

# 74VHCV540FT, 74VHCV541FT

## 1. Functional Description

- Octal Schmitt Bus Buffer
- 74VHCV540FT: Inverted, 3-State Outputs  
74VHCV541FT: Non-Inverted, 3-State Outputs

## 2. General

The 74VHCV540FT and 74VHCV541FT are advanced high speed CMOS OCTAL BUS BUFFERS fabricated with silicon gate CMOS technology.

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

The 74VHCV540FT is an inverting type, and the 74VHCV541FT is a non-inverting type.

When either  $\overline{G1}$  or  $\overline{G2}$  are high, the terminal outputs are in the high-impedance state.

Input pin have hysteresis between the positive-going and negative-going thresholds. Thus the 74VHCV540FT and 74VHCV541FT are capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity.

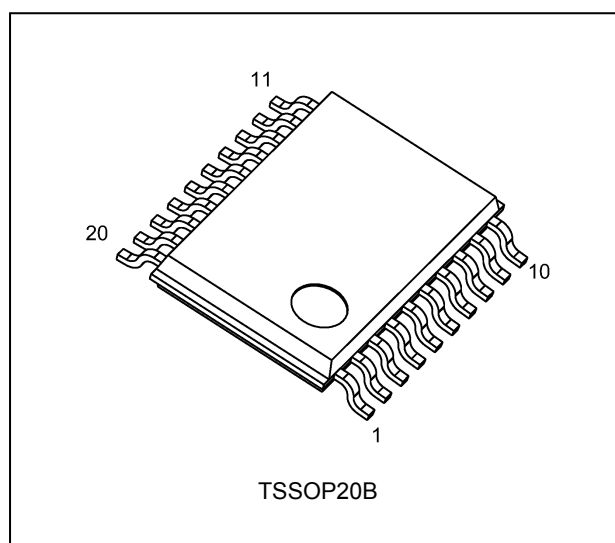
Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output (Note) pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

Note: Output in off-state

## 3. Features

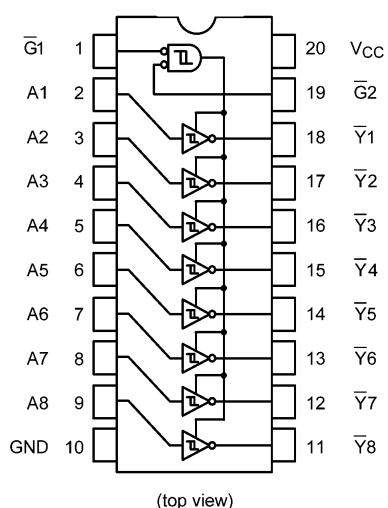
- (1) AEC-Q100 (Rev. H) (Note 1)
  - (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125^{\circ}\text{C}$
  - (3) High speed:  $t_{pd} = 4.1$  ns (typ.) at  $V_{CC} = 5.0$  V
  - (4) Low power dissipation:  $I_{CC} = 2.0$   $\mu\text{A}$  (max) at  $T_a = 25^{\circ}\text{C}$
  - (5) Wide operating voltage range:  $V_{CC(opr)} = 1.8$  V to  $5.5$  V
  - (6) Output current:  $|I_{OH}|/I_{OL} = 16$  mA (min) ( $V_{CC} = 4.5$  V)
  - (7) Power-down protection provided on all inputs and outputs.
  - (8) Pin and function compatible with the 74 series (74AC/HC/AHC/LV etc.) 540 or 541 type.
- Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

