

TC74VCX16374FT

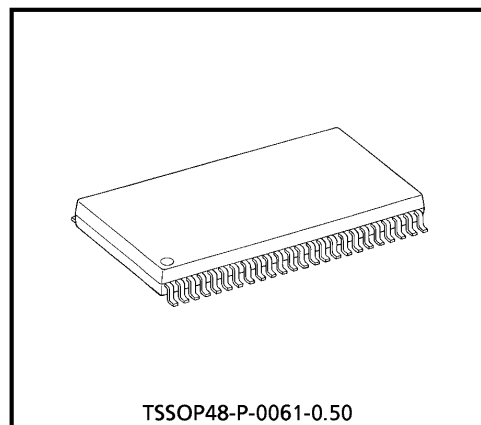
LOW-VOLTAGE 16-BIT D-TYPE FLIP-FLOP WITH 3.6 V TOLERANT INPUTS AND OUTPUTS

The TC74VCX16374FT is a high performance CMOS 16-bit D-TYPE FLIP FLOP. 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 3.6 V.

This 16-bit D-type flip-flop is controlled by a clock input (CK) and a output enable input (\overline{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 \overline{OE} input is high, the outputs are in a high impedance state.

All inputs are equipped with protection circuits against static discharge.



Weight : 0.25 g (Typ.)

FEATURES

- Low Voltage Operation : $V_{CC} = 1.8\sim 3.6\text{ V}$
- High Speed Operation : $t_{pd} = 3.0\text{ ns (max) at } V_{CC} = 3.0\sim 3.6\text{ V}$
 $t_{pd} = 3.9\text{ ns (max) at } V_{CC} = 2.3\sim 2.7\text{ V}$
 $t_{pd} = 6.0\text{ ns (max) at } V_{CC} = 1.8\text{ V}$
- 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 $> \pm 200\text{ V}$
- 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

| | | | |
|------------------|----|----|----------|
| $\overline{1OE}$ | 1 | 48 | 1CK |
| 1Q1 | 2 | 47 | 1D1 |
| 1Q2 | 3 | 46 | 1D2 |
| GND | 4 | 45 | GND |
| 1Q3 | 5 | 44 | 1D3 |
| 1Q4 | 6 | 43 | 1D4 |
| V_{CC} | 7 | 42 | V_{CC} |
| 1Q5 | 8 | 41 | 1D5 |
| 1Q6 | 9 | 40 | 1D6 |
| GND | 10 | 39 | GND |
| 1Q7 | 11 | 38 | 1D7 |
| 1Q8 | 12 | 37 | 1D8 |
| 2Q1 | 13 | 36 | 2D1 |
| 2Q2 | 14 | 35 | 2D2 |
| GND | 15 | 34 | GND |
| 2Q3 | 16 | 33 | 2D3 |
| 2Q4 | 17 | 32 | 2D4 |
| V_{CC} | 18 | 31 | V_{CC} |
| 2Q5 | 19 | 30 | 2D5 |
| 2Q6 | 20 | 29 | 2D6 |
| GND | 21 | 28 | GND |
| 2Q7 | 22 | 27 | 2D7 |
| 2Q8 | 23 | 26 | 2D8 |
| $\overline{2OE}$ | 24 | 25 | 2CK |

(TOP VIEW)

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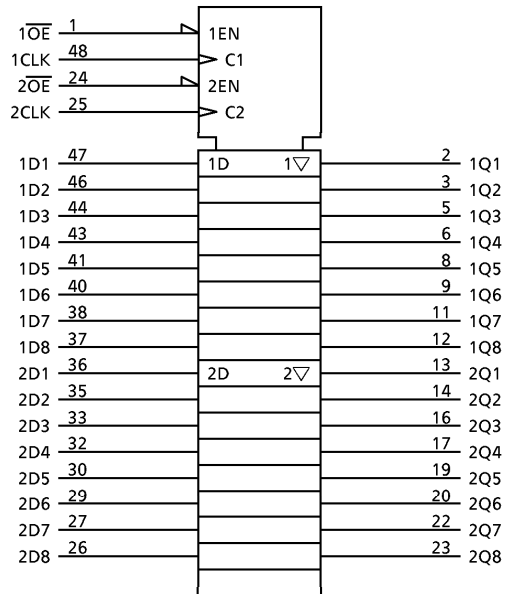
TRUTH TABLE

| INPUT | | | OUTPUT |
|-------------------|-----|---------|---------|
| 1 \overline{OE} | 1CK | 1D1-1D8 | 1Q1-1Q8 |
| H | X | X | Z |
| L | | X | Qn |
| L | | L | L |
| L | | H | H |

