QUALITY
SEMICONDUCTOR, INC.

High Speed 3.3V CMOS 32-Bit Transceiver

FEATURES/BENEFITS

- 32-bit function compatible to the 74LCX245
- 5V tolerant inputs and outputs
- 40µA I_{CCQ} quiescent power supply current
- Hot insertable
- 2.0V-3.6V V_{CC} supply operation
- ±24mA balanced output drive
- Power down high impedance inputs and outputs
- Meets or exceeds JEDEC 36 specifications
- t_{PD} = 5.0ns
- 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/R̄) input determines the direction of data flow, whether from A to B or B to A, and the Output Enable (OE̅) 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.
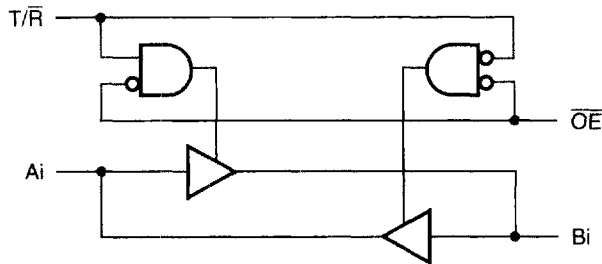
Figure 1. Functional Block Diagram

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Figure 2. Pin Configuration
(All Pins Top View)

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T/R̄0  [ 1          80 ]  V_CC
  A0  [ 2          79 ]  ŌĒ0
  A1  [ 3          78 ]  B0
  A2  [ 4          77 ]  B1
  A3  [ 5          76 ]  B2
  A4  [ 6          75 ]  B3
  A5  [ 7          74 ]  B4
  A6  [ 8          73 ]  B5
  A7  [ 9          72 ]  B6
 GND  [ 10         71 ]  B7
T/R̄1  [ 11         70 ]  V_CC
  A8  [ 12         69 ]  ŌĒ1
  A9  [ 13         68 ]  B8
 A10  [ 14         67 ]  B9
 A11  [ 15         66 ]  B10
 A12  [ 16         65 ]  B11
 A13  [ 17         64 ]  B12
 A14  [ 18         63 ]  B13
 A15  [ 19         62 ]  B14
 GND  [ 20         61 ]  B15
T/R̄2  [ 21         60 ]  V_CC
 A16  [ 22         59 ]  ŌĒ2
 A17  [ 23         58 ]  B16
 A18  [ 24         57 ]  B17
 A19  [ 25         56 ]  B18
 A20  [ 26         55 ]  B19
 A21  [ 27         54 ]  B20
 A22  [ 28         53 ]  B21
 A23  [ 29         52 ]  B22
 GND  [ 30         51 ]  B23
T/R̄3  [ 31         50 ]  V_CC
 A24  [ 32         49 ]  ŌĒ3
 A25  [ 33         48 ]  B24
 A26  [ 34         47 ]  B25
 A27  [ 35         46 ]  B26
 A28  [ 36         45 ]  B27
 A29  [ 37         44 ]  B28
 A30  [ 38         43 ]  B29
 A31  [ 39         42 ]  B30
 GND  [ 40         41 ]  B31
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Table 1. Pin Description

Name	I/O	Description
Ai	I/O	Data Bus A
Bi	I/O	Data Bus B
T/R̄0	I	Direction for A/B7-A/B0
T/R̄1	I	Direction for A/B15-A/B8
T/R̄2	I	Direction for A/B23-A/B16
T/R̄3	I	Direction for A/B31-A/B24
ŌĒ0	I	Output Enables for A/B7-A/B0
ŌĒ1	I	Output Enables for A/B15-A/B8
ŌĒ2	I	Output Enables for A/B23-A/B16
ŌĒ3	I	Output Enables for A/B24-A/B31

Table 2. Function Table

ŌĒn	T/R̄n	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

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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	$V_{CC} = 3.3V$, $V_{IN} = 0V$, or V_{CC} f=10 MHz

Note: Capacitance is characterized but not production tested.

Table 4. Absolute Maximum Ratings

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Supply Voltage to Ground ............................................. −0.5V to +7.0V
DC Output Voltage V_OUT
    Outputs HIGH-Z ..................................................... −0.5V to +7.0V
    Ouputs 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) .................................. ±50mA
DC Supply Current per Supply Pin .......................................... ±100mA
DC Ground Current per Ground Pin ........................................ ±100mA
T_STG Storage Temperature ............................................ −65° to +150°C
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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. Recomended 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	$V_{CC} = 3.0 - 3.6V$	—	±12	mA
		$V_{CC} = 2.7V$	—	±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, $T_A = -40°C$ to $+85°C$.

