CMOS Digital Integrated Circuits Silicon Monolithic

TC74LCX16244

1. Functional Description

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

2. General

The TC74LCX16244 is a high-performance CMOS 16-bit bus buffer. 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 device is non-inverting 3-state buffer having four active-low output enables. It can be used as four 4-bit buffers two 8-bit buffers or one 16-bit buffer. When the $\overline{OE}$ input is high, the outputs are in a high-impedance state. This device is designed to be used with 3-state memory address drivers, etc.

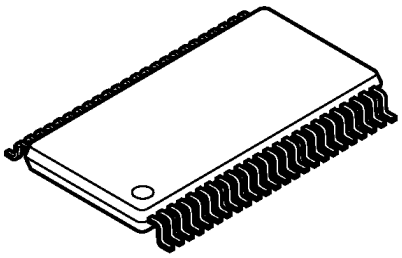
All inputs are equipped with protection circuits against static discharge.

3. Features (Note)

(1) Wide operating temperature range: T_{opr} = -40 to 125 °C (Note 1)
(2) Low-voltage operation: V_{CC} = 2.0 to 3.6 V
(3) High-speed operation: t_{pd} = 4.5 ns (max) (V_{CC} = 3.0 to 3.6 V)
(4) Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)
(5) Package: TSSOP
(6) Power-down protection provided on all inputs and outputs

Note 1: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after January 2020.

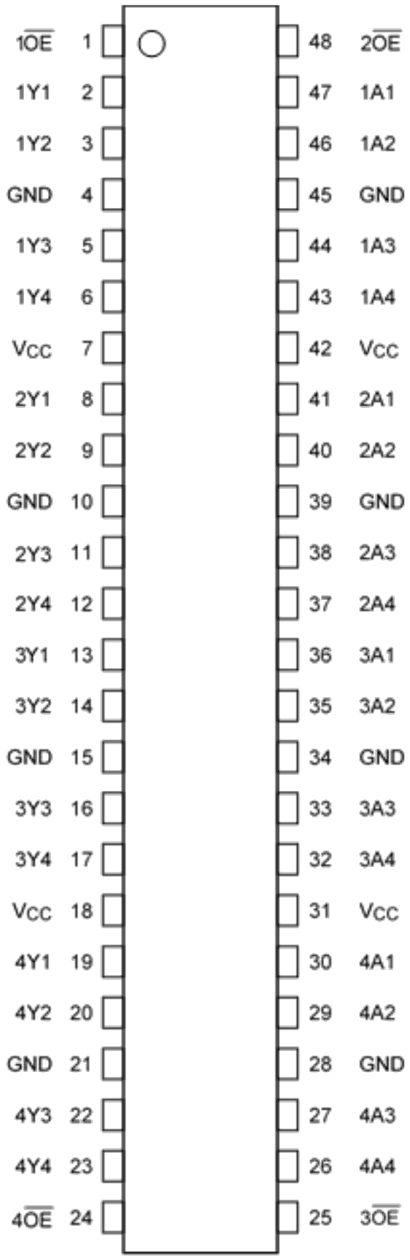
4. Packaging



TSSOP48

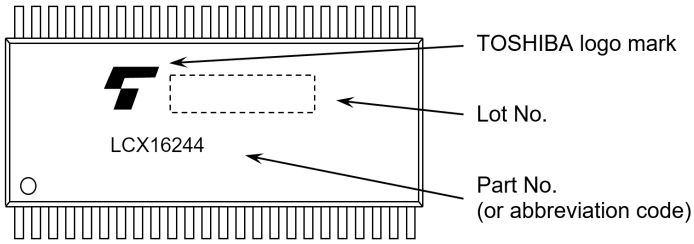
Start of commercial production
2020-01

5. Pin Assignment

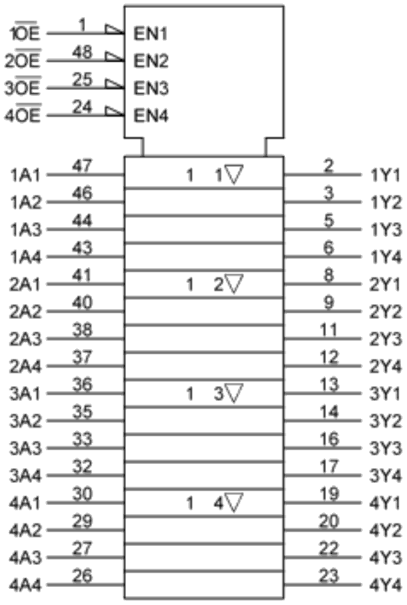


(top view)

