FAIRCHILD SEMICONDUCTOR™

January 1999
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74LVT16373 • 74LVTH16373
Low Voltage 16-Bit Transparent Latch with 3-STATE Outputs

General Description

The LVT16373 and LVTH16373 contain sixteen non-inverting latches with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. The flip-flops appear transparent to the data when the Latch Enable (LE) is HIGH. When LE is LOW, the data that meets the setup time is latched. Data appears on the bus when the Output Enable ($\overline{OE}$) is LOW. When $\overline{OE}$ is HIGH, the outputs are in a high impedance state.

The LVTH16373 data inputs include bushold, eliminating the need for external pull-up resistors to hold unused inputs.

These latches are designed for low-voltage (3.3V) V_{CC} applications, but with the capability to provide a TTL interface to a 5V environment. The LVT16373 and LVTH16373 are fabricated with an advanced BiCMOS technology to achieve high speed operation similar to 5V ABT while maintaining a low power dissipation.

Features

- Input and output interface capability to systems at 5V V_{CC}
- Bushold data inputs eliminate the need for external pull-up resistors to hold unused inputs (74LVTH16373), also available without bushold feature (74LVT16373)
- Live insertion/extraction permitted
- Power Up/Power Down high impedance provides glitch-free bus loading
- Outputs source/sink −32 mA/+64 mA
- Functionally compatible with the 74 series 16373
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human-body model > 2000V
  - Machine model > 200V
  - Charged-device model > 1000V
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA) (Preliminary)

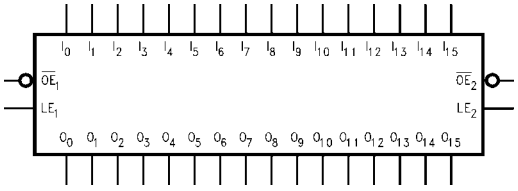
Ordering Code:

Order Number	Package Number	Package Description
74LVT16373GX (Note 1)	BGA54A (Preliminary)	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
74LVT16373MEA (Note 2)	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
74LVT16373MTD (Note 2)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide
74LVTH16373GX (Note 1)	BGA54A (Preliminary)	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
74LVTH16373MEA (Note 2)	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
74LVTH16373MTD (Note 2)	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Note 1: BGA package available in Tape and Reel only.

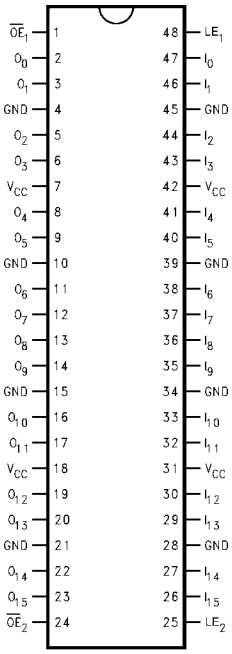
Note 2: Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

Logic Symbol

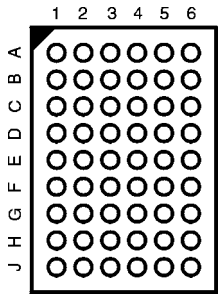


Connection Diagrams

Pin Assignment for SSOP and TSSOP



Pin Assignment for FBGA



(Top Thru View)

Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
LE_n	Latch Enable Input
I_0–I_{15}	Inputs
O_0–O_{15}	3-STATE Outputs
NC	No Connect

FBGA Pin Assignments

	1	2	3	4	5	6
A	O_0	NC	$\overline{OE}_1$	LE_1	NC	I_0
B	O_2	O_1	NC	NC	I_1	I_2
C	O_4	O_3	V_{CC}	V_{CC}	I_3	I_4
D	O_6	O_5	GND	GND	I_5	I_6
E	O_8	O_7	GND	GND	I_7	I_8
F	O_{10}	O_9	GND	GND	I_9	I_{10}
G	O_{12}	O_{11}	V_{CC}	V_{CC}	I_{11}	I_{12}
H	O_{14}	O_{13}	NC	NC	I_{13}	I_{14}
J	O_{15}	NC	$\overline{OE}_2$	LE_2	NC	I_{15}