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	$V_{CC} = 2.7V$, $I_{OH} = -100\mu A$	$V_{CC} - 0.2$	—	—	V
		$V_{CC} = 2.7V$, $I_{OH} = -12mA$	2.2	—	—	
		$V_{CC} = 3.0V$, $I_{OH} = -18mA$	2.4	—	—	
		$V_{CC} = 3.0V$, $I_{OH} = -24mA$	2.2	—	—	
V_{OL}	Output LOW Voltage	$V_{CC} = 2.7V$, $I_{OL} = 100\mu A$	—	—	0.2	V
		$V_{CC} = 2.7V$, $I_{OL} = 12mA$	—	—	0.4	
		$V_{CC} = 3.0V$, $I_{OL} = 16mA$	—	—	0.4	
		$V_{CC} = 3.0V$, $I_{OL} = 24mA$	—	—	0.5	
ΔV_T	Input Hysteresis[3]	$V_{TLH} - V_{THL}$ for All Inputs	—	150	—	mV
$\|I_{OZ}\|$	Off-State Output Current (Hi-Z)	$V_{CC} = 3.6V$, $V_O = 0V$, $V_O = 5.5V$	—	—	1	μA
I_{OS}	Short Circuit Current[3,4]	$V_{CC} = 3.6V$, $V_{OUT} = GND$	-60	—	-240	mA
V_{IK}	Input Clamp Voltage	$V_{CC} = 2.7V$, $I_{IN} = -18mA$	—	-0.7	-1.2	V
I_I	Input Leakage Current	$V_I = 0V$, $V_I = 5.5V$ $V_{CC} = 3.6V$	—	—	±1.0	μA
I_{OFF}	Power Off Leakage	$V_{CC} = 0V$, V_I or $V_O = 5.5V$	—	—	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 $V_{CC} = 3.3V$ and $T_A = 25°C$.
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.

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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 $x\overline{OE} = $ GND		50	75	μA/ 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 $= 10$MHz	$V_{IN} = V_{CC}{-}0.6V$ $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 $= 2.5$MHz	$V_{IN} = V_{CC}{-}0.6V$ $V_{IN} = $ GND	4.0[5]	6.8[5]	mA

Notes:
1. For conditions shown as Min. or Max., use the appropriate values specified under Recommended Operating Conditions for applicable device type.
2. Typical values are at $V_{CC} = 3.3V$, $+25°C$ ambient.
3. Per TTL driven input. All Other Inputs at V_{CC} or GND.
4. This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
5. Values of these conditions are examples of the I_{CC} formula. These limits are guaranteed by design but not tested.
6. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$.
   $I_C = I_{CCQ} + \Delta I_{CC} D_H N_T + I_{CCD} f N_O$.
   $I_{CCQ} = $ Quiescent Current (I_{CCL}, I_{CCH}, and I_{CCZ}).
   $\Delta I_{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)	$T_A = 25°C$ 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:
1. Characterized but not production tested.

Table 9. Switching Characteristics Over Operating Range

Industrial Temperature Range, $T_A = -40°C$ to $+85°C$.

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

| Symbol | Description[1] | 4X245 | | | | 4X245C | | Unit |
| | | $V_{CC} = 3.3 \pm 0.3V$ | | $V_{CC} = 2.7V$[2] | | $V_{CC} = 3.3 \pm 0.3V$ | | |
		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 x$\overline{OE}$ to A/B	1.5	8.5	1.5	9.5	1.5	6.5	ns
t_{PHZ} t_{PLZ}	Output Disable Time[2] x$\overline{OE}$ 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
$t_{SK(o)}$	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
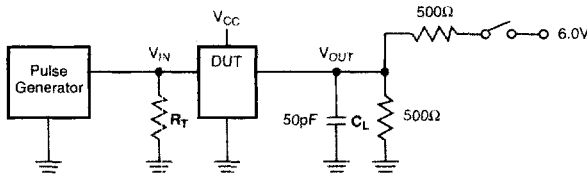
SWITCH POSITION

Test	Switch
Open Drain Disable LOW Enable LOW	6V
Disable HIGH Enable HIGH	GND
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.

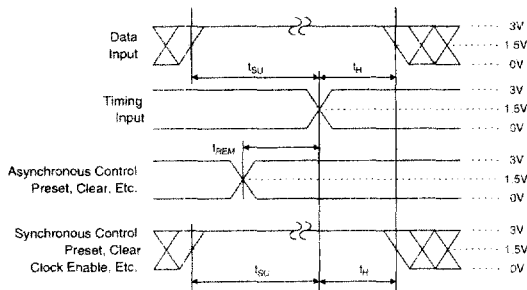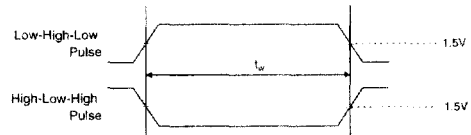### Figure 4. Setup, Hold, and Release Timing

Figure 6. Pulse Width
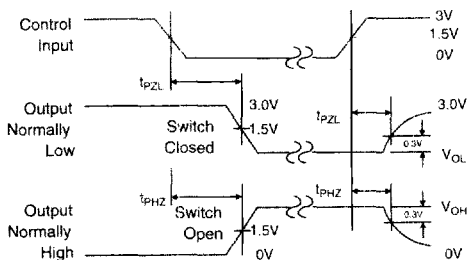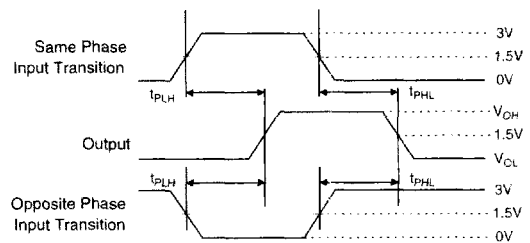

Figure 5. Enable and Disable Timing

Figure 7. Propagation Delay

Notes:

1. Input Control Enable = LOW and input Control Disable = HIGH.
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; Z_{OUT} ≤ 50Ω; t_F, t_R ≤ 2.5ns.