



High Speed 3.3V CMOS 32-Bit Transceiver

QS74LCX4X245

FEATURES/BENEFITS

- 32-bit function compatible to the 74LCX245
- 5V tolerant inputs and outputs
- 40 μ A I_{CCQ} quiescent power supply current
- Hot insertable
- 2.0V-3.6V V_{CC} supply operation
- ± 24 mA balanced output drive
- Power down high impedance inputs and outputs
- Meets or exceeds JEDEC 36 specifications
- $t_{PD} = 5.0$ ns
- Input hysteresis for noise immunity
- Operating temperature range:
-40°C to +85°C
- Latch-up performance exceeds 500mA
- ESD performance:
Human body model > 2000V
Machine model > 200V

DESCRIPTION

The LCX4X245 is a 32-bit non-inverting transceiver with three-state output that is useful for bus-oriented applications. The Transmit/Receive (T/\bar{R}) input determines the direction of data flow, whether from A to B or B to A, and the Output Enable (\bar{OE}) inputs enable the selected port for output. The 3.3V LCX family features low power, low switching noise, and fast switching speeds for low power portable applications as well as high-end, advanced workstation applications. 5V tolerant inputs and outputs allow this LCX product to be used in mixed-voltage applications. The MillipaQ 80-pin small outline package provides the smallest possible footprint while also offering an easy layout flow-through, dual-in-line format.

Figure 1. Functional Block Diagram

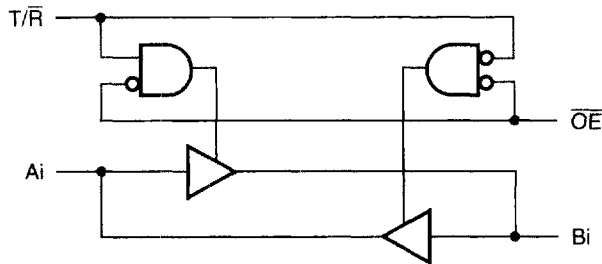


Figure 2. Pin Configuration
(All Pins Top View)

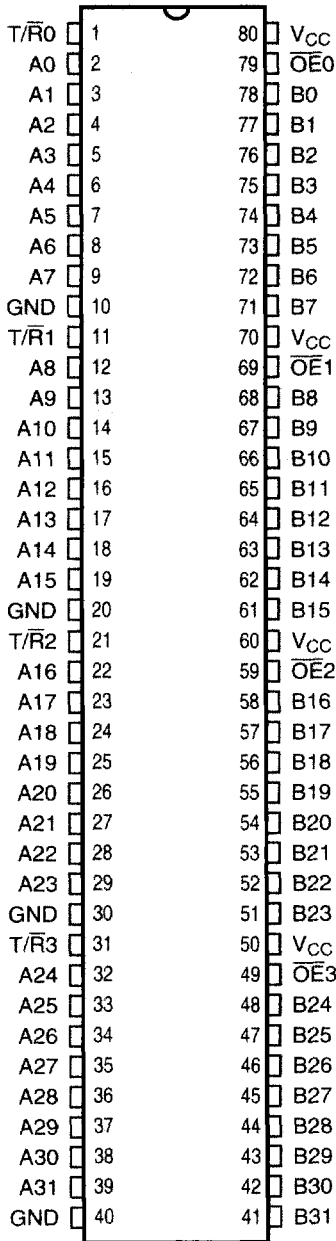


Table 1. Pin Description

Name	I/O	Description
Ai	I/O	Data Bus A
Bi	I/O	Data Bus B
T/R0	I	Direction for A/B7-A/B0
T/R1	I	Direction for A/B15-A/B8
T/R2	I	Direction for A/B23-A/B16
T/R3	I	Direction for A/B31-A/B24
$\overline{OE}0$	I	Output Enables for A/B7-A/B0
$\overline{OE}1$	I	Output Enables for A/B15-A/B8
$\overline{OE}2$	I	Output Enables for A/B23-A/B16
$\overline{OE}3$	I	Output Enables for A/B24-A/B31

