

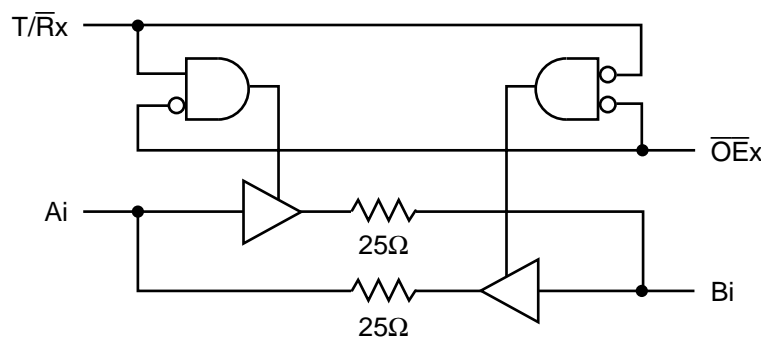
## FEATURES/BENEFITS

- 16-bit function compatible to the QS74LCX2H245
- 5V tolerant inputs and outputs
- 25Ω series resistor for low switching noise
- Bus Hold feature holds last active state during 3-state operation
- 20μA  $I_{CCQ}$  quiescent power supply current
- Hot insertable
- 2.0V–3.6V  $V_{CC}$  supply operation
- ±12mA balanced output drive
- Power down high impedance inputs and outputs
- Meets or exceeds JEDEC 36 specifications
- $t_{PD} = 7.0ns$
- Input hysteresis for noise immunity
- Operating temperature range:  
–40°C to 85°C
- Latch-up performance exceeds 400mA
- ESD performance:  
Human body model > 2000V  
Machine model > 200V
- Packaged in 40-pin QVSOP (Q2)

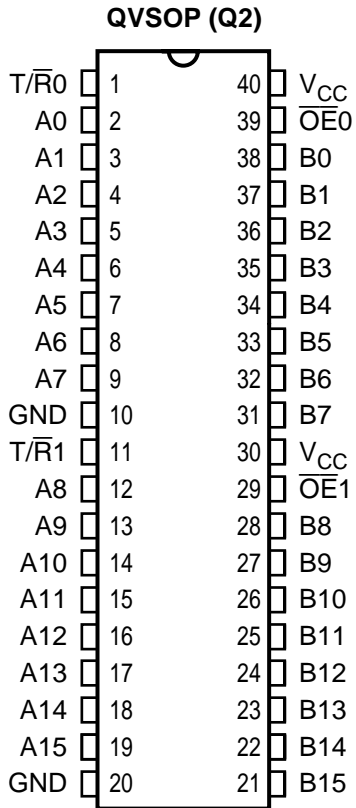
## DESCRIPTION

The LCX2X2H245 is a 16-bit non-inverting transceiver that has three-state outputs which are useful for bus-oriented applications. The Transmit/Receive (T/R) input determines the direction of data flow, either from A to B or B to A, and the Output Enable (OE) inputs enables the selected port for output. The 3.3V LCXPlus 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 LCXPlus product to be used in mixed-voltage applications. The LCX2X2H245 with integrated output resistor is ideally suited for low noise environments where reduced output overshoot and undershoot are critical requirements. Active Bus Hold feature retains the last valid logic state at unused or floating inputs, thus eliminating the need for external pull-up resistors. To accommodate hot-plug or live insertion applications, this product is designed not to load an active bus when  $V_{CC}$  is removed.

Figure 1. Functional Block Diagram



**Figure 2. Pin Configuration**  
(All Pins Top View)



**Table 1. Pin Description**

Name	I/O	Description
A <sub>i</sub>	I/O	Data Bus A (Bus Hold Inputs)
B <sub>i</sub>	I/O	Data Bus B (Bus Hold Inputs)
T/R <sub>0</sub>	I	Direction for A/B7-A/B0
T/R <sub>1</sub>	I	Direction for A/B15-A/B8
OE <sub>0</sub>	I	Output EnableS A/B7-A/B0
OE <sub>1</sub>	I	Output EnableS A/B15-A/B8

