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June 1998 Revised February 2001

#### 74LCX112

## Low Voltage Dual J-K Negative Edge-Triggered Flip-Flop with 5V Tolerant Inputs

#### **General Description**

The LCX112 is a dual J-K flip-flop. Each flip-flop has independent J, K, PRESET, CLEAR, and CLOCK inputs with Q, Q outputs. These devices are edge sensitive and change state on the negative going transition of the clock pulse. Clear and preset are independent of the clock and accomplished by a low logic level on the corresponding input. LCX devices are designed for low voltage (3.3V or 2.5) operation with the added capability of interfacing to a 5V signal environment.

The 74LCX112 is fabricated with advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

#### **Features**

- 5V tolerant inputs
- 2.3V-3.6V V<sub>CC</sub> specifications provided
- $\blacksquare$  7.5 ns  $t_{PD}$  max (V  $_{CC}$  = 3.3V), 10  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- $\blacksquare$  ±24 mA output drive (V<sub>CC</sub> = 3.0V)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:

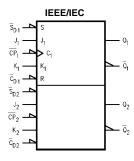
Human body model > 2000V Machine model > 2000V

#### **Ordering Code:**

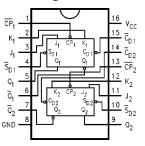
Order Number	Package Number	Package Description
74LCX112M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow
74LCX112SJ	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74LCX112MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4,4mm Wide

Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

#### **Logic Symbol**



#### **Connection Diagram**



#### **Pin Descriptions**

Pin Names	Description
J <sub>1</sub> , J <sub>2</sub> , K <sub>1</sub> , K <sub>2</sub>	Data Inputs
$\overline{CP}_1$ , $\overline{CP}_2$	Clock Pulse Inputs (Active Falling Edge)
$\overline{C}_{D1}$ , $\overline{C}_{D2}$	Direct Clear Inputs (Active LOW)
$\overline{S}_{D1}$ , $\overline{S}_{D2}$	Direct Set Inputs (Active LOW)
$Q_1, Q_2, \overline{Q}_1, \overline{Q}_2$	Outputs

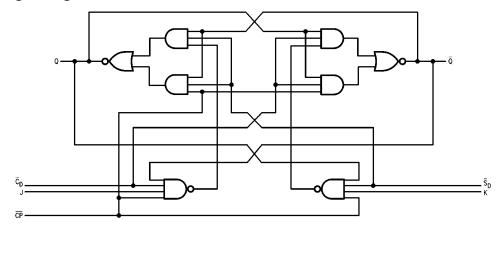
#### **Truth Table**

(Each half)

Inputs					Outputs	
S <sub>D</sub>	C <sub>D</sub>	CP	J	К	Q	Ια
L	Н	Х	Х	Х	Н	L
Н	Ш	Χ	Χ	Χ	L	Н
L	L	Х	Х	Х	Н	H
Н	Н	7	h	h	$\overline{Q}_{O}$	$Q_O$
Н	Н	7	1	h	L	Н
Н	Н	7	h	- 1	Н	L
Н	Н	7	1	1	Q <sub>O</sub>	$\overline{Q}_{O}$
Н	Н	Н	Х	Х	QO	$\overline{Q}_{O}$

H(h) = HIGH Voltage Level
L(l) = LOW Voltage Level
X = Immaterial
= HIGH-to-LOW Clock Transition
Q<sub>O</sub>(\overline{O}\_0) = Before HIGH-to-LOW Transition of Clock
Lower case letters indicate the state of the referenced input or output one setup time prior to the HIGH-to-LOW clock transition.

### **Logic Diagram**



°C

#### **Absolute Maximum Ratings**(Note 1) Parameter Value Units Symbol Conditions -0.5 to +7.0 ٧ Supply Voltage $V_{CC}$ DC Input Voltage ٧ $V_{I}$ -0.5 to +7.0 DC Output Voltage Output in HIGH or LOW State (Note 2) ٧o -0.5 to $V_{CC} + 0.5$ V V<sub>I</sub> < GND DC Input Diode Current -50 mΑ DC Output Diode Current V<sub>O</sub> < GND $I_{OK}$ mΑ +50 $V_O > V_{CC}$ ±50 DC Output Source/Sink Current mΑ ±100 DC Supple Current per Supply Pin mΑ DC Ground Current per Ground Pin ±100 $I_{GND}$ mΑ

