

74LVTH162374

Low Voltage 16-Bit D-Type Flip-Flop with 3-STATE Outputs and 25Ω Series Resistors in the Outputs

General Description

The LVTH162374 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 (OE) are common to each byte and can be shorted together for full 16-bit operation.

The LVTH162374 is designed with equivalent 25Ω series resistance in both the HIGH and LOW states of the output. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers/transmitters.

The LVTH162374 data inputs include bushold, eliminating the need for external pull-up resistors to hold unused inputs.

These flip-flops are designed for low-voltage (3.3V) V_{CC} applications, but with the capability to provide a TTL interface to a 5V environment. The LVTH162374 is fabricated with an advanced BiCMOS technology to achieve high speed operation similar to 5V ABT while maintaining a low power dissipation.

Features

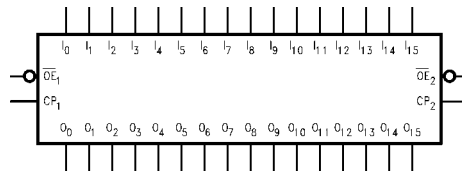
- Input and output interface capability to systems at 5V V_{CC}
- Bushold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- Power Up/Power Down high impedance provides glitch-free bus loading
- Outputs include equivalent series resistance of 25Ω to make external termination resistors unnecessary and reduce overshoot and undershoot
- Functionally compatible with the 74 series 16374
- 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
74LVTH162374GX (Note 1)	BGA54A (Preliminary)	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
74LVTH162374MEA	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide [TUBES]
74LVTH162374MEX	MS48A	48-Lead Small Shrink Outline Package (SSOP), JEDEC MO-118, 0.300" Wide [TAPE and REEL]
74LVTH162374MTD	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [TUBES]
74LVTH162374MTX	MTD48	48-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide [TAPE and REEL]

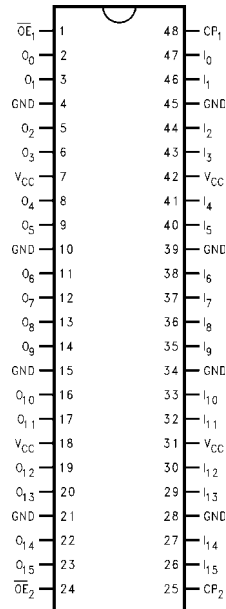
Note 1: BGA package available in Tape and Reel only.

Logic Symbol

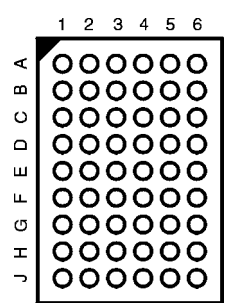


Connection Diagrams

Pin Assignments for SSOP and TSSOP



Pin Assignment for FBGA



(Top Thru View)

Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
CP_n	Clock Pulse 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	$\overline{OE}_1$	CP_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	$\overline{OE}_2$	CP_2	NC	I_{15}

Truth Tables

Inputs			Outputs
CP_1	$\overline{OE}_1$	I_0-I_7	O_0-O_7
	L	H	H
	L	L	L
L	L	X	O_0
X	H	X	Z

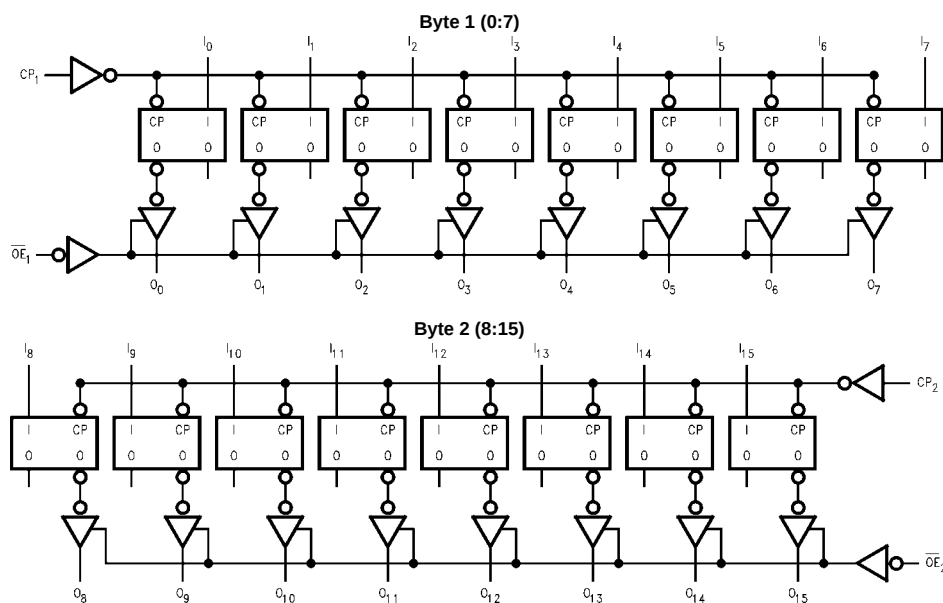
Inputs			Outputs
CP_2	$\overline{OE}_2$	I_8-I_{15}	O_8-O_{15}
	L	H	H
	L	L	L
L	L	X	O_0
X	H	X	Z

