

TC7SH09F

1. Functional Description

- 2-Input AND Gate (Open Drain)

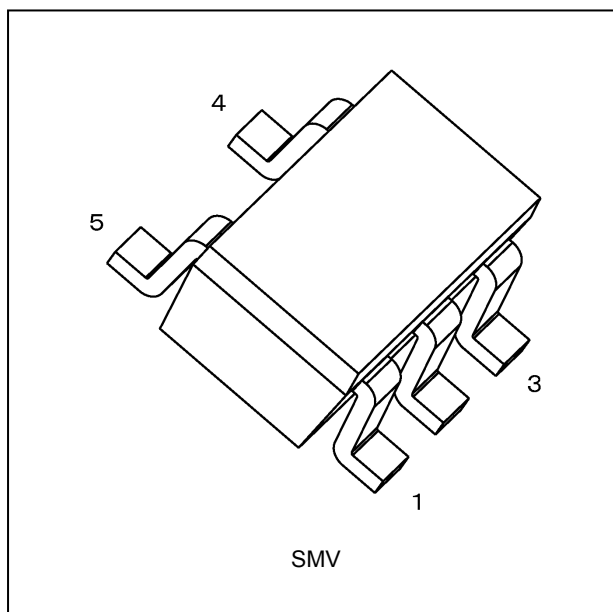
2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature : $T_{opr} = -40$ to 125 °C (Note 2)
- (3) High speed operation: $t_{pZL} = 3.2$ ns (typ.) ($V_{CC} = 5.0$ V, $C_L = 15$ pF)
- (4) Low power dissipation: $I_{CC} = 2.0$ μ A (max) ($T_a = 25$ °C)
- (5) Wide operating voltage range: $V_{CC} = 2.0$ to 5.5 V
- (6) 5.5 V tolerant inputs
- (7) 5.5 V power down protection output

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

Note 2: For devices with the ordering part number ending in J(CT). $T_{opr} = -40$ to 85 °C for the other devices.

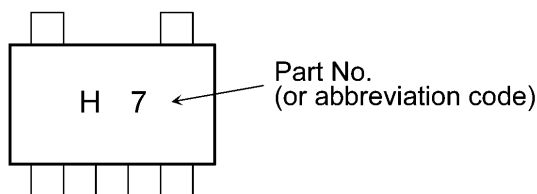
3. Packaging



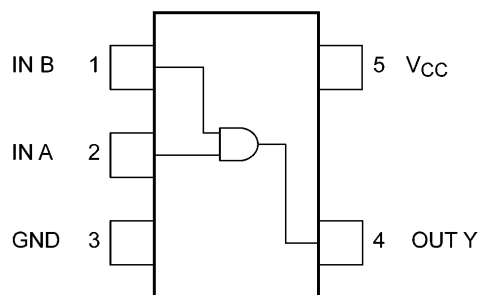
Start of commercial production

2011-08

4. Marking and Pin Assignment

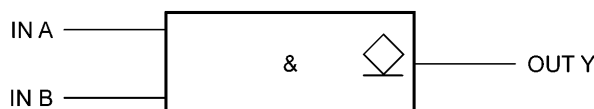


Marking



Pin Assignment (Top view)

5. IEC Logic Symbol



6. Truth Table

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

Z: High impedance

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} | (Note 1) | -0.5 to 7.0 | |
| Input diode current | I_{IK} | | -20 | mA |
| Output diode current | I_{OK} | (Note 2) | -20 | |
| DC output current | I_{OUT} | | +25 | |
| V_{CC} /ground current | I_{CC} | | ± 50 | |
| Power dissipation | P_D | | 200 | 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: Do not exceed I_{OUT} of absolute maximum ratings.

Note 2: $V_{OUT} < GND$

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 | V |
| Output voltage | V_{OUT} | (Note 1) | — | 0 to 5.5 | V |
| | | (Note 2) | — | 0 to V_{CC} | |
| Operating temperature | T_{opr} | (Note 3) | — | -40 to 125 | °C |
| | | (Note 4) | — | -40 to 85 | |
| Input rise and fall time | 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.

Note 1: High impedance state.

Note 2: Low state.

Note 3: For devices with the ordering part number ending in J(CT).

Note 4: For devices except those with the ordering part number ending in J(CT).

