

CMOS Digital Integrated Circuits Silicon Monolithic

TC7WH04FU

1. Functional Description

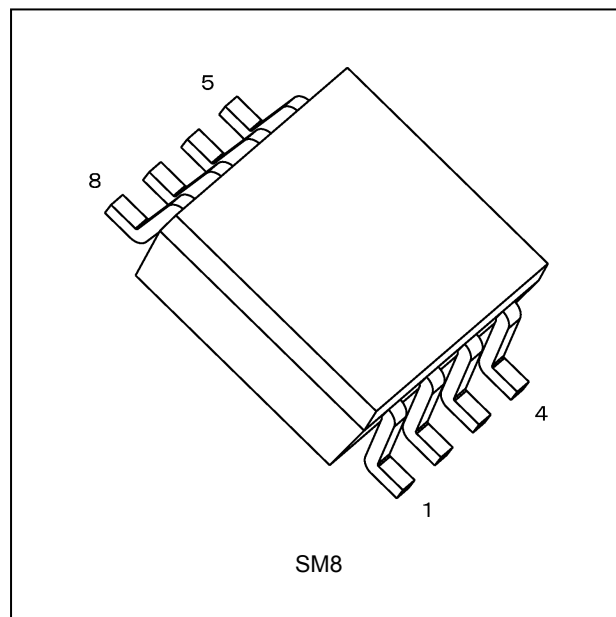
- Triple Inverter

2. Features

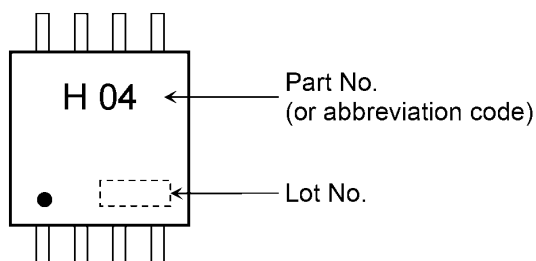
- (1) Wide operating temperature range: $T_{opr} = -40$ to 125 °C (Note 1)
- (2) High speed operation: $t_{pd} = 3.8$ ns (typ.) ($V_{CC} = 5.0$ V, $C_L = 15$ pF)
- (3) Low power dissipation: $I_{CC} = 2.0$ μ A (max) ($T_a = 25$ °C)
- (4) High noise immunity: $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (min)
- (5) 5.5 V tolerant inputs
- (6) Wide operating voltage range: $V_{CC} = 2.0$ to 5.5 V
- (7) Identical pin assignment and function with TC7W04

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

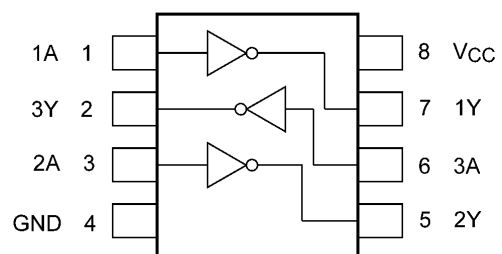
3. Packaging



4. Marking and Pin Assignment



Marking



Pin Assignment (Top view)

Start of commercial production

2020-01

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)	± 20	
DC output current	I_{OUT}		± 25	
V_{CC} /ground current	I_{CC}		± 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	$^\circ\text{C}$
		(Note 2)	—	-40 to 85	
Input rise and fall time	dt/dv		$V_{CC} = 3.3 \pm 0.3\text{ V}$	0 to 100	ns/V
			$V_{CC} = 5.0 \pm 0.5\text{ V}$	0 to 20	

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, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit		
High-level input voltage	V_{IH}	—	2.0	1.5	—	—	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		

9.2. 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	1.5	—	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	—	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}	$V_{IN} = V_{IH}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	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	

9.3. 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	1.5	—	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}	$V_{IN} = V_{IL}$	$I_{OH} = -50 \mu A$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4$ mA	3.0	2.40	—	
			$I_{OH} = -8$ mA	4.5	3.70	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 50 \mu A$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4$ mA	3.0	—	0.55	
			$I_{OL} = 8$ mA	4.5	—	0.55	
Input leakage current	I_{IN}	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	± 2.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ 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 ± 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	—	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 ± 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

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

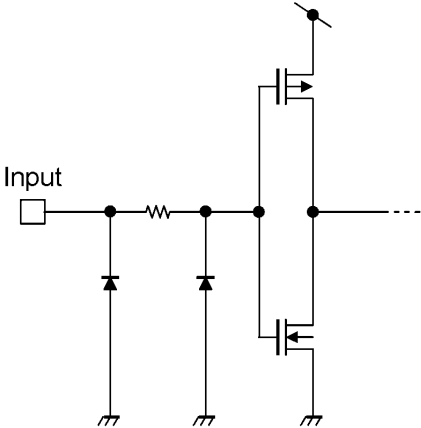
Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PLH}, t_{PHL}	—	3.3 ± 0.3	15	1.0	10.0	ns
				50	1.0	13.5	
			5.0 ± 0.5	15	1.0	7.5	
				50	1.0	9.5	
Input capacitance	C_{IN}	—			—	10	pF

