

# 74VHC540FT, 74VHC541FT

## 1. Functional Description

- Octal Bus Buffer
- 74VHC540FT: Inverted, 3-State Outputs
- 74VHC541FT: Non-Inverted, 3-State Outputs

## 2. General

The 74VHC540FT/74VHC541FT are advanced high speed CMOS OCTAL BUS BUFFERs fabricated with silicon gate C<sup>2</sup>MOS technology.

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

The 74VHC540FT is an inverting type, and the 74VHC541FT is a non-inverting type.

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

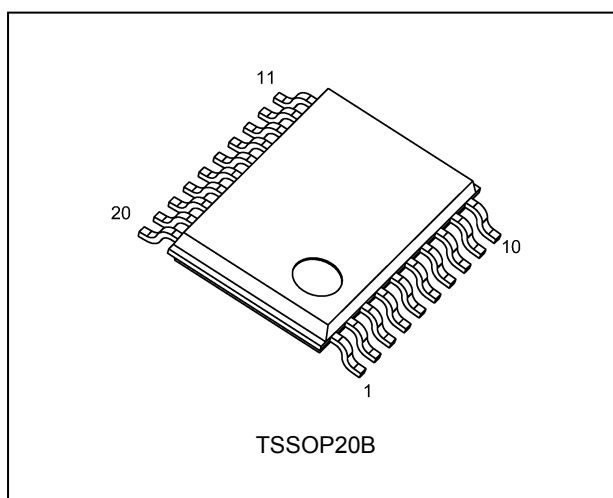
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C
- (3) High speed: Propagation delay time = 3.7 ns (typ.) at  $V_{CC} = 5.0$  V
- (4) Low power dissipation:  $I_{CC} = 4.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- (6) Power down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to 5.5 V
- (9) Low noise:  $V_{OLP} = 1.0$  V (max)
- (10) Pin and function compatible with 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

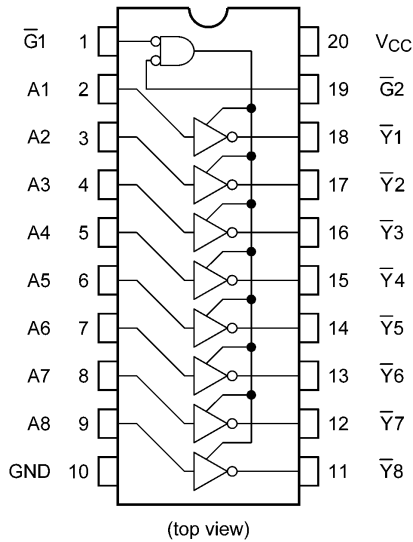


Start of commercial production

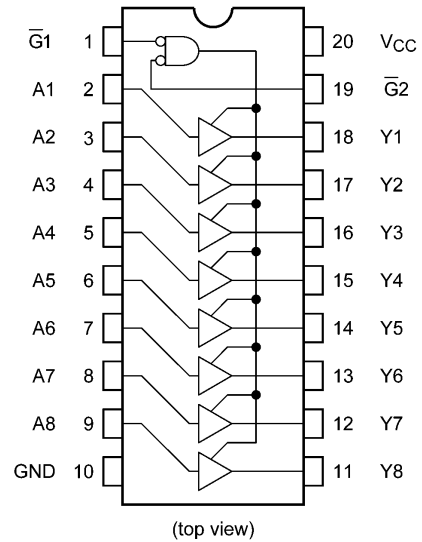
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**5. Pin Assignment**