6. Marking



7. IEC Logic Symbol

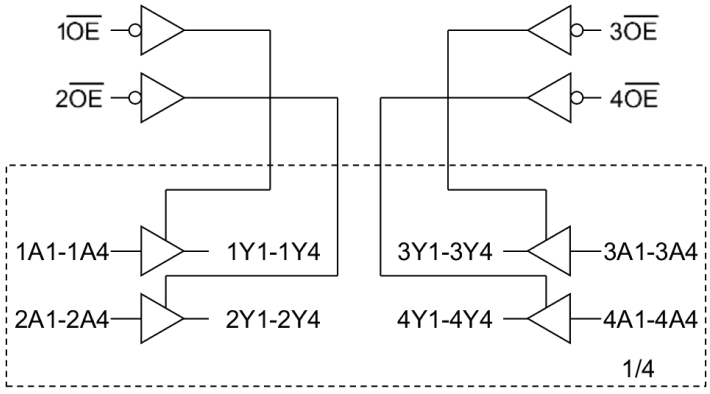


8. Truth Table

Inputs $1\overline{OE}$ $2\overline{OE}$ $3\overline{OE}$ $4\overline{OE}$	Inputs 1A1-1A4 2A1-2A4 3A1-3A4 4A1-4A4	Outputs 1Y1-1Y4 2Y1-2Y4 3Y1-3Y4 4Y1-4Y4
L	L	L
L	H	H
H	X	Z

X: Don't care
Z: High impedance

9. System Diagram



10. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 6.0	V
Input voltage	V_{IN}		-0.5 to 7.0	V
Output voltage	V_{OUT}	(Note 1)	-0.5 to 7.0	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	(Note 4)	400	mW
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 (H) or Low (L) 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.

11. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		2.0 to 3.6	V
		(Note 1)	1.5 to 3.6	
Input voltage	V_{IN}		0 to 5.5	V
Output voltage	V_{OUT}	(Note 2)	0 to 5.5	V
		(Note 3)	0 to V_{CC}	
Output current	I_{OH},I_{OL}	(Note 4)	±24	mA
		(Note 5)	±12	
		(Note 6)	±8	
Operating temperature	T_{opr}	(Note 7)	-40 to 125	°C
Input rise and fall times	dt/dv	(Note 8)	0 to 10	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs and bus 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 (H) or Low (L) 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 T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after January 2020.
Note 8: V_{IN} = 0.8 to 2.0 V , V_{CC} = 3.0 V

12. Electrical Characteristics

12.1. 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}	—		2.3 to 2.7	1.7	—	V
				2.7 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		2.3 to 2.7	—	0.7	V
				2.7 to 3.6	—	0.8	
High-level output voltage	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	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 3.6	—	0.2	V
			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 leakage 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	
	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per input)		2.3 to 3.6	—	500	μA

12.2. DC Characteristics (Note) (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}	—		2.3 to 2.7	1.7	—	V
				2.7 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		2.3 to 2.7	—	0.7	V
				2.7 to 3.6	—	0.8	
High-level output voltage	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	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 3.6	—	0.2	V
			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 leakage 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	
	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per input)		2.3 to 3.6	—	5000	μA

Note: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after January 2020.

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	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}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1	2.5 ± 0.2	30	1.5	7.2	ns
				2.7	50	1.5	6.3	
				3.3 ± 0.3	50	1.5	5.5	
3-state output disable time	t_{PLZ},t_{PHZ}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1	2.5 ± 0.2	30	1.5	6.5	ns
				2.7	50	1.5	5.7	
				3.3 ± 0.3	50	1.5	5.4	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	2.5 ± 0.2	30	—	—	ns
				2.7	50	—	—	
				3.3 ± 0.3	50	—	1.0	

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

12.4. AC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	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}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1	2.5 ± 0.2	30	1.5	8.0	ns
				2.7	50	1.5	7.0	
				3.3 ± 0.3	50	1.5	6.1	
3-state output disable time	t_{PLZ},t_{PHZ}		See 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.2, Table 12.8.1	2.5 ± 0.2	30	1.5	7.2	ns
				2.7	50	1.5	6.3	
				3.3 ± 0.3	50	1.5	6.0	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	2.5 ± 0.2	30	—	—	ns
				2.7	50	—	—	
				3.3 ± 0.3	50	—	1.0	

Note: Operating Range spec of T_{opr} = -40 °C to 125 °C is applicable only for the products which manufactured after January 2020.

