

# 74VHC08FT

## 1. Functional Description

- Quad 2-Input AND Gate

## 2. General

The 74VHC08FT is an advanced high speed CMOS 2-INPUT AND GATE fabricated with silicon gate C<sup>2</sup>MOS 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 4 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.

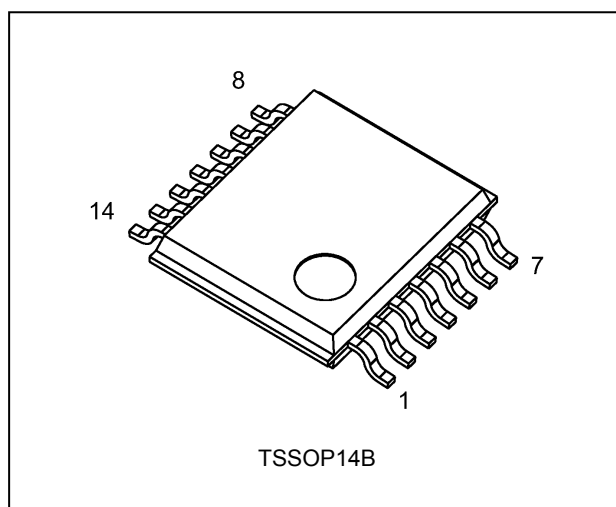
This circuit prevents device destruction due to mismatched supply and input voltages.

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature :  $T_{opr} = -40$  to  $125$  °C
- (3) High speed:  $t_{pd} = 4.3$  ns (typ.) ( $V_{CC} = 5.0$  V)
- (4) Low power dissipation:  $I_{CC} = 2.0$   $\mu$ A (max) ( $T_a = 25$  °C)
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28$  %  $V_{CC}$  (min)
- (6) Power down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to  $5.5$  V
- (9) Low noise:  $V_{OLP} = 0.8$  V (max)
- (10) Pin and function compatible with the 74 series (AC/HC/AHC/LV etc.) 08 type.

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

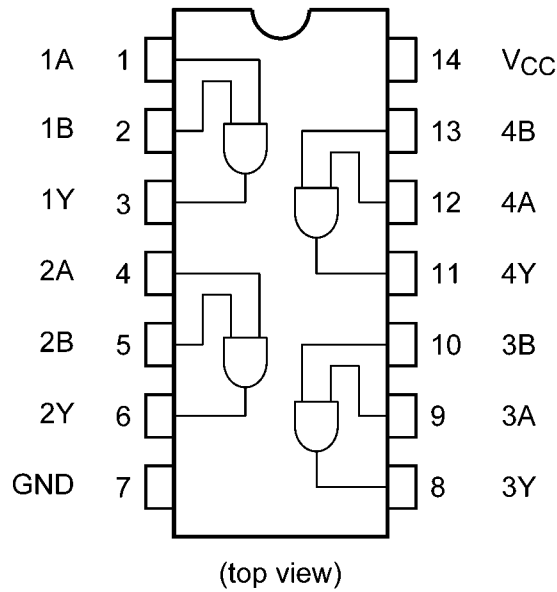
## 4. Packaging



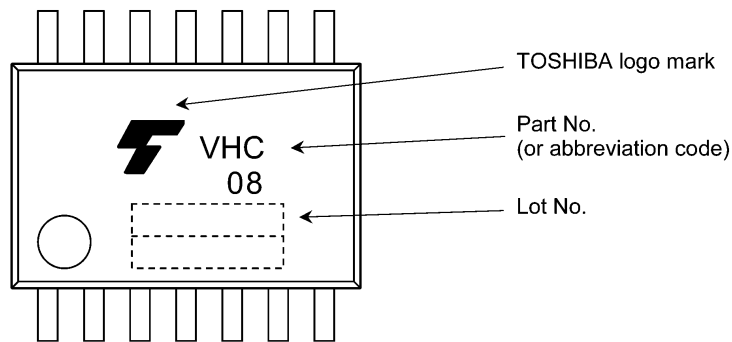
Start of commercial production

2013-01

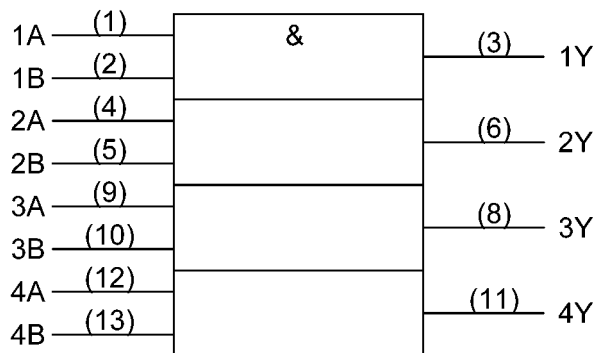
**5. Pin Assignment**



**6. Marking**



**7. IEC Logic Symbol**



## 8. Truth Table

| A | B | Y |
|---|---|---|
| L | L | L |
| L | H | L |
| H | L | L |
| H | H | H |

## 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 7.0            | V           |
| Output voltage           | $V_{OUT}$ |          | -0.5 to $V_{CC} + 0.5$ | V           |
| Input diode current      | $I_{IK}$  |          | -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) | 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).

