TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74LCX16374FT

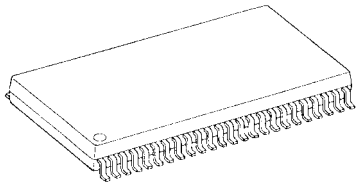
Low-Voltage 16-Bit D-Type Flip-Flop with 5-V Tolerant Inputs and Outputs

The TC74LCX16374FT is a high-performance CMOS 16-bit D-type flip-flop. Designed for use in 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (2.5-V or 3.3-V) V_{CC} applications, but it could be used to interface to 5-V supply environment for both inputs and outputs.

This 16-bit D-type flip-flop is controlled by a clock input (CK) and an output enable input ($\overline{OE}$) which are common to each byte. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. When the $\overline{OE}$ input is high, the outputs are in a high-impedance state.

All inputs are equipped with protection circuits against static discharge.



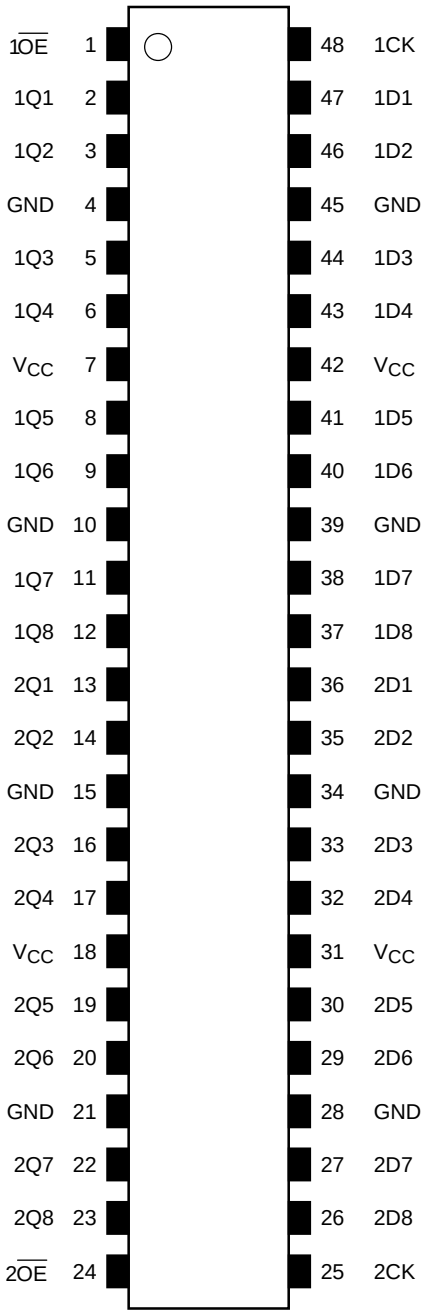
TSSOP48-P-0061-0.50

Weight: 0.25 g (typ.)

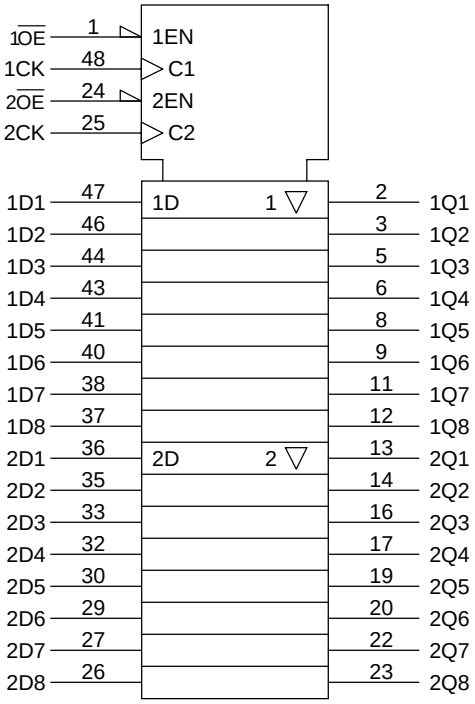
Features

- Low-voltage operation: V_{CC} = 2.0 to 3.6 V
- High-speed operation: t_{pd} = 6.2 ns (max) (V_{CC} = 3.0 to 3.6 V)
- Ouput current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)
- Latch-up performance: ±500 mA
- Package: TSSOP (thin shrink small outline package)
- Power-down protection provided on all inputs and outputs

