# 74AHC9541A

## Octal buffer/line driver; 3-state

Rev. 2 — 7 September 2023 Product data sheet

## 1. General description

The 74AHC9541A is an 8-bit buffer/line driver with 3-state outputs and Schmitt trigger inputs. The device features an output enable input ($\overline{OE}$) and select input (S). A HIGH on $\overline{OE}$ causes the associated outputs to assume a high-impedance OFF-state. A LOW on the select input S causes the buffer/line driver to act as an inverter.

Inputs are overvoltage tolerant. This feature allows the use of these devices as translators in mixed voltage environments.

The data (An), select (S) and output enable ($\overline{OE}$) inputs include Schmitt trigger inputs, capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

This device is fully specified for partial Power-down applications using $I_{OFF}$. The $I_{OFF}$ circuitry disables the output, preventing the damaging backflow current through the device when it is powered down.

## 2. Features and benefits

- Wide supply voltage range from 1.8 V to 5.5 V
- Typical $t_{pd}$ of 5.1 ns at 5 V
- Typical $V_{OL(p)}$ < 0.8 V at $V_{CC}$ = 3.3 V, $T_{amb}$ = 25 °C
- Typical $V_{OH(v)}$ > 2.3 V at $V_{CC}$ = 3.3 V, $T_{amb}$ = 25 °C
- Supports mixed-mode voltage operation on all ports
- $I_{OFF}$ circuitry provides partial Power-down mode operation
- Latch-up performance exceeds 250 mA per JESD 78 Class II
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 2000 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

## 3. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| 74AHC9541APW | -40 °C to +125 °C | TSSOP20 | plastic thin shrink small outline package; 20 leads; body width 4.4 mm | SOT360-1 |

# 4. Functional diagram

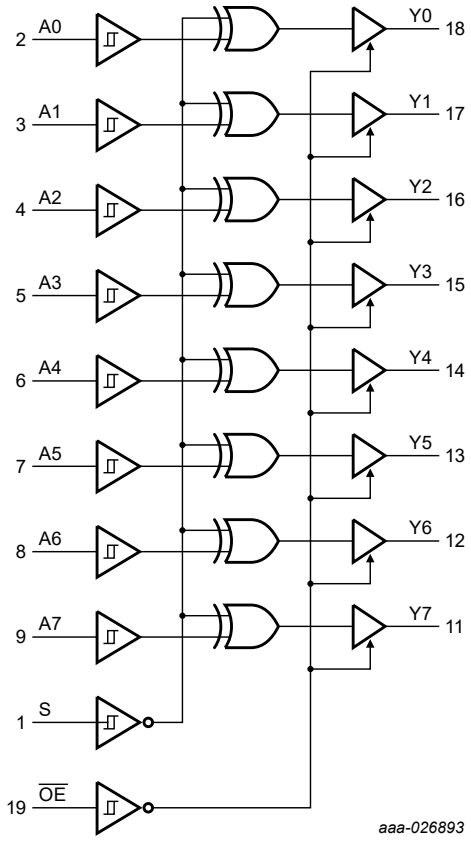
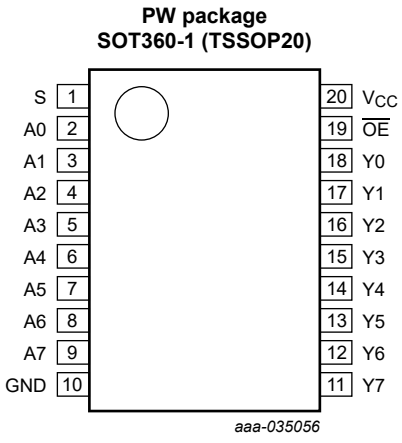



