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74HC164D

1. Functional Description

- 8-Bit Shift Register (S-IN, P-OUT)

2. General

The 74HC164D is a high speed CMOS 8-BIT SERIAL-IN PARALLEL-OUT SHIFT REGISTER fabricated with silicon gate C²MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

It consists of a serial-in, parallel-out 8-bit shift register with a CK input and an overriding $\overline{\text{CLR}}$ input.

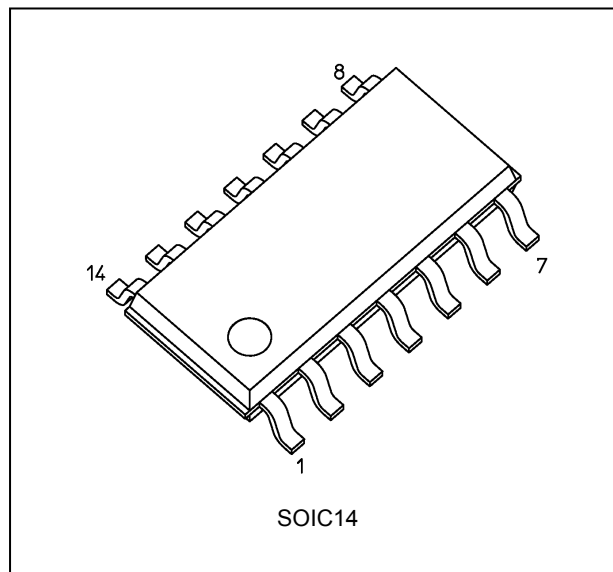
Two serial data inputs (A, B) are provided so that one may be used as a data enable.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

3. Features

- (1) High speed: $f_{\text{MAX}} = 58 \text{ MHz}$ (typ.) at $V_{\text{CC}} = 5 \text{ V}$
- (2) Low power dissipation: $I_{\text{CC}} = 4.0 \mu\text{A}$ (max) at $T_a = 25 \text{ }^\circ\text{C}$
- (3) Balanced propagation delays: $t_{\text{PLH}} \approx t_{\text{PHL}}$
- (4) Wide operating voltage range: $V_{\text{CC(opr)}} = 2.0 \text{ to } 6.0 \text{ V}$

