

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC74VCX16373FT

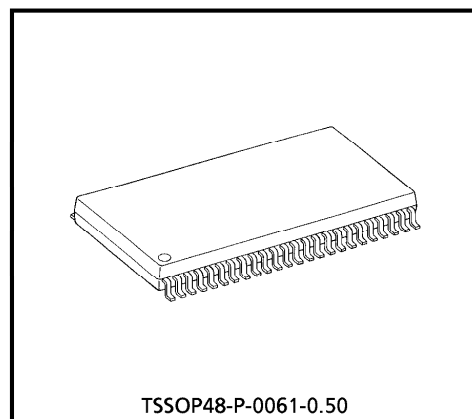
## LOW-VOLTAGE 16-BIT D-TYPE LATCH WITH 3.6 V TOLERANT INPUTS AND OUTPUTS

The TC74VCX16373FT is a high performance CMOS 16-bit D-TYPE LATCH. Designed for use in 1.8, 2.5 or 3.3 Volt systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6V.

This 16-bit D-type latch is controlled by a latch enable input (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.

All inputs are equipped with protection circuits against static discharge.



TSSOP48-P-0061-0.50

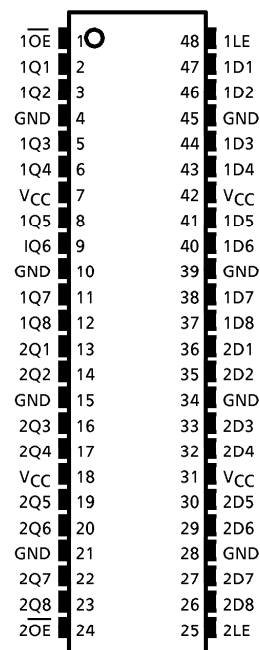
Weight : 0.25 g (Typ.)

### FEATURES

- Low Voltage Operation :  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High Speed Operation :  $t_{pd} = 3.0\text{ ns (max.) at } V_{CC} = 3.0\sim 3.6\text{ V}$   
 :  $t_{pd} = 3.4\text{ ns (max.) at } V_{CC} = 2.3\sim 2.7\text{ V}$   
 :  $t_{pd} = 5.7\text{ ns (max.) at } V_{CC} = 1.8\text{ V}$
- 3.6 V Tolerant inputs and outputs.
- Output Current :  $I_{OH}/I_{OL} = \pm 24\text{ mA (min.) at } V_{CC} = 3.0\text{ V}$   
 :  $I_{OH}/I_{OL} = \pm 18\text{ mA (min.) at } V_{CC} = 2.3\text{ V}$   
 :  $I_{OH}/I_{OL} = \pm 6\text{ mA (min.) at } V_{CC} = 1.8\text{ V}$
- Latch-up Performance :  $\pm 300\text{ mA}$
- ESD Performance : Human Body Model  $> \pm 2000\text{ V}$   
 : Machine Model  $> 200\text{ V}$
- Package : TSSOP  
 (Thin Shrink Small Outline Package)
- Power Down Protection is provided on all inputs and outputs.
- Supports live insertion / withdrawal (Note 1)

(Note 1) To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

### PIN CONNECTION



(TOP VIEW)

980910EBA2

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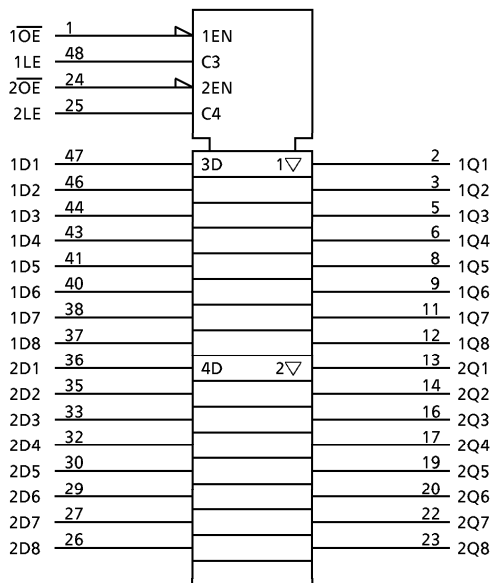
**TRUTH TABLE**

INPUT			OUTPUT
1OE	1LE	1D1-1D8	1Q1-1Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

