National Semiconductor

PRELIMINARY

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.

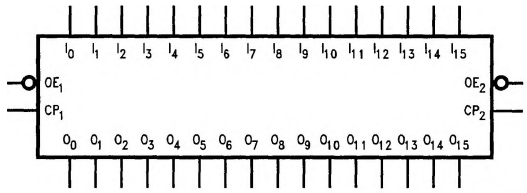
The LCX16374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs and outputs
- Ideal for low power/low noise 2.7V to 3.6V applications
- Power-down static overvoltage protection on input and output
- Outputs source/sink 24 mA
- Guaranteed simultaneous switching noise level
- Available in SSOP and TSSOP
- Implements patented Quiet Series noise/EMI reduction circuitry
- Functionally compatible with the 74 series 16374
- Latchup performance exceeds 300 mA
- ESD performance:
  Human Body Model > 2000V
  Machine Model > 250V

Ordering Code: See Section 11

Logic Symbol



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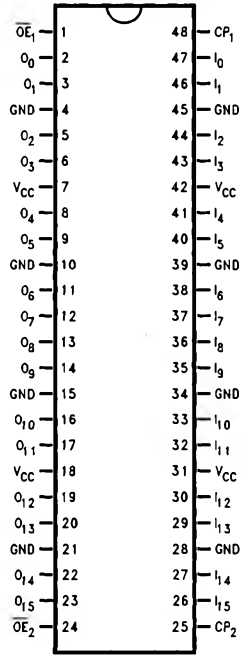
Pin Names	Description
$\overline{OE}_n$	Output Enable Input (Active Low)
CP_n	Clock Pulse Input
I_0–I_{15}	Inputs
O_0–O_{15}	Outputs

Connection Diagram

Pin Assignment for SSOP and TSSOP



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

Preliminary Data: National Semiconductor reserves the right to make changes at any time without notice.

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

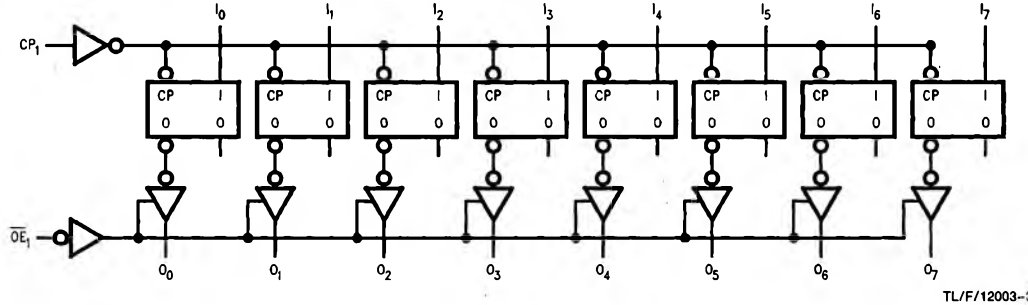
Inputs			Outputs
CP_1	$\overline{OE}_1$	I_0–I_7	O_0–O_7
↑	L	H	H
↑	L	L	L
L	L	X	O_0
X	H	X	Z

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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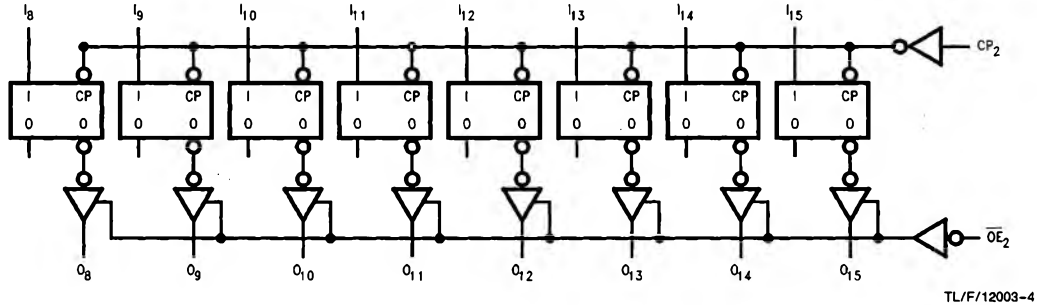
Byte 2 (8:15)



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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.

