

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VHCV374FK

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

The TC74VHCV374FK is an advanced high speed CMOS OCTAL FLIP-FLOP with 3-STATE OUTPUT fabricated with silicon gate CMOS 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}).

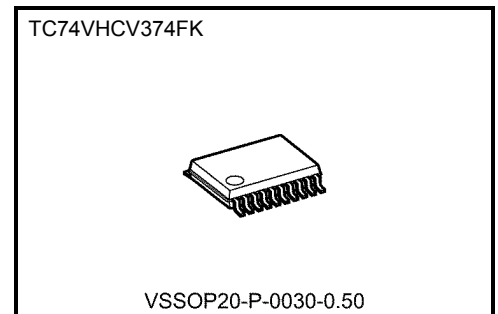
When the \overline{OE} input is high, the eight outputs are in a high impedance state. Input pin have hysteresis between the positive-going and negative-going thresholds. Thus the TC74VHCV374FK are capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output (^{Note}) pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

Note: Output in off-state

Features

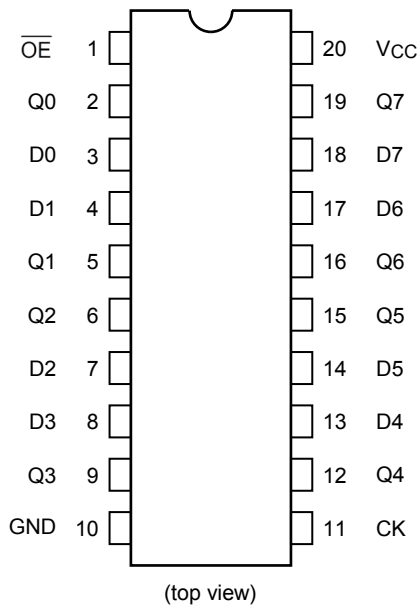
- High speed: $f_{max} = 185$ MHz (typ.) at $V_{CC} = 5$ V
- Low power dissipation: $I_{CC} = 2$ μ A (max) at $T_a = 25^\circ\text{C}$
- Wide operating voltage range: $V_{CC}(\text{opr}) = 1.8$ V to 5.5 V
- Output current: $|I_{OH}|/I_{OL} = 16$ mA (min) ($V_{CC} = 4.5$ V)
- Available in VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series
(74AC/VHC/HC/F/ALS/LS etc.) 374 typ



Weight
VSSOP20-P-0030-0.50 : 0.03 g (typ.)

Start of commercial production
2010-01

Pin Assignment



Truth Table

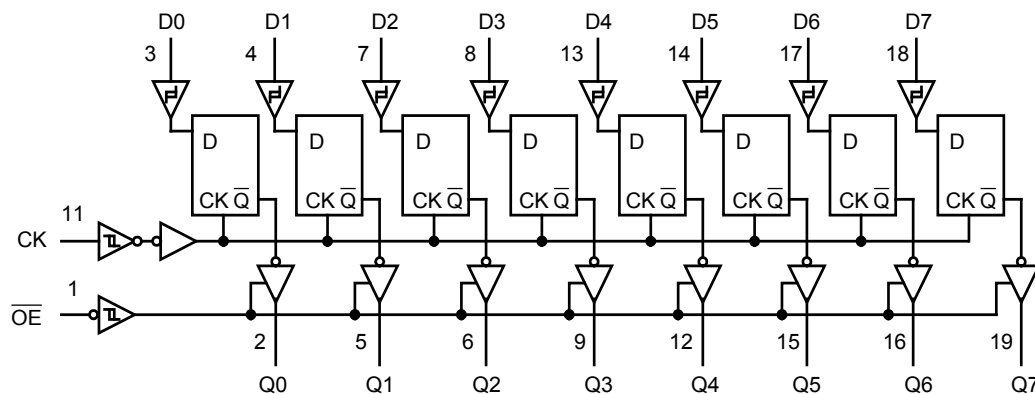
Inputs			Output
\overline{OE}	CK	D	
H	X	X	Z
L	\downarrow	X	Qn
L	\uparrow	L	L
L	\uparrow	H	H

X: Don't care

Z: High impedance

Qn: No change

System Diagram



Absolute Maximum Ratings (Note1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V _{CC}	-0.5 to 7.0	V
DC input voltage	V _{IN}	-0.5 to 7.0	V
DC output voltage	V _{OUT}	-0.5 to 7.0 (Note 2)	V
		-0.5 to V _{CC} + 0.5 (Note 3)	
Input diode current	I _{IK}	-50	mA
Output diode current	I _{OK}	±50 (Note 4)	mA
DC output current	I _{OUT}	±50	mA
Power dissipation	P _D	180	mW
DC V _{CC} /ground current	I _{CC} /I _{GND}	±100	mA
Storage temperature	T _{stg}	-65 to 150	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: Output in off-state

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: V_{OUT} < GND, V_{OUT} > V_{CC}

Operating Ranges (Note1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V _{CC}	1.8 to 5.5	V
Input voltage	V _{IN}	0 to 5.5	V
Output voltage	V _{OUT}	0 to 5.5 (Note 2)	V
		0 to V _{CC} (Note 3)	
Operating temperature	T _{opr}	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 20 (V _{CC} = 3.3 ± 0.3V) 0 to 1 (V _{CC} = 5 ± 0.5V)	ms/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either V_{CC} or GND.