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

Inputs			Outputs
$1\overline{OE}$	1CK	1D1-1D8	1Q1-1Q8
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

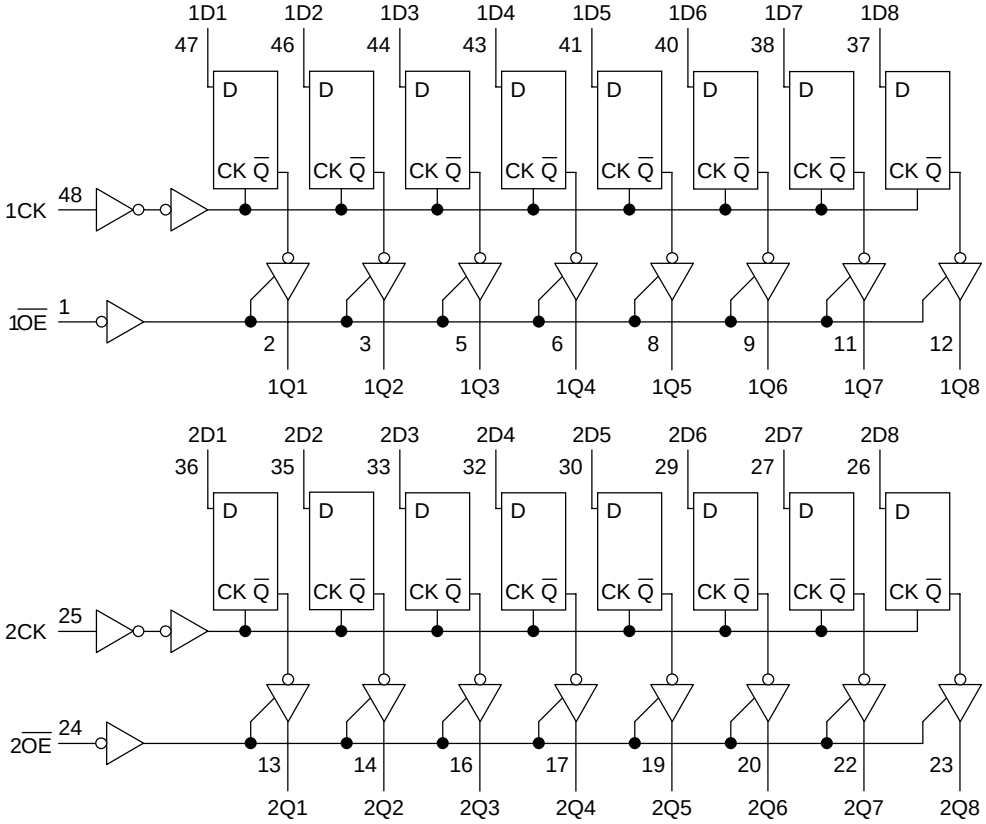
Inputs			Outputs
$2\overline{OE}$	2CK	2D1-2D8	2Q1-2Q8
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

X: Don't care

Z: High impedance

Qn: No change

System Diagram



Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5 to 6.0	V
Input voltage	V_{IN}	−0.5 to 7.0	V
Output voltage	V_{OUT}	−0.5 to 7.0 (Note 1)	V
		−0.5 to V_{CC} + 0.5 (Note 2)	
Input diode current	I_{IK}	−50	mA
Output diode current	I_{OK}	±50 (Note 3)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	400	mW
DC V_{CC}/ground current per supply pin	I_{CC}/I_{GND}	±100	mA
Storage temperature	T_{stg}	−65 to 150	°C

Note 1: Output in OFF state

Note 2: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 3: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Conditions

