

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCX245FT

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

The TC74VCX245FT is a high-performance CMOS octal bus transceiver. 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 over-voltage tolerant inputs and outputs up to 3.6 V.

The direction of data transmission is determined by the level of the DIR inputs. The OE inputs can be used to disable the device so that the busses are effectively isolated.

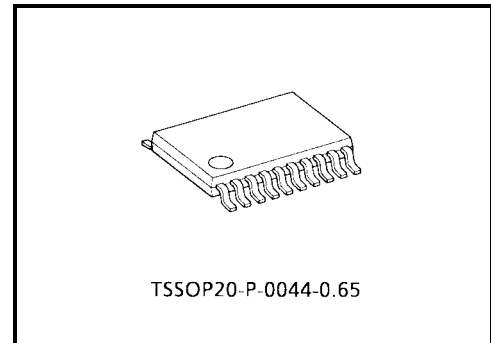
All inputs are equipped with protection circuits against static discharge.

### Features

- Low-voltage operation:  $V_{CC} = 1.8$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 3.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
:  $t_{pd} = 4.2$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)  
:  $t_{pd} = 8.4$  ns (max) ( $V_{CC} = 1.8$  V)
- Output current:  $I_{OH}/I_{OL} = \pm 24$  mA (min) ( $V_{CC} = 3.0$  V)  
:  $I_{OH}/I_{OL} = \pm 18$  mA (min) ( $V_{CC} = 2.3$  V)  
:  $I_{OH}/I_{OL} = \pm 6$  mA (min) ( $V_{CC} = 1.8$  V)
- Latch-up performance:  $\pm 300$  mA
- ESD performance: Machine model  $> \pm 200$  V  
: Human body model  $> \pm 2000$  V
- Package: TSSOP (thin shrink small outline package)
- Bidirectional interface between 2.5 V and 3.3 V signals.
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

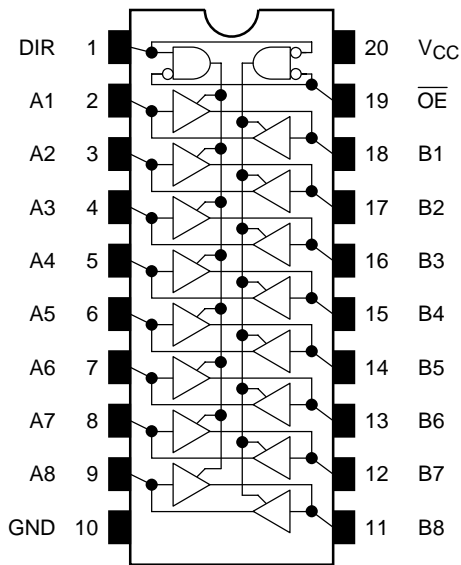
Note 1: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.

All floating (high impedance) bus pins must have their input level fixed by means of pull-up or pull-down resistors.

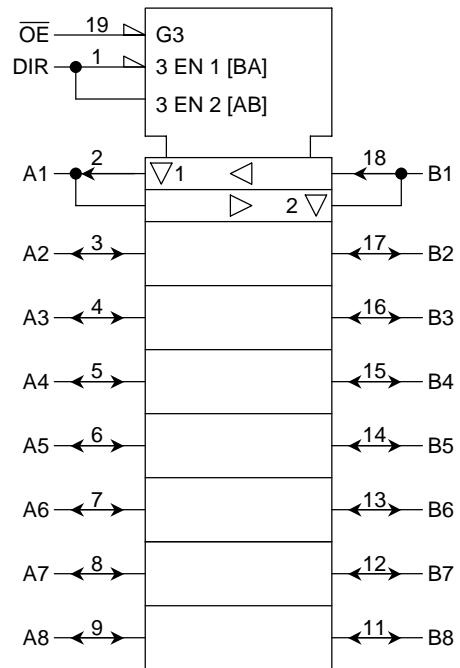


Weight: 0.08 g (typ.)

**Pin Assignment (top view)**



**IEC Logic Symbol**



**Truth Table**

Inputs		Outputs	Function	
$\overline{OE}$	DIR		A-Bus	B-Bus
L	L	A = B	Output	Input
L	H	B = A	Input	Output
H	X	Z	High impedance	

X: Don't care

Z: High impedance

## Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5 to 4.6	V
DC input voltage (DIR, $\overline{OE}$ )	$V_{IN}$	-0.5 to 4.6	V
DC bus I/O voltage	$V_{I/O}$	-0.5 to 4.6 (Note 2)	V
		-0.5 to $V_{CC} + 0.5$ (Note 3)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note 4)	mA
DC output current	$I_{OUT}$	$\pm 50$	mA
Power dissipation	$P_D$	180	mW
DC $V_{CC}$ /ground current	$I_{CC}/I_{GND}$	$\pm 100$	mA
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

Note 2: OFF state

Note 3: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 4:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