-65 to 150

#### **Recommended Operating Conditions** (Note 3)

Symbol	Parameter	Min	Max	Units	
V <sub>CC</sub>	Supply Voltage	2.0	3.6	V	
		Data Retention	1.5	3.6	V
VI	Input Voltage		0	5.5	V
Vo	Output Voltage	HIGH or LOW State	0	V <sub>CC</sub>	V
I <sub>OH</sub> /I <sub>OL</sub>	Output Current	$V_{CC} = 3.0V - 3.6V$		±24	
		$V_{CC} = 2.7V - 3.0V$		±12	mA
		$V_{CC} = 2.3V - 2.7V$		±8	
T <sub>A</sub>	Free-Air Operating Temperature		-40	85	°C
Δt/ΔV	Input Edge Rate, V <sub>IN</sub> = 0.8V–2.0V, V <sub>CC</sub> = 3.0V		0	10	ns/V

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

Note 2: I<sub>O</sub> Absolute Maximum rating must be observed.

Storage Temperature

T<sub>STG</sub>

Note 3: Unused Inputs must be held HIGH or LOW. They may not float.

#### **DC Electrical Characteristics**

Symbol	Parameter	Conditions	v <sub>cc</sub>	$T_A = 40^{\circ}C$	to +85°C	Units
Cymbol		Conditions	(V)	Min	Max	Units
V <sub>IH</sub>	HIGH Level Input Voltage		2.3 – 2.7	1.7		V
			2.7 – 3.6	2.0		V
V <sub>IL</sub>	LOW Level Input Voltage		2.3 – 2.7		0.7	V
			2.7 – 3.6		0.8	V
V <sub>OH</sub>	HIGH Level Output Voltage	$I_{OH} = -100\mu A$	2.3 – 3.6	V <sub>CC</sub> - 0.2	0.7	
		I <sub>OH</sub> = -8 mA	2.3	1.8		1
		$I_{OH} = -12 \text{ mA}$	2.7	2.2		V
		$I_{OH} = -18 \text{ mA}$	3.0	2.4		
		I <sub>OH</sub> = -24 mA	3.0	2.2		
V <sub>OL</sub>	LOW Level Output Voltage	$I_{OL} = 100 \mu A$	2.3 – 3.6		0.6	
		I <sub>OL</sub> = 8mA	2.3		0.2	
		I <sub>OL</sub> = 12 mA	2.7		0.4	V
		I <sub>OL</sub> = 16 mA	3.0		0.4	
		I <sub>OL</sub> = 24 mA	3.0		0.55	
I <sub>I</sub>	Input Leakage Current	$0 \le I_1 \le 5.5V$	2.3 – 3.6		±5.0	μΑ
I <sub>OFF</sub>	Power-Off Leakage Current	$V_I$ or $V_O = 5.5V$	0		10	μΑ
Icc	Quiescent Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND	2.3 – 3.6		10	μΑ
		$3.6 \text{V} \leq \text{V}_{\text{I}} \leq 5.5 \text{V}$	2.3 – 3.6		±10	μΑ
Δl <sub>CC</sub>	Increase in I <sub>CC</sub> per Input	$V_{IH} = V_{CC} - 0.6V$	2.3 – 3.6		500	μΑ

#### **AC Electrical Characteristics**

		$T_A = 40^{\circ} \text{C}$ to $85^{\circ} \text{C}$ , $R_L = 500 \Omega$						
Symbol	Parameters	$V_{CC} = 3.3V \pm 0.3V$ $C_L = 50 \text{ pF}$		$V_{CC} = 2.7V$ $C_L = 50 \text{ pF}$		$V_{CC} = 2.5V \pm 0.2V$ $C_L=30 \text{ pF}$		Units
Symbol	Farameters							
		Min	Max	Min	Max	Min	Max	
f <sub>MAX</sub>	Maximum Clock Frequency	150		150		150		MHz
t <sub>PHL</sub>	Propagation Delay	1.5	7.5	1.5	8.0	1.5	9.0	
t <sub>PLH</sub>	$\overline{CP}_n$ to $Q_n$ or $\overline{Q}_n$	1.5	7.5	1.5	8.0	1.5	9.0	ns
t <sub>PHL</sub>	Propagation Delay	1.5	7.0	1.5	8.0	1.5	8.4	
t <sub>PLH</sub>	$\overline{C}_{Dn}$ or $\overline{S}_{Dn}$ to $Q_n$ or $\overline{Q}_n$	1.5	7.0	1.7	8.0	1.5	8.4	ns
t <sub>S</sub>	Setup Time	2.5		2.5		4.0		ns
t <sub>H</sub>	Hold Time	1.5		1.5		2.0		ns
t <sub>W</sub>	Pulse Width CP	3.3		3.3		4.0		ns
t <sub>W</sub>	Pulse Width $(\overline{C}_D, \overline{S}_D)$	3.3		3.3		4.0		ns
t <sub>REC</sub>	Recovery Time	2.0		2.5		4.5		ns
t <sub>OSHL</sub>	Output to Output Skew		1.0					ns
t <sub>OSLH</sub>	(Note 4)		1.0					115

