

**TENTATIVE**

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCXH162373FT

## Low-Voltage 16-Bit D-Type Latch with Bushold

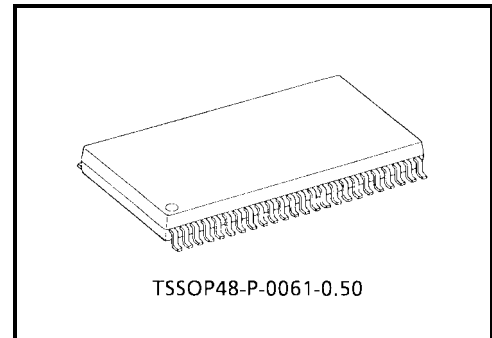
The TC74VCXH162373FT is a high-performance CMOS 16-bit D-type latch. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

This 16-bit D-type latch is controlled by a latch enable input ( $\overline{LE}$ ) and a output enable input ( $\overline{OE}$ ) which are common to each byte. It can be used as two 8-bit latches or one 16-bit latch. When the  $\overline{OE}$  input is high, the outputs are in a high-impedance state.

The 26- $\Omega$  series resistor helps reducing output overshoot and undershoot without external resistor.

The D 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.

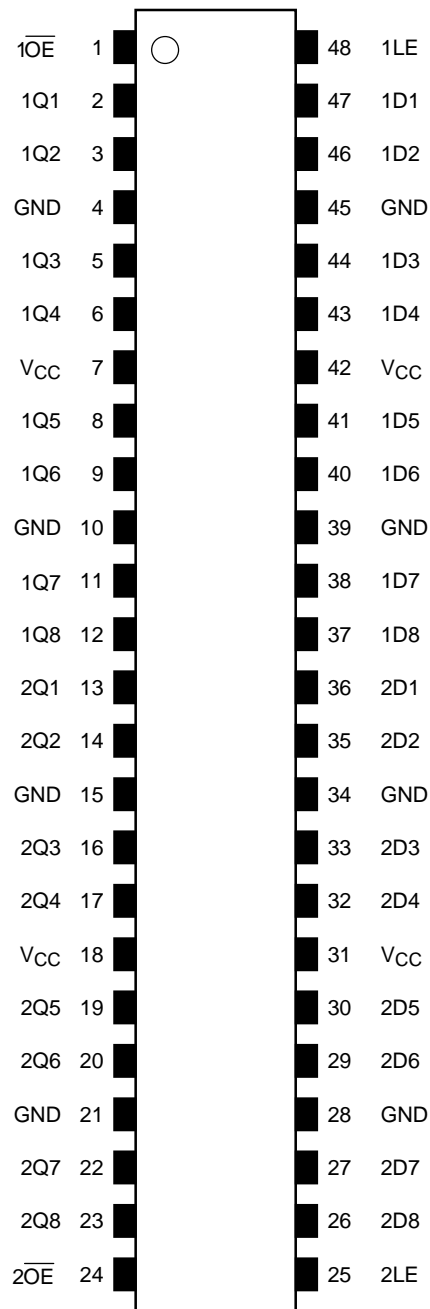


Weight: 0.25 g (typ.)