## Recommended Operating Range

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	1.8 to 3.6	V
		1.2 to 3.6 (Note 5)	
Input voltage (DIR, $\overline{OE}$ )	$V_{IN}$	-0.3 to 3.6	V
Bus I/O voltage	$V_{I/O}$	0 to 3.6 (Note 6)	V
		0 to $V_{CC}$ (Note 7)	
Output current	$I_{OH}/I_{OL}$	$\pm 24$ (Note 8)	mA
		$\pm 18$ (Note 9)	
		$\pm 6$ (Note 10)	
Operating temperature	$T_{opr}$	-40 to 85	$^{\circ}C$
Input rise and fall time	dt/dv	0 to 10 (Note 11)	ns/V

Note 5: Data retention only

Note 6: OFF state

Note 7: High or low state

Note 8:  $V_{CC} = 3.0$  to  $3.6$  V

Note 9:  $V_{CC} = 2.3$  to  $2.7$  V

Note 10:  $V_{CC} = 1.8$  V

Note 11:  $V_{IN} = 0.8$  to  $2.0$  V,  $V_{CC} = 3.0$  V

**Electrical Characteristics**

**DC Characteristics (Ta = -40 to 85°C, 2.7 V < VCC ≤ 3.6 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.7 to 3.6	2.0	—	V
	L-level	V <sub>IL</sub>	—		2.7 to 3.6	—	0.8	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7 to 3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -12 mA	2.7	2.2	—	
				I <sub>OH</sub> = -18 mA	3.0	2.4	—	
				I <sub>OH</sub> = -24 mA	3.0	2.2	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.7 to 3.6	—	0.2	
				I <sub>OL</sub> = 12 mA	2.7	—	0.4	
				I <sub>OL</sub> = 18 mA	3.0	—	0.4	
				I <sub>OL</sub> = 24 mA	3.0	—	0.55	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.7 to 3.6	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7 to 3.6	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7 to 3.6	—	±20.0	
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7 to 3.6	—	750	

**DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ VCC ≤ 2.7 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.3 to 2.7	1.6	—	V
	L-level	V <sub>IL</sub>	—		2.3 to 2.7	—	0.7	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3 to 2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.3	2.0	—	
				I <sub>OH</sub> = -12 mA	2.3	1.8	—	
				I <sub>OH</sub> = -18 mA	2.3	1.7	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.3 to 2.7	—	0.2	
				I <sub>OL</sub> = 12 mA	2.3	—	0.4	
				I <sub>OL</sub> = 18 mA	2.3	—	0.6	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.3 to 2.7	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3 to 2.7	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3 to 2.7	—	±20.0	

**DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ VCC < 2.3 V)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		1.8 to 2.3	0.7 × V <sub>CC</sub>	—	V
	L-level	V <sub>IL</sub>	—		1.8 to 2.3	—	0.2 × V <sub>CC</sub>	
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	1.8	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	1.8	1.4	—	
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	
				I <sub>OL</sub> = 6 mA	1.8	—	0.3	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		1.8	—	±5.0	μA
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		1.8	—	±10.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		1.8	—	±20.0	

**AC Characteristics (Ta = -40 to 85°C, input: t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω)**

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit	
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2			1.8	1.5	8.4	ns	
					2.5 ± 0.2	0.8	4.2		
					3.3 ± 0.3	0.6	3.5		
3-state output enable time	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3			1.8	1.5	9.8	ns	
					2.5 ± 0.2	0.8	5.6		
					3.3 ± 0.3	0.6	4.5		
3-state output disable time	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3			1.8	1.5	7.2	ns	
					2.5 ± 0.2	0.8	4.0		
					3.3 ± 0.3	0.6	3.6		
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note 12)				1.8	—	0.5	ns
						2.5 ± 0.2	—	0.5	
						3.3 ± 0.3	—	0.5	

For C<sub>L</sub> = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 12: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

**Dynamic Switching Characteristics (Ta = 25°C, input: tr = tf = 2.0 ns, CL = 30 pF)**

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note 13)	1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V (Note 13)	2.5	0.6	
		VIH = 3.3 V, VIL = 0 V (Note 13)	3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note 13)	1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V (Note 13)	2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V (Note 13)	3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note 13)	1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V (Note 13)	2.5	1.9	
		VIH = 3.3 V, VIL = 0 V (Note 13)	3.3	2.2	

Note 13: Parameter guaranteed by design.

**Capacitive Characteristics (Ta = 25°C)**

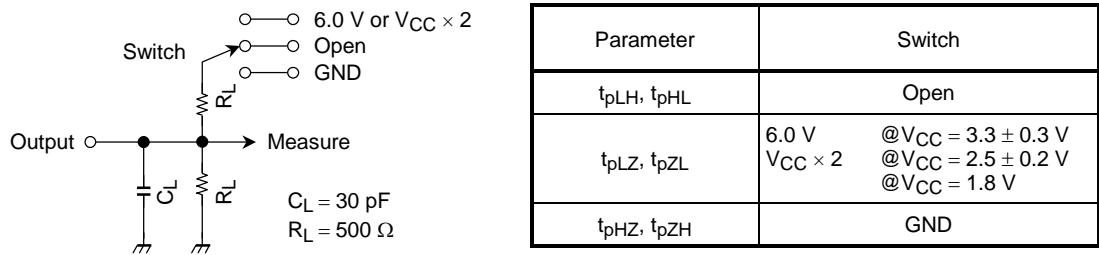
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	CIO	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note 14)	1.8, 2.5, 3.3	20	pF

