CMOS Digital Integrated Circuits Silicon Monolithic

# 74VHC9151FT,74VHC9152FT

## 1. Functional Description

74VHC9151FT: 9-BIT SCHMITT BUFFER
74VHC9152FT: 9-BIT SCHMITT INVERTER

## 2. General

The 74VHC9151FT/74VHC9152FT are an ultra-high-speed 9-bit Schmitt Buffer / Inverter fabricated using silicon-gate CMOS technology. The 74VHC9151FT/74VHC9152FT combines low power consumption of CMOS with Schottky TTL speeds.

74VHC9151FT output is a non-inverting type and the 74VHC9152FT output is an inverting type.

All the inputs have hysteresis between the positive-going and negative-going thresholds. Thus the 74VHC9151FT/74VHC9152FT are capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity.

Additionally, all the inputs have a newly developed protection circuit without a diode returned to $V_{CC}$. This enables the inputs to be tolerant of up to 5 volts even when power supply is down.

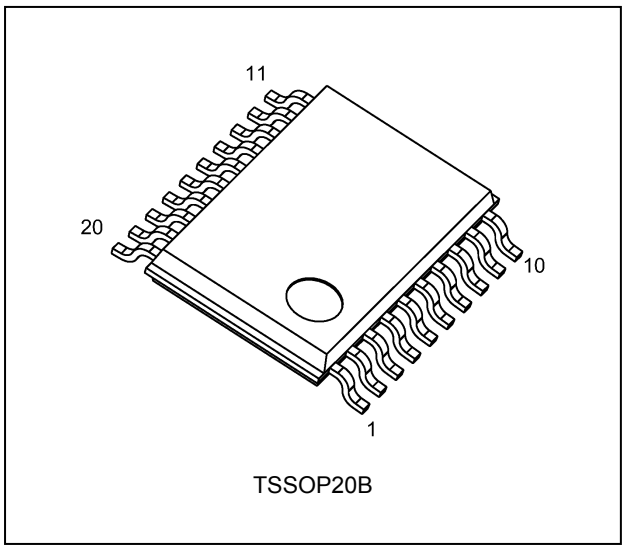
The input power-down protection capability makes the 74VHC9151FT/74VHC9152FT ideal for a wide range of applications, such as interfacing between different voltages, voltage translation from 5 V to 3 V and battery back-up circuits.

## 3. Features

(1) AEC-Q100 (Rev. H) (Note 1)
(2) Wide operating temperature range: $T_{opr}$ = -40 to 125 °C
(3) High speed: $t_{pd}$ = 3.6 ns (typ.) at $V_{CC}$ = 5.0 V
(4) Low power dissipation: $I_{CC}$ = 4.0 μA (max) at $T_a$ = 25 °C
(5) Power down protection is provided on all inputs.
(6) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
(7) Wide operating voltage range: $V_{CC(opr)}$ = 2.0 V to 5.5 V

