



August 2001  
Revised August 2001

## 74LCX32646 Low Voltage 32-Bit Transceiver/Register with 5V Tolerant Inputs and Outputs (Preliminary)

### General Description

The LCX32646 contains thirty-two non-inverting bidirectional registered bus transceivers with 3-STATE outputs, providing multiplexed transmission of data directly from the input bus or from the internal storage registers. Each byte has separate control inputs which can be shorted together for full 32-bit operation. The DIR<sub>n</sub> inputs determine the direction of data flow through the device. The CPAB<sub>n</sub> and CPBA<sub>n</sub> inputs load data into the registers on the LOW-to-HIGH transition (see Functional Description).

The LCX32646 is designed for low voltage (2.5V or 3.3V) V<sub>CC</sub> applications with capability of interfacing to a 5V signal environment.

The LCX32646 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<sub>CC</sub> specifications provided
- 5.2 ns t<sub>PD</sub> max (V<sub>CC</sub> = 3.3V), 20 μA I<sub>CC</sub> max
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ±24 mA Output Drive (V<sub>CC</sub> = 3.0V)
- Implements 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) (Preliminary)

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

### Ordering Code:

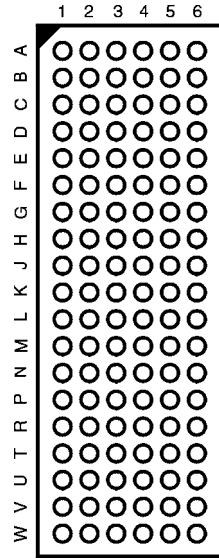
Order Number	Package Number	Package Description
74LCX32646GX (Note 2)	BGA114A (Preliminary)	114-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]

**Note 2:** BGA package available in Tape and Reel only.

74LCX32646 Low Voltage 32-Bit Transceiver/Register with 5V Tolerant Inputs and Outputs (Preliminary)

**Connection Diagram**

Pin Assignment for FBGA



(Top Thru View)

**Pin Descriptions**

Pin Names	Description
1A <sub>0</sub> - 1A <sub>15</sub>	Side A Inputs or 3-STATE Outputs
2A <sub>0</sub> - 2A <sub>15</sub>	Side A Inputs or 3-STATE Outputs
1B <sub>0</sub> - 1B <sub>15</sub>	Side B Inputs or 3-STATE Outputs
2B <sub>0</sub> - 2B <sub>15</sub>	Side B Inputs or 3-STATE Outputs
$\overline{OE}_n$	Output Enable Inputs
CPAB <sub>n</sub> , CPBA <sub>n</sub>	Clock Pulse Inputs
SAB <sub>n</sub> , SBA <sub>n</sub>	Select Inputs
DIR <sub>n</sub>	Direction Control Inputs
NC	No Connect

