

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCXHR162245FT

## Low-Voltage 16-Bit Bus Transceiver with Bushold

The TC74VCXHR162245FT 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.

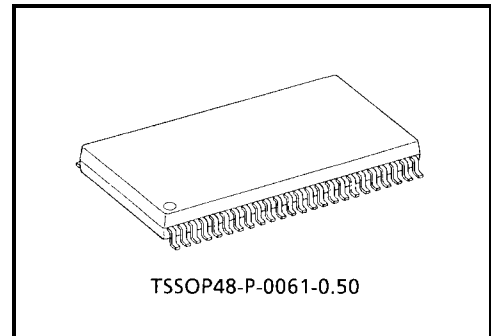
This 16-bit bus transceiver is controlled by direction control (DIR) inputs and output enable ( $\overline{OE}$ ) inputs which are common to each byte. It can be used as two 8-bit transceivers or one 16-bit transceiver. The direction of data transmission is determined by the level of the DIR inputs. The  $\overline{OE}$  inputs can be used to disable the device so that the busses are effectively isolated.

The 26- $\Omega$  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.



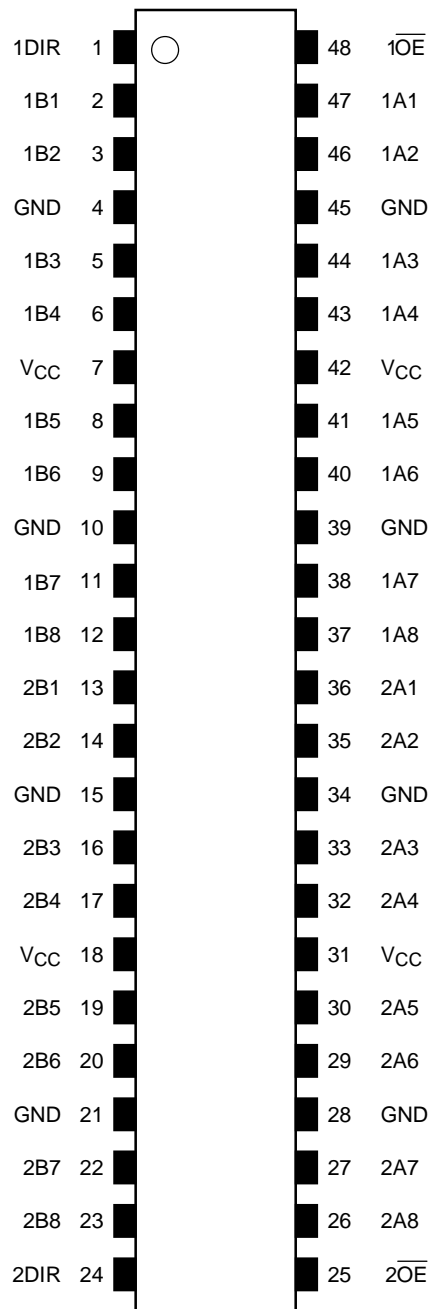
Weight: 0.25 g (typ.)

## Features

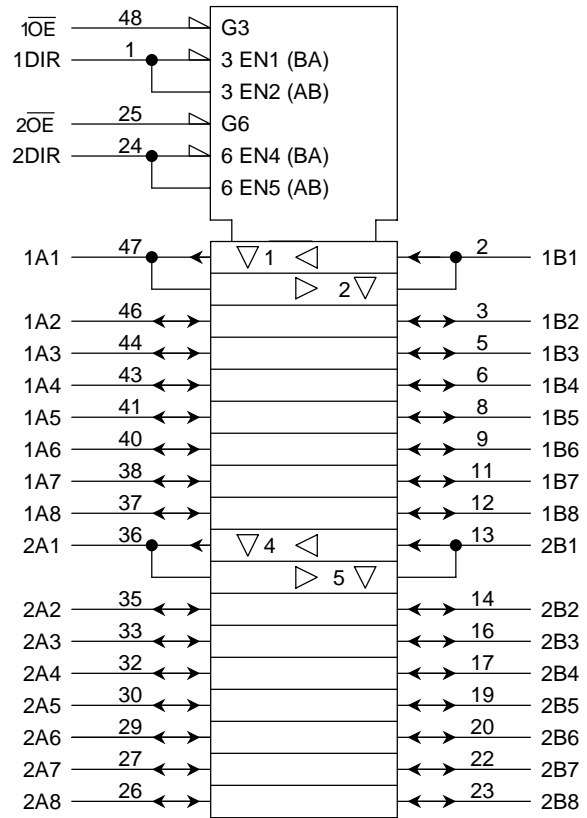
- 26- $\Omega$  series resistors on all outputs
- Low-voltage operation:  $V_{CC} = 1.8$  to 3.6 V
- Bushold on data inputs eliminating the need for external pull-up/pull-down resistors
- High-speed operation:  $t_{pd} = 3.4$  ns (max) ( $V_{CC} = 3.0$  to 3.6 V)  
:  $t_{pd} = 4.3$  ns (max) ( $V_{CC} = 2.3$  to 2.7 V)  
:  $t_{pd} = 5.7$  ns (max) ( $V_{CC} = 1.8$  V)
- 3.6-V tolerant control inputs.
- Output current:  $I_{OH}/I_{OL} = \pm 12$  mA (min) ( $V_{CC} = 3.0$  V)  
:  $I_{OH}/I_{OL} = \pm 8$  mA (min) ( $V_{CC} = 2.3$  V)  
:  $I_{OH}/I_{OL} = \pm 4$  mA (min) ( $V_{CC} = 1.8$  V)
- Latch-up performance:  $\pm 300$  mA
- ESD performance: Machine model  $> \pm 200$  V  
: Human body model  $> \pm 2000$  V
- Package: TSSOP (thin shrink small outline package)