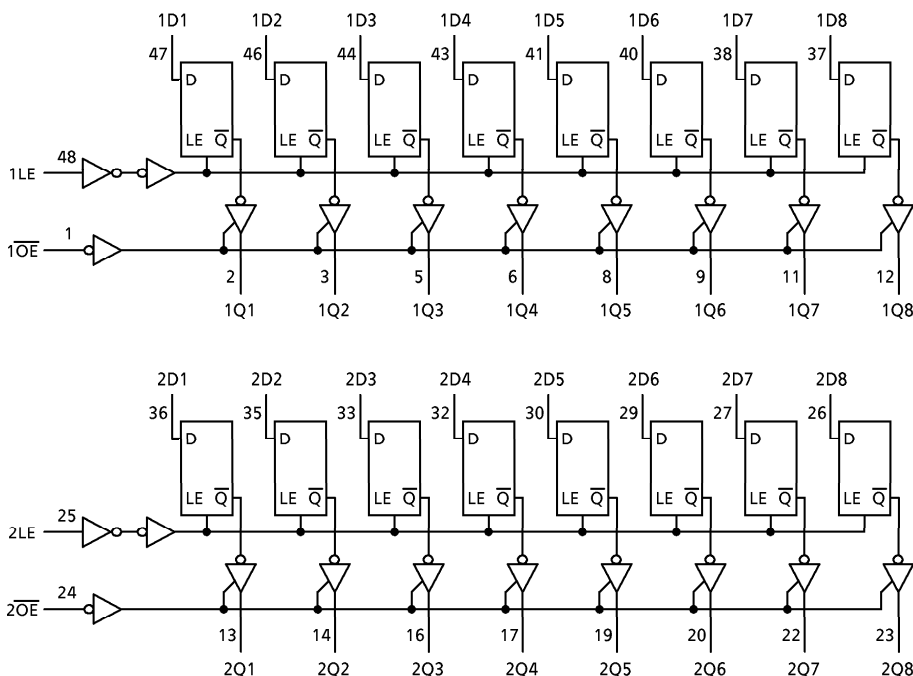
INPUT			OUTPUT
2OE	2LE	2D1-2D8	2Q1-2Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

X : Don't Care  
 Z : High impedance  
 Qn : No change

**IEC LOGIC SYMBOL**



**SYSTEM DIAGRAM**



980910EBA2'

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## MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage	$V_{CC}$	-0.5~4.6	V
DC Input Voltage	$V_{IN}$	-0.5~4.6	V
DC Output Voltage	$V_{OUT}$	-0.5~4.6 (Note 1)	V
		-0.5~ $V_{CC}$ + 0.5 (Note 2)	
Input Diode Current	$I_{IK}$	-50	mA
Output Diode Current	$I_{OK}$	±50 (Note 3)	mA
DC 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	$T_{stg}$	-65~150	°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

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V_{CC}$	1.8~3.6	V
		1.2~3.6 (Note 4)	
Input Voltage	$V_{IN}$	-0.3~3.6	V
Output Voltage	$V_{OUT}$	0~3.6 (Note 5)	V
		0~ $V_{CC}$ (Note 6)	
Output Current	$I_{OH} / I_{OL}$	±24 (Note 7)	mA
		±18 (Note 8)	
		±6 (Note 9)	
Operating Temperature	$T_{opr}$	-40~85	°C
Input Rise And Fall Time	$dt / dv$	0~10 (Note 10)	ns / V

(Note 4) Data Retention Only

(Note 5) Off-State

(Note 6) High or Low State

(Note 7)  $V_{CC} = 3.0\sim 3.6$  V

(Note 8)  $V_{CC} = 2.3\sim 2.7$  V

(Note 9)  $V_{CC} = 1.8$  V

(Note 10)  $V_{IN} = 0.8\sim 2.0$  V,  $V_{CC} = 3.0$  V

**ELECTRICAL CHARACTERISTICS**

DC characteristics (Ta = -40~85°C, 2.7 V < VCC ≤ 3.6 V)