74VHC540FT

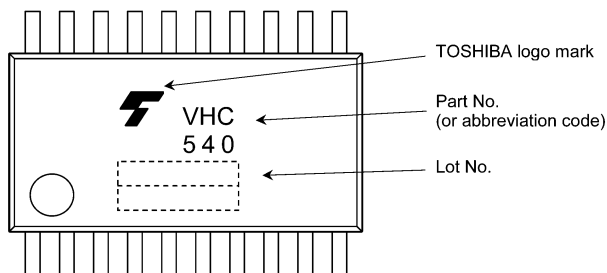


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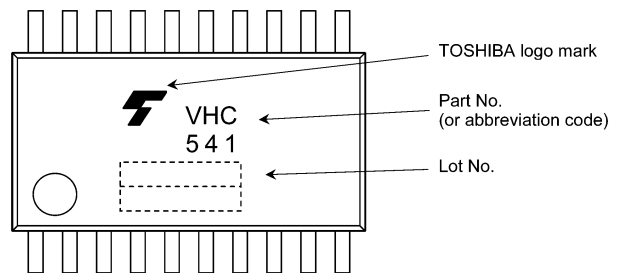


**6. Marking**

74VHC540FT

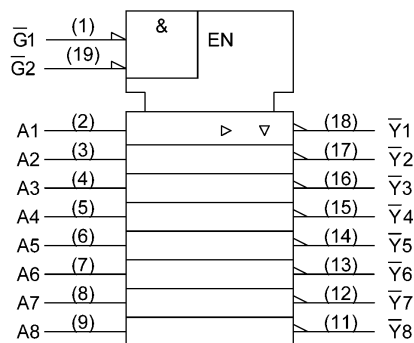


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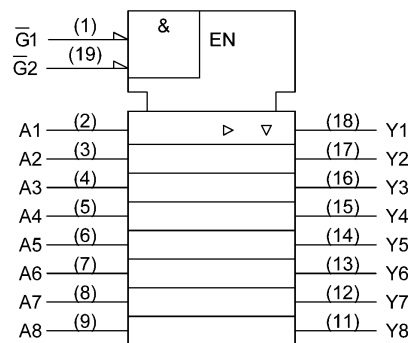


**7. IEC Logic Symbol**

74VHC540FT



74VHC541FT



**8. Truth Table**

Input $\bar{G}1$	Input $\bar{G}2$	Input $A_n$	Output $Y_n$	Output $\bar{Y}_n$
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<sub>n</sub>: 74VHC541FT  
 $\bar{Y}_n$ : 74VHC540FT

**9. 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	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 75$	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.

**10. Operating Ranges (Note)**

Characteristics	Symbol	Test Condition	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
Input rise and fall times	$dt/dv$	$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	ns/V
		$V_{CC} = 5.0 \pm 0.5$ V	0 to 20	

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.

**11. Electrical Characteristics**

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Typ.	Max	Unit	
High-level input voltage	$V_{IH}$	—	2.0	1.50	—	—	V	
			3.0 to 5.5	$V_{CC} \times 0.7$	—	—		
Low-level input voltage	$V_{IL}$	—	2.0	—	—	0.50	V	
			3.0 to 5.5	—	—	$V_{CC} \times 0.3$		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.58	—	—	
$I_{OH} = -8\text{ mA}$	4.5	3.94		—	—			
	Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.0	0.1
3.0					—	0.0	0.1	
4.5					—	0.0	0.1	
$I_{OL} = 4\text{ mA}$				3.0	—	—	0.36	
				$I_{OL} = 8\text{ mA}$	4.5	—	—	0.36
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = V_{CC}$ or GND	5.5		—	—	$\pm 0.25$	$\mu\text{A}$
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	—	—	4.0	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—	2.0	1.50	—	V	
			3.0 to 5.5	$V_{CC} \times 0.7$	—		
Low-level input voltage	$V_{IL}$	—	2.0	—	0.50	V	
			3.0 to 5.5	—	$V_{CC} \times 0.3$		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.48	—	
$I_{OH} = -8\text{ mA}$	4.5	3.80		—			
	Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1
3.0					—	0.1	
4.5					—	0.1	
$I_{OL} = 4\text{ mA}$				3.0	—	0.44	
				$I_{OL} = 8\text{ mA}$	4.5	—	0.44
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = V_{CC}$ or GND	5.5		—	—	$\pm 2.50$
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	—	—	40.0	$\mu\text{A}$

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

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50 \mu A$	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 $V_{IL}$	$I_{OL} = 50 \mu A$	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	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = V_{CC}$ or GND		5.5	—	$\pm 10.0$	$\mu A$
Input leakage current	$I_{IN}$	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	$\pm 2.0$	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	80.0	$\mu A$

