

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 ($\overline{\text{OE}}$) 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 $\overline{\text{OE}}$ 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.

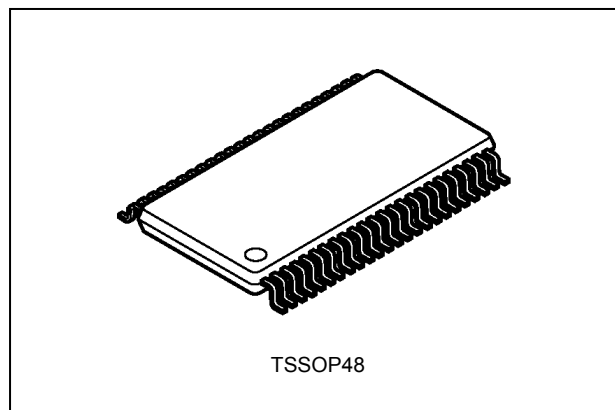
3. Features (Note)

- (1) Wide operating temperature range: $T_{\text{opr}} = -40$ to 125 °C (Note 1)
- (2) 26 Ω series resistors on all outputs
- (3) Low-voltage operation: $V_{\text{CC}} = 1.8$ to 3.6 V
- (4) Bushold on data inputs eliminating the need for external pull-up, pull-down resistors
- (5) High-speed operation: $t_{\text{pd}} = 3.4$ ns (max) ($V_{\text{CC}} = 3.0$ to 3.6 V)
 $t_{\text{pd}} = 4.3$ ns (max) ($V_{\text{CC}} = 2.3$ to 2.7 V)
 $t_{\text{pd}} = 5.7$ ns (max) ($V_{\text{CC}} = 1.8$ V)
- (6) Output current: $I_{\text{OH}}/I_{\text{OL}} = \pm 12$ mA (min) ($V_{\text{CC}} = 3.0$ V)
 $I_{\text{OH}}/I_{\text{OL}} = \pm 8$ mA (min) ($V_{\text{CC}} = 2.3$ V)
 $I_{\text{OH}}/I_{\text{OL}} = \pm 4$ mA (min) ($V_{\text{CC}} = 1.8$ 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.

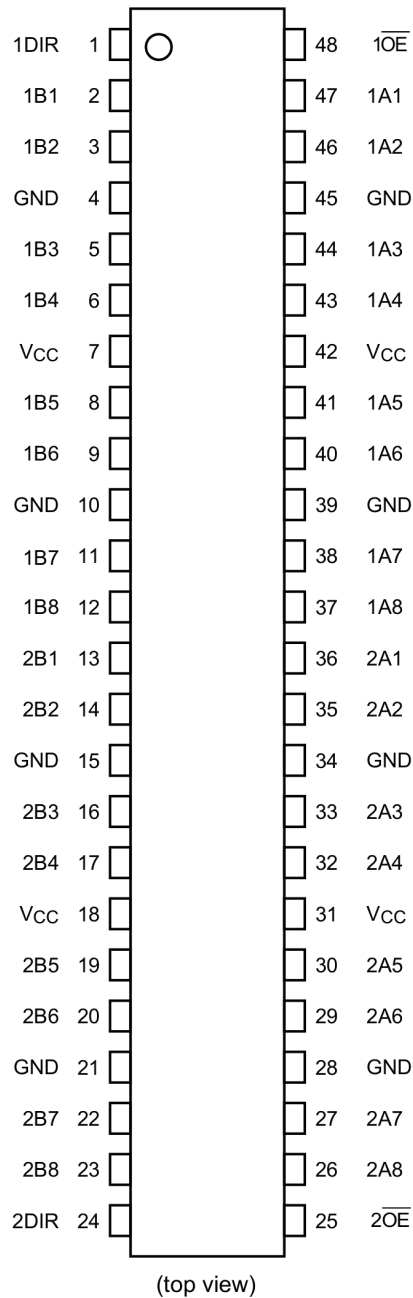
Note 1: Operating Range spec of $T_{\text{opr}} = -40$ °C to 125 °C is applicable only for the products which manufactured after April 2020.

