

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MH374FK

Octal D-Type Flip-Flop with 3-State Output

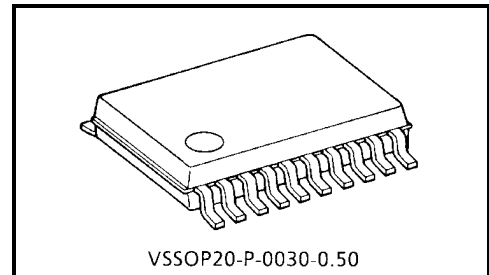
The TC7MH374FK is an advanced high speed CMOS octal flip-flop with 3-state output fabricated with silicon gate C²MOS technology.

It achieves the high speed operation similar to equivalent bipolar schottky TTL while maintaining the CMOS low power dissipation.

This 8-bit D-type flip-flop is controlled by a clock input (CK) and an output enable input (\overline{OE}).

When the \overline{OE} input is high, the eight outputs are in a high impedance state.

An input protection circuit ensures that 0 to 7 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.



Weight: 0.03 g (typ.)

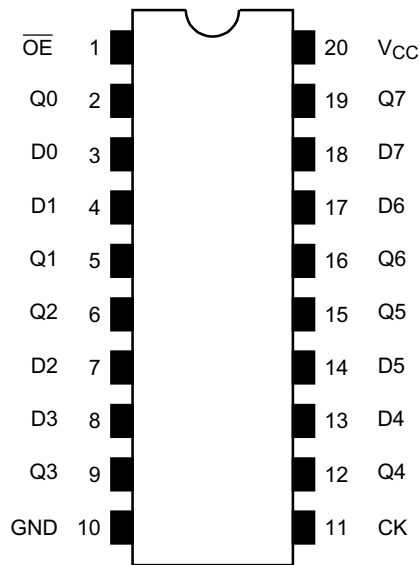
Features

- High speed: $f_{max} = 185 \text{ MHz (typ.) (VCC = 5 V)}$
- Low power dissipation: $I_{CC} = 4 \mu\text{A (max) (Ta = 25^\circ\text{C})}$
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Power down protection is provided on all inputs.
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC} \text{ (opr)} = 2\sim 5.5 \text{ V}$
- Low noise: $V_{OLP} = 0.8 \text{ V (max)}$
- Pin and function compatible with 74ALS374

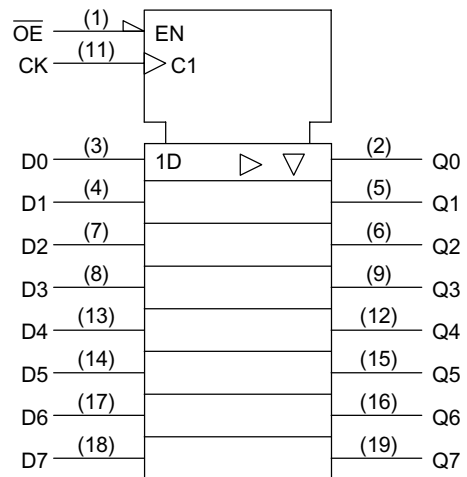
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Pin Assignment (top view)



IEC Logic Symbol



Truth Table

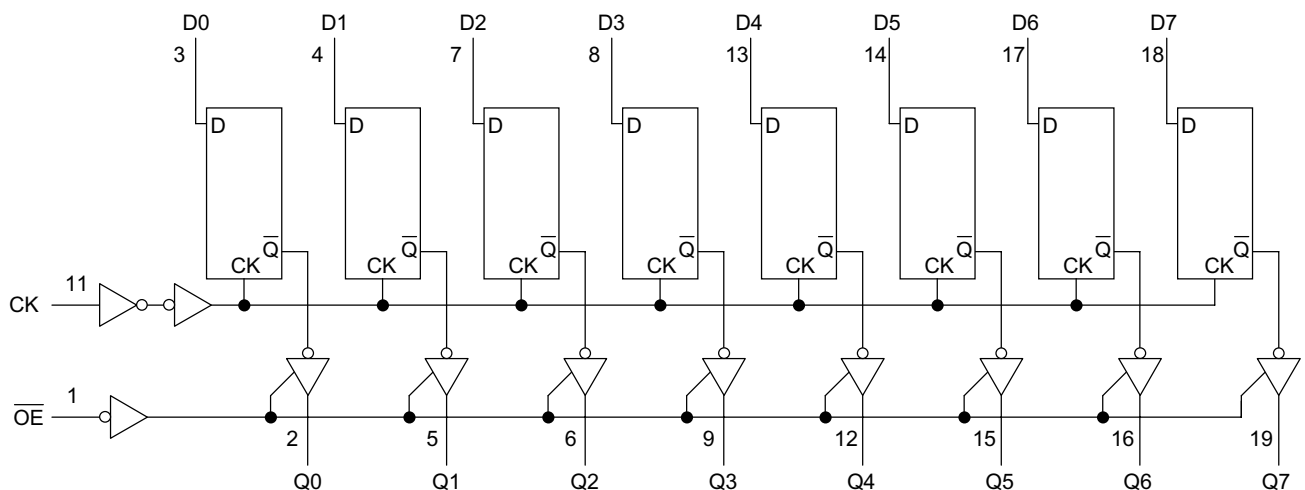
Inputs			Outputs
\overline{OE}	CK	D	
H	X	X	Z
L		X	Q_n
L		L	L
L		H	H

