

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX245F, TC74LCX245FK

## Low-Voltage Octal Bus Transceiver with 5-V Tolerant Inputs and Outputs

The TC74LCX245 is a high-performance CMOS octal bus transceiver. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V)  $V_{CC}$  applications, but it could be used to interface to 5-V supply environment for both inputs and outputs.

The direction of data transmission is determined by the level of the DIR input. The enable input ( $\overline{OE}$ ) can be used to disable the device so that the busses are effectively isolated.

All inputs are equipped with protection circuits against static discharge.

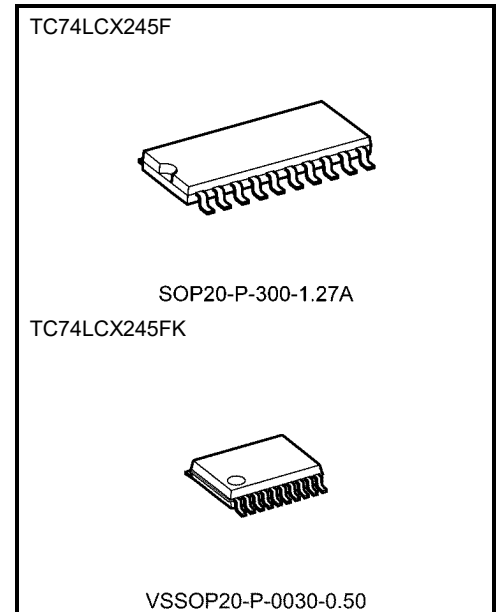
### Features (Note)

- Low-voltage operation:  $V_{CC} = 1.65$  to 3.6 V
- High-speed operation:  $t_{pd} = 7.0$  ns (max) ( $V_{CC} = 3.0$  to 3.6 V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Available in JEITA SOP, VSSOP (US)
- Bidirectional interface between 5.0 V and 3.3 V signals
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 245 type

Note: 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 levels fixed by means of pull-up or pull-down resistors.

Note: The Electrical Characteristics of  $V_{CC} = 1.8 \pm 0.15$  V is only applicable for products which manufactured from January 2009 onward.



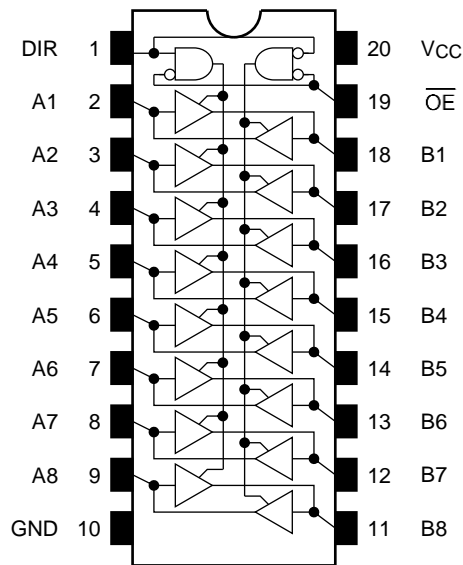
Weight

SOP20-P-300-1.27A : 0.22 g (typ.)

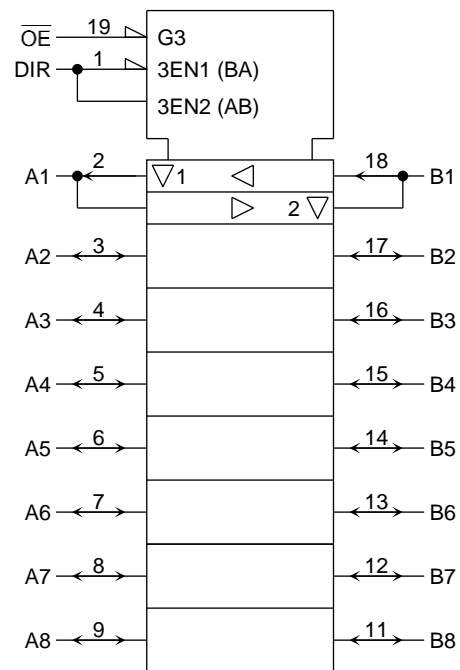
VSSOP20-P-0030-0.50 : 0.03 g (typ.)