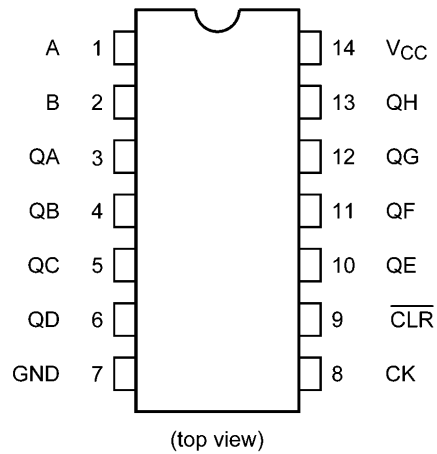
4. Packaging



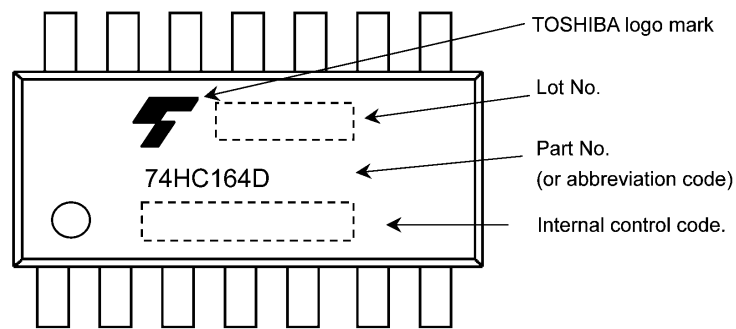
Start of commercial production

2016-02

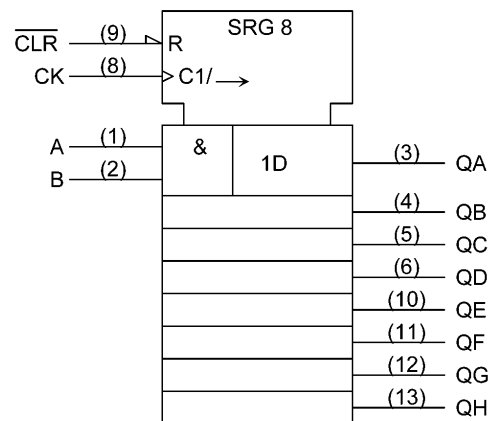
5. Pin Assignment







6. Marking



7. IEC Logic Symbol



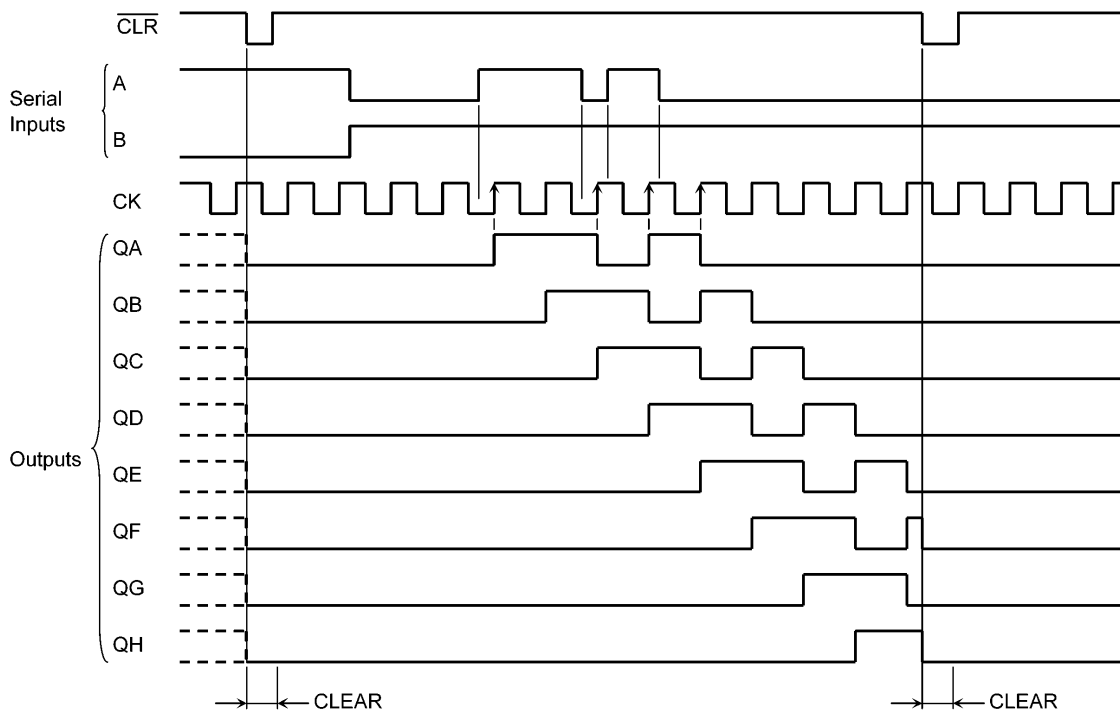
8. Truth Table

| Inputs | | | | Outputs | | | |
|-------------------------|-----------------------------------------------------------------------------------|-----------|---|-----------|-----|-----|-----|
| $\overline{\text{CLR}}$ | CK | Serial IN | | QA | QB | ... | QH |
| | | A | B | | | | |
| L | X | X | X | L | L | ... | L |
| H |  | X | X | No Change | | | |
| H |  | L | X | L | QAn | ... | QGn |
| H |  | X | L | L | QAn | ... | QGn |
| H |  | H | H | H | QAn | ... | QGn |

