National Semiconductor

74LCX16374
Low-Voltage 16-Bit D Flip-Flop with 5V Tolerant Inputs and Outputs

General Description

The LCX16374 contains sixteen non-inverting D flip-flops with TRI-STATE® outputs and is intended for bus oriented applications. The device is byte controlled. A buffered clock (CP) and Output Enable (CE) are common to each byte and can be shorted together for full 16-bit operation.

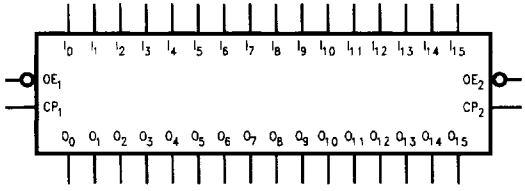
The LCX16374 is designed for low voltage (3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment.

The LCX16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 6.2 ns t_{PD} max, 20 μA I_{CCQ} max
- 5V tolerant inputs and outputs
- Power down high impedance inputs and outputs
- Supports live insertion/withdrawal
- 2.0V–3.6V V_{CC} supply operation
- ±24 mA output drive
- Implements patented Quiet Series™ noise/EMI reduction circuitry
- Functionally compatible with the 74 series 16374
- Latch-up performance exceeds 500 mA
- ESD performance:
  Human body model > 2000V
  Machine model > 200V

Logic Symbol



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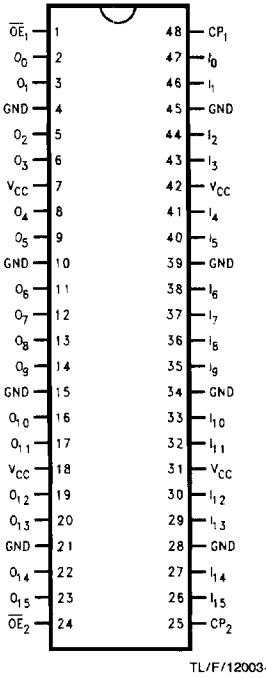
Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active Low)
CP_n	Clock Pulse Input
I_0–I_{15}	Inputs
O_0–O_{15}	Outputs

	SSOP	TSSOP
Order Number	74LCX16374MEA 74LCX16374MEAX	74LCX16374MTD 74LCX16374MTDX
See NS Package Number	MS48A	MTD48

Connection Diagram

Pin Assignment for SSOP and TSSOP



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Functional Description

The LCX16374 consists of sixteen edge-triggered flip-flops with individual D-type inputs and TRI-STATE true outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain full 16-bit operation. Each byte has a buffered clock and buffered Output Enable common to all flip-flops within that byte. The description which follows applies to each byte. Each flip-flop will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP_n) transition. With the Output Enable ($\overline{OE}_n$) LOW, the contents of the flip-flops are available at the outputs. When $\overline{OE}_n$ is HIGH, the outputs go to the high impedance state. Operation of the OE_n input does not affect the state of the flip-flops.

Truth Tables

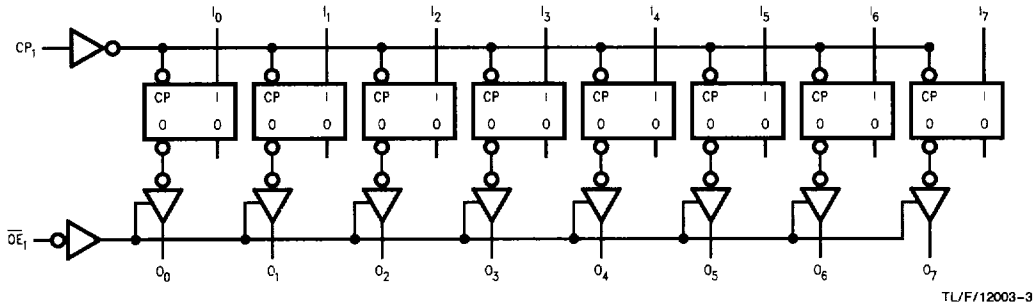
Inputs			Outputs
CP_1	$\overline{OE}_1$	I_0–I_7	O_0–O_7
↑	L	H	H
↑	L	L	L
L	L	X	O_0
X	H	X	Z

Inputs			Outputs
CP_2	$\overline{OE}_2$	I_8–I_{15}	O_8–O_{15}
↑	L	H	H
↑	L	L	L
L	L	X	O_0
X	H	X	Z

H = High Voltage Level
L = Low Voltage Level
X = Immaterial
Z = High Impedance
O_0 = Previous O_0 before HIGH to LOW of CP

Logic Diagrams

Byte 1 (0:7)