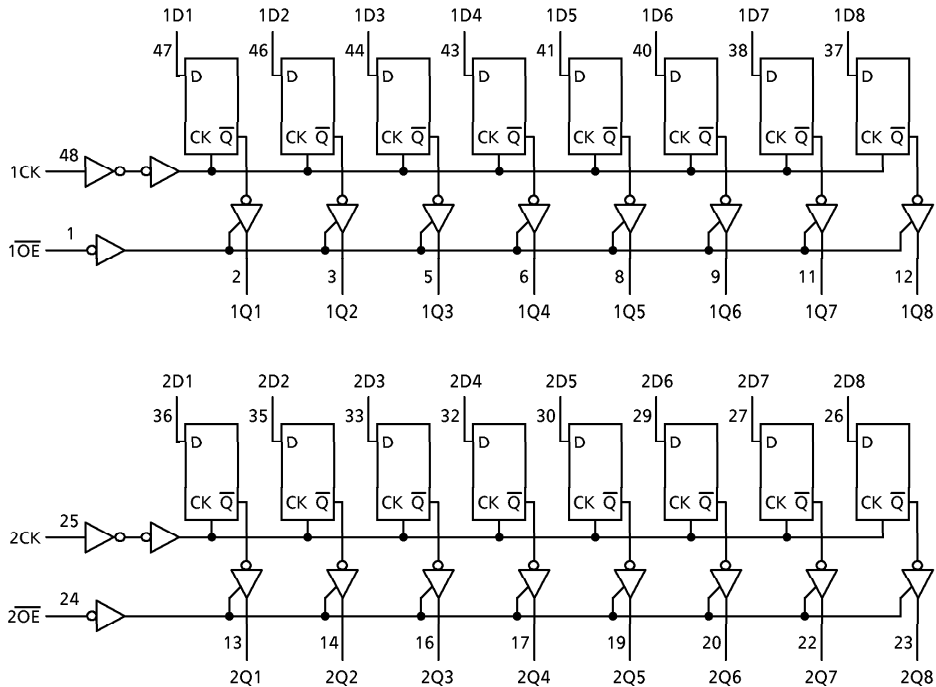
| INPUT | | | OUTPUT |
|-------------------|-----|---------|---------|
| 2 \overline{OE} | 2CK | 2D1-2D8 | 2Q1-2Q8 |
| H | X | X | Z |
| L | | X | Qn |
| L | | L | L |
| L | | H | H |

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

IEC LOGIC SYMBOL



SYSTEM DIAGRAM



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} = 3.0~3.6 V

(Note 8) : V_{CC} = 2.3~2.7 V

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

(Note 10) : V_{IN} = 0.8~2.0 V, V_{CC} = 3.0 V

ELECTRICAL CHARACTERISTICS

DC characteristics (Ta = -40~85°C, 2.7 V < V_{CC} ≤ 3.6 V)

| PARAMETER | | SYMBOL | TEST CONDITION | | V _{CC} (V) | MIN | MAX | UNIT |
|---------------------------------------|-----------|------------------|--|---------------------------|---------------------|-----------------------|--------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 2.7~3.6 | 2.0 | — | V |
| | "L" Level | V _{IL} | | | 2.7~3.6 | — | 0.8 | |
| Output Voltage | "H" Level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.7~3.6 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -12 mA | 2.7 | 2.2 | — | |
| | | | | I _{OH} = -18 mA | 3.0 | 2.4 | — | |
| | | | | I _{OH} = -24 mA | 3.0 | 2.2 | — | |
| | "L" Level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.7~3.6 | — | 0.2 | |
| | | | | I _{OL} = 12 mA | 2.7 | — | 0.4 | |
| | | | | I _{OL} = 18 mA | 3.0 | — | 0.4 | |
| | | | | I _{OL} = 24 mA | 3.0 | — | 0.55 | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 2.7~3.6 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 2.7~3.6 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 2.7~3.6 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 2.7~3.6 | — | ± 20.0 | |
| Increase In I _{CC} Per Input | | ΔI _{CC} | V _{IH} = V _{CC} - 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 |
|----------------------------------|-----------|------------------|--|---------------------------|---------|-----------------------|--------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 2.3~2.7 | 1.6 | — | V |
| | "L" Level | V _{IL} | | | 2.3~2.7 | — | 0.7 | |
| Output Voltage | "H" Level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.3~2.7 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -6 mA | 2.3 | 2.0 | — | |
| | | | | I _{OH} = -12 mA | 2.3 | 1.8 | — | |
| | | | | I _{OH} = -18 mA | 2.3 | 1.7 | — | |
| | "L" Level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.3~2.7 | — | 0.2 | |
| | | | | I _{OL} = 12 mA | 2.3 | — | 0.4 | |
| | | | I _{OL} = 18 mA | 2.3 | — | 0.6 | | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 2.3~2.7 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 2.3~2.7 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 2.3~2.7 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 2.3~2.7 | — | ± 20.0 | |