Truth Tables

Inputs			Outputs
LE_1	$\overline{OE}_1$	I_0–I_7	O_0–O_7
X	H	X	Z
H	L	L	L
H	L	H	H
L	L	X	O_o

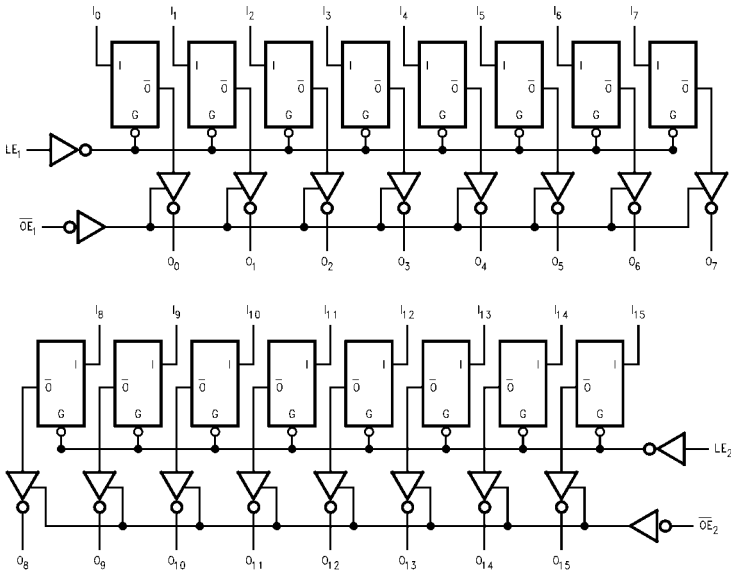
Inputs			Outputs
LE_2	$\overline{OE}_2$	I_8–I_{15}	O_8–O_{15}
X	H	X	Z
H	L	L	L
H	L	H	H
L	L	X	O_o

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = HIGH Impedance
O_o = Previous output prior to HIGH-to-LOW transition of LE

Functional Description

The LVT16373 and LVTH16373 contain sixteen D-type latches with 3-STATE standard outputs. The device is byte controlled with each byte functioning identically, but independent of the other. Control pins can be shorted together to obtain full 16-bit operation. The following description applies to each byte. When the Latch Enable (LE_n) input is HIGH, data on the D_n enters the latches. In this condition the latches are transparent, i.e, a latch output will change states each time its D input changes. When LE_n is LOW, the latches store information that was present on the D inputs a setup time preceding the HIGH-to-LOW transition of LE_n. The 3-STATE standard outputs are controlled by the Output Enable ($\overline{OE}_n$) input. When $\overline{OE}_n$ is LOW, the standard outputs are in the 2-state mode. When $\overline{OE}_n$ is HIGH, the standard outputs are in the high impedance mode but this does not interfere with entering new data into the latches.

Logic Diagrams



Please note that these diagrams are provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings(Note 3)

Symbol	Parameter	Value	Conditions	Units
V_{CC}	Supply Voltage	−0.5 to +4.6		V
V_I	DC Input Voltage	−0.5 to +7.0		V
V_O	DC Output Voltage	−0.5 to +7.0	Output in 3-STATE	V
		−0.5 to +7.0	Output in HIGH or LOW State (Note 4)	
I_{IK}	DC Input Diode Current	−50	V_I < GND	mA
I_{OK}	DC Output Diode Current	−50	V_O < GND	mA
I_O	DC Output Current	64	$V_O > V_{CC}$ Output at HIGH State	mA
		128	$V_O > V_{CC}$ Output at LOW State	
I_{CC}	DC Supply Current per Supply Pin	±64		mA
I_{GND}	DC Ground Current per Ground Pin	±128		mA
T_{STG}	Storage Temperature	−65 to +150		°C

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Units
V_{CC}	Supply Voltage	2.7	3.6	V
V_I	Input Voltage	0	5.5	V
I_{OH}	HIGH Level Output Current		−32	mA
I_{OL}	LOW Level Output Current		64	mA
T_A	Free-Air Operating Temperature	−40	85	°C
$\Delta t/\Delta V$	Input Edge Rate, V_{IN} = 0.8V–2.0V, V_{CC} = 3.0V	0	10	ns/V

Note 3: Absolute Maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum rated conditions is not implied.

Note 4: I_O Absolute Maximum Rating must be observed.

