

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VHC174F, TC74VHC174FT, TC74VHC174FK

Hex D-Type Flip Flop with Clear

The TC74VHC174 is an advanced high speed CMOS HEX D-TYPE FLIP FLOP 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.

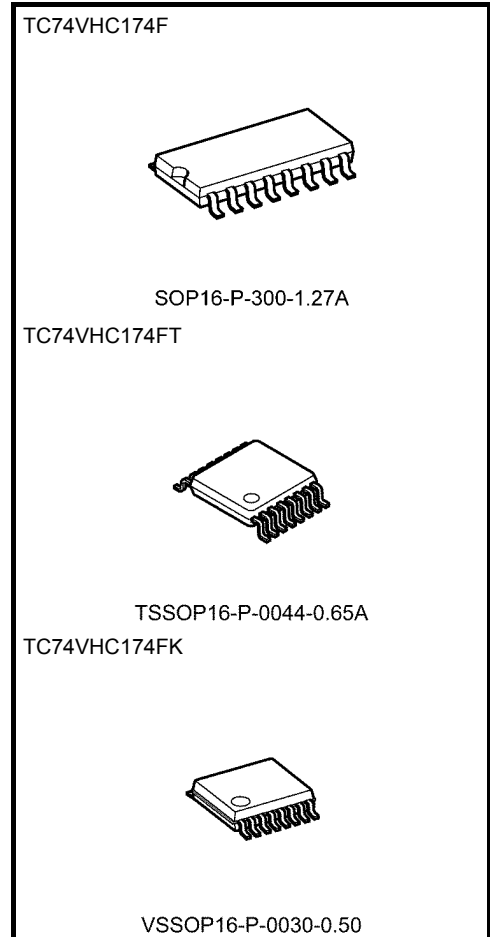
Information signals applied to D inputs are transferred to the Q output on the positive going edge of the clock pulse.

When the CLR input is held low, the Q output are in the low logic level independent of the other inputs.

An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 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.

Features

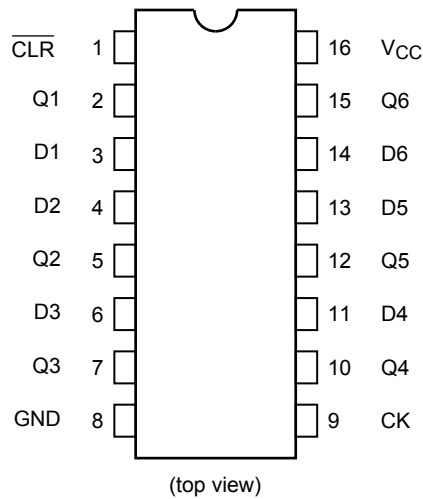
- High speed: $f_{max} = 175$ MHz (typ.) at $V_{CC} = 5$ V
- Low power dissipation: $I_{CC} = 4$ μ A (max) at $T_a = 25^\circ$ C
- High noise immunity: $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC(opr)} = 2$ to 5.5 V
- Low noise: $V_{OLP} = 0.8$ V (max)
- Pin and function compatible with 74ALS174



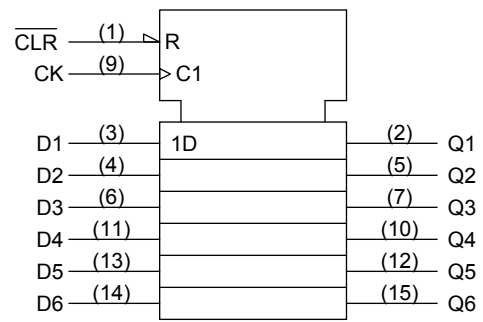
Weight

SOP16-P-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)
VSSOP16-P-0030-0.50	: 0.02 g (typ.)

