

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC7MH573FK

### Octal D-Type Latch with 3-State Output

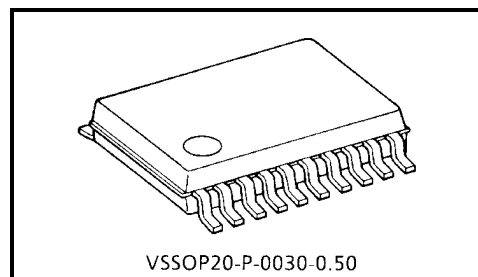
The TC7MH573FK is an advanced high speed CMOS octal latch with 3-state output fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent bipolar schottky TTL while maintaining the CMOS low power dissipation.

This 8 bit D-type latch is controlled by a latch enable input (LE) and a output enable input ( $\overline{OE}$ ).

When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

An input protection circuit ensures that 0 to 7 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.



VSSOP20-P-0030-0.50

Weight: 0.03 g (typ.)

### Features

- High speed:  $t_{pd} = 4.5 \text{ ns}$  (typ.) ( $V_{CC} = 5 \text{ V}$ )
- Low power dissipation:  $I_{CC} = 4 \mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC}(\text{opr}) = 2 \sim 5.5 \text{ V}$
- Low noise:  $V_{OLP} = 1.0 \text{ V}$  (max)
- Pin and function compatible with 74ALS573

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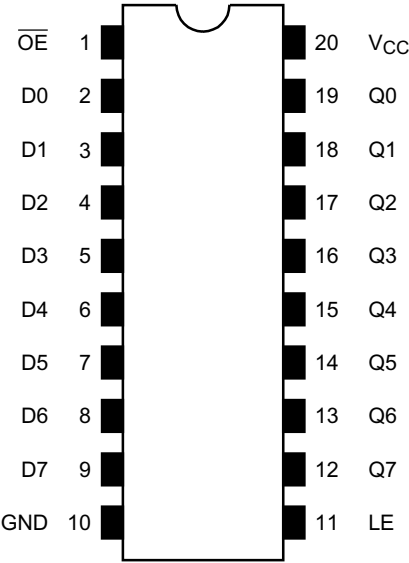
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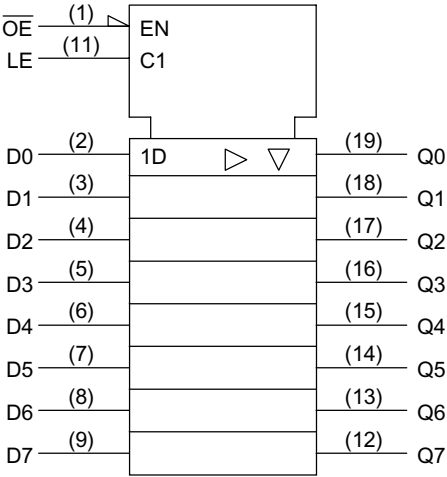
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Pin Assignment (top view)



IEC Logic Symbol



Truth Table

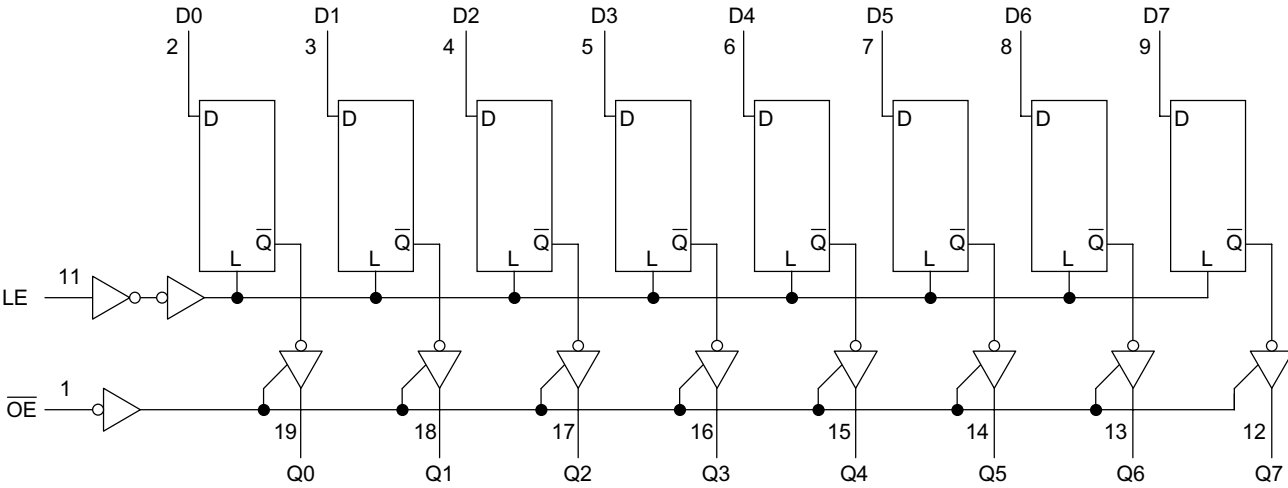
| Inputs |    |   | Outputs        |
|--------|----|---|----------------|
| OE     | LE | D |                |
| H      | X  | X | Z              |
| L      | L  | X | Q <sub>n</sub> |
| L      | H  | L | L              |
| L      | H  | H | H              |

