

## 74LCX32500

### Low Voltage 36-Bit Universal Bus Transceivers with 5V Tolerant Inputs and Outputs

#### General Description

These 36-bit universal bus transceivers combine 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 ( $\overline{\text{OEAB}}$  and  $\overline{\text{OEBA}}$ ), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs.

The LCX32500 is designed for low voltage (2.5V or 3.3V)  $V_{CC}$  applications with the capability of interfacing to a 5V signal environment.

The LCX32500 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power.

#### Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 6.0 ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 20  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Uses patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V
- Packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

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

#### Ordering Code:

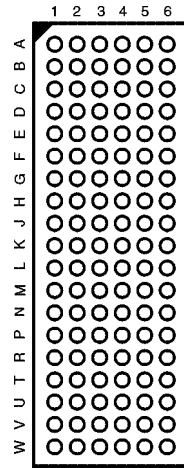
Order Number	Package Number	Package Description
74LCX32500G (Note 2)(Note 3)	BGA114A	114-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide

**Note 2:** Ordering code "G" indicates Trays.

**Note 3:** Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

74LCX32500 Low Voltage 36-Bit Universal Bus Transceivers with 5V Tolerant Inputs and Outputs

### Connection Diagram



(Top Thru View)

### Truth Table (Note 4)

Inputs				Output
OEAB <sub>n</sub>	LEAB <sub>n</sub>	CLKAB <sub>n</sub>	A <sub>n</sub>	B <sub>n</sub>
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 5)
H	L	L	X	B <sub>0</sub> (Note 6)

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial (HIGH or LOW, inputs may not float)  
 Z = High Impedance

**Note 4:** A-to-B data flow is shown; B-to-A flow is similar but uses OEBA, LEBA, and CLKBA.

**Note 5:** Output level before the indicated steady-state input conditions were established.

**Note 6:** 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 LCX32500 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

### Pin Descriptions

Pin Names	Description
1A <sub>1</sub> - 1A <sub>18</sub> 2A <sub>1</sub> - 2A <sub>18</sub>	Data Register A Inputs/3-STATE Outputs
1B <sub>1</sub> - 1B <sub>18</sub> 2B <sub>1</sub> - 2B <sub>18</sub>	Data Register B Inputs/3-STATE Outputs
CLKAB <sub>1</sub> , CLKBA <sub>1</sub> CLKAB <sub>2</sub> , CLKBA <sub>2</sub>	Clock Pulse Inputs
LEAB <sub>1</sub> , LEBA <sub>1</sub> LEAB <sub>2</sub> , LEBA <sub>2</sub>	Latch Enable Inputs
OEAB <sub>1</sub> , OEBA <sub>1</sub> OEAB <sub>2</sub> , OEBA <sub>2</sub>	Output Enable Inputs