Note 14: CPD 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:

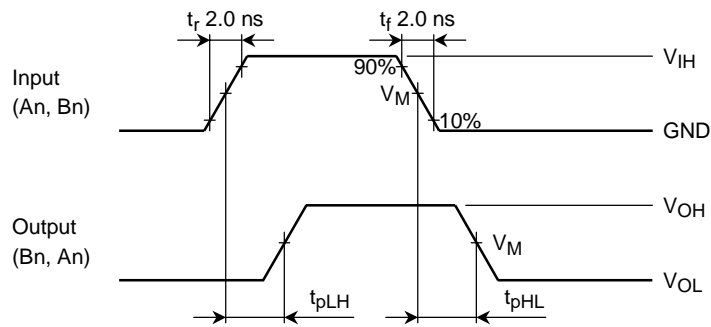
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per bit)}$$

**AC Test Circuit**

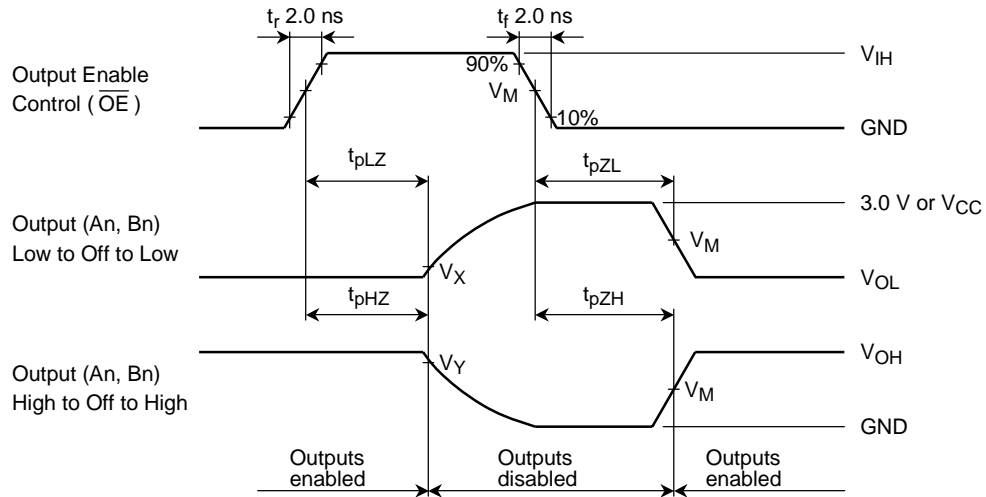


**Figure 1**

**AC Waveform**



**Figure 2  $t_{pLH}, t_{pHL}$**



**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

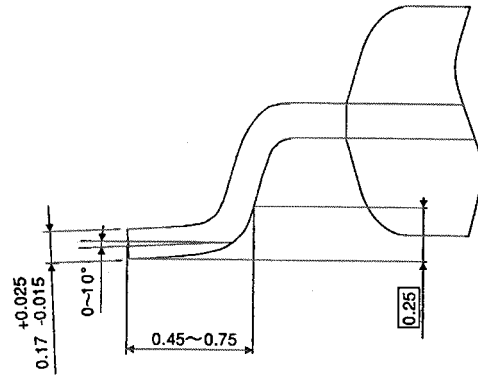
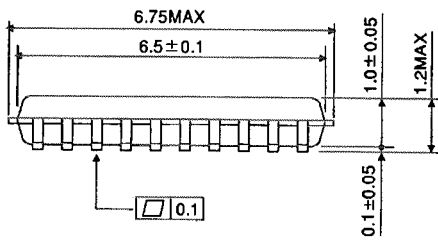
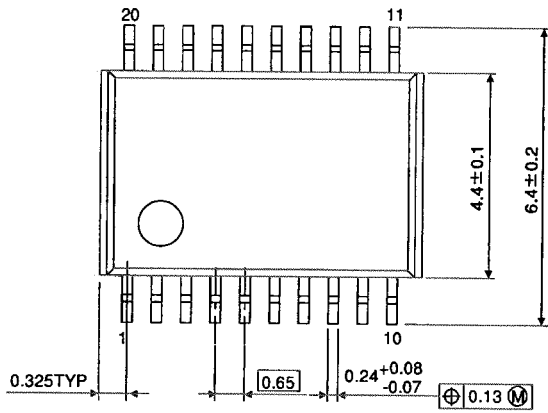
Symbol	$V_{CC}$		
	$3.3 \pm 0.3$ V	$2.5 \pm 0.2$ V	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V
$V_Y$	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V



**Package Dimensions**

TSSOP20-P-0044-0.65

Unit : mm



Weight: 0.08 g (typ.)

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000707EBA

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