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

## 4. Packaging

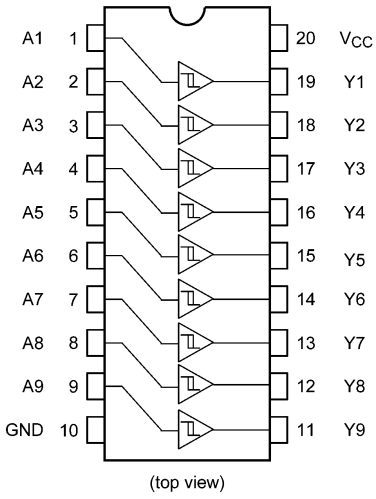



TSSOP20B

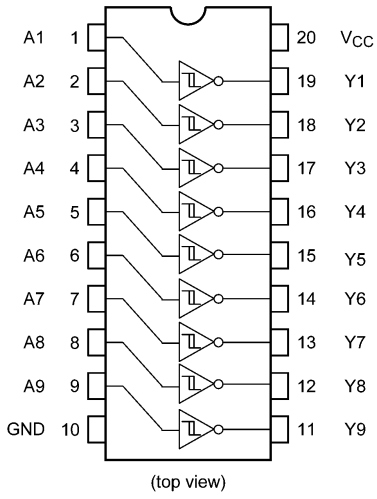
Start of commercial production
2014-06

## 5. Pin Assignment

74VHC9151FT

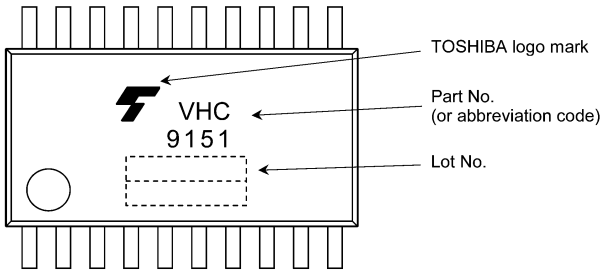



74VHC9152FT

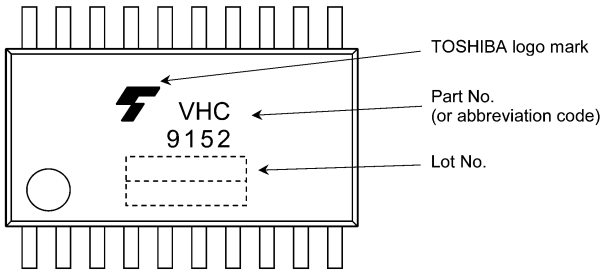



## 6. Marking

74VHC9151FT




74VHC9152FT




## 7. Truth Table

| A | Y<br>74VHC9151FT | Y<br>74VHC9152FT |
|---|---|---|
| L | L | H |
| H | H | L |

## 8. 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 | $I_{CC}$ | | ±75 | 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.

## 9. Operating Ranges (Note)

| Characteristics | Symbol | 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 |

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.

## 10. Electrical Characteristics

### 10.1. DC Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Positive threshold voltage | $V_P$ | — | | 3.0 | — | — | 2.20 | V |
| | | | | 4.5 | — | — | 3.15 | |
| | | | | 5.5 | — | — | 3.85 | |
| Negative threshold voltage | $V_N$ | — | | 3.0 | 0.90 | — | — | V |
| | | | | 4.5 | 1.35 | — | — | |
| | | | | 5.5 | 1.65 | — | — | |
| Hysteresis voltage | $V_H$ | — | | 3.0 | 0.30 | — | 1.20 | V |
| | | | | 4.5 | 0.40 | — | 1.40 | |
| | | | | 5.5 | 0.50 | — | 1.60 | |
| High-level output voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -50 μA | 2.0 | 1.9 | 2.0 | — | V |
| | | | | 3.0 | 2.9 | 3.0 | — | |
| | | | | 4.5 | 4.4 | 4.5 | — | |
| | | | $I_{OH}$ = -4 mA | 3.0 | 2.58 | — | — | |
| | | | $I_{OH}$ = -8 mA | 4.5 | 3.94 | — | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 50 μA | 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 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 5.5 | — | — | 4.0 | μA |

### 10.2. DC Characteristics (Unless otherwise specified, $T_a$ = -40 to 85 °C)

| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Positive threshold voltage | $V_P$ | — | | 3.0 | — | 2.20 | V |
| | | | | 4.5 | — | 3.15 | |
| | | | | 5.5 | — | 3.85 | |
| Negative threshold voltage | $V_N$ | — | | 3.0 | 0.90 | — | V |
| | | | | 4.5 | 1.35 | — | |
| | | | | 5.5 | 1.65 | — | |
| Hysteresis voltage | $V_H$ | — | | 3.0 | 0.30 | 1.20 | V |
| | | | | 4.5 | 0.40 | 1.40 | |
| | | | | 5.5 | 0.50 | 1.60 | |
| High-level output voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -50 μA | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | | $I_{OH}$ = -4 mA | 3.0 | 2.48 | — | |
| | | | $I_{OH}$ = -8 mA | 4.5 | 3.80 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 50 μA | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL}$ = 4 mA | 3.0 | — | 0.44 | |
| | | | $I_{OL}$ = 8 mA | 4.5 | — | 0.44 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = 5.5 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 |

## 10.3. DC Characteristics (Unless otherwise specified, $T_a$ = -40 to 125 °C)

| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| Positive threshold voltage | $V_P$ | — | | 3.0 | — | 2.20 | V |
| | | | | 4.5 | — | 3.15 | |
| | | | | 5.5 | — | 3.85 | |
| Negative threshold voltage | $V_N$ | — | | 3.0 | 0.90 | — | V |
| | | | | 4.5 | 1.35 | — | |
| | | | | 5.5 | 1.65 | — | |
| Hysteresis voltage | $V_H$ | — | | 3.0 | 0.30 | 1.20 | V |
| | | | | 4.5 | 0.40 | 1.40 | |
| | | | | 5.5 | 0.50 | 1.60 | |
| High-level output voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -50 μA | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | | $I_{OH}$ = -4 mA | 3.0 | 2.40 | — | |
| | | | $I_{OH}$ = -8 mA | 4.5 | 3.70 | — | |
| Low-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 50 μA | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL}$ = 4 mA | 3.0 | — | 0.55 | |
| | | | $I_{OL}$ = 8 mA | 4.5 | — | 0.55 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = 5.5 V or GND | | 0 to 5.5 | — | ±2.0 | μA |
| Quiescent supply current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 5.5 | — | 80.0 | μA |

