

# TC7WHU04FU

## 1. Functional Description

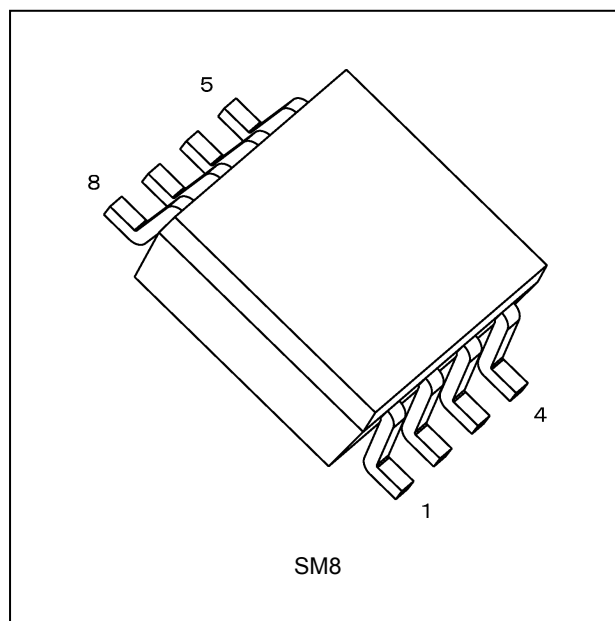
- Triple Inverter (Unbuffer)

## 2. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125\text{ }^{\circ}\text{C}$  (Note 1)
- (2) High speed operation:  $t_{pd} = 3.5\text{ ns}$  (typ.) ( $V_{CC} = 5.0\text{ V}$ ,  $C_L = 15\text{ pF}$ )
- (3) Low power dissipation:  $I_{CC} = 2.0\text{ }\mu\text{A}$  (max) ( $T_a = 25\text{ }^{\circ}\text{C}$ )
- (4) High noise immunity:  $V_{NIH} = V_{NIL} = 10\text{ \% }V_{CC}$  (min)
- (5) 5.5 V tolerant inputs
- (6) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (7) Wide operating voltage range:  $V_{CC} = 2.0$  to  $5.5\text{ V}$
- (8) Identical pin assignment and function with TC7WU04

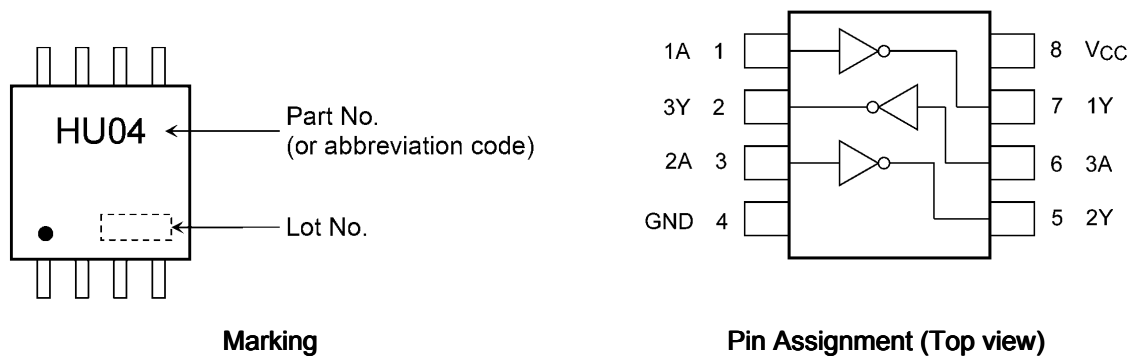
Note 1: For devices with the ordering part number ending in J(CT).  $T_{opr} = -40$  to  $85\text{ }^{\circ}\text{C}$  for the other devices.

## 3. Packaging



Start of commercial production  
2020-01

4. Marking and Pin Assignment



5. IEC Logic Symbol



6. Truth Table

A	Y
L	H
H	L

7. Absolute Maximum Ratings (Note) (Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ )

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 7.0	V
Input voltage	$V_{IN}$		-0.5 to 7.0	
DC output voltage	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		-20	mA
Output diode current	$I_{OK}$	(Note 1)	$\pm 20$	
DC output current	$I_{OUT}$		$\pm 25$	
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	
Power dissipation	$P_D$		300	mW
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}\text{C}$

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:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

### 8. Operating Ranges (Note)

Characteristics	Symbol	Note	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	$T_{opr}$	(Note 1)	—	-40 to 125	°C
		(Note 2)	—	-40 to 85	

Note: 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 1: For devices with the ordering part number ending in J(CT).

