

CMOS Digital Integrated Circuits Silicon Monolithic

# TC7WH14FU

## 1. Functional Description

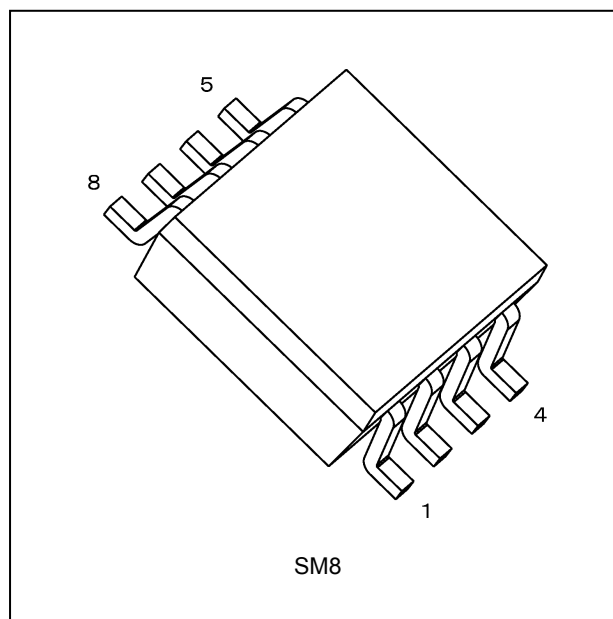
- Triple Schmitt Inverter

## 2. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 1)
- (2) High speed operation:  $t_{pd} = 5.5$  ns (typ.) ( $V_{CC} = 5.0$  V,  $C_L = 15$  pF)
- (3) Low power dissipation:  $I_{CC} = 2.0$   $\mu$ 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) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (7) Wide operating voltage range:  $V_{CC} = 2.0$  to  $5.5$  V
- (8) Identical pin assignment and function with TC7W14

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

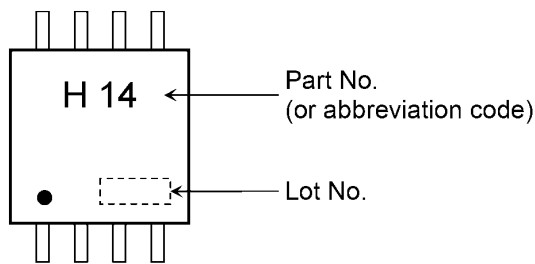
## 3. Packaging



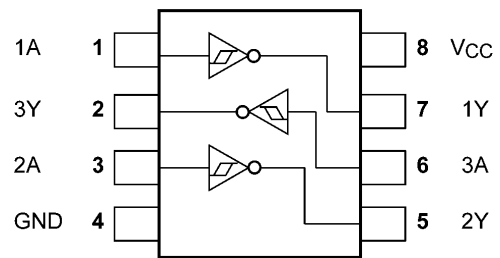
Start of commercial production

2020-01

### 4. Marking and Pin Assignment

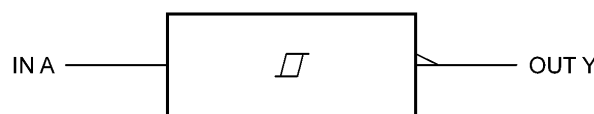


Marking



Pin Assignment (Top view)

### 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          |
|----------------------------|----------|--------------------------|-----------------------------|---------------------------------|----------|------|------|---------------|
| Positive threshold voltage | $V_P$    | —                        |                             | 3.0                             | —        | —    | 2.20 | V             |
|                            |          |                          |                             | 4.5                             | —        | —    | 3.15 |               |
|                            |          |                          |                             | 5.5                             | —        | —    | 3.85 |               |
| Negative threshold voltage | $V_N$    | —                        |                             | 3.0                             | 0.90     | —    | —    | V             |
|                            |          |                          |                             | 4.5                             | 1.35     | —    | —    |               |
|                            |          |                          |                             | 5.5                             | 1.65     | —    | —    |               |
| Hysteresis voltage         | $V_H$    | —                        |                             | 3.0                             | 0.30     | —    | 1.20 | V             |
|                            |          |                          |                             | 4.5                             | 0.40     | —    | 1.40 |               |
|                            |          |                          |                             | 5.5                             | 0.50     | —    | 1.60 |               |
| High-level output voltage  | $V_{OH}$ | $V_{IN} = V_{IL}$        | $I_{OH} = -50\ \mu\text{A}$ | 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     | —    | —    |               |
| Low-level output voltage   | $V_{OL}$ | $V_{IN} = V_{IH}$        | $I_{OL} = 50\ \mu\text{A}$  | 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 |               |
| Quiescent supply current   | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND |                             | 5.5                             | —        | —    | 2.0  | $\mu\text{A}$ |
|                            |          |                          |                             | $I_{IN} = 5.5\ \text{V}$ or GND | 0 to 5.5 | —    | —    |               |

