I_I$	Input Leakage Current	$0 \leq V_I \leq 3.6V$	3.6		±5.0	µA			
$I_{OZ}$	3-STATE Output Leakage	$0 \leq V_O \leq 3.6V$	3.6		±10	µA			
$I_{CC}$	Quiescent Supply Current	$V_I = V_{CC}$ or GND, $I_O = 0$	3.6		40	µA			
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	$V_{IH} = V_{CC} - 0.6V$	3 -3.6		750	µA			

### 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		
$t_{MAX}$	Maximum Clock Frequency	250		200		200		100		ns	
$t_{PHL}, t_{PLH}$	Propagation Delay Bus to Bus	1.3	3.5	1.5	4.4	1.0	3.9	1.5	7.8	ns	
$t_{PZL}, t_{PZH}$	Output Enable Time	1.3	4.0	1.5	5.1	1.0	4.6	1.5	9.2	ns	
$t_{PLZ}, t_{PHZ}$	Output Disable Time	1.3	4.0	1.5	4.3	1.0	3.8	1.5	6.8	ns	
$t_W$	Pulse Width	1.5		1.5		1.5		4.0		ns	
$t_S$	Setup Time	1.5		1.5		1.5		2.5		ns	
$t_H$	Hold Time	1.0		1.0		1.0		1.0		ns	

### Capacitance

Symbol	Parameter	Conditions		$T_A = +25^\circ\text{C}$		Units
				$V_{CC}$	Typical	
$C_{IN}$	Input Capacitance	$V_I = 0V$ or $V_{CC}$		3.3	6	pF
$C_{OUT}$	Output Capacitance	$V_I = 0V$ or $V_{CC}$		3.3	7	pF
$C_{PD}$	Power Dissipation Capacitance	Outputs Enabled	$f = 10 \text{ MHz}, C_L = 50 \text{ pF}$	3.3	20	pF
				2.5	20	

## AC Loading and Waveforms

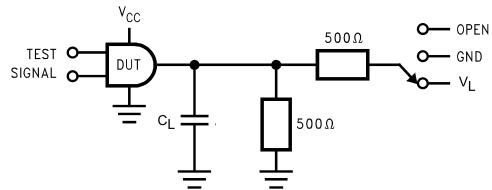


FIGURE 1. AC Test Circuit

TABLE 1.

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

TABLE 2.

Symbol	$V_{CC}$			
	$3.3V \pm 0.3V$	$2.7V$	$2.5V \pm 0.2V$	$1.8V \pm 0.15V$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$	$V_{OL} + 0.15V$
$V_Y$	$V_{OL} - 0.3V$	$V_{OL} - 0.3V$	$V_{OL} - 0.15V$	$V_{OL} - 0.15V$
$V_L$	V6	6V	$V_{CC}^*2$	$V_{CC}^*2$

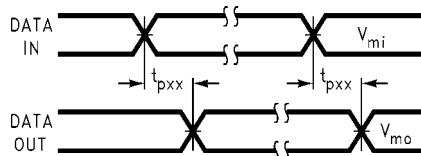


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

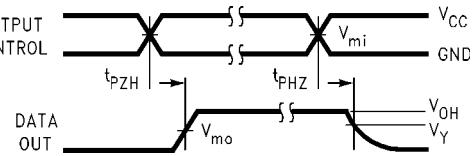


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

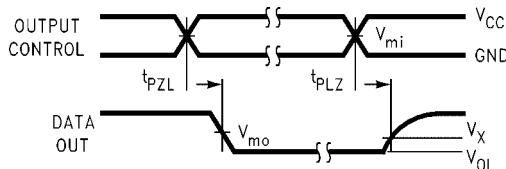


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

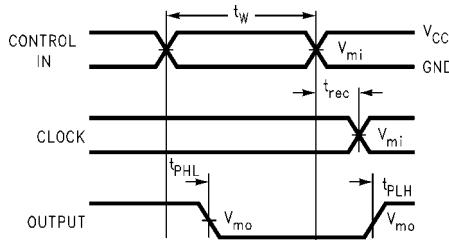
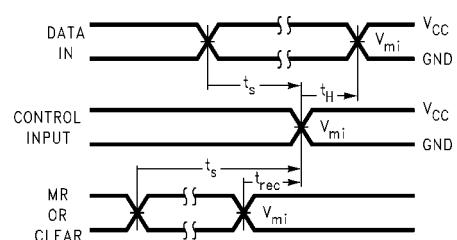
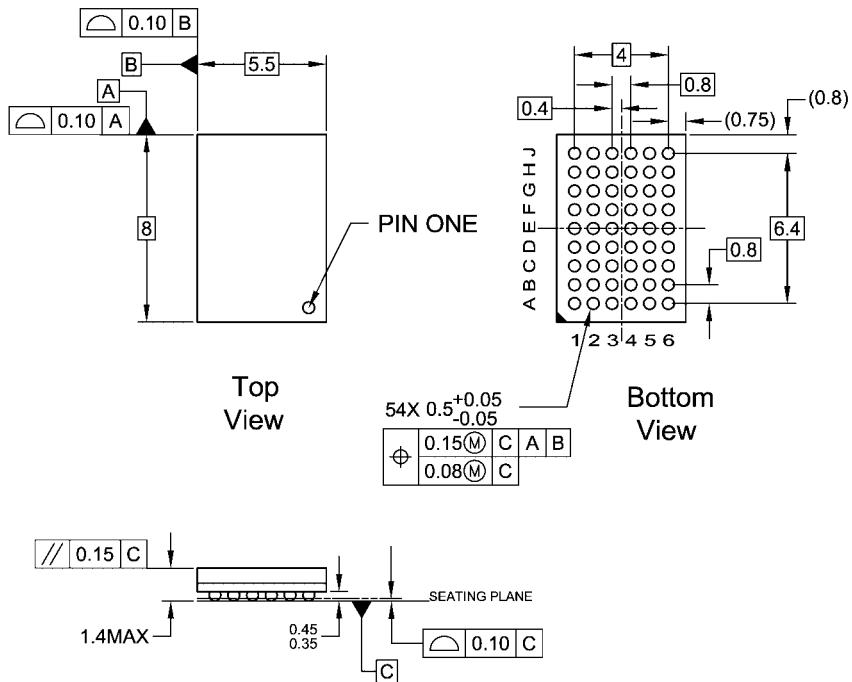
FIGURE 5. Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms

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

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



**NOTES:**

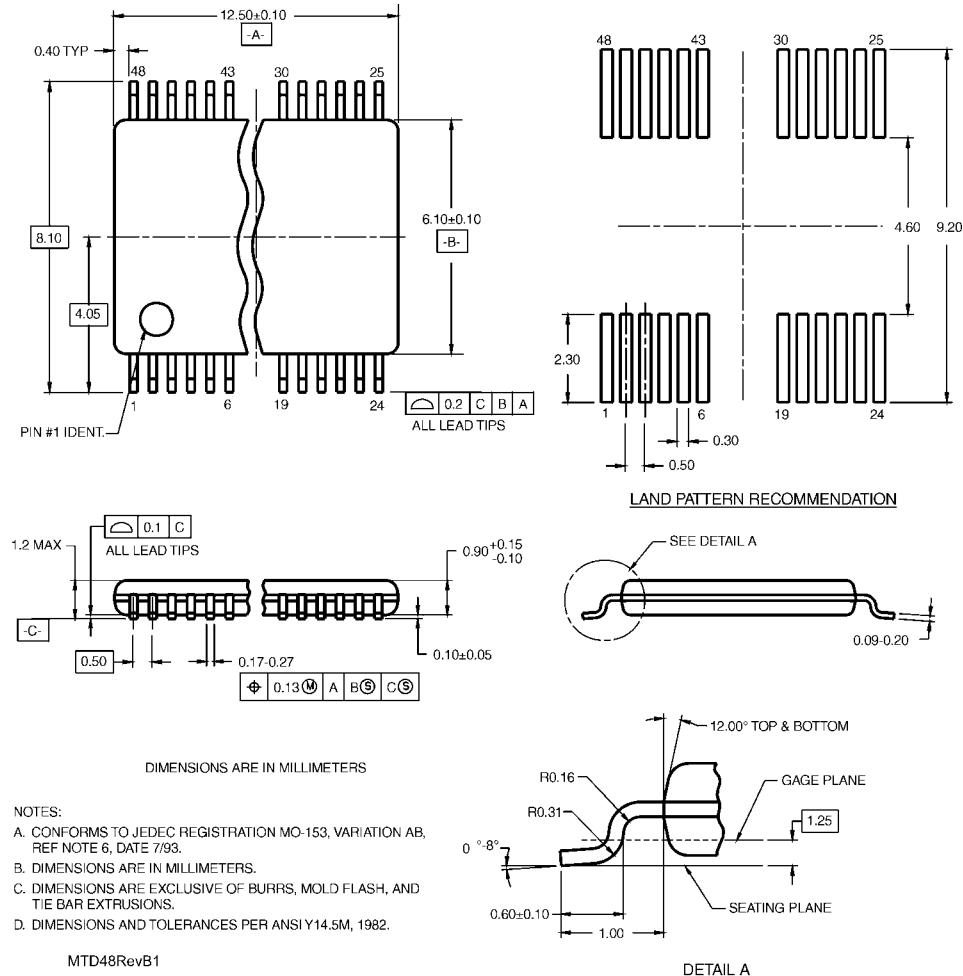
- A. THIS PACKAGE CONFORMS TO JEDEC M0-205
- B. ALL DIMENSIONS IN MILLIMETERS
- C. LAND PATTERN RECOMMENDATION: NSMD (Non Solder Mask Defined)  
.35MM DIA PADS WITH A SOLDERMASK OPENING OF .45MM CONCENTRIC TO PADS
- D. DRAWING CONFORMS TO ASME Y14.5M-1994

BGA54RevD

54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC M0-205, 5.5mm Wide  
Package Number BGA54A

## 74ALVC16374 Low Voltage 16-Bit D-Type Flip-Flop with 3.6V Tolerant Inputs and Outputs

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



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