

74VHC04FT

1. Functional Description

- Hex Inverter

2. General

The 74VHC04FT is an advanced high speed CMOS INVERTER 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.

The internal circuit is composed of 3 stages including buffer output, which provide high noise immunity and stable output.

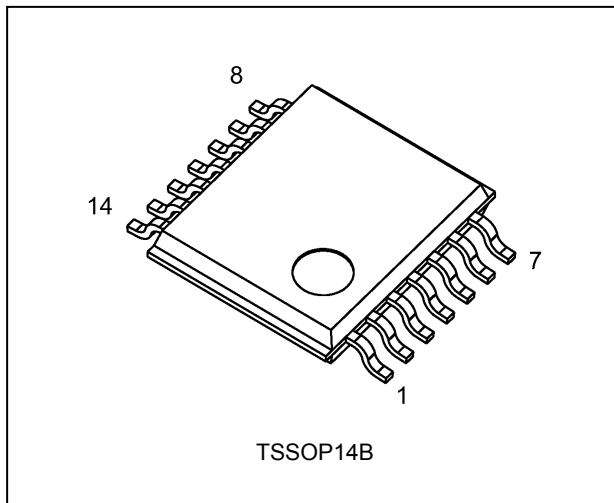
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up.

This circuit prevents device destruction due to mismatched supply and input voltages.

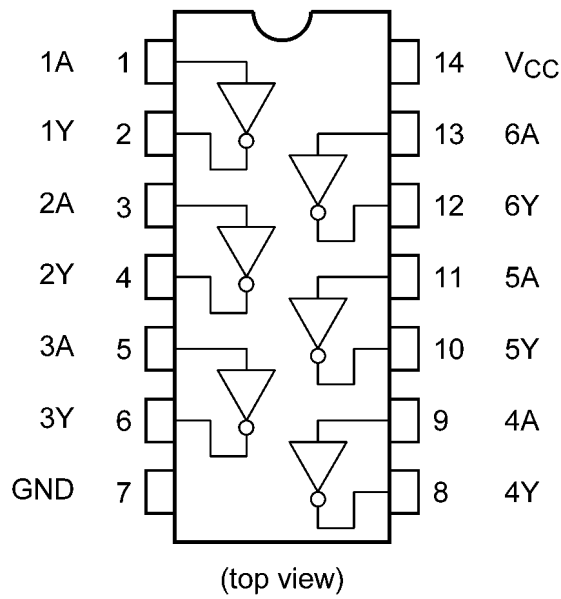
3. Features

- (1) High speed: Propagation delay time = 3.8 ns (typ.) at $V_{CC} = 5\text{ V}$
- (2) Low power dissipation: $I_{CC} = 2.0\ \mu\text{A}$ (max) at $T_a = 25\text{ }^\circ\text{C}$
- (3) High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- (4) Power-down protection is provided on all inputs.
- (5) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- (6) Wide operating voltage range: $V_{CC(\text{opr})} = 2.0$ to 5.5 V
- (7) Low noise: $V_{OLP} = 0.8\text{ V}$ (max)
- (8) Pin and function compatible with the 74 series (74AC/HC/AHC/LV etc.) 04 type.

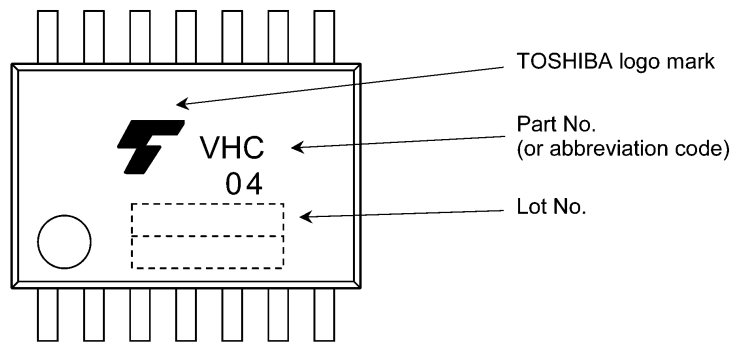
4. Packaging



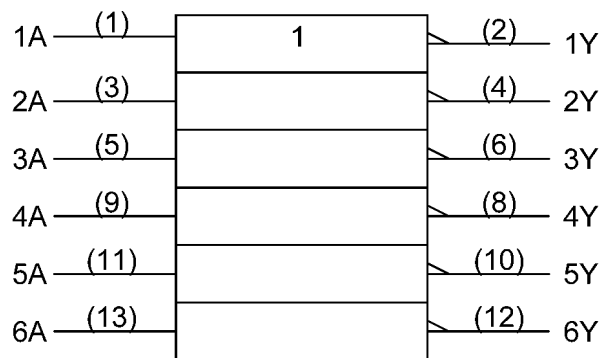
5. Pin Assignment



6. Marking



7. IEC Logic Symbol



8. Truth Table

A	Y
L	H
H	L

9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	-0.5 to 7.0	V
Input voltage	V_{IN}	-0.5 to 7.0	
Output voltage	V_{OUT}	-0.5 to $V_{CC} + 0.5$	
Input diode current	I_{IK}	-20	mA
Output diode current	I_{OK}	± 20	
Output current	I_{OUT}	± 25	
V_{CC} /ground current	I_{CC}	± 50	
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).