Table 2. Function Table

$\overline{OE}n$	T/Rn	Bus A	Bus B	Function
H	X	Hi-Z	Hi-Z	Disable
L	L	Output	Input	Bus B to Bus A
L	H	Input	Output	Bus A to Bus B

5

Table 3. Capacitance

Symbol	Pins	Typ	Unit	Conditions
C_{IN}	Input Capacitance	7.0	pF	$V_{IN} = 0V, V_{OUT} = 0V, f=1MHz$
$C_{I/O}$	I/O Capacitance	8.0	pF	$V_{IN} = 0V, V_{OUT} = 0V, f=1 MHz$
C_{PD}	Power Dissipation Capacitance	20	pF	$V_{CC} = 3.3V, V_{IN} = 0V, \text{ or } V_{CC}$ $f=10 MHz$

Note: Capacitance is characterized but not production tested.

Table 4. Absolute Maximum Ratings

Supply Voltage to Ground	-0.5V to +7.0V
DC Output Voltage V_{OUT}	
Outputs HIGH-Z	-0.5V to +7.0V
Outputs Active	-0.5V to $V_{CC} + 0.5V$
DC Input Voltage V_{IN}	-0.5V to +7.0V
DC Input Diode Current with $V_{IN} < 0$	-50mA
DC Output Diode Current	
$V_O < 0$	-50mA
$V_O > V_{CC}$	+50mA
DC Output Source/Sink Current (I_{OH}/I_{OL})	$\pm 50mA$
DC Supply Current per Supply Pin	$\pm 100mA$
DC Ground Current per Ground Pin	$\pm 100mA$
T_{STG} Storage Temperature	-65° to +150°C

Note: Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to QSI devices that result in functional or reliability type failures.

Table 5. Recommended Operating Conditions

Symbol	Description	Min	Max	Unit
V_{CC}	Supply Voltage	2.0	3.6	V
V_{IN}	Input Voltage	0	5.5	V
V_{OUT}	Output Voltage in Active State	0	V_{CC}	V
V_{OUT}	Output Voltage in "OFF" State	0	5.5	V
I_{OH}/I_{OL}	Output Current			mA
	$V_{CC} = 3.0 - 3.6V$	—	± 12	
	$V_{CC} = 2.7V$	—	± 6	
$\Delta t/\Delta V$	Input Transition Slew Rate	—	10	ns/V
T_A	Ambient Temperature Range	-40	+85	°C

Table 6. DC Electrical Characteristics Over Operating Range

Industrial Temperature Range, $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$.

Symbol	Parameter	Test Conditions ⁽¹⁾	Min	Typ ⁽²⁾	Max	Unit
V_{IH}	Input HIGH Voltage	Logic HIGH for All Inputs	2.0	—	—	V
V_{IL}	Input LOW Voltage	Logic LOW for All Inputs	—	—	0.8	V
V_{OH}	Output HIGH Voltage	$V_{CC} = 2.7\text{V}, I_{OH} = -100\mu\text{A}$ $V_{CC} = 2.7\text{V}, I_{OH} = -12\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OH} = -18\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OH} = -24\text{mA}$	$V_{CC} - 0.2$ 2.2 2.4 2.2	— — — —	— — — —	V
V_{OL}	Output LOW Voltage	$V_{CC} = 2.7\text{V}, I_{OL} = 100\mu\text{A}$ $V_{CC} = 2.7\text{V}, I_{OL} = 12\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OL} = 16\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OL} = 24\text{mA}$	— — — —	— — — —	0.2 0.4 0.4 0.5	V
ΔV_T	Input Hysteresis ⁽³⁾	$V_{TLH} - V_{THL}$ for All Inputs	—	150	—	mV
$ I_{OZ} $	Off-State Output Current (Hi-Z)	$V_{CC} = 3.6\text{V}, V_O = 0\text{V},$ $V_O = 5.5\text{V}$	—	—	1	μA
I_{OS}	Short Circuit Current ^(3,4)	$V_{CC} = 3.6\text{V}, V_{OUT} = \text{GND}$	-60	—	-240	mA
V_{IK}	Input Clamp Voltage	$V_{CC} = 2.7\text{V}, I_{IN} = -18\text{mA}$	—	-0.7	-1.2	V
I_I	Input Leakage Current	$V_I = 0\text{V}, V_I = 5.5\text{V}$ $V_{CC} = 3.6\text{V}$	—	—	± 1.0	μA
I_{OFF}	Power Off Leakage	$V_{CC} = 0\text{V}, V_I$ or $V_O = 5.5\text{V}$	—	—	10	μA

