FAIRCHILD SEMICONDUCTOR™

April 2002
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74LCXH32245
Low Voltage 32-Bit Bidirectional Transceiver with 5V Tolerant Inputs and Outputs with Bushold

General Description

The LCXH32245 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 $T/\overline{R}$ inputs determine the direction of data flow through the device. The $\overline{OE}$ inputs disable both the A and B ports by placing them in a high impedance state. The 26Ω series resistor in the A Port output helps reduce output overshoot and undershoot.

The LCXH32245 data inputs include bushold, eliminating the need for external pull-up/down resistors to hold unused inputs.

The LCXH32245 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 to 3.6V V_{CC} specifications provided
- 4.5 ns t_{PD} max (V_{CC} = 3.3V), 20 μA I_{CC} max
- Power-off high impedance inputs and outputs
- Equivalent 26Ω series resistor on A Port outputs
- Bushold on inputs eliminates the need for external pull-up/down resistors
- Supports live insertion/withdrawal (Note 1)
- ±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 VCC through a pull-up resistor: the minimum value or the resistor is determined by the current-sourcing capability of the driver.

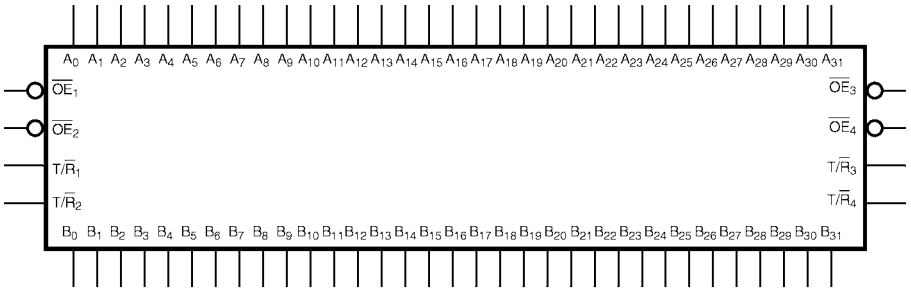
Ordering Code:

Order Number	Package Number	Package Description
74LCXH32245G (Note 2) (Note 3)	BGA96A	96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide

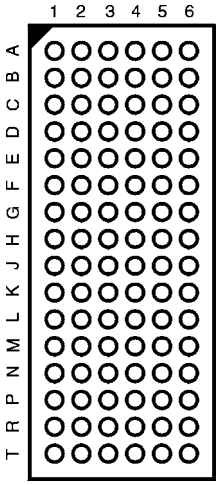
Note 2: Ordering Code "G" indicates Trays.

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

Logic Symbol



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_0–A_{31}	Side A Inputs/3-STATE Outputs
B_0–B_{31}	Side B Inputs/3-STATE Outputs

FBGA Pin Assignments

	1	2	3	4	5	6
A	B_1	B_0	$T/\overline{R}_1$	$\overline{OE}_1$	A_0	A_1
B	B_3	B_2	GND	GND	A_2	A_3
C	B_5	B_4	V_{CC1}	V_{CC1}	A_4	A_5
D	B_7	B_6	GND	GND	A_6	A_7
E	B_9	B_8	GND	GND	A_8	A_9
F	B_{11}	B_{10}	V_{CC1}	V_{CC1}	A_{10}	A_{11}
G	B_{13}	B_{12}	GND	GND	A_{12}	A_{13}
H	B_{14}	B_{15}	$T/\overline{R}_2$	$\overline{OE}_2$	A_{15}	A_{14}
J	B_{17}	B_{16}	$T/\overline{R}_3$	$\overline{OE}_3$	A_{16}	A_{17}
K	B_{19}	B_{18}	GND	GND	A_{18}	A_{19}
L	B_{21}	B_{20}	V_{CC2}	V_{CC2}	A_{20}	A_{21}
M	B_{23}	B_{22}	GND	GND	A_{22}	A_{23}
N	B_{25}	B_{24}	GND	GND	A_{24}	A_{25}
P	B_{27}	B_{26}	V_{CC2}	V_{CC2}	A_{26}	A_{27}
R	B_{29}	B_{28}	GND	GND	A_{28}	A_{29}
T	B_{30}	B_{31}	$T/\overline{R}_4$	$\overline{OE}_4$	A_{31}	A_{30}

