TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74LCX16245FT

Low-Voltage 16-Bit Bus Transceiver with 5-V Tolerant Inputs and Outputs

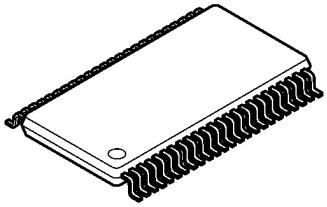
The TC74LCX16245FT is a high-performance CMOS 16-bit bus transceiver. Designed for use in 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (2.5-V or 3.3-V) V_{CC} applications, but it could be used to interface to 5-V supply environment for both inputs and outputs.

This 16-bit bus transceiver is controlled by direction control (DIR) inputs and output enable ($\overline{OE}$) inputs which

h are common to each byte. It can be used as two 8-bit transceiver or one 16-bit transceiver. The direction of data transmission is determined by the level of the DIR inputs. The $\overline{OE}$ 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.



TSSOP48-P-0061-0.50A

Weight: 0.25 g (typ.)

Features (Note)

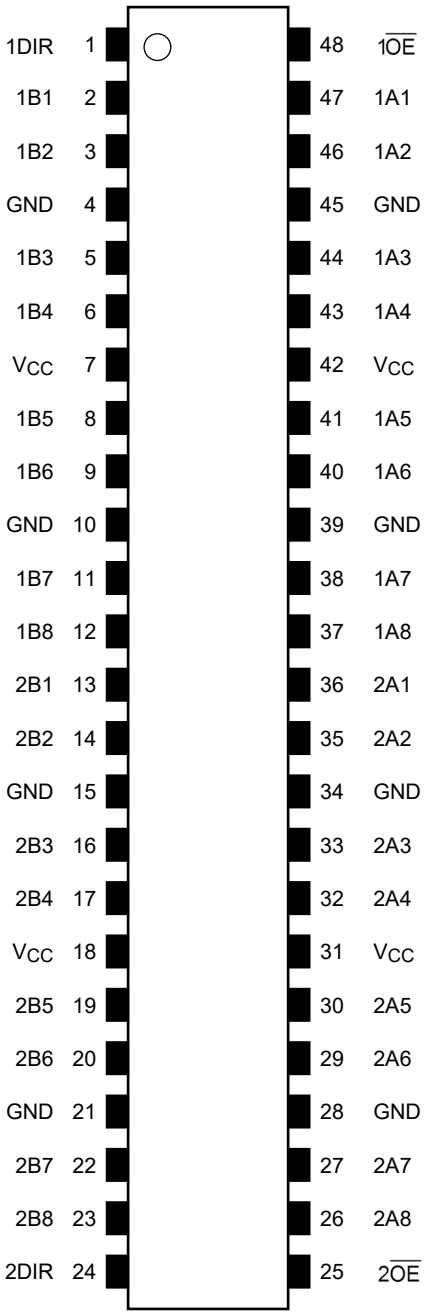
- Low-voltage operation: V_{CC} = 2.0 to 3.6 V
- Wide operating temperature range: Topr = -40 to 125 °C (Note 1)
- High-speed operation: t_{pd} = 4.5 ns (max) (V_{CC} = 3.0 to 3.6 V)
- Ouput current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)
- Latch-up performance: −500 mA
- Package: TSSOP
- Bidirectional interface between 5.0 V and low-voltage (2.5-V or 3.3-V) signals
- Power-down protection provided on all inputs and outputs

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 level fixed by means of pull-up or pull-down resistors.