**Fig. 1. Logic symbol**

# 5. Pinning information

## 5.1. Pinning



### 5.2. Pin description

**Table 2. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| S | 1 | select input (active LOW) |
| A0, A1, A2, A3, A4, A5, A6, A7 | 2, 3, 4, 5, 6, 7, 8, 9 | data input |
| GND | 10 | ground (0 V) |
| Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7 | 18, 17, 16, 15, 14, 13, 12, 11 | data output |
| $\overline{OE}$ | 19 | output enable input (active LOW) |
| $V_{CC}$ | 20 | supply voltage |

## 6. Functional description

**Table 3. Functional table**

*H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.*

| Control | | Input | Output |
|---|---|---|---|
| $\overline{OE}$ | S | An | Yn |
| H | X | X | Z |
| L | L | L | H |
| L | L | H | L |
| L | H | L | L |
| L | H | H | H |

## 7. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | | -0.5 | +7.0 | V |
| $V_I$ | input voltage | | [1] | -0.5 | +7.0 | V |
| $V_O$ | output voltage | active mode | [2] [3] | -0.5 | $V_{CC}$ + 0.5 | V |
| | | power-down or 3-state mode | [2] | -0.5 | +7.0 | V |
| $I_{IK}$ | input clamping current | $V_I$ < 0 V | | -50 | - | mA |
| $I_{OK}$ | output clamping current | $V_O$ < 0 V | | -50 | - | mA |
| $I_O$ | output current | $V_O$ = 0 V to $V_{CC}$ | | - | ±50 | mA |
| $I_{CC}$ | supply current | | | - | 100 | mA |
| $I_{GND}$ | ground current | | | -100 | - | mA |
| $T_{stg}$ | storage temperature | | | -65 | +150 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = -40 °C to +125 °C | [4] | - | 500 | mW |

[1] The minimum input voltage ratings may be exceeded if the input current ratings are observed.
[2] The output voltage ratings may be exceeded if the output current ratings are observed.
[3] This value is limited to 7.0 V maximum.
[4] For SOT360-1 (TSSOP20) package: $P_{tot}$ derates linearly with 10.0 mW/K above 100 °C.

# 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

*Voltages are referenced to GND (ground = 0 V).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | 1.8 | 5.5 | V |
| $V_I$ | input voltage | | 0 | 5.5 | V |
| $V_O$ | output voltage | active mode | 0 | $V_{CC}$ | V |
| | | power-down or 3-state mode | 0 | 5.5 | V |
| $T_{amb}$ | ambient temperature | | -40 | +125 | °C |
| Δt/ΔV | input transition rise and fall rate | $V_{CC}$ = 2.3 V to 2.7 V | - | 50 | ms/V |
| | | $V_{CC}$ = 3.0 V to 3.6 V | - | 20 | ms/V |
| | | $V_{CC}$ = 4.5 V to 5.5 V | - | 1 | ms/V |

