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Revised May 2000

74LVTH16500 Low Voltage 18-Bit Universal Bus Transceivers

## 74LVTH16500 Low Voltage 18-Bit Universal Bus Transceivers with 3-STATE Outputs (Preliminary)

### General Description

The LVTH16500 is an 18-bit universal bus transceiver combining D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes.

Data flow in each direction is controlled by output-enable (OEAB and OEBA), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs.

The LVTH16500 data inputs include bushold, eliminating the need for external pull-up resistors to hold unused inputs.

The transceiver is designed for low voltage (3.3V)  $V_{CC}$  applications, but with the capability to provide a TTL interface to a 5V environment. The LVTH16500 is fabricated with an advanced BiCMOS technology to achieve high speed operation similar to 5V ABT while maintaining low power dissipation.

### Features

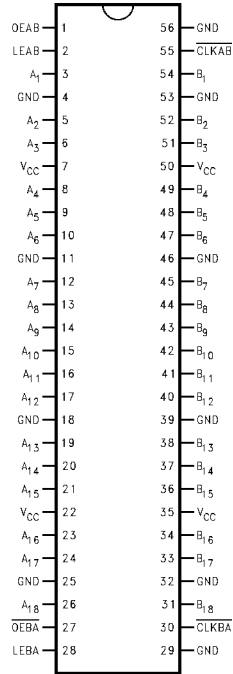
- Input and output interface capability to systems at 5V  $V_{CC}$
- Bushold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- Power Up/Down high impedance provides glitch-free bus loading
- Outputs source/sink -32 mA/+64 mA
- Functionally compatible with the 74 series 16500
- Latch-up performance exceeds 500 mA

### Ordering Code:

Order Number	Package Number	Package Description
74LVTH16500MEA	MS56A	56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300 Wide
74LVTH16500MTD	MTD56	56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Devices also available in Tape and Reel. Specify by appending the suffix "X" to the ordering code.

### Connection Diagram



### Pin Descriptions

Pin Names	Description
A <sub>1</sub> -A <sub>18</sub>	Data Register A Inputs/3-STATE Outputs
B <sub>1</sub> -B <sub>18</sub>	Data Register B Inputs/3-STATE Outputs
CLKAB, CLKBA	Clock Pulse Inputs
LEAB, LEBA	Latch Enable Inputs
OEAB, OEBA	Output Enable Inputs

### Function Table (Note 1)

Inputs				Output B
OEAB	LEAB	CLKAB	A	
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	↓	L	L
H	L	↓	H	H
H	L	H	X	B <sub>0</sub> (Note 2)
H	L	L	X	B <sub>0</sub> (Note 3)

H = HIGH Voltage Level      L = LOW Voltage Level  
 X = Immaterial                  Z = High Impedance  
 ↓ = HIGH-to-LOW Clock Transition

**Note 1:** A-to-B data flow is shown: B-to-A flow is similar but uses OEBA, LEBA, and CLKBA.

**Note 2:** Output level before the indicated steady-state input conditions were established.

**Note 3:** Output level before the indicated steady-state input conditions were established, provided that CLKAB was LOW before LEAB went LOW.

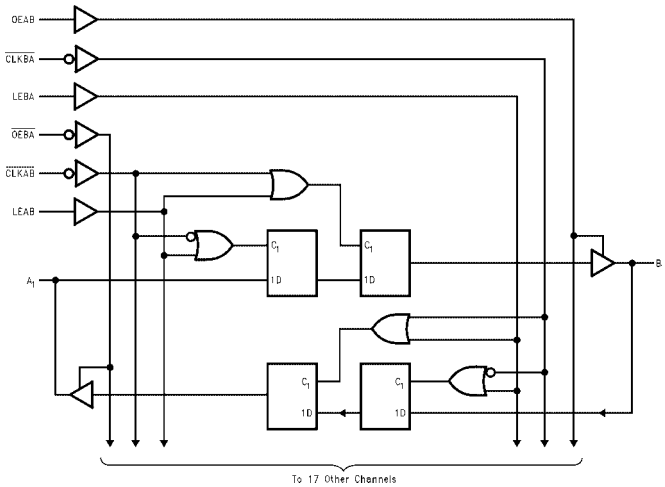
### Functional Description

For A-to-B data flow, the device operates in the transparent mode when LEAB is HIGH. When LEAB is LOW, the A data is latched if CLKAB is held at a HIGH or LOW logic level. If LEAB is LOW, the A bus data is stored in the latch/flip-flop on the HIGH-to-LOW transition of CLKAB. Output-enable OEAB is active-HIGH. When OEAB is HIGH, the

outputs are active. When OEAB is LOW, the outputs are in the high-impedance state.