Supply Voltage (V_{CC})	−0.5V to +7.0V
DC Input Voltage (V_I)	−0.5V to +7.0V
OutputVoltage (V_O)	
Outputs TRI-STATE	−0.5V to +7.0V
Outputs Active (Note 2)	−0.5V to V_{CC} + 0.5V
DC Input Diode Current (I_{IK})	
V_I < 0	−50 mA
DC Output Diode Current (I_{OK})	
V_O < 0	−50 mA
V_O > V_{CC}	+50 mA
DC Output Source/Sink Current (I_{OH}/I_{OL})	±50 mA
DC V_{CC} or Ground Current per Supply Pin (I_{CC} or I_{GND})	±100 mA
Storage Temperature Range (T_{STG})	−65°C 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

Supply Voltage (V_{CC})	
Operating	2.0V to 3.6V
Data Retention Only	1.5V to 3.6V
Input Voltage (V_I)	0.0V to 5.5V
Output Voltage (V_O)	
Output in Active State	0.0V to V_{CC}
Output in "OFF" State	0.0V to 5.5V
Output Current I_{OH}/I_{OL}	
V_{CC} = 3.0V to 3.6V	±24 mA
V_{CC} = 2.7V to 3.0V	±12 mA
Free Air Operating Temperature (T_A)	−40°C to +85°C
Minimum Input Edge Rate ($\Delta t/\Delta V$)	
V_{IN} = 0.8V to 2.0V, V_{CC} = 3.0V	10 ns/V

DC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	T_A = −40°C to +85°C		Units	Conditions
			Min	Max		
V_{IH}	High Level Input Voltage	2.7–3.6	2.0		V	V_{OUT} ≤ 0.1V or ≥ V_{CC} − 0.1V
V_{IL}	Low Level Input Voltage	2.7–3.6		0.8	V	V_{OUT} ≤ 0.1V or ≥ V_{CC} − 0.1V
V_{OH}	High Level Output Voltage	2.7–3.6	V_{CC} − 0.2		V	I_{OH} = −100 μA
		2.7	2.2		V	I_{OH} = −12 mA
		3.0	2.4		V	I_{OH} = −18 mA
		3.0	2.2		V	I_{OH} = −24 mA
V_{OL}	Low Level Output Voltage	2.7–3.6		0.2	V	I_{OL} = 100 μA
		2.7		0.4	V	I_{OL} = 12 mA
		3.0		0.55	V	I_{OL} = 24 mA
I_I	Input Leakage Curent	2.7–3.6		±5.0	μA	0 ≤ V_I ≤ 5.5V
I_{OZ}	TRI-STATE Output Leakage	2.7–3.6		±5.0	μA	0 ≤ V_O ≤ 5.5V V_L = V_{IH} or V_{IL}
I_{OFF}	Power Off Leakage Current	0		100	μA	V_I or V_O = 5.5V
I_{CC}	Quiescent Supply Current	2.7–3.6		20	μA	V_I = V_{CC} or GND
				±20	μA	3.6 ≤ (V_I, V_O) ≤ 5.5V
ΔI_{CC}	Increase in I_{CC} per Input	2.7–3.6		500	μA	V_{IH} = V_{CC} − 0.6V

AC Electrical Characteristics: See Section 2 for Test Methodology

Symbol	Parameter	V_{CC} (V)	$T_A = -40°C$ to $+85°C$, $C_L = 50$ pF		Units
			Min	Max (Note 2)	
t_{PHL}, t_{PLH}	Propagation Delay CP to Output	2.7 3.0–3.6	1.5 1.5	7.7 7.0	ns
t_{PZH}, t_{PZL}	Output Enable Time	2.7 3.0–3.6	1.5 1.5	8.0 7.2	ns
t_{PHZ}, t_{PLZ}	Output Disable Time	2.7 3.0–3.6	1.5 1.5	8.0 7.2	ns
t_S	Setup Time	2.7 3.0–3.6	2.5 2.5		ns
t_H	Hold Time	2.7 3.0–3.6	1.5 1.5		ns
t_W	Pulse Width	2.7 3.0–3.6	4.0 4.0		ns
T_{OSHL}, T_{OSLH}	Output to Output Skew (Note 1)	3.0		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.

Note 2. The maximum AC limits are design targets. Actual performance will be specified upon completion of characterization.

Dynamic Switching Characteristics: See Section 2 for Test Methodology

Symbol	Parameter	V_{CC} (V)	$T_A = 25°C$ Typical	Units	Conditions
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	3.3	0.8	V	$C_L = 50$ pF, $V_{IH} = 3.3$V, $V_{IL} = 0$V
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	3.	0.8	V	$C_L = 50$ pF, $V_{IH} = 3.3$V, $V_{IL} = 0$V

Capacitance

Symbol	Parameter	Typical	Units	Conditions
C_{IN}	Input Capacitance	7	pF	V_{CC} = Open $V_I = 0$V or V_{CC}
C_{OUT}	Output Capacitance	8	pF	$V_{CC} = 3.3$V $V_I = 0$V or V_{CC}
C_{PD}	Power Dissipation Capacitance	32	pF	$V_{CC} = 3.3$V $V_I = 0$V or V_{CC} F = 10 MHz