Note 2: Output in off-state

Note 3: High or low state.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
				VCC (V)	Min	Typ.	Max	Min		Max
Positive threshold voltage	V _P	—		1.8	—	—	1.65	—	1.65	V
				2.3	—	—	1.85	—	1.85	
				3.0	—	—	2.20	—	2.20	
				4.5	—	—	3.15	—	3.15	
				5.5	—	—	3.85	—	3.85	
Negative threshold voltage	V _N	—		1.8	0.15	—	—	0.15	—	V
				2.3	0.45	—	—	0.45	—	
				3.0	0.90	—	—	0.90	—	
				4.5	1.35	—	—	1.35	—	
				5.5	1.65	—	—	1.65	—	
Hysteresis voltage	V _H	—		1.8	0.15	—	1.05	0.15	1.05	V
				2.3	0.20	—	1.10	0.20	1.10	
				3.0	0.30	—	1.20	0.30	1.20	
				4.5	0.40	—	1.40	0.40	1.40	
				5.5	0.50	—	1.60	0.50	1.60	
High-level output voltage	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -50 μA	1.8	1.7	1.8	—	1.7	—	V
				3.0	2.9	3.0	—	2.9	—	
			I _{OH} = -8 mA I _{OH} = -16 mA	3.0	2.58	—	—	2.48	—	
				4.5	3.94	—	—	3.80	—	
Low-level output voltage	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 50 μA	1.8	—	0.0	0.1	—	0.1	V
				3.0	—	0.0	0.1	—	0.1	
			I _{OL} = 8 mA I _{OL} = 16 mA	3.0	—	—	0.36	—	0.44	
				4.5	—	—	0.44	—	0.55	
3-state output off-state current	I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 5.5V	1.8 to 5.5	—	—	±0.5	—	±5.0	μA	
Power-off leakage current	I _{OFF}	V _{IN} /V _{OUT} = 5.5 V	0	—	—	0.5	—	5.0	μA	
Input leakage current	I _{IN}	V _{IN} = 5.5 V or GND	0 to 5.5	—	—	±0.1	—	±1.0	μA	
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND	5.5	—	—	2.0	—	20.0	μA	

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

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C	Unit
			VCC (V)	Typ.	Limit	Limit	
Minimum pulse width (CK)	t_w (H) t_w (L)	—	2.5 ± 0.2	—	6.0	7.0	ns
			3.3 ± 0.3	—	5.0	5.5	
			5.0 ± 0.5	—	5.0	5.0	
Minimum set-up time	t_s	—	2.5 ± 0.2	—	5.0	5.5	ns
			3.3 ± 0.3	—	4.5	4.5	
			5.0 ± 0.5	—	3.0	3.0	
Minimum hold time	t_h	—	2.5 ± 0.2	—	2.5	2.5	ns
			3.3 ± 0.3	—	2.0	2.0	
			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 to 85°C		Unit			
		VCC (V)	CL (pF)	Min	Typ.	Max	Min	Max				
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	—	2.5 ± 0.2	15	—	12.1	16.3	1.0	19.0	ns		
				50	—	14.9	19.3	1.0	23.0			
			3.3 ± 0.3	15	—	7.1	12.7	1.0	15.0		ns	
				50	—	9.2	16.2	1.0	18.5			
			5.0 ± 0.5	15	—	5.4	8.1	1.0	9.5			ns
				50	—	7.1	10.1	1.0	11.5			
3-state output enable time	t_{pZL} t_{pZH}	$R_L = 1 \text{ k}\Omega$	2.5 ± 0.2	15	—	9.4	15.9	1.0	19.0	ns		
				50	—	12.3	18.8	1.0	22.0			
			3.3 ± 0.3	15	—	6.5	11.0	1.0	13.0		ns	
				50	—	8.7	14.5	1.0	16.5			
			5.0 ± 0.5	15	—	4.5	7.6	1.0	9.0			ns
				50	—	6.2	9.6	1.0	11.0			
3-state output disable time	t_{pLZ} t_{pHZ}	$R_L = 1 \text{ k}\Omega$	2.5 ± 0.2	50	—	14.5	17.3	1.0	19.0	ns		
			3.3 ± 0.3	50	—	10.9	14.0	1.0	16.0			
			5.0 ± 0.5	50	—	8.0	8.8	1.0	10.0			
Maximum clock frequency	f_{max}	—	2.5 ± 0.2	15	60	80	—	50	—	MHz		
				50	50	65	—	40	—			
			3.3 ± 0.3	15	80	140	—	70	—		MHz	
				50	55	105	—	50	—			
			5.0 ± 0.5	15	130	185	—	110	—			MHz
				50	85	140	—	75	—			
Output to output skew	t_{osLH} t_{osHL}	(Note 1)	2.5 ± 0.2	50	—	—	2.0	—	2.0	ns		
			3.3 ± 0.3	50	—	—	1.5	—	1.5			
			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}	(Note 2)		—	21	—	—	—	pF			