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = HIGH Impedance
 O_0 = Previous O_0 before HIGH-to-LOW of CP

Functional Description

The LVTH162374 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 byte 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 D-type 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. Operation of the $\overline{OE}_n$ input does not affect the state of the flip-flops.

Logic Diagrams



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

Absolute Maximum Ratings(Note 2)

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 3)	
I_{IK}	DC Input Diode Current	-50	$V_I < \text{GND}$	mA
I_{OK}	DC Output Diode Current	-50	$V_O < \text{GND}$	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		-12	mA
I_{OL}	LOW Level Output Current		12	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 2: 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 3: I_O Absolute Maximum Rating must be observed.

DC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		Units	Conditions
			Min	Max		
V_{IK}	Input Clamp Diode Voltage	2.7		-1.2	V	$I_I = -18 \text{ mA}$
V_{IH}	Input HIGH Voltage	2.7-3.6	2.0		V	$V_O \leq 0.1V$ or
V_{IL}	Input LOW Voltage	2.7-3.6		0.8	V	$V_O \geq V_{CC} - 0.1V$
V_{OH}	Output HIGH Voltage	2.7-3.6	$V_{CC} - 0.2$		V	$I_{OH} = -100 \mu\text{A}$
		3.0	2.0		V	$I_{OH} = -12 \text{ mA}$
V_{OL}	Output LOW Voltage	2.7		0.2	V	$I_{OL} = 100 \mu\text{A}$
		3.0		0.8	V	$I_{OL} = 12 \text{ mA}$
$I_{I(HOLD)}$	Bushold Input Minimum Drive	3.0	75		μA	$V_I = 0.8V$
			-75			$V_I = 2.0V$
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State	3.0	500		μA	(Note 4)
			-500			(Note 5)
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	$0V \leq V_I$ or $V_O \leq 5.5V$
$I_{PU/PD}$	Power Up/Down 3-STATE	0-1.5V		± 100	μA	$V_O = 0.5V$ to $3.0V$
	Output Current					$V_I = \text{GND}$ 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	$V_{CC} < V_O \leq 5.5V$
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

DC Electrical Characteristics (Continued)

Symbol	Parameter	V _{CC} (V)	T _A = -40°C to +85°C		Units	Conditions
			Min	Max		
I _{CCZ} ⁺	Power Supply Current	3.6		0.19	mA	V _{CC} ≤ V _O ≤ 5.5V, Outputs Disabled
ΔI _{CC}	Increase in Power Supply Current (Note 6)	3.6		0.2	mA	One Input at V _{CC} - 0.6V Other Inputs at V _{CC} or GND

Note 4: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 5: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

Note 6: 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 7)

Symbol	Parameter	V _{CC} (V)	T _A = 25°C			Units	Conditions C _L = 50 pF, R _L = 500Ω
			Min	Typ	Max		
V _{OLP}	Quiet Output Maximum Dynamic V _{OL}	3.3		0.8		V	(Note 8)
V _{OLV}	Quiet Output Minimum Dynamic V _{OL}	3.3		-0.8		V	(Note 8)

Note 7: Characterized in SSOP package. Guaranteed parameter, but not tested.

Note 8: Max number of outputs defined as (n). n-1 data inputs are driven 0V to 3V. Output under test held LOW.