Note 2: For devices except those with the ordering part number ending in J(CT).

### 9. Electrical Characteristics

#### 9.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ °C}$ )

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Typ.	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.7	—	—	V
				3.0 to 5.5	$V_{CC} \times 0.8$	—	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.3	V
				3.0 to 5.5	—	—	$V_{CC} \times 0.2$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.8	2.0	—	V
				3.0	2.7	3.0	—	
				4.5	4.0	4.5	—	
		$V_{IN} = \text{GND}$	$I_{OH} = -4\text{ mA}$	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	0.2	V
				3.0	—	0.0	0.3	
				4.5	—	0.0	0.5	
		$V_{IN} = V_{CC}$	$I_{OL} = 4\text{ mA}$	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	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC} \text{ or GND}$		5.5	—	—	2.0	$\mu\text{A}$

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

Characteristics	Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit	
High-level input voltage	V <sub>IH</sub>	—		2.0	1.7	—	V	
				3.0 to 5.5	V <sub>CC</sub> × 0.8	—		
Low-level input voltage	V <sub>IL</sub>	—		2.0	—	0.3	V	
				3.0 to 5.5	—	V <sub>CC</sub> × 0.2		
High-level output voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -50 μA	2.0	1.8	—	V	
				3.0	2.7	—		
				4.5	4.0	—		
		V <sub>IN</sub> = GND	I <sub>OH</sub> = -4 mA	3.0	2.48	—		
				I <sub>OH</sub> = -8 mA	4.5	3.80		—
Low-level output voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 50 μA	2.0	—	0.2	V	
				3.0	—	0.3		
				4.5	—	0.5		
		V <sub>IN</sub> = V <sub>CC</sub>	I <sub>OL</sub> = 4 mA	3.0	—	0.44		
				I <sub>OL</sub> = 8 mA	4.5	—		0.44
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0 to 5.5	—	±1.0	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		5.5	—	20.0	μA	

### 9.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit	
High-level input voltage	V <sub>IH</sub>	—		2.0	1.7	—	V	
				3.0 to 5.5	V <sub>CC</sub> × 0.8	—		
Low-level input voltage	V <sub>IL</sub>	—		2.0	—	0.3	V	
				3.0 to 5.5	—	V <sub>CC</sub> × 0.2		
High-level output voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>	I <sub>OH</sub> = -50 μA	2.0	1.8	—	V	
				3.0	2.7	—		
				4.5	4.0	—		
		V <sub>IN</sub> = GND	I <sub>OH</sub> = -4 mA	3.0	2.40	—		
				I <sub>OH</sub> = -8 mA	4.5	3.70		—
Low-level output voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 50 μA	2.0	—	0.2	V	
				3.0	—	0.3		
				4.5	—	0.5		
		V <sub>IN</sub> = V <sub>CC</sub>	I <sub>OL</sub> = 4 mA	3.0	—	0.55		
				I <sub>OL</sub> = 8 mA	4.5	—		0.55
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0 to 5.5	—	±2.0	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		5.5	—	40.0	μA	

Note: For devices with the ordering part number ending in J(CT).

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	5.0	8.9	ns
					50	—	7.5	11.4	
				$5.0 \pm 0.5$	15	—	3.5	5.5	
					50	—	5.0	7.0	
Input capacitance	$C_{IN}$		—			—	5	10	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—			—	11	—	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.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/3 \text{ (per 1 gate)}$$

### 9.5. 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	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	10.5	ns
				50	1.0	13.0	
			$5.0 \pm 0.5$	15	1.0	6.5	
				50	1.0	8.0	
Input capacitance	$C_{IN}$	—			—	10	pF

### 9.6. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^{\circ}\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

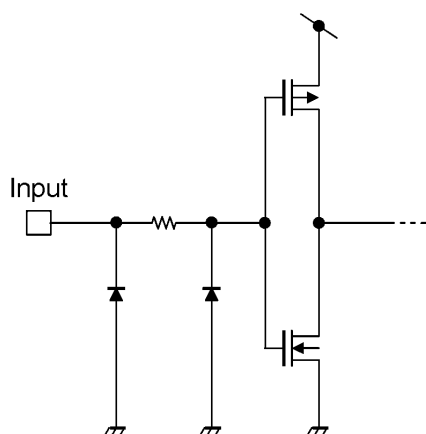
Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	11.0	ns
				50	1.0	14.5	
			$5.0 \pm 0.5$	15	1.0	7.0	
				50	1.0	9.0	
Input capacitance	$C_{IN}$	—			—	10	pF

Note: For devices with the ordering part number ending in J(CT).

