

74VHC4020FT

1. Functional Description

- 14-Stage Ripple Carry Binary Counter

2. General

The 74VHC4020FT is an advanced high speed CMOS 14-STAGE BINARY COUNTER/DIVIDER fabricated with silicon gate C²MOS technology.

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

Setting CLR to high resets the counter to low.

A negative transition on the \overline{CK} input brings one increment into the counter.

This counter provides all divided output stages, and at Q12, a 1/4096 divided frequency will be output.

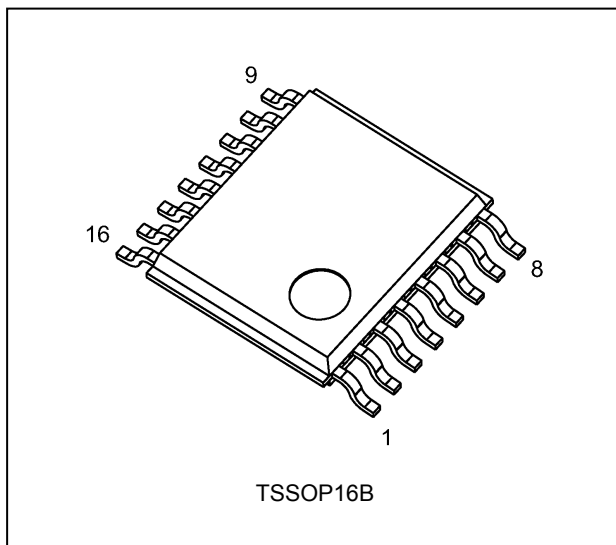
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to 125 °C
- (3) High speed: $f_{MAX} = 210$ MHz (typ.) at $V_{CC} = 5$ V
- (4) Low power dissipation: $I_{CC} = 4.0$ μ A (max) at $T_a = 25$ °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: $V_{OLP} = 1.5$ V (max)
- (10) Pin and function compatible with 74HC4020

