CMOS Digital Integrated Circuits Silicon Monolithic

TC74VCX2541FK

1. Functional Description

- Low-Voltage Octal Bus Buffer with 3.6-V Tolerant Inputs and Outputs

2. General

The TC74VCX2541FK is a high-performance CMOS octal bus buffer. Designed for use in 1.8 V, 2.5 V or 3.3 V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

It is also designed with overvoltage tolerant inputs and outputs up to 3.6 V.

This device is a non-inverting 3-state buffer having two active-low output enables. When either $\overline{OE1}$ or $\overline{OE2}$ are high, the terminal outputs are in the high-impedance state. This device is designed to be used with 3-state memory address drivers, etc. The 26Ω series resistor helps reducing output overshoot and undershoot without external resistor.

All inputs are equipped with protection circuits against static discharge.

3. Features

(1) 26 Ω series resistors on outputs.

(2) Low-voltage operation: V_{CC} = 1.8 to 3.6 V

(3) High-speed operation: t_{pd} = 4.4 ns (max) (V_{CC} = 3.0 to 3.6 V)
t_{pd} = 5.6 ns (max) (V_{CC} = 2.3 to 2.7 V)
t_{pd} = 9.8 ns (max) (V_{CC} = 1.8 V)

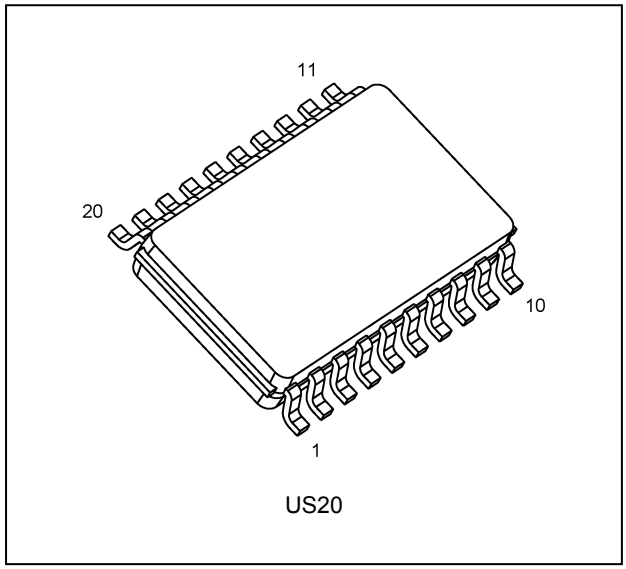
(4) Output current: I_{OH}/I_{OL} = ±12 mA (min) (V_{CC} = 3.0 V)
I_{OH}/I_{OL} = ±8 mA (min) (V_{CC} = 2.3 V)
I_{OH}/I_{OL} = ±4 mA (min) (V_{CC} = 1.8 V)

(5) Latch-up performance: -300 mA

(6) ESD performance: Human Body Model ≥ ±2000 V

(7) 3.6 V tolerant function and power-down protection provided on all inputs and outputs.