Pin Assignment



IEC Logic Symbol

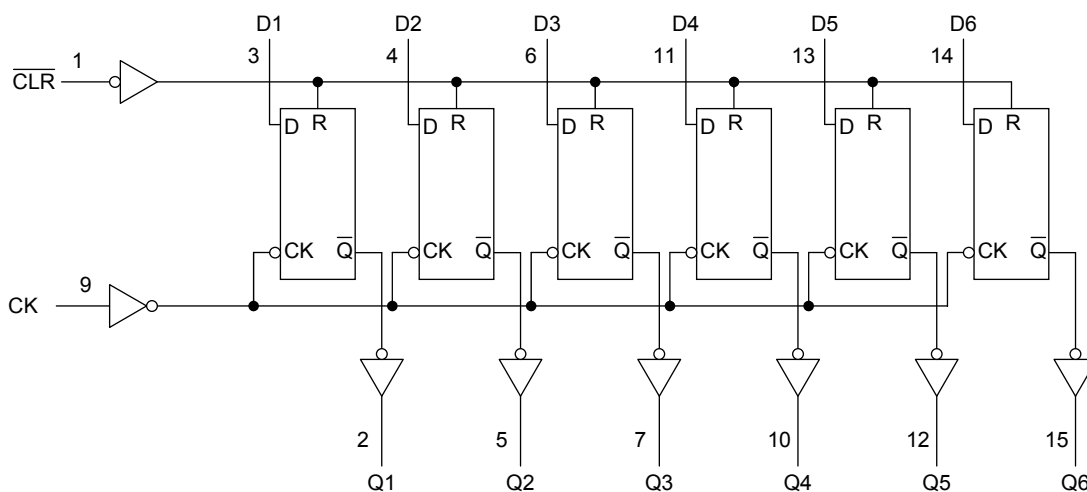


Truth Table

Inputs			Output	Function
$\overline{\text{CLR}}$	D	CK	Q	
L	X	X	L	Clear
H	L		L	—
H	H		H	—
H	X		Q_n	No Change

X: Don't care

System Diagram



Absolute Maximum Ratings (Note)

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 $V_{CC} + 0.5$	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}	± 50	mA
Power dissipation	P_D	180	mW
Storage temperature	T_{stg}	-65 to 150	$^{\circ}C$

Note: 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).

Operating Ranges (Note)

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

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
				V _{CC} (V)	Min	Typ.	Max	Min		Max
High-level input voltage	V _{IH}	—		2.0 3.0 to 5.5	1.50 V _{CC} × 0.7	— —	— —	1.50 V _{CC} × 0.7	— —	V
Low-level input voltage	V _{IL}	—		2.0 3.0 to 5.5	— —	— —	0.50 V _{CC} × 0.3	— —	0.50 V _{CC} × 0.3	V
High-level output voltage	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	—	
Low-level output voltage	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 50 μA	2.0 3.0 4.5	— — —	0.0 0.0 0.0	0.1 0.1 0.1	— — —	0.1 0.1 0.1	V
			I _{OL} = 4 mA	3.0	—	—	0.36	—	0.44	
			I _{OL} = 8 mA	4.5	—	—	0.36	—	0.44	
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	—	—	4.0	—	40.0	μA

Timing Requirements (input: t_r = t_f = 3 ns)

Characteristics	Symbol	Test Condition		Ta = 25°C		Ta = -40 to 85°C	Unit	
				V _{CC} (V)	Typ.	Limit		Limit
Minimum pulse width (CK)	t _w (L)	—		3.3 ± 0.3	—	5.0	5.0	ns
	t _w (H)	—		5.0 ± 0.5	—	5.0	5.0	
Minimum pulse width ($\overline{\text{CLR}}$)	t _w (L)	—		3.3 ± 0.3 5.0 ± 0.5	— —	5.0 5.0	5.0 5.0	ns
Minimum set-up time	t _s	—		3.3 ± 0.3 5.0 ± 0.5	— —	5.0 4.5	6.0 4.5	ns
		—		3.3 ± 0.3 5.0 ± 0.5	— —	0.0 0.5	0.0 0.5	
Minimum hold time	t _h	—		3.3 ± 0.3 5.0 ± 0.5	— —	0.0 0.5	0.0 0.5	ns
Minimum removal time ($\overline{\text{CLR}}$)	t _{rem}	—		3.3 ± 0.3	—	3.0	3.0	ns
		—		5.0 ± 0.5	—	2.5	2.5	

AC Characteristics (input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
		V _{CC} (V)	C _L (pF)	Min	Typ.	Max	Min	Max		
Propagation delay time (CK-Q)	t _{pLH}	—	3.3 ± 0.3	15	—	7.2	11.0	1.0	13.0	ns
				50	—	9.7	14.5	1.0	16.5	
	5.0 ± 0.5		15	—	4.9	7.2	1.0	8.5		
			50	—	6.4	9.2	1.0	10.5		
Propagation delay time ($\overline{\text{CLR}}$ -Q)	t _{pHL}	—	3.3 ± 0.3	15	—	7.4	11.4	1.0	13.5	ns
				50	—	9.9	14.9	1.0	17.0	
			5.0 ± 0.5	15	—	5.1	7.6	1.0	9.0	
				50	—	6.6	9.6	1.0	11.0	
Maximum clock frequency	f _{max}	—	3.3 ± 0.3	15	95	150	—	80	—	MHz
				50	55	85	—	50	—	
			5.0 ± 0.5	15	130	175	—	110	—	
				50	90	120	—	80	—	
Output to output skew	t _{osLH}	(Note 1)	3.3 ± 0.3	50	—	—	1.5	—	1.5	ns
	t _{osHL}		5.5 ± 0.5	50	—	—	1.0	—	1.0	
Input capacitance	C _{IN}	—		—	4	10	—	10	pF	
Power dissipation capacitance	C _{PD}	(Note 2)		—	29	—	—	—	pF	

Note 1: Parameter guaranteed by design.