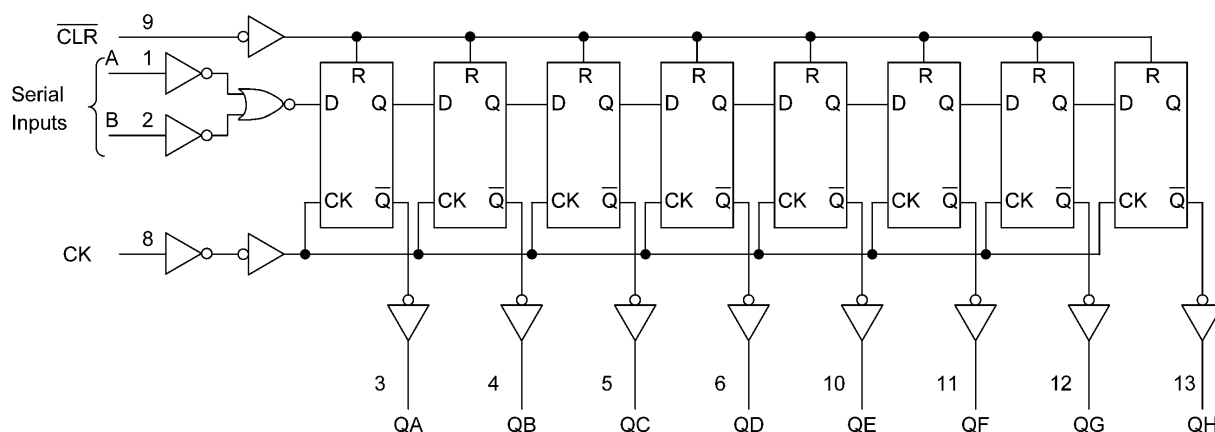
X: Don't care

QAn to QGn: The level of QA to QG, respectively, before the most recent positive edge of the CK.

9. Timing Diagrams



10. System Diagram



11. 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 $V_{CC} + 0.5$ | 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} | | ± 20 | mA |
| Output current | I_{OUT} | | ± 25 | mA |
| V_{CC} /ground current | I_{CC} | | ± 50 | mA |
| Power dissipation | P_D | (Note 1) | 500 | 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: P_D derates linearly with -8 mW/ $^{\circ}C$ above 85 $^{\circ}C$

12. Operating Ranges (Note)

| Characteristics | Symbol | Test Condition | Rating | Unit |
|---------------------------|------------|----------------|---------------|-------------|
| Supply voltage | V_{CC} | — | 2.0 to 6.0 | V |
| Input voltage | V_{IN} | — | 0 to V_{CC} | V |
| Output voltage | V_{OUT} | — | 0 to V_{CC} | V |
| Operating temperature | T_{opr} | — | -40 to 125 | $^{\circ}C$ |
| Input rise and fall times | t_r, t_f | — | 0 to 50 | μs |

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.

13. Electrical Characteristics

13.1. 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 |
| | | | | 4.5 | 3.15 | — | — | |
| | | | | 6.0 | 4.20 | — | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | — | 0.50 | V |
| | | | | 4.5 | — | — | 1.35 | |
| | | | | 6.0 | — | — | 1.80 | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -20\text{ }\mu\text{A}$ | 2.0 | 1.9 | 2.0 | — | V |
| | | | | 4.5 | 4.4 | 4.5 | — | |
| | | | 6.0 | 5.9 | 6.0 | — | | |
| | | | $I_{OH} = -4\text{ mA}$ | 4.5 | 4.18 | 4.31 | — | |
| | | | $I_{OH} = -5.2\text{ mA}$ | 6.0 | 5.68 | 5.80 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 20\text{ }\mu\text{A}$ | 2.0 | — | 0.0 | 0.1 | V |
| | | | | 4.5 | — | 0.0 | 0.1 | |
| | | | | 6.0 | — | 0.0 | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 4.5 | — | 0.17 | 0.26 | |
| | | | $I_{OL} = 5.2\text{ mA}$ | 6.0 | — | 0.18 | 0.26 | |
| Input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | — | ± 0.1 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | — | 4.0 | μA |