Note 4: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t<sub>OSHL</sub>), or LOW-to-HIGH (t<sub>OSLH</sub>).

#### **Dynamic Switching Characteristics**

Symbol	Parameter	Conditions	V <sub>CC</sub>	<b>T</b> <sub>A</sub> = 25°C	Units
•			(V)	Typical	
V <sub>OLP</sub>	Quiet Output Dynamic Peak V <sub>OL</sub>	$C_L = 50 \text{ pF}, V_{IH} = 3.3 \text{V}, V_{IL} = 0 \text{V}$	3.3	0.8	V
		$C_L = 30 \text{ pF}, V_{IH} = 2.5 \text{V}, V_{IL} = 0 \text{V}$	2.5	0.6	V
V <sub>OLV</sub>	Quiet Output Dynamic Valley V <sub>OL</sub>	$C_L = 50 \text{ pF}, V_{IH} = 3.3 \text{V}, V_{IL} = 0 \text{V}$	3.3	-0.8	V
İ		$C_L = 30 \text{ pF}, V_{IH} = 2.5 \text{V}, V_{IL} = 0 \text{V}$	2.5	-0.6	V

### Capacitance

Symbol	Parameter	Conditions	Typical	Units
C <sub>IN</sub>	Input Capacitance	$V_{CC} = Open, V_I = 0V \text{ or } V_{CC}$	7	pF
C <sub>OUT</sub>	Output Capacitance	$V_{CC} = 3.3V$ , $V_I = 0V$ or $V_{CC}$	8	pF
C <sub>PD</sub>	Power Dissipation Capacitance	$V_{CC} = 3.3V$ , $V_I = 0V$ or $V_{CC}$ , $f = 10$ MHz	25	pF

#### AC Loading and Waveforms Generic for LCX Family

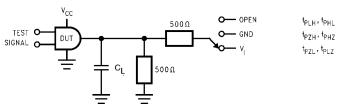
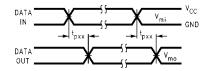
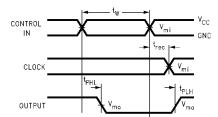


FIGURE 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)

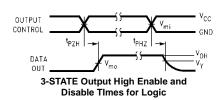
Test	Switch
t <sub>PLH</sub> , t <sub>PHL</sub>	Open
t <sub>PZL</sub> , t <sub>PLZ</sub>	6V at $V_{CC} = 3.3 \pm 0.3V$ $V_{CC}$ x 2 at $V_{CC} = 2.5 \pm 0.2V$
t <sub>PZH</sub> ,t <sub>PHZ</sub>	GND