Truth Tables

Inputs		Outputs
$\overline{OE}_1$	$T/\overline{R}_1$	
L	L	Bus B_0–B_7 Data to Bus A_0–A_7
L	H	Bus A_0–A_7 Data to Bus B_0–B_7
H	X	HIGH–Z State on A_0–A_7,B_0–B_7

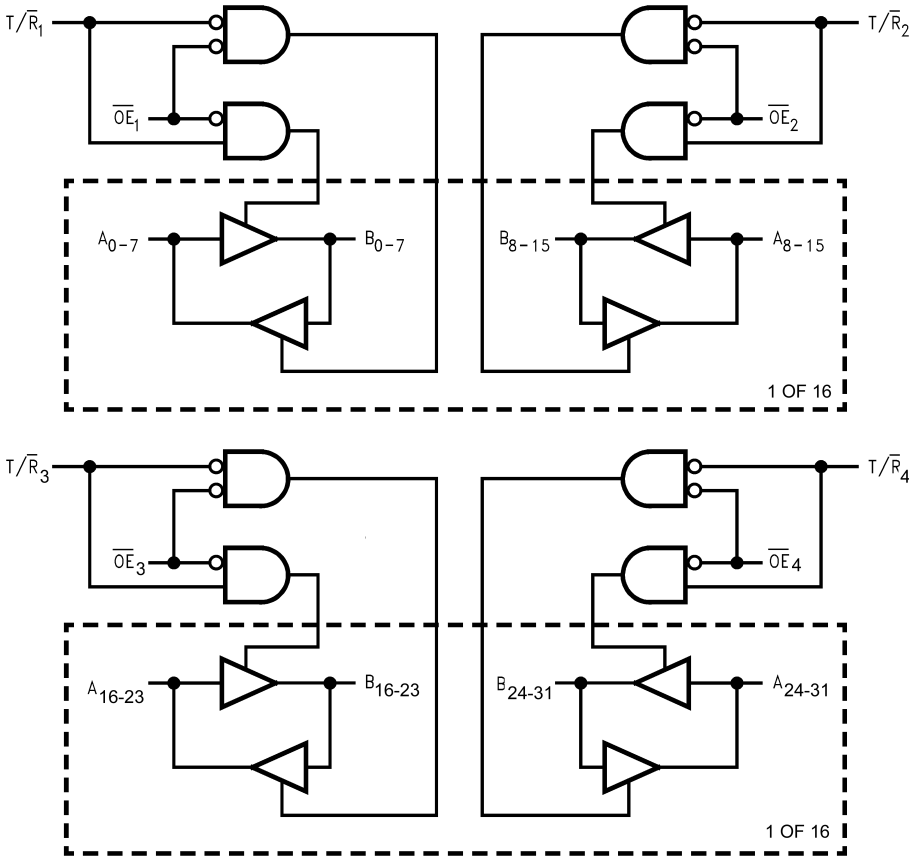
Inputs		Outputs
$\overline{OE}_3$	$T/\overline{R}_3$	
L	L	Bus B_{16}–B_{23} Data to Bus A_{16}–A_{23}
L	H	Bus A_{16}–A_{23} Data to Bus B_{16}–B_{23}
H	X	HIGH–Z State on A_{16}–A_{23},B_{16}–B_{23}

Inputs		Outputs
$\overline{OE}_2$	$T/\overline{R}_2$	
L	L	Bus B_8–B_{15} Data to Bus A_8–A_{15}
L	H	Bus A_8–A_{15} Data to Bus B_8–B_{15}
H	X	HIGH–Z State on A_8–A_{15},B_8–B_{15}

Inputs		Outputs
$\overline{OE}_4$	$T/\overline{R}_4$	
L	L	Bus B_{24}–B_{31} Data to Bus A_{24}–A_{31}
L	H	Bus B_{24}–A_{31} Data to Bus B_{24}–B_{31}
H	X	HIGH–Z State on A_{24}–A_{31},B_{24}–B_{31}

