

CMOS Digital Integrated Circuits Silicon Monolithic

74VHC9541FT

1. Functional Description

· Octal Universal Schmitt Buffer with 3-State Outputs

2. General

The 74VHC9541FT is an ultra-high-speed octal Schmitt buffer fabricated using silicon-gate CMOS technology. The 74VHC9541FT combines low power consumption of CMOS with Schottky TTL speeds.

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 74VHC9541FT as an inverter; a logic HIGH on the CONT input configures the 74VHC9541FT as a buffer.

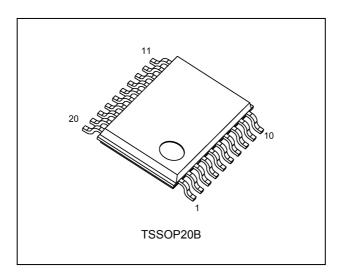
All the inputs have hysteresis between the positive-going and negative-going thresholds. Thus the 74VHC9541FT is capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity. Additionally, all the inputs have a newly developed protection circuit without 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 74VHC9541FT 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: tpd = 5.0 ns (typ.) at $V_{CC} = 5.0 \text{ V}$
- (4) Low supply current: I_{CC} = 4.0 μA (max) (T_a = 25 $^{\circ}$ C)
- (5) All inputs are provided with power-down protection.
- (6) Symmetrical rise and fall delays: t_{PLH} ≈ t_{PHL}
- (7) Wide operating voltage range: $V_{CC(opr)} = 2.0 \text{ V}$ to 5.5 V

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

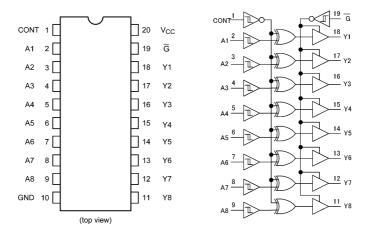
4. Packaging



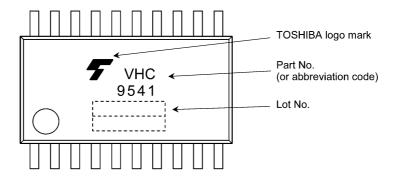
Start of commercial production



5. Pin Assignment



6. Marking



7. Truth Table

Input G	Input CONT	Input An	Output Yn
Н	Х	Х	Z
L	L	L	Н
L	L	Н	L
L	Н	L	L
L	Н	Н	Н

X: Don't care

Z: High impedance

Rev.4.0



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	Тур.	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	1
3-state output OFF-state leakage current	I _{OZ}	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = V_{CC} \text{ or GND}$		5.5	_	-	±0.25	μА
Input leakage current	I _{IN}	V _{IN} = 5.5 V or GND		0 to 5.5	_	_	±0.1	μА
Quiescent supply current	Icc	V _{IN} = V _{CC} or GND		5.5	_	_	4.0	μА



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	
3-state output OFF-state leakage current	I _{OZ}	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = V_{CC} \text{ or GND}$		5.5	_	±2.50	μА
Input leakage current	I _{IN}	V _{IN} = 5.5 V or GND		0 to 5.5	_	±1.0	μА
Quiescent supply current	I _{CC}	$V_{IN} = V_{CC}$ or GND		5.5	-	40.0	μА



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

Characteristics	Symbol	Test Condition	1	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		\ \
				4.5	1.35	_	
				5.5	1.65	_	
Hysteresis voltage	V _H	_		3.0	0.30	1.20	\ \
				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	
3-state output OFF-state leakage current	I _{OZ}	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = V_{CC} \text{ or GND}$		5.5	_	±10.0	μА
Input leakage current	I _{IN}	V _{IN} = 5.5 V or GND			_	±2.0	μА
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND		5.5		80.0	μА