Note 1: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.

## Pin Assignment (top view)



## IEC Logic Symbol



**Truth Table**

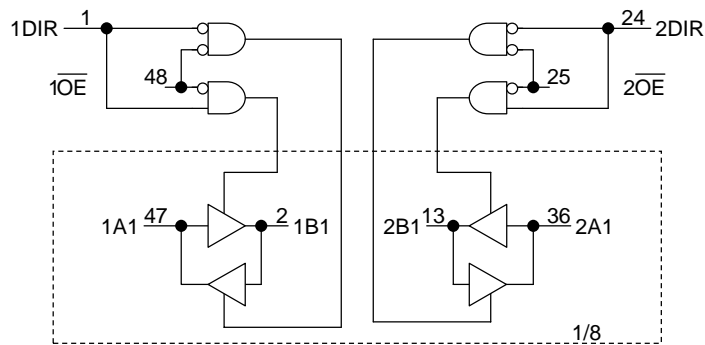
Inputs		Function		Outputs
$\overline{1OE}$	1DIR	Bus 1A1-1A8	Bus 1B1-1B8	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z		Z

Inputs		Function		Outputs
$\overline{2OE}$	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**



## Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5 to 4.6	V
DC input voltage	(DIR, $\overline{OE}$ )	-0.5 to 4.6	V
	(An, Bn)	-0.5 to $V_{CC} + 0.5$ (Note 2)	
DC output voltage	(An, Bn) $V_{OUT}$	-0.5 to $V_{CC} + 0.5$ (Note 3)	V
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note 4)	mA
Output current	$I_{OUT}$	$\pm 50$	mA
Power dissipation	$P_D$	400	mW
DC $V_{CC}$ /ground current per supply pin	$I_{CC}/I_{GND}$	$\pm 100$	mA
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

Note 2: OFF state

Note 3: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 4:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

## Recommended Operating Range (Note 5)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	1.8 to 3.6	V
		1.2 to 3.6 (Note 6)	
Input voltage	(DIR, $\overline{OE}$ )	-0.3 to 3.6	V
	(An, Bn)	0 to $V_{CC}$ (Note 7)	
Output voltage	(An, Bn) $V_{OUT}$	0 to $V_{CC}$ (Note 8)	V
Output current	$I_{OH}/I_{OL}$	$\pm 12$ (Note 9)	mA
		$\pm 8$ (Note 10)	
		$\pm 4$ (Note 11)	
Operating temperature	$T_{opr}$	-40 to 85	$^{\circ}C$
Input rise and fall time	$dt/dv$	0 to 10 (Note 12)	ns/V

Note 5: Floating or unused control inputs must be held high or low.

Note 6: Data retention only

Note 7: OFF state

Note 8: High or low state

Note 9:  $V_{CC} = 3.0$  to  $3.6$  V

Note 10:  $V_{CC} = 2.3$  to  $2.7$  V

Note 11:  $V_{CC} = 1.8$  V

Note 12:  $V_{IN} = 0.8$  to  $2.0$  V,  $V_{CC} = 3.0$  V

## Electrical Characteristics

### DC Characteristics (Ta = -40 to 85°C, 2.7 V < VCC ≤ 3.6 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.7 to 3.6	2.0	—	V
	L-level	V <sub>IL</sub>	—		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	2.7 to 3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.7	2.2	—	
				I <sub>OH</sub> = -8 mA	3.0	2.4	—	
				I <sub>OH</sub> = -12 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	2.7 to 3.6	—	0.2	
				I <sub>OL</sub> = 6 mA	2.7	—	0.4	
				I <sub>OL</sub> = 8 mA	3.0	—	0.5	
				I <sub>OL</sub> = 12 mA	3.0	—	0.8	
Input leakage current (DIR, $\overline{OE}$ )		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
Bushold input minimum drive hold current		I <sub>I (HOLD)</sub>	V <sub>IN</sub> = 0.8 V		3.0	75	—	μA
			V <sub>IN</sub> = 2.0 V		3.0	-75	—	
Bushold input over-drive current to change state		I <sub>I (OD)</sub>	(Note 13)		3.6	—	450	μA
			(Note 14)		3.6	—	-450	
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> = V <sub>CC</sub> or GND		2.7 to 3.6	—	±10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7 to 3.6	—	20.0	μA
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7 to 3.6	—	750	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

## DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ VCC ≤ 2.7 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		2.3 to 2.7	1.6	—	V
	L-level	V <sub>IL</sub>	—		2.3 to 2.7	—	0.7	
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	2.3 to 2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -4 mA	2.3	2.0	—	
				I <sub>OH</sub> = -6 mA	2.3	1.8	—	
	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	2.3 to 2.7	—	0.2	
				I <sub>OL</sub> = 6 mA	2.3	—	0.4	
				I <sub>OL</sub> = 8 mA	2.3	—	0.6	
Input leakage current (DIR, $\overline{OE}$ )		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
Bushold input minimum drive hold current		I <sub>I</sub> (HOLD)	V <sub>IN</sub> = 0.7 V		2.3	45	—	μA
			V <sub>IN</sub> = 1.6 V		2.3	-45	—	
Bushold input over-drive current to change state		I <sub>I</sub> (OD)	(Note 13)		2.7	—	300	μA
			(Note 14)		2.7	—	-300	
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> = V <sub>CC</sub> or GND		2.3 to 2.7	—	±10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3 to 2.7	—	20.0	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

## DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ VCC < 2.3 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—		1.8 to 2.3	0.7 × V <sub>CC</sub>	—	V
	L-level	V <sub>IL</sub>	—		1.8 to 2.3	—	0.2 × V <sub>CC</sub>	
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	1.8	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -4 mA	1.8	1.4	—	
	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	1.8	—	0.2	
				I <sub>OL</sub> = 4 mA	1.8	—	0.3	
Input leakage current (DIR, $\overline{OE}$ )		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		1.8	—	±5.0	μA
Bushold input minimum drive hold current		I <sub>I</sub> (HOLD)	V <sub>IN</sub> = 0.36 V		1.8	25	—	μA
			V <sub>IN</sub> = 1.26 V		1.8	-25	—	
Bushold input over-drive current to change state		I <sub>I</sub> (OD)	(Note 13)		1.8	—	200	μA
			(Note 14)		1.8	—	-200	
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> = V <sub>CC</sub> or GND		1.8	—	±10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA

Note 13: An external driver must source at least the specified current to switch from LOW-to-HIGH.

Note 14: An external driver must sink at least the specified current to switch from HIGH-to-LOW.

## AC Characteristics (Ta = -40 to 85°C, input: t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.8		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 <sub>pZL</sub> t <sub>pZH</sub>	Figure 1, Figure 3	1.8		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 <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1, Figure 3	1.8		1.5	5.7	ns	
			2.5 ± 0.2		1.0	4.8		
			3.3 ± 0.3		0.8	4.1		
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note 15)	1.8		—	0.5	ns	
			2.5 ± 0.2		—	0.5		
			3.3 ± 0.3		—	0.5		

For C<sub>L</sub> = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 15: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

## Dynamic Switching Characteristics (Ta = 25°C, input: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 16)	1.8	0.15	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 16)	2.5	0.25	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 16)	3.3	0.35	
Quiet output minimum dynamic VOL	VOLV	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 16)	1.8	-0.15	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 16)	2.5	-0.25	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 16)	3.3	-0.35	
Quiet output minimum dynamic VOH	VOHV	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 16)	1.8	1.55	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 16)	2.5	2.05	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 16)	3.3	2.65	

Note 16: Parameter guaranteed by design.

## Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	C <sub>I/O</sub>	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note 17)	1.8, 2.5, 3.3	20	pF

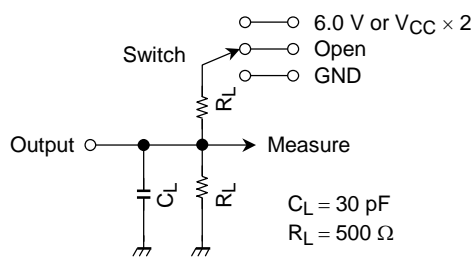
Note 17: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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



