

TENTATIVE

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCXH162374FT

Low-Voltage 16-Bit D-Type Flip-Flop with Bushold

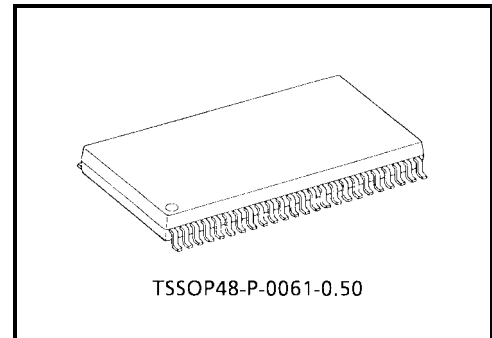
The TC74VCXH162374FT is a high-performance CMOS 16-bit D-type flip-flop. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

This 16-bit D-type flip-flop is controlled by a clock input (CK) and a output enable input (OE) which are common to each byte. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. When the OE input is high, the outputs are in a high impedance state.

The 26- Ω 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.

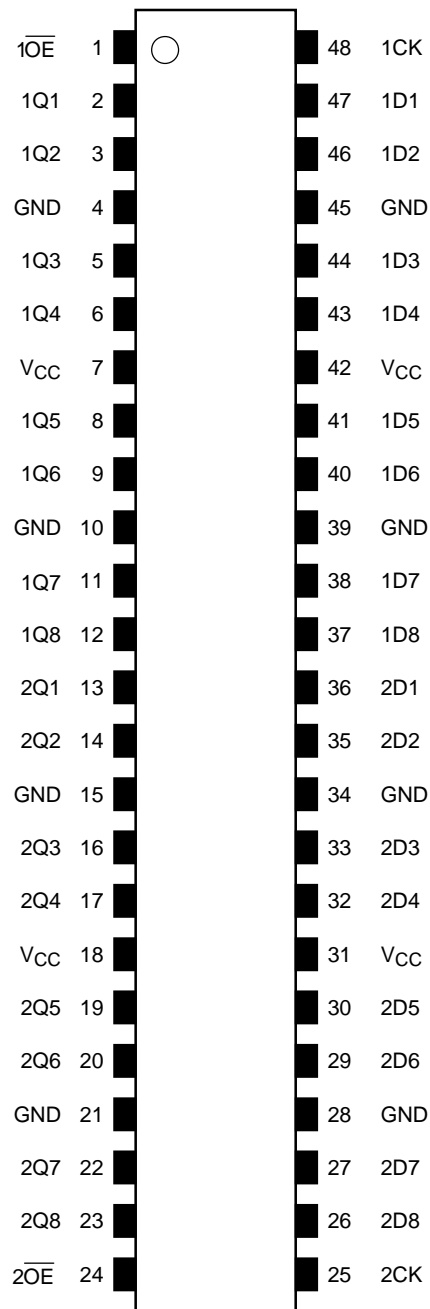


Weight: 0.25 g (typ.)

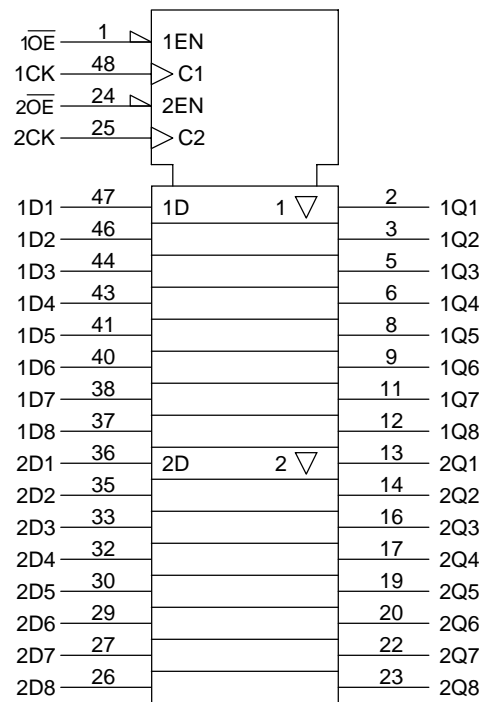
Features

- 26- Ω 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: $t_{pd} = 3.4$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 4.8$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
: $t_{pd} = 6.0$ 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: ± 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
$\overline{1OE}$	1CK	1D1-1D8	1Q1-1Q8
H	X	X	Z
L	\downarrow	X	Qn
L	\uparrow	L	L
L	\uparrow	H	H