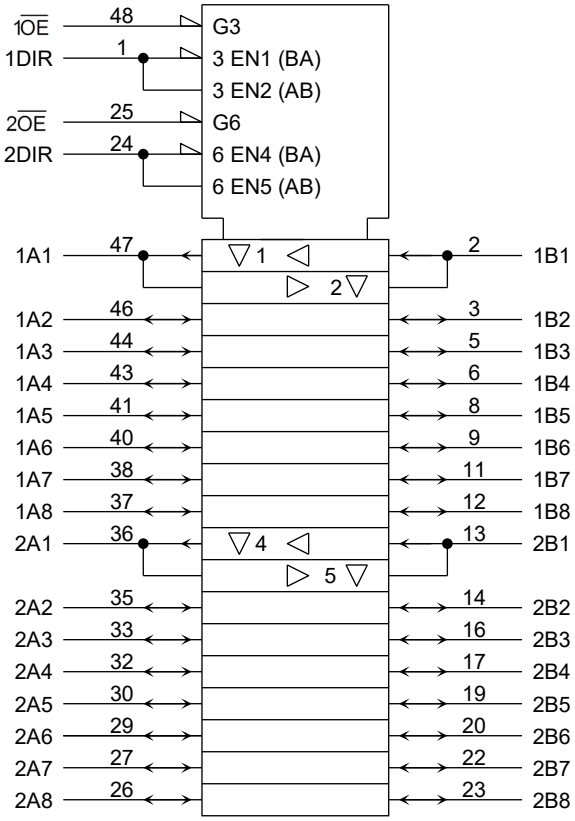
Note 1: Operating Range spec of Topr= -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

Start of commercial production
2020-04

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

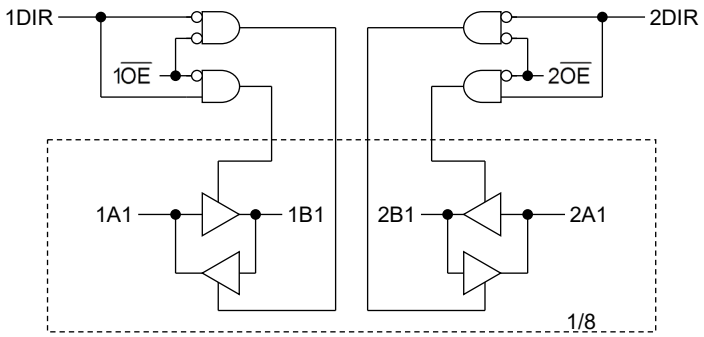
Inputs		Function		Outputs
$1\overline{OE}$	1DIR	Bus 1A1-1A8	Bus 1B1-1B8	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

Inputs		Function		Outputs
$2\overline{OE}$	2DIR	Bus 2A1-2A8	Bus 2B1-2B8	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

X: Don't care

Z: High impedance

System Diagram



Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5 to 6.0	V
DC input voltage (DIR, $\overline{OE}$)	V_{IN}	−0.5 to 7.0	V
DC bus I/O voltage	$V_{I/O}$	−0.5 to 7.0 (Note 1)	V
		−0.5 to V_{CC} + 0.5 (Note 2)	
Input diode current	I_{IK}	−50	mA
Output diode current	I_{OK}	±50 (Note 3)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	400 (Note 4)	mW
DC V_{CC}/ground current per supply pin	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 or low state. I_{OUT} absolute maximum rating must be observed.

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

Note 4: 400 mW in the range of Ta = -40 to 85 °C. From Ta = 85 to 125 °C a derating factor of -6.25 mW/°C shall be applied until 150 mW.

Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	2.0 to 3.6	V
		1.5 to 3.6 (Note 1)	
Input voltage (DIR, $\overline{OE}$)	V_{IN}	0 to 5.5	V
Bus I/O voltage	$V_{I/O}$	0 to 5.5 (Note 2)	V
		0 to V_{CC} (Note 3)	
Output current	I_{OH}/I_{OL}	±24 (Note 4)	mA
		±12 (Note 5)	
		±8 (Note 6)	
Operating temperature	T_{opr}	−40 to 125 (Note 7)	°C
Input rise and fall time	dt/dv	0 to 10 (Note 8)	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. Please connect both bus inputs and the bus outputs with V_{CC} 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 1: Data retention only

Note 2: Output in OFF state

Note 3: High or low state

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

Note 5: V_{CC} = 2.7 to 3.0 V

Note 6: V_{CC} = 2.3 to 2.7 V

Note 7: Operating Range spec of Topr= -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