**FBGA Pin Assignments**

	1	2	3	4	5	6
<b>A</b>	1A <sub>0</sub>	SAB <sub>1</sub>	CPAB <sub>1</sub>	CPBA <sub>1</sub>	SBA <sub>1</sub>	1B <sub>0</sub>
<b>B</b>	1A <sub>2</sub>	1A <sub>1</sub>	DIR <sub>1</sub>	$\overline{OE}_1$	1B <sub>1</sub>	1B <sub>2</sub>
<b>C</b>	1A <sub>4</sub>	1A <sub>3</sub>	GND	GND	1B <sub>3</sub>	1B <sub>4</sub>
<b>D</b>	1A <sub>6</sub>	1A <sub>5</sub>	V <sub>CC</sub>	V <sub>CC</sub>	1B <sub>5</sub>	1B <sub>6</sub>
<b>E</b>	1A <sub>8</sub>	1A <sub>7</sub>	GND	GND	1B <sub>7</sub>	1B <sub>8</sub>
<b>F</b>	1A <sub>10</sub>	1A <sub>9</sub>	GND	GND	1B <sub>9</sub>	1B <sub>10</sub>
<b>G</b>	1A <sub>12</sub>	1A <sub>11</sub>	V <sub>CC</sub>	V <sub>CC</sub>	1B <sub>11</sub>	1B <sub>12</sub>
<b>H</b>	1A <sub>13</sub>	1A <sub>14</sub>	GND	GND	1B <sub>14</sub>	1B <sub>13</sub>
<b>J</b>	1A <sub>15</sub>	SAB <sub>2</sub>	CPAB <sub>2</sub>	CPBA <sub>2</sub>	SBA <sub>2</sub>	1B <sub>15</sub>
<b>K</b>	NC	CPAB <sub>3</sub>	DIR <sub>2</sub>	$\overline{OE}_2$	CPBA <sub>3</sub>	NC
<b>L</b>	2A <sub>0</sub>	SAB <sub>3</sub>	DIR <sub>3</sub>	$\overline{OE}_3$	SBA <sub>3</sub>	2B <sub>0</sub>
<b>M</b>	2A <sub>2</sub>	2A <sub>1</sub>	GND	GND	2B <sub>1</sub>	2B <sub>2</sub>
<b>N</b>	2A <sub>4</sub>	2A <sub>3</sub>	V <sub>CC</sub>	V <sub>CC</sub>	2B <sub>3</sub>	2B <sub>4</sub>
<b>P</b>	2A <sub>6</sub>	2A <sub>5</sub>	GND	GND	2B <sub>5</sub>	2B <sub>6</sub>
<b>R</b>	2A <sub>8</sub>	2A <sub>7</sub>	GND	GND	2B <sub>7</sub>	2B <sub>8</sub>
<b>T</b>	2A <sub>10</sub>	2A <sub>9</sub>	V <sub>CC</sub>	V <sub>CC</sub>	2B <sub>9</sub>	2B <sub>10</sub>
<b>U</b>	2A <sub>12</sub>	2A <sub>11</sub>	GND	GND	2B <sub>11</sub>	2B <sub>12</sub>
<b>V</b>	2A <sub>13</sub>	2A <sub>14</sub>	CPAB <sub>4</sub>	CPBA <sub>4</sub>	2B <sub>14</sub>	2B <sub>13</sub>
<b>W</b>	2A <sub>15</sub>	SAB <sub>4</sub>	DIR <sub>4</sub>	$\overline{OE}_4$	SBA <sub>4</sub>	2B <sub>15</sub>

**Truth Table**

(Note 3)

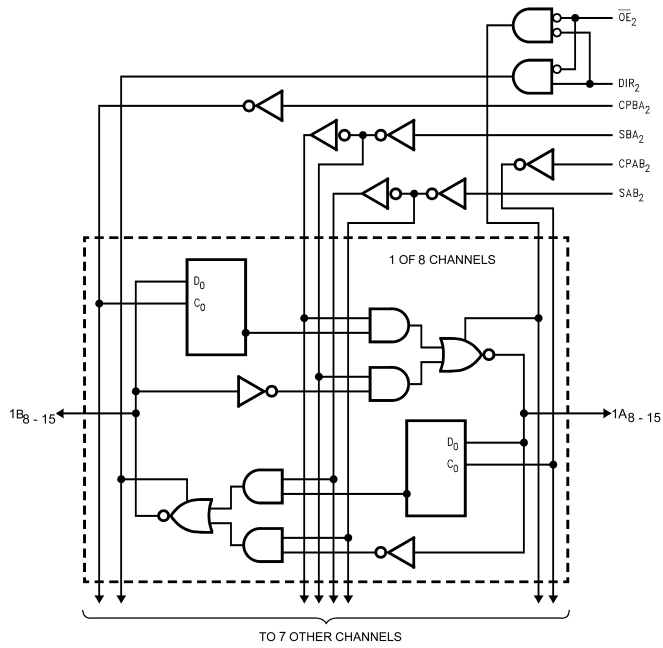
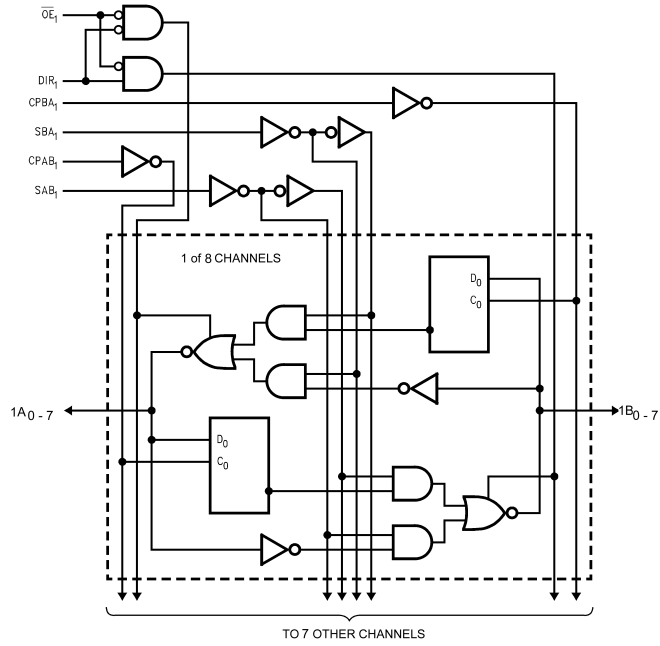
Inputs						Data I/O (Note 4)		Output Operation Mode
$\overline{OE}_1$	DIR <sub>1</sub>	CPAB <sub>1</sub>	CPBA <sub>1</sub>	SAB <sub>1</sub>	SBA <sub>1</sub>	1A <sub>0-7</sub>	1B <sub>0-7</sub>	
H	X	H or L	H or L	X	X	Input	Input	Isolation
H	X	↘	X	X	X			Clock A <sub>n</sub> Data into A Register
H	X	X	↘	X	X			Clock B <sub>n</sub> Data Into B Register
L	H	X	X	L	X	Input	Output	A <sub>n</sub> to B <sub>n</sub> — Real Time (Transparent Mode)
L	H	↘	X	L	X			Clock A <sub>n</sub> Data to A Register
L	H	H or L	X	H	X			A Register to B <sub>n</sub> (Stored Mode)
L	H	↘	X	H	X			Clock A <sub>n</sub> Data into A Register and Output to B <sub>n</sub>
L	L	X	X	X	L	Output	Input	B <sub>n</sub> to A <sub>n</sub> — Real Time (Transparent Mode)
L	L	X	↘	X	L			Clock B <sub>n</sub> Data into B Register
L	L	X	H or L	X	H			B Register to A <sub>n</sub> (Stored Mode)
L	L	X	↘	X	H			Clock B <sub>n</sub> into B Register and Output to A <sub>n</sub>

