TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VHCT9541AFK

## Octal Universal Schmitt Buffer with 3-State Outputs

The TC74VHCT9541A is an ultra-high-speed octal Schmitt buffer fabricated using silicon-gate CMOS technology. The TC74VHC9541A combines low power consumption of CMOS with Schottky TTL speeds.

The input voltage are compatible with TTL output voltage.

This device may be used as a level converter for interfacing 3.3 V to 5 V system.

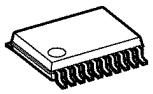
The outputs can be put in the high-impedance state by placing a logic HIGH on the Enable ($\overline{G}$) input. The CONT input determines the logical inversion of data. A logic LOW on the CONT input configures the TC74VHCT9541A as an inverter; a logic HIGH on the CONT input configures the TC74VHCT9541A as a buffer.

All the inputs have hysteresis between the positive-going and negative-going thresholds. Thus the TC74VHCT9541A is capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output (Note) pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, etc.

Note: Output in off-state

TC74VHCT9541AFK



VSSOP20-P-0030-0.50

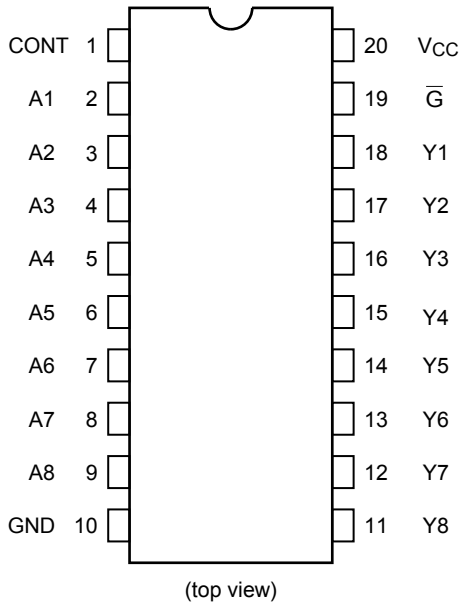
Weight
VSSOP20-P-0030-0.50 : 0.03 g (typ.)

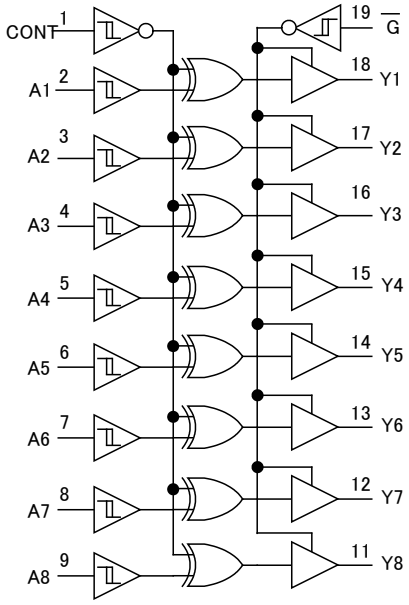
## Features

- High speed: tpd = 6.5ns (typ.) at $V_{CC}$ = 5 V
- Low power dissipation: $I_{CC}$ = 4 μA (max) at Ta = 25°C
- Compatible with TTL inputs
  $V_{IL}$ = 0.5 V (max)
  $V_{IH}$ = 2.1 V (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Input terminals are at the opposite side of Output terminals

Start of commercial production
2010-06

## Pin Assignment




## Truth Table

| Inputs | | | Outputs |
|---|---|---|---|
| $\overline{G}$ | CONT | An | Yn |
| H | X | X | Z |
| L | L | L | H |
| L | L | H | L |
| L | H | L | L |
| L | H | H | H |

X: Don’t care

Z: High impedance

## Absolute Maximum Ratings (Note1)

| Characteristics | Symbol | Rating | | Unit |
|---|---|---|---|---|
| Supply voltage range | $V_{CC}$ | −0.5 to 7.0 | | V |
| DC input voltage | $V_{IN}$ | −0.5 to 7.0 | | V |
| DC output voltage | $V_{OUT}$ | −0.5 to 7.0 | (Note 2) | V |
| | | −0.5 to $V_{CC}$ + 0.5 | (Note 3) | |
| Input diode current | $I_{IK}$ | −20 | | mA |
| Output diode current | $I_{OK}$ | ±20 | (Note 4) | mA |
| DC output current | $I_{OUT}$ | ±25 | | mA |
| DC $V_{CC}$/ground current | $I_{CC}$ | ±75 | | mA |
| Power dissipation | $P_D$ | 180 | | mW |
| Storage temperature | $T_{stg}$ | −65 to 150 | | °C |