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

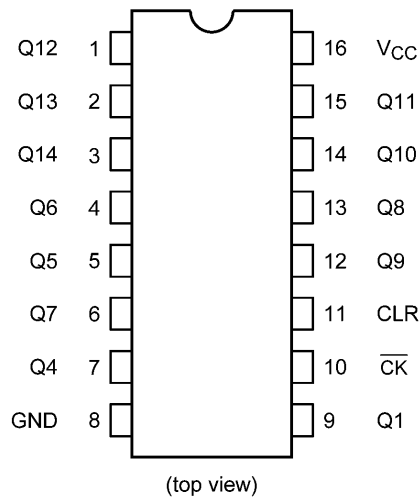
4. Packaging



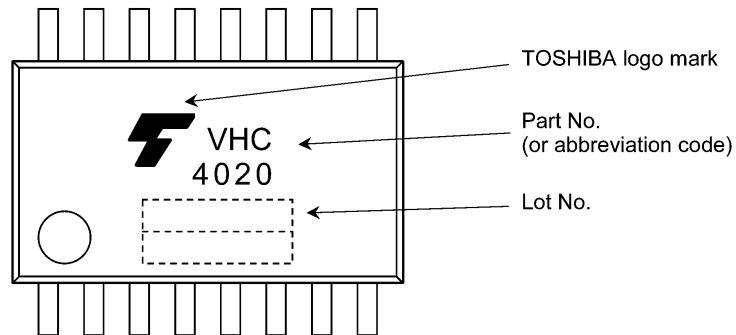
Start of commercial production

2014-10

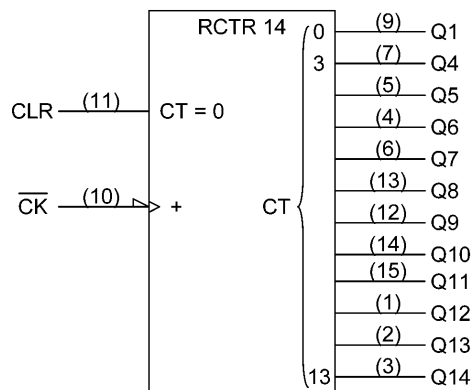
5. Pin Assignment





6. Marking



7. IEC Logic Symbol

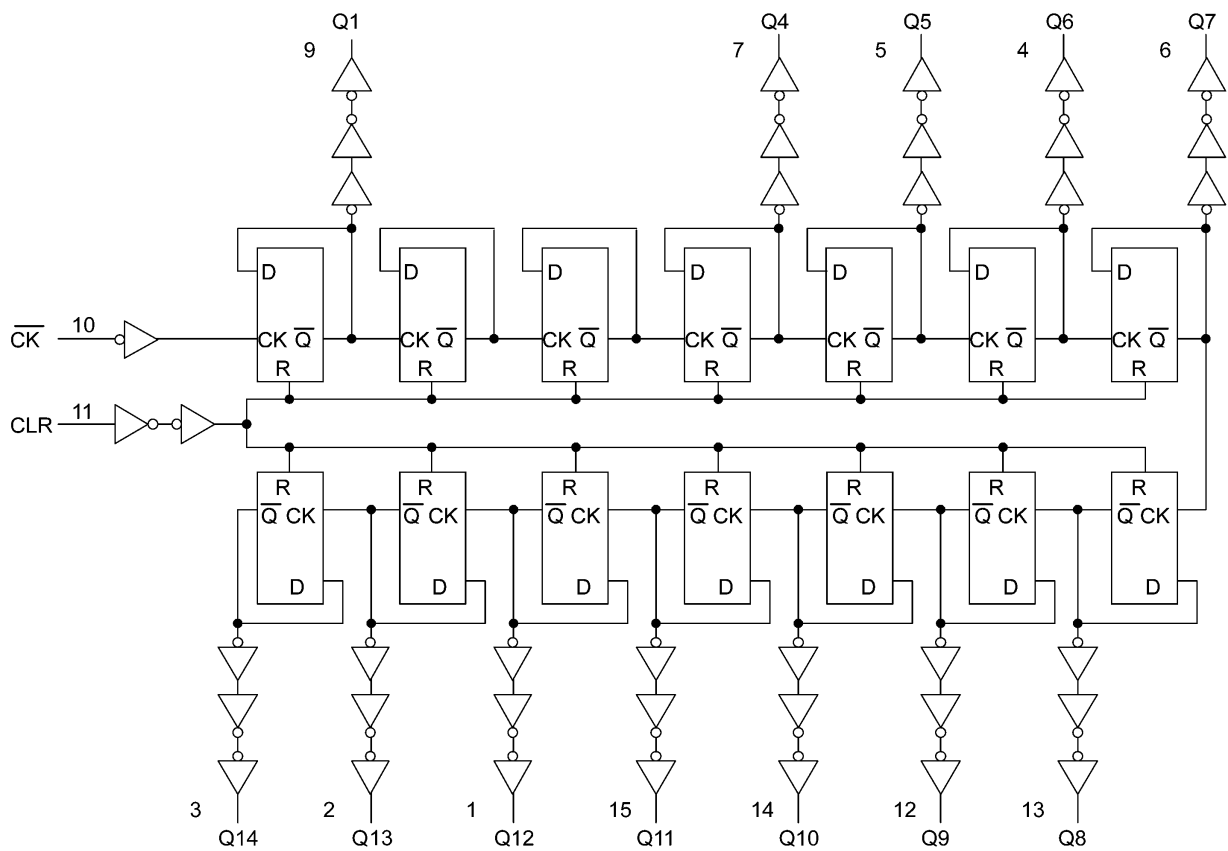


8. Truth Table

| \overline{CK} | CLR | Output State |
|---|-----|-----------------------|
| X | H | All Outputs = "L" |
|  | L | No Change |
|  | L | Advance to Next State |

X: Don't care

9. System Diagram



10. 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} | | ± 20 | mA |
| Output current | I_{OUT} | | ± 25 | mA |
| V_{CC} /ground current | I_{CC} | | ± 100 | mA |
| Power dissipation | P_D | (Note 1) | 180 | mW |
| Storage temperature | T_{stg} | | -65 to 150 | °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 °C. From $T_a = 85$ to 125 °C a derating factor of -3.25 mW/°C shall be applied until 50 mW.

11. 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 | °C |
| Input rise and fall times | dt/dv | $V_{CC} = 3.3 \pm 0.3$ V | 0 to 100 | ns/V |
| | | $V_{CC} = 5 \pm 0.5$ 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.

12. Electrical Characteristics

12.1. 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} | $V_{IN} = V_{IH}$ or 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} | $V_{IN} = V_{IH}$ 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 | — | — | ± 0.1 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | 5.5 | — | — | 4.0 | μA | |

12.2. 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} | $V_{IN} = V_{IH}$ or 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} | $V_{IN} = V_{IH}$ 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 | — | ± 1.0 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | 5.5 | — | 40.0 | μA | |

12.3. 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} | $V_{IN} = V_{IH}$ or 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 | |
| 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 | — | ± 2.0 | μA |
| | | | | 5.5 | — | 80.0 | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 5.5 | — | 80.0 | μA |

12.4. Timing Requirements (Unless otherwise specified, $T_a = 25$ °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|---------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR) | $t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum removal time | t_{rem} | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |

12.5. Timing Requirements (Unless otherwise specified, $T_a = -40$ to 85 °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|---------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR) | $t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum removal time | t_{rem} | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |

12.6. Timing Requirements (Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|---------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR) | $t_{w(H)}$ | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum removal time | t_{rem} | — | 3.3 ± 0.3 | 6.0 | ns |
| | | | 5.0 ± 0.5 | 5.5 | |

12.7. 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 (CK-Q1) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | — | 7.5 | 11.9 | ns | |
| | | | | | 50 | — | 10.0 | 15.4 | | |
| | | | | 5.0 ± 0.5 | 15 | — | 4.8 | 7.3 | | |
| | | | | | 50 | — | 6.3 | 9.3 | | |
| Propagation delay time (Q_n - Q_{n+1}) | Δt_{PD} | | — | 3.3 ± 0.3 | 50 | — | 2.4 | 4.4 | ns | |
| | | | | 5.0 ± 0.5 | 50 | — | 1.6 | 3.1 | | |
| Propagation delay time (CLR-Q) | t_{PHL} | | — | 3.3 ± 0.3 | 15 | — | 8.3 | 12.8 | ns | |
| | | | | | 50 | — | 10.8 | 16.3 | | |
| | | | | 5.0 ± 0.5 | 15 | — | 5.6 | 8.6 | | |
| | | | | | 50 | — | 7.1 | 10.6 | | |
| Maximum clock frequency | f_{MAX} | | — | 3.3 ± 0.3 | 15 | 75 | 140 | — | MHz | |
| | | | | | 50 | 55 | 80 | — | | |
| | | | | 5.0 ± 0.5 | 15 | 150 | 210 | — | | |
| | | | | | 50 | 95 | 125 | — | | |
| Input capacitance | C_{IN} | | — | | | — | 4 | 10 | pF | |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | | | | — | 21 | — | 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.

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

12.8. 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 (CK-Q1) | t_{PLH}, t_{PHL} | — | 3.3 ± 0.3 | 15 | — | 14.0 | ns |
| | | | | 50 | — | 17.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 8.5 | |
| | | | | 50 | — | 10.5 | |
| Propagation delay time (Q_n - Q_{n+1}) | Δt_{PD} | — | 3.3 ± 0.3 | 50 | — | 5.0 | ns |
| | | | 5.0 ± 0.5 | 50 | — | 3.5 | |
| Propagation delay time (CLR-Q) | t_{PHL} | — | 3.3 ± 0.3 | 15 | — | 15.0 | ns |
| | | | | 50 | — | 18.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 10.0 | |
| | | | | 50 | — | 12.0 | |
| Maximum clock frequency | f_{MAX} | — | 3.3 ± 0.3 | 15 | 75 | — | MHz |
| | | | | 50 | 50 | — | |
| | | | 5.0 ± 0.5 | 15 | 125 | — | |
| | | | | 50 | 80 | — | |
| Input capacitance | C_{IN} | | | | — | 10 | pF |

12.9. AC Characteristics

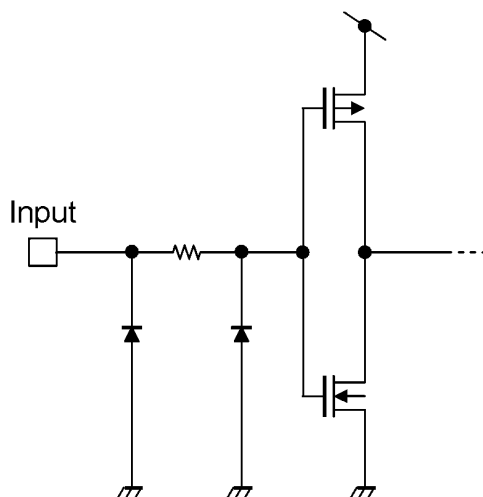
(Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|--|--------------------|----------------|---------------|------------|-----|------|------|
| Propagation delay time (CK-Q1) | t_{PLH}, t_{PHL} | — | 3.3 ± 0.3 | 15 | — | 16.0 | ns |
| | | | | 50 | — | 19.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 10.0 | |
| | | | | 50 | — | 12.0 | |
| Propagation delay time (Q_n - Q_{n+1}) | Δt_{PD} | — | 3.3 ± 0.3 | 50 | — | 5.5 | ns |
| | | | 5.0 ± 0.5 | 50 | — | 4.0 | |
| Propagation delay time (CLR-Q) | t_{PHL} | — | 3.3 ± 0.3 | 15 | — | 17.0 | ns |
| | | | | 50 | — | 20.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 11.5 | |
| | | | | 50 | — | 13.5 | |
| Maximum clock frequency | f_{MAX} | — | 3.3 ± 0.3 | 15 | 60 | — | MHz |
| | | | | 50 | 40 | — | |
| | | | 5.0 ± 0.5 | 15 | 120 | — | |
| | | | | 50 | 75 | — | |
| Input capacitance | C_{IN} | — | | | — | 10 | pF |