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

12.5. Dynamic Switching Characteristics (Unless otherwise specified, T_a = 25°C, Input: $t_r = t_f$ = 2.5 ns, R_L = 500 Ω)

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 = 30 pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L = 50 pF	3.3	0.8	
Quiet output minimum dynamic V_{OL}	$\|V_{OLV}\|$	V_{IH} = 2.5 V, V_{IL} = 0 V, C_L = 30 pF	2.5	0.6	V
		V_{IH} = 3.3 V, V_{IL} = 0 V, C_L = 50 pF	3.3	0.8	

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}		—	3.3	7	pF
Bus I/O capacitance	$C_{I/O}$		—	3.3	8	pF
Power dissipation capacitance	C_{PD}	(Note 1)	f_{IN} = 10 MHz	3.3	25	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.

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

12.7. AC Test Circuit

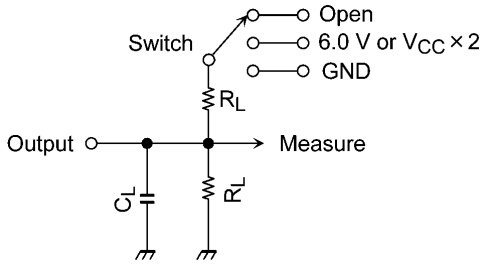


Table 12.7.1 Parameter for AC Test Circuit

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
t_{PHZ}, t_{PZH}	GND	—

12.8. AC Waveform

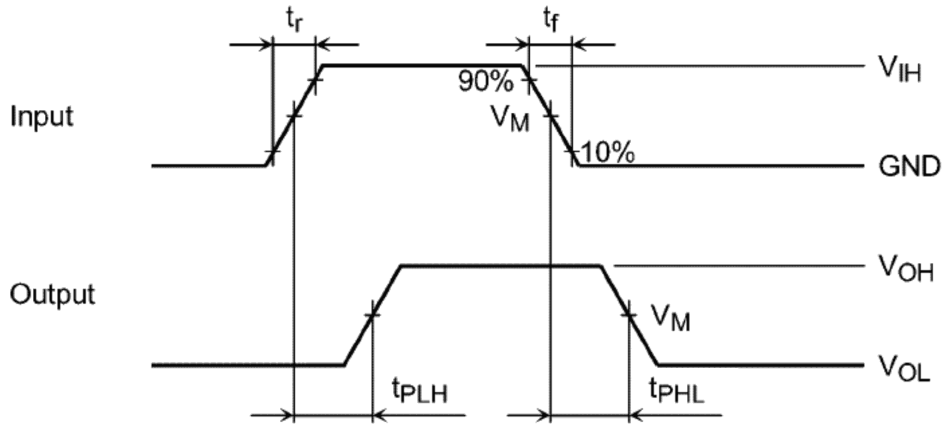


Fig. 12.8.1 t_{PLH}, t_{PHL}

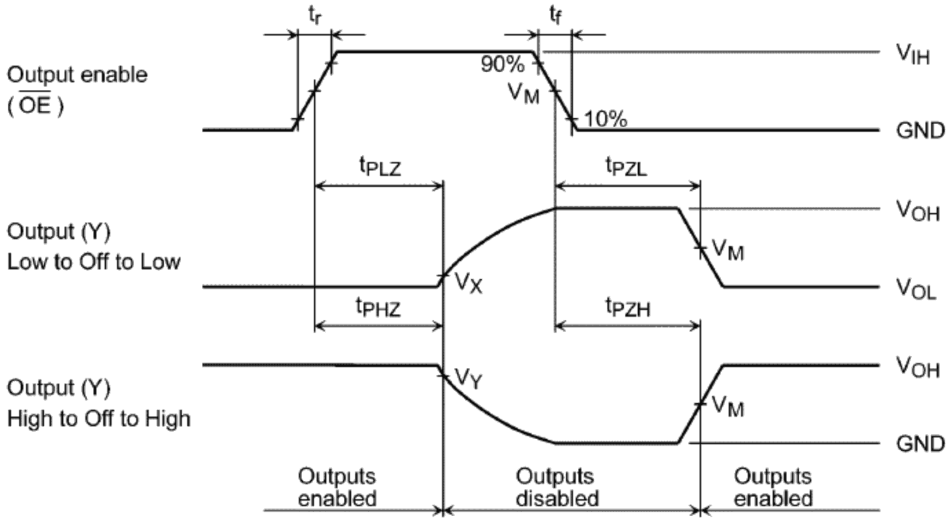


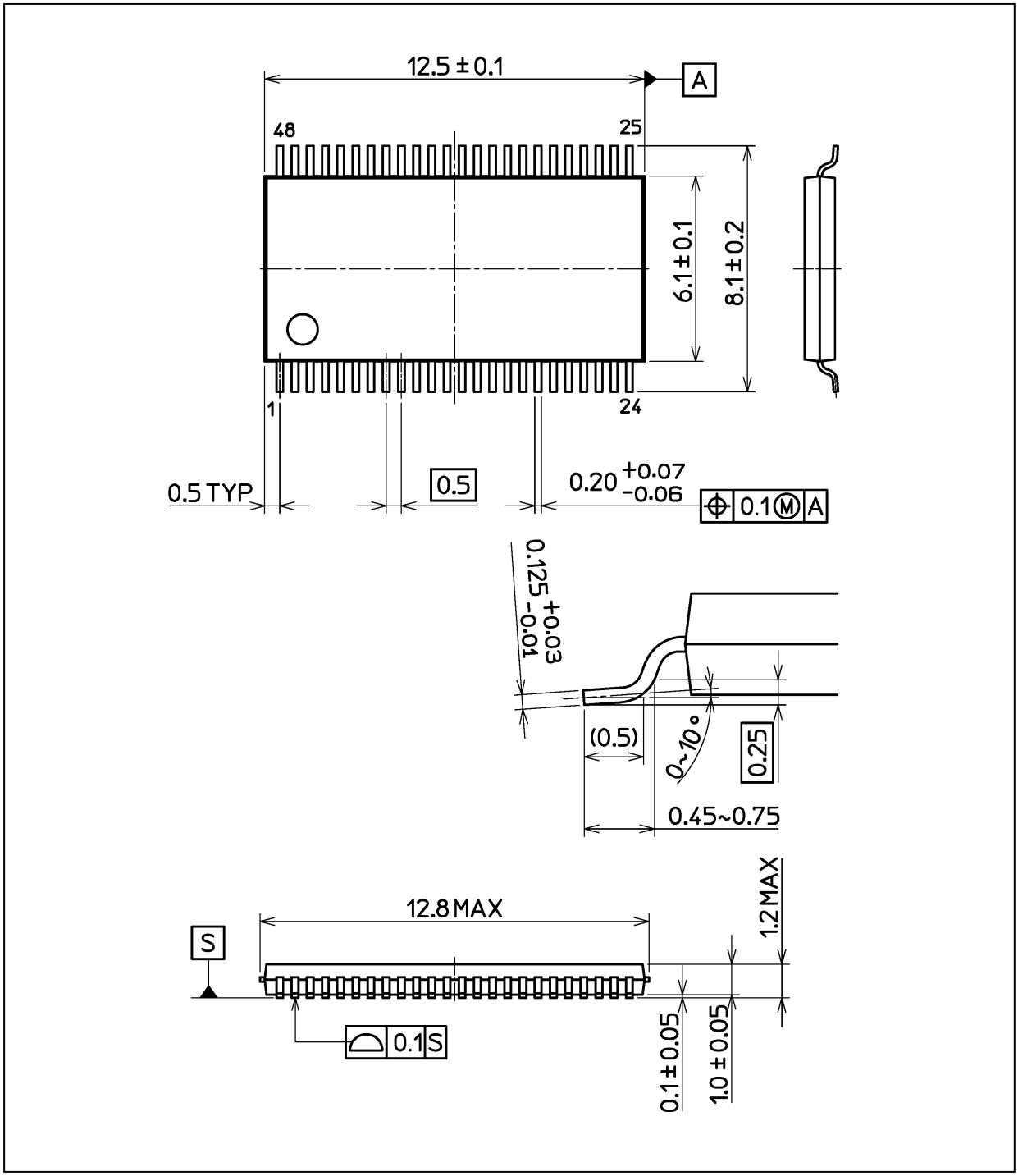
Fig. 12.8.2 t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

Table 12.8.1 AC Waveform Symbols

Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.7 V	V_{CC} = 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
C_L	50 pF	30 pF	30 pF
R_L	500 Ω	500 Ω	500 Ω

Package Dimensions

Unit: mm



Weight: 0.25 g (typ.)

Package Name(s)
Nickname: TSSOP48

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