PARAMETER		SYMBOL	TEST CONDITION		VCC (V)	MIN.	MAX.	UNIT
Input Voltage	"H" Level	V <sub>IH</sub>			2.7~3.6	2.0	—	V
	"L" Level	V <sub>IL</sub>			2.7~3.6	—	0.8	V
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	2.7~3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -12 mA	2.7	2.2	—	
				I <sub>OH</sub> = -18 mA	3.0	2.4	—	
				I <sub>OH</sub> = -24 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	2.7~3.6	—	0.2	V
				I <sub>OL</sub> = 12 mA	2.7	—	0.4	
				I <sub>OL</sub> = 18 mA	3.0	—	0.4	
				I <sub>OL</sub> = 24 mA	3.0	—	0.55	
Input Leakage Current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		2.7~3.6	—	± 5.0	μA
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> = 0~3.6 V		2.7~3.6	—	± 10.0	μA
Power Off Leakage Current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7~3.6	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7~3.6	—	± 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		2.7~3.6	—	750	μA

**ELECTRICAL CHARACTERISTICS**

DC characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

PARAMETER		SYMBOL	TEST CONDITION		VCC (V)	MIN.	MAX.	UNIT
					2.3~2.7			
Input Voltage	"H" Level	V <sub>IH</sub>			2.3~2.7	1.6	—	V
	"L" Level	V <sub>IL</sub>			2.3~2.7	—	0.7	V
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	2.3~2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.3	2.0	—	
				I <sub>OH</sub> = -12 mA	2.3	1.8	—	
				I <sub>OH</sub> = -18 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	2.3~2.7	—	0.2	V
				I <sub>OL</sub> = 12 mA	2.3	—	0.4	
				I <sub>OL</sub> = 18 mA	2.3	—	0.6	
Input Leakage Current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		2.3~2.7	—	± 5.0	μA
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> = 0~3.6 V		2.3~2.7	—	± 10.0	μA
Power Off Leakage Current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3~2.7	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3~2.7	—	± 20.0	

## ELECTRICAL CHARACTERISTICS

DC characteristics ( $T_a = -40\sim 85^\circ\text{C}$ ,  $1.8\text{ V} \leq V_{CC} < 2.3\text{ V}$ )

PARAMETER		SYMBOL	TEST CONDITION		$V_{CC}$ (V)	MIN.	MAX.	UNIT
Input Voltage	"H" Level	$V_{IH}$			1.8~2.3	$0.7 \times V_{CC}$	—	V
	"L" Level	$V_{IL}$			1.8~2.3	—	$0.2 \times V_{CC}$	V
Output Voltage	"H" Level	$V_{OH}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -100\mu\text{A}$	1.8	$V_{CC} - 0.2$	—	V
				$I_{OH} = -6\text{mA}$	1.8	1.4	—	
	"L" Level	$V_{OL}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 100\mu\text{A}$	1.8	—	0.2	V
				$I_{OL} = 6\text{mA}$	1.8	—	0.3	
Input Leakage Current		$I_{IN}$	$V_{IN} = 0\sim 3.6\text{V}$		1.8	—	$\pm 5.0$	$\mu\text{A}$
3-State Output Off-State Current		$I_{OZ}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = 0\sim 3.6\text{V}$		1.8	—	$\pm 10.0$	$\mu\text{A}$
Power Off Leakage Current		$I_{OFF}$	$V_{IN}, V_{OUT} = 0\sim 3.6\text{V}$		0	—	10.0	$\mu\text{A}$
Quiescent Supply Current		$I_{CC}$	$V_{IN} = V_{CC} \text{ or } \text{GND}$		1.8	—	20.0	$\mu\text{A}$
			$V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6\text{V}$		1.8	—	$\pm 20.0$	

AC characteristics (Ta = -40~85°C, Input  $t_r = t_f = 2.0$  ns,  $C_L = 30$  pF,  $R_L = 500 \Omega$ )