4. Packaging

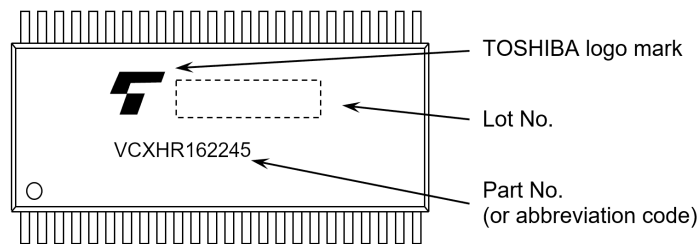


Start of commercial production
2020-04

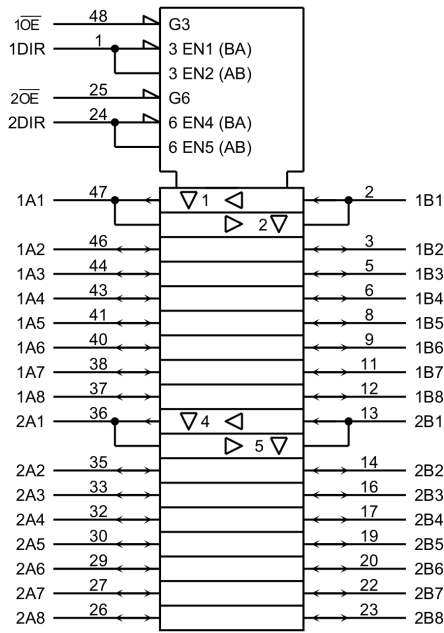
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