Note 1: Parameter guaranteed by design.

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

Note 2: CPD 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:

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

And the total CPD when n pcs. of latch operate can be gained by the following equation:

$$CPD \text{ (total)} = 11 + 10 \cdot n$$

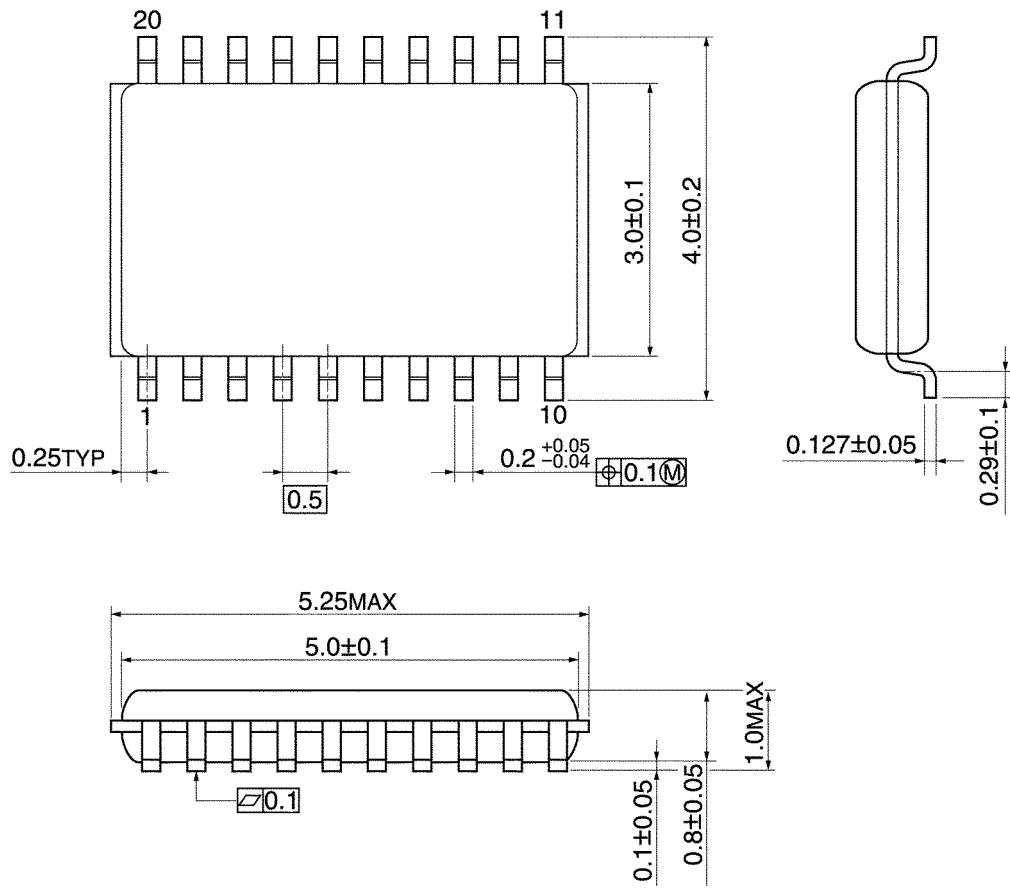
Noise Characteristics (input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition	Ta = 25°C			Unit
			V _{CC} (V)	Typ.	Max	
Quiet output maximum dynamic V _{OL}	V _{OLP}	C _L = 50 pF	3.3	0.3	—	V
			5.0	0.7	—	
Quiet output minimum dynamic V _{OL}	V _{OLV}	C _L = 50 pF	3.3	-0.1	—	V
			5.0	-0.4	—	
Minimum high level dynamic input voltage	V _{IHD}	C _L = 50 pF	5.0	—	3.5	V
Maximum low level dynamic input voltage	V _{ILD}	C _L = 50 pF	5.0	—	1.5	V

Package Dimensions

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)

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