Notes:

1. For conditions shown as Max. or Min. use appropriate value specified under Recommended Operating Conditions for the applicable device type.
2. Typical values are at $V_{CC} = 3.3\text{V}$ and $T_A = 25^{\circ}\text{C}$.
3. These parameters are guaranteed by characterization, but not production tested.
4. Not more than one output should be tested at one time. Duration of test should not exceed one second.



Table 7. Power Supply Characteristics

Symbol	Parameter	Test Conditions ⁽¹⁾	Typ ⁽²⁾	Max	Unit	
I_{CC}	Quiescent Power Supply Current	$V_{CC} = 3.6$, Freq = 0 $V_{IN} = GND$ or V_{CC}	0.4	40	μA	
ΔI_{CC}	Supply Current per Input @ TTL HIGH ⁽³⁾	$V_{CC} = 3.6V$ $V_{IN} = V_{CC} - 0.6V$, Freq = 0	—	30	μA	
I_{CCD}	Supply Current per Input per MHz ⁽⁴⁾	$V_{CC} = 3.6V$, Outputs Open One Bit Toggling @ 50% Duty Cycle $\overline{xOE} = GND$	50	75	$\mu A / MHz$	
I_C	Total Power Supply Current ⁽⁶⁾	$V_{CC} = 3.6V$, Outputs Open One Bit Toggling @ 50% Duty Cycle $\overline{OE}x = GND$, $f = 10MHz$	$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = GND$	0.5 ⁽⁵⁾	0.8 ⁽⁵⁾	mA
		$V_{CC} = 3.6V$, Outputs Open Thirty-two Bits Toggling @ 50% Duty Cycle $\overline{OE}x = GND$, $f = 2.5MHz$	$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = GND$	4.0 ⁽⁵⁾	6.8 ⁽⁵⁾	mA

Notes:

- For conditions shown as Min. or Max., use the appropriate values specified under Recommended Operating Conditions for applicable device type.
- Typical values are at $V_{CC} = 3.3V$, +25°C ambient.
- Per TTL driven input. All Other Inputs at V_{CC} or GND.
- This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
- Values of these conditions are examples of the I_{CC} formula. These limits are guaranteed by design but not tested.
- $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
 $I_C = I_{CCQ} + \Delta I_{CC} D_H N_T + I_{CCD} f N_O$
 I_{CCQ} = Quiescent Current (I_{CCL} , I_{CCH} , and I_{CCZ}).
 ΔI_{CC} = Power Supply Current for a TTL-High Input ($V_{IN} = V_{CC} - 0.6V$).
 D_H = Duty Cycle for TTL High Inputs.
 N_T = Number of TTL High Inputs.
 I_{CCD} = Dynamic Current Caused by an Input Transition Pair (HLH or LHL).
 f = Average Switching Frequency per Output.
 N_O = Number of Outputs Switching.

Table 8. Dynamic Switching Characteristics⁽¹⁾

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

Note:

- Characterized but not production tested.

Table 9. Switching Characteristics Over Operating Range

Industrial Temperature Range, $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$.

$C_{\text{LOAD}} = 50 \text{ pF}$, $R_{\text{LOAD}} = 500\Omega$ unless otherwise noted.