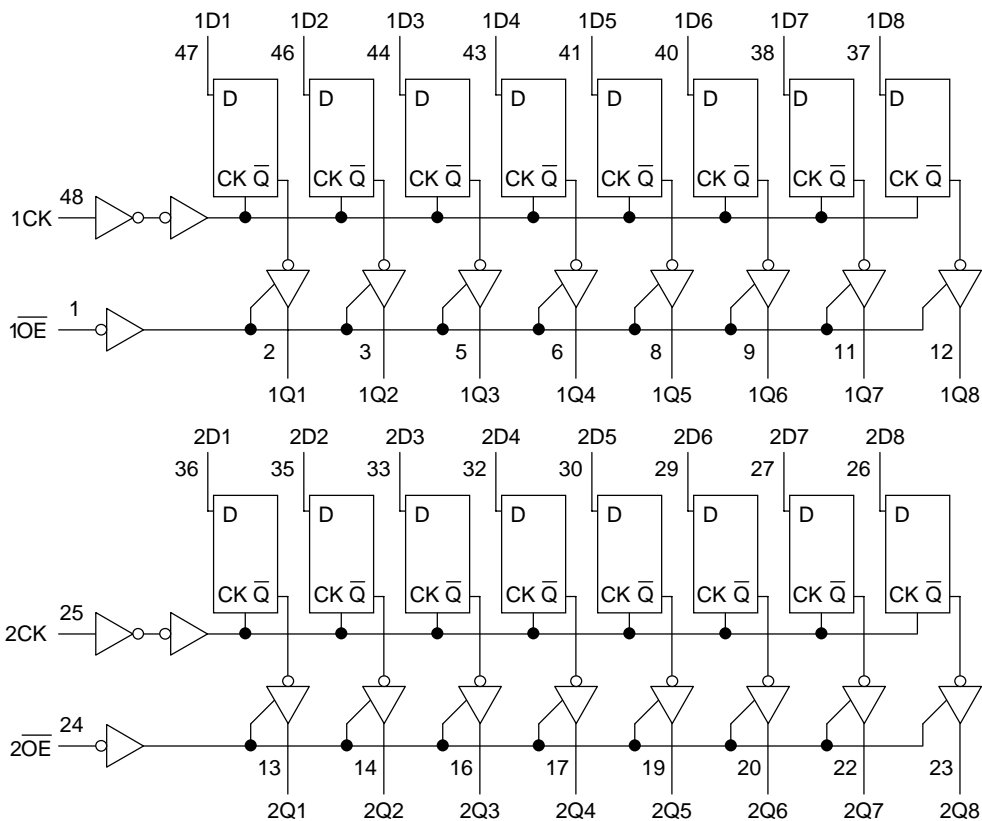
Inputs			Outputs
$\overline{2OE}$	2CK	2D1-2D8	2Q1-2Q8
H	X	X	Z
L	\downarrow	X	Qn
L	\uparrow	L	L
L	\uparrow	H	H