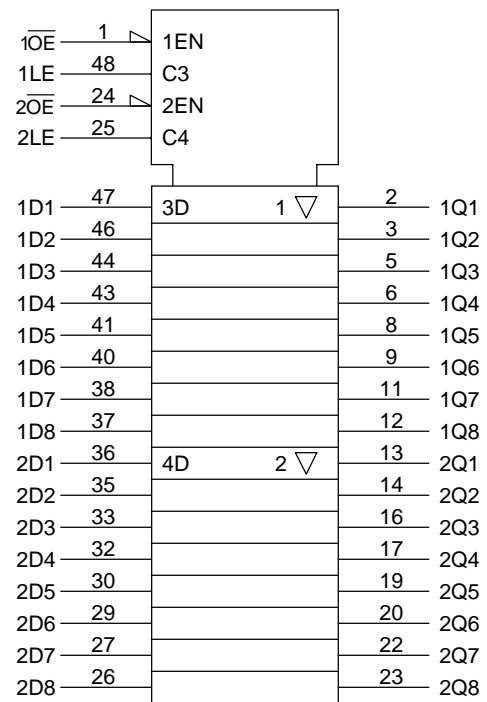
## Features

- 26- $\Omega$  series resistors on 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:  $t_{pd} = 3.3$  ns (max) ( $V_{CC} = 3.0$  to 3.6 V)  
     :  $t_{pd} = 4.5$  ns (max) ( $V_{CC} = 2.3$  to 2.7 V)  
     :  $t_{pd} = 5.8$  ns (max) ( $V_{CC} = 1.8$  V)
- 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)
- 3.6-V tolerant function and power-down protection control inputs and outputs

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

Inputs			Outputs
$\overline{1OE}$	1LE	1D1-1D8	1Q1-1Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

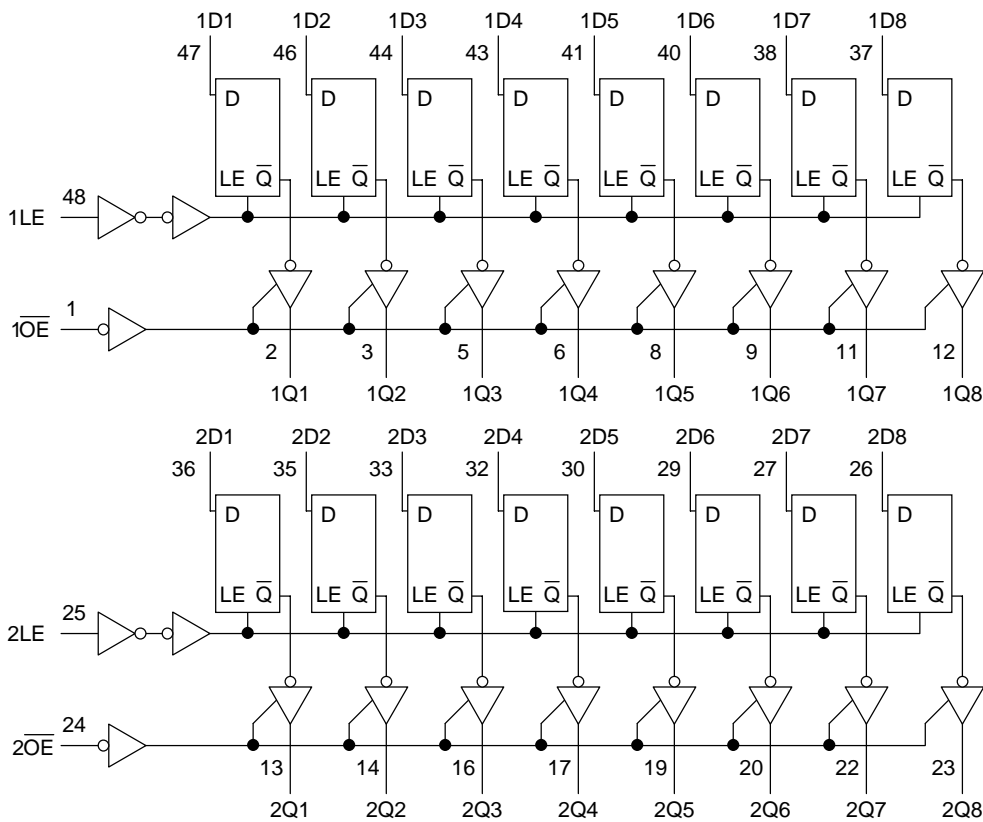
Inputs			Outputs
$\overline{2OE}$	2LE	2D1-2D8	2Q1-2Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

X: Don't care

Z: High impedance

Qn: Q outputs are latched at the time when the LE input is taken to a low logic level.