Symbol	Description ⁽¹⁾	4X245				4X245C		Unit
		$V_{\text{CC}} = 3.3 \pm 0.3\text{V}$		$V_{\text{CC}} = 2.7\text{V}^{(2)}$		$V_{\text{CC}} = 3.3 \pm 0.3\text{V}$		
		Min	Max	Min	Max	Min	Max	
t_{PHL} t_{PLH}	Propagation Delay Ai to Bi	1.5	7.0	1.5	8.0	1.5	5.0	ns
t_{PZH} t_{PZL}	Output Enable Time \overline{xOE} to A/B	1.5	8.5	1.5	9.5	1.5	6.5	ns
t_{PHZ} t_{PLZ}	Output Disable Time ⁽²⁾ \overline{xOE} to A/B	1.5	7.5	1.5	8.5	1.5	5.2	ns
t_{PZH} t_{PZL}	Output Enable Time ⁽²⁾ T/\overline{R} to A/B	1.5	8.5	1.5	9.5	1.5	6.5	ns
t_{PHZ} t_{PLZ}	Output Disable Time ⁽²⁾ T/\overline{R} to A/B	1.5	7.5	1.5	8.5	1.5	5.2	ns
$t_{\text{SK}(o)}$	Output Skew ⁽³⁾	—	0.5	—	—	—	0.5	ns

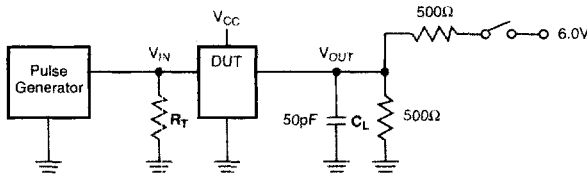
Notes:

1. Minimums guaranteed but not tested. See Test Circuit and Waveforms.
2. Guaranteed by characterization.
3. Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by characterization but not production tested.



TEST CIRCUIT AND WAVEFORMS

Figure 3. Test Circuit



SWITCH POSITION

Test	Switch
Open Drain	6V
Disable LOW	
Enable LOW	
Disable HIGH	GND
Enable HIGH	
All Other Inputs	Open

DEFINITIONS:

C_L = Load capacitance: includes jig and probe capacitance.

R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse generator.

Figure 4. Setup, Hold, and Release Timing

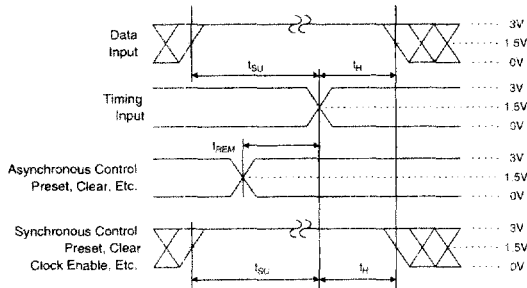


Figure 6. Pulse Width

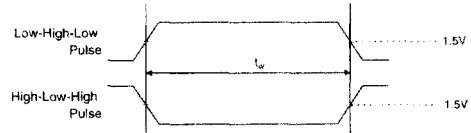


Figure 5. Enable and Disable Timing

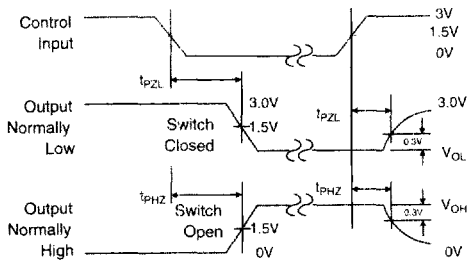
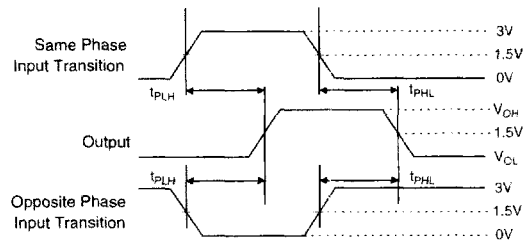


Figure 7. Propagation Delay



Notes:

1. Input Control Enable = LOW and input Control Disable = HIGH.
2. Pulse Generator for All Pulses: Rate \leq 1.0MHz;
 $Z_{OUT} \leq 50\Omega$; t_r , $t_f \leq 2.5ns$.