**11.4. 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	74VHC540FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	4.8	7.0	ns
						50	—	7.3	10.5	
					$5.0 \pm 0.5$	15	—	3.7	5.0	
						50	—	5.2	7.0	
	74VHC541FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	5.0	7.0	ns
						50	—	7.5	10.5	
					$5.0 \pm 0.5$	15	—	3.5	5.0	
						50	—	5.0	7.0	
3-state output enable time		$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	—	6.8	10.5	ns
						50	—	9.3	14.0	
					$5.0 \pm 0.5$	15	—	4.7	7.2	
						50	—	6.2	9.2	
3-state output disable time		$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	50	—	11.2	15.4	ns
					$5.0 \pm 0.5$	50	—	6.0	8.8	
Output skew		$t_{osLH}, t_{osHL}$	(Note 1)	—	$3.3 \pm 0.3$	50	—	—	1.5	ns
					$5.0 \pm 0.5$	50	—	—	1.0	
Input capacitance		$C_{IN}$		—			—	4	10	pF
Output capacitance		$C_{OUT}$		—			—	6	—	pF
Power dissipation capacitance	74VHC540FT	$C_{PD}$	(Note 2)	—			—	17	—	pF
	74VHC541FT						—	18	—	

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.

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

**11.5. AC Characteristics (Unless otherwise specified,  $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ , 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	74VHC540FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	1.0	8.5	ns
						50	1.0	12.0	
					$5.0 \pm 0.5$	15	1.0	6.0	
						50	1.0	8.0	
	74VHC541FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	1.0	8.5	ns
						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		$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	12.5	ns
						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		$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	50	1.0	17.5	ns
					$5.0 \pm 0.5$	50	1.0	10.0	
Output skew		$t_{osLH}, t_{osHL}$	(Note 1)	—	$3.3 \pm 0.3$	50	—	1.5	ns
					$5.0 \pm 0.5$	50	—	1.0	
Input capacitance		$C_{IN}$		—			—	10	pF

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

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

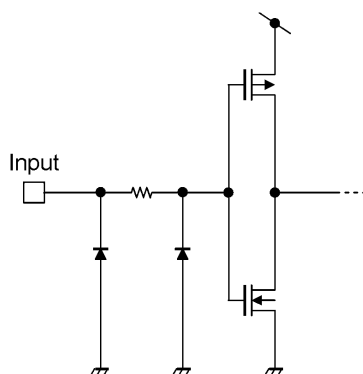
Characteristics	Part Number	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time	74VHC540FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	1.0	10.0	ns
						50	1.0	13.5	
					$5.0 \pm 0.5$	15	1.0	7.0	
						50	1.0	9.0	
Propagation delay time	74VHC541FT	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	1.0	10.0	ns
						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		$t_{PZL}, t_{PZH}$		$R_L = 1$ k $\Omega$	$3.3 \pm 0.3$	15	1.0	14.0	ns
						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		$t_{PLZ}, t_{PHZ}$		$R_L = 1$ k $\Omega$	$3.3 \pm 0.3$	50	1.0	19.5	ns
					$5.0 \pm 0.5$	50	1.0	11.0	
Output skew		$t_{osLH}, t_{osHL}$	(Note 1)	—	$3.3 \pm 0.3$	50	—	1.5	ns
					$5.0 \pm 0.5$	50	—	1.0	
Input capacitance		$C_{IN}$		—			—	10	pF

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50$ pF	5.0	0.7	1.0	V
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50$ pF	5.0	-0.7	-1.0	V
Minimum high-level dynamic input voltage	$V_{IHD}$	$C_L = 50$ pF	5.0	—	3.5	V
Maximum low-level dynamic input voltage	$V_{ILD}$	$C_L = 50$ pF	5.0	—	1.5	V

**12. Internal Equivalent Circuit**



**Package Dimensions**

Unit: mm



Weight: 0.071 g (typ.)

Package Name(s)
Nickname: TSSOP20B



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