## System Diagram



## Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5 to 4.6	V
DC input voltage	( $\overline{OE}$ , LE)	-0.5 to 4.6	V
	(An)	-0.5 to $V_{CC} + 0.5$	
DC output voltage	$V_{OUT}$	-0.5 to 4.6 (Note 1)	V
		-0.5 to $V_{CC} + 0.5$ (Note 2)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note 3)	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 1: OFF state

Note 2: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

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

## Recommended Operating Range (Note 4)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	1.8 to 3.6	V
		1.2 to 3.6 (Note 5)	
Input voltage	( $\overline{OE}$ , LE)	-0.3 to 3.6	V
	(An)	0 to $V_{CC}$	
Output voltage	$V_{OUT}$	0 to 3.6 (Note 6)	V
		0 to $V_{CC}$ (Note 7)	
Output current	$I_{OH}/I_{OL}$	$\pm 12$ (Note 8)	mA
		$\pm 8$ (Note 9)	
		$\pm 4$ (Note 10)	
Operating temperature	$T_{opr}$	-40 to 85	$^{\circ}C$
Input rise and fall time	dt/dv	0 to 10 (Note 11)	ns/V

Note 4: Floating or unused control inputs must be held high or low.

Note 5: Data retention

Note 6: OFF state

Note 7: High or low state

Note 8:  $V_{CC} = 3.0$  to  $3.6$  V

Note 9:  $V_{CC} = 2.3$  to  $2.7$  V

Note 10:  $V_{CC} = 1.8$  V

Note 11:  $V_{IN} = 0.8$  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	( $\overline{OE}$ , LE)	I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V	2.7 to 3.6	—	±5.0	μA
	(An)		V <sub>IN</sub> = V <sub>CC</sub> or GND	2.7 to 3.6	—	±5.0	
Bushold input minimum drive hold current	I <sub>I</sub> (HOLD)	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</sub> (OD)	(Note 12)	3.6	—	450	μA	
		(Note 13)	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> = 0 to 3.6 V	2.7 to 3.6	—	±10.0	μA	
Power-off leakage current	I <sub>OFF</sub>	V <sub>OUT</sub> = 0 to 3.6 V	0	—	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	
		V <sub>CC</sub> ≤ V <sub>OUT</sub> ≤ 3.6 V (Note 14)	2.7 to 3.6	—	±20.0		
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 12: An external driver must source at least the specified current to switch LOW-to-HIGH.

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

Note 14: Outputs high impedance only.

## 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	
				I <sub>OH</sub> = -8 mA	2.3	1.7	
	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	( $\overline{OE}$ , LE)	I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V	2.3 to 2.7	—	±5.0	μA
	(An)		V <sub>IN</sub> = V <sub>CC</sub> or GND	2.3 to 2.7	—	±5.0	
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 12)	2.7	—	300	μA	
		(Note 13)	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> = 0 to 3.6 V	2.3 to 2.7	—	±10.0	μA	
Power-off leakage current	I <sub>OFF</sub>	V <sub>OUT</sub> = 0 to 3.6 V	0	—	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	
		V <sub>CC</sub> ≤ V <sub>OUT</sub> ≤ 3.6 V (Note 14)	2.3 to 2.7	—	±20.0		

Note 12: An external driver must source at least the specified current to switch LOW-to-HIGH.

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

Note 14: Outputs high impedance only.

## 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		
	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	( $\overline{OE}$ )	I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V	1.8	—	±5.0	μA	
	(An)		V <sub>IN</sub> = V <sub>CC</sub> or GND	1.8	—	±5.0		
Bushold input minimum drive hold current	I <sub>I (HOLD)</sub>	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 (OD)</sub>	(Note 12)	1.8	—	200	μA		
		(Note 13)	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> = 0 to 3.6 V	1.8	—	±10.0	μA		
Power-off leakage current	I <sub>OFF</sub>	V <sub>OUT</sub> = 0 to 3.6 V	0	—	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		
		V <sub>CC</sub> ≤ V <sub>OUT</sub> ≤ 3.6 V (Note 14)	1.8	—	±20.0			

Note 12: An external driver must source at least the specified current to switch LOW-to-HIGH.

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

Note 14: Outputs high impedance only.