4. Packaging

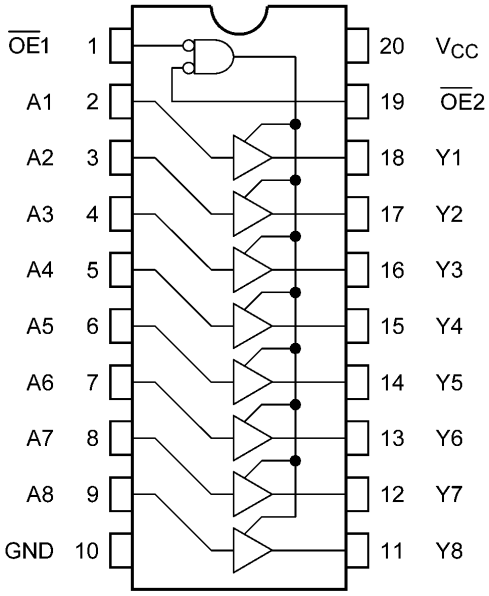


US20

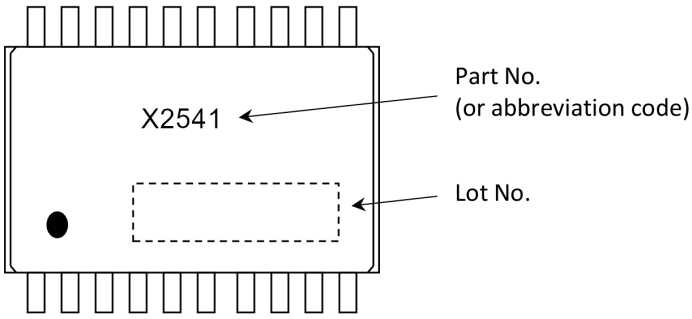
Start of commercial production
2006-04

2020-10-29
Rev.1.0

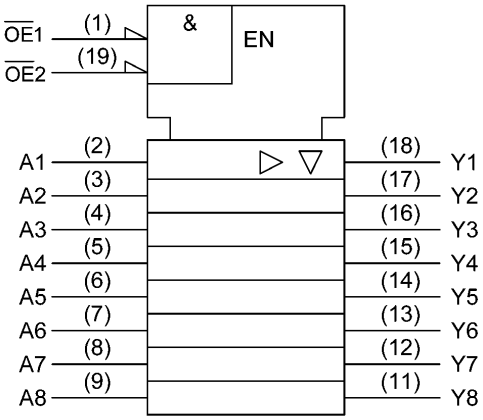
5. Pin Assignment



6. Marking



7. IEC Logic Symbol



8. Truth Table

Input $\overline{OE1}$	Input $\overline{OE2}$	Inputs An	Outputs
H	X	X	Z
X	H	X	Z
L	L	H	H
L	L	L	L

X: Don't care
Z: High impedance

9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 4.6	V
Input voltage	V_{IN}		-0.5 to 4.6	V
Output voltage	V_{OUT}	(Note 1)	-0.5 to 4.6	V
		(Note 2)	-0.5 to V_{CC} + 0.5	
Input diode current	I_{IK}		-50	mA
Output diode current	I_{OK}	(Note 3)	±50	mA
Output current	I_{OUT}		±50	mA
Power dissipation	P_D		180	mW
V_{CC}/ground current	I_{CC}/I_{GND}		±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}

10. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		1.8 to 3.6	V
		(Note 1)	1.2 to 3.6	
Input voltage	V_{IN}		-0.3 to 3.6	V
Output voltage	V_{OUT}	(Note 2)	0 to 3.6	V
		(Note 3)	0 to V_{CC}	
Output current	I_{OH},I_{OL}	(Note 4)	±12	mA
		(Note 5)	±8	
		(Note 6)	±4	
Operating temperature	T_{opr}		-40 to 85	°C
Input rise and fall times	dt/dv	(Note 7)	0 to 10	ns/V

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: Data retention only.

Note 2: Output in OFF state.

Note 3: High (H) or Low (L) state.

Note 4: V_{CC} = 3.0 to 3.6 V

Note 5: V_{CC} = 2.3 to 2.7 V

Note 6: V_{CC} = 1.8 V

Note 7: V_{IN} = 0.8 to 2.0 V , V_{CC} = 3.0 V

11. Electrical Characteristics

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

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		1.8 to 2.3	V_{CC} × 0.7	—	V
				2.3 to 2.7	1.6	—	
				2.7 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		1.8 to 2.3	—	V_{CC} × 0.2	V
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -100 μA	1.8 to 3.6	V_{CC} - 0.2	—	V
			I_{OH} = -4 mA	1.8	1.4	—	
				2.3	2.0	—	
			I_{OH} = -6 mA	2.3	1.8	—	
				2.7	2.2	—	
			I_{OH} = -8 mA	2.3	1.7	—	
				3.0	2.4	—	
			I_{OH} = -12 mA	3.0	2.2	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.8 to 3.6	—	0.2	V
			I_{OL} = 4 mA	1.8	—	0.3	
			I_{OL} = 6 mA	2.3	—	0.4	
				2,7	—	0.4	
			I_{OL} = 8 mA	2.3	—	0.6	
				3.0	—	0.55	
			I_{OL} = 12 mA	3.0	—	0.8	
Input leakage current	I_{IN}	V_{IN} = 0 to 3.6 V		1.2 to 3.6	—	±5.0	μA
3-state output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 3.6 V		1.2 to 3.6	—	±10.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN}/V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		1.2 to 3.6	—	20.0	μA
		V_{CC} ≤ (V_{IN}/V_{OUT}) ≤ 3.6 V		1.2 to 3.6	—	±20.0	
	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per input)		2.7 to 3.6	—	750	μA

11.2. AC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		See 11.5 AC Test Circuit, Table 11.5.1, Fig. 11.6.1, Table 11.6.1	1.8	1.5	9.8	ns
				2.5 ± 0.2	0.8	5.6	
				3.3 ± 0.3	0.6	4.4	
3-state output enable time	t_{PZL},t_{PZH}		See 11.5 AC Test Circuit, Table 11.5.1, Fig. 11.6.2, Table 11.6.1	1.8	1.5	9.8	ns
				2.5 ± 0.2	0.8	6.5	
				3.3 ± 0.3	0.6	5.0	
3-state output disable time	t_{PLZ},t_{PHZ}		See 11.5 AC Test Circuit, Table 11.5.1, Fig. 11.6.2, Table 11.6.1	1.8	1.5	7.7	ns
				2.5 ± 0.2	0.8	4.3	
				3.3 ± 0.3	0.6	3.9	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	1.8	—	0.5	ns
				2.5 ± 0.2	—	0.5	
				3.3 ± 0.3	—	0.5	