13.2. 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 |
| | | | | 4.5 | 3.15 | — | |
| | | | | 6.0 | 4.20 | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.50 | V |
| | | | | 4.5 | — | 1.35 | |
| | | | | 6.0 | — | 1.80 | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -20\text{ }\mu\text{A}$ | 2.0 | 1.9 | — | V |
| | | | | 4.5 | 4.4 | — | |
| | | | 6.0 | 5.9 | — | | |
| | | | $I_{OH} = -4\text{ mA}$ | 4.5 | 4.13 | — | |
| | | | $I_{OH} = -5.2\text{ mA}$ | 6.0 | 5.63 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 20\text{ }\mu\text{A}$ | 2.0 | — | 0.1 | V |
| | | | | 4.5 | — | 0.1 | |
| | | | | 6.0 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 4.5 | — | 0.33 | |
| | | | $I_{OL} = 5.2\text{ mA}$ | 6.0 | — | 0.33 | |
| Input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | ± 1.0 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | 40.0 | μA |

13.3. 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 |
| | | | | 4.5 | 3.15 | — | |
| | | | | 6.0 | 4.20 | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.50 | V |
| | | | | 4.5 | — | 1.35 | |
| | | | | 6.0 | — | 1.80 | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -20$ μ A | 2.0 | 1.9 | — | V |
| | | | | 4.5 | 4.4 | — | |
| | | | | 6.5 | 5.9 | — | |
| | | | $I_{OH} = -4$ mA | 4.5 | 3.7 | — | |
| | | | | 6.0 | 5.2 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 20$ μ A | 2.0 | — | 0.1 | V |
| | | | | 4.5 | — | 0.1 | |
| | | | | 6.0 | — | 0.1 | |
| | | | $I_{OL} = 4$ mA | 4.5 | — | 0.4 | |
| | | | | 6.0 | — | 0.4 | |
| Input leakage current | I_{IN} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | ± 1.0 | μ A |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 6.0 | — | 160 | μ A |

13.4. Timing Requirements (Unless otherwise specified, $T_a = 25$ °C, Input: $t_r = t_f = 6$ ns)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|-------------------------------------------|----------------------|----------------|--------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 2.0 | 75 | ns |
| | | | 4.5 | 15 | |
| | | | 6.0 | 13 | |
| Minimum pulse width (\overline{CLR}) | $t_{w(L)}$ | — | 2.0 | 80 | ns |
| | | | 4.5 | 16 | |
| | | | 6.0 | 14 | |
| Minimum setup time (A, B) | t_s | — | 2.0 | 50 | ns |
| | | | 4.5 | 10 | |
| | | | 6.0 | 9 | |
| Minimum hold time (A, B) | t_h | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Minimum removal time (\overline{CLR}) | t_{rem} | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Clock frequency | f | — | 2.0 | 6 | MHz |
| | | | 4.5 | 31 | |
| | | | 6.0 | 36 | |

13.5. Timing Requirements
 (Unless otherwise specified, $T_a = -40$ to 85 °C, Input: $t_r = t_f = 6$ ns)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Limit | Unit |
|--------------------------------------------------|----------------------|----------------|---------------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 2.0 | 95 | ns |
| | | | 4.5 | 19 | |
| | | | 6.0 | 16 | |
| Minimum pulse width ($\overline{\text{CLR}}$) | $t_{w(L)}$ | — | 2.0 | 100 | ns |
| | | | 4.5 | 20 | |
| | | | 6.0 | 17 | |
| Minimum setup time (A, B) | t_s | — | 2.0 | 65 | ns |
| | | | 4.5 | 13 | |
| | | | 6.0 | 11 | |
| Minimum hold time (A, B) | t_h | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Minimum removal time ($\overline{\text{CLR}}$) | t_{rem} | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Clock frequency | f | — | 2.0 | 5 | MHz |
| | | | 4.5 | 25 | |
| | | | 6.0 | 29 | |

13.6. Timing Requirements
 (Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 6$ ns)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Limit | Unit |
|--------------------------------------------------|----------------------|----------------|---------------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 2.0 | 120 | ns |
| | | | 4.5 | 24 | |
| | | | 6.0 | 20 | |
| Minimum pulse width ($\overline{\text{CLR}}$) | $t_{w(L)}$ | — | 2.0 | 120 | ns |
| | | | 4.5 | 24 | |
| | | | 6.0 | 20 | |
| Minimum setup time (A, B) | t_s | — | 2.0 | 90 | ns |
| | | | 4.5 | 18 | |
| | | | 6.0 | 15 | |
| Minimum hold time (A, B) | t_h | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Minimum removal time ($\overline{\text{CLR}}$) | t_{rem} | — | 2.0 | 5 | ns |
| | | | 4.5 | 5 | |
| | | | 6.0 | 5 | |
| Clock frequency | f | — | 2.0 | 4 | MHz |
| | | | 4.5 | 20 | |
| | | | 6.0 | 24 | |