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

Note 2: 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:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per F/F)}$$

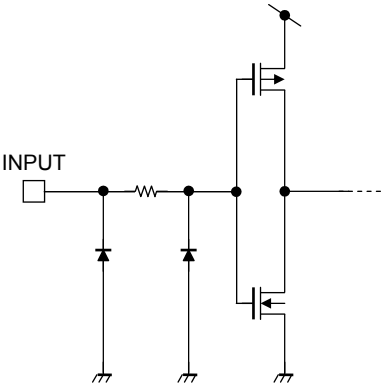
And the total C_{PD} when n pcs. of flip flop operate can be gained by the following equation:

$$C_{PD}(\text{total}) = 19 + 10 \cdot n$$

Noise Characteristics (input: $t_r = t_f = 3$ 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	5.0	0.4	0.8	V
Quiet output minimum dynamic V _{OL}	V _{OLV}	C _L = 50 pF	5.0	-0.4	-0.8	V
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

Input Equivalent Circuit



Package Dimensions

SOP16-P-300-1.27A

Unit: mm

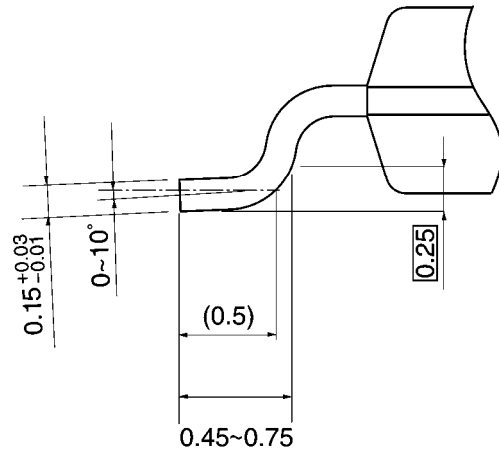
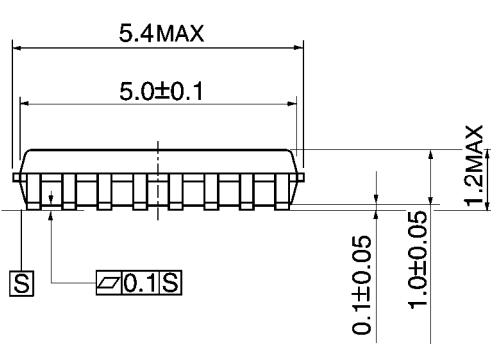
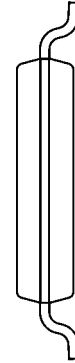


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

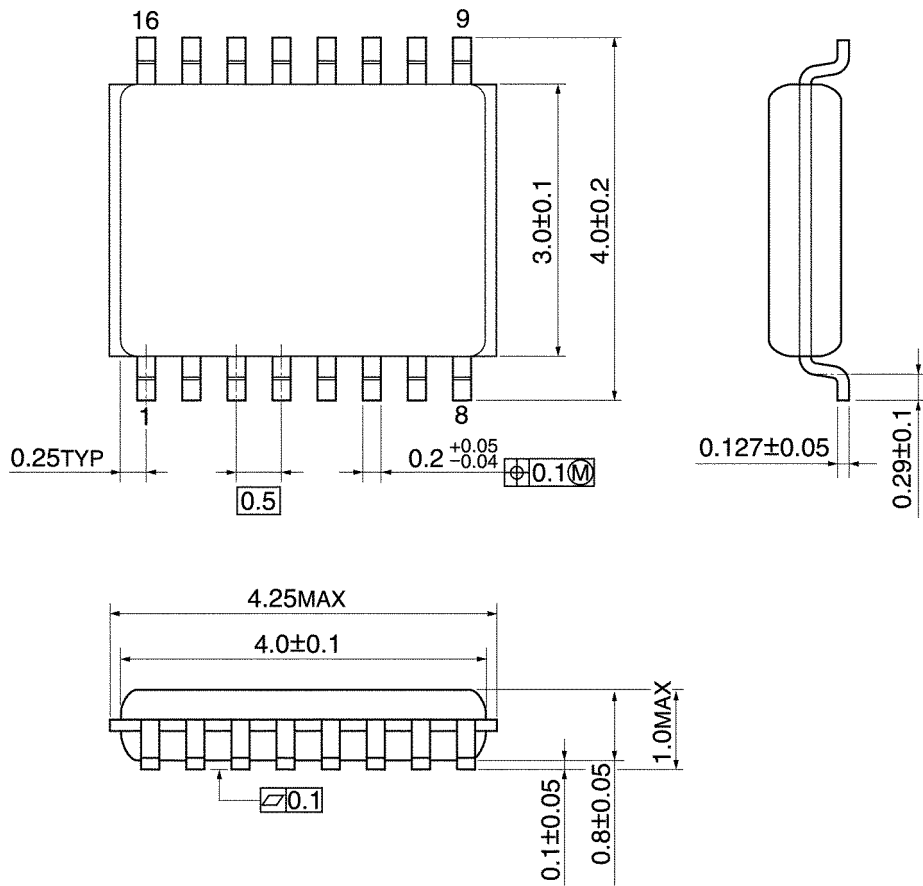


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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