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

11.3. Dynamic Switching Characteristics (Note) (Unless otherwise specified, T_a = 25°C, Input: t_r = t_f = 2.0 ns, C_L = 30 pF)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 1.8 V, V_{IL} = 0 V	1.8	0.15	V
		V_{IH} = 2.5 V, V_{IL} = 0 V	2.5	0.25	V
		V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.35	
Quiet output minimum dynamic V_{OL}	V_{OLV}	V_{IH} = 1.8 V, V_{IL} = 0 V	1.8	-0.15	V
		V_{IH} = 2.5 V, V_{IL} = 0 V	2.5	-0.25	
		V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	-0.35	
Quiet output minimum dynamic V_{OH}	V_{OHV}	V_{IH} = 1.8 V, V_{IL} = 0 V	1.8	1.55	V
		V_{IH} = 2.5 V, V_{IL} = 0 V	2.5	2.05	
		V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	2.65	

Note: Parameter guaranteed by design.

11.4. Capacitive Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}		—	1.8, 2.5, 3.3	6	pF
Output capacitance	C_{OUT}		—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C_{PD}	(Note 1)	f_{IN} = 10 MHz	1.8, 2.5, 3.3	20	pF

Note 1: 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} × V_{CC} × f_{IN} + I_{CC}/8 (per gate)

11.5. AC Test Circuit

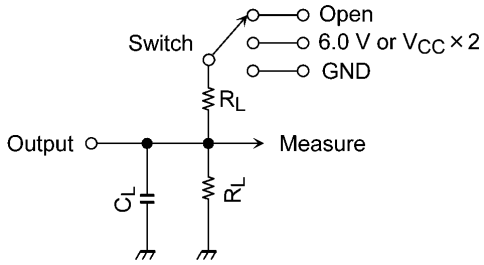


Table 11.5.1 Parameter for AC Test Circuit

Parameter	Switch	Test Condition
t_{PLH}, t_{PHL}	OPEN	—
t_{PLZ}, t_{PZL}	6.0 V	V_{CC} = 3.3 ± 0.3 V
	V_{CC} × 2	V_{CC} = 2.5 ± 0.2 V
		V_{CC} = 1.8 V
t_{PHZ}, t_{PZH}	GND	—