Note 8: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Unless otherwise specified, Ta = -40 to 85°C)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	H-level	V_{IH}	—		2.3 to 2.7	1.7	—	V
					2.7 to 3.6	2.0	—	
	L-level	V_{IL}	—		2.3 to 2.7	—	0.7	
					2.7 to 3.6	—	0.8	
Output voltage	H-level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −100 μA	2.3 to 3.6	V_{CC} − 0.2	—	V
				I_{OH} = −8 mA	2.3	1.8	—	
				I_{OH} = −12 mA	2.7	2.2		
				I_{OH} = −18 mA	3.0	2.4	—	
				I_{OH} = −24 mA	3.0	2.2	—	
	L-level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 3.6	—	0.2	
				I_{OL} = 8 mA	2.3	—	0.6	
				I_{OL} = 12 mA	2.7	—	0.4	
				I_{OL} = 16 mA	3.0	—	0.4	
				I_{OL} = 24 mA	3.0	—	0.55	
Input leakage current		I_{IN}	V_{IN} = 0 to 5.5 V		2.3 to 3.6	—	±5.0	μA
3-state output OFF state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 5.5 V		2.3 to 3.6	—	±5.0	μA
Power-off leakage current		I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		2.3 to 3.6	—	20.0	μA
			V_{IN}/V_{OUT} = 3.6 to 5.5 V		2.3 to 3.6	—	±20.0	
Increase in I_{CC} per input		ΔI_{CC}	V_{IH} = V_{CC} − 0.6 V		2.3 to 3.6	—	500	

DC Characteristics (Note) (Unless otherwise specified, Ta = -40 to 125°C)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	H-level	V_{IH}	—		2.3 to 2.7	1.7	—	V
					2.7 to 3.6	2.0	—	
	L-level	V_{IL}	—		2.3 to 2.7	—	0.7	
					2.7 to 3.6	—	0.8	
Output voltage	H-level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −100 μA	2.3 to 3.6	V_{CC} − 0.2	—	V
				I_{OH} = −8 mA	2.3	1.55	—	
				I_{OH} = −12 mA	2.7	2.0	—	
				I_{OH} = −18 mA	3.0	2.2	—	
				I_{OH} = −24 mA	3.0	1.9	—	
	L-level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 3.6	—	0.2	
				I_{OL} = 8 mA	2.3	—	0.9	
				I_{OL} = 12 mA	2.7	—	0.6	
				I_{OL} = 16 mA	3.0	—	0.6	
				I_{OL} = 24 mA	3.0	—	0.8	
Input leakage current		I_{IN}	V_{IN} = 0 to 5.5 V		2.3 to 3.6	—	±20.0	μA
3-state output OFF state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 5.5 V		2.3 to 3.6	—	±20.0	μA
Power-off leakage current		I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	40.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		2.3 to 3.6	—	80.0	μA
			V_{IN}/V_{OUT} = 3.6 to 5.5 V		2.3 to 3.6	—	±80.0	
Increase in I_{CC} per input		ΔI_{CC}	V_{IH} = V_{CC} − 0.6 V		2.3 to 3.6	—	5000	

Note : Operating Range spec of Topr= -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

AC Characteristics (Unless otherwise specified, Ta = –40 to 85°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	CL(pF)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	2.5 ± 0.2	30	1.5	5.4	ns
			2.7	50	1.5	5.2	
			3.3 ± 0.3	50	1.5	4.5	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	8.5	ns
			2.7	50	1.5	7.2	
			3.3 ± 0.3	50	1.5	6.5	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	7.7	ns
			2.7	50	1.5	6.9	
			3.3 ± 0.3	50	1.5	6.0	
Output to output skew	t_{osLH} t_{osHL}	(Note)	2.5 ± 0.2	30	—	—	ns
			2.7	50	—	—	
			3.3 ± 0.3	50	—	1.0	

Note: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

AC Characteristics (Note) (Unless otherwise specified, Ta = –40 to 125°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	CL(pF)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	2.5 ± 0.2	30	1.5	5.9	ns
			2.7	50	1.5	5.7	
			3.3 ± 0.3	50	1.5	4.9	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	9.4	ns
			2.7	50	1.5	8.0	
			3.3 ± 0.3	50	1.5	7.2	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	2.5 ± 0.2	30	1.5	8.5	ns
			2.7	50	1.5	7.6	
			3.3 ± 0.3	50	1.5	6.6	
Output to output skew	t_{osLH} t_{osHL}	(Note1)	2.5 ± 0.2	30	—	—	ns
			2.7	50	—	—	
			3.3 ± 0.3	50	—	1.0	

Note : Operating Range spec of Topr= -40 °C to 125 °C is applicable only for the products which manufactured after April 2020.