Start of commercial production  
1994-03

### 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	Z	

X: Don't care

Z: High impedance

### Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	-0.5 to 7.0	V
DC input voltage (DIR, $\overline{OE}$ )	V <sub>IN</sub>	-0.5 to 7.0	V
DC bus I/O voltage	V <sub>I/O</sub>	-0.5 to 7.0 (Note 2)	V
		-0.5 to V <sub>CC</sub> + 0.5 (Note 3)	
Input diode current	I <sub>IK</sub>	-50	mA
Output diode current	I <sub>OK</sub>	±50 (Note 4)	mA
DC output current	I <sub>OUT</sub>	±50	mA
Power dissipation	P <sub>D</sub>	180	mW
DC V <sub>CC</sub> /ground current	I <sub>CC</sub> /I <sub>GND</sub>	±100	mA
Storage temperature	T <sub>stg</sub>	-65 to 150	°C

Note 1: 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 2: Output in OFF state

Note 3: High or low state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 4: V<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

### Operating Ranges (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	1.65 to 3.6	V
		1.5 to 3.6 (Note 2)	
Input voltage (DIR, $\overline{OE}$ )	V <sub>IN</sub>	0 to 5.5	V
Bus I/O voltage	V <sub>I/O</sub>	0 to 5.5 (Note 3)	V
		0 to V <sub>CC</sub> (Note 4)	
Output current	I <sub>OH</sub> /I <sub>OL</sub>	±24 (Note 5)	mA
		±12 (Note 6)	
Operating temperature	T <sub>opr</sub>	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 7)	ns/V

Note 1: The operating ranges are required to ensure the normal operation of the device. Unused inputs and bus inputs must be tied to either V<sub>CC</sub> or GND. Please connect both bus inputs and the bus outputs with V<sub>CC</sub> or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 2: Data retention only

Note 3: Output in OFF state

Note 4: High or low state

Note 5: V<sub>CC</sub> = 3.0 to 3.6 V

Note 6: V<sub>CC</sub> = 2.7 to 3.0 V

Note 7: V<sub>IN</sub> = 0.8 to 2.0 V, V<sub>CC</sub> = 3.0 V

### Electrical Characteristics

#### DC Characteristics (Ta = -40 to 85°C)

Characteristics		Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—	1.65 to 2.3	V <sub>CC</sub> × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
	L-level	V <sub>IL</sub>	—	1.65 to 2.3	—	V <sub>CC</sub> × 0.1	
				2.3 to 2.7	—	0.7	
				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	1.65 to 3.6	V <sub>CC</sub> -0.2	—
				I <sub>OH</sub> = -4 mA	1.65	1.05	—
				I <sub>OH</sub> = -8 mA	2.3	1.7	—
				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	1.65 to 3.6	—	0.2
				I <sub>OL</sub> = 4 mA	1.65	—	0.45
				I <sub>OL</sub> = 8 mA	2.3	—	0.7
				I <sub>OL</sub> = 12 mA	2.7	—	0.4
				I <sub>OL</sub> = 16 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 5.5 V	1.65 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 5.5 V	1.65 to 3.6	—	±5.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> /V <sub>OUT</sub> = 5.5 V	0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	1.65 to 3.6	—	10.0	μA
			V <sub>IN</sub> /V <sub>OUT</sub> = 3.6 to 5.5 V	1.65 to 3.6	—	±10.0	
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V (per 1 input)	2.7 to 3.6	—	500	