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

| Characteristics | Part Number | Symbol | Note | Test Condition | $V_{CC}$ (V) | $C_L$ (pF) | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| Propagation delay time | 74VHC9151FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | — | 4.8 | 9.4 | ns |
| | | | | | | 50 | — | 8.1 | 16.1 | |
| | | | | | 5.0 ± 0.5 | 15 | — | 3.3 | 6.0 | |
| | | | | | | 50 | — | 5.7 | 10.5 | |
| Propagation delay time | 74VHC9152FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | — | 4.8 | 9.3 | ns |
| | | | | | | 50 | — | 7.8 | 15.4 | |
| | | | | | 5.0 ± 0.5 | 15 | — | 3.6 | 6.3 | |
| | | | | | | 50 | — | 5.7 | 10.2 | |
| Output skew | | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 3.3 ± 0.3 | 50 | — | — | 1.5 | ns |
| | | | | | 5.0 ± 0.5 | 50 | — | — | 1.0 | |
| Input capacitance | | $C_{IN}$ | | — | | | — | 4 | 10 | pF |
| Power dissipation capacitance | 74VHC9151FT | $C_{PD}$ | (Note 2) | $f_{IN}$ = 1 MHz | | | — | 11 | — | pF |
| | 74VHC9152FT | | | | | | — | 10 | — | |

Note 1: Parameter guaranteed by design. ($t_{osLH}$ = $|t_{PLH}m-t_{PLH}n|$, $t_{osHL}$ = $|t_{PHL}m-t_{PHL}n|$)

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.

$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/9$ (per bit)

### 10.5. AC Characteristics
**(Unless otherwise specified, $T_a$ = -40 to 85 °C, Input: $t_r = t_f$ = 3 ns)**

| Characteristics | Part Number | Symbol | Note | Test Condition | $V_{CC}$ (V) | $C_L$ (pF) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Propagation delay time | 74VHC9151FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | 1.0 | 10.7 | ns |
| | | | | | | 50 | 1.0 | 18.4 | |
| | | | | | 5.0 ± 0.5 | 15 | 1.0 | 6.8 | |
| | | | | | | 50 | 1.0 | 11.9 | |
| Propagation delay time | 74VHC9152FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | 1.0 | 10.6 | ns |
| | | | | | | 50 | 1.0 | 17.6 | |
| | | | | | 5.0 ± 0.5 | 15 | 1.0 | 7.1 | |
| | | | | | | 50 | 1.0 | 11.6 | |
| Output skew | | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 3.3 ± 0.3 | 50 | — | 1.5 | ns |
| | | | | | 5.0 ± 0.5 | 50 | — | 1.0 | |
| Input capacitance | | $C_{IN}$ | | — | | | — | 10 | pF |

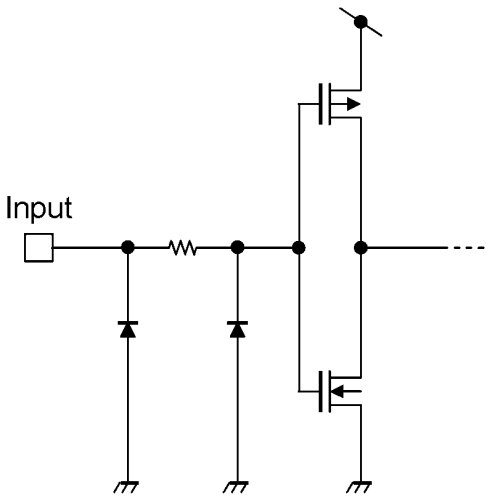
Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLH}m - t_{PLH}n|$, $t_{osHL} = |t_{PHL}m - t_{PHL}n|$)