Note 1: 180 mW in the range of  $T_a = -40$  to  $85^{\circ}C$ . From  $T_a = 85$  to  $125^{\circ}C$  a derating factor of  $-3.25$  mW/ $^{\circ}C$  shall be applied until 50 mW.

## 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      | V           |
| Output voltage            | $V_{OUT}$ |                          | 0 to $V_{CC}$ | V           |
| Operating temperature     | $T_{opr}$ |                          | -40 to 125    | $^{\circ}C$ |
| Input rise and fall times | $dt/dv$   | $V_{CC} = 3.3 \pm 0.3$ V | 0 to 100      | ns/V        |
|                           |           | $V_{CC} = 5.0 \pm 0.5$ 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.

**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                               | —                      | —    | 0.50                | V             |   |      |
|                           |          |                                | 3.0 to 5.5                        | —                      | —    | $V_{CC} \times 0.3$ |               |   |      |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$              | $I_{OH} = -50\text{ }\mu\text{A}$ | 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  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OL} = 50\text{ }\mu\text{A}$  | 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                          | —                      | —    | $\pm 0.1$           | $\mu\text{A}$ |   |      |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND       | 5.5                               | —                      | —    | 2.0                 | $\mu\text{A}$ |   |      |

**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             |   |      |
|                           |          |                                | 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 | $V_{OH}$ | $V_{IN} = V_{IH}$              | $I_{OH} = -50\text{ }\mu\text{A}$ | 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  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OL} = 50\text{ }\mu\text{A}$  | 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                          | —                       | $\pm 1.0$           | $\mu\text{A}$ |   |      |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND       | 5.5                               | —                       | 20.0                | $\mu\text{A}$ |   |      |

**11.3. DC Characteristics (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       |
|                           |          |                               |                      | 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 | $V_{OH}$ | $V_{IN} = V_{IH}$             | $I_{OH} = -50 \mu A$ | 2.0              | 1.9                 | —                   | V       |
|                           |          |                               |                      | 3.0              | 2.9                 | —                   |         |
|                           |          |                               |                      | 4.5              | 4.4                 | —                   |         |
|                           |          |                               |                      | $I_{OH} = -4$ mA | 3.0                 | 2.40                |         |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 50 \mu A$  | 2.0              | —                   | 0.1                 | V       |
|                           |          |                               |                      | 3.0              | —                   | 0.1                 |         |
|                           |          |                               |                      | 4.5              | —                   | 0.1                 |         |
|                           |          |                               |                      | $I_{OL} = 4$ mA  | 3.0                 | —                   |         |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5$ V or GND       |                      | 0 to 5.5         | —                   | $\pm 2.0$           | $\mu A$ |
|                           |          |                               |                      | 5.5              | —                   | 40.0                |         |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                      | 5.5              | —                   | 40.0                | $\mu A$ |

**11.4. AC Characteristics (Unless otherwise specified,  $T_a = 25$  °C, Input:  $t_r = t_f = 3$  ns)**

| Characteristics               | Symbol             | Note     | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Typ. | Max  | Unit |
|-------------------------------|--------------------|----------|---------------|------------|-----|------|------|------|
| Propagation delay time        | $t_{PLH}, t_{PHL}$ |          | $3.3 \pm 0.3$ | 15         | —   | 6.2  | 8.8  | ns   |
|                               |                    |          |               | 50         | —   | 8.7  | 12.3 |      |
|                               |                    |          | $5.0 \pm 0.5$ | 15         | —   | 4.3  | 5.9  |      |
|                               |                    |          |               | 50         | —   | 5.8  | 7.9  |      |
| 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.