PARAMETER	SYMBOL	TEST CONDITION	V <sub>CC</sub> (V)	MIN.	MAX.	UNIT
Propagation Delay Time (D-Q)	$t_{pLH}$ $t_{pHL}$	(Fig.1, 2)	1.8	1.5	5.7	ns
			$2.5 \pm 0.2$	1.0	3.4	
			$3.3 \pm 0.3$	0.8	3.0	
Propagation Delay Time (LE-Q)	$t_{pLH}$ $t_{pHL}$	(Fig.1, 2)	1.8	1.5	6.0	ns
			$2.5 \pm 0.2$	1.0	3.9	
			$3.3 \pm 0.3$	0.8	3.0	
3-State Output Enable Time	$t_{pZL}$ $t_{pZH}$	(Fig.1, 3)	1.8	1.5	7.0	ns
			$2.5 \pm 0.2$	1.0	4.6	
			$3.3 \pm 0.3$	0.8	3.5	
3-State Output Disable Time	$t_{pLZ}$ $t_{pHZ}$	(Fig.1, 3)	1.8	1.5	5.0	ns
			$2.5 \pm 0.2$	1.0	3.8	
			$3.3 \pm 0.3$	0.8	3.5	
Minimum Pulse Width (LE)	$t_w$ (H)	(Fig.1, 2)	1.8	3.0	—	ns
			$2.5 \pm 0.2$	1.5	—	
			$3.3 \pm 0.3$	1.5	—	
Minimum Set-up Time	$t_s$	(Fig.1, 2)	1.8	2.5	—	ns
			$2.5 \pm 0.2$	1.5	—	
			$3.3 \pm 0.3$	1.5	—	
Minimum Hold Time	$t_h$	(Fig.1, 2)	1.8	1.0	—	ns
			$2.5 \pm 0.2$	1.0	—	
			$3.3 \pm 0.3$	1.0	—	
Output To Output Skew	$t_{osLH}$ $t_{osHL}$	(Note 11)	1.8	—	0.5	ns
			$2.5 \pm 0.2$	—	0.5	
			$3.3 \pm 0.3$	—	0.5	

For  $C_L = 50$  pF, add approximately 300 ps to the AC maximum specification.

(Note 11) 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)

PARAMETER	SYMBOL	TEST CONDITION	VCC (V)	TYP.	UNIT
Quiet Output Maximum Dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note 12)	1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V (Note 12)	2.5	0.6	
		VIH = 3.3 V, VIL = 0 V (Note 12)	3.3	0.8	
Quiet Output Minimum Dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note 12)	1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V (Note 12)	2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V (Note 12)	3.3	-0.8	
Quiet Output Minimum Dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note 12)	1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V (Note 12)	2.5	1.9	
		VIH = 3.3 V, VIL = 0 V (Note 12)	3.3	2.2	

(Note 12) Parameter guaranteed by design.

Capacitive characteristics (Ta = 25°C)

PARAMETER	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 13)	1.8, 2.5, 3.3	20	pF

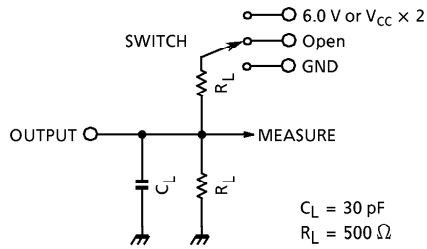
(Note 13) CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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



