

## 74LCX32245

### Low Voltage 32-Bit Bidirectional Transceiver with 5V Tolerant Inputs and Outputs

#### General Description

The LCX32245 contains thirty-two non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The device is designed for low voltage (2.5V or 3.3V)  $V_{CC}$  applications with capability of interfacing to a 5V signal environment. The device is byte controlled. Each byte has separate control inputs which could be shorted together for full 32-bit operation. The T/R inputs determine the direction of data flow through the device. The OE inputs disable both the A and B ports by placing them in a high impedance state.

The LCX32245 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

#### Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 4.5 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, OE should be tied to  $V_{CC}$  through a pull-up resistor; the minimum value or the resistor is determined by the current-sourcing capability of the driver.

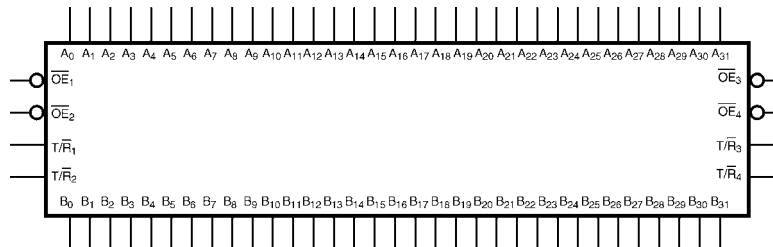
#### Ordering Code:

Order Number	Package Number	Package Description
74LCX32245G (Note 2)(Note 3)	BGA96A	96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide

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

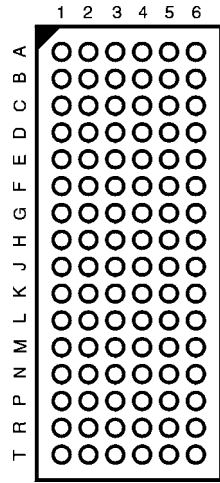
**Note 3:** Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Logic Symbol



74LCX32245 Low Voltage 32-Bit Bidirectional Transceiver with 5V Tolerant Inputs and Outputs

### Connection Diagram



(Top Thru View)

### Pin Descriptions

Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active LOW)
$T/\overline{R}_n$	Transmit/Receive Input
A <sub>0</sub> -A <sub>31</sub>	Side A Inputs or 3-STATE Outputs
B <sub>0</sub> -B <sub>31</sub>	Side B Inputs or 3-STATE Outputs

### FBGA Pin Assignments

	1	2	3	4	5	6
<b>A</b>	B <sub>1</sub>	B <sub>0</sub>	$T/\overline{R}_1$	$\overline{OE}_1$	A <sub>0</sub>	A <sub>1</sub>
<b>B</b>	B <sub>3</sub>	B <sub>2</sub>	GND	GND	A <sub>2</sub>	A <sub>3</sub>
<b>C</b>	B <sub>5</sub>	B <sub>4</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>4</sub>	A <sub>5</sub>
<b>D</b>	B <sub>7</sub>	B <sub>6</sub>	GND	GND	A <sub>6</sub>	A <sub>7</sub>
<b>E</b>	B <sub>9</sub>	B <sub>8</sub>	GND	GND	A <sub>8</sub>	A <sub>9</sub>
<b>F</b>	B <sub>11</sub>	B <sub>10</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>10</sub>	A <sub>11</sub>
<b>G</b>	B <sub>13</sub>	B <sub>12</sub>	GND	GND	A <sub>12</sub>	A <sub>13</sub>
<b>H</b>	B <sub>14</sub>	B <sub>15</sub>	$T/\overline{R}_2$	$\overline{OE}_2$	A <sub>15</sub>	A <sub>14</sub>
<b>J</b>	B <sub>17</sub>	B <sub>16</sub>	$T/\overline{R}_3$	$\overline{OE}_3$	A <sub>16</sub>	A <sub>17</sub>
<b>K</b>	B <sub>19</sub>	B <sub>18</sub>	GND	GND	A <sub>18</sub>	A <sub>19</sub>
<b>L</b>	B <sub>21</sub>	B <sub>20</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>20</sub>	A <sub>21</sub>
<b>M</b>	B <sub>23</sub>	B <sub>22</sub>	GND	GND	A <sub>22</sub>	A <sub>23</sub>
<b>N</b>	B <sub>25</sub>	B <sub>24</sub>	GND	GND	A <sub>24</sub>	A <sub>25</sub>
<b>P</b>	B <sub>27</sub>	B <sub>26</sub>	V <sub>CC</sub>	V <sub>CC</sub>	A <sub>26</sub>	A <sub>27</sub>
<b>R</b>	B <sub>29</sub>	B <sub>28</sub>	GND	GND	A <sub>28</sub>	A <sub>29</sub>
<b>T</b>	B <sub>30</sub>	B <sub>31</sub>	$T/\overline{R}_4$	$\overline{OE}_4$	A <sub>31</sub>	A <sub>30</sub>

