CMOS Digital Integrated Circuits Silicon Monolithic

T74VCXHR162245

1. Functional Description

- Low-Voltage 16-Bit Bus Transceiver with Bushold and Series Resistor

2. General

The T74VCXHR162245 is a high-performance CMOS 16-bit 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.

This 16-bit bus transceiver is controlled by direction control (DIR) inputs and output enable ($\overline{OE}$) inputs which are common to each byte. It can be used as two 8-bit transceivers 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.

The 26 Ω series resistor helps reducing output overshoot and undershoot without external resistor.

The A, B data inputs include active bushold circuitry, eliminating the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

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) 26 Ω series resistors on all outputs

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

(4) Bushold on data inputs eliminating the need for external pull-up, pull-down resistors

(5) High-speed operation: t_{pd} = 3.4 ns (max) (V_{CC} = 3.0 to 3.6 V)
t_{pd} = 4.3 ns (max) (V_{CC} = 2.3 to 2.7 V)
t_{pd} = 5.7 ns (max) (V_{CC} = 1.8 V)

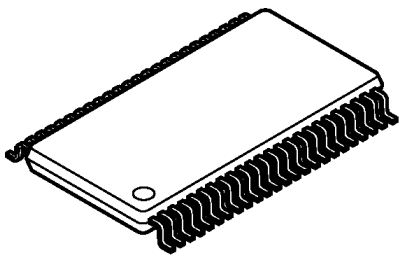
(6) Output current: I_{OH}/I_{OL} = ±12 mA (min) (V_{CC} = 3.0 V)
I_{OH}/I_{OL} = ±8 mA (min) (V_{CC} = 2.3 V)
I_{OH}/I_{OL} = ±4 mA (min) (V_{CC} = 1.8 V)

(7) 3.6-V tolerant control inputs

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

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

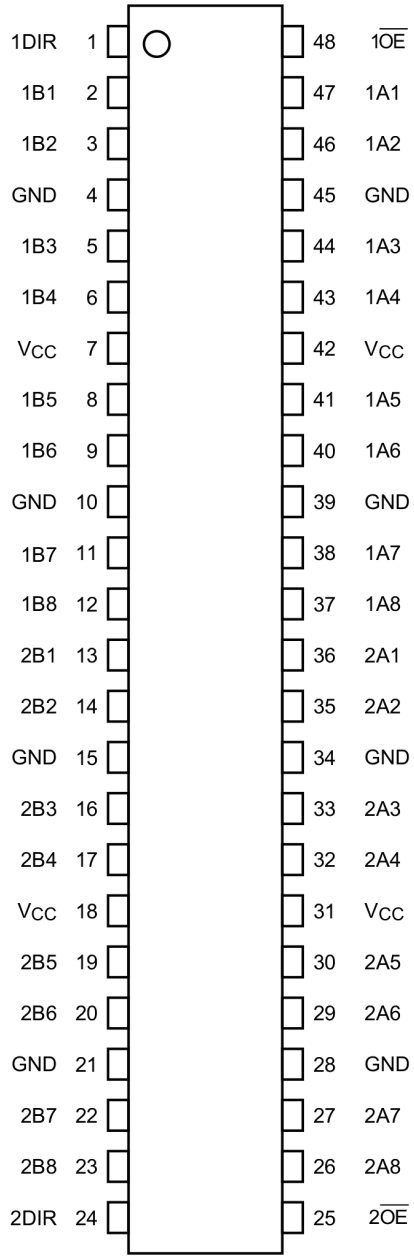
4. Packaging



TSSOP48

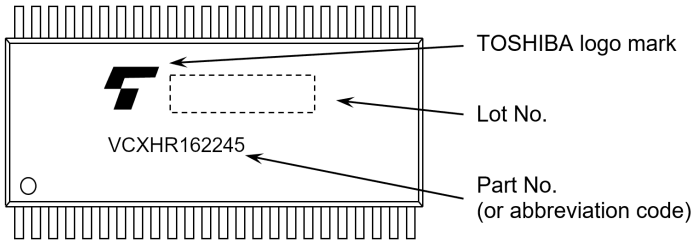
Start of commercial production
2020-04

5. Pin Assignment

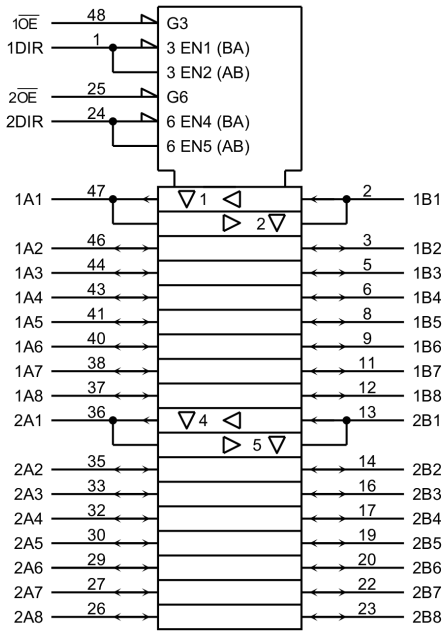


(top view)