### AC Characteristics (Ta = -40 to 85°C)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.8 ± 0.15	—	25.0	ns
			2.5 ± 0.2	—	9.0	
			2.7	—	8.0	
			3.3 ± 0.3	1.5	7.0	
Output enable time	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.8 ± 0.15	—	34.0	ns
			2.5 ± 0.2	—	17.0	
			2.7	—	9.5	
			3.3 ± 0.3	1.5	8.5	
Output disable time	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.8 ± 0.15	—	32.0	ns
			2.5 ± 0.2	—	16.0	
			2.7	—	8.5	
			3.3 ± 0.3	1.5	7.5	
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note)	2.7	—	—	ns
			3.3 ± 0.3	—	1.0	

Note: Parameter guaranteed by design.  
 (t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

### Dynamic Switching Characteristics (Ta = 25°C, input: tr = tf = 2.5 ns, CL = 50 pF, RL = 500 Ω)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V
Quiet output minimum dynamic VOL	VOLV	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V

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

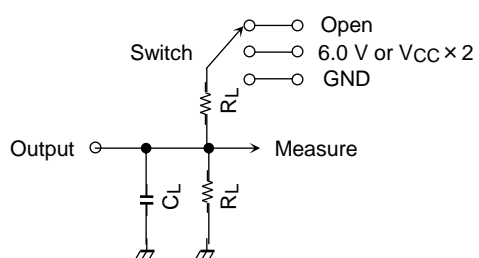
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	DIR, $\overline{\text{OE}}$	3.3	7	pF
Bus input capacitance	C <sub>I/O</sub>	An, Bn	3.3	8	pF
Power dissipation capacitance	CPD	f <sub>IN</sub> = 10 MHz (Note)	3.3	25	pF

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption.

Average operating current can be obtained by the equation:

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

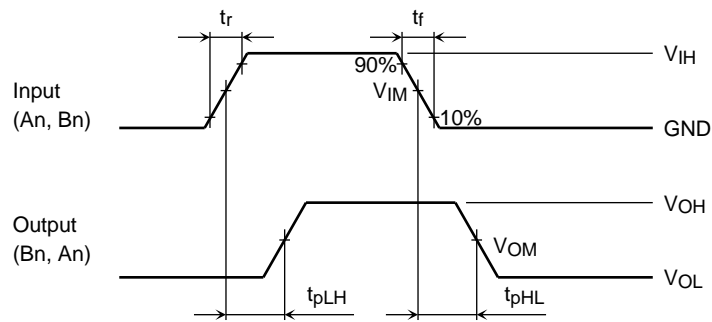
### AC Test Circuit



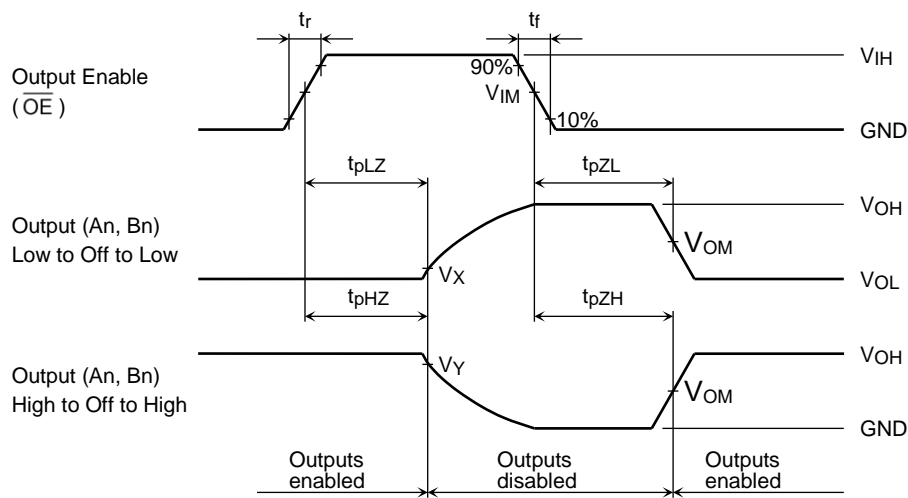
Parameter	Switch
$t_{pLH}$ , $t_{pHL}$	Open
$t_{pLZ}$ , $t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V @ $V_{CC} = 2.7$ V
	$V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2$ V @ $V_{CC} = 1.8 \pm 0.15$ V
$t_{pHZ}$ , $t_{pZH}$	GND