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	2.0 to 3.6	V
		1.5 to 3.6 (Note 4)	
Input voltage	V_{IN}	0 to 5.5	V
Output voltage	V_{OUT}	0 to 5.5 (Note 5)	V
		0 to V_{CC} (Note 6)	
Output current	I_{OH}/I_{OL}	±24 (Note 7)	mA
		±12 (Note 8)	
		±8 (Note 9)	
Operating temperature	T_{opr}	−40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 10)	ns/V

Note 4: Data retention only

Note 5: Output in OFF state

Note 6: High or low state

Note 7: V_{CC} = 3.0 to 3.6 V

Note 8: V_{CC} = 2.7 to 3.0 V

Note 9: V_{CC} = 2.3 to 2.7 V

Note 10: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = −40 to 85°C)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	H-level	V_{IH}	—		2.3 to 2.7	1.7	—	V
					2.7 to 3.6	2.0	—	
	L-level	V_{IL}	—		2.3 to 2.7	—	0.7	
					2.7 to 3.6	—	0.8	
Output voltage	H-level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −100 μA	2.3 to 3.6	V_{CC} − 0.2	—	V
				I_{OH} = −8 mA	2.3	1.8	—	
				I_{OH} = −12 mA	2.7	2.2		
				I_{OH} = −18 mA	3.0	2.4	—	
				I_{OH} = −24 mA	3.0	2.2	—	
	L-level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 3.6	—	0.2	
				I_{OL} = 8 mA	2.3	—	0.6	
				I_{OL} = 12 mA	2.7	—	0.4	
				I_{OL} = 16 mA	3.0	—	0.4	
				I_{OL} = 24 mA	3.0	—	0.55	
Input leakage current		I_{IN}	V_{IN} = 0 to 5.5 V		2.3 to 3.6	—	±5.0	μA
3-state output OFF state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 5.5 V		2.3 to 3.6	—	±5.0	μA
Power-off leakage current		I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		2.3 to 3.6	—	20.0	μA
			V_{IN}/V_{OUT} = 3.6 to 5.5 V		2.3 to 3.6	—	±20.0	
Increase in Icc per input		ΔI_{CC}	V_{IH} = V_{CC} − 0.6 V		2.3 to 3.6	—	500	

AC Characteristics (Ta = –40 to 85°C)

Characteristics	Symbol	Test Condition			Min	Max	Unit
			V_{CC} (V)	CL(pF)			
Maximum clock frequency	f_{max}	Figure 1, Figure 2	2.5 ± 0.2	30	—	—	MHz
			2.7	50	—	—	
			3.3 ± 0.3	50	170	—	
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	Figure 1, Figure 2	2.5 ± 0.2	30	1.5	7.4	ns
			2.7	50	1.5	6.5	
			3.3 ± 0.3	50	1.5	6.2	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	7.9	ns
			2.7	50	1.5	6.3	
			3.3 ± 0.3	50	1.5	6.1	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	7.2	ns
			2.7	50	1.5	6.2	
			3.3 ± 0.3	50	1.5	6.0	
Minimum pulse width (CK)	t_w (H) t_w (L)	Figure 1, Figure 2	2.5 ± 0.2	30	3.5	—	ns
			2.7	50	3.0	—	
			3.3 ± 0.3	50	3.0	—	
Minimum setup time	t_s	Figure 1, Figure 2	2.5 ± 0.2	30	3.0	—	ns
			2.7	50	2.5	—	
			3.3 ± 0.3	50	2.5	—	
Minimum hold time	t_h	Figure 1, Figure 2	2.5 ± 0.2	30	2.0	—	ns
			2.7	50	1.5	—	
			3.3 ± 0.3	50	1.5	—	
Output to output skew	t_{osLH} t_{osHL}	(Note 11)	2.5 ± 0.2	30	—	—	ns
			2.7	50	—	—	
			3.3 ± 0.3	50	—	1.0	

Note 11: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

Dynamic Switching Characteristics
(Ta = 25°C, input: $t_r = t_f = 2.5$ ns, $R_L = 500\ \Omega$)