## AC Characteristics (Ta = -40 to 85°C, input: tr = tf = 2.0 ns, CL = 30 pF, RL = 500 Ω)

Characteristics	Symbol	Test Condition	VCC (V)	Min	Max	Unit
			1.8	1.5	5.8	
Propagation delay time (D-Q)	tpLH tpHL	Figure 1, Figure 2	2.5 ± 0.2	1.0	4.5	ns
			3.3 ± 0.3	0.8	3.3	
			1.8	1.5	6.2	
Propagation delay time (LE-Q)	tpLH tpHL	Figure 1, Figure 2	2.5 ± 0.2	1.0	4.9	ns
			3.3 ± 0.3	0.8	3.6	
			1.8	1.5	7.6	
3-state output enable time	tpZL tpZH	Figure 1, Figure 3	2.5 ± 0.2	1.0	5.4	ns
			3.3 ± 0.3	0.8	3.9	
			1.8	1.5	5.3	
3-state output disable time	tpLZ tpHZ	Figure 1, Figure 3	2.5 ± 0.2	1.0	4.4	ns
			3.3 ± 0.3	0.8	4.0	
			1.8	3.0	—	
Minimum pulse width (LE)	tw (H)	Figure 1, Figure 2	2.5 ± 0.2	1.5	—	ns
			3.3 ± 0.3	1.5	—	
			1.8	2.5	—	
Minimum set-up time	ts	Figure 1, Figure 2	2.5 ± 0.2	1.5	—	ns
			3.3 ± 0.3	1.5	—	
			1.8	1.0	—	
Minimum hold time	th	Figure 1, Figure 2	2.5 ± 0.2	1.0	—	ns
			3.3 ± 0.3	1.0	—	
			1.8	—	0.5	
Output to output skew	tosLH tosHL	(Note 15)	2.5 ± 0.2	—	0.5	ns
			3.3 ± 0.3	—	0.5	
			1.8	—	0.5	

For CL = 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)

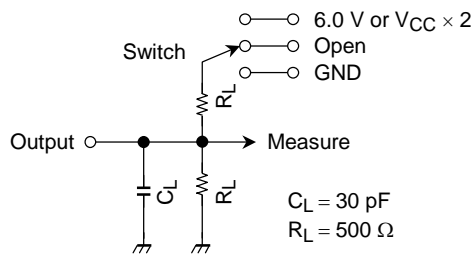
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C <sub>O</sub>	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note 17)	1.8, 2.5, 3.3	20	pF

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:

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

## AC Test Circuit



Parameter	Switch
$t_{pLH}$ , $t_{pHL}$	Open
$t_{pLZ}$ , $t_{pZL}$	6.0 V $V_{CC} \times 2$
$t_{pHZ}$ , $t_{pZH}$	GND

@  $V_{CC} = 3.3 \pm 0.3 \text{ V}$   
 @  $V_{CC} = 2.5 \pm 0.2 \text{ V}$   
 @  $V_{CC} = 1.8 \text{ V}$