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

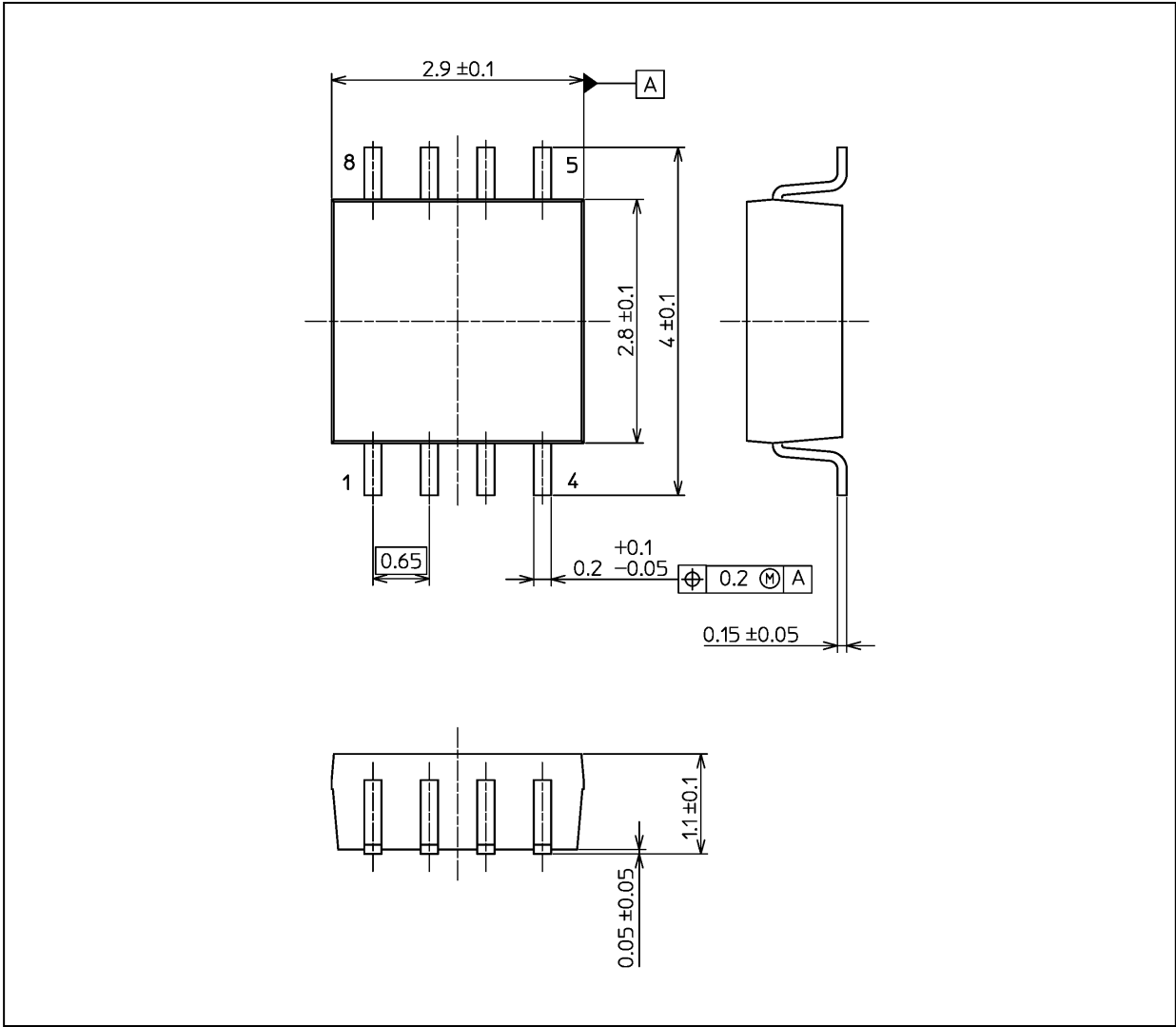
Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50\text{ pF}$	5.0	0.3	0.8	V
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50\text{ pF}$	5.0	-0.3	-0.8	V
Minimum high-level dynamic input voltage	$V_{IHD}$	$C_L = 50\text{ pF}$	5.0	—	4.0	V
Maximum low-level dynamic input voltage	$V_{ILD}$	$C_L = 50\text{ pF}$	5.0	—	1.0	V

## 9.8. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 21 mg (typ.)

Package Name(s)
JEDEC: SOT-505
Nickname: SM8

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