Figure 1

### AC Waveform



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



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

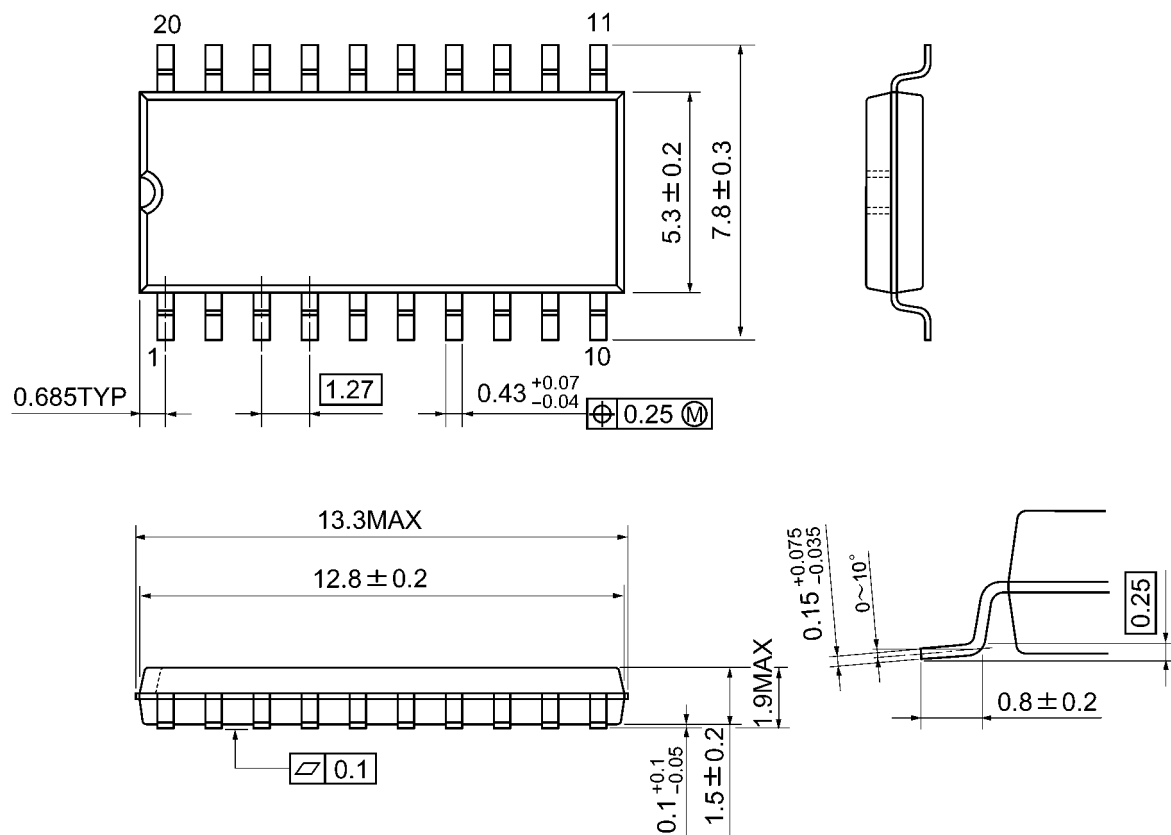
	Symbol	V <sub>CC</sub>		
		3.3 ± 0.3 V 2.7 V	2.5 ± 0.2 V	1.8 ± 0.15 V
Input	V <sub>IH</sub>	2.7 V	V <sub>CC</sub>	V <sub>CC</sub>
	V <sub>IM</sub>	1.5 V	V <sub>CC</sub> /2	V <sub>CC</sub> /2
	t <sub>r</sub> , t <sub>f</sub>	2.5 ns	2.0 ns	2.0 ns
Output	V <sub>OM</sub>	1.5 V	V <sub>OH</sub> /2	V <sub>OH</sub> /2
	V <sub>X</sub>	V <sub>OL</sub> + 0.3 V	V <sub>OL</sub> + 0.15 V	V <sub>OL</sub> + 0.15 V
	V <sub>Y</sub>	V <sub>OH</sub> - 0.3 V	V <sub>OL</sub> - 0.15 V	V <sub>OL</sub> - 0.15 V
Load	C <sub>L</sub>	50 pF	30 pF	30 pF
	R <sub>L</sub>	500 Ω	500 Ω	1 kΩ