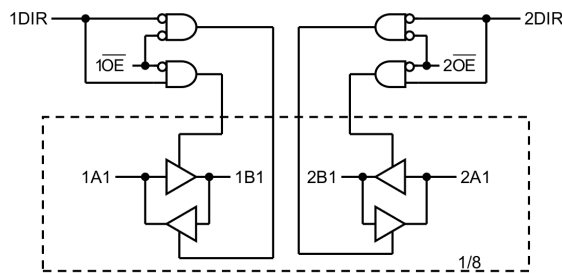


8. Truth Table

Inputs 1OE 2OE	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	$^{\circ}C$

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 $T_a = -40$ to $85^{\circ}C$. From $T_a = 85$ to $125^{\circ}C$ a derating factor of -6.25 mW/ $^{\circ}C$ 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	$^{\circ}C$
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 $T_{opr} = -40^{\circ}C$ to $125^{\circ}C$ 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	$V_{CC} \times 0.7$	—	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	—	$V_{CC} \times 0.2$	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}	$I_{OH} = -100 \mu\text{A}$	1.8 to 3.6	$V_{CC} - 0.2$	V	
				$I_{OH} = -4 \text{ mA}$	1.8	1.4		—
					2.3	2.0		—
				$I_{OH} = -6 \text{ mA}$	2.3	1.8		—
					2.7	2.2		—
				$I_{OH} = -8 \text{ mA}$	2.3	1.7		—
$I_{OH} = -12 \text{ mA}$	3.0	2.2	—					
Low-level output voltage	V_{OL}		$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100 \mu\text{A}$	1.8 to 3.6	—	V	
				$I_{OL} = 4 \text{ mA}$	1.8	—		0.3
					2.3	—		0.4
				$I_{OL} = 6 \text{ mA}$	2.7	—		0.4
					2.3	—		0.6
				$I_{OL} = 8 \text{ mA}$	3.0	—		0.55
$I_{OL} = 12 \text{ mA}$	3.0	—	0.8					
Input leakage current (DIR/OE)	I_{IN}		$V_{IN} = 0$ to 3.6 V	1.8 to 3.6	—	± 5.0	μA	
Bushold input minimum drive hold current	$I_{I(\text{HOLD})}$		$V_{IN} = 0.36 \text{ V}$	1.8	25	—	μA	
			$V_{IN} = 1.26 \text{ V}$	1.8	-25	—		
			$V_{IN} = 0.7 \text{ V}$	2.3	45	—		
			$V_{IN} = 1.6 \text{ V}$	2.3	-45	—		
			$V_{IN} = 0.8 \text{ V}$	3.0	75	—		
			$V_{IN} = 2.0 \text{ V}$	3.0	-75	—		
Bushold input over-drive current to change state	$I_{I(\text{OD})}$	(Note 1)	$V_{IN} = L \rightarrow H$	1.8	—	200	μA	
			$V_{IN} = H \rightarrow L$	1.8	—	-200		
			$V_{IN} = L \rightarrow H$	2.3	—	300		
			$V_{IN} = H \rightarrow L$	2.3	—	-300		
			$V_{IN} = L \rightarrow H$	3.6	—	500		
			$V_{IN} = H \rightarrow L$	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}		$V_{IH} = V_{CC} - 0.6 \text{ V}$ (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	$V_{CC} \times 0.7$	—	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	—	$V_{CC} \times 0.2$	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}	$I_{OH} = -100 \mu A$	1.8 to 3.6	$V_{CC} - 0.2$	V	
				$I_{OH} = -4 \text{ mA}$	1.8	1.4		—
					2.3	2.0		—
				$I_{OH} = -6 \text{ mA}$	2.3	1.8		—
					2.7	2.2		—
				$I_{OH} = -8 \text{ mA}$	2.3	1.7		—
3.0	2.4	—						
Low-level output voltage	V_{OL}		$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100 \mu A$	1.8 to 3.6	—	V	
				$I_{OL} = 4 \text{ mA}$	1.8	—		0.3
					2.3	—		0.4
				$I_{OL} = 6 \text{ mA}$	2.7	—		0.4
					2.3	—		0.6
				$I_{OL} = 8 \text{ mA}$	3.0	—		0.55
$I_{OL} = 12 \text{ mA}$	3.0	—	0.8					
Input leakage current (DIR/OE)	I_{IN}		$V_{IN} = 0$ to 3.6 V	1.8 to 3.6	—	± 20.0	μA	
Bushold input minimum drive hold current	$I_{(HOLD)}$		$V_{IN} = 0.36 \text{ V}$	1.8	25	—	μA	
			$V_{IN} = 1.26 \text{ V}$	1.8	-25	—		
			$V_{IN} = 0.7 \text{ V}$	2.3	45	—		
			$V_{IN} = 1.6 \text{ V}$	2.3	-45	—		
			$V_{IN} = 0.8 \text{ V}$	3.0	75	—		
			$V_{IN} = 2.0 \text{ V}$	3.0	-75	—		
Bushold input over-drive current to change state	$I_{(OD)}$	(Note 1)	$V_{IN} = L \rightarrow H$	1.8	—	200	μA	
			$V_{IN} = H \rightarrow L$	1.8	—	-200		
			$V_{IN} = L \rightarrow H$	2.3	—	300		
			$V_{IN} = H \rightarrow L$	2.3	—	-300		
			$V_{IN} = L \rightarrow H$	3.0	—	500		
			$V_{IN} = H \rightarrow L$	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}		$V_{IH} = V_{CC} - 0.6 \text{ V}$ (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	$t_{oS LH}, t_{oS HL}$	(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. ($t_{oS LH} = |t_{PLHM} - t_{PLHN}|$, $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$)

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	$t_{oS LH}, t_{oS HL}$	(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 $T_{opr} = -40^\circ\text{C}$ to 125°C is applicable only for the products which manufactured after April 2020.

Note 1: Parameter guaranteed by design. ($t_{oS LH} = |t_{PLHM} - t_{PLHN}|$, $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$)

12.5. Dynamic Switching Characteristics (Note) (Unless otherwise specified, $T_a = 25^\circ\text{C}$, 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, $T_a = 25^\circ\text{C}$)

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)	$f_{IN} = 10 \text{ MHz}$	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.

