

# 74HC02D

## 1. Functional Description

- Quad 2-Input NOR Gate

## 2. General

The 74HC02D is a high speed CMOS 2-INPUT NOR GATE fabricated with silicon gate C<sup>2</sup>MOS technology.

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

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

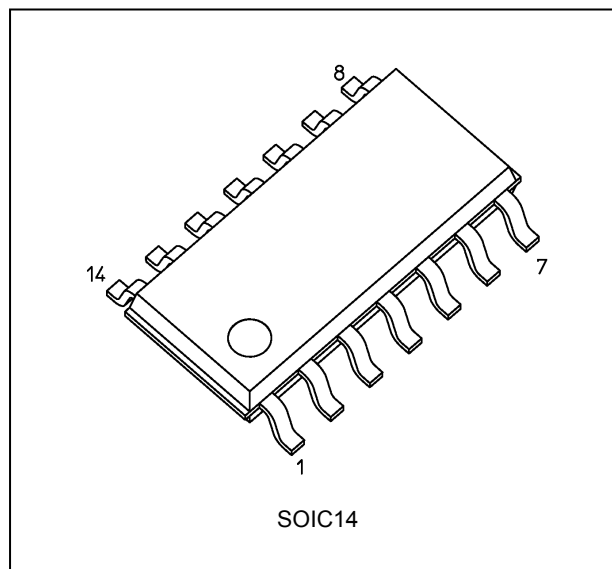
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 1)
- (2) High speed:  $t_{pd} = 6$  ns (typ.) at  $V_{CC} = 5$  V
- (3) Low power dissipation:  $I_{CC} = 1.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (4) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (5) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  to  $6.0$  V

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

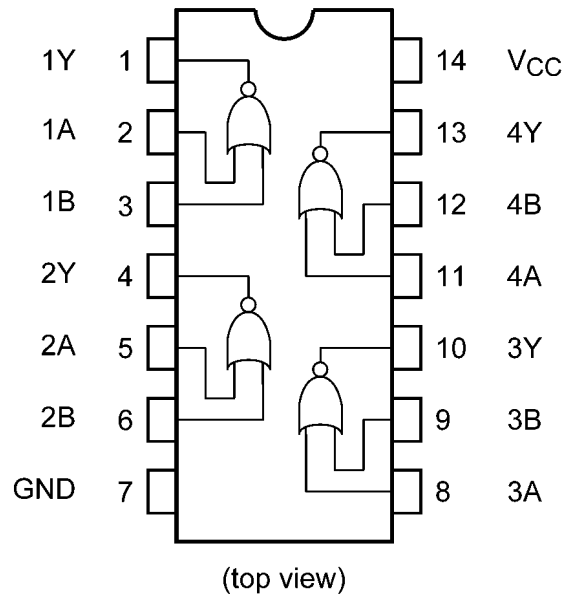
## 4. Packaging



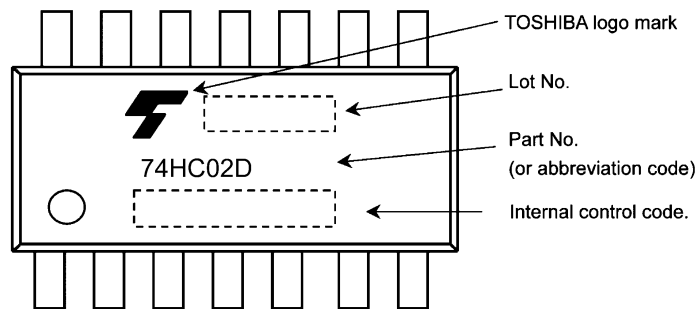
Start of commercial production

2020-07

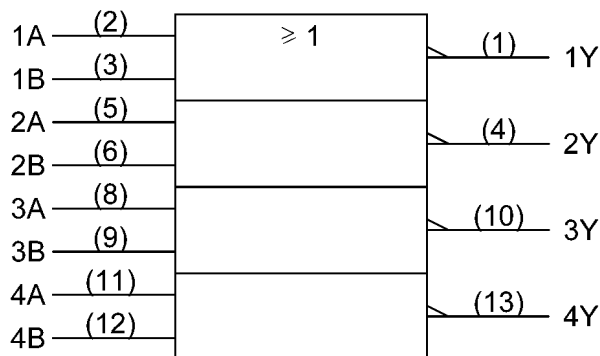
## 5. Pin Assignment



## 6. Marking



## 7. IEC Logic Symbol



### 8. Truth Table

A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

### 9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 7.0	V
Input voltage	$V_{IN}$		-0.5 to $V_{CC} + 0.5$	V
Output voltage	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$		$\pm 20$	mA
Output diode current	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 1)	500	mW
Storage temperature	$T_{stg}$		-65 to 150	°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).