X: Don't care

Z: High impedance

Qn: No change

System Diagram



Maximum Ratings

Characteristics		Symbol	Rating	Unit
Power supply voltage		V_{CC}	-0.5 to 4.6	V
DC input voltage	(\overline{OE} , CK)	V_{IN}	-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}	± 50 (Note 3)	mA
Output current		I_{OUT}	± 50	mA
Power dissipation		P_D	400	mW
DC V_{CC} /ground current per supply pin		I_{CC}/I_{GND}	± 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} , CK)	V_{IN}	-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}	± 12 (Note 8)	mA
			± 8 (Note 9)	
			± 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 _{IH}	—		2.7 to 3.6	2.0	—	V
	L-level	V _{IL}	—		2.7 to 3.6	—	0.8	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.7 to 3.6	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	2.7	2.2	—	
				I _{OH} = -8 mA	3.0	2.4	—	
				I _{OH} = -12 mA	3.0	2.2	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.7 to 3.6	—	0.2	
				I _{OL} = 6 mA	2.7	—	0.4	
				I _{OL} = 8 mA	3.0	—	0.5	
				I _{OL} = 12 mA	3.0	—	0.8	
Input leakage current	(\overline{OE} , CK)	I _{IN}	V _{IN} = 0 to 3.6 V	2.7 to 3.6	—	±5.0	μA	
	(An)		V _{IN} = V _{CC} or GND	2.7 to 3.6	—	±5.0		
Bushold input minimum drive hold current	I _I (HOLD)	V _{IN} = 0.8 V	3.0	75	—	μA		
		V _{IN} = 2.0 V	3.0	-75	—			
Bushold input over-drive current to change state	I _I (OD)	(Note 12)	3.6	—	450	μA		
		(Note 13)	3.6	—	-450			
3-state output OFF state current	I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V	2.7 to 3.6	—	±10.0	μA		
Power-off leakage current	I _{OFF}	V _{OUT} = 0 to 3.6 V	0	—	10.0	μA		
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND	2.7 to 3.6	—	20.0	μA		
		V _{CC} ≤ V _{OUT} ≤ 3.6 V (Note 14)	2.7 to 3.6	—	±20.0			
Increase in I _{CC} per input	ΔI _{CC}	V _{IH} = V _{CC} - 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 _{IH}	—		2.3 to 2.7	1.6	—	V
	L-level	V _{IL}	—		2.3 to 2.7	—	0.7	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3 to 2.7	V _{CC} - 0.2	—	V
				I _{OH} = -4 mA	2.3	2.0	—	
				I _{OH} = -6 mA	2.3	1.8	—	
	I _{OH} = -8 mA	2.3	1.7	—				
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3 to 2.7	—	0.2	
				I _{OL} = 6 mA	2.3	—	0.4	
I _{OL} = 8 mA				2.3	—	0.6		
Input leakage current	(\overline{OE} , CK)	I _{IN}	V _{IN} = 0 to 3.6 V	2.3 to 2.7	—	±5.0	μA	
	(An)		V _{IN} = V _{CC} or GND	2.3 to 2.7	—	±5.0		
Bushold input minimum drive hold current	I _I (HOLD)	V _{IN} = 0.7 V	2.3	45	—	μA		
		V _{IN} = 1.6 V	2.3	-45	—			
Bushold input over-drive current to change state	I _I (OD)	(Note 12)	2.7	—	300	μA		
		(Note 13)	2.7	—	-300			
3-state output OFF state current	I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V	2.3 to 2.7	—	±10.0	μA		
Power-off leakage current	I _{OFF}	V _{OUT} = 0 to 3.6 V	0	—	10.0	μA		
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND	2.3 to 2.7	—	20.0	μA		
		V _{CC} ≤ V _{OUT} ≤ 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 _{IH}	—		1.8 to 2.3	0.7 × V _{CC}	—	V
	L-level	V _{IL}	—		1.8 to 2.3	—	0.2 × V _{CC}	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.8	V _{CC} - 0.2	—	V
				I _{OH} = -4 mA	1.8	1.4	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.8	—	0.2	
				I _{OL} = 4 mA	1.8	—	0.3	
Input leakage current	($\overline{\text{OE}}$, CK)	I _{IN}	V _{IN} = 0 to 3.6 V		1.8	—	±5.0	μA
	(An)		V _{IN} = V _{CC} or GND		1.8	—	±5.0	
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	—		
Bushold input over-drive current to change state	I _I (OD)	(Note 12)		1.8	—	200	μA	
		(Note 13)		1.8	—	-200		
3-state output OFF state current	I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		1.8	—	±10.0	μA	
Power-off leakage current	I _{OFF}	V _{OUT} = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current	I _{CC}	V _{IN} = V _{CC} or GND		1.8	—	20.0	μA	
		V _{CC} ≤ V _{OUT} ≤ 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
Maximum clock frequency	f _{max}	Figure 1, Figure 2	1.8	125	—	MHz
			2.5 ± 0.2	200	—	
			3.3 ± 0.3	250	—	
Propagation delay time (CK-Q)	t _{pLH} t _{pHL}	Figure 1, Figure 2	1.8	1.5	6.0	ns
			2.5 ± 0.2	1.0	4.8	
			3.3 ± 0.3	0.8	3.4	
3-state output enable time	t _{pZL} t _{pZH}	Figure 1, Figure 3	1.8	1.5	7.6	ns
			2.5 ± 0.2	1.0	5.4	
			3.3 ± 0.3	0.8	3.9	
3-state output disable time	t _{pLZ} t _{pHZ}	Figure 1, Figure 3	1.8	1.5	5.3	ns
			2.5 ± 0.2	1.0	4.4	
			3.3 ± 0.3	0.8	4.0	
Minimum pulse width (CK)	t _w (H) t _w (L)	Figure 1, Figure 2	1.8	3.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum set-up time	t _s	Figure 1, Figure 2	1.8	2.5	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum hold time	t _h	Figure 1, Figure 2	1.8	1.0	—	ns
			2.5 ± 0.2	1.0	—	
			3.3 ± 0.3	1.0	—	
Output to output skew	t _{osLH} t _{osHL}	(Note 15)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