13.7. AC Characteristics

(Unless otherwise specified, $C_L = 15 \text{ pF}$, $V_{CC} = 5 \text{ V}$, $T_a = 25 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|-------------------------------------------------------|--------------------|----------------|-----|------|-----|------|
| Output transition time | t_{TLH}, t_{THL} | — | — | 4 | 8 | ns |
| Propagation delay time (CK-Qn) | t_{PLH}, t_{PHL} | — | — | 15 | 27 | |
| Propagation delay time ($\overline{\text{CLR}}$ -Qn) | t_{PHL} | — | — | 16 | 30 | |
| Maximum clock frequency | f_{MAX} | — | 33 | 58 | — | MHz |

13.8. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = 25 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | Note | V_{CC} (V) | Min | Typ. | Max | Unit |
|-------------------------------------------------------|--------------------|----------|--------------|-----|------|-----|------|
| Output transition time | t_{TLH}, t_{THL} | | 2.0 | — | 25 | 75 | ns |
| | | | 4.5 | — | 7 | 15 | |
| | | | 6.0 | — | 6 | 13 | |
| Propagation delay time (CK-Qn) | t_{PLH}, t_{PHL} | | 2.0 | — | 57 | 160 | ns |
| | | | 4.5 | — | 19 | 32 | |
| | | | 6.0 | — | 16 | 27 | |
| Propagation delay time ($\overline{\text{CLR}}$ -Qn) | t_{PHL} | | 2.0 | — | 60 | 175 | ns |
| | | | 4.5 | — | 20 | 35 | |
| | | | 6.0 | — | 17 | 30 | |
| Maximum clock frequency | f_{MAX} | | 2.0 | 6 | 18 | — | MHz |
| | | | 4.5 | 31 | 53 | — | |
| | | | 6.0 | 36 | 62 | — | |
| Input capacitance | C_{IN} | | — | — | 3 | — | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | — | 30 | — | 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.

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

13.9. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | V_{CC} (V) | Min | Max | Unit |
|-------------------------------------------------------|--------------------|--------------|-----|-----|------|
| Output transition time | t_{TLH}, t_{THL} | 2.0 | — | 95 | ns |
| | | 4.5 | — | 19 | |
| | | 6.0 | — | 16 | |
| Propagation delay time (CK-Qn) | t_{PLH}, t_{PHL} | 2.0 | — | 200 | ns |
| | | 4.5 | — | 40 | |
| | | 6.0 | — | 34 | |
| Propagation delay time ($\overline{\text{CLR}}$ -Qn) | t_{PHL} | 2.0 | — | 220 | ns |
| | | 4.5 | — | 44 | |
| | | 6.0 | — | 37 | |
| Maximum clock frequency | f_{MAX} | 2.0 | 5 | — | MHz |
| | | 4.5 | 25 | — | |
| | | 6.0 | 29 | — | |