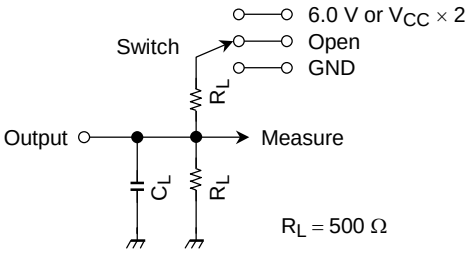
Characteristics	Symbol	Test Condition		Typ.	Unit
			V_{CC} (V)		
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 2.5 V, V_{IL} = 0 V, C_L =30pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L =50pF	3.3	0.8	
Quiet output minimum dynamic V_{OL}	$\|V_{OLV}\|$	V_{IH} = 2.5 V, V_{IL} = 0 V, C_L =30pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L =50pF	3.3	0.8	

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—	3.3	7	pF
Output capacitance	C_{OUT}	—	3.3	8	pF
Power dissipation capacitance	C_{PD}	f_{IN} = 10 MHz (Note 12)	3.3	25	pF

Note 12: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16$ (per bit)

AC Test Circuit



Parameter	Switch	
t_{pLH}, t_{pHL}	Open	
t_{pLZ}, t_{pZL}	6.0 V	@V_{CC} = 3.3 ± 0.3 V
	V_{CC} × 2	@V_{CC} = 2.5 ± 0.2 V
t_{pHZ}, t_{pZH}	GND	