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial  
 ↘ = LOW-to-HIGH Transition

**Note 3:** Data I/O paths (1A and 1B: 0 - 7) is shown. This also applies to data I/O (1A and 1B: 8 - 15) and #2 control pins, to data (2A and 2B: 0 - 7) and #3 control pins, to data (2A and 2B: 8 - 15) and #4 control pins.

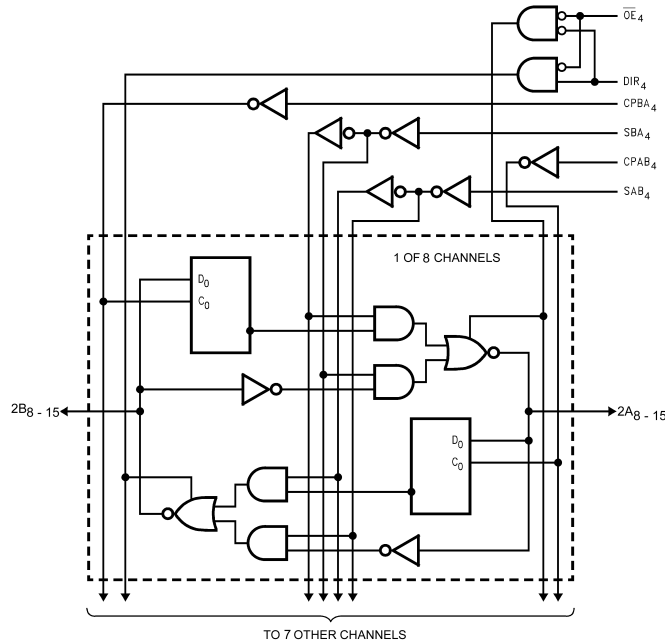
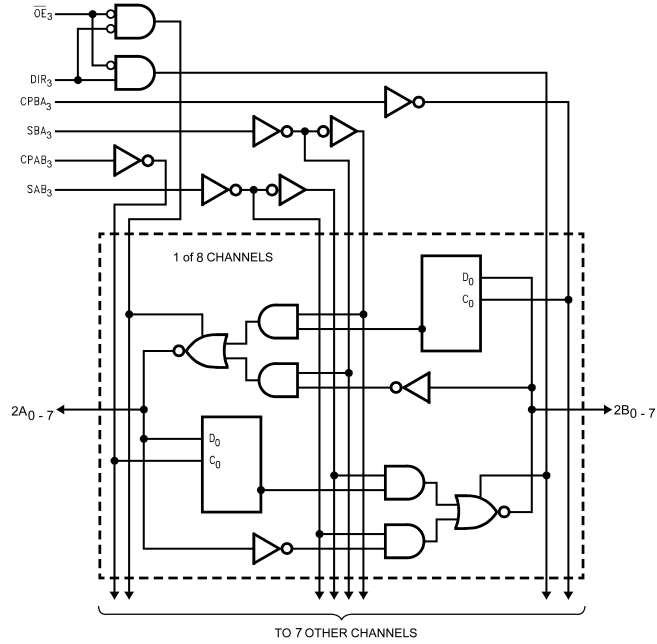
**Note 4:** The data output functions may be enabled or disabled by various signals at the  $\overline{OE}$  and DIR inputs. Data input functions are always enabled; i.e., data at the bus pins will be stored on every LOW-to-HIGH transition of the appropriate clock inputs.