# 9. Static characteristics

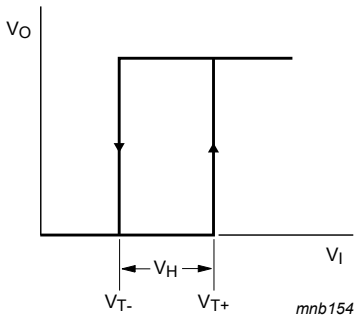
**Table 6. Static characteristics**

*Voltages are referenced to GND (ground = 0 V).*

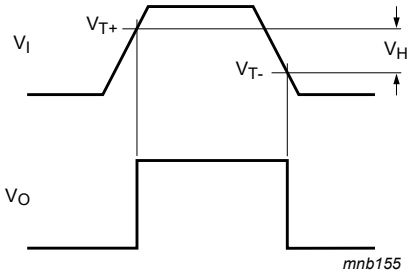
| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| $V_{T+}$ | positive-going threshold voltage | $V_{CC}$ = 1.8 V | - | - | 1.65 | - | 1.65 | - | 1.65 | V |
| | | $V_{CC}$ = 2.3 V | - | - | 1.85 | - | 1.85 | - | 1.85 | V |
| | | $V_{CC}$ = 3.0 V | - | - | 2.2 | - | 2.2 | - | 2.2 | V |
| | | $V_{CC}$ = 4.5 V | - | - | 3.15 | - | 3.15 | - | 3.15 | V |
| | | $V_{CC}$ = 5.5 V | - | - | 3.85 | - | 3.85 | - | 3.85 | V |
| $V_{T-}$ | negative-going threshold voltage | $V_{CC}$ = 1.8 V | 0.15 | - | - | 0.15 | - | 0.15 | - | V |
| | | $V_{CC}$ = 2.3 V | 0.45 | - | - | 0.45 | - | 0.45 | - | V |
| | | $V_{CC}$ = 3.0 V | 0.9 | - | - | 0.9 | - | 0.9 | - | V |
| | | $V_{CC}$ = 4.5 V | 1.35 | - | - | 1.35 | - | 1.35 | - | V |
| | | $V_{CC}$ = 5.5 V | 1.65 | - | - | 1.65 | - | 1.65 | - | V |
| $V_H$ | hysteresis voltage | $V_{CC}$ = 1.8 V | 0.15 | - | 1.05 | 0.15 | 1.05 | 0.15 | 1.05 | V |
| | | $V_{CC}$ = 2.3 V | 0.2 | - | 1.1 | 0.2 | 1.1 | 0.2 | 1.1 | V |
| | | $V_{CC}$ = 3.0 V | 0.3 | - | 1.2 | 0.3 | 1.2 | 0.3 | 1.2 | V |
| | | $V_{CC}$ = 4.5 V | 0.4 | - | 1.4 | 0.4 | 1.4 | 0.4 | 1.4 | V |
| | | $V_{CC}$ = 5.5 V | 0.5 | - | 1.6 | 0.5 | 1.6 | 0.5 | 1.6 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{T+}$ or $V_{T-}$ | | | | | | | | V |
| | | $V_{CC}$ = 1.8 V to 5.5 V; $I_O$ = -50 µA | $V_{CC}$ - 0.1 | $V_{CC}$ | - | $V_{CC}$ - 0.1 | - | $V_{CC}$ - 0.1 | - | V |
| | | $I_O$ = -4 mA; $V_{CC}$ = 3.0 V | 2.58 | - | - | 2.48 | - | 2.40 | - | V |
| | | $I_O$ = -8 mA; $V_{CC}$ = 4.5 V | 3.94 | - | - | 3.80 | - | 3.70 | - | |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{T+}$ or $V_{T-}$ | | | | | | | | |
| | | $V_{CC}$ = 1.8 V to 5.5 V; $I_O$ = 50 µA | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| | | $I_O$ = 4 mA; $V_{CC}$ = 3.0 V | - | - | 0.36 | - | 0.44 | - | 0.55 | V |
| | | $I_O$ = 8 mA; $V_{CC}$ = 4.5 V | - | - | 0.36 | - | 0.44 | - | 0.55 | V |

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| $I_{OZ}$ | OFF-state output current | $V_{CC}$ = 1.8 V to 5.5 V; $V_I = V_{IH}$ or $V_{IL}$; $V_O$ = GND to 5.5 V | - | - | ±0.25 | - | ±2.5 | - | ±2.5 | µA |
| $I_{OFF}$ | power-off leakage current | $V_I$ or $V_O$ = GND to 5.5 V; $V_{CC}$ = 0 V | - | - | 0.5 | - | 5 | - | 5 | µA |
| $I_I$ | input leakage current | $V_I = V_{CC}$ or GND; $V_{CC}$ = 0 V to 5.5 V | - | - | ±0.1 | - | ±1 | - | ±1 | µA |
| $I_{CC}$ | supply current | $V_I = V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 5.5 V | - | - | 2 | - | 20 | - | 20 | µA |