X: Don't care

Z: High impedance

Q<sub>n</sub>: 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 |
|-----------------------------|-----------|----------------------|------|
| Supply voltage range        | $V_{CC}$  | -0.5~7.0             | V    |
| DC input voltage            | $V_{IN}$  | -0.5~7.0             | V    |
| DC output voltage           | $V_{OUT}$ | -0.5~ $V_{CC} + 0.5$ | V    |
| Input diode current         | $I_{IK}$  | -20                  | mA   |
| Output diode current        | $I_{OK}$  | ±20                  | mA   |
| DC output current           | $I_{OUT}$ | ±25                  | mA   |
| DC $V_{CC}$ /ground current | $I_{CC}$  | ±75                  | mA   |
| Power dissipation           | $P_D$     | 180                  | mW   |
| Storage temperature         | $T_{stg}$ | -65~150              | °C   |

**Recommended Operating Conditions**

| Characteristics          | Symbol    | Rating  | Unit |
|--------------------------|-----------|---|------|
| Supply voltage           | $V_{CC}$  | 2.0~5.5   | V    |
| Input voltage            | $V_{IN}$  | 0~5.5   | V    |
| Output voltage           | $V_{OUT}$ | 0~ $V_{CC}$   | V    |
| Operating temperature    | $T_{opr}$ | -40~85  | °C   |
| Input rise and fall time | dt/dv     | 0~100 ( $V_{CC} = 3.3 \pm 0.3$ V)<br>0~20 ( $V_{CC} = 5 \pm 0.5$ V) | ns/V |

## Electrical Characteristics

## DC Characteristics

| Characteristics                  |            | Symbol          | Test Condition  |                          | Ta = 25°C               |                               |                            |           | Ta = -40~85°C                 |        | Unit |
|----------------------------------|------------|-----------------|---|--------------------------|-------------------------|-------------------------------|----------------------------|-----------|-------------------------------|--------|------|
|                                  |            |                 |   |                          | V <sub>CC</sub> (V)     | Min                           | Typ.                       | Max       | Min                           | Max    |      |
| Input voltage                    | High level | V <sub>IH</sub> | —   |                          | 2.0<br>3.0~5.5          | 1.50<br>V <sub>CC</sub> × 0.7 | —<br>—                     | —<br>—    | 1.50<br>V <sub>CC</sub> × 0.7 | —<br>— | V    |
|                                  | Low level  | V <sub>IL</sub> | —   |                          | 2.0<br>3.0~5.5          | —<br>—                        | —<br>V <sub>CC</sub> × 0.3 | 0.50<br>— | 0.50<br>V <sub>CC</sub> × 0.3 | —<br>— |      |
| Output voltage                   | High level | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>   | I <sub>OH</sub> = -50 μA | 2.0                     | 1.9                           | 2.0                        | —         | 1.9                           | —      | V    |
|                                  |            |                 |   |                          | 3.0                     | 2.9                           | 3.0                        | —         | 2.9                           | —      |      |
|                                  |            |                 |   |                          | 4.5                     | 4.4                           | 4.5                        | —         | 4.4                           | —      |      |
|                                  |            |                 |   | I <sub>OH</sub> = -4 mA  | 3.0                     | 2.58                          | —                          | —         | 2.48                          | —      |      |
|                                  |            |                 |   |                          | I <sub>OH</sub> = -8 mA | 4.5                           | 3.94                       | —         | —                             | 3.80   |      |
|                                  | Low level  | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub><br>or V <sub>IL</sub>   | I <sub>OL</sub> = 50 μA  | 2.0                     | —                             | 0                          | 0.1       | —                             | 0.1    |      |
|                                  |            |                 |   |                          | 3.0                     | —                             | 0                          | 0.1       | —                             | 0.1    |      |
|                                  |            |                 |   |                          | 4.5                     | —                             | 0                          | 0.1       | —                             | 0.1    |      |
|                                  |            |                 |   | I <sub>OL</sub> = 4 mA   | 3.0                     | —                             | —                          | 0.36      | —                             | 0.44   |      |
|                                  |            |                 |   |                          | I <sub>OL</sub> = 8 mA  | 4.5                           | —                          | —         | 0.36                          | —      |      |
| 3-state output off-state current |            | I <sub>OZ</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>OUT</sub> = V <sub>CC</sub> or GND |                          | 5.5                     | —                             | —                          | ±0.25     | —                             | ±2.50  | μA   |
| Input leakage current            |            | I <sub>IN</sub> | V <sub>IN</sub> = 5.5 V or GND  |                          | 0~5.5                   | —                             | —                          | ±0.1      | —                             | ±1.0   | μA   |
| Quiescent supply current         |            | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND  |                          | 5.5                     | —                             | —                          | 4.0       | —                             | 40.0   | μA   |