**Table 2. Function Table**

OE <sub>n</sub>	T/R <sub>n</sub>	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

**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	$V_{IN} = 0V, V_{OUT} = 0V, f = 1MHz$
$C_{PD}$	Power Dissipation Capacitance	20	pF	$V_{CC} = 3.3V, V_{IN} = 0V, \text{ or } V_{CC}, f = 10MHz$

**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°C 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	Parameter	Min	Max	Unit	
$V_{CC}$	Supply Voltage, Operating	2.0	3.6	V	
	Supply Voltage, Data Retention Only	1.5	3.6		
$V_{IN}$	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	$V_{CC} = 3.0 - 3.6V$	—	$\pm 12$	mA
		$V_{CC} = 2.7V$	—	$\pm 6$	
$\Delta t/\Delta v$	Input Transition Slew Rate	—	10	ns/V	
$T_A$	Operating Free Air Temperature	-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 <sup>(1)</sup>	Min	Typ <sup>(2)</sup>	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	$V_{CC} = 2.7\text{V}, I_{OH} = -100\mu\text{A}$ $V_{CC} = 3.0\text{V}, I_{OH} = -12\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OH} = -18\text{mA}$	$V_{CC} - 0.2$ 2.4 2.2	— — —	— — —	V
$V_{OL}$	Output LOW Voltage	$V_{CC} = 2.7\text{V}, I_{OL} = 100\mu\text{A}$ $V_{CC} = 3.0\text{V}, I_{OL} = 12\text{mA}$ $V_{CC} = 3.0\text{V}, I_{OL} = 18\text{mA}$	— — —	— — —	0.2 0.55 0.8	V
$\Delta V_T$	Input Hysteresis <sup>(3)</sup>	$V_{TLH} - V_{THL}$ for All Inputs	—	150	—	mV
$I_{OZ}$	High-Z I/O Leakage <sup>(3)</sup>	$V_O = 0\text{V}, V_O = 5.5\text{V},$ $V_I = V_{IH}$ or $V_{IL}, V_{CC} = 3.6\text{V}$	—	—	$\pm 1.0$	$\mu\text{A}$
$I_{OS}$	Short Circuit Current <sup>(3,4)</sup>	$V_{CC} = 3.6\text{V}, V_{OUT} = \text{GND}$	-60	—	-200	mA
$I_{OR}$	Current Drive <sup>(3)</sup>	$V_{CC} = 3.6\text{V}, V_{OUT} = 2.0\text{V}$	40	—	—	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	$V_I = 0\text{V}, V_I = 5.5\text{V},$ $V_{CC} = 3.6\text{V}$	—	—	$\pm 1.0$	$\mu\text{A}$
$ I_{BH} $	Input Current Input HIGH or LOW	$V_{CC} = 3.6\text{V}, V_{IN} = 0\text{V}$ or $V_{IN} = V_{CC}$	—	—	50	$\mu\text{A}$
	Bus Hold Inputs <sup>(3,5)</sup>	$V_{CC} = 3.6\text{V}, 0.8 < V_{IN} < 2.0\text{V}$	—	—	500 <sup>(6)</sup>	$\mu\text{A}$
$I_{BHH}$	Bus Hold Sustaining Current	$V_{CC} = 3.0\text{V}$	$V_{IN} = 2.0\text{V}$	-75	—	$\mu\text{A}$
$I_{BHL}$	Bus Hold Inputs			$V_{IN} = 0.8\text{V}$	75	—
$R_{OUT}$	Output Resistance	$V_{CC} = 3.0\text{V}, I_{OL} = 12\text{mA}$	—	28	—	$\Omega$
$I_{OFF}$	Power Off Leakage	$V_{CC} = 0\text{V}, V_I$ or $V_O = 5.5\text{V}$	—	—	10	$\mu\text{A}$

**Notes:**

1. For conditions shown as Min. or Max. 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.
5. Pins with Bus Hold are identified in the Pin Description.
6. An external driver must provide at least  $|I_{BH}|$  during transition to guarantee that the Bus Hold input will change state.