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.

Logic Diagrams (Continued)

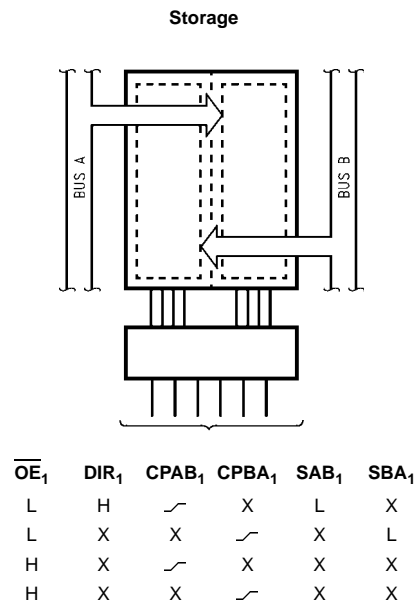
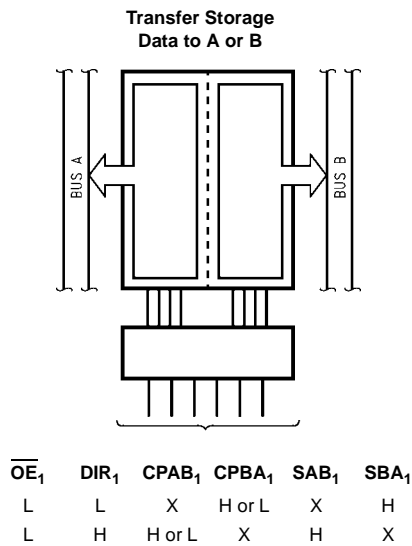
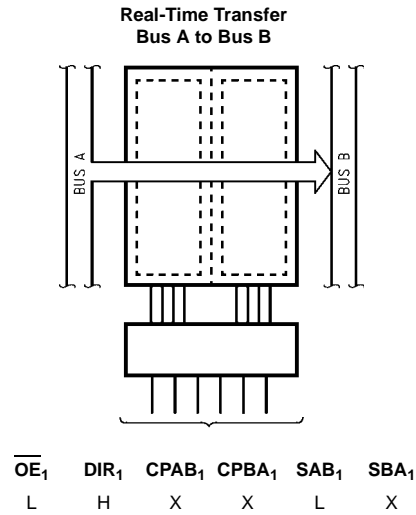
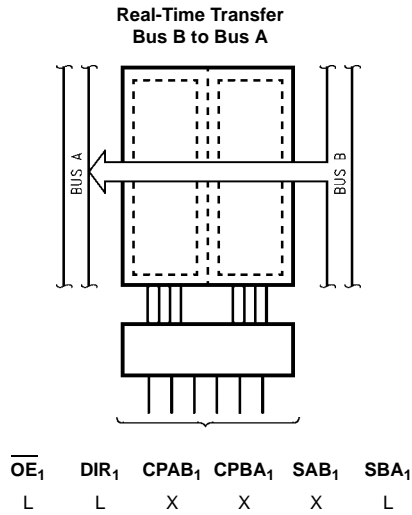


Please note that these diagrams are provided only for the understanding of logic operations and should not be used to estimate propagation delays.

### Functional Description

In the transceiver mode, data present at the HIGH impedance port may be stored in either the A or B register or both. The select ( $SAB_n$ ,  $SBA_n$ ) controls can multiplex stored and real-time. The examples shown below demonstrate the four fundamental bus-management functions that can be performed for data I/O 1A and 1B: 0 - 7.