Note 1: 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 2: Output in off-state

Note 3: High or low state. $I_{OUT}$ absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

## Operating Ranges (Note1)

| Characteristics | Symbol | Rating | | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 4.5 to 5.5 | | V |
| Input voltage | $V_{IN}$ | 0 to 5.5 | | V |
| Output voltage | $V_{OUT}$ | 0 to 5.5 | (Note 2) | V |
| | | 0 to $V_{CC}$ | (Note 3) | |
| Operating temperature | $T_{opr}$ | −40 to 85 | | °C |

Note 1: 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 2: Output in off-state

Note 3: High or low state.

## Electrical Characteristics

### DC Characteristics

| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 25°C Min | Ta = 25°C Typ | Ta = 25°C Max | Ta = −40 to 85°C Min | Ta = −40 to 85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| Positive threshold voltage | $V_P$ | — | | 4.5 | — | — | 1.90 | — | 1.90 | V |
| | | | | 5.5 | — | — | 2.10 | — | 2.10 | |
| Negative threshold voltage | $V_N$ | — | | 4.5 | 0.50 | — | — | 0.50 | — | V |
| | | | | 5.5 | 0.60 | — | — | 0.60 | — | |
| Hysteresis voltage | $V_H$ | — | | 4.5 | 0.40 | — | 1.40 | 0.40 | 1.40 | V |
| | | | | 5.5 | 0.40 | — | 1.50 | 0.40 | 1.50 | |
| High-level output voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = −50 μA | 4.5 | 4.4 | 4.5 | — | 4.4 | — | V |
| | | | $I_{OH}$ = −8 mA | 4.5 | 3.94 | — | — | 3.80 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 50 μA | 4.5 | — | 0.0 | 0.1 | — | 0.1 | V |
| | | | $I_{OL}$ = 8 mA | 4.5 | — | — | 0.36 | — | 0.44 | |
| 3-state output off-state current | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = $V_{CC}$ or GND | | 5.5 | — | — | ±0.25 | — | ±2.5 | μA |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = 5.5 V or GND | | 0 to 5.5 | — | — | ±0.1 | — | ±1.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 5.5 | — | — | 4.0 | — | 40.0 | μA |
| | $I_{CCT}$ | Per input: $V_{IN}$ = 3.4 V<br>Other input: $V_{CC}$ or GND | | 5.5 | — | — | 1.35 | — | 1.50 | mA |
| Output leakage current (Power-OFF) | $I_{OPD}$ | $V_{OUT}$ = 5.5 V | | 0 | — | — | 0.5 | — | 5.0 | μA |

## AC Characteristics (input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | | | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | $C_L$ (pF) | Min | Typ. | Max | Min | Max | |
| Propagation delay time (An-Yn) | $t_{pLH}$ $t_{pHL}$ | — | 5.0 ± 0.5 | 15 | — | 6.5 | 8.5 | 1.0 | 10.0 | ns |
| | | | | 50 | — | 8.6 | 11.5 | 1.0 | 13.0 | |
| Propagation delay time (CONT-Yn) | $t_{pLH}$ $t_{pHL}$ | — | 5.0 ± 0.5 | 15 | — | 8.2 | 10.5 | 1.0 | 12.0 | ns |
| | | | | 50 | — | 10.8 | 14.5 | 1.0 | 17.0 | |
| 3-state output enable time | $t_{pZL}$ $t_{pZH}$ | $R_L$ = 1 kΩ | 5.0 ± 0.5 | 15 | — | 6.9 | 8.5 | 1.0 | 10.0 | ns |
| | | | | 50 | — | 9.1 | 12.5 | 1.0 | 14.5 | |
| 3-state output disable time | $t_{pLZ}$ $t_{pHZ}$ | $R_L$ = 1 kΩ | 5.0 ± 0.5 | 50 | — | 7.4 | 11.5 | 1.0 | 13.0 | ns |
| Output to output skew | $t_{osHL}$ $t_{osLH}$ | (Note 1) | 5.0 ± 0.5 | 50 | — | — | 1.0 | — | 1.0 | ns |
| Input capacitance | $C_{IN}$ | — | | | — | 4 | 10 | — | 10 | pF |
| Output capacitance | $C_{OUT}$ | — | | | — | 9 | — | — | — | pF |
| Power dissipation capacitance (Note 2) | $C_{PD}$ | $f_{IN}$ = 1 MHz | | | — | 16 | — | — | — | pF |

Note 1: Parameter guaranteed by design.