For C_L = 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	VIH = 1.8 V, VIL = 0 V (Note 16)	1.8	0.15	V
			VIH = 2.5 V, VIL = 0 V (Note 16)	2.5	0.25	
			VIH = 3.3 V, VIL = 0 V (Note 16)	3.3	0.35	
Quiet output minimum dynamic	VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note 16)	1.8	-0.15	V
			VIH = 2.5 V, VIL = 0 V (Note 16)	2.5	-0.25	
			VIH = 3.3 V, VIL = 0 V (Note 16)	3.3	-0.35	
Quiet output minimum dynamic	VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note 16)	1.8	1.55	V
			VIH = 2.5 V, VIL = 0 V (Note 16)	2.5	2.05	
			VIH = 3.3 V, VIL = 0 V (Note 16)	3.3	2.65	

Note 16: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

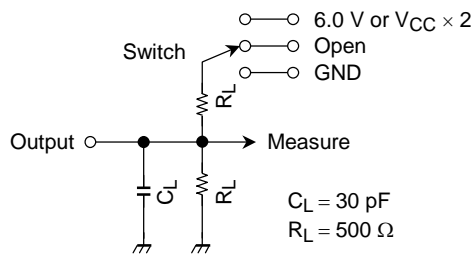
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Output capacitance	CO	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note 17)	1.8, 2.5, 3.3	20	pF

Note 17: CPD 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 @ $V_{CC} = 3.3 \pm 0.3 \text{ V}$ $V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2 \text{ V}$ @ $V_{CC} = 1.8 \text{ V}$
t_{pHZ}, t_{pZH}	GND