Note 1:  $P_D$  derates linearly with -8 mW/°C above 85 °C

### 10. Operating Ranges (Note)

Characteristics	Symbol	Test Condition	Note	Rating	Unit
Supply voltage	$V_{CC}$	—		2.0 to 6.0	V
Input voltage	$V_{IN}$	—		0 to $V_{CC}$	V
Output voltage	$V_{OUT}$	—		0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	—	(Note 1)	-40 to 125	°C
Input rise and fall times	$t_r, t_f$	$V_{CC} = 2.0\text{ V}$		0 to 1000	ns
		$V_{CC} = 4.5\text{ V}$		0 to 500	
		$V_{CC} = 6.0\text{ V}$		0 to 400	

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs and bus inputs must be tied to either  $V_{CC}$  or GND.

Note 1: Operating Range spec of  $T_{opr} = -40\text{ °C}$  to  $125\text{ °C}$  is applicable only for the products which manufactured after July 2020.

### 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
				4.5	3.15	—	—	
				6.0	4.20	—	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.50	V
				4.5	—	—	1.35	
				6.0	—	—	1.80	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				4.5	4.4	4.5	—	
			6.0	5.9	6.0	—		
			$I_{OH} = -4\text{ mA}$	4.5	4.18	4.31	—	
			$I_{OH} = -5.2\text{ mA}$	6.0	5.68	5.80	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V
				4.5	—	0.0	0.1	
				6.0	—	0.0	0.1	
			$I_{OL} = 4\text{ mA}$	4.5	—	0.17	0.26	
			$I_{OL} = 5.2\text{ mA}$	6.0	—	0.18	0.26	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	1.0	$\mu\text{A}$

#### 11.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ 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
				4.5	3.15	—	
				6.0	4.20	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				4.5	—	1.35	
				6.0	—	1.80	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	—	V
				4.5	4.4	—	
			6.0	5.9	—		
			$I_{OH} = -4\text{ mA}$	4.5	4.13	—	
			$I_{OH} = -5.2\text{ mA}$	6.0	5.63	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.1	V
				4.5	—	0.1	
				6.0	—	0.1	
			$I_{OL} = 4\text{ mA}$	4.5	—	0.33	
			$I_{OL} = 5.2\text{ mA}$	6.0	—	0.33	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	10.0	$\mu\text{A}$

### 11.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125$ °C)

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V	
				4.5	3.15	—		
				6.0	4.20	—		
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V	
				4.5	—	1.35		
				6.0	—	1.80		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20$ $\mu$ A	2.0	1.9	—	V	
				4.5	4.4	—		
				6.0	5.9	—		
				$I_{OH} = -4$ mA	4.5	3.7		—
				$I_{OH} = -5.2$ mA	6.0	5.2		—
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20$ $\mu$ A	2.0	—	0.1	V	
				4.5	—	0.1		
				6.0	—	0.1		
				$I_{OL} = 4$ mA	4.5	—		0.4
				$I_{OL} = 5.2$ mA	6.0	—		0.4
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	20.0	$\mu$ A	

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after July 2020.

### 11.4. AC Characteristics (Unless otherwise specified, $C_L = 15$ pF, $V_{CC} = 5$ V, $T_a = 25$ °C, Input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	—	—	4	8	ns
Propagation delay time	$t_{PLH}, t_{PHL}$	—	—	6	12	ns

### 11.5. AC Characteristics (Unless otherwise specified, $C_L = 50$ pF, $T_a = 25$ °C, Input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Note	$V_{CC}$ (V)	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$		2.0	—	25	75	ns
			4.5	—	7	15	
			6.0	—	6	13	
Propagation delay time	$t_{PLH}, t_{PHL}$		2.0	—	27	75	ns
			4.5	—	9	15	
			6.0	—	8	13	
Input capacitance	$C_{IN}$		—	—	5	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	—	21	—	pF

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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4 \text{ (per gate)}$$

### 11.6. AC Characteristics

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	
Propagation delay time	$t_{PLH}, t_{PHL}$	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	