9. Electrical Characteristics

9.1. DC Characteristics (Unless otherwise specified, $T_a = 25$ °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 | — | — | $V_{CC} \times 0.3$ | | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 50$ μ A | 2.0 | — | 0.0 | 0.1 | V | |
| | | | | 3.0 | — | 0.0 | 0.1 | | |
| | | | | 4.5 | — | 0.0 | 0.1 | | |
| | | | | $I_{OL} = 4$ mA | 3.0 | — | — | | 0.36 |
| | | | | $I_{OL} = 8$ mA | 4.5 | — | — | | 0.36 |
| Input leakage current | I_{IN} | $V_{IN} = 5.5$ V or GND | | 0 to 5.5 | — | — | ± 0.1 | μ A | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND | | 0 to 5.5 | — | — | ± 0.25 | μ A | |
| Power-OFF leakage current | I_{OFF} | $V_{IN} = 5.5$ V or $V_{OUT} = 0$ to 5.5 V | | 0.0 | — | — | 1.0 | μ A | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 5.5 | — | — | 2.0 | μ A | |

9.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 85 °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 | — | $V_{CC} \times 0.3$ | | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 50 \mu A$ | 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 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND | | 0 to 5.5 | — | ± 2.5 | μA | |
| Power-OFF leakage current | I_{OFF} | $V_{IN} = 5.5 \text{ V}$ or $V_{OUT} = 0$ to 5.5 V | | 0.0 | — | 10.0 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ 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 | — | $V_{CC} \times 0.3$ | | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 50 \mu A$ | 2.0 | — | 0.1 | V | |
| | | | | 3.0 | — | 0.1 | | |
| | | | | 4.5 | — | 0.1 | | |
| | | | | $I_{OL} = 4 \text{ mA}$ | 3.0 | — | | 0.55 |
| | | | | $I_{OL} = 8 \text{ mA}$ | 4.5 | — | | 0.55 |
| Input leakage current | I_{IN} | $V_{IN} = 5.5 \text{ V}$ or GND | | 0 to 5.5 | — | ± 2.0 | μA | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = V_{CC}$ or GND | | 0 to 5.5 | — | ± 10.0 | μA | |
| Power-OFF leakage current | I_{OFF} | $V_{IN} = 5.5 \text{ V}$ or $V_{OUT} = 0$ to 5.5 V | | 0.0 | — | 20.0 | 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_{PZL} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | — | 4.6 | 7.5 | ns |
| | | | | | 50 | — | 6.5 | 11.0 | |
| | | | | 5.0 ± 0.5 | 15 | — | 3.2 | 5.5 | |
| | | | | | 50 | — | 4.6 | 7.5 | |
| Propagation delay time | t_{PLZ} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | — | 4.6 | 7.5 | ns |
| | | | | | 50 | — | 6.5 | 11.0 | |
| | | | | 5.0 ± 0.5 | 15 | — | 3.2 | 5.5 | |
| | | | | | 50 | — | 4.6 | 7.5 | |
| Input capacitance | C_{IN} | | — | | | — | 1.5 | 10 | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | | | — | 5 | — | 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.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

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 | Note | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|-----------|------|--------------------------|---------------|------------|-----|------|------|
| Propagation delay time | t_{PZL} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | 1.0 | 8.5 | ns |
| | | | | | 50 | 1.5 | 12.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 6.5 | |
| | | | | | 50 | 1.5 | 8.0 | |
| Propagation delay time | t_{PLZ} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | 1.0 | 8.5 | ns |
| | | | | | 50 | 1.5 | 12.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 6.5 | |
| | | | | | 50 | 1.5 | 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 | Note | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|-----------|------|--------------------------|---------------|------------|-----|------|------|
| Propagation delay time | t_{PZL} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | 1.0 | 10.5 | ns |
| | | | | | 50 | 1.5 | 14.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 7.5 | |
| | | | | | 50 | 1.5 | 9.5 | |
| Propagation delay time | t_{PLZ} | | $R_L = 1\text{ k}\Omega$ | 3.3 ± 0.3 | 15 | 1.0 | 10.5 | ns |
| | | | | | 50 | 1.5 | 14.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 7.5 | |
| | | | | | 50 | 1.5 | 9.5 | |
| Input capacitance | C_{IN} | | — | | | — | 10 | pF |

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

Package Dimensions

Unit: mm



Weight: 14 mg (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-25 |
| Nickname: SMV |

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