## 4. Packaging

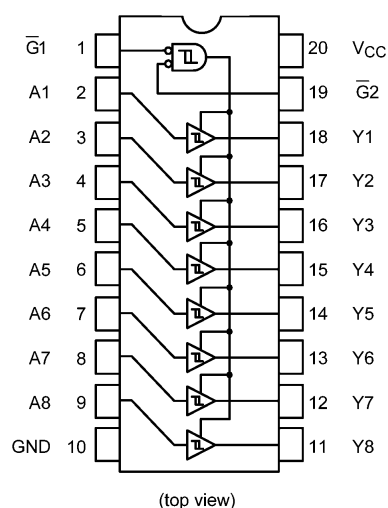


## 5. Pin Assignment

74VHCV540FT

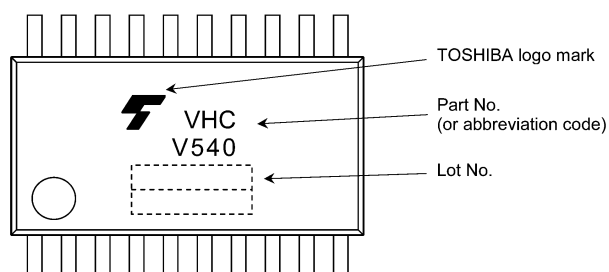


74VHCV541FT

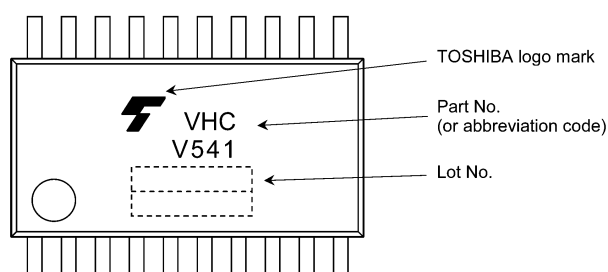


## 6. Marking

74VHCV540FT



74VHCV541FT



## 7. Truth Table

Input $\bar{G}1$	Input $\bar{G}2$	Inputs $A_n$	Outputs $Y_n$	Outputs $\bar{Y}_n$
H	X	X	Z	Z
X	H	X	Z	Z
L	L	H	H	L
L	L	L	L	H

X: Don't care

Z: High impedance

 $Y_n$ : 74VHCV541FT $\bar{Y}_n$ : 74VHCV540FT

## 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	$V_{OUT}$	(Note 1)	-0.5 to 7.0	V
		(Note 2)	-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		-50	mA
Output diode current	$I_{OK}$	(Note 3)	$\pm 50$	mA
Output current	$I_{OUT}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 4)	180	mW
$V_{CC}$ /ground current	$I_{CC}/I_{GND}$		$\pm 100$	mA
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: Output in OFF state.

Note 2: High (H) or Low (L) state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

Note 4: 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	Test Condition	Note	Rating	Unit
Supply voltage	$V_{CC}$			1.8 to 5.5	V
Input voltage	$V_{IN}$			0 to 5.5	V
Output voltage	$V_{OUT}$		(Note 1)	0 to 5.5	V
			(Note 2)	0 to $V_{CC}$	
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 20	ms/V
		$V_{CC} = 5.0 \pm 0.5$ V		0 to 1	

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.

Note 1: Output in OFF state.

Note 2: High (H) or Low (L) state.

## 10. Electrical Characteristics

### 10.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$ )

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Typ.	Max	Unit
Positive threshold voltage	$V_P$	—		1.8	—	—	1.65	V
				2.3	—	—	1.85	
				3.0	—	—	2.20	
				4.5	—	—	3.15	
				5.5	—	—	3.85	
Negative threshold voltage	$V_N$	—		1.8	0.15	—	—	V
				2.3	0.45	—	—	
				3.0	0.90	—	—	
				4.5	1.35	—	—	
				5.5	1.65	—	—	
Hysteresis voltage	$V_H$	—		1.8	0.15	—	1.05	V
				2.3	0.20	—	1.10	
				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 $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	1.8	1.7	1.8	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			$I_{OH} = -8\text{ mA}$	3.0	2.58	—	—	
			$I_{OH} = -16\text{ mA}$	4.5	3.94	—	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	1.8	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 8\text{ mA}$	3.0	—	—	0.36	
			$I_{OL} = 16\text{ mA}$	4.5	—	—	0.44	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5\text{ V}$		1.8 to 5.5	—	—	$\pm 0.5$	$\mu\text{A}$
Power-OFF leakage current	$I_{OFF}$	$V_{IN} / V_{OUT} = 5.5\text{ V}$		0	—	—	0.5	$\mu\text{A}$
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	—	2.0	$\mu\text{A}$