**Waveform for Inverting and Non-Inverting Functions** 



Propagation Delay, Pulse Width and  $t_{\text{rec}}$  Waveforms



OUTPUT CONTROL

TepzL

Vmo

Vcc

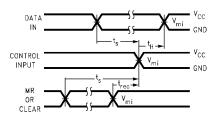
GND

VX

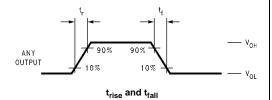
VX

Vol

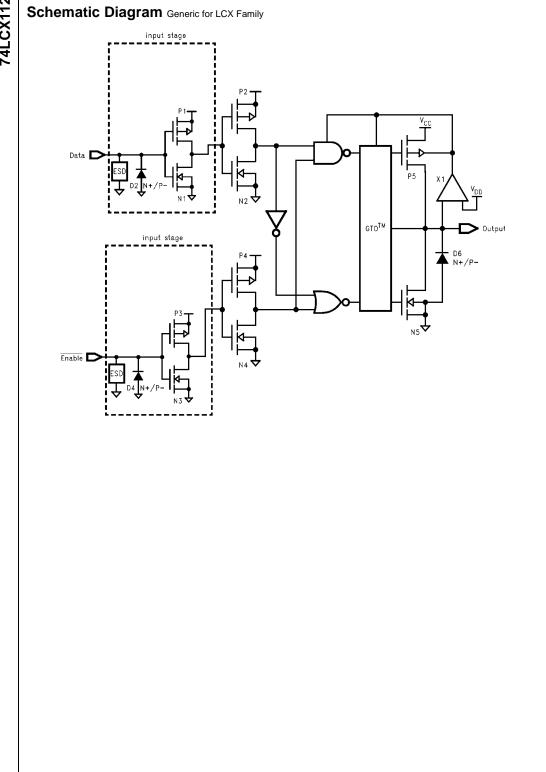
### 3-STATE Output Low Enable and Disable Times for Logic

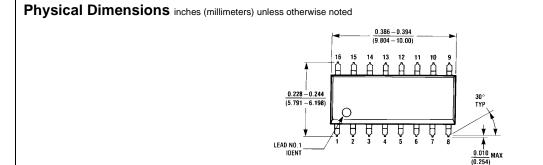


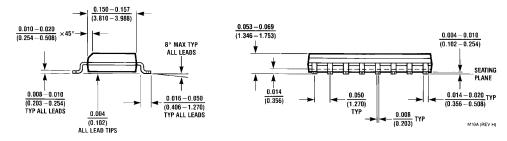
Setup Time, Hold Time and Recovery Time for Logic



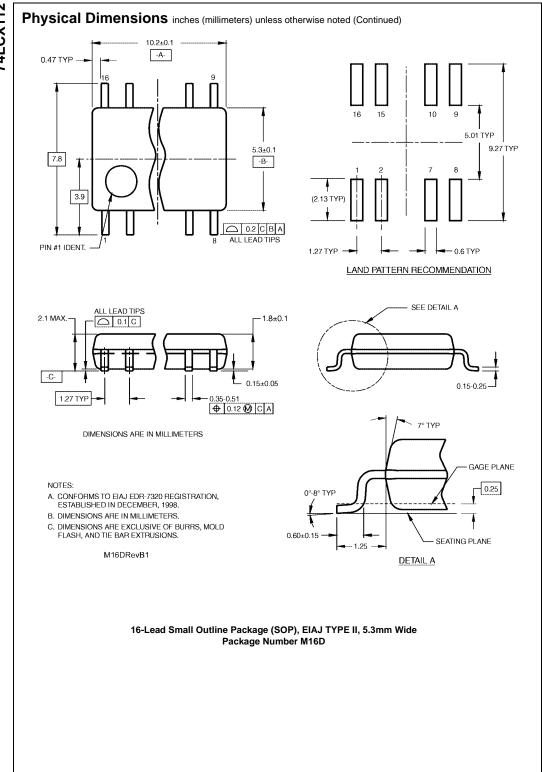
Symbol	V <sub>CC</sub>					
Cymbol	$3.3V \pm 0.3V$	2.7V	2.5V ± 0.2V			
V <sub>mi</sub>	1.5V	1.5V	V <sub>CC</sub> /2			
$V_{mo}$	1.5V	1.5V	V <sub>CC</sub> /2			
V <sub>x</sub>	V <sub>OL</sub> + 0.3V	V <sub>OL</sub> + 0.3V	V <sub>OL</sub> + 0.15V			
V <sub>y</sub>	V <sub>OH</sub> – 0.3V	V <sub>OH</sub> – 0.3V	V <sub>OH</sub> – 0.15V			

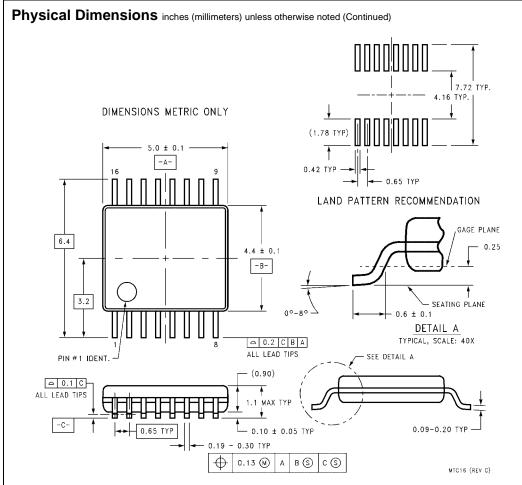






16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow Package Number M16A





16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC16

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