The direction control ( $DIR_n$ ) determines which bus will receive data when  $\overline{OE}_n$  is LOW. In the isolation mode ( $\overline{OE}_n$  HIGH), A data may be stored in one register and/or B data may be stored in the other register. When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two busses, A or B, may be driven at a time.

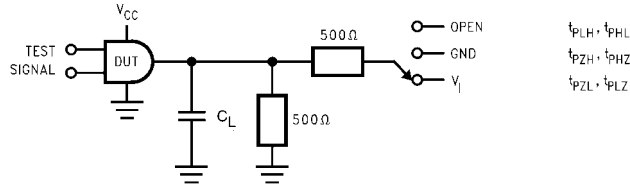


Absolute Maximum Ratings (Note 5)						
Symbol	Parameter	Value	Conditions	Units		
V <sub>CC</sub>	Supply Voltage	-0.5 to +7.0		V		
V <sub>I</sub>	DC Input Voltage	-0.5 to +7.0		V		
V <sub>O</sub>	DC Output Voltage	-0.5 to +7.0	Output in 3-STATE	V		
		-0.5 to V <sub>CC</sub> + 0.5	Output in HIGH or LOW State (Note 6)			
I <sub>IK</sub>	DC Input Diode Current	-50	V <sub>I</sub> < GND	mA		
I <sub>OK</sub>	DC Output Diode Current	-50	V <sub>O</sub> < GND	mA		
		+50	V <sub>O</sub> > V <sub>CC</sub>			
I <sub>O</sub>	DC Output Source/Sink Current	±50		mA		
I <sub>CC</sub>	DC Supply Current per Supply Pin	±100		mA		
I <sub>GND</sub>	DC Ground Current per Ground Pin	±100		mA		
T <sub>STG</sub>	Storage Temperature	-65 to +150		°C		
Recommended Operating Conditions (Note 7)						
Symbol	Parameter	Min	Max	Units		
V <sub>CC</sub>	Supply Voltage	Operating	2.0	3.6	V	
		Data Retention	1.5	3.6		
V <sub>I</sub>	Input Voltage	0	5.5	V		
V <sub>O</sub>	Output Voltage	HIGH or LOW State	0	V <sub>CC</sub>	V	
		3-STATE	0	5.5		
I <sub>OH</sub> /I <sub>OL</sub>	Output Current	V <sub>CC</sub> = 3.0V – 3.6V		±24	mA	
		V <sub>CC</sub> = 2.7V – 3.0V		±12		
		V <sub>CC</sub> = 2.3V – 2.7V		±8		
T <sub>A</sub>	Free-Air Operating Temperature	-40	85	°C		
Δt/ΔV	Input Edge Rate, V <sub>IN</sub> = 0.8V–2.0V, V <sub>CC</sub> = 3.0V	0	10	ns/V		
<p><b>Note 5:</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 6:</b> I<sub>O</sub> Absolute Maximum Rating must be observed.</p> <p><b>Note 7:</b> Unused inputs and I/Os must be held HIGH or LOW. They may not float.</p>						
DC Electrical Characteristics						
Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C		Units
				Min	Max	
V <sub>IH</sub>	HIGH Level Input Voltage		2.3 – 2.7	1.7		V
			2.7 – 3.6	2.0		
V <sub>IL</sub>	LOW Level Input Voltage		2.3 – 2.7		0.7	V
			2.7 – 3.6		0.8	
V <sub>OH</sub>	HIGH Level Output Voltage	I <sub>OH</sub> = -100 μA	2.3 – 3.6	V <sub>CC</sub> - 0.2		V
		I <sub>OH</sub> = -8 mA	2.3	1.8		
		I <sub>OH</sub> = -12 mA	2.7	2.2		
		I <sub>OH</sub> = -18 mA	3.0	2.4		
		I <sub>OH</sub> = -24 mA	3.0	2.2		
V <sub>OL</sub>	LOW Level Output Voltage	I <sub>OL</sub> = 100 μA	2.3 – 3.6		0.2	V
		I <sub>OL</sub> = 8 mA	2.3		0.6	
		I <sub>OL</sub> = 12 mA	2.7		0.4	
		I <sub>OL</sub> = 16 mA	3.0		0.4	
		I <sub>OL</sub> = 24 mA	3.0		0.55	
I <sub>I</sub>	Input Leakage Current	0 ≤ V <sub>I</sub> ≤ 5.5V	2.3 – 3.6		±5.0	μA
I <sub>OZ</sub>	3-STATE I/O Leakage	0 ≤ V <sub>O</sub> ≤ 5.5V V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.3 – 3.6		±5.0	μA
I <sub>OFF</sub>	Power-Off Leakage Current	V <sub>I</sub> or V <sub>O</sub> = 5.5V	0		10	μA