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

**11.5. AC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 3$  ns)**

| Characteristics        | Symbol             | $V_{CC}$ (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 | 14.0 |      |
|                        |                    | $5.0 \pm 0.5$ | 15         | 1.0 | 7.0  |      |
|                        |                    |               | 50         | 1.0 | 9.0  |      |
| Input capacitance      | $C_{IN}$           |               | —          | 10  | pF   |      |

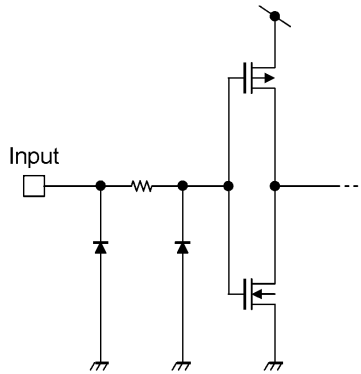
**11.6. AC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 3$  ns)**

| Characteristics        | Symbol             | Note | 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 | 12.0 | ns   |
|                        |                    |      |                |               | 50         | 1.0 | 15.5 |      |
|                        |                    |      |                | $5.0 \pm 0.5$ | 15         | 1.0 | 8.0  |      |
|                        |                    |      |                |               | 50         | 1.0 | 10.0 |      |
| Input capacitance      | $C_{IN}$           |      | —              | —             | 10         | pF  |      |      |

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

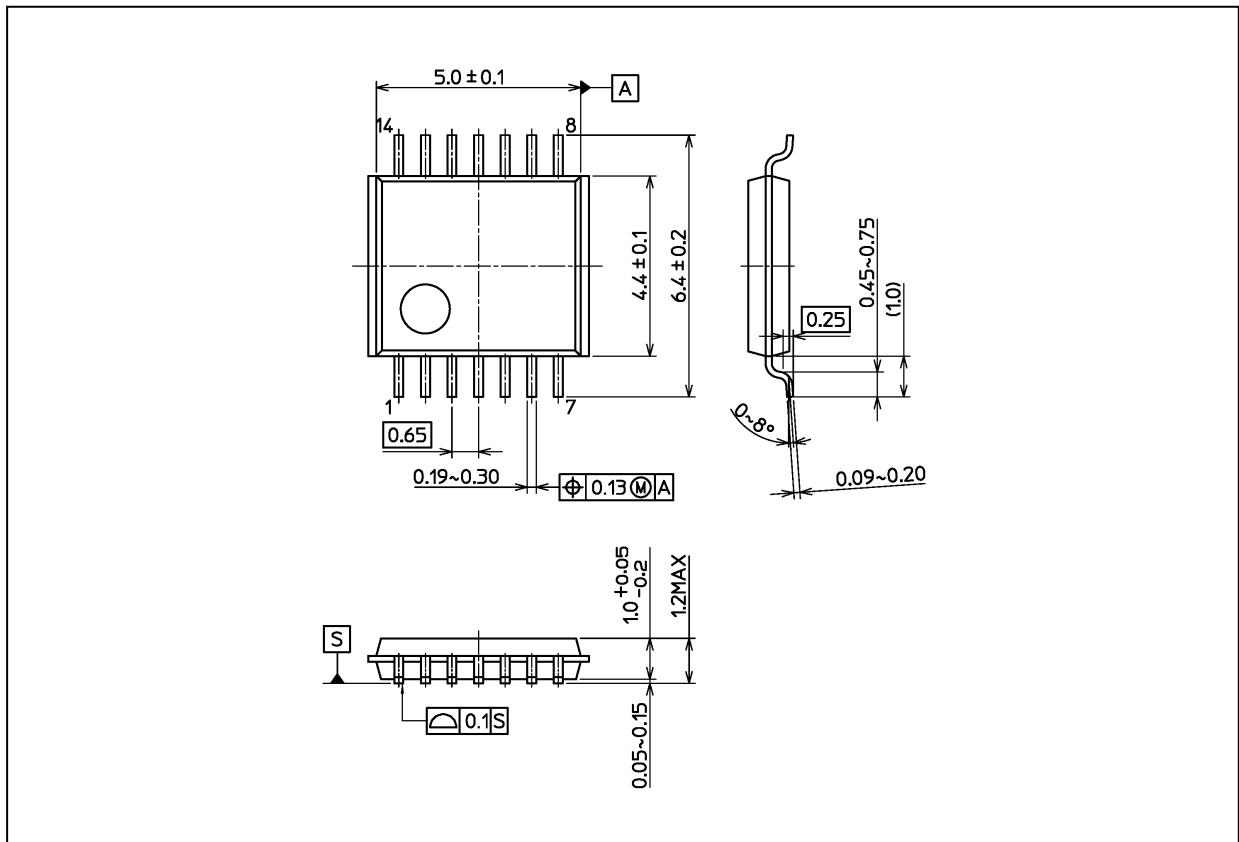
| Characteristics                          | Symbol    | Test Condition       | $V_{CC}$ (V) | Typ. | Limit | Unit |
|--|-----------|----------------------|--------------|------|-------|------|
| Quiet output maximum dynamic $V_{OL}$    | $V_{OLP}$ | $C_L = 50\text{ pF}$ | 5.0          | 0.3  | 0.8   | 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    |

**11.8. Internal Equivalent Circuit**



**Package Dimensions**

Unit: mm



Weight: 0.054 g (typ.)

|                    |
|--------------------|
| Package Name(s)    |
| Nickname: TSSOP14B |

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