**10.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85\text{ }^\circ\text{C}$ )**

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
Positive threshold voltage	$V_P$	—		1.8	—	1.65	V
				2.3	—	1.85	
				3.0	—	2.20	
				4.5	—	3.15	
				5.5	—	3.85	
Negative threshold voltage	$V_N$	—		1.8	0.15	—	V
				2.3	0.45	—	
				3.0	0.90	—	
				4.5	1.35	—	
				5.5	1.65	—	
Hysteresis voltage	$V_H$	—		1.8	0.15	1.05	V
				2.3	0.20	1.10	
				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 $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	1.8	1.7	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -8\text{ mA}$	3.0	2.48	—	
			$I_{OH} = -16\text{ mA}$	4.5	3.80	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	1.8	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 8\text{ mA}$	3.0	—	0.44	
			$I_{OL} = 16\text{ mA}$	4.5	—	0.55	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5\text{ V}$		1.8 to 5.5	—	$\pm 5.0$	$\mu\text{A}$
Power-OFF leakage current	$I_{OFF}$	$V_{IN} / V_{OUT} = 5.5\text{ V}$		0	—	5.0	$\mu\text{A}$
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	20.0	$\mu\text{A}$

**10.3. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ )**

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
Positive threshold voltage	$V_P$	—		1.8	—	1.65	V
				2.3	—	1.85	
				3.0	—	2.20	
				4.5	—	3.15	
				5.5	—	3.85	
Negative threshold voltage	$V_N$	—		1.8	0.15	—	V
				2.3	0.45	—	
				3.0	0.90	—	
				4.5	1.35	—	
				5.5	1.65	—	
Hysteresis voltage	$V_H$	—		1.8	0.15	1.05	V
				2.3	0.20	1.10	
				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 $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	1.8	1.7	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -8\text{ mA}$	3.0	2.40	—	
			$I_{OH} = -16\text{ mA}$	4.5	3.70	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	1.8	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 8\text{ mA}$	3.0	—	0.55	
			$I_{OL} = 16\text{ mA}$	4.5	—	0.65	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $5.5\text{ V}$		1.8 to 5.5	—	$\pm 20.0$	$\mu\text{A}$
Power-OFF leakage current	$I_{OFF}$	$V_{IN} / V_{OUT} = 5.5\text{ V}$		0	—	20.0	$\mu\text{A}$
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	$\pm 2.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	40.0	$\mu\text{A}$

10.4. AC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Part Number	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time	74VHCV540FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	—	6.3	12.0	ns
						50	—	8.8	16.8	
					$3.3 \pm 0.3$	15	—	5.2	7.0	
						50	—	7.0	10.5	
					$5.0 \pm 0.5$	15	—	4.1	5.0	
						50	—	5.6	7.0	
Propagation delay time	74VHCV541FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	—	6.2	11.3	ns
						50	—	8.8	15.9	
					$3.3 \pm 0.3$	15	—	5.0	7.0	
						50	—	6.9	10.5	
					$5.0 \pm 0.5$	15	—	3.9	5.0	
						50	—	5.3	7.0	
3-state output enable time		$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	15	—	7.9	17.4	ns
						50	—	10.4	22.2	
					$3.3 \pm 0.3$	15	—	6.4	10.5	
						50	—	8.2	14.0	
					$5.0 \pm 0.5$	15	—	4.9	7.2	
						50	—	6.3	9.2	
3-state output disable time		$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	50	—	13.3	22.3	ns
					$3.3 \pm 0.3$	50	—	11.4	15.4	
					$5.0 \pm 0.5$	50	—	8.9	10.5	
Output skew		$t_{osLH}, t_{osHL}$	(Note 1)	—	$2.5 \pm 0.2$	50	—	—	2.0	ns
					$3.3 \pm 0.3$	50	—	—	1.5	
					$5.0 \pm 0.5$	50	—	—	1.0	
Input capacitance		$C_{IN}$		—			—	4	10	pF
Output capacitance		$C_{OUT}$		—			—	6	—	pF
Power dissipation capacitance	74VHCV540FT	$C_{PD}$	(Note 2)	—			—	28	—	pF
	74VHCV541FT			—			—	29	—	