Fig.1 Test circuit



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

**AC WAVEFORM**

Fig.2  $t_{pLH}, t_{pHL}, t_w, t_s, t_h$

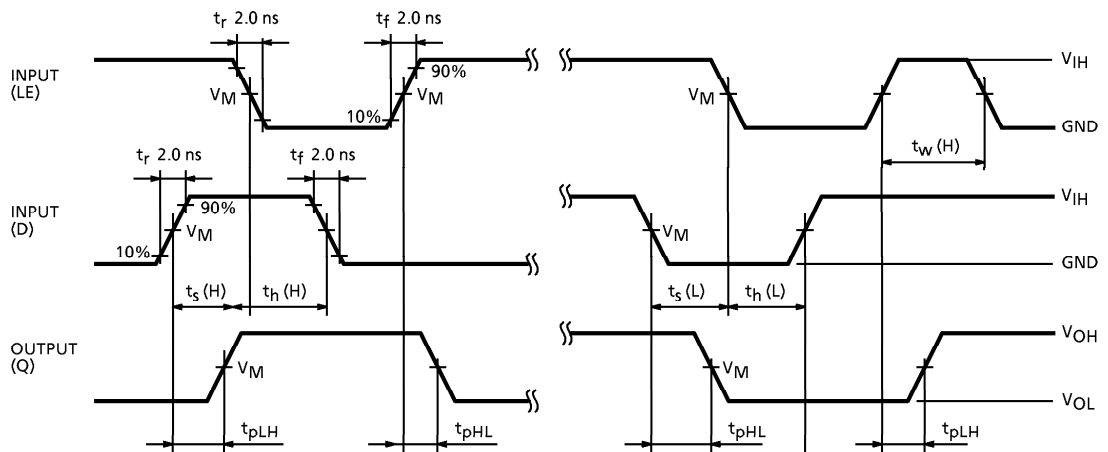
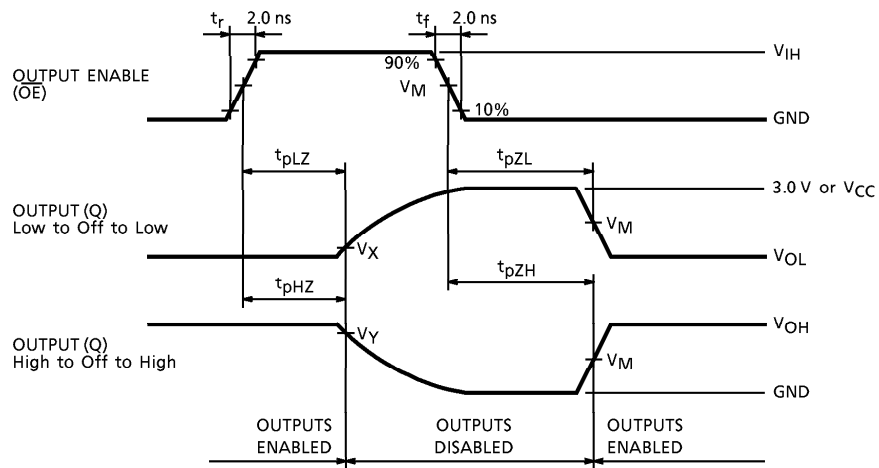


Fig.3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

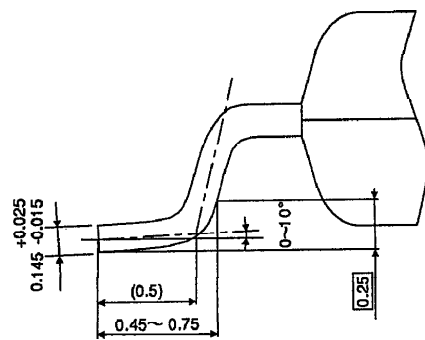
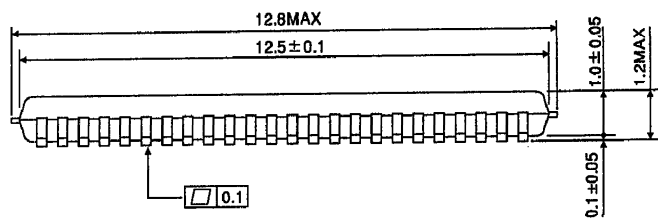
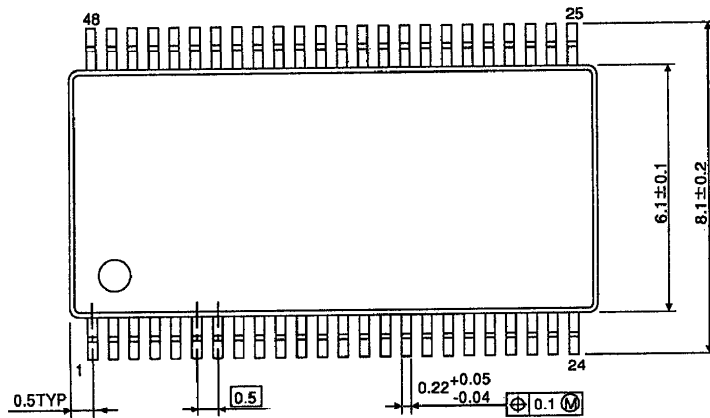


SYMBOL	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \text{ V}$
$V_{IH}$	$2.7 \text{ V}$	$V_{CC}$	$V_{CC}$
$V_M$	$1.5 \text{ V}$	$V_{CC} / 2$	$V_{CC} / 2$
$V_X$	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
$V_Y$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15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

**OUTLINE DRAWING**

TSSOP48-P-0061-0.50

Unit : mm



Weight : 0.25 g (Typ.)