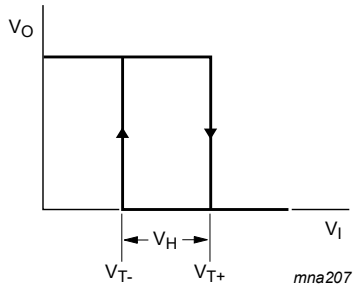
## 9.1. Transfer characteristics waveforms



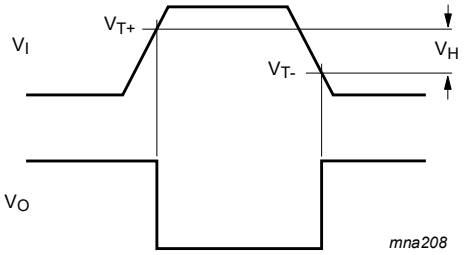

a. Non-inverting transfer characteristic




b. Non-inverting transfer characteristic definition

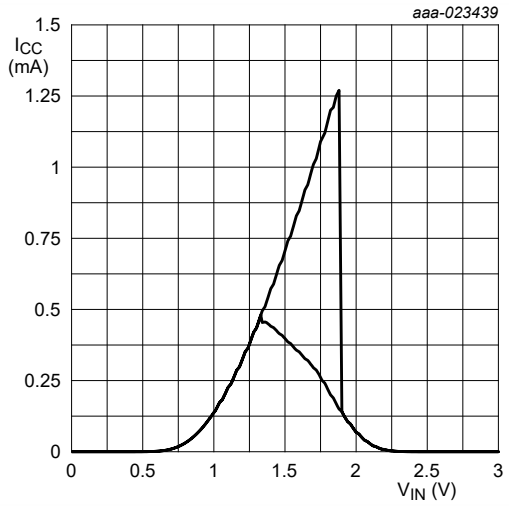



c. Inverting transfer characteristic

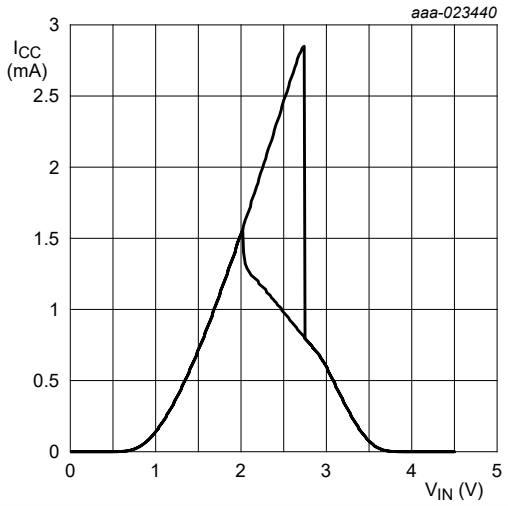



d. Inverting transfer characteristic definition

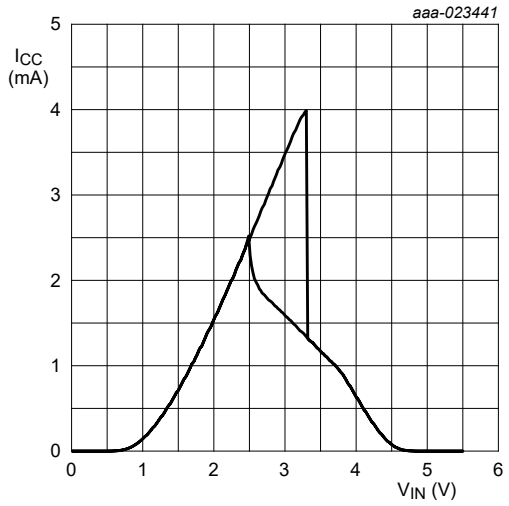
**Fig. 2. Transfer characteristics and definitions**