### Truth Tables

Inputs		Outputs
$\overline{OE}_1$	$T/\overline{R}_1$	
L	L	Bus B <sub>0</sub> -B <sub>7</sub> Data to Bus A <sub>0</sub> -A <sub>7</sub>
L	H	Bus A <sub>0</sub> -A <sub>7</sub> Data to Bus B <sub>0</sub> -B <sub>7</sub>
H	X	HIGH Z State on A <sub>0</sub> -A <sub>7</sub> , B <sub>0</sub> -B <sub>7</sub>

Inputs		Outputs
$\overline{OE}_2$	$T/\overline{R}_2$	
L	L	Bus B <sub>8</sub> -B <sub>15</sub> Data to Bus A <sub>8</sub> -A <sub>15</sub>
L	H	Bus A <sub>8</sub> -A <sub>15</sub> Data to Bus B <sub>8</sub> -B <sub>15</sub>
H	X	HIGH Z State on A <sub>8</sub> -A <sub>15</sub> , B <sub>8</sub> -B <sub>15</sub>

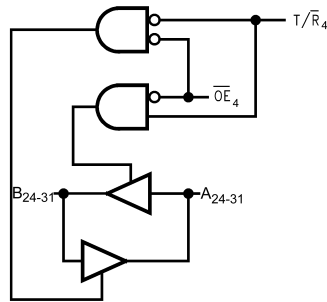
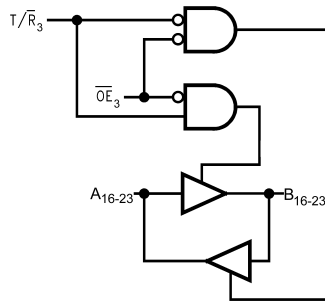
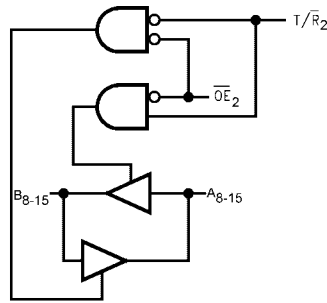
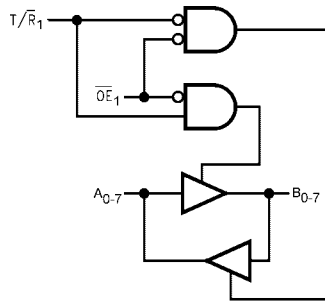
Inputs		Outputs
$\overline{OE}_3$	$T/\overline{R}_3$	
L	L	Bus B <sub>16</sub> -B <sub>23</sub> Data to Bus A <sub>16</sub> -A <sub>23</sub>
L	H	Bus A <sub>16</sub> -A <sub>23</sub> Data to Bus B <sub>16</sub> -B <sub>23</sub>
H	X	HIGH Z State on A <sub>16</sub> -A <sub>23</sub> , B <sub>16</sub> -B <sub>23</sub>

Inputs		Outputs
$\overline{OE}_4$	$T/\overline{R}_4$	
L	L	Bus B <sub>24</sub> -B <sub>31</sub> Data to Bus A <sub>24</sub> -A <sub>31</sub>
L	H	Bus A <sub>24</sub> -A <sub>31</sub> Data to Bus B <sub>24</sub> -B <sub>31</sub>
H	X	HIGH Z State on A <sub>24</sub> -A <sub>31</sub> , B <sub>24</sub> -B <sub>31</sub>