Note 1: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

Dynamic Switching Characteristics

(Ta = 25°C, input: $t_r = t_f = 2.5$ ns, $R_L = 500\ \Omega$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 2.5 V, V_{IL} = 0 V, C_L =30pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L =50pF	3.3	0.8	
Quiet output minimum dynamic V_{OL}	$\lvert V_{OLV} \rvert$	V_{IH} = 2.5 V, V_{IL} = 0 V, C_L =30pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L =50pF	3.3	0.8	

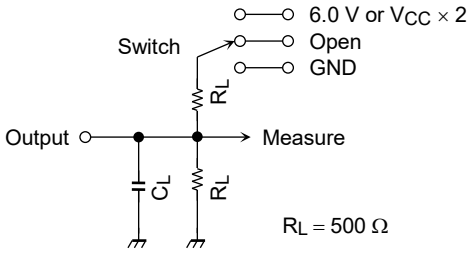
Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—	3.3	7	pF
Bus input capacitance	$C_{I/O}$	—	3.3	8	pF
Power dissipation capacitance	C_{PD}	f_{IN} = 10 MHz (Note)	3.3	25	pF

Note: 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:

$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16$ (per bit)

AC Test Circuit



Parameter	Switch	
t_{pLH}, t_{pHL}	Open	
t_{pLZ}, t_{pZL}	6.0 V V_{CC} × 2	@V_{CC} = 3.3 ± 0.3 V @V_{CC} = 2.5 ± 0.2 V
t_{pHZ}, t_{pZH}	GND	