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: $t_r = t_f = 3\text{ ns}$)

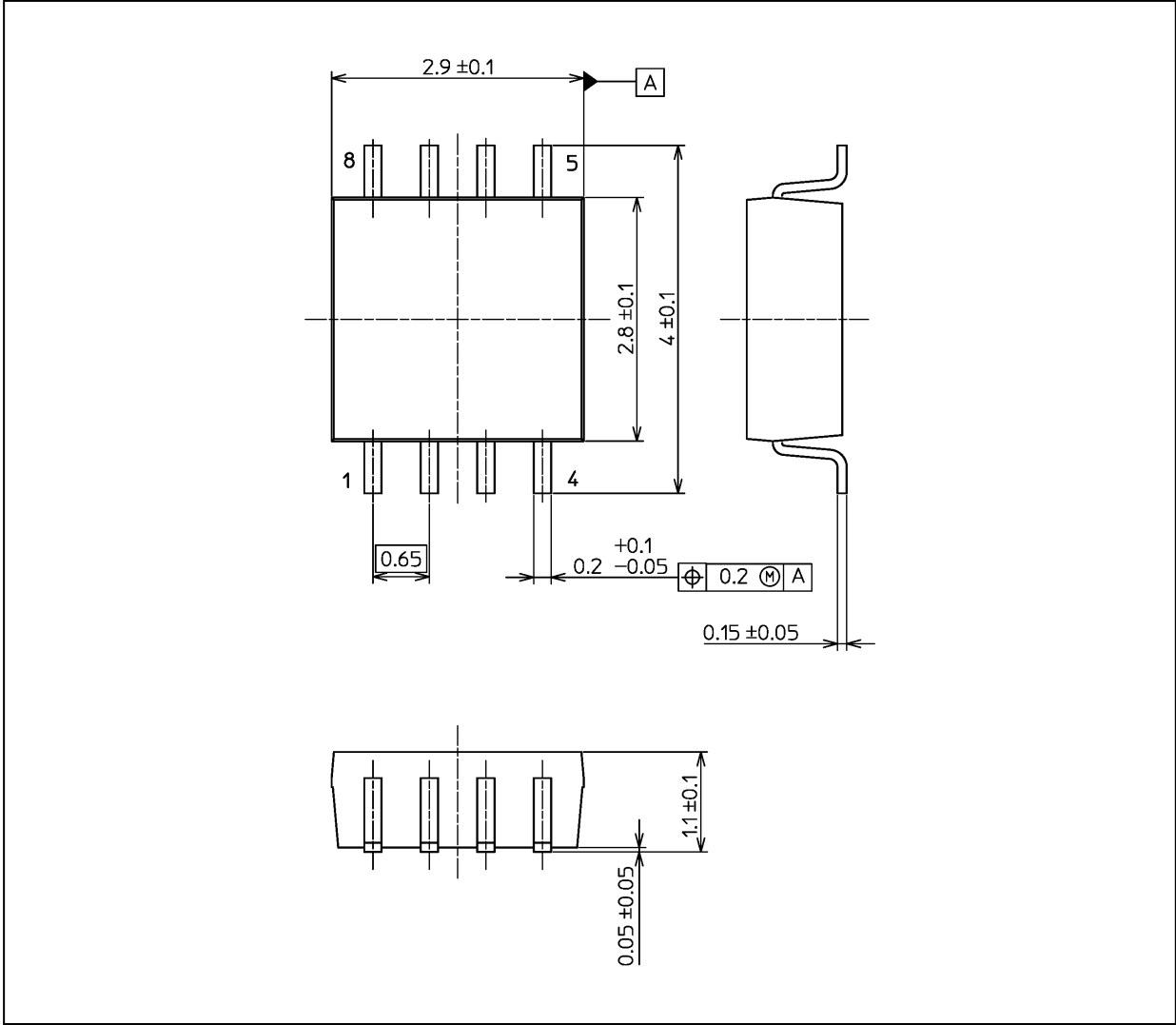
Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Limit	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	$C_L = 50\text{ pF}$	5.0	0.3	0.8	V
Quiet output minimum dynamic V_{OL}	V_{OLV}	$C_L = 50\text{ pF}$	5.0	-0.3	-0.8	V
Minimum high-level dynamic input voltage	V_{IHD}	$C_L = 50\text{ pF}$	5.0	—	3.5	V
Maximum low-level dynamic input voltage	V_{ILD}	$C_L = 50\text{ pF}$	5.0	—	1.5	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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