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

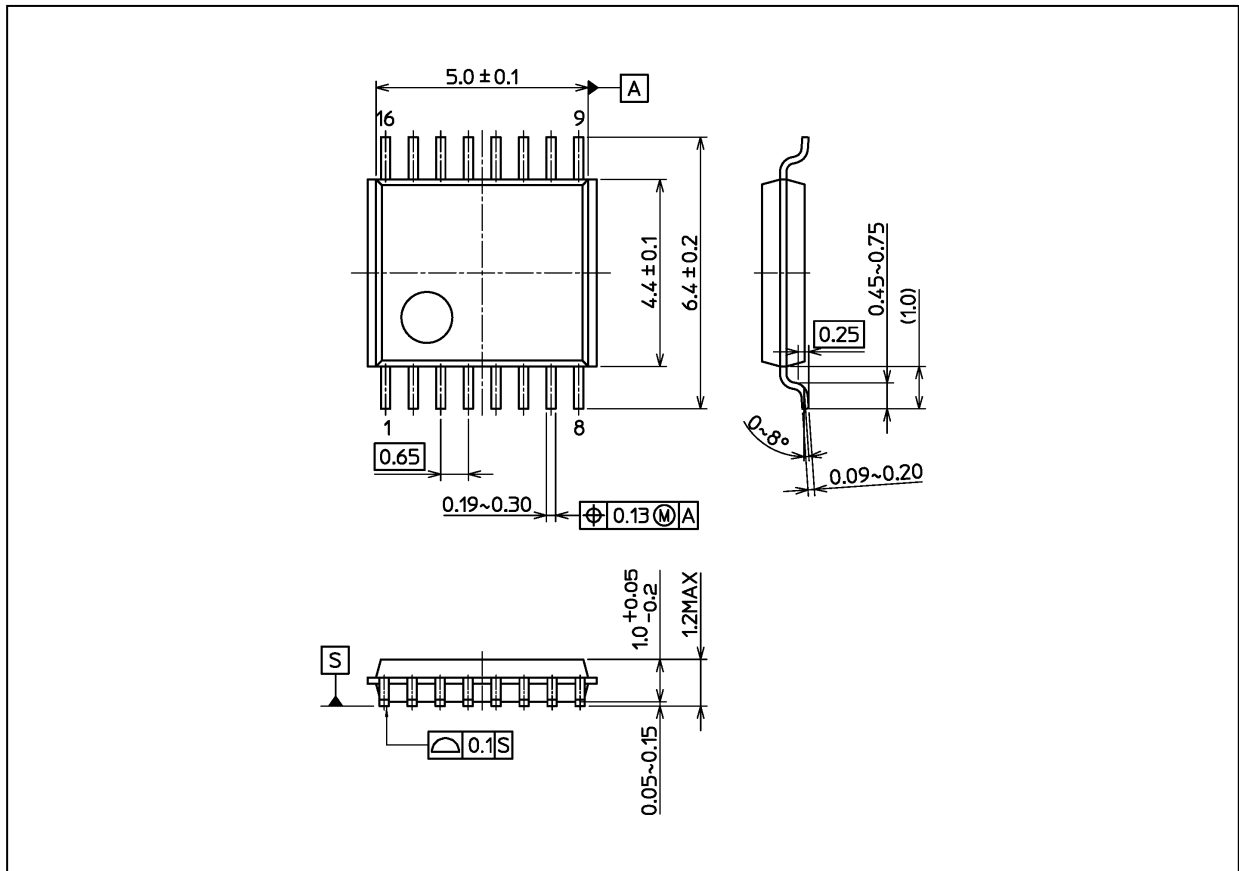
| Characteristics | Symbol | Test Condition | V_{CC} (V) | Typ. | Limit | Unit |
|--|-----------|----------------|--------------|------|-------|------|
| Quiet output maximum dynamic V_{OL} | V_{OLP} | $C_L = 50$ pF | 5.0 | 1.2 | 1.5 | V |
| Quiet output minimum dynamic V_{OL} | V_{OLV} | $C_L = 50$ pF | 5.0 | -1.2 | -1.5 | V |
| Minimum high-level dynamic input voltage | V_{IHD} | $C_L = 50$ pF | 5.0 | — | 3.5 | V |
| Maximum low-level dynamic input voltage | V_{ILD} | $C_L = 50$ pF | 5.0 | — | 1.5 | V |

13. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

| |
|--------------------|
| Package Name(s) |
| Nickname: TSSOP16B |

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