DC Electrical Characteristics

Symbol	Parameter		V_{CC} (V)	T_A = −40°C to +85°C Min	T_A = −40°C to +85°C Max	Units	Conditions
V_{IK}	Input Clamp Diode Voltage		2.7		−1.2	V	I_I = −18 mA
V_{IH}	Input HIGH Voltage		2.7–3.6	2.0		V	$V_O \le$ 0.1V or
V_{IL}	Input LOW Voltage		2.7–3.6		0.8	V	$V_O \ge V_{CC}$ − 0.1V
V_{OH}	Output HIGH Voltage		2.7–3.6	V_{CC} − 0.2		V	I_{OH} = −100 μA
			2.7	2.4			I_{OH} = −8 mA
			3.0	2.0			I_{OH} = −32 mA
V_{OL}	Output LOW Voltage		2.7		0.2	V	I_{OL} = 100 μA
			2.7		0.5		I_{OL} = 24 mA
			3.0		0.4		I_{OL} = 16 mA
			3.0		0.5		I_{OL} = 32 mA
			3.0		0.55		I_{OL} = 64 mA
$I_{I(HOLD)}$ (Note 5)	Bushold Input Minimum Drive		3.0	75		μA	V_I = 0.8V
				−75			V_I = 2.0V
$I_{I(OD)}$ (Note 5)	Bushold Input Over-Drive Current to Change State		3.0	500		μA	(Note 6)
				−500			(Note 7)
I_I	Input Current		3.6		10	μA	V_I = 5.5V
		Control Pins	3.6		±1		V_I = 0V or V_{CC}
		Data Pins	3.6		−5		V_I = 0V
					1		V_I = V_{CC}
I_{OFF}	Power Off Leakage Current		0		±100	μA	0V ≤ V_I or V_O ≤ 5.5V
$I_{PU/PD}$	Power Up/Down 3-STATE Output Current		0–1.5V		±100	μA	V_O = 0.5V to 3.0V, V_I = GND or V_{CC}
I_{OZL}	3-STATE Output Leakage Current		3.6		−5	μA	V_O = 0.5V
I_{OZH}	3-STATE Output Leakage Current		3.6		5	μA	V_O = 3.0V
I_{OZH^+}	3-STATE Output Leakage Current		3.6		10	μA	$V_{CC} < V_O \le$ 5.5V

DC Electrical Characteristics (Continued)

Symbol	Parameter	V_{CC} (V)	$T_A = -40°C$ to $+85°C$		Units	Conditions
			Min	Max		
I_{CCH}	Power Supply Current	3.6		0.19	mA	Outputs HIGH
I_{CCL}	Power Supply Current	3.6		5	mA	Outputs LOW
I_{CCZ}	Power Supply Current	3.6		0.19	mA	Outputs Disabled
I_{CCZ+}	Power Supply Current	3.6		0.19	mA	$V_{CC} \le V_O \le 5.5V$, Outputs Disabled
ΔI_{CC}	Increase in Power Supply Current (Note 8)	3.6		0.2	mA	One Input at $V_{CC} - 0.6V$ Other Inputs at V_{CC} or GND

Note 5: Applies to bushold versions only (74LVTH16373).

Note 6: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 7: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

Note 8: This is the increase in supply current for each input that is at the specified voltage level rather than V_{CC} or GND.

Dynamic Switching Characteristics (Note 9)

Symbol	Parameter	V_{CC} (V)	$T_A = 25°C$			Units	Conditions $C_L = 50$ pF, $R_L = 500\Omega$
			Min	Typ	Max		
V_{OLP}	Quiet Output Maximum Dynamic V_{OL}	3.3		0.8		V	(Note 10)
V_{OLV}	Quiet Output Minimum Dynamic V_{OL}	3.3		–0.8		V	(Note 10)

Note 9: Characterized in SSOP package. Guaranteed parameter, but not tested.

Note 10: Max number of outputs defined as (n). n–1 data inputs are driven 0V to 3V. Output under test held LOW.