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.

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

**10.5. AC Characteristics**

(Unless otherwise specified,  $T_a = -40$  to  $85\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Part Number	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	74VHCV540FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	1.0	14.5	ns
						50	1.0	18.5	
					$3.3 \pm 0.3$	15	1.0	8.5	
						50	1.0	12.0	
					$5.0 \pm 0.5$	15	1.0	6.0	
						50	1.0	8.0	
Propagation delay time	74VHCV541FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	1.0	13.5	ns
						50	1.0	18.5	
					$3.3 \pm 0.3$	15	1.0	8.5	
						50	1.0	12.0	
					$5.0 \pm 0.5$	15	1.0	6.0	
						50	1.0	8.0	
3-state output enable time		$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	15	1.0	21.0	ns
						50	1.0	25.5	
					$3.3 \pm 0.3$	15	1.0	12.5	
						50	1.0	16.0	
					$5.0 \pm 0.5$	15	1.0	8.5	
						50	1.0	10.5	
3-state output disable time		$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	50	1.0	25.5	ns
					$3.3 \pm 0.3$	50	1.0	17.5	
					$5.0 \pm 0.5$	50	1.0	11.5	
Output skew		$t_{oS LH}, t_{oS HL}$	(Note 1)	—	$2.5 \pm 0.2$	50	—	2.0	ns
					$3.3 \pm 0.3$	50	—	1.5	
					$5.0 \pm 0.5$	50	—	1.0	
Input capacitance		$C_{IN}$		—			—	10	pF

Note 1: Parameter guaranteed by design. ( $t_{oS LH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{oS HL} = |t_{PHLm} - t_{PHLn}|$ )