X: Don't care

Z: High impedance

Q_n : No change

System Diagram



Maximum Ratings

Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	-0.5~7.0	V
DC input voltage	V_{IN}	-0.5~7.0	V
DC output voltage	V_{OUT}	-0.5~ $V_{CC} + 0.5$	V
Input diode current	I_{IK}	-20	mA
Output diode current	I_{OK}	± 20	mA
DC output current	I_{OUT}	± 25	mA
DC V_{CC} /ground current	I_{CC}	± 75	mA
Power dissipation	P_D	180	mW
Storage temperature	T_{stg}	-65~150	$^{\circ}\text{C}$

Recommended Operating Conditions

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	2.0~5.5	V
Input voltage	V_{IN}	0~5.5	V
Output voltage	V_{OUT}	0~ V_{CC}	V
Operating temperature	T_{opr}	-40~85	$^{\circ}\text{C}$
Input rise and fall time	dt/dv	0~100 ($V_{CC} = 3.3 \pm 0.3 \text{ V}$) 0~20 ($V_{CC} = 5 \pm 0.5 \text{ V}$)	ns/V

Electrical Characteristics

DC Characteristics

Characteristics		Symbol	Test Condition		Ta = 25°C			Ta = -40~85°C		Unit		
					V _{CC} (V)	Min	Typ.	Max	Min		Max	
Input voltage	High level	V _{IH}	—		2.0 3.0~5.5	1.50 V _{CC} × 0.7	— —	— —	1.50 V _{CC} × 0.7	— —	V	
	Low level	V _{IL}	—		2.0 3.0~5.5	— —	— —	0.50 V _{CC} × 0.3	— —	0.50 V _{CC} × 0.3		
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -50 μA	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5	— — —	1.9 2.9 4.4	— — —	V	
				I _{OH} = -4 mA	3.0	2.58	—	—	2.48	—		
				I _{OH} = -8 mA	4.5	3.94	—	—	3.80	—		
				I _{OH} = -50 μA	2.0 3.0 4.5	— — —	0 0 0	0.1 0.1 0.1	— — —	0.1 0.1 0.1		
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 50 μA	3.0 4.5	— —	— —	— —	0.36 0.36	— —		0.44 0.44
				I _{OL} = 4 mA	3.0	—	—	—	—	—		
				I _{OL} = 8 mA	4.5	—	—	—	—	—		
				I _{OL} = 50 μA	2.0	—	—	—	—	—		
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = V _{CC} or GND		5.5	—	—	±0.25	—	±2.50	μA	
Input leakage current		I _{IN}	V _{IN} = 5.5 V or GND		0~5.5	—	—	±0.1	—	±1.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		5.5	—	—	4.0	—	40.0	μA	

Timing Requirements (Input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40~85°C		Unit
			V _{CC} (V)	Typ.	Limit	Limit	
Minimum pulse width (CK)	t_w (H) t_w (L)	—	3.3 ± 0.3	—	5.0	5.5	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum set-up time	t_s	—	3.3 ± 0.3	—	4.5	4.5	ns
			5.0 ± 0.5	—	3.0	3.0	
Minimum hold time	t_h	—	3.3 ± 0.3	—	2.0	2.0	ns
			5.0 ± 0.5	—	2.0	2.0	