AC Electrical Characteristics

Symbol	Parameter	$T_A = -40°C$ to $+85°C$, $C_L = 50$pF, $R_L = 500\Omega$				Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		
		Min	Max	Min	Max	
t_{PHL}	Propagation Delay	1.5	3.9	1.5	4.3	ns
t_{PLH}	D_n to O_n	1.5	3.8	1.5	4.2	
t_{PHL}	Propagation Delay	1.9	4.2	1.9	4.4	ns
t_{PLH}	LE to O_n	1.6	4.3	1.6	4.8	
t_{PZL}	Output Enable Time	1.3	4.3	1.3	4.9	ns
t_{PZH}		1.0	4.3	1.0	5.1	
t_{PLZ}	Output Disable Time	1.5	4.7	1.5	4.8	ns
t_{PHZ}		2.0	5.0	2.0	5.4	
t_S	Setup Time, D_n to LE	1.0		0.8		ns
t_H	Hold Time, D_n to LE	1.0		1.1		ns
t_W	LE Pulse Width	3.0		3.0		ns
t_{OSHL}	Output to Output Skew (Note 11)		1.0		1.0	ns
t_{OSLH}			1.0		1.0	

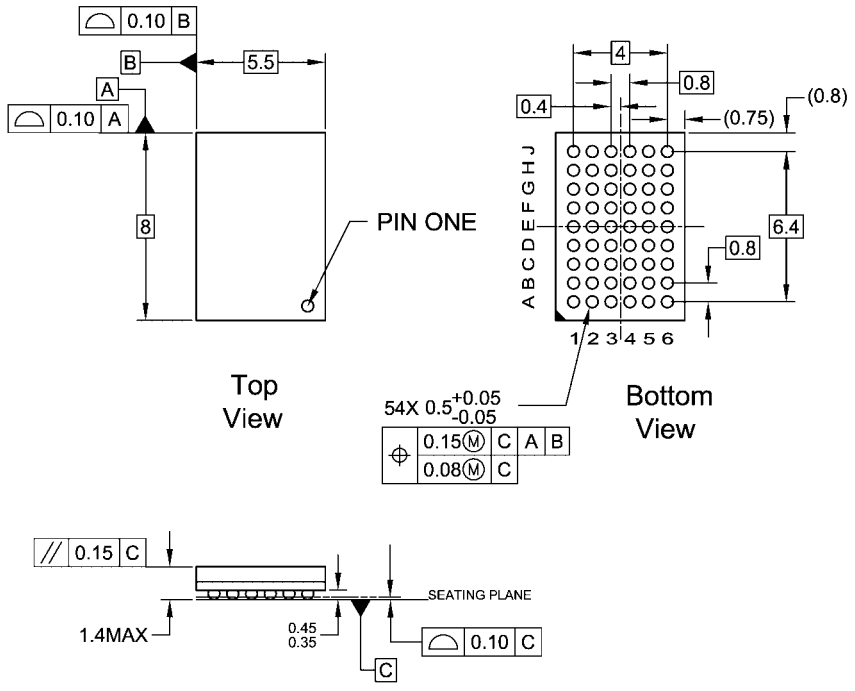
Note 11: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}).

Capacitance (Note 12)

Symbol	Parameter	Conditions	Typical	Units
C_{IN}	Input Capacitance	V_{CC} = Open, $V_I = 0V$ or V_{CC}	4	pF
C_{OUT}	Output Capacitance	$V_{CC} = 3.0V$, $V_O = 0V$ or V_{CC}	8	pF

Note 12: Capacitance is measured at frequency f = 1 MHz, per MIL-STD-883, Method 3012.