11.6. AC Waveform

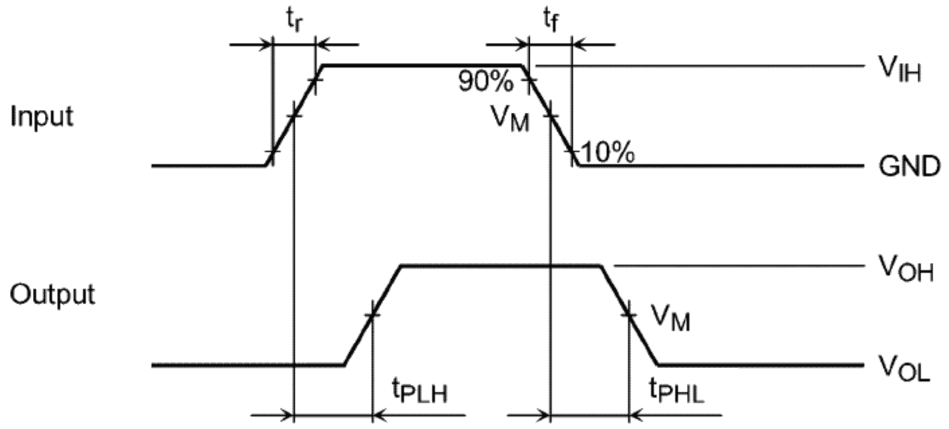


Fig. 11.6.1 t_{PLH}, t_{PHL}

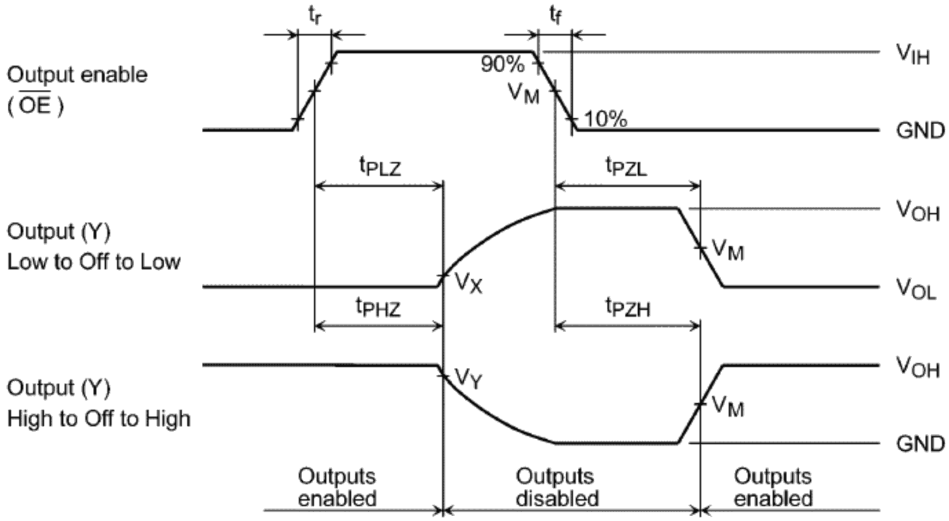


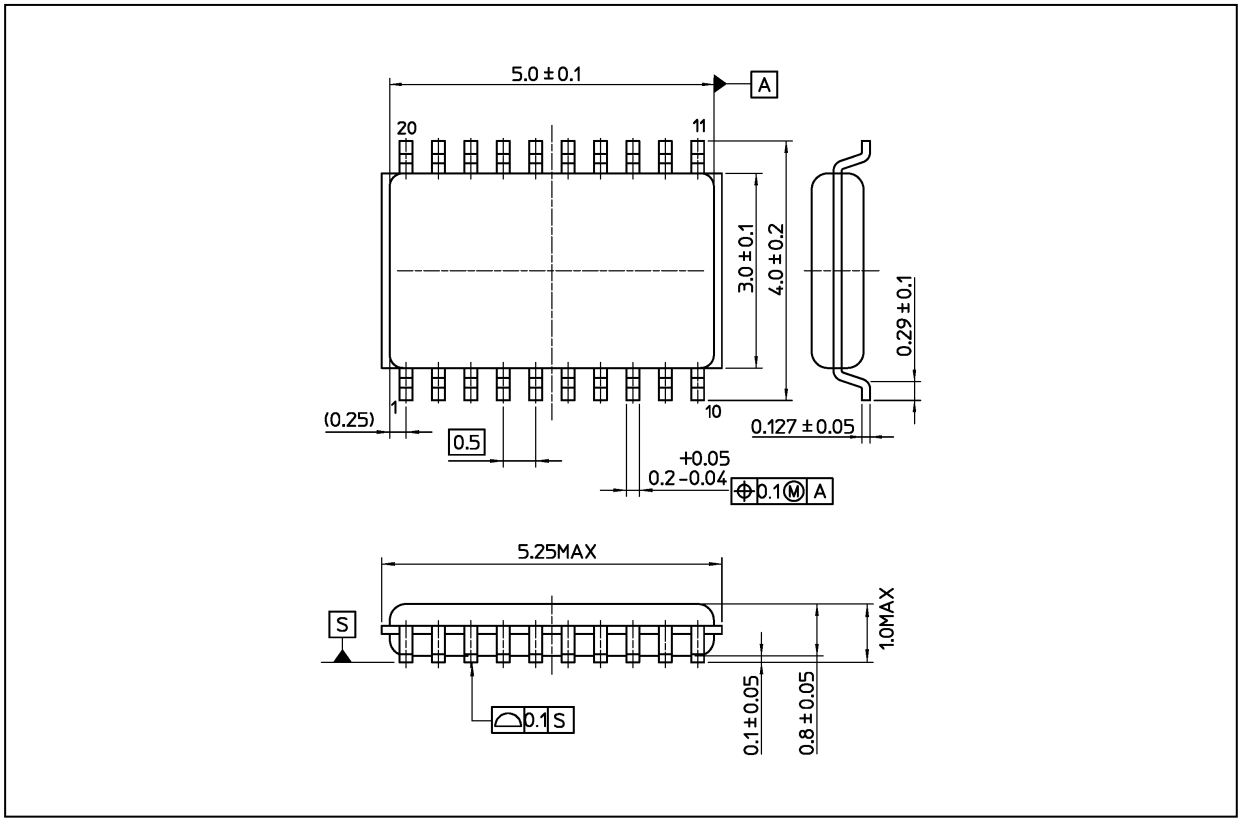
Fig. 11.6.2 t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

Table 11.6.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 V
Input	V_{IH}	2.7 V	V_{CC}	V_{CC}
	V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	t_r, t_f	2.0 ns	2.0 ns	2.0 ns
Output	V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	V_X	V_{OL} + 0.3 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V
	V_Y	V_{OH} - 0.3 V	V_{OH} - 0.15 V	V_{OH} - 0.15 V
Load	C_L	30 pF	30 pF	15 pF
	R_L	500 Ω	500 Ω	2 kΩ

Package Dimensions

Unit: mm



Weight: 0.03 g (typ.)

Package Name(s)
Nickname: US20

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