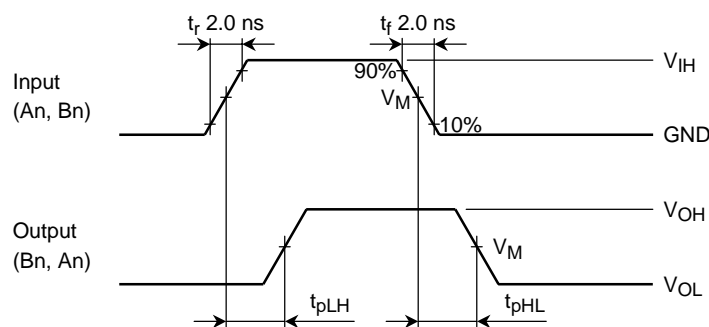
## AC Test Circuit



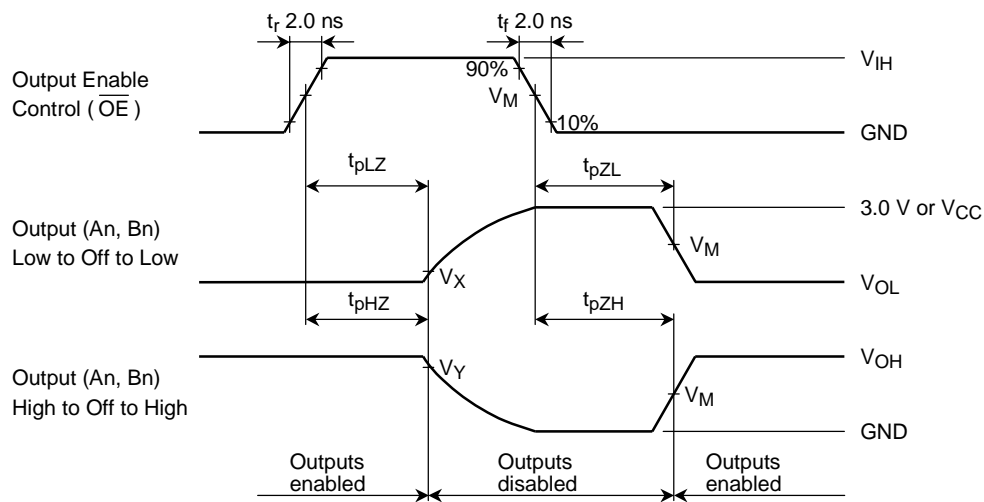
Parameter	Switch
$t_{pLH}$ , $t_{pHL}$	Open
$t_{pLZ}$ , $t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3 \text{ V}$ $V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2 \text{ V}$ @ $V_{CC} = 1.8 \text{ V}$
$t_{pHZ}$ , $t_{pZH}$	GND

**Figure 1**

## AC Waveform



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



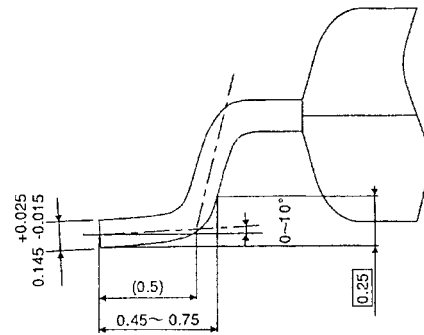
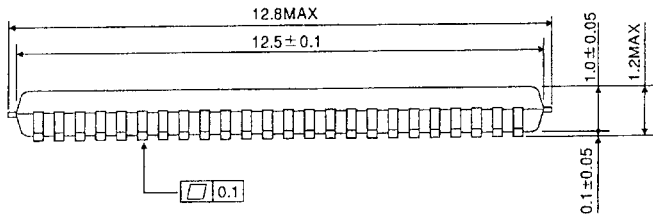
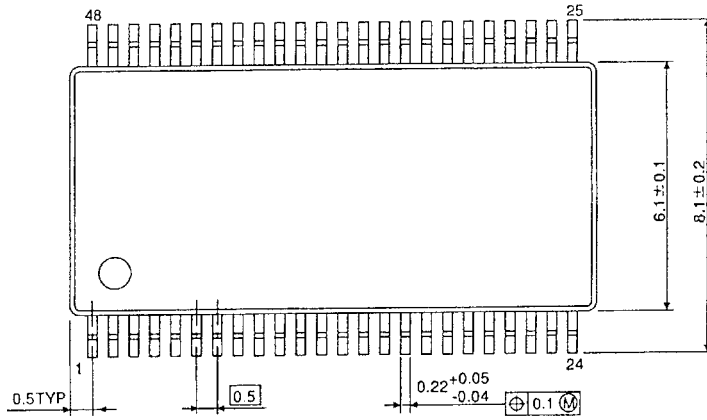
**Figure 3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**

Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
$V_Y$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

**Package Dimensions**

TSSOP48-P-0061-0.50

Unit : mm



Weight: 0.25 g (typ.)

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