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance

Logic Diagrams



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

Absolute Maximum Ratings(Note 4)

Symbol	Parameter	Value	Conditions	Units
V_{CC}	Supply Voltage	−0.5 to +7.0		V
V_I	$T/\overline{R}$, $\overline{OE}$	−0.5 to +7.0		V
	I/O Ports	−0.5 to V_{CC} + 0.5		
V_O	DC Output Voltage	−0.5 to V_{CC} + 0.5	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
		+50	V_O > V_{CC}	
I_O	DC Output Source/Sink Current	±50		mA
I_{CC}	DC Supply Current per Supply Pin	±100		mA
I_{GND}	DC Ground Current per Ground Pin	±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	V_{CC}	V
V_O	Output Voltage	HIGH or LOW State	0	V_{CC}	V
		3-STATE	0	5.5	
I_{OH}/I_{OL}	Output Current – B Outputs	V_{CC} = 3.0V – 3.6V		±24	mA
		V_{CC} = 2.7V – 3.0V		±12	
		V_{CC} = 2.3V – 2.7V		±8	
	Output Current in I_{OH}/I_{OL} – A Outputs	V_{CC} = 3.0V – 3.6V		±12	
		V_{CC} = 2.7V – 3.0V		±8	
		V_{CC} = 2.3V – 2.7V		±4	
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 4: 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.

Note 5: I_O Absolute Maximum Rating must be observed.

Note 6: Floating or unused control inputs must be HIGH or LOW.

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

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

DC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = −40°C to +85°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 μA	2.3 – 3.6	V_{CC} – 0.2		V
		I_{OH} = −8 mA	2.3	1.8		
		I_{OH} = −12 mA	2.7	2.2		
		I_{OH} = −18 mA	3.0	2.4		
		I_{OH} = −24 mA	3.0	2.4		

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40°C$ to $+85°C$		Units
				Min	Max	
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 µA	2.3 – 3.6		0.2	V
		I_{OL} = 8 mA	2.3		0.6	
		I_{OL} = 12 mA	2.7		0.4	
		I_{OL} = 16 mA	3.0		0.4	
		I_{OL} = 24 mA	2.7		0.6	
I_I	Input Leakage Current	$0 \le V_I \le 5.5V$	2.3 – 3.6		±5.0	µA
$I_{I(HOLD)}$	Bushold Input Minimum Drive Hold Current	V_{IN} = 0.7V	2.3	45		
		V_{IN} = 1.7V		-45		
		V_{IN} = 0.8V	3.0	75		
		V_{IN} = 2.0V		–75		
$I_{I(OD)}$	Bushold Input Over-Drive Current to Change State		2.7	300		
				–300		
			3.6	450		
				–450		
I_{OZ}	3-STATE I/O Leakage	$0 \le V_O \le 5.5V$, $V_I = V_{IH}$ or V_{IL}	2.3 – 3.6		±5.0	µA
I_{OFF}	Power-Off Leakage Current	V_I or V_O = 5.5V	0		10	µA
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	2.3–3.6		20	µA
		$3.6V \le V_I$, $V_O \le 5.5V$ (Note 7)	2.3–3.6		±20	
ΔI_{CC}	Increase in I_{CC} per Input	$V_{IH} = V_{CC} - 0.6V$	2.3–3.6		500	µA

Note 7: Outputs disabled or 3-STATE only.