### 9.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85$ °C)

| Characteristics            | Symbol   | Test Condition           |                      | $V_{CC}$ (V) | Min  | Max       | Unit    |
|----------------------------|----------|--------------------------|----------------------|--------------|------|-----------|---------|
| Positive threshold voltage | $V_P$    | —                        |                      | 3.0          | —    | 2.20      | V       |
|                            |          |                          |                      | 4.5          | —    | 3.15      |         |
|                            |          |                          |                      | 5.5          | —    | 3.85      |         |
| Negative threshold voltage | $V_N$    | —                        |                      | 3.0          | 0.90 | —         | V       |
|                            |          |                          |                      | 4.5          | 1.35 | —         |         |
|                            |          |                          |                      | 5.5          | 1.65 | —         |         |
| Hysteresis voltage         | $V_H$    | —                        |                      | 3.0          | 0.30 | 1.20      | V       |
|                            |          |                          |                      | 4.5          | 0.40 | 1.40      |         |
|                            |          |                          |                      | 5.5          | 0.50 | 1.60      |         |
| 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          | 2.48 | —         |         |
|                            |          |                          | $I_{OH} = -8$ mA     | 4.5          | 3.80 | —         |         |
| 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          | —    | 0.44      |         |
|                            |          |                          | $I_{OL} = 8$ mA      | 4.5          | —    | 0.44      |         |
| Input leakage current      | $I_{IN}$ | $V_{IN} = 5.5$ V or GND  |                      | 0 to 5.5     | —    | $\pm 1.0$ | $\mu A$ |
| Quiescent supply current   | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND |                      | 5.5          | —    | 20.0      | $\mu A$ |

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

| Characteristics            | Symbol   | Test Condition           |                      | $V_{CC}$ (V) | Min  | Max       | Unit    |
|----------------------------|----------|--------------------------|----------------------|--------------|------|-----------|---------|
| Positive threshold voltage | $V_P$    | —                        |                      | 3.0          | —    | 2.20      | V       |
|                            |          |                          |                      | 4.5          | —    | 3.15      |         |
|                            |          |                          |                      | 5.5          | —    | 3.85      |         |
| Negative threshold voltage | $V_N$    | —                        |                      | 3.0          | 0.90 | —         | V       |
|                            |          |                          |                      | 4.5          | 1.35 | —         |         |
|                            |          |                          |                      | 5.5          | 1.65 | —         |         |
| Hysteresis voltage         | $V_H$    | —                        |                      | 3.0          | 0.30 | 1.20      | V       |
|                            |          |                          |                      | 4.5          | 0.40 | 1.40      |         |
|                            |          |                          |                      | 5.5          | 0.50 | 1.60      |         |
| 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     | —    | $\pm 2.0$ | $\mu A$ |
| Quiescent supply current   | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND |                      | 5.5          | —    | 40.0      | $\mu A$ |

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         | —   | 8.3  | 12.8 | ns   |
|                               |                    |          |                |               | 50         | —   | 10.8 | 16.3 |      |
|                               |                    |          |                | $5.0 \pm 0.5$ | 15         | —   | 5.5  | 8.6  |      |
|                               |                    |          |                |               | 50         | —   | 7.0  | 10.6 |      |
| Input capacitance             | $C_{IN}$           |          | —              |               | —          | 4   | 10   | pF   |      |
| Power dissipation capacitance | $C_{PD}$           | (Note 1) | —              |               | —          | 12  | —    | 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.