a. $V_{CC}$ = 3.0 V




b. $V_{CC}$ = 4.5 V




c. $V_{CC}$ = 5.5 V

**Fig. 3. Typical transfer characteristics**

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

*GND = 0 V. For test circuit see Fig. 6.*

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ[1] | Max | Min | Max | Min | Max | |
| $t_{pd}$ | propagation delay | An to Yn; see Fig. 4 [2] | | | | | | | | |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 5.7 | 11 | 1 | 13 | 1 | 15 | ns |
| | | $C_L$ = 50 pF | - | 8.3 | 17 | 1 | 20 | 1 | 22 | ns |
| | | $V_{CC}$ = 3.0 V to 3.6 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 4.4 | 8 | 1 | 10 | 1 | 11.5 | ns |
| | | $C_L$ = 50 pF | - | 6.5 | 12.5 | 1 | 15 | 1 | 17 | ns |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 3.4 | 5.5 | 1 | 7 | 1 | 8 | ns |
| | | $C_L$ = 50 pF | - | 5.1 | 8.5 | 1 | 10 | 1 | 11 | ns |
| | | S to Yn; see Fig. 4 | | | | | | | | |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 6.6 | 17 | 1 | 19 | 1 | 21 | ns |
| | | $C_L$ = 50 pF | - | 9.2 | 24 | 1 | 27 | 1 | 29 | ns |
| | | $V_{CC}$ = 3.0 V to 3.6 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 5.1 | 11.5 | 1 | 13.5 | 1 | 15 | ns |
| | | $C_L$ = 50 pF | - | 7.2 | 17 | 1 | 20.5 | 1 | 23 | ns |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 3.9 | 8 | 1 | 9.5 | 1 | 10.5 | ns |
| | | $C_L$ = 50 pF | - | 5.6 | 12.5 | 1 | 15 | 1 | 17 | ns |
| $t_{en}$ | enable time | $\overline{OE}$ to Yn; see Fig. 5 [2] | | | | | | | | |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 6.2 | 12 | 1 | 14 | 1 | 16 | ns |
| | | $C_L$ = 50 pF | - | 8.9 | 18 | 1 | 20 | 1 | 22 | ns |
| | | $V_{CC}$ = 3.0 V to 3.6 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 4.7 | 8 | 1 | 9.5 | 1 | 10.5 | ns |
| | | $C_L$ = 50 pF | - | 6.8 | 13.5 | 1 | 16.5 | 1 | 18.5 | ns |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 3.6 | 5.5 | 1 | 6.5 | 1 | 7.5 | ns |
| | | $C_L$ = 50 pF | - | 5.3 | 10.5 | 1 | 12.5 | 1 | 14 | ns |

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ[1] | Max | Min | Max | Min | Max | |
| $t_{dis}$ | disable time | $\overline{OE}$ to Yn; see Fig. 5 [2] | | | | | | | | |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 6.3 | 13 | 1 | 16 | 1 | 18 | ns |
| | | $C_L$ = 50 pF | - | 11.1 | 18 | 1 | 21 | 1 | 23 | ns |
| | | $V_{CC}$ = 3.0 V to 3.6 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 5 | 10 | 1 | 12 | 1 | 14 | ns |
| | | $C_L$ = 50 pF | - | 8.6 | 13.5 | 1 | 16 | 1 | 18 | ns |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | | | | | | | |
| | | $C_L$ = 15 pF | - | 3.9 | 7 | 1 | 8 | 1 | 9 | ns |
| | | $C_L$ = 50 pF | - | 6.2 | 9.5 | 1 | 11 | 1 | 12 | ns |
| $t_{sk(o)}$ | skew | $C_L$ = 50 pF | | | | | | | | |
| | | $V_{CC}$ = 2.3 V to 2.7 V | - | - | 2 | - | 2 | - | 2 | ns |
| | | $V_{CC}$ = 3.0 V to 3.6 V | - | - | 1.5 | - | 1.5 | - | 1.5 | ns |
| | | $V_{CC}$ = 4.5 V to 5.5 V | - | - | 1 | - | 1 | - | 1 | ns |
| $C_I$ | input capacitance | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 3.3 V | - | 2 | 6 | - | 6 | - | 6 | pF |
| $C_O$ | output capacitance | $V_O$ = $V_{CC}$ or GND; $V_{CC}$ = 3.3 V | - | 5 | - | - | - | - | - | pF |
| $C_{PD}$ | power dissipation capacitance | per buffer; $C_L$ = 0 pF; f = 10 MHz; $V_{CC}$ = 5 V; $V_I$ = GND to $V_{CC}$ [3] | - | 9 | - | - | - | - | - | pF |