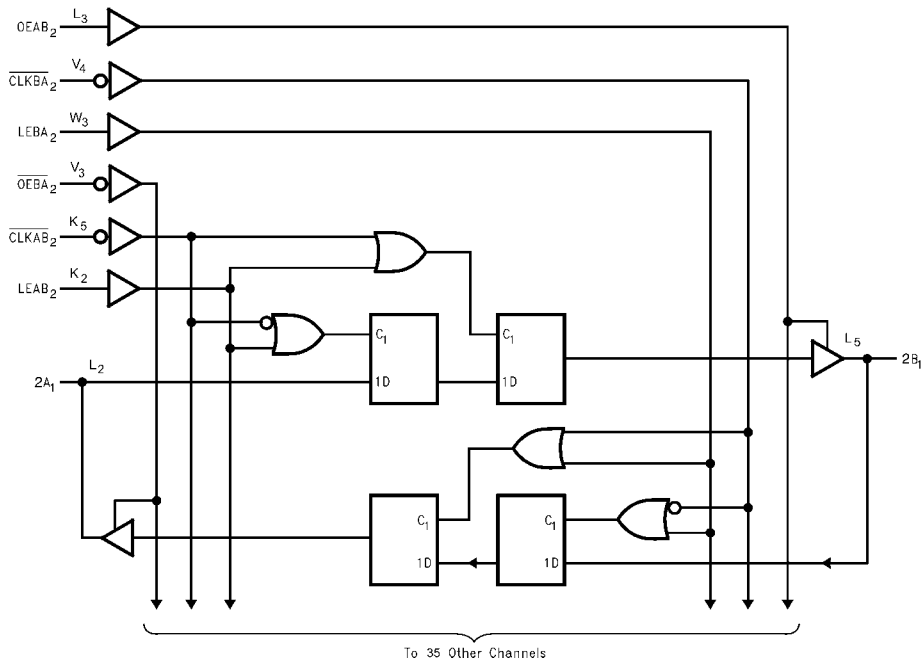
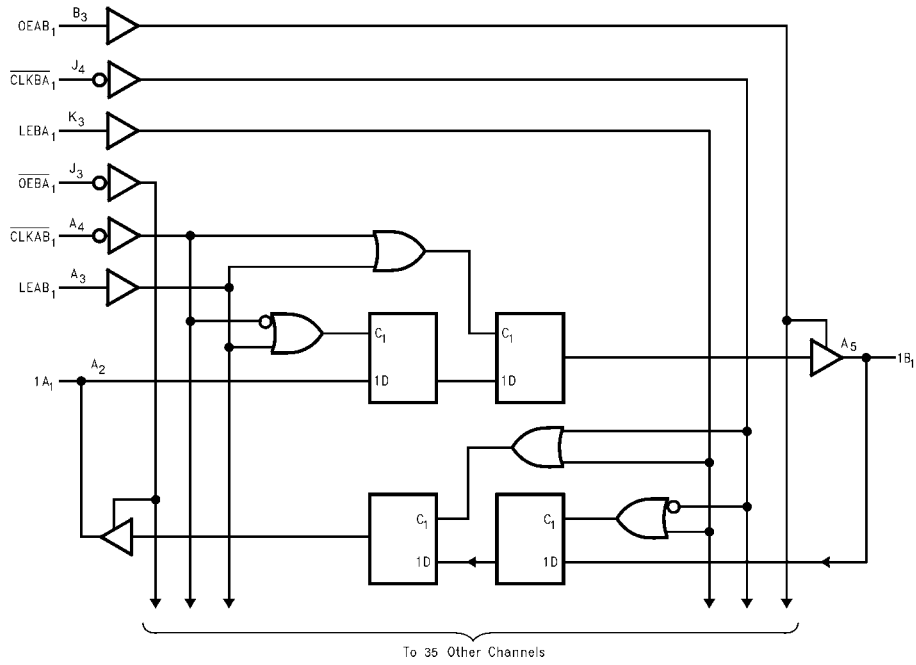
### FBGA Pin Assignments