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 8)	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 8:</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	
f <sub>MAX</sub>	Maximum Clock Frequency	170					ns	
t <sub>PHL</sub>	Propagation Delay	1.5	5.2	1.5	6.0	1.5	6.2	ns
t <sub>PLH</sub>	Bus to Bus	1.5	5.2	1.5	6.0	1.5	6.2	
t <sub>PHL</sub>	Propagation Delay	1.5	6.0	1.5	7.0	1.5	7.2	ns
t <sub>PLH</sub>	Clock to Bus	1.5	6.0	1.5	7.0	1.5	7.2	
t <sub>PHL</sub>	Propagation Delay	1.5	6.0	1.5	7.0	1.5	7.2	ns
t <sub>PLH</sub>	Select to Bus	1.5	6.0	1.5	7.0	1.5	7.2	
t <sub>PZL</sub>	Output Enable Time	1.5	7.5	1.5	8.5	1.5	9.8	ns
t <sub>PZH</sub>		1.5	7.5	1.5	8.5	1.5	9.8	
t <sub>PLZ</sub>	Output Disable Time	1.5	6.5	1.5	7.5	1.5	7.8	ns
t <sub>PHZ</sub>		1.5	6.5	1.5	7.5	1.5	7.8	
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			

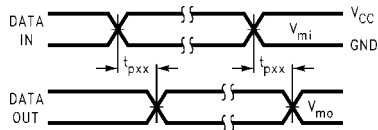


**AC LOADING and WAVEFORMS** Generic for LCX Family

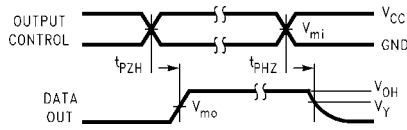


**FIGURE 1. AC Test Circuit** ( $C_L$  includes probe and jig capacitance)

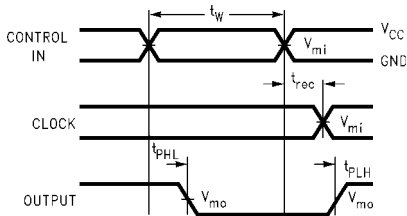
Test	Switch
$t_{PLH}, t_{PHL}$	Open
$t_{PZL}, t_{PLZ}$	6V at $V_{CC} = 3.3 \pm 0.3V$ , and 2.7V $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$
$t_{PZH}, t_{PHZ}$	GND



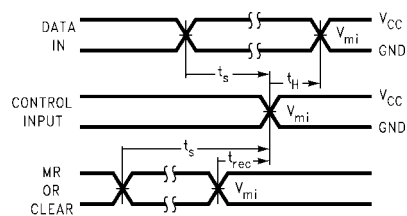
**Waveform for Inverting and Non-Inverting Functions**



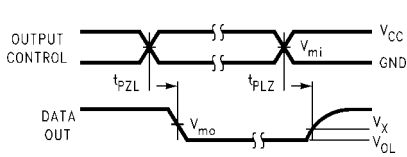
**3-STATE Output High Enable and Disable Times for Logic**



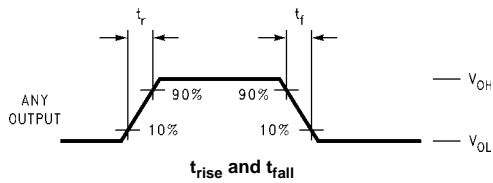
**Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms**