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

### 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 | 15.0 | ns   |
|                        |                    |                |               | 50         | 1.0 | 18.5 |      |
|                        |                    |                | $5.0 \pm 0.5$ | 15         | 1.0 | 10.0 |      |
|                        |                    |                |               | 50         | 1.0 | 12.0 |      |
| 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 | 17.0 | ns   |
|                        |                    |                |               | 50         | 1.0 | 20.5 |      |
|                        |                    |                | $5.0 \pm 0.5$ | 15         | 1.0 | 11.5 |      |
|                        |                    |                |               | 50         | 1.0 | 13.5 |      |
| Input capacitance      | $C_{IN}$           | —              |               | —          | 10  | pF   |      |

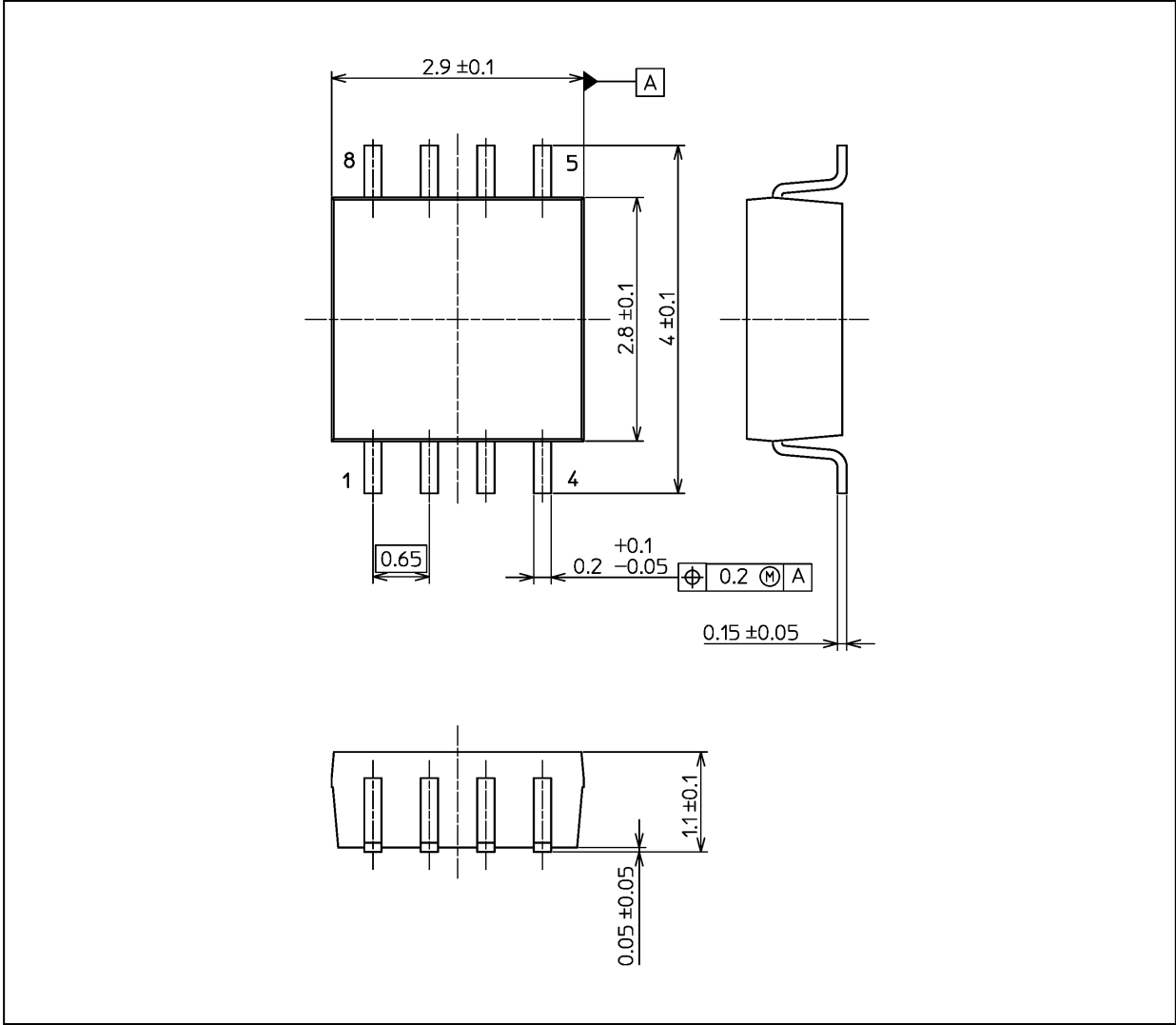
Note: For devices with the ordering part number ending in J(CT).

### 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    |

Package Dimensions

Unit: mm



Weight: 21 mg (typ.)

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

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