Data flow for B-to-A is similar to that of A-to-B but uses OEBA, LEBA, and CLKBA. The output enables are complementary (OEAB is active-HIGH and OEBA is active-LOW).

### Logic Diagram



Absolute Maximum Ratings <sup>(Note 4)</sup>				
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 5)	V
$I_{IK}$	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	$\pm 64$		mA
$I_{GND}$	DC Ground Current per Ground Pin	$\pm 128$		mA
$T_{STG}$	Storage Temperature	-65 to +150		$^{\circ}C$

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	$^{\circ}C$
$\Delta t/\Delta V$	Input Edge Rate, $V_{IN} = 0.8V - 2.0V$ , $V_{CC} = 3.0V$	0	10	ns/V

**Note 4:** 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 5:**  $I_O$  Absolute Maximum Rating must be observed.

## DC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C		Units	Conditions
			Min	Max		
V <sub>IK</sub>	Input Clamp Diode Voltage	2.7		-1.2	V	I <sub>I</sub> = -18 mA
V <sub>IH</sub>	Input HIGH Voltage	2.7-3.6	2.0		V	V <sub>O</sub> ≤ 0.1V or V <sub>O</sub> ≥ V <sub>CC</sub> - 0.1V
V <sub>IL</sub>	Input LOW Voltage	2.7-3.6		0.8	V	
V <sub>OH</sub>	Output HIGH Voltage	2.7-3.6	V <sub>CC</sub> - 0.2		V	I <sub>OH</sub> = -100 μA
		2.7	2.4		V	I <sub>OH</sub> = -8 mA
		3.0	2.0		V	I <sub>OH</sub> = -32 mA
V <sub>OL</sub>	Output LOW Voltage	2.7		0.2	V	I <sub>OL</sub> = 100 μA
		2.7		0.5	V	I <sub>OL</sub> = 24 mA
		3.0		0.4	V	I <sub>OL</sub> = 16 mA
		3.0		0.5	V	I <sub>OL</sub> = 32 mA
		3.0		0.55	V	I <sub>OL</sub> = 64 mA
I <sub>I(HOLD)</sub>	Bushold Input Minimum Drive	3.0	75		μA	V <sub>I</sub> = 0.8V
			-75		μA	V <sub>I</sub> = 2.0V
I <sub>I(OD)</sub>	Bushold Input Over-Drive Current to Change State	3.0	500		μA	(Note 6)
			-500		μA	(Note 7)
I <sub>I</sub>	Input Current	3.6		10	μA	V <sub>I</sub> = 5.5V
		Control Pins	3.6	±1	μA	V <sub>I</sub> = 0V or V <sub>CC</sub>
		Data Pins	3.6	-5	μA	V <sub>I</sub> = 0V
				1	μA	V <sub>I</sub> = V <sub>CC</sub>
I <sub>OFF</sub>	Power Off Leakage Current	0		±100	μA	0V ≤ V <sub>I</sub> or V <sub>O</sub> ≤ 5.5V
I <sub>PU/PD</sub>	Power Up/Down 3-STATE Output Current	0-1.5V		±100	μA	V <sub>O</sub> = 0.5V to 3.0V V <sub>I</sub> = GND or V <sub>CC</sub>
I <sub>OZL</sub>	3-STATE Output Leakage Current	3.6		-5	μA	V <sub>O</sub> = 0.0V
I <sub>OZH</sub>	3-STATE Output Leakage Current	3.6		5	μA	V <sub>O</sub> = 3.6V
I <sub>OZH+</sub>	3-STATE Output Leakage Current	3.6		10	μA	V <sub>CC</sub> < V <sub>O</sub> ≤ 5.5V
I <sub>CCH</sub>	Power Supply Current	3.6		0.19	mA	Outputs HIGH
I <sub>CCL</sub>	Power Supply Current	3.6		5	mA	Outputs LOW
I <sub>CCZ</sub>	Power Supply Current	3.6		0.19	mA	Outputs Disabled
I <sub>CCZ+</sub>	Power Supply Current	3.6		0.19	mA	V <sub>CC</sub> ≤ V <sub>O</sub> ≤ 5.5V, Outputs Disabled
ΔI <sub>CC</sub>	Increase in Power Supply Current (Note 8)	3.6		0.2	mA	One Input at V <sub>CC</sub> - 0.6V Other Inputs at V <sub>CC</sub> or GND