ELECTRICAL CHARACTERISTICS

DC characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

| PARAMETER | | SYMBOL | TEST CONDITION | | VCC (V) | MIN | MAX | UNIT |
|----------------------------------|-----------|------------------|--|---------------------------|---------|-----------------------|-----------------------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 1.8~2.3 | 0.7 × V _{CC} | — | V |
| | "L" Level | V _{IL} | | | 1.8~2.3 | — | 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} = -6 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} = 6 mA | 1.8 | — | 0.3 | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 1.8 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 1.8 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 1.8 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 1.8 | — | ± 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 _{CC} (V) | MIN | MAX | UNIT |
|-------------------------------|--|----------------|---------------------|-----|-----|------|
| | | | | | | |
| Maximum Clock Frequency | f _{MAX} | (Fig.1, 2) | 1.8 | 125 | — | MHz |
| | | | 2.5 ± 0.2 | 200 | — | |
| | | | 3.3 ± 0.3 | 250 | — | |
| Propagation Delay Time (CK-Q) | t _{pLH} t _{pHL} | (Fig.1, 2) | 1.8 | 1.5 | 6.0 | ns |
| | | | 2.5 ± 0.2 | 1.0 | 3.9 | |
| | | | 3.3 ± 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 ± 0.2 | 1.0 | 4.6 | |
| | | | 3.3 ± 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 ± 0.2 | 1.0 | 3.8 | |
| | | | 3.3 ± 0.3 | 0.8 | 3.5 | |
| Minimum Pulse Width (CK) | t _w (H) t _w (L) | (Fig.1, 2) | 1.8 | 3.0 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum Set-up Time | t _s | (Fig.1, 2) | 1.8 | 2.5 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum Hold Time | t _h | (Fig.1, 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 11) | 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 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 | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | 0.25 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | 0.6 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note 12) | 3.3 | 0.8 | |
| Quiet Output Minimum Dynamic VOL | VOLV | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | -0.25 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | -0.6 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note 12) | 3.3 | -0.8 | |
| Quiet Output Minimum Dynamic VOH | VOHV | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | 1.5 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | 1.9 | |
| | | V _{IH} = 3.3 V, V _{IL} = 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 | C _{IN} | | 1.8, 2.5, 3.3 | 6 | pF |
| Output Capacitance | C _O | | 1.8, 2.5, 3.3 | 7 | pF |
| Power Dissipation Capacitance | C _{PD} | f _{IN} = 10 MHz (Note 13) | 1.8, 2.5, 3.3 | 20 | pF |

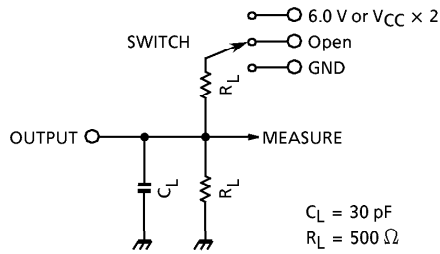
(Note 13) : C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

TEST CIRCUIT

Fig.1



| 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 $t_{pLH}, t_{pHL}, t_w, t_s, t_h$