Figure 1

AC Waveform

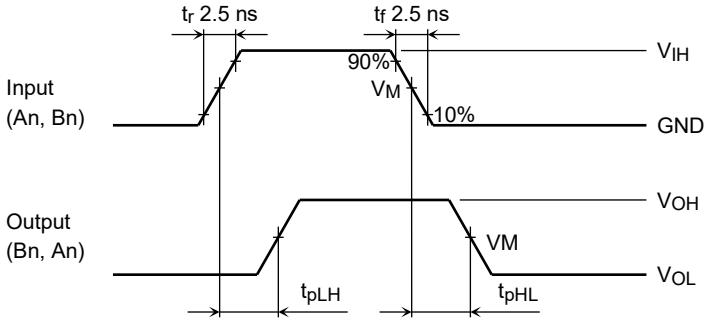


Figure 2 t_{pLH}, t_{pHL}

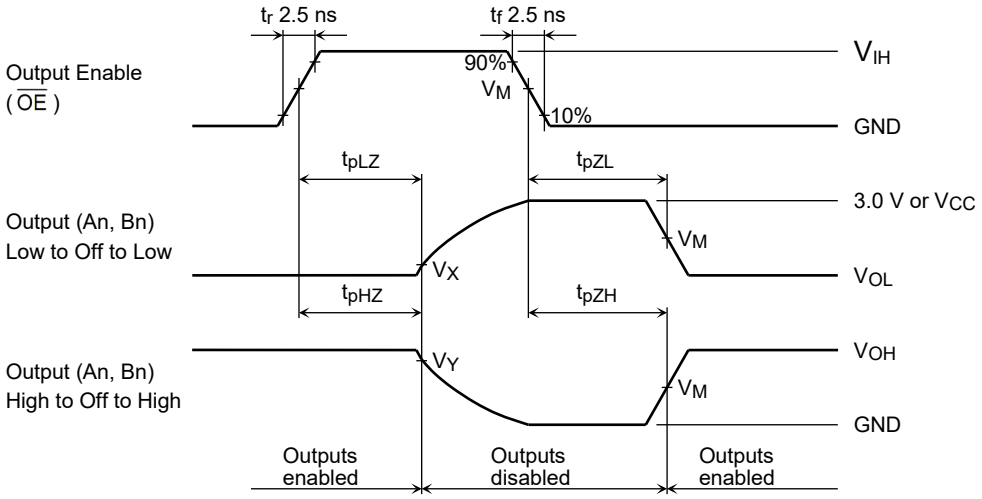
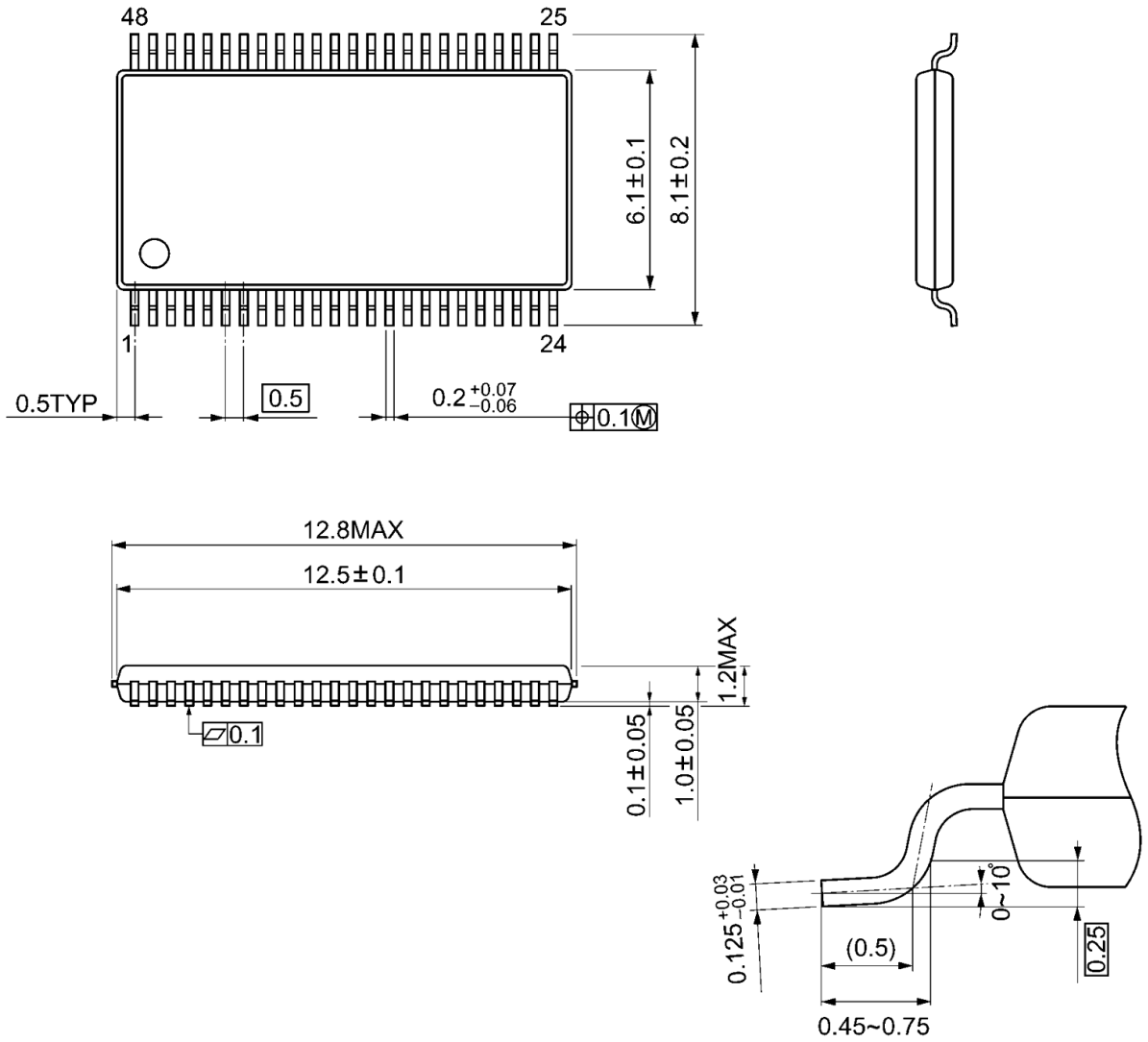


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.7 V	2.5 ± 0.2 V
V_{IH}	2.7 V	2.7 V	V_{CC}
V_M	1.5 V	1.5 V	V_{CC}/2
V_X	V_{OL} + 0.3 V	V_{OL} + 0.3 V	V_{OL} + 0.15 V
V_Y	V_{OH} − 0.3 V	V_{OH} − 0.3 V	V_{OH} − 0.15 V

Package Dimensions

TSSOP48-P-0061-0.50A Unit: mm



Weight: 0.25 g (typ.)

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