AC Electrical Characteristics

Symbol	Parameter	$T_A = -40°C$ to $+85°C$, $R_L = 500\Omega$						Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		$V_{CC} = 2.5V \pm 0.2V$		
		C_L = 50 pF		C_L = 50 pF		C_L = 30 pF		
		Min	Max	Min	Max	Min	Max	
t_{PHL}	Propagation Delay	1.0	4.5	1.0	5.2	1.0	5.4	ns
t_{PLH}	A_n to B_n or B_n to A_n	1.0	4.5	1.0	5.2	1.0	5.4	
t_{PZL}	Output Enable Time	1.0	6.5	1.0	7.2	1.0	8.5	ns
t_{PZH}		1.0	6.5	1.0	7.2	1.0	8.5	
t_{PLZ}	Output Disable Time	1.0	6.4	1.0	6.9	1.0	7.7	ns
t_{PHZ}		1.0	6.4	1.0	6.9	1.0	7.7	

Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = 25°C$ Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	C_L = 50 pF, V_{IH} = 3.3V, V_{IL} = 0V	3.3	0.8	V
		C_L = 30 pF, V_{IH} = 2.5V, V_{IL} = 0V	2.5	0.6	
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	C_L = 50 pF, V_{IH} = 3.3V, V_{IL} = 0V	3.3	–0.8	V
		C_L = 30 pF, V_{IH} = 2.5V, V_{IL} = 0V	2.5	–0.6	

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C_{IN}	Input Capacitance	V_{CC} = Open, V_I = 0V or V_{CC}	7	pF
$C_{I/O}$	Input/Output Capacitance	V_{CC} = 3.3V, V_I = 0V or V_{CC}	8	pF
C_{PD}	Power Dissipation Capacitance	V_{CC} = 3.3V, V_I = 0V or V_{CC}, f = 10 MHz	20	pF

AC LOADING and WAVEFORMS Generic for LCX Family

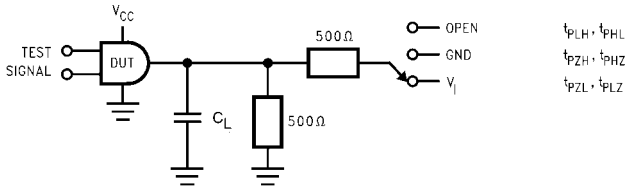
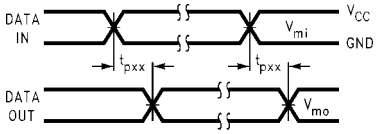
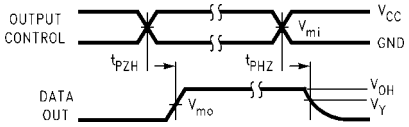


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

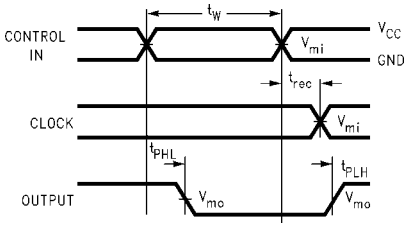
Test	Switch
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3 ± 0.3V, and 2.7V V_{CC} x 2 at V_{CC} = 2.5 ± 0.2V
t_{PZH}, t_{PHZ}	GND



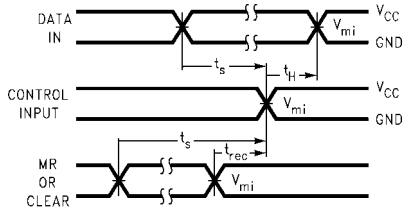
Waveform for Inverting and Non-Inverting Functions



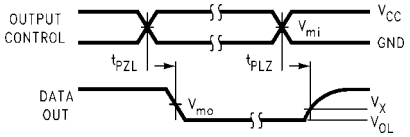
3-STATE Output High Enable and Disable Times for Logic



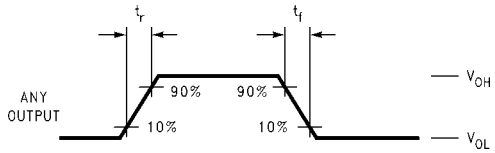
Propagation Delay. Pulse Width and t_{rec} Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output Low Enable and Disable Times for Logic