## 10.6. AC Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

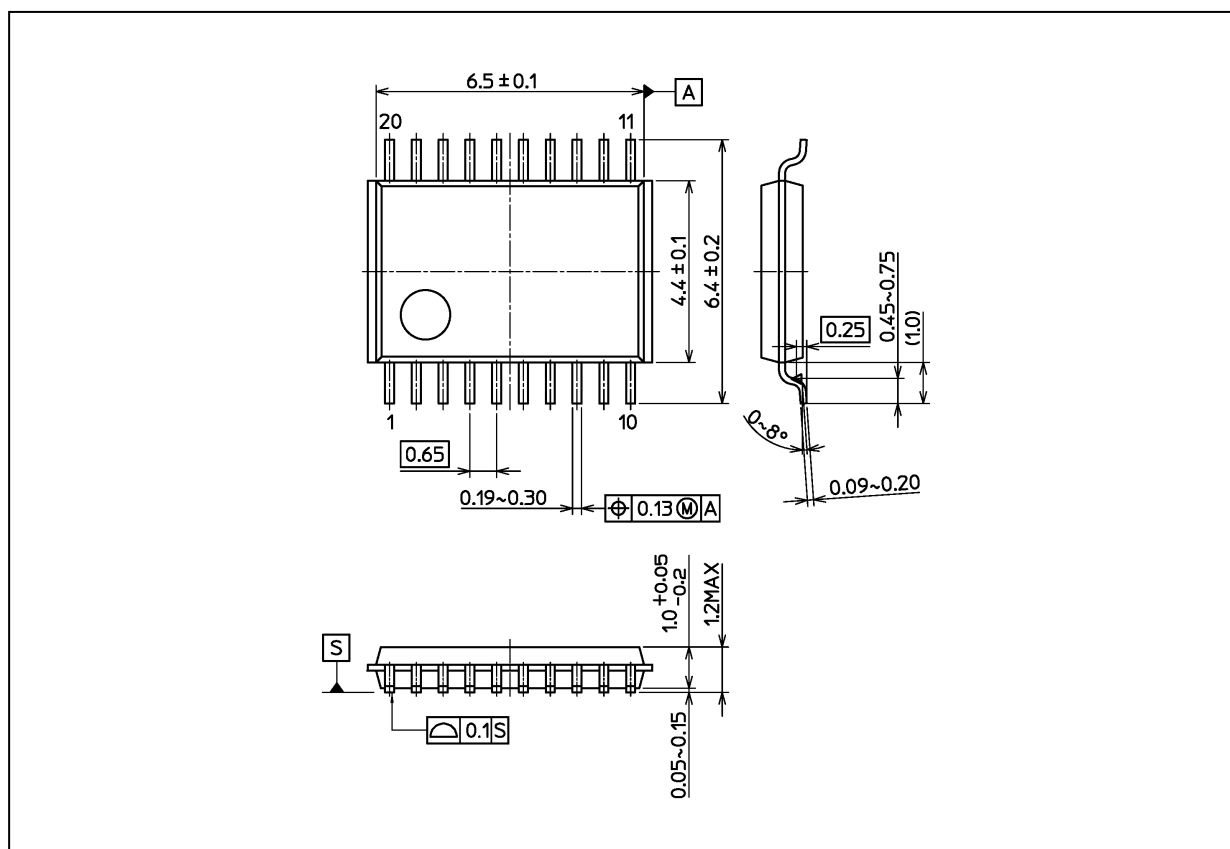
Characteristics	Part Number	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	74VHCV540FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	1.0	16.5	ns
						50	1.0	20.0	
					$3.3 \pm 0.3$	15	1.0	10.0	
						50	1.0	13.5	
					$5.0 \pm 0.5$	15	1.0	7.0	
						50	1.0	9.0	
Propagation delay time	74VHCV541FT	$t_{PLH}, t_{PHL}$		—	$2.5 \pm 0.2$	15	1.0	15.0	ns
						50	1.0	20.5	
					$3.3 \pm 0.3$	15	1.0	10.0	
						50	1.0	13.5	
					$5.0 \pm 0.5$	15	1.0	7.0	
						50	1.0	9.0	
3-state output enable time		$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	15	1.0	23.5	ns
						50	1.0	28.0	
					$3.3 \pm 0.3$	15	1.0	14.0	
						50	1.0	17.5	
					$5.0 \pm 0.5$	15	1.0	9.5	
						50	1.0	11.5	
3-state output disable time		$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$2.5 \pm 0.2$	50	1.0	28.0	ns
					$3.3 \pm 0.3$	50	1.0	19.5	
					$5.0 \pm 0.5$	50	1.0	13.5	
Output skew		$t_{osLH}, t_{osHL}$	(Note 1)	—	$2.5 \pm 0.2$	50	—	2.0	ns
					$3.3 \pm 0.3$	50	—	1.5	
					$5.0 \pm 0.5$	50	—	1.0	
Input capacitance		$C_{IN}$		—			—	10	pF

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )10.7. Noise Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50\text{ pF}$	3.3	0.3	—	V
			5.0	0.6	—	
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50\text{ pF}$	3.3	-0.1	—	V
			5.0	-0.3	—	
Minimum high-level dynamic input voltage	$V_{IHD}$	$C_L = 50\text{ pF}$	5.0	—	3.5	V
Maximum low-level dynamic input voltage	$V_{ILD}$	$C_L = 50\text{ pF}$	5.0	—	1.5	V

## Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

Package Name(s)
Nickname: TSSOP20B

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