Physical Dimensions inches (millimeters) unless otherwise noted



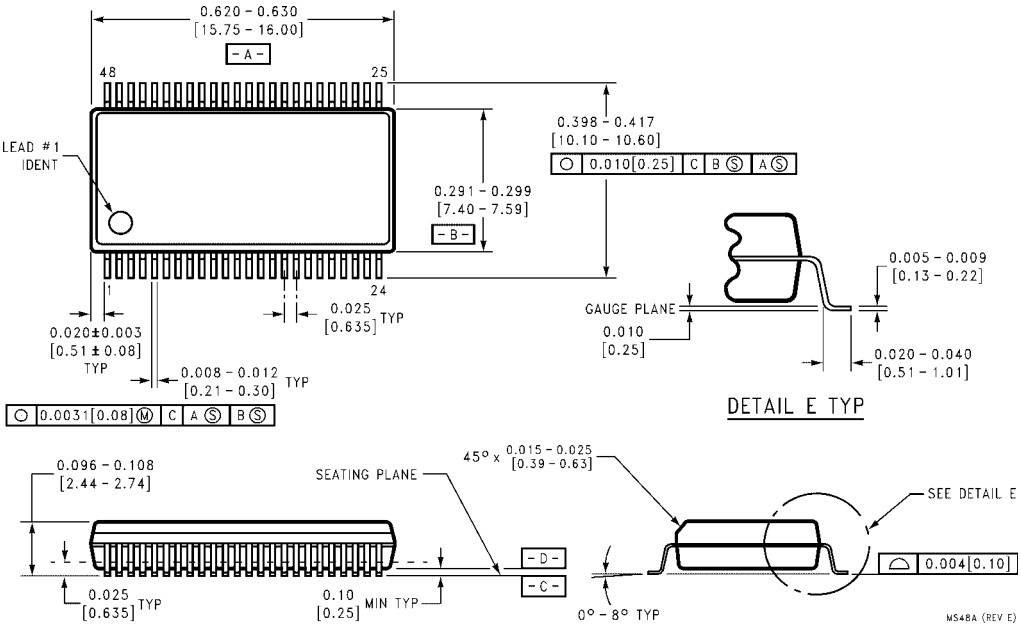
NOTES:

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

BGA54ArevD

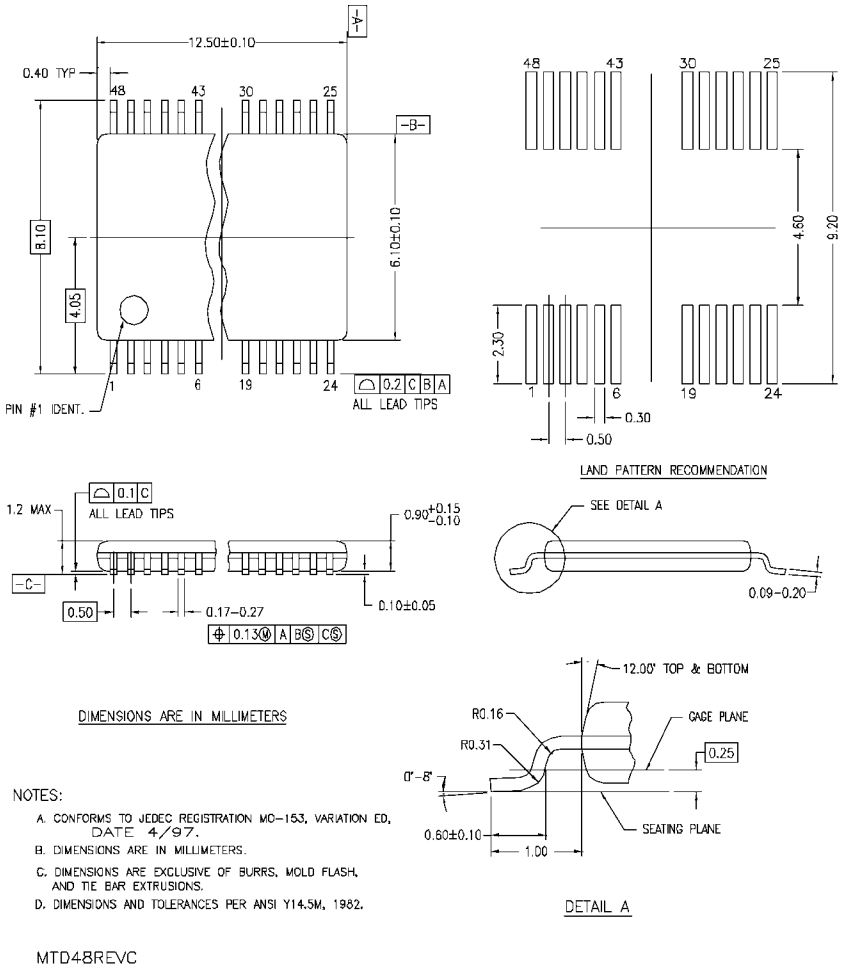
54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA54A
Preliminary

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



48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide
Package Number MS48A

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



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

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