	1	2	3	4	5	6
<b>A</b>	1A <sub>2</sub>	1A <sub>1</sub>	LEAB <sub>1</sub>	CLKAB <sub>1</sub>	1B <sub>1</sub>	1B <sub>2</sub>
<b>B</b>	1A <sub>4</sub>	1A <sub>3</sub>	OEAB <sub>1</sub>	GND	1B <sub>3</sub>	1B <sub>4</sub>
<b>C</b>	1A <sub>6</sub>	1A <sub>5</sub>	GND	GND	1B <sub>5</sub>	1B <sub>6</sub>
<b>D</b>	1A <sub>8</sub>	1A <sub>7</sub>	V <sub>CC</sub>	V <sub>CC</sub>	1B <sub>7</sub>	1B <sub>8</sub>
<b>E</b>	1A <sub>10</sub>	1A <sub>9</sub>	GND	GND	1B <sub>9</sub>	1B <sub>10</sub>
<b>F</b>	1A <sub>12</sub>	1A <sub>11</sub>	GND	GND	1B <sub>11</sub>	1B <sub>12</sub>
<b>G</b>	1A <sub>14</sub>	1A <sub>13</sub>	V <sub>CC</sub>	V <sub>CC</sub>	1B <sub>13</sub>	1B <sub>14</sub>
<b>H</b>	1A <sub>15</sub>	1A <sub>16</sub>	GND	GND	1B <sub>16</sub>	1B <sub>15</sub>
<b>J</b>	1A <sub>17</sub>	1A <sub>18</sub>	OEBA <sub>1</sub>	CLKBA <sub>1</sub>	1B <sub>18</sub>	1B <sub>17</sub>
<b>K</b>	NC	LEAB <sub>2</sub>	LEBA <sub>1</sub>	GND	CLKAB <sub>2</sub>	NC
<b>L</b>	2A <sub>2</sub>	2A <sub>1</sub>	OEAB <sub>2</sub>	GND	2B <sub>1</sub>	2B <sub>2</sub>
<b>M</b>	2A <sub>4</sub>	2A <sub>3</sub>	GND	GND	2B <sub>3</sub>	2B <sub>4</sub>
<b>N</b>	2A <sub>6</sub>	2A <sub>5</sub>	V <sub>CC</sub>	V <sub>CC</sub>	2B <sub>5</sub>	2B <sub>6</sub>
<b>P</b>	2A <sub>8</sub>	2A <sub>7</sub>	GND	GND	2B <sub>7</sub>	2B <sub>8</sub>
<b>R</b>	2A <sub>10</sub>	2A <sub>9</sub>	GND	GND	2B <sub>9</sub>	2B <sub>10</sub>
<b>T</b>	2A <sub>12</sub>	2A <sub>11</sub>	V <sub>CC</sub>	V <sub>CC</sub>	2B <sub>11</sub>	2B <sub>12</sub>
<b>U</b>	2A <sub>14</sub>	2A <sub>13</sub>	GND	GND	2B <sub>13</sub>	2B <sub>14</sub>
<b>V</b>	2A <sub>15</sub>	2A <sub>16</sub>	OEBA <sub>2</sub>	CLKBA <sub>2</sub>	2B <sub>16</sub>	2B <sub>15</sub>
<b>W</b>	2A <sub>17</sub>	2A <sub>18</sub>	LEBA <sub>2</sub>	GND	2B <sub>18</sub>	2B <sub>17</sub>