6. Marking



7. IEC Logic Symbol

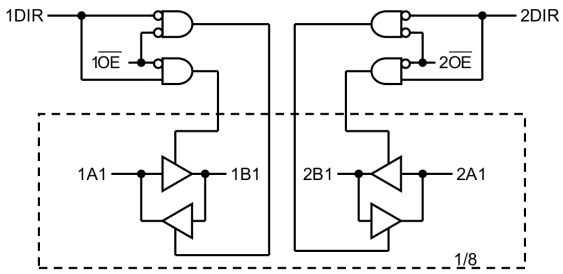


8. Truth Table

Inputs 1$\overline{OE}$ 2$\overline{OE}$	Inputs 1DIR 2DIR	Outputs	Function Bus 1A1-1A8 Bus 2A1-2A8	Function Bus 1B1-1B8 Bus 2B1-2B8
L	L	A = B	Output	Input
L	H	B = A	Input	Output
H	X	Z	Z	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 4.6	V
Input voltage (DIR/$\overline{OE}$)	V_{IN}		-0.5 to 4.6	V
Bus I/O voltage	$V_{I/O}$	(Note 1)	-0.5 to V_{CC} + 0.5	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}		1.8 to 3.6	V
		(Note 1)	1.2 to 3.6	
Input voltage (DIR/$\overline{OE}$)	V_{IN}		-0.3 to 3.6	V
Bus I/O voltage	$V_{I/O}$	(Note 2)	0 to V_{CC}	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}	(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: Floating or unused control inputs must be held high or low.

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: Operating Range spec of T_{opr} = -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

12. Electrical Characteristics

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

Characteristics	Symbol	Note	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 (DIR/$\overline{OE}$)	I_{IN}		V_{IN} = 0 to 3.6 V		1.8 to 3.6	—	±5.0	μA
Bushold input minimum drive hold current	$I_{I(HOLD)}$		V_{IN} = 0.36 V		1.8	25	—	μA
			V_{IN} = 1.26 V		1.8	-25	—	
			V_{IN} = 0.7 V		2.3	45	—	
			V_{IN} = 1.6 V		2.3	-45	—	
			V_{IN} = 0.8 V		3.0	75	—	
			V_{IN} = 2.0 V		3.0	-75	—	
Bushold input over-drive current to change state	$I_{I(OD)}$	(Note 1)	V_{IN} = L → H		1.8	—	200	μA
			V_{IN} = H → L		1.8	—	-200	
			V_{IN} = L → H		2.3	—	300	
			V_{IN} = H → L		2.3	—	-300	
			V_{IN} = L → H		3.6	—	500	
			V_{IN} = H → L		3.6	—	-500	
3-state output OFF-state leakage current	I_{OZ}		V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 3.6 V		1.8 to 3.6	—	±10.0	
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND		1.8 to 3.6	—	20.0	μA
	ΔI_{CC}		V_{IH} = V_{CC} - 0.6 V (per input)		2.7 to 3.6	—	750	μA

Note 1: It is a necessary electric current to change the input in "L" or "H".

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

Characteristics	Symbol	Note	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 (DIR/$\overline{OE}$)	I_{IN}		V_{IN} = 0 to 3.6 V		1.8 to 3.6	—	±20.0	μA
Bushold input minimum drive hold current	$I_{I(HOLD)}$		V_{IN} = 0.36 V		1.8	25	—	μA
			V_{IN} = 1.26 V		1.8	-25	—	
			V_{IN} = 0.7 V		2.3	45	—	
			V_{IN} = 1.6 V		2.3	-45	—	
			V_{IN} = 0.8 V		3.0	75	—	
			V_{IN} = 2.0 V		3.0	-75	—	
Bushold input over-drive current to change state	$I_{I(OD)}$	(Note 1)	V_{IN} = L → H		1.8	—	200	μA
			V_{IN} = H → L		1.8	—	-200	
			V_{IN} = L → H		2.3	—	300	
			V_{IN} = H → L		2.3	—	-300	
			V_{IN} = L → H		3.0	—	500	
			V_{IN} = H → L		3.0	—	-500	
3-state output OFF-state leakage current	I_{OZ}		V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0 to 3.6 V		1.8 to 3.6	—	±40.0	μA
Quiescent supply current	I_{CC}		V_{IN} = V_{CC} or GND		1.8 to 3.6	—	80.0	μA
	ΔI_{CC}		V_{IH} = V_{CC} - 0.6 V (per input)		2.7 to 3.6	—	1.5	mA

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

Note 1: It is a necessary electric current to change the input in "L" or "H".