10. Operating Ranges (Note)

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

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

11. Electrical Characteristics

11.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Typ.	Max	Unit
High-level input voltage	V_{IH}	—		2.0	1.50	—	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.5	V
				3.0 to 5.5	—	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.58	—	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.94	—	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	—	0.36	
			$I_{OL} = 8\text{ mA}$	4.5	—	—	0.36	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V or GND}$		0 to 5.5	—	—	± 0.1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}\text{ or GND}$		5.5	—	—	2.0	μA

11.2. DC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		2.0	1.50	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.48	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.80	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
		$V_{IN} = V_{IH}$	$I_{OL} = 4\text{ mA}$	3.0	—	0.44	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.44	
Input leakage current	I_{IN}	$V_{IN} = 5.5\text{ V or GND}$		0 to 5.5	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}\text{ or GND}$		5.5	—	20.0	μA

11.3. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Note	V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Unit
Propagation delay time	t_{PLH}, t_{PHL}		3.3 ± 0.3	15	—	5.0	7.1	ns
				50	—	7.5	10.6	
			5.0 ± 0.5	15	—	3.8	5.5	
				50	—	5.3	7.5	
Input capacitance	C_{IN}				—	4	10	pF
Power dissipation capacitance	C_{PD}	(Note 1)			—	18	—	

Note 1: 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.

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

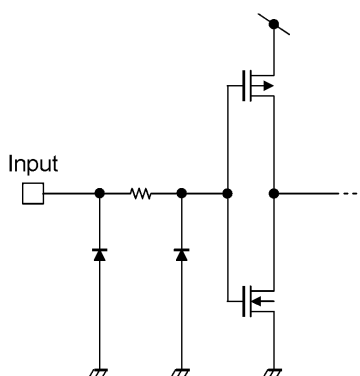
11.4. AC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PLH}, t_{PHL}	3.3 ± 0.3	15	1.0	8.5	ns
			50	1.0	12.0	
		5.0 ± 0.5	15	1.0	6.5	
			50	1.0	8.5	
Input capacitance	C_{IN}			—	10	pF

11.5. Noise Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

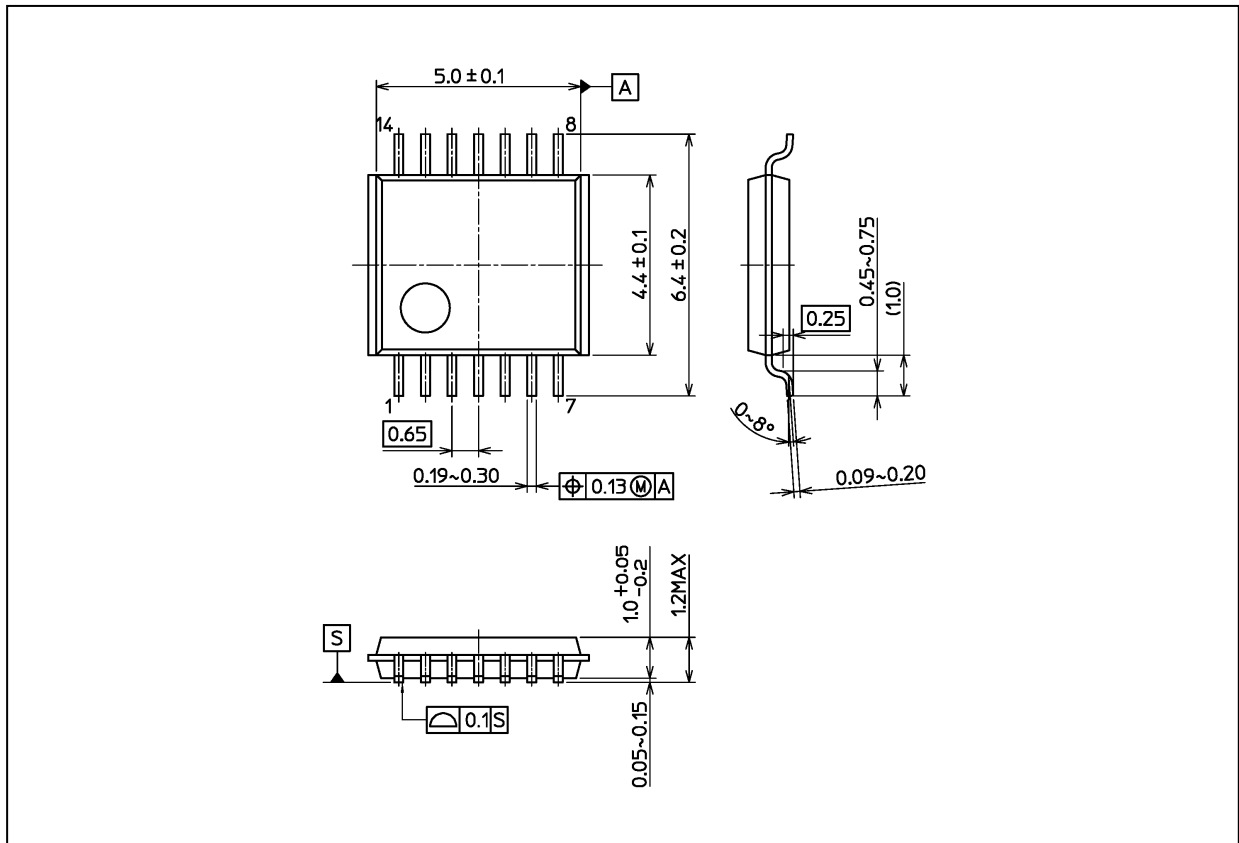
Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Limit	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	$C_L = 50\text{ pF}$	5.0	0.4	0.8	V
Quiet output minimum dynamic V_{OL}	V_{OLV}	$C_L = 50\text{ pF}$	5.0	-0.4	-0.8	
Minimum high-level dynamic input voltage	V_{IHD}	$C_L = 50\text{ pF}$	5.0	—	3.5	
Maximum low-level dynamic input voltage	V_{ILD}	$C_L = 50\text{ pF}$	5.0	—	1.5	

11.6. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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