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 Diagrams



Absolute Maximum Ratings (Note 7)						
Symbol	Parameter	Value	Conditions	Units		
$V_{CC}$	Supply Voltage	-0.5 to +7.0		V		
$V_I$	DC Input Voltage	-0.5 to +7.0		V		
$V_O$	DC Output Voltage	-0.5 to +7.0 -0.5 to $V_{CC} + 0.5$	Output in 3-STATE Output in HIGH or LOW State (Note 8)	V		
$I_{IK}$	DC Input Diode Current	-50	$V_I < GND$	mA		
$I_{OK}$	DC Output Diode Current	-50 +50	$V_O < GND$ $V_O > V_{CC}$	mA		
$I_O$	DC Output Source/Sink Current	$\pm 50$		mA		
$I_{CC}$	DC Supply Current per Supply Pin	$\pm 100$		mA		
$I_{GND}$	DC Ground Current per Ground Pin	$\pm 100$		mA		
$T_{STG}$	Storage Temperature	-65 to +150		°C		
Recommended Operating Conditions (Note 9)						
Symbol	Parameter	Min	Max	Units		
$V_{CC}$	Supply Voltage	Operating	2.0	3.6	V	
		Data Retention	1.5	3.6		
$V_I$	Input Voltage	0	5.5	V		
$V_O$	Output Voltage	HIGH or LOW State	0	$V_{CC}$	V	
		3-STATE	0	5.5		
$I_{OH}/I_{OL}$	Output Current	$V_{CC} = 3.0V - 3.6V$		$\pm 24$	mA	
		$V_{CC} = 2.7V - 3.0V$		$\pm 12$		
		$V_{CC} = 2.3V - 2.7V$		$\pm 8$		
$T_A$	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		
<p><b>Note 7:</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.</p> <p><b>Note 8:</b> <math>I_O</math> Absolute Maximum Rating must be observed.</p> <p><b>Note 9:</b> Unused (inputs or I/O's) must be held HIGH or LOW. They may not float.</p>						
DC Electrical Characteristics						
Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^\circ C$ to $+85^\circ C$		Units
				Min	Max	
$V_{IH}$	HIGH Level Input Voltage		2.3 - 2.7	1.7		V
			2.7 - 3.6	2.0		
$V_{IL}$	LOW Level Input Voltage		2.3 - 2.7		0.7	V
			2.7 - 3.6		0.8	
$V_{OH}$	HIGH Level Output Voltage	$I_{OH} = -100 \mu A$	2.3 - 3.6	$V_{CC} - 0.2$		V
			2.3	1.8		
			2.7	2.2		
			3.0	2.4		
			3.0	2.2		
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu A$	2.3 - 3.6		0.2	V
			2.3		0.6	
			2.7		0.4	
			3.0		0.4	
			3.0		0.55	
$I_I$	Input Leakage Current	$0 \leq V_I \leq 5.5V$	2.3 - 3.6		$\pm 5.0$	$\mu A$
$I_{OZ}$	3-STATE I/O Leakage	$0 \leq V_O \leq 5.5V$ $V_I = V_{IH}$ or $V_{IL}$	2.3 - 3.6		$\pm 5.0$	$\mu A$
$I_{OFF}$	Power-Off Leakage Current	$V_I$ or $V_O = 5.5V$	0		10	$\mu A$

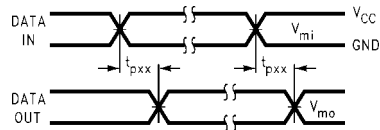
DC Electrical Characteristics (Continued)								
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C		Units		
				Min	Max			
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	2.3 – 3.6		20	μA		
		3.6V ≤ V <sub>I</sub> , V <sub>O</sub> ≤ 5.5V (Note 10)	2.3 – 3.6		±20			
ΔI <sub>CC</sub>	Increase in I <sub>CC</sub> per Input	V <sub>IH</sub> = V <sub>CC</sub> - 0.6V	2.3 – 3.6		500	μA		
<b>Note 10:</b> Outputs disabled or 3-STATE only.								
AC Electrical Characteristics								
Symbol	Parameter	T <sub>A</sub> = -40°C to +85°C, R <sub>L</sub> = 500 Ω						Units
		V <sub>CC</sub> = 3.3V ± 0.3V		V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 2.5V ± 0.2V		
		C <sub>L</sub> = 50 pF		C <sub>L</sub> = 50 pF		C <sub>L</sub> = 30 pF		
		Min	Max	Min	Max	Min	Max	
f <sub>MAX</sub>	Maximum Clock Frequency	170						MHz
t <sub>PHL</sub>	Propagation Delay	1.5	6.0	1.5	7.0	1.5	7.2	ns
t <sub>PLH</sub>	Bus to Bus	1.5	6.0	1.5	7.0	1.5	7.2	
t <sub>PHL</sub>	Propagation Delay	1.5	6.7	1.5	8.0	1.5	8.4	ns
t <sub>PLH</sub>	Clock to Bus	1.5	6.7	1.5	8.0	1.5	8.4	
t <sub>PHL</sub>	Propagation Delay	1.5	7.0	1.5	8.0	1.5	8.4	ns
t <sub>PLH</sub>	LE to Bus	1.5	7.0	1.5	8.0	1.5	8.4	
t <sub>PZL</sub>	Output Enable Time	1.5	7.2	1.5	8.2	1.5	9.4	ns
t <sub>PZH</sub>		1.5	7.2	1.5	8.2	1.5	9.4	
t <sub>PLZ</sub>	Output Disable Time	1.5	7.0	1.5	8.0	1.5	8.4	ns
t <sub>PHZ</sub>		1.5	7.0	1.5	8.0	1.5	8.4	
t <sub>S</sub>	Setup Time	2.5		2.5		3.0		ns
t <sub>H</sub>	Hold Time	1.5		1.5		2.0		ns
t <sub>W</sub>	Pulse Width	3.0		3.0		3.5		ns
Dynamic Switching Characteristics								
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C		Units		
				Typical				
V <sub>OLP</sub>	Quiet Output Dynamic Peak V <sub>OL</sub>	C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	3.3	0.8		V		
		C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V	2.5	0.6				
V <sub>OLV</sub>	Quiet Output Dynamic Valley V <sub>OL</sub>	C <sub>L</sub> = 50 pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	3.3	-0.8		V		
		C <sub>L</sub> = 30 pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V	2.5	-0.6				
Capacitance								
Symbol	Parameter	Conditions	Typical	Units				
C <sub>IN</sub>	Input Capacitance	V <sub>CC</sub> = Open, V <sub>I</sub> = 0V or V <sub>CC</sub>	7	pF				
C <sub>I/O</sub>	Input/Output Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub>	8	pF				
C <sub>PD</sub>	Power Dissipation Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub> , f = 10 MHz	20	pF				