Figure 1

AC Waveform

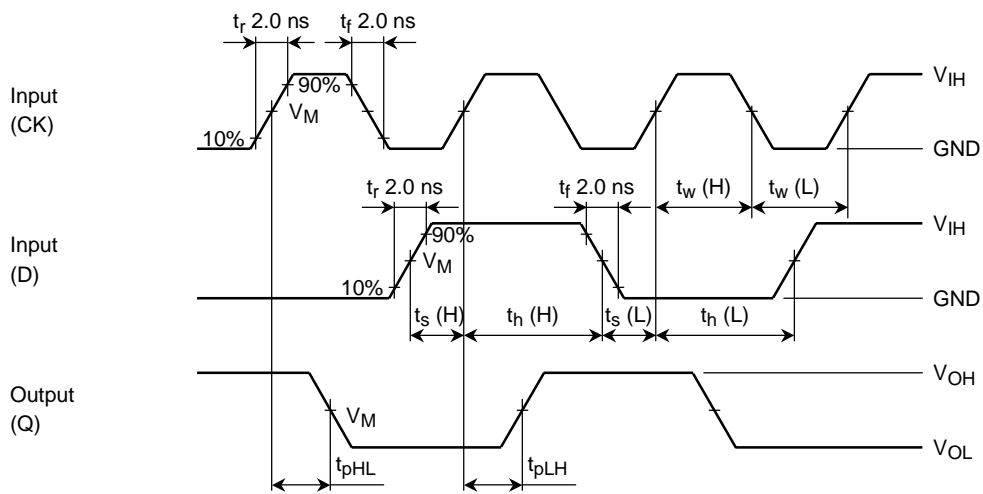


Figure 2 $t_{pLH}, t_{pHL}, t_w, t_s, t_h$

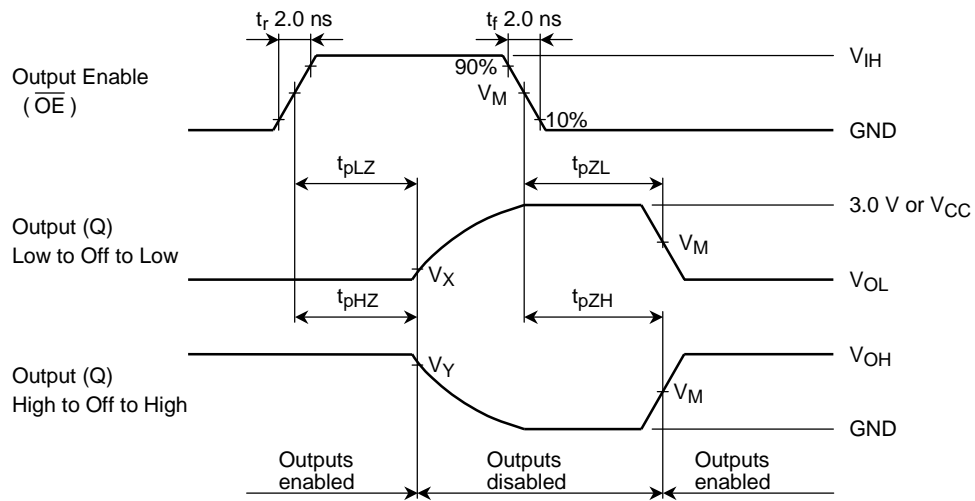


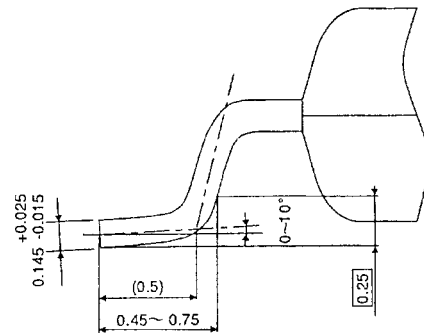
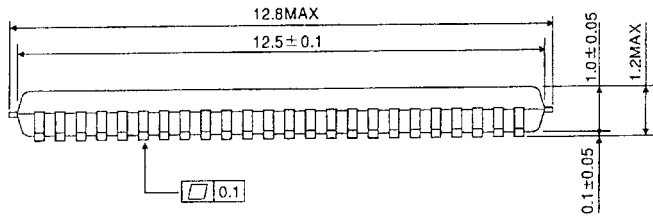
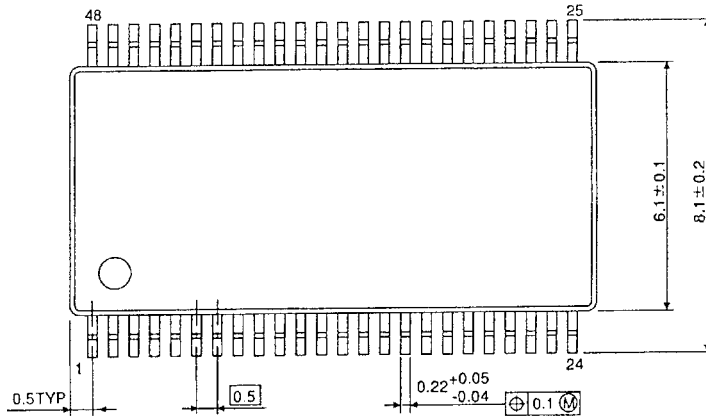
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 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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