**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<sub>CC</sub> or GND.

## Dynamic Switching Characteristics (Note 9)

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			Units	Conditions C <sub>L</sub> = 50 pF, R <sub>L</sub> = 500Ω
			Min	Typ	Max		
V <sub>OLP</sub>	Quiet Output Maximum Dynamic V <sub>OL</sub>	3.3		0.8		V	(Note 10)
V <sub>OLV</sub>	Quiet Output Minimum Dynamic V <sub>OL</sub>	3.3		-0.8		V	(Note 10)

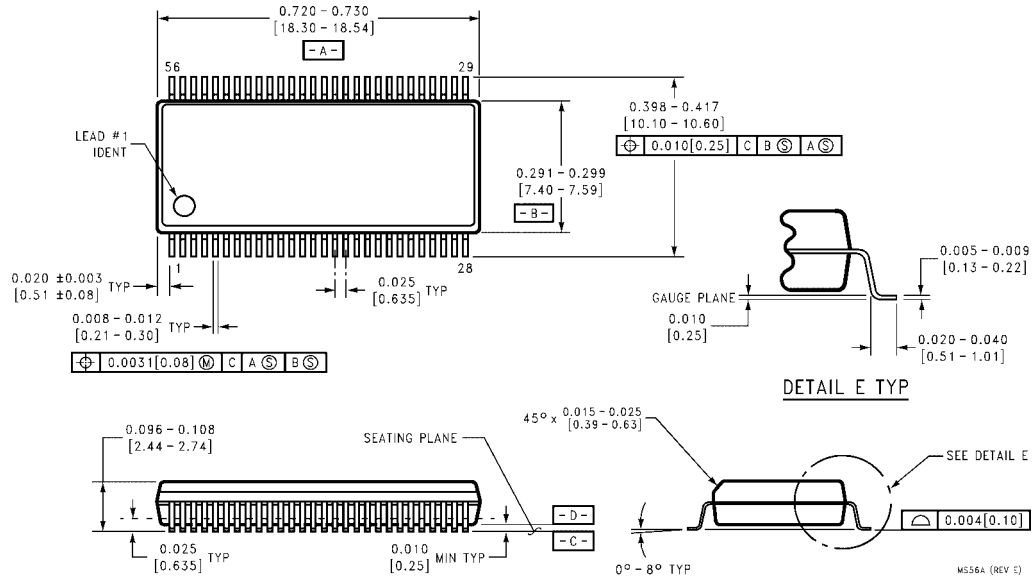
**Note 9:** Characterized in SSOP package. Guaranteed parameter, but not tested.