Figure 1

AC Waveform

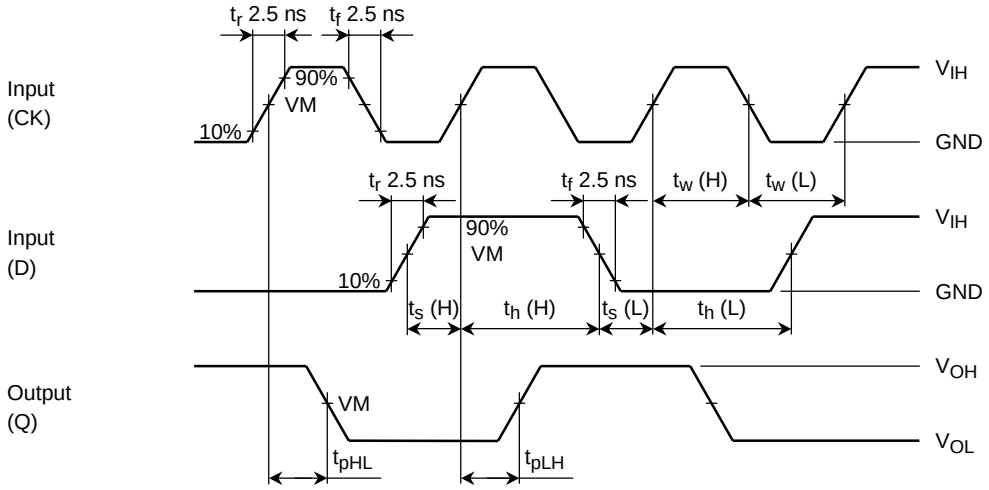


Figure 2 t_{pLH}, t_{pHL}, t_w, t_s, t_h

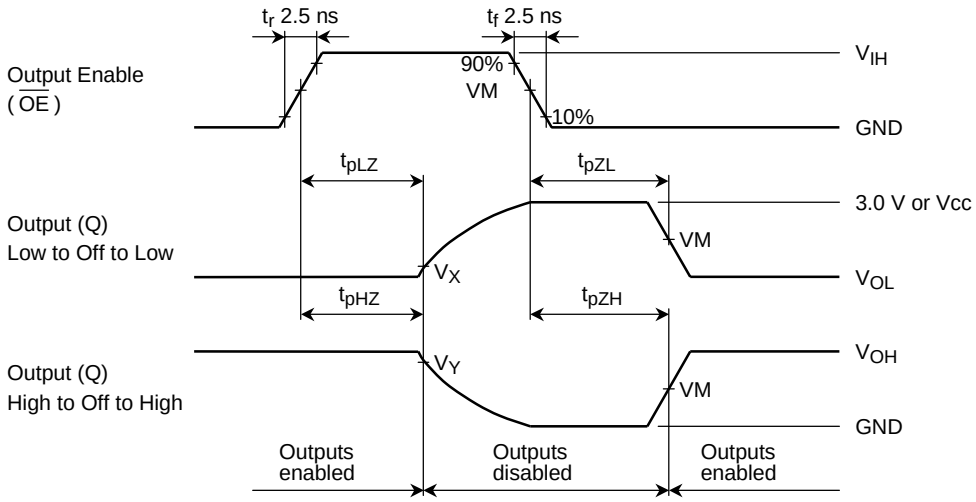
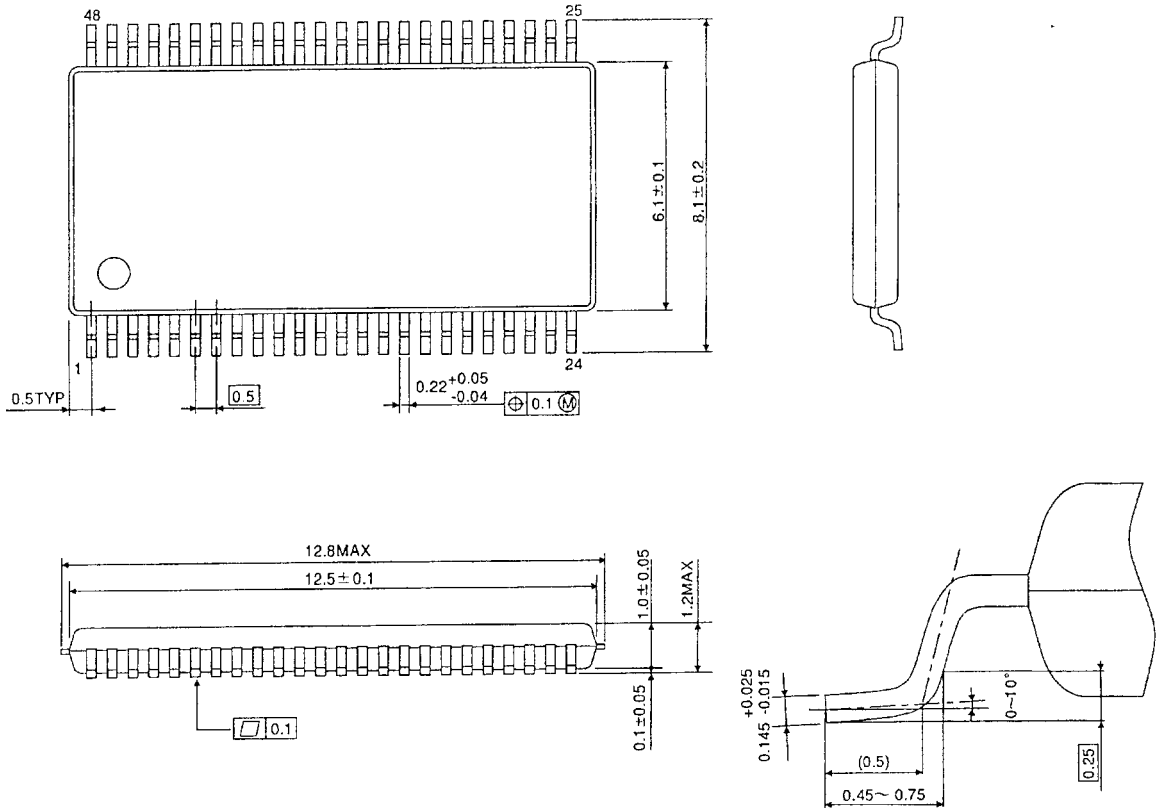


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.7 V	2.5 ± 0.2 V
V_{IH}	2.7 V	2.7 V	V_{CC}
V_M	1.5 V	1.5 V	$V_{CC}/2$
V_X	V_{OL} + 0.3 V	V_{OL} + 0.3 V	V_{OL} + 0.15 V
V_Y	V_{OH} − 0.3 V	V_{OH} − 0.3 V	V_{OH} − 0.15 V

Package Dimensions

TSSOP48-P-0061-0.50 Unit : mm



Weight: 0.25 g (typ.)

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