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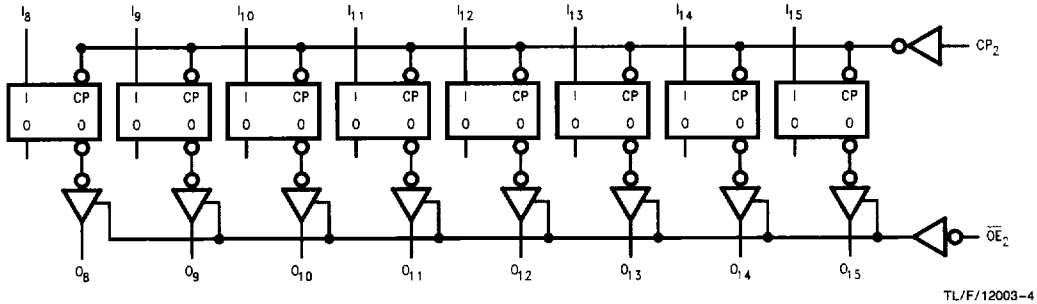
Byte 2 (8:15)



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Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Symbol	Parameter	Value	Conditions	Units
V_{CC}	Supply Voltage	−0.5 to +7.0		V
V_I	DC Input Voltage	−0.5 to +7.0		V
V_O	DC Output Voltage	−0.5 to +7.0	Output in TRI-STATE	V
		−0.5 to V_{CC} + 0.5	Output in High or Low State (Note 2)	V
I_{IK}	DC Input Diode Current	−50	V_I < GND	mA
I_{OK}	DC Output Diode Current	−50 +50	V_O < GND V_O > V_{CC}	mA
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

Note 1: 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" table are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Note 2: I_O Absolute Maximum Rating must be observed.

Recommended Operating Conditions

Symbol	Parameter		Min	Max	Units
V_{CC}	Supply Voltage	Operating Data Retention	2.0 1.5	3.6 3.6	V
V_I	Input Voltage		0	5.5	V
V_O	Output Voltage	HIGH or LOW State TRI-STATE	0 0	V_{CC} 5.5	V
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0V − 3.6V V_{CC} = 2.7V		±24 ±12	mA
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

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		2.7–3.6	2.0		V
V_{IL}	LOW Level Input Voltage		2.7–3.6		0.8	V
V_{OH}	HIGH Level Output Voltage	I_{OH} = −100 μA	2.7–3.6	V_{CC} − 0.2		V
		I_{OH} = −12 mA	2.7	2.2		V
		I_{OH} = −18 mA	3.0	2.4		V
		I_{OH} = −24 mA	3.0	2.2		V
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 μA	2.7–3.6		0.2	V
		I_{OL} = 12 mA	2.7		0.4	V
		I_{OL} = 16 mA	3.0		0.4	V
		I_{OL} = 24 mA	3.0		0.55	V
I_I	Input Leakage Current	0 ≤ V_I ≤ 5.5V	2.7–3.6		±5.0	μA
I_{OZ}	TRI-STATE Output Leakage	0 ≤ V_O ≤ 5.5V V_I = V_{IH} or V_{IL}	2.7–3.6		±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	2.7–3.6		20	μA
		3.6V ≤ V_I, V_O ≤ 5.5V	2.7–3.6		±20	μA
ΔI_{CC}	Increase in I_{CC} per Input	V_{IH} = V_{CC} −0.6V	2.7–3.6		500	μA

AC Electrical Characteristics

Symbol	Parameter	$T_A = -40°C$ to $+85°C$				Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		
		Min	Max	Min	Max	
f_{MAX}	Maximum Clock Frequency	170				MHz
t_{PHL} t_{PLH}	Propagation Delay CP to O_n	1.5 1.5	6.2 6.2	1.5 1.5	6.5 6.5	ns
t_{PZL} t_{PZH}	Output Enable Time	1.5 1.5	6.1 6.1	1.5 1.5	6.3 6.3	ns
t_{PLZ} t_{PHZ}	Output Disable Time	1.5 1.5	6.0 6.0	1.5 1.5	6.2 6.2	ns
t_S	Setup Time	2.5		2.5		ns
t_H	Hold Time	1.5		1.5		ns
t_W	Pulse Width	3.0		3.0		ns
t_{OSHL} t_{OSLH}	Output to Output Skew (Note 1)		1.0 1.0			ns

Note 1: Skew is defined as the absolute value of the difference between the actual propagation delay for any two seperate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH to LOW (t_{OSHL}) or LOW to HIGH (t_{OSLH}). Parameter guaranteed by design.

Dynamic Switching Characteristics

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

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C_{IN}	Input Capacitance	V_{CC} = Open, $V_I = 0V$ or V_{CC}	7	pF
C_{OUT}	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