**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	$T_A = -40^\circ\text{C to } +85^\circ\text{C}, C_L = 50 \text{ pF}, R_L = 500 \Omega$				Units															
		$V_{CC} = 3.3 \pm 0.3\text{V}$		$V_{CC} = 2.7\text{V}$																	
		Min	Max	Min	Max																
$f_{MAX}$		150		150		MHz															
$t_{PLH}$	Propagation Delay	1.3	3.7	1.3	4.0	ns															
$t_{PHL}$	Data to Outputs	1.3	3.7	1.3	4.0																
$t_{PLH}$	Propagation Delay	1.5	5.1	1.5	5.7	ns															
$t_{PHL}$	LEBA or LEAB to B or A	1.5	5.1	1.5	5.7																
$t_{PLH}$	Propagation Delay	1.3	5.0	1.3	5.9	ns															
$t_{PHL}$	CLKBA or CLKAB to B or A	1.3	5.0	1.3	5.9																
$t_{PZH}$	Output Enable Time	1.3	4.8	1.3	5.5	ns															
$t_{PZL}$		1.3	4.8	1.3	5.5																
$t_{PHZ}$	Output Disable Time	1.7	5.8	1.7	6.3	ns															
$t_{PLZ}$		1.7	5.8	1.7	6.3																
$t_{SU}$	Setup Time	A before $\overline{\text{CLKAB}}$	2.9		2.9	ns															
		B before $\overline{\text{CLKBA}}$	2.9		2.9																
		A or B before LE, $\overline{\text{CLK}}$ HIGH	1.4		0.5																
		A or B before LE, $\overline{\text{CLK}}$ LOW	2.9		2.3																
$t_H$	Hold Time	A or B after $\overline{\text{CLK}}$	0.4		0.4	ns															
		A or B after LE	1.6		1.6																
$t_W$	Pulse Duration	LE HIGH	3.3		3.3	ns															
		$\overline{\text{CLK}}$ HIGH or LOW	3.3		3.3																
$t_{OSLH}$	Output to Output Skew (Note 11)		1.0		1.0	ns															
$t_{OSHL}$			1.0		1.0																
<p><b>Note 11:</b> 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 (<math>t_{OSHL}</math>) or LOW-to-HIGH (<math>t_{OSLH}</math>).</p>																					
<p><b>Capacitance</b> (Note 12)</p> <table border="1"> <thead> <tr> <th>Symbol</th> <th>Parameter</th> <th>Conditions</th> <th>Typical</th> <th>Units</th> </tr> </thead> <tbody> <tr> <td><math>C_{IN}</math></td> <td>Input Capacitance</td> <td><math>V_{CC} = 0\text{V}, V_I = 0\text{V or } V_{CC}</math></td> <td>4</td> <td>pF</td> </tr> <tr> <td><math>C_{I/O}</math></td> <td>Input/Output Capacitance</td> <td><math>V_{CC} = 3.0\text{V}, V_O = 0\text{V or } V_{CC}</math></td> <td>8</td> <td>pF</td> </tr> </tbody> </table> <p><b>Note 12:</b> Capacitance is measured at frequency <math>f = 1 \text{ MHz}</math>, per MIL-STD-883, Method 3012.</p>							Symbol	Parameter	Conditions	Typical	Units	$C_{IN}$	Input Capacitance	$V_{CC} = 0\text{V}, V_I = 0\text{V or } V_{CC}$	4	pF	$C_{I/O}$	Input/Output Capacitance	$V_{CC} = 3.0\text{V}, V_O = 0\text{V or } V_{CC}$	8	pF
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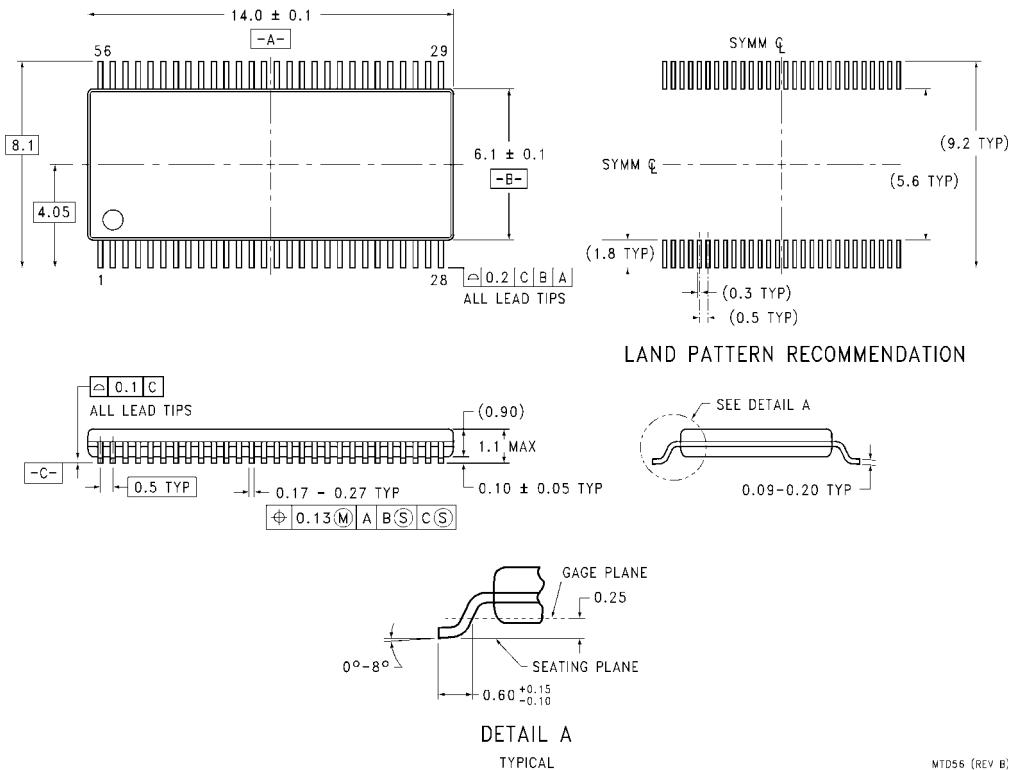
74LVTH16500

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



**56-Lead Shrink Small Outline Package (SSOP), JEDEC MO-118, 0.300 Wide  
Package Number MS56A**

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



**56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide  
Package Number MTD56**

MTD56 (REV. B)

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