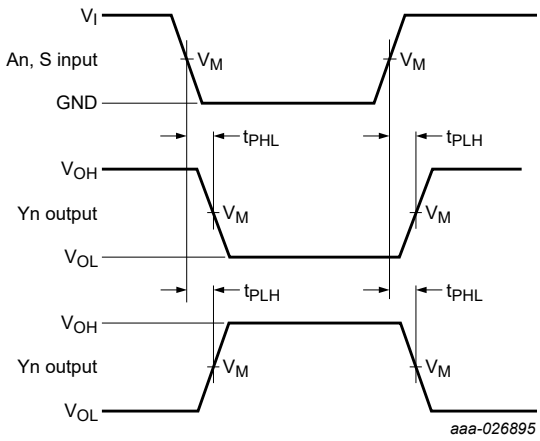
[1] Typical values are measured at $T_{amb}$ = 25 °C and $V_{CC}$ = 2.5 V, 3.3 V, and 5 V respectively, unless otherwise specified.
[2] $t_{pd}$ is the same as $t_{PLH}$ and $t_{PHL}$; $t_{en}$ is the same as $t_{PZL}$ and $t_{PZH}$; $t_{dis}$ is the same as $t_{PLZ}$ and $t_{PHZ}$.
[3] $C_{PD}$ is used to determine the dynamic power dissipation $P_D$ (µW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
$f_i$ = input frequency in MHz;
$f_o$ = output frequency in MHz;
$C_L$ = output load capacitance in pF;
$V_{CC}$ = supply voltage in Volts.

### Table 8. Noise characteristics

*GND = 0 V. For test circuit see Fig. 6.*

| Symbol | Parameter | Conditions | $T_{amb}$ = 25 °C | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| **$V_{CC}$ = 3.3 V; $C_L$ = 50 pF** | | | | | | |
| $V_{OL(p)}$ | LOW-level output voltage (peak) | | - | 0.2 | 0.8 | V |
| $V_{OL(v)}$ | LOW-level output voltage (valley) | | -0.8 | -0.1 | - | V |
| $V_{OH(v)}$ | HIGH-level output voltage (valley) | | - | 3.0 | - | V |
| $V_{IH(AC)}$ | AC HIGH-level input voltage | | 2.31 | - | - | V |
| $V_{IL(AC)}$ | AC LOW-level input voltage | | - | - | 0.99 | V |
| **$V_{CC}$ = 5.0 V; $C_L$ = 50 pF** | | | | | | |
| $V_{OL(p)}$ | LOW-level output voltage (peak) | | - | 0.5 | 1.5 | V |
| $V_{OL(v)}$ | LOW-level output voltage (valley) | | -1.5 | -0.3 | - | V |
| $V_{OH(v)}$ | HIGH-level output voltage (valley) | | - | 4.5 | - | V |
| $V_{IH(AC)}$ | AC HIGH-level input voltage | | 3.5 | - | - | V |
| $V_{IL(AC)}$ | AC LOW-level input voltage | | - | - | 1.5 | V |