H = HIGH Voltage Level  
L = LOW Voltage Level

X = Immaterial (HIGH or LOW, inputs and I/O's may not float)  
Z = High Impedance

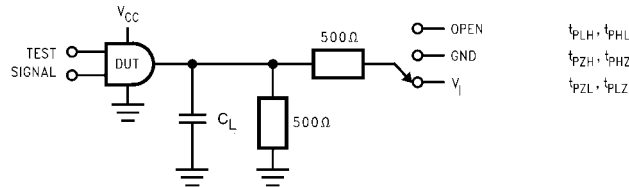
Logic Diagrams



Absolute Maximum Ratings (Note 4)						
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 5)	V		
$I_{IK}$	DC Input Diode Current	-50	$V_I < \text{GND}$	mA		
$I_{OK}$	DC Output Diode Current	-50 +50	$V_O < \text{GND}$ $V_O > V_{CC}$	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 6)						
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 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.</p> <p><b>Note 5:</b> <math>I_O</math> Absolute Maximum Rating must be observed.</p> <p><b>Note 6:</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)	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		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	$I_{OH} = -100 \mu\text{A}$	2.3 - 3.6	$V_{CC} - 0.2$		V
		$I_{OH} = -8 \text{ mA}$	2.3	1.8		
		$I_{OH} = -12 \text{ mA}$	2.7	2.2		
		$I_{OH} = -18 \text{ mA}$	3.0	2.4		
		$I_{OH} = -24 \text{ mA}$	3.0	2.2		
$V_{OL}$	LOW Level Output Voltage	$I_{OL} = 100 \mu\text{A}$	2.3 - 3.6		0.2	V
		$I_{OL} = 8 \text{ mA}$	2.3		0.6	
		$I_{OL} = 12 \text{ mA}$	2.7		0.4	
		$I_{OL} = 16 \text{ mA}$	3.0		0.4	
		$I_{OL} = 24 \text{ mA}$	3.0		0.55	
$I_I$	Input Leakage Current	$0 \leq V_I \leq 5.5V$	2.3 - 3.6		$\pm 5.0$	$\mu\text{A}$
$I_{OZ}$	3-STATE I/O Leakage	$0 \leq V_O \leq 5.5V$ $V_I = V_{IH}$ or $V_{IL}$	2.3 - 3.6		$\pm 5.0$	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current	$V_I$ or $V_O = 5.5V$	0		10	$\mu\text{A}$

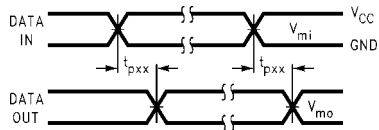
DC Electrical Characteristics (Continued)								
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C		Units		
				Min	Max			
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	2.3-3.6		20	μA		
		3.6V ≤ V <sub>I</sub> , V <sub>O</sub> ≤ 5.5V (Note 7)	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 7:</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> = 500Ω						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	
t <sub>PHL</sub>	Propagation Delay	1.5	4.5	1.5	5.2	1.5	5.4	ns
t <sub>PLH</sub>	A <sub>n</sub> to B <sub>n</sub> or B <sub>n</sub> to A <sub>n</sub>	1.5	4.5	1.5	5.2	1.5	5.4	
t <sub>PZL</sub>	Output Enable Time	1.5	6.5	1.5	7.2	1.5	8.5	ns
t <sub>PZH</sub>	Output Disable Time	1.5	6.5	1.5	7.2	1.5	8.5	
t <sub>PLZ</sub>	Output Disable Time	1.5	6.4	1.5	6.9	1.5	7.7	ns
t <sub>PHZ</sub>	Output Disable Time	1.5	6.4	1.5	6.9	1.5	7.7	
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