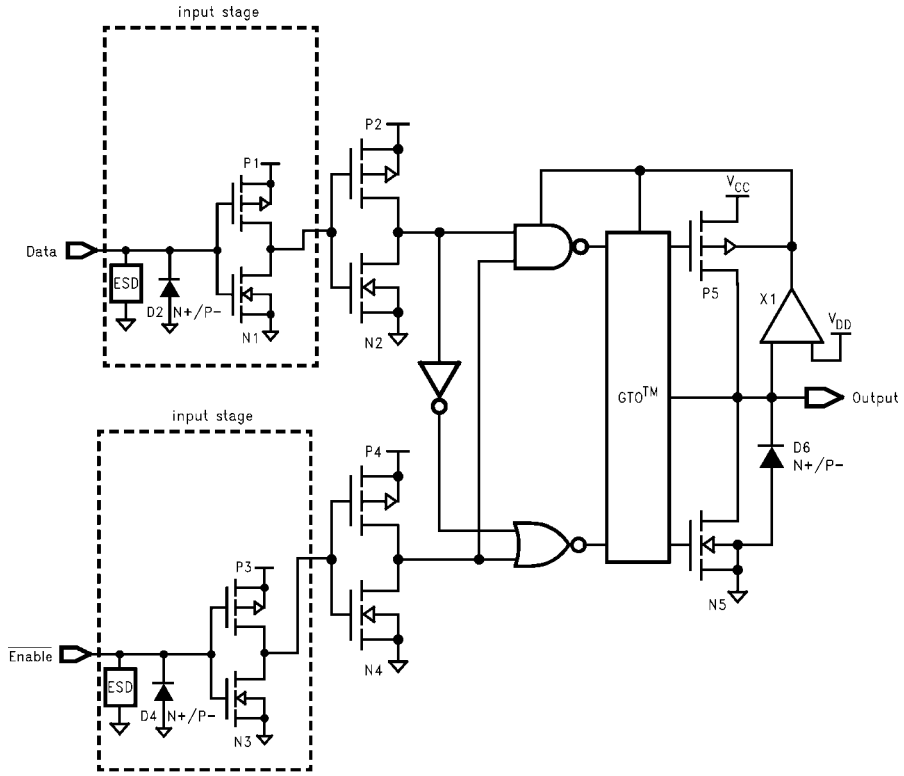


t_{rise} and t_{fall}

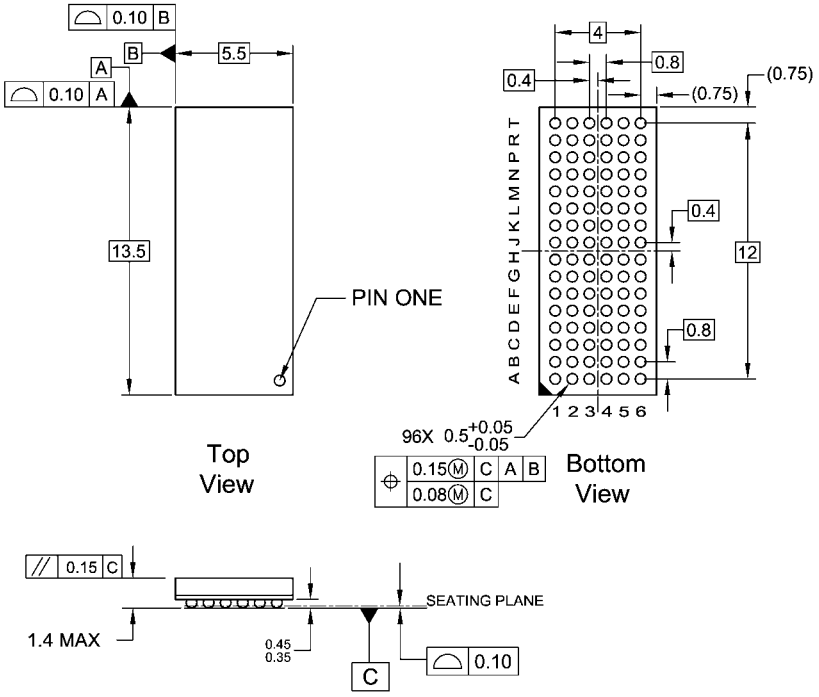
FIGURE 2. Waveforms
(Input Characteristics; f =1MHz, t_r = t_f = 3ns)

Symbol	V_{CC}		
	3.3V ± 0.3V	**2.7V**	**2.5V ± 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



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

BGA96ArevE

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

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