12.3. 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 12.7 AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	1.5	5.7	ns
				2.5 ± 0.2	1.0	4.3	
				3.3 ± 0.3	0.8	3.4	
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	1.8 ± 0.15	1.5	7.6	ns
				2.5 ± 0.2	1.0	5.7	
				3.3 ± 0.3	0.8	4.2	
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	1.8 ± 0.15	1.5	5.7	ns
				2.5 ± 0.2	1.0	4.8	
				3.3 ± 0.3	0.8	4.1	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	1.8 ± 0.15	—	0.5	ns
				2.5 ± 0.2	—	0.5	
				3.3 ± 0.3	—	0.5	

Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLHm} - t_{PLHn}|$, $t_{osHL} = |t_{PHLm} - t_{PHLn}|$)

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	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	1.8 ± 0.15	1.5	6.8	ns
				2.5 ± 0.2	1.0	5.1	
				3.3 ± 0.3	0.8	4.1	
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	1.8 ± 0.15	1.5	9.0	ns
				2.5 ± 0.2	1.0	6.8	
				3.3 ± 0.3	0.8	5.0	
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	1.8 ± 0.15	1.5	6.8	ns
				2.5 ± 0.2	1.0	5.7	
				3.3 ± 0.3	0.8	4.9	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	1.8 ± 0.15	—	1.0	ns
				2.5 ± 0.2	—	1.0	
				3.3 ± 0.3	—	1.0	

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

Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLHm} - t_{PLHn}|$, $t_{osHL} = |t_{PHLm} - t_{PHLn}|$)

12.5. 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_{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.

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}		—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	$C_{I/O}$		—	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.

$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$ (per gate)

12.7. AC Test Circuit

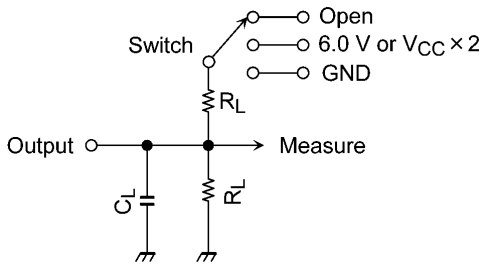


Table 12.7.1 Parameter for AC Test Circuit

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
		V_{CC} = 1.8 ± 0.15 V
t_{PHZ}, t_{PZH}	GND	—