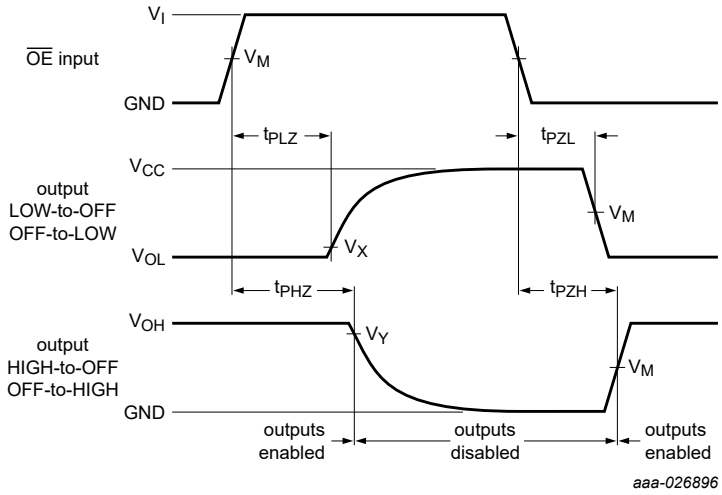
## 10.1. Waveforms and test circuit




Measurement points are given in Table 9.

$V_{OL}$ and $V_{OH}$ are typical voltage output levels that occur with the output load.

**Fig. 4. Propagation delay input (An, S) to output (Yn)**



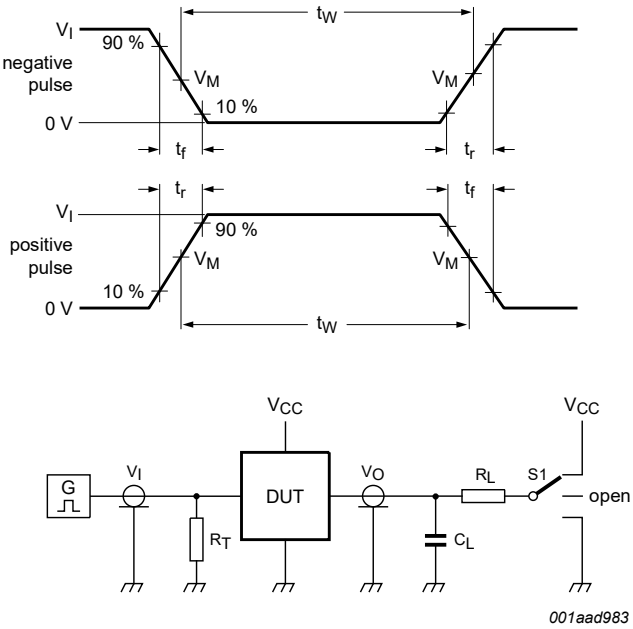

Measurement points are given in Table 9.

$V_{OL}$ and $V_{OH}$ are typical voltage output levels that occur with the output load.

**Fig. 5. Enable and disable times**

**Table 9. Measurement points**

| Input | Output | | |
|---|---|---|---|
| $V_M$ | $V_M$ | $V_X$ | $V_Y$ |
| $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL}$ + 0.3 V | $V_{OH}$ - 0.3 V |




Test data is given in Table 10.

Definitions test circuit:

$R_T$ = Termination resistance should be equal to output impedance $Z_o$ of the pulse generator