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

12.7. AC Test Circuit

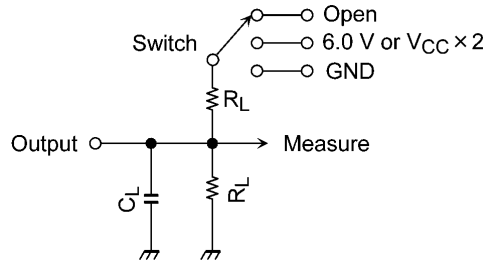


Table 12.7.1 Parameter for AC Test Circuit

Parameter	Switch	Test Condition
t_{PLH} , t_{PHL}	OPEN	—
t_{PLZ} , t_{PZL}	6.0 V	$V_{CC} = 3.3 \pm 0.3 \text{ V}$
	$V_{CC} \times 2$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$
		$V_{CC} = 1.8 \pm 0.15 \text{ V}$
t_{PHZ} , t_{PZH}	GND	—

12.8. AC Waveform

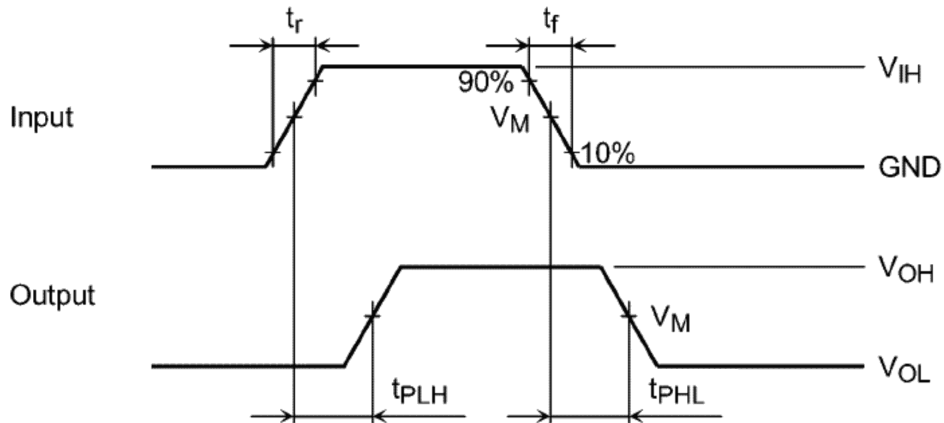


Fig. 12.8.1 t_{PLH} , t_{PHL}

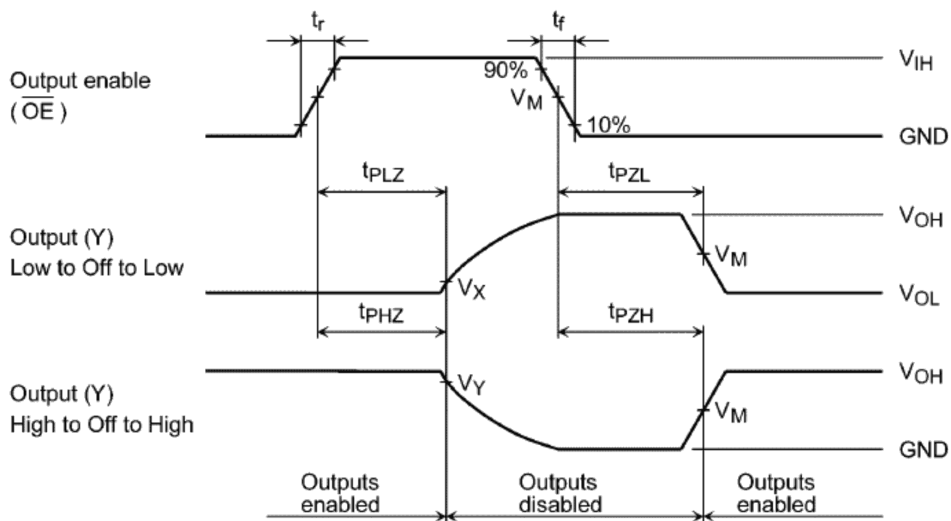