**AC LOADING and WAVEFORMS** Generic for LCX Family

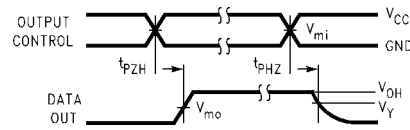


**FIGURE 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)**

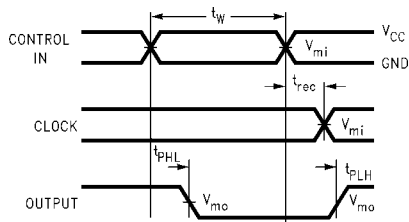
Test	Switch
$t_{PLH}, t_{PHL}$	Open
$t_{PZH}, t_{PHZ}$	6V at $V_{CC} = 3.3 \pm 0.3V$ , and 2.7V $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$
$t_{PZL}, t_{PLZ}$	GND



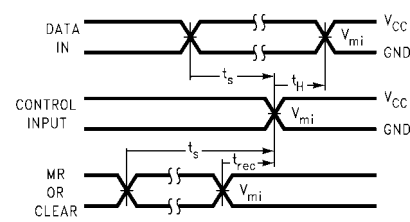
**Waveform for Inverting and Non-Inverting Functions**



**3-STATE Output High Enable and Disable Times for Logic**



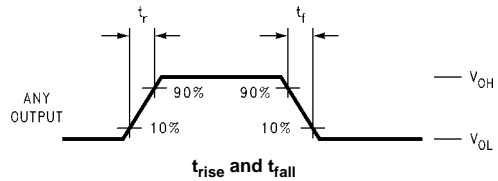
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



**Setup Time, Hold Time and Recovery Time for Logic**



**3-STATE Output Low Enable and Disable Times for Logic**



**FIGURE 2. Waveforms (Input Characteristics;  $f = 1MHz, t_r = t_f = 3ns$ )**

Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	2.7V	$2.5V \pm 0.2V$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

**Schematic Diagram** Generic for LCX Family



74LCX32500

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

PIN ONE

Top View

Bottom View

114X0.5 <sup>+0.05</sup> / <sub>-0.05</sub>
0.15(M) C A B
0.08(M) C

SEATING PLANE

NOTES:

- A. THIS PACKAGE CONFORMS TO JEDEC MO-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

BGA114ArevE

**114-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide  
Package Number BGA114A**

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