### Package Dimensions

SOP20-P-300-1.27A

Unit: mm

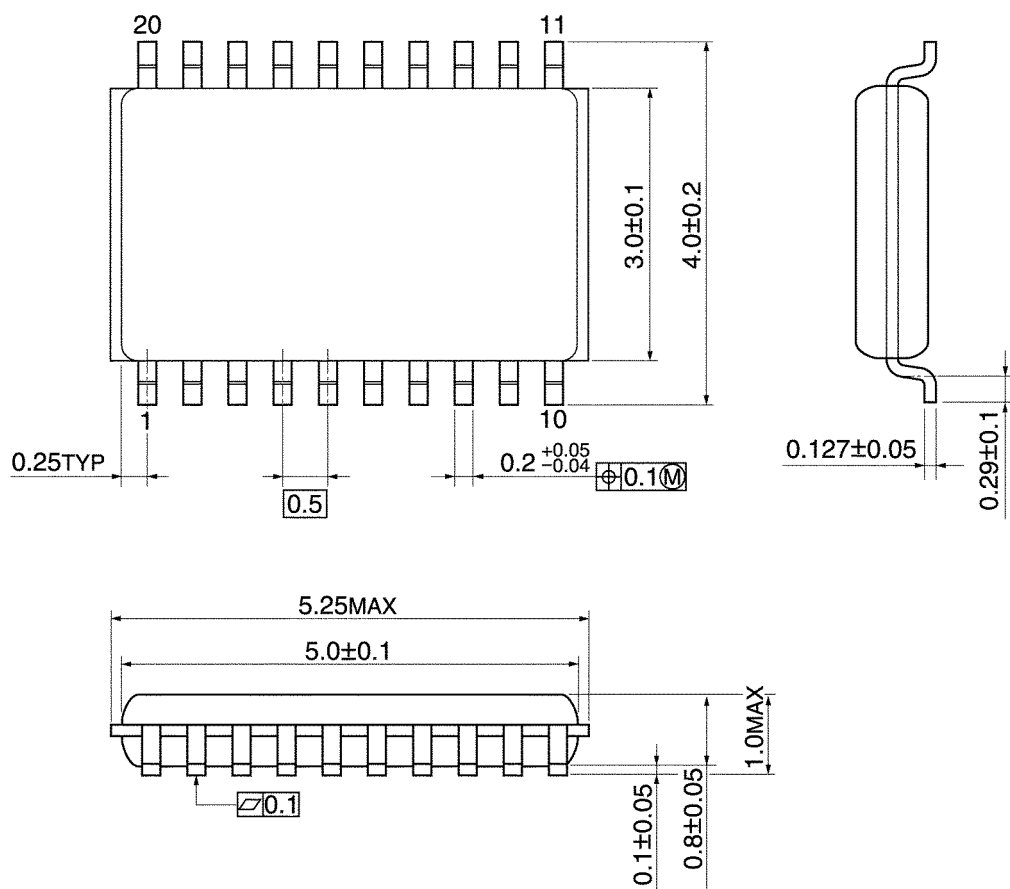


Weight: 0.22 g (typ.)

### Package Dimensions

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)

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