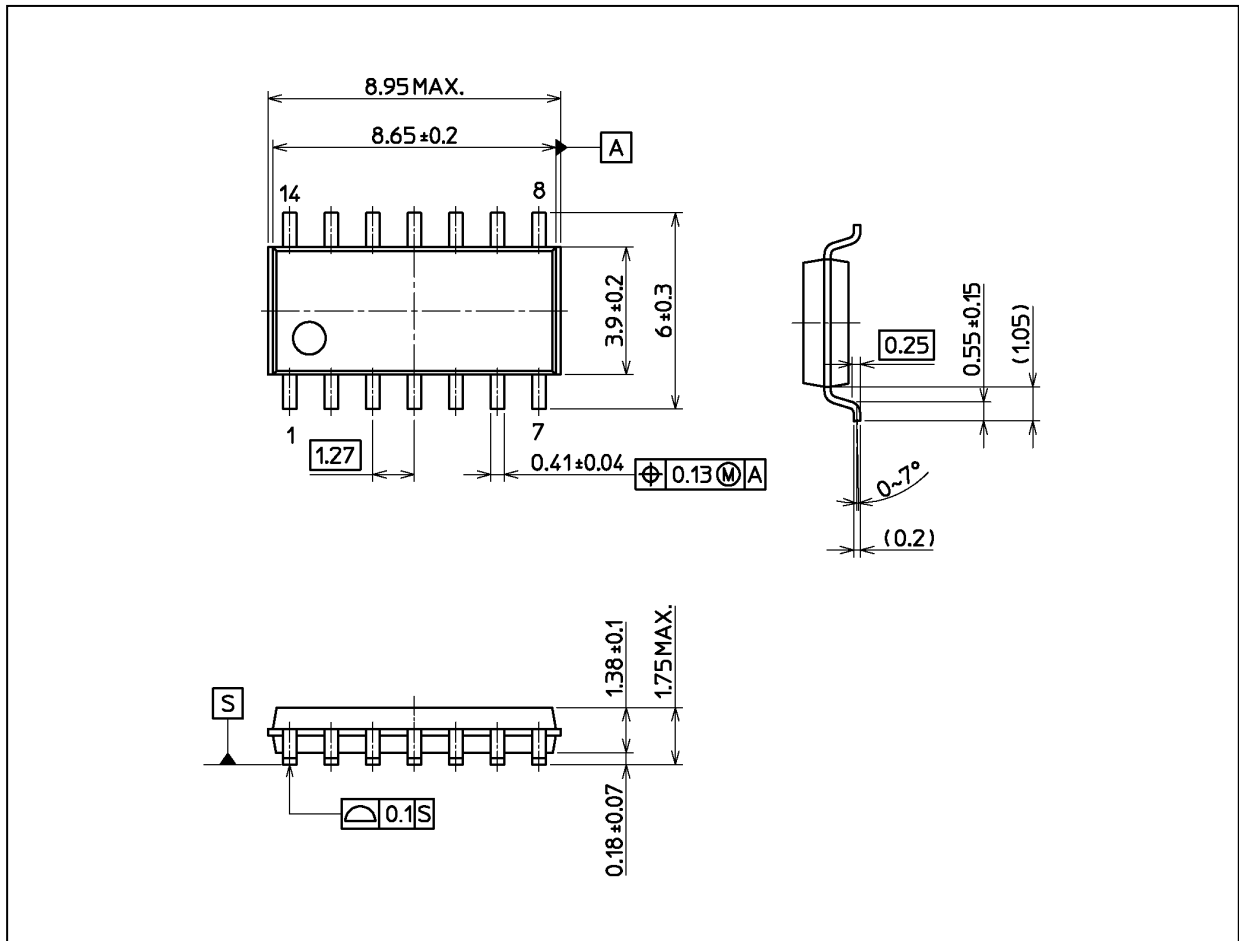
13.10. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

| Characteristics | Symbol | V_{CC} (V) | Min | Max | Unit |
|-------------------------------------------------------|--------------------|--------------|-----|-----|------|
| Output transition time | t_{TLH}, t_{THL} | 2.0 | — | 110 | ns |
| | | 4.5 | — | 22 | |
| | | 6.0 | — | 19 | |
| Propagation delay time (CK-Qn) | t_{PLH}, t_{PHL} | 2.0 | — | 240 | ns |
| | | 4.5 | — | 48 | |
| | | 6.0 | — | 41 | |
| Propagation delay time ($\overline{\text{CLR}}$ -Qn) | t_{PHL} | 2.0 | — | 265 | ns |
| | | 4.5 | — | 53 | |
| | | 6.0 | — | 45 | |
| Maximum clock frequency | f_{MAX} | 2.0 | 4 | — | MHz |
| | | 4.5 | 20 | — | |
| | | 6.0 | 24 | — | |

Package Dimensions

Unit: mm



Weight: 0.13 g (typ.)

| |
|------------------|
| Package Name(s) |
| Nickname: SOIC14 |

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