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

Characteristics	Symbol	Note	Test Condition	V _{CC} (V)	C _L (pF)	Min	Тур.	Max	Unit
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	_	6.0	8.0	ns
(An - Yn)					50		9.0	12.5	
				5.0 ± 0.5	15		5.0	5.5	
					50	_	7.0	8.5	
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	_	8.5	11.5	ns
(CONT - Yn)					50	_	13.0	17.0	
				5.0 ± 0.5	15	_	6.5	8.0	
					50	_	10.5	12.5	
3-state output enable time	t _{PZL} ,t _{PZH}		$R_L = 1 k\Omega$	3.3 ± 0.3	15	_	6.0	8.0	ns
					50	_	10.5	13.5	
				5.0 ± 0.5	15	_	4.5	5.5	
					50	_	9.0	10.5	
3-state output disable time	t_{PLZ}, t_{PHZ}		$R_L = 1 k\Omega$	3.3 ± 0.3	50	_	12.5	13.5	ns
				5.0 ± 0.5	50	_	9.0	9.5	
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
Output capacitance	C _{OUT}						6		pF
Power dissipation capacitance	C _{PD}	(Note 2)	f _{IN} = 1 MHz			_	11	_	pF

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. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{|N} + I_{CC}/8 \text{ (per bit)}$

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

Characteristics	Symbol	Note	Test Condition	V _{CC} (V)	C _L (pF)	Min	Max	Unit
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	1.0	10.0	ns
(An - Yn)					50	1.0	15.0	
				5.0 ± 0.5	15	1.0	7.0	
					50	1.0	10.0	
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	1.0	13.5	ns
(CONT - Yn)					50	1.0	20.5	
				5.0 ± 0.5	15	1.0	9.5	
					50	1.0	15.0	
3-state output enable time	t _{PZL} ,t _{PZH}		$R_L = 1 k\Omega$	3.3 ± 0.3	15	1.0	9.5	ns
					50	1.0	16.5	
				5.0 ± 0.5	15	1.0	6.5	
					50	1.0	12.5	
3-state output disable time	t_{PLZ}, t_{PHZ}		$R_L = 1 k\Omega$	3.3 ± 0.3	50	1.0	16.0	ns
				5.0 ± 0.5	50	1.0	11.0	
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. $(t_{osLH} = |t_{PLH}m-t_{PLH}n|, t_{osHL} = |t_{PHL}m-t_{PHL}n|)$

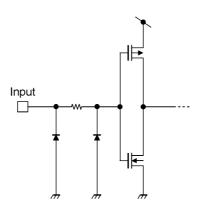


10.6. AC Characteristics (Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Note	Test Condition	V _{CC} (V)	C _L (pF)	Min	Max	Unit
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	1.0	11.5	ns
(An - Yn)					50	1.0	17.0	
				5.0 ± 0.5	15	1.0	8.0	
					50	1.0	11.0	
Propagation delay time	t _{PLH} ,t _{PHL}		_	3.3 ± 0.3	15	1.0	15.0	ns
(CONT - Yn)					50	1.0	23.0	
				5.0 ± 0.5	15	1.0	10.5	
					50	1.0	17.0	
3-state output enable time	t_{PZL}, t_{PZH}		$R_L = 1 k\Omega$	3.3 ± 0.3	15	1.0	10.5	ns
					50	1.0	18.5	
				5.0 ± 0.5	15	1.0	7.5	
					50	1.0	14.0	
3-state output disable time	t_{PLZ}, t_{PHZ}		$R_L = 1 k\Omega$	3.3 ± 0.3	50	1.0	18.0	ns
				5.0 ± 0.5	50	1.0	12.0	
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. ($t_{OSLH} = |t_{PLH}m - t_{PLH}n|$, $t_{OSHL} = |t_{PHL}m - t_{PHL}n|$)

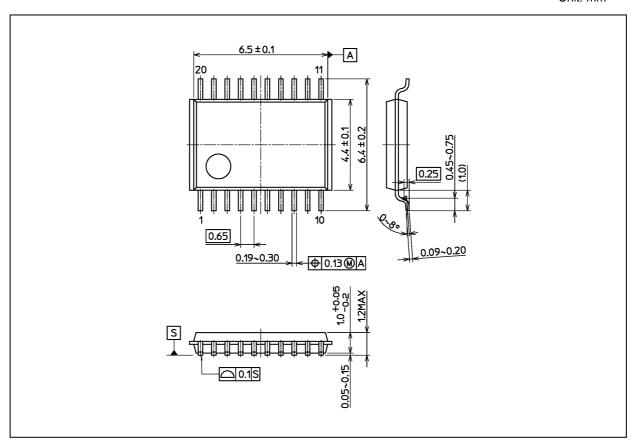
11. Internal Equivalent Circuit





Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

	Package Name(s)
Nickname: TSSOP20B	



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