**Table 7. Power Supply Characteristics**

Symbol	Parameter	Test Conditions <sup>(1)</sup>	Typ <sup>(2)</sup>	Max	Unit	
$I_{CC}$	Quiescent Power Supply Current	$V_{CC} = \text{Max.}$ , Freq = 0 $V_{IN} = \text{GND or } V_{CC}$	0.2	20	$\mu\text{A}$	
$\Delta I_{CC}$	Supply Current per Input @ TTL HIGH <sup>(3)</sup>	$V_{CC} = \text{Max.}$ $V_{IN} = V_{CC} - 0.6\text{V}$ , Freq = 0	Control Inputs	2.0	30	$\mu\text{A}$
			Bus Hold Inputs	—	500	$\mu\text{A}$
$I_{CCD}$	Supply Current per Input per MHz <sup>(4)</sup>	$V_{CC} = \text{Max.}$ , Outputs Open One Bit Toggling @ 50% Duty Cycle $\overline{OE} = \text{GND}$	50	75	$\mu\text{A}/\text{MHz}$	
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}$ , Outputs Open One Bit Toggling @ 50% Duty Cycle $\overline{OE} = \text{GND}$ , $f = 10\text{MHz}$	$V_{IN} = V_{CC} - 0.6\text{V}$ $V_{IN} = \text{GND}$	0.5 <sup>(5)</sup>	1.0 <sup>(5)</sup>	$\text{mA}$
		$V_{CC} = \text{Max.}$ , Outputs Open Sixteen Bits Toggling @ 50% Duty Cycle $\overline{OE} = \text{GND}$ , $f = 2.5\text{MHz}$	$V_{IN} = V_{CC} - 0.6\text{V}$ $V_{IN} = \text{GND}$	2.0 <sup>(5)</sup>	7.0 <sup>(5)</sup>	$\text{mA}$

**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  $V_{CC} = 3.3\text{V}$ ,  $25^\circ\text{C}$  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 for these conditions are examples of the  $I_{CC}$  formula. These limits are guaranteed by design but not tested.
- $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CCQ} + \Delta I_{CC} D_H N_T + I_{CCD} f N_O$   
 $I_{CCQ} = \text{Quiescent Current } (I_{CC1}, I_{CC2}, \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL-High Input } (V_{IN} = V_{CC} - 0.6\text{V})$   
 $D_H = \text{Duty Cycle for TTL High Inputs}$   
 $N_T = \text{Number of TTL High Inputs}$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f = \text{Average Switching Frequency per Output}$   
 $N_O = \text{Number of Outputs Switching}$

**Table 8. Dynamic Switching Characteristics<sup>(1)</sup>**

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = 25^\circ\text{C}$	
				Typical	Units
$V_{OLP}$	Quiet Output Dynamic Peak $V_{OL}$	$C_L = 30\text{pF}$ , $V_{IH} = 3.3\text{V}$ , $V_{IL} = 0\text{V}$	3.3	0.8	V
$V_{OLV}$	Quiet Output Dynamic Valley $V_{OL}$	$C_L = 30\text{pF}$ , $V_{IH} = 3.3\text{V}$ , $V_{IL} = 0\text{V}$	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  $85^\circ\text{C}$ .

$C_{\text{LOAD}} = 30\text{pF}$ ,  $R_{\text{LOAD}} = 500\Omega$  unless otherwise noted.

Symbol	Description <sup>(1)</sup>	$V_{\text{CC}} = 3.3 \pm 0.3\text{V}$		$V_{\text{CC}} = 2.7\text{V}^{(2)}$		Unit
		Min	Max	Min	Max	
$t_{\text{PHL}}$ $t_{\text{PLH}}$	Propagation Delay Ai to Bi	1.5	7.0	1.5	8.0	ns
$t_{\text{PZH}}$ $t_{\text{PZL}}$	Output Enable Time $\overline{\text{OEx}}$ to Ai, Bi	1.5	8.5	1.5	9.5	ns
$t_{\text{PHZ}}$ $t_{\text{PLZ}}$	Output Disable Time <sup>(2)</sup> $\overline{\text{OEx}}$ to Ai, Bi	1.5	7.5	1.5	8.5	ns
$t_{\text{PZH}}$ $t_{\text{PZL}}$	Output Enable Time <sup>(2)</sup> $\text{T}/\overline{\text{Rx}}$ to Ai, Bi	1.5	8.5	1.5	9.5	ns
$t_{\text{PHZ}}$ $t_{\text{PLZ}}$	Output Disable Time <sup>(2)</sup> $\text{T}/\overline{\text{Rx}}$ to Ai, Bi	1.5	7.5	1.5	8.5	ns
$t_{\text{SK(O)}}$	Output Skew <sup>(3)</sup>	—	0.5	—	—	ns