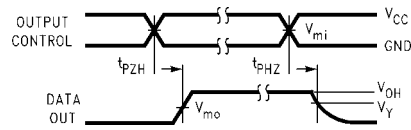


**FIGURE 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)**

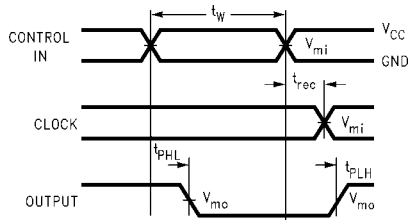
Test	Switch
$t_{PLH}$ , $t_{PHL}$	Open
$t_{PZL}$ , $t_{PLZ}$	6V at $V_{CC} = 3.3 \pm 0.3V$ , and 2.7V $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$
$t_{PZH}$ , $t_{PHZ}$	GND



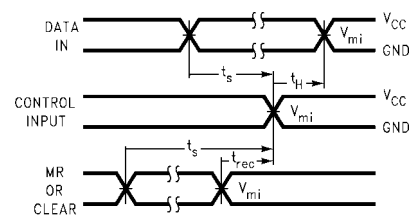
**Waveform for Inverting and Non-Inverting Functions**



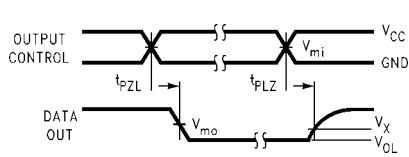
**3-STATE Output High Enable and Disable Times for Logic**



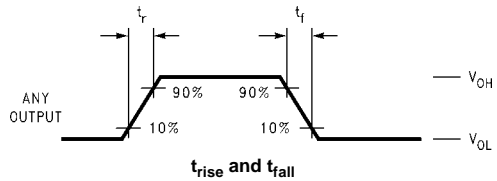
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



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



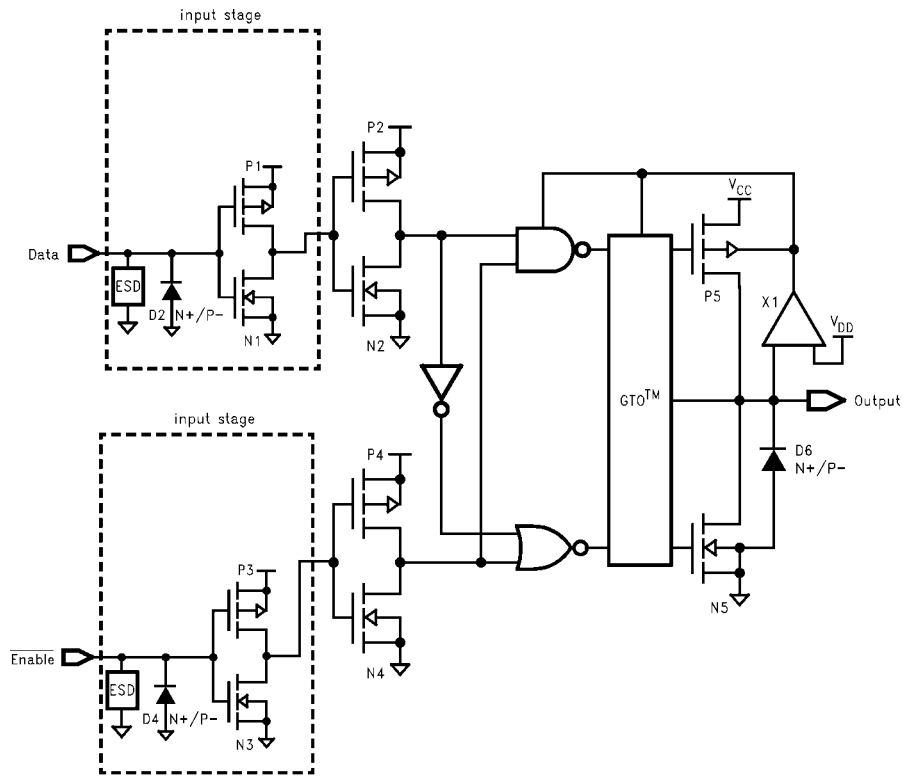
**3-STATE Output Low Enable and Disable Times for Logic**



**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



74LCX32245

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

**Top View**

**Bottom View**

**Side View**

**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

BGA96ArevE

**96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide  
 Package Number BGA96A**

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