12.8. AC Waveform

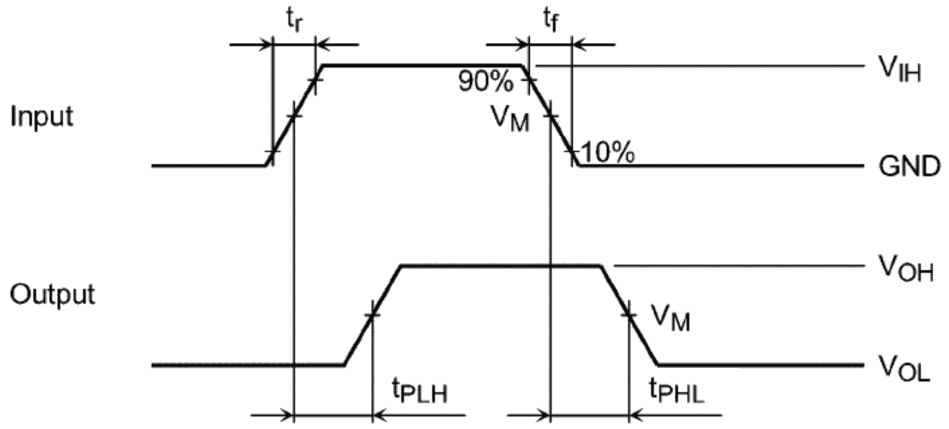


Fig. 12.8.1 t_{PLH}, t_{PHL}

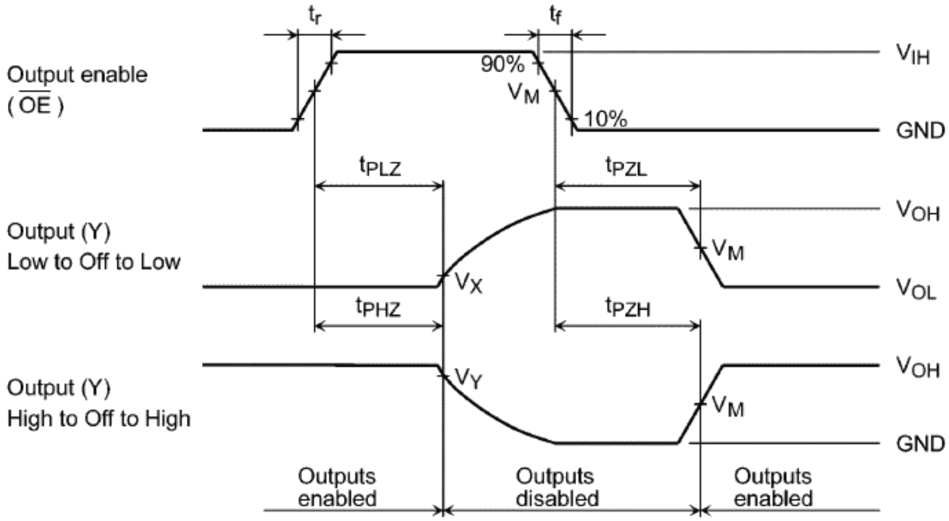


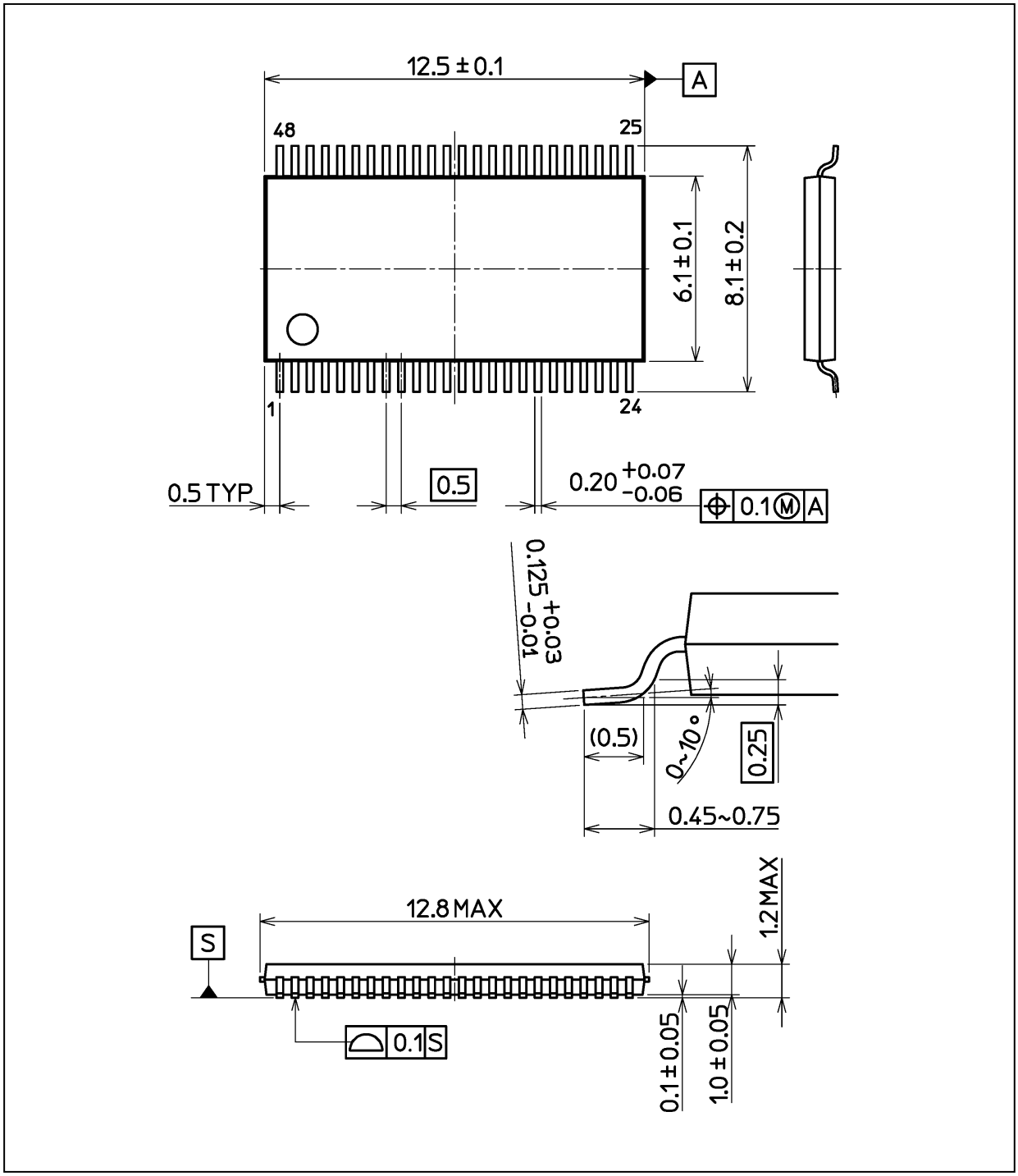
Fig. 12.8.2 t_{PLZ}, t_{PHZ}, t_{PZL}, t_{PZH}

Table 12.8.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 0.15 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	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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