$C_L$ = Load capacitance including jig and probe capacitance

$R_L$ = Load resistance

S1 = Test selection switch

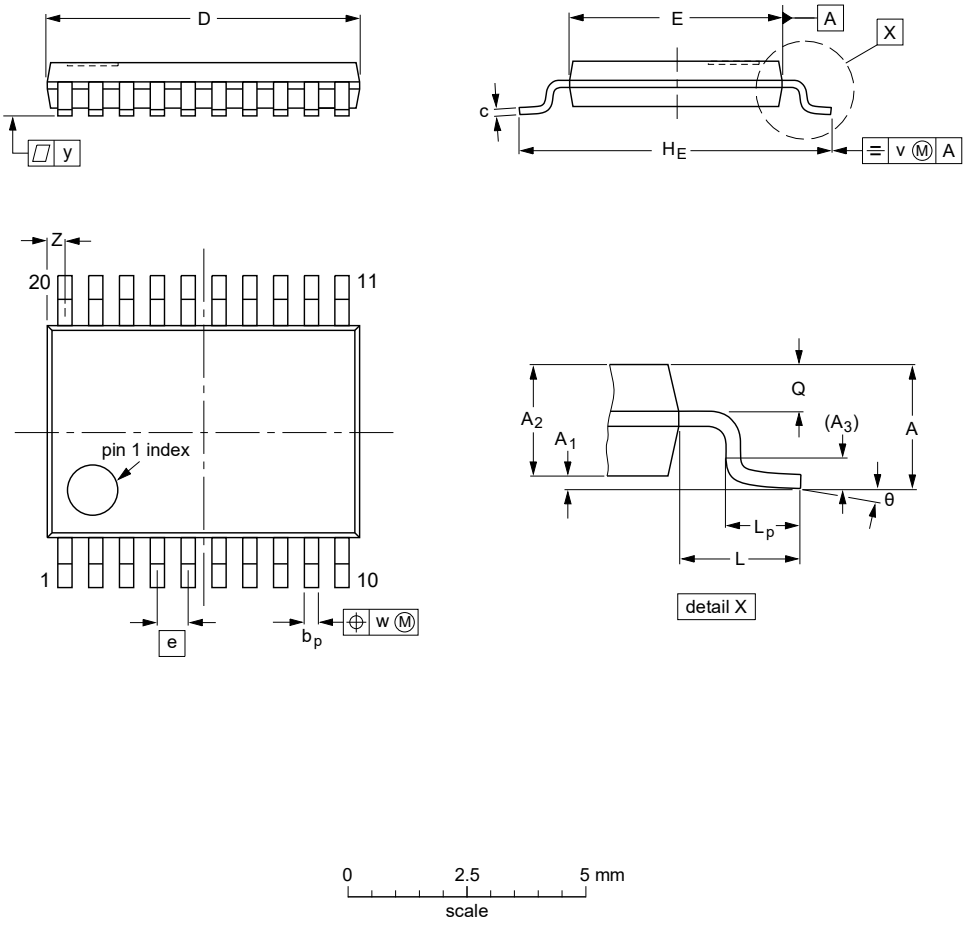
**Fig. 6. Test circuit for measuring switching times**

**Table 10. Test data**

| Input | | Load | | S1 position | | |
|---|---|---|---|---|---|---|
| $V_I$ | $t_r$, $t_f$ | $C_L$ | $R_L$ | $t_{PHL}$, $t_{PLH}$ | $t_{PZH}$, $t_{PHZ}$ | $t_{PZL}$, $t_{PLZ}$ |
| GND to $V_{CC}$ | 3.0 ns | 15 pF, 50 pF | 1 kΩ | open | GND | $V_{CC}$ |

# 11. Package outline

**TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm** **SOT360-1**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | D (1) | E (2) | e | $H_E$ | L | $L_p$ | Q | v | w | y | Z (1) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1 | 0.15<br>0.05 | 0.95<br>0.80 | 0.25 | 0.30<br>0.19 | 0.2<br>0.1 | 6.6<br>6.4 | 4.5<br>4.3 | 0.65 | 6.6<br>6.2 | 1 | 0.75<br>0.50 | 0.4<br>0.3 | 0.2 | 0.13 | 0.1 | 0.5<br>0.2 | 8°<br>0° |

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT360-1 | | MO-153 | | | | ~~99-12-27~~<br>03-02-19 |

**Fig. 7. Package outline SOT360-1 (TSSOP20)**

# 12. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description |
|---|---|
| CDM | Charge Device Model |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |

# 13. Revision history

**Table 12. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| 74AHC9541A v.2 | 20230907 | Product data sheet | - | 74AHC9541A v.1 |
| Modifications: | • Section 2: ESD specification updated according to the latest JEDEC standard. | | | |
| 74AHC9541A v.1 | 20170628 | Product data sheet | - | - |

# 14. Legal information

## Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at https://www.nexperia.com.

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