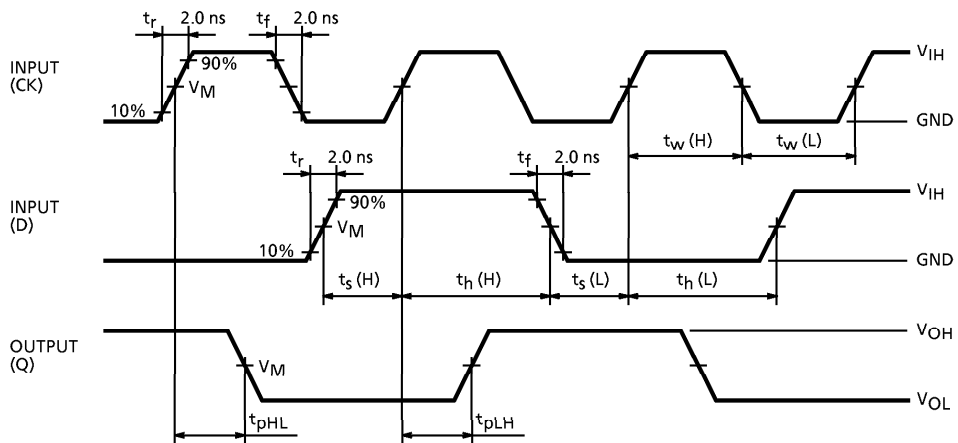
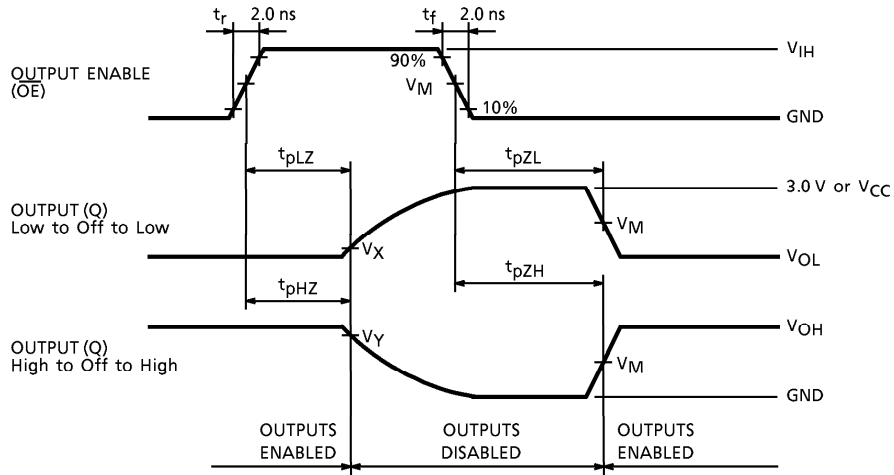


Fig.3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

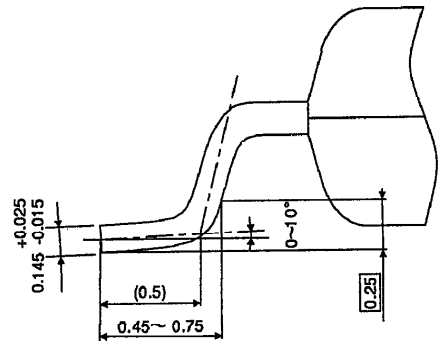
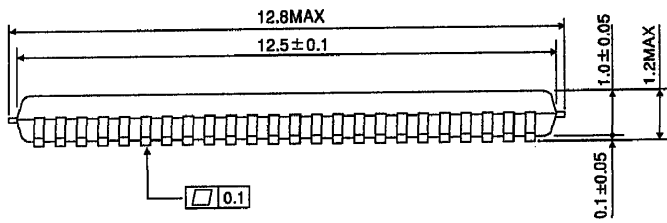
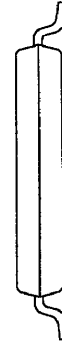
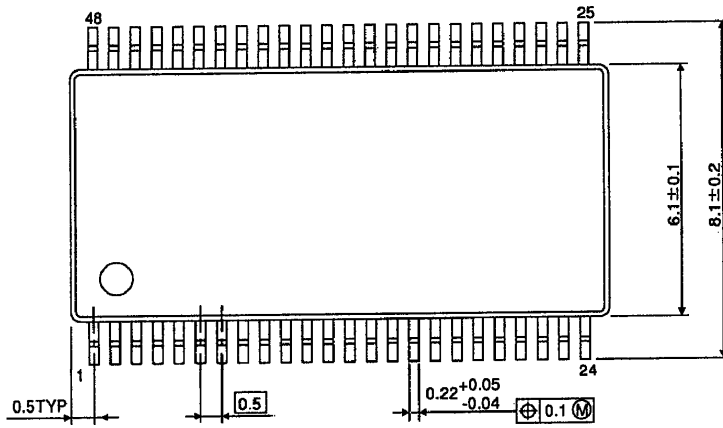


| SYMBOL | V_{CC} | | |
|----------|------------------|-------------------|-------------------|
| | $3.3 \pm 0.3 V$ | $2.5 \pm 0.2 V$ | $1.8 V$ |
| V_{IH} | $2.7 V$ | V_{CC} | V_{CC} |
| V_M | $1.5 V$ | $V_{CC} / 2$ | $V_{CC} / 2$ |
| V_X | $V_{OL} + 0.3 V$ | $V_{OL} + 0.15 V$ | $V_{OL} + 0.15 V$ |
|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