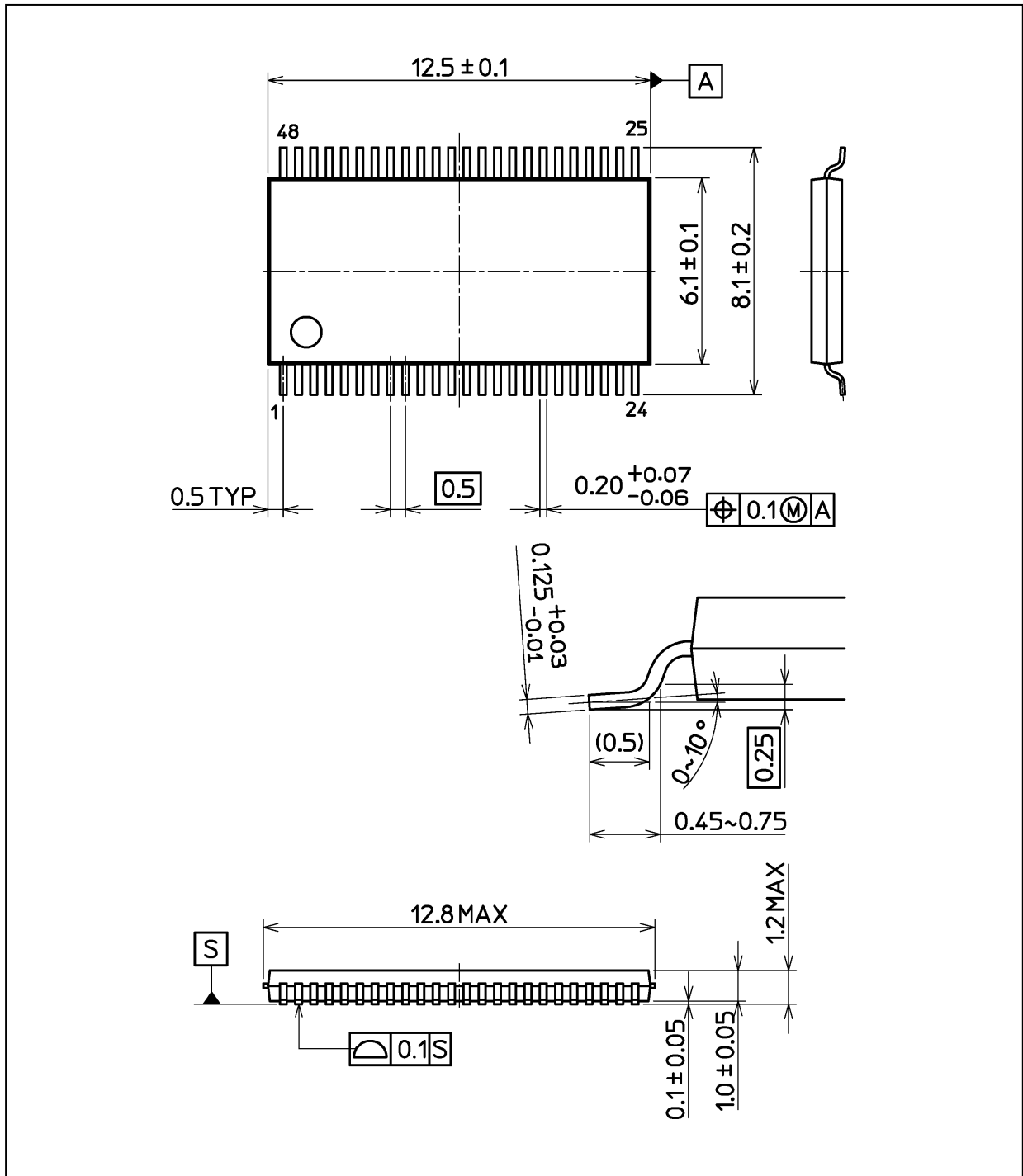
Fig. 12.8.2 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Table 12.8.1 AC Waveform Symbols

	Symbol	$V_{CC} = 3.3 \pm 0.3 \text{ V}$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$	$V_{CC} = 1.8 \pm 0.15 \text{ V}$
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	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
	V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
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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