**Notes:**

1. Minimums guaranteed but not production 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

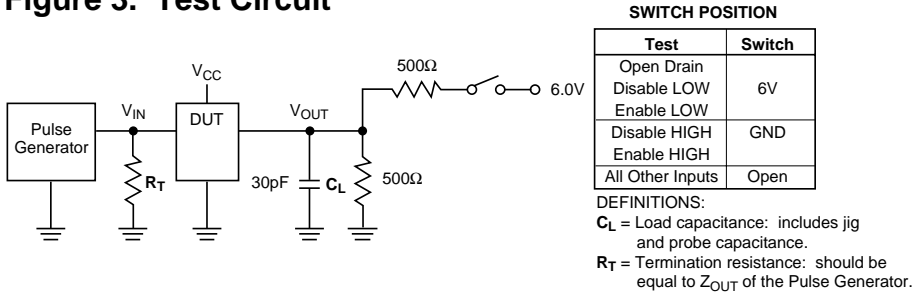


Figure 4. Setup, Hold, and Release Timing

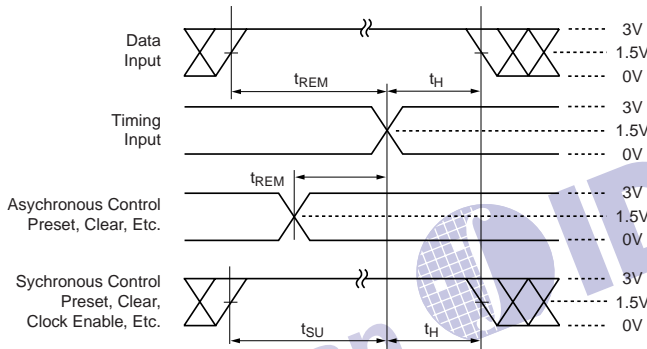


Figure 6. Pulse Width

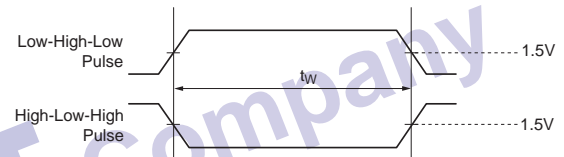


Figure 5. Enable and Disable Timing

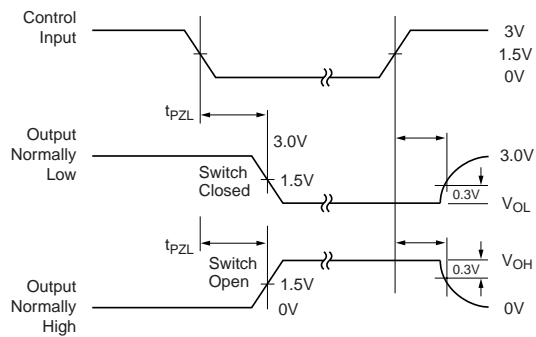
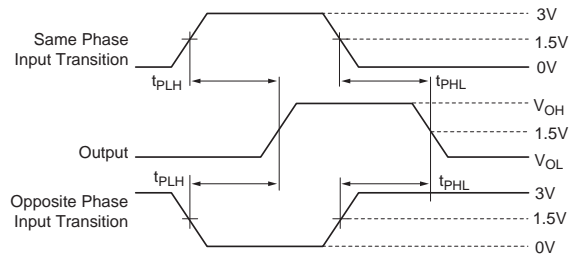


Figure 7. Propagation Delay



Notes:

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