$t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$

Note 2: $C_{PD}$ 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:

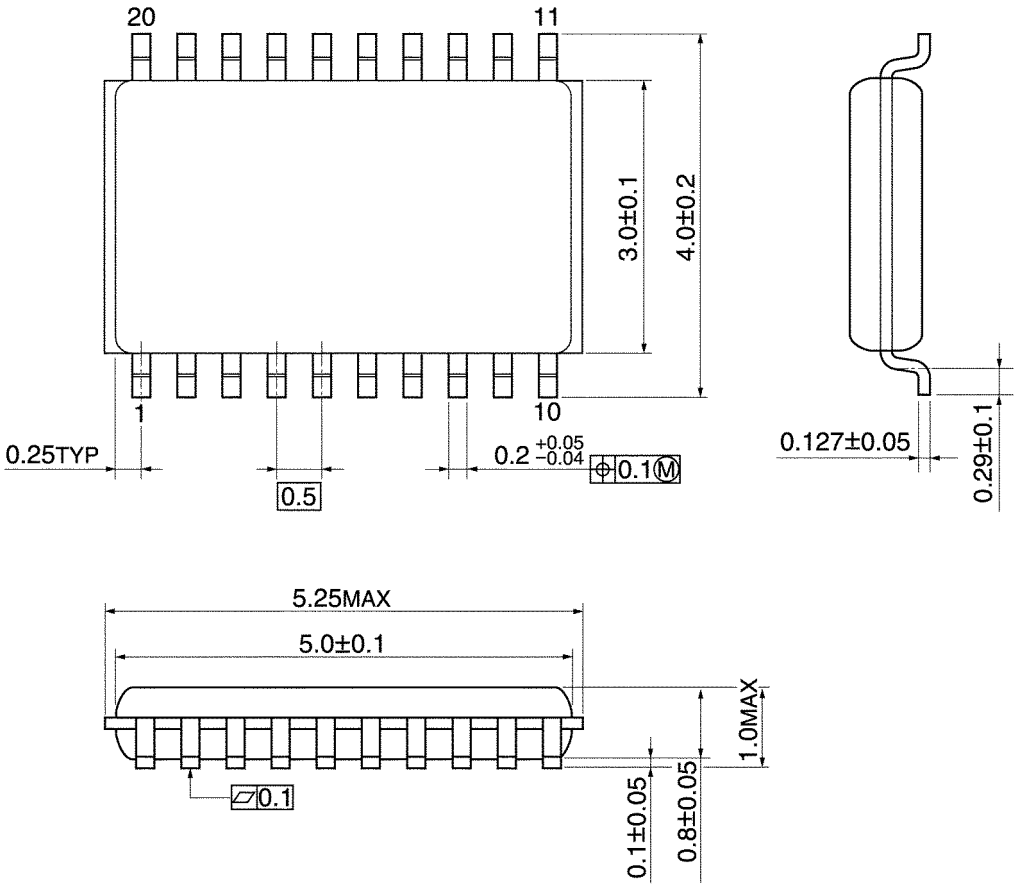
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 8$ (per bit)

## Noise Characteristics (input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | Ta = 25°C | | | Unit |
|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Typ. | Limit | |
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | $C_L$ = 50 pF | 5.0 | 1.0 | 1.5 | V |
| Quiet output minimum dynamic $V_{OL}$ | $V_{OLV}$ | $C_L$ = 50 pF | 5.0 | −0.3 | −1.5 | V |
| Minimum high level dynamic input voltage | $V_{IHD}$ | $C_L$ = 50 pF | 5.0 | — | 2.1 | V |
| Maximum low level dynamic input voltage | $V_{ILD}$ | $C_L$ = 50 pF | 5.0 | — | 0.5 | V |

## Package Dimensions

VSSOP20-P-0030-0.50 Unit: mm




Weight: 0.03 g (typ.)

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