### 10.6. AC Characteristics
**(Unless otherwise specified, $T_a$ = -40 to 125 °C, Input: $t_r = t_f$ = 3 ns)**

| Characteristics | Part Number | Symbol | Note | Test Condition | $V_{CC}$ (V) | $C_L$ (pF) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Propagation delay time | 74VHC9151FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | 1.0 | 12.0 | ns |
| | | | | | | 50 | 1.0 | 20.0 | |
| | | | | | 5.0 ± 0.5 | 15 | 1.0 | 7.5 | |
| | | | | | | 50 | 1.0 | 13.0 | |
| Propagation delay time | 74VHC9152FT | $t_{PLH}$,$t_{PHL}$ | | — | 3.3 ± 0.3 | 15 | 1.0 | 11.5 | ns |
| | | | | | | 50 | 1.0 | 19.5 | |
| | | | | | 5.0 ± 0.5 | 15 | 1.0 | 8.0 | |
| | | | | | | 50 | 1.0 | 13.0 | |
| Output skew | | $t_{osLH}$,$t_{osHL}$ | (Note 1) | — | 3.3 ± 0.3 | 50 | — | 1.5 | ns |
| | | | | | 5.0 ± 0.5 | 50 | — | 1.0 | |
| Input capacitance | | $C_{IN}$ | | — | | | — | 10 | pF |

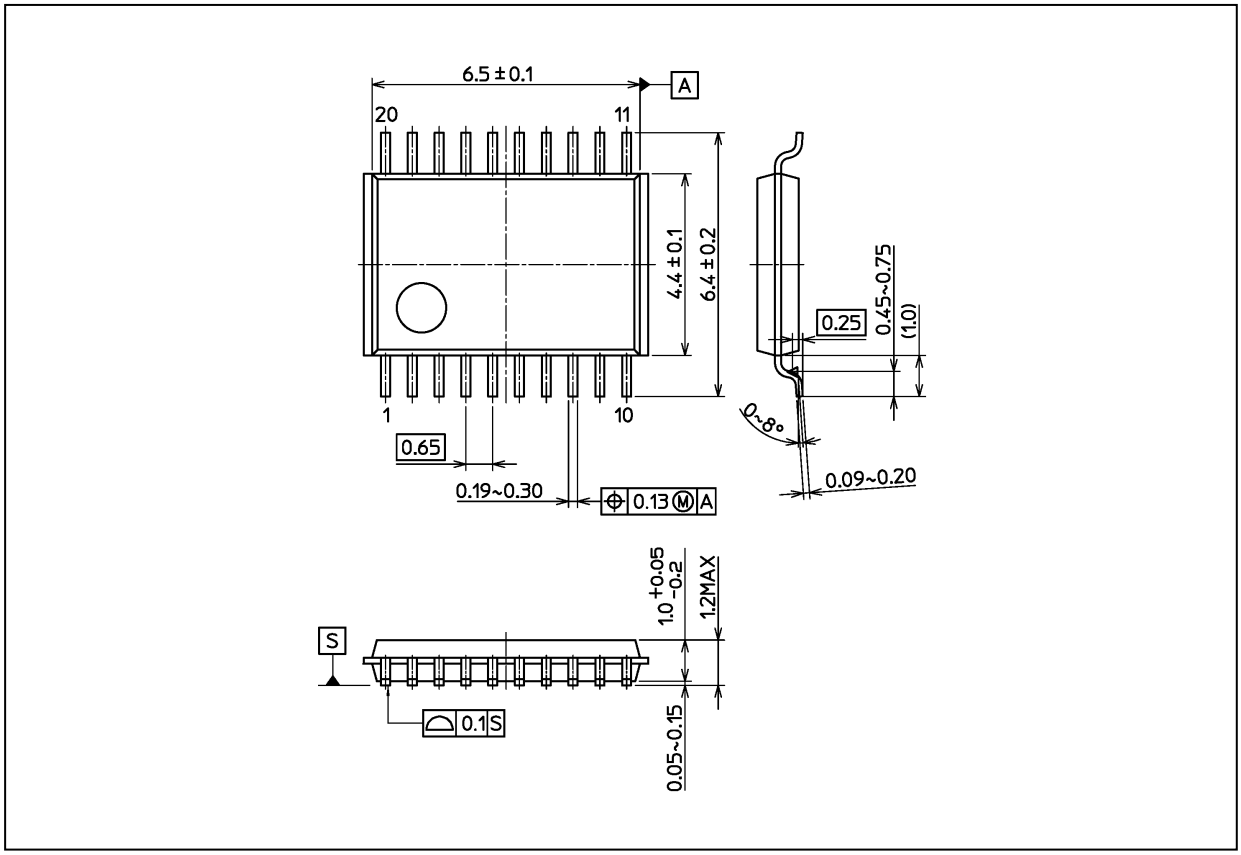
Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLH}m - t_{PLH}n|$, $t_{osHL} = |t_{PHL}m - t_{PHL}n|$)

## 11. Internal Equivalent Circuit



## Package Dimensions

Unit: mm




Weight: 0.071 g (typ.)

| Package Name(s) |
| --- |
| Nickname: TSSOP20B |

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