AC Electrical Characteristics

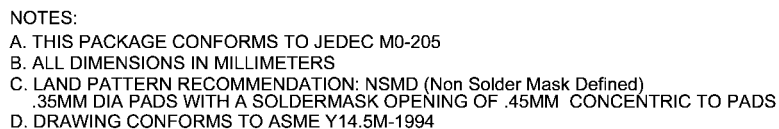
Symbol	Parameter	T _A = -40°C to +85°C, C _L = 50 pF, R _L = 500Ω				Units
		V _{CC} = 3.3V ± 0.3V		V _{CC} = 2.7V		
		Min	Max	Min	Max	
f _{MAX}	Maximum Clock Frequency	160		150		MHz
t _{PHL}	Propagation Delay	2.0	5.1	2.0	5.3	ns
t _{PLH}	CP to O _n	1.6	5.3	1.6	6.2	
t _{PZL}	Output Enable Time	1.8	5.0	1.8	6.0	ns
t _{PZH}		1.2	5.6	1.2	6.9	
t _{PLZ}	Output Disable Time	1.9	5.0	1.9	5.1	ns
t _{PHZ}		2.0	5.4	2.0	5.7	
t _S	Setup Time	1.8		2.0		ns
t _H	Hold Time	0.8		0.1		ns
t _W	Pulse Width	3.0		3.0		ns
t _{OSHL}	Output to Output Skew (Note 9)		1.0		1.0	ns
t _{OSLH}			1.0		1.0	

Note 9: 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 10)

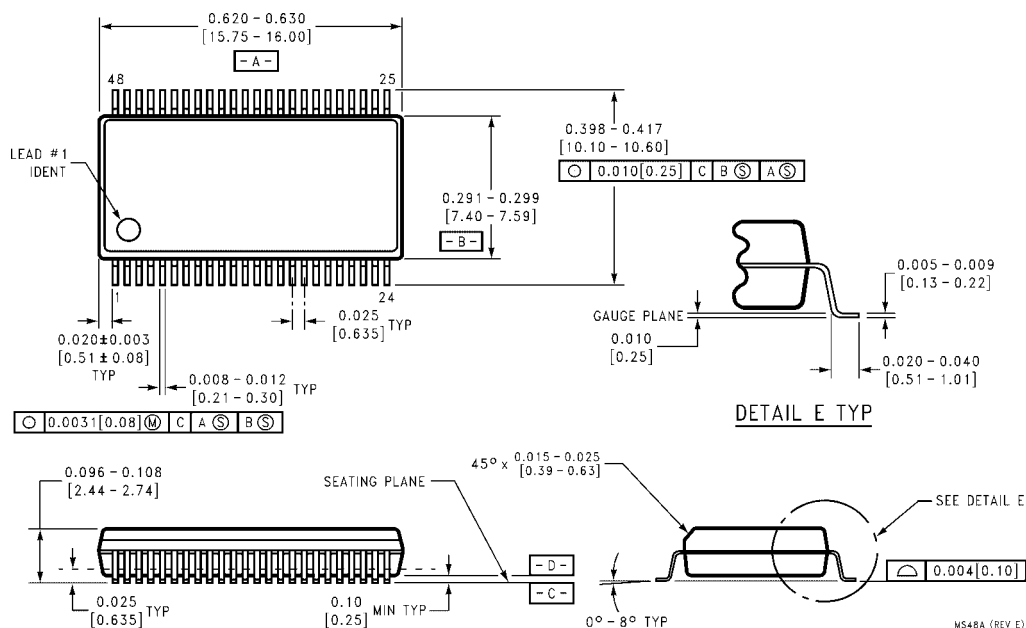
Symbol	Parameter	Conditions	Typical	Units
C _{IN}	Input Capacitance	V _{CC} = OPEN, V _I = 0V or V _{CC}	4	pF
C _{OUT}	Output Capacitance	V _{CC} = 3.0V, V _O = 0V or V _{CC}	8	pF

Note 10: Capacitance is measured at frequency f = 1 MHz, per MIL-STD-883, Method 3012.

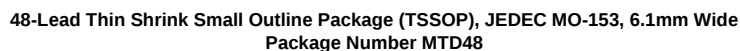


**54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide
Package Number BGA54A
(Preliminary)**

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



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



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