Figure 1

## AC Waveform

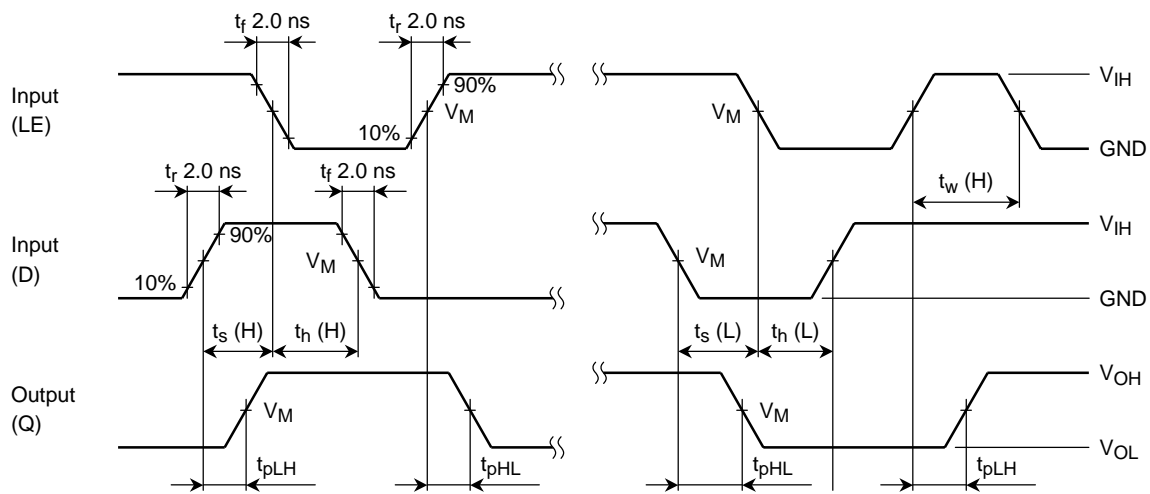
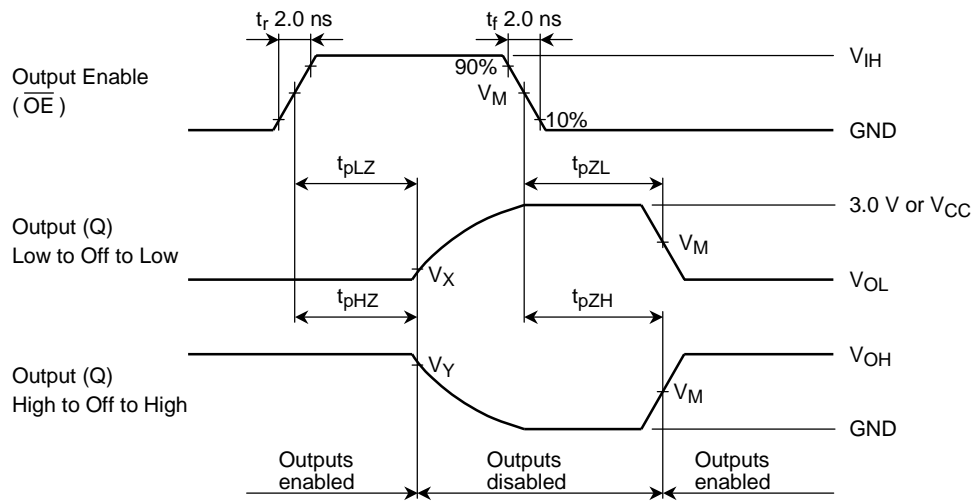


Figure 2  $t_{pLH}$ ,  $t_{pHL}$ ,  $t_w$ ,  $t_s$ ,  $t_h$



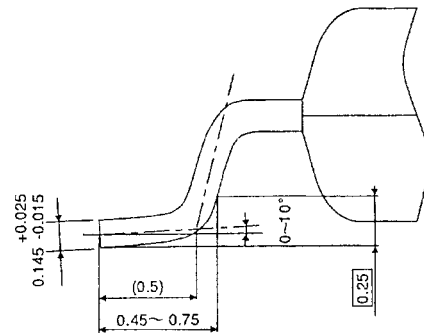
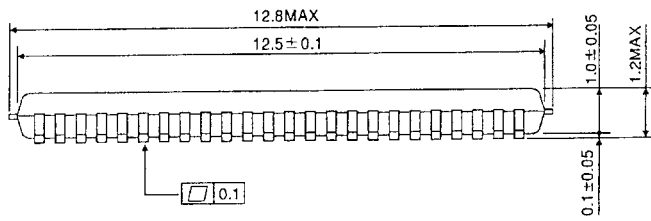
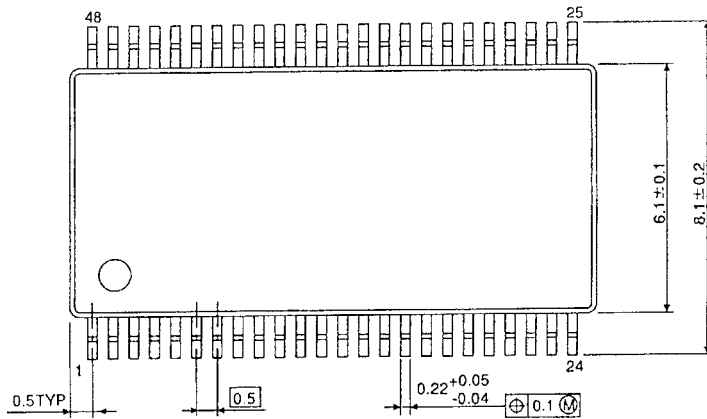
**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

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

## Package Dimensions

TSSOP48-P-0061-0.50

Unit : mm



Weight: 0.25 g (typ.)

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