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



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

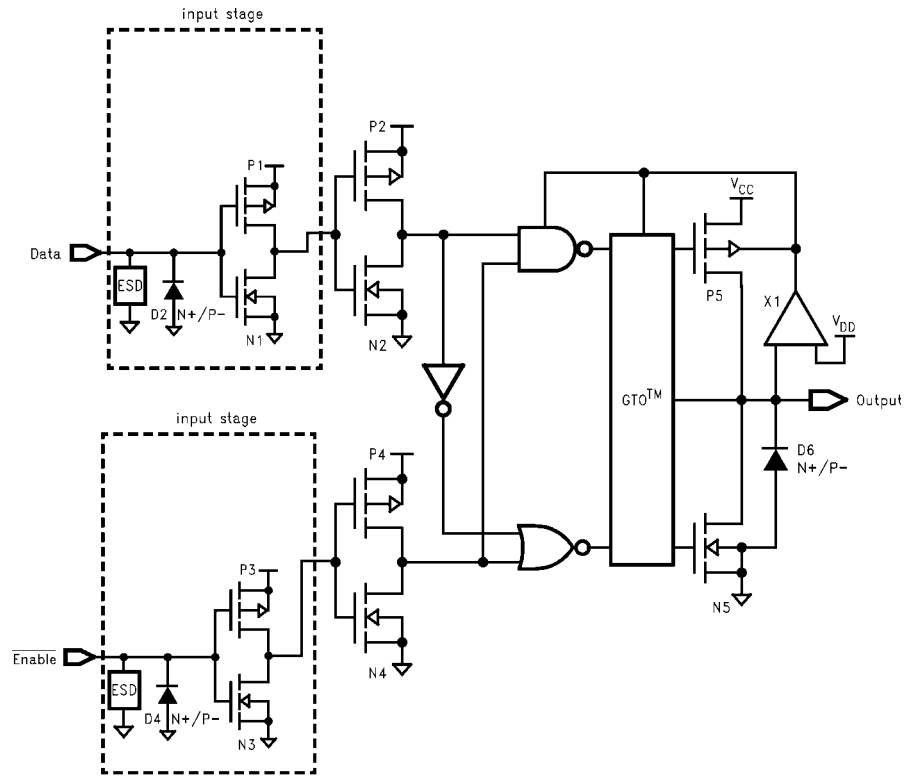


**FIGURE 2. Waveforms**  
(Input Characteristics;  $f = 1MHz$ ,  $t_r = t_f = 3ns$ )

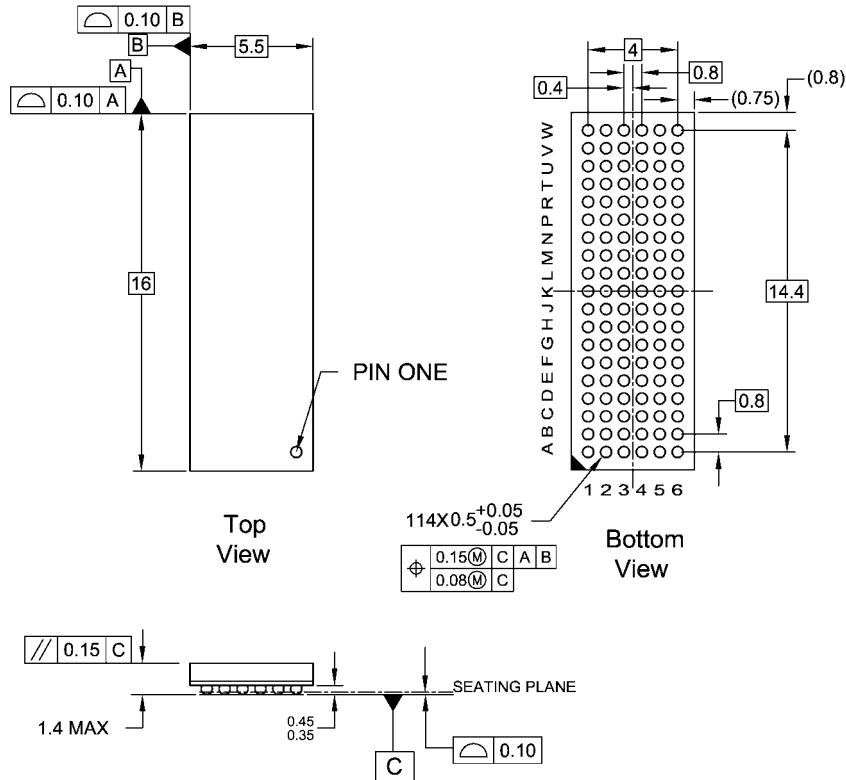
Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	2.7V	$2.5V \pm 0.2V$
$V_{mi}$	1.5V	1.5V	$V_{CC}/2$
$V_{mo}$	1.5V	1.5V	$V_{CC}/2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

74LCX32646

Schematic Diagram Generic for LCX Family



**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

BGA114ArevE

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

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**LIFE SUPPORT POLICY**

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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