AC Characteristics (Input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition			Ta = 25°C			Ta = -40~85°C		Unit	
			V _{CC} (V)	C _L (pF)	Min	Typ.	Max	Min	Max		
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	—	3.3 ± 0.3	15	—	8.1	12.7	1.0	15.0	ns	
				50	—	10.6	16.2	1.0	18.5		
			5.0 ± 0.5	15	—	5.4	8.1	1.0	9.5		ns
				50	—	6.9	10.1	1.0	11.5		
3-state output enable time	t_{pZL} t_{pZH}	R _L = 1 kΩ	3.3 ± 0.3	15	—	7.1	11.0	1.0	13.0	ns	
				50	—	9.6	14.5	1.0	16.5		
			5.0 ± 0.5	15	—	5.1	7.6	1.0	9.0		ns
				50	—	6.6	9.6	1.0	11.0		
3-state output disable time	t_{pLZ} t_{pHZ}	R _L = 1 kΩ	3.3 ± 0.3	50	—	10.2	14.0	1.0	16.0	ns	
			5.0 ± 0.5	50	—	6.1	8.8	1.0	10.0		
Maximum clock frequency	f_{max}	—	3.3 ± 0.3	15	80	130	—	70	—	MHz	
				50	55	85	—	50	—		
			5.0 ± 0.5	15	130	185	—	110	—		MHz
				50	85	120	—	75	—		
Output to output skew	t_{osLH} t_{osHL}	(Note1)	3.3 ± 0.3	50	—	—	1.5	—	1.5	ns	
			5.0 ± 0.5	50	—	—	1.0	—	1.0		
Input capacitance	C _{IN}	—	—	—	4	10	—	10	pF		
Output capacitance	C _{OUT}	—	—	—	6	—	—	—	pF		
Power dissipation capacitance	C _{PD}	—	(Note2)	—	32	—	—	—	pF		

Note1: This parameter is guaranteed by design.

$$t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|$$

Note2: 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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per F/F)}$$

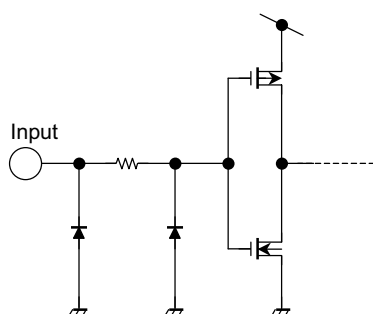
And the total C_{PD} when n pcs of latch operate can be gained by the following equation:

$$C_{PD (total)} = 20 + 12 \cdot n$$

Noise Characteristics (Input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition	Ta = 25°C			Unit
			V _{CC} (V)	Typ.	Limit	
Quiet output maximum dynamic V _{OL}	V _{OLP}	C _L = 50 pF	5.0	0.5	0.8	V
Quiet output minimum dynamic V _{OL}	V _{OLV}	C _L = 50 pF	5.0	-0.5	-0.8	V
Minimum high level dynamic input voltage V _{IH}	V _{IHD}	C _L = 50 pF	5.0	—	3.5	V
Maximum low level dynamic input voltage V _{IL}	V _{ILD}	C _L = 50 pF	5.0	—	1.5	V

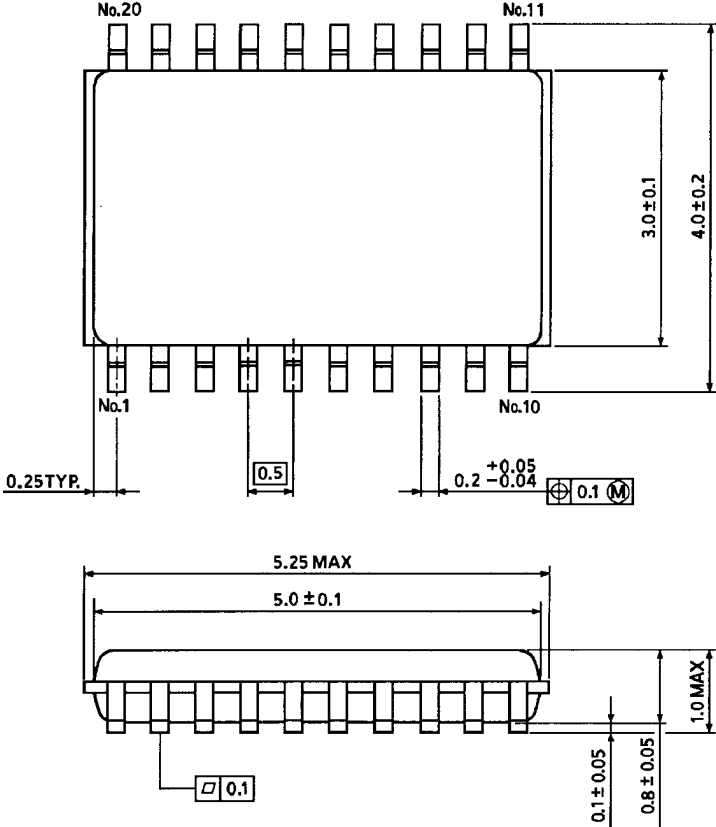
Input Equivalent Circuit



Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)