### 11.7. AC Characteristics (Note)

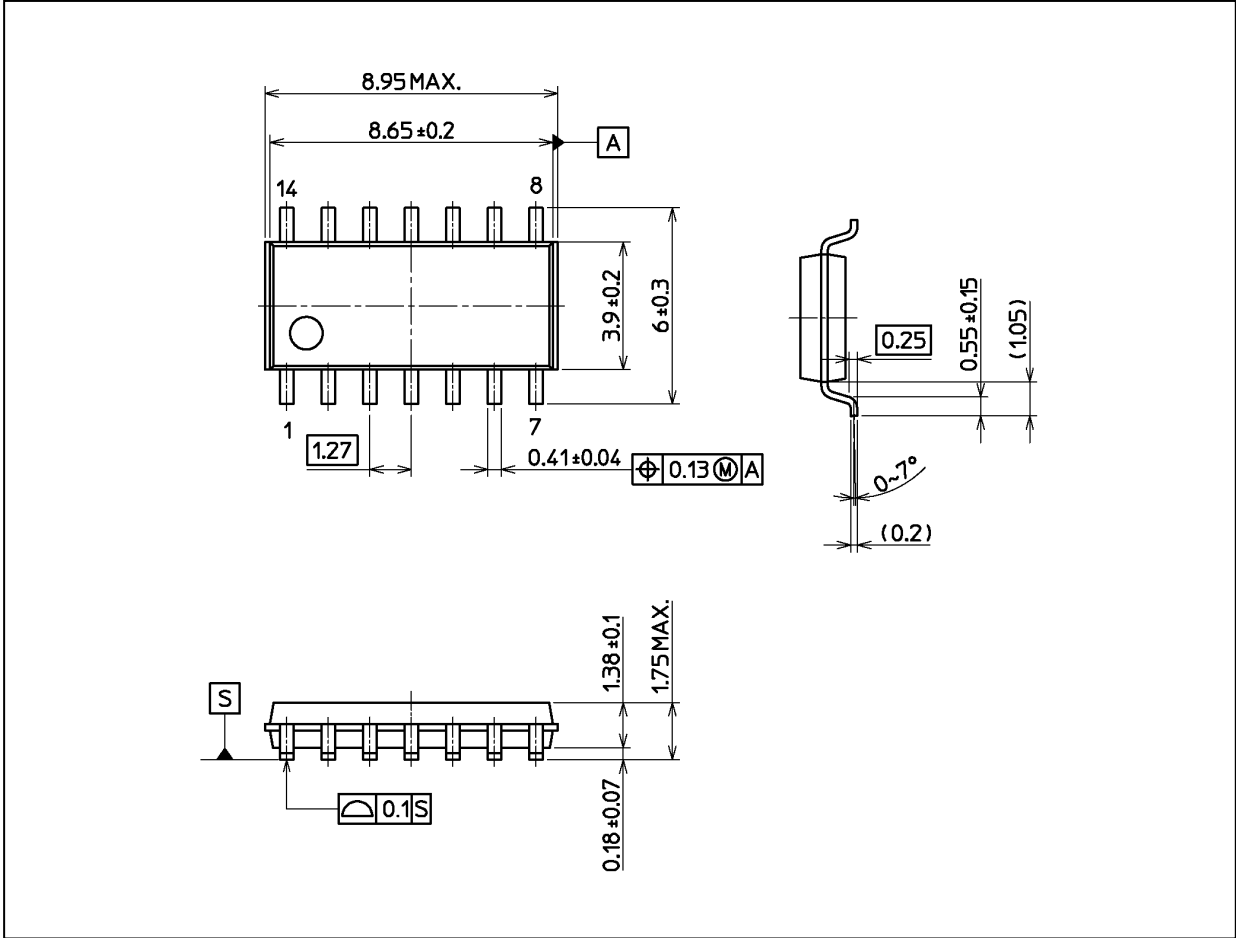
(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	110	ns
		4.5	—	22	
		6.0	—	18	
Propagation delay time	$t_{PLH}, t_{PHL}$	2.0	—	110	ns
		4.5	—	22	
		6.0	—	18	

Note: Operating Range spec of  $T_{opr} = -40 \text{ }^\circ\text{C}$  to  $125 \text{ }^\circ\text{C}$  is applicable only for the products which manufactured after July 2020.

Package Dimensions

Unit: mm



Weight: 0.13 g (typ.)

Package Name(s)
Nickname: SOIC14

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