Timing Requirements (Input: t<sub>r</sub> = t<sub>f</sub> = 3 ns)

| Characteristics             | Symbol             | Test Condition | Ta = 25°C           |      |       | Ta = -40~85°C |       | Unit |
|-----------------------------|--------------------|----------------|---------------------|------|-------|---------------|-------|------|
|                             |                    |                | V <sub>CC</sub> (V) | Typ. | Limit | Limit         | Limit |      |
| Minimum pulse width<br>(LE) | t <sub>w</sub> (H) | —              | 3.3 ± 0.3           | —    | 5.0   | 5.0           | 5.0   | ns   |
|                             |                    |                | 5.0 ± 0.5           | —    | 5.0   | 5.0           | 5.0   |      |
| Minimum set-up time         | t <sub>s</sub>     | —              | 3.3 ± 0.3           | —    | 3.5   | 3.5           | 3.5   | ns   |
|                             |                    |                | 5.0 ± 0.5           | —    | 3.5   | 3.5           | 3.5   |      |
| Minimum hold time           | t <sub>h</sub>     | —              | 3.3 ± 0.3           | —    | 1.5   | 1.5           | 1.5   | ns   |
|                             |                    |                | 5.0 ± 0.5           | —    | 1.5   | 1.5           | 1.5   |      |

AC Characteristics (Input:  $t_r = t_f = 3 \text{ ns}$ )

| Characteristics               | Symbol                   | Test Condition            |                     |                     | Ta = 25°C |      |      | Ta = -40~85°C |      | Unit |
|-------------------------------|--------------------------|---------------------------|---------------------|---------------------|-----------|------|------|---------------|------|------|
|                               |                          |                           | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min       | Typ. | Max  | Min           | Max  |      |
| Propagation delay time (LE-Q) | $t_{pLH}$<br>$t_{pHL}$   | —                         | $3.3 \pm 0.3$       | 15                  | —         | 7.6  | 11.9 | 1.0           | 14.0 | ns   |
|                               |                          |                           |                     | 50                  | —         | 10.1 | 15.4 | 1.0           | 17.5 |      |
|                               |                          |                           | $5.0 \pm 0.5$       | 15                  | —         | 5.0  | 7.7  | 1.0           | 9.0  |      |
|                               |                          |                           |                     | 50                  | —         | 6.5  | 9.7  | 1.0           | 11.0 |      |
| Propagation delay time (D-Q)  | $t_{pLH}$<br>$t_{pHL}$   | —                         | $3.3 \pm 0.3$       | 15                  | —         | 7.0  | 11.0 | 1.0           | 13.0 | ns   |
|                               |                          |                           |                     | 50                  | —         | 9.5  | 14.5 | 1.0           | 16.5 |      |
|                               |                          |                           | $5.0 \pm 0.5$       | 15                  | —         | 4.5  | 6.8  | 1.0           | 8.0  |      |
|                               |                          |                           |                     | 50                  | —         | 6.0  | 8.8  | 1.0           | 10.0 |      |
| 3-state output enable time    | $t_{pZL}$<br>$t_{pZH}$   | $R_L = 1 \text{ k}\Omega$ | $3.3 \pm 0.3$       | 15                  | —         | 7.3  | 11.5 | 1.0           | 13.5 | ns   |
|                               |                          |                           |                     | 50                  | —         | 9.8  | 15.0 | 1.0           | 17.0 |      |
|                               |                          |                           | $5.0 \pm 0.5$       | 15                  | —         | 5.2  | 7.7  | 1.0           | 9.0  |      |
|                               |                          |                           |                     | 50                  | —         | 6.7  | 9.7  | 1.0           | 11.0 |      |
| 3-state output disable time   | $t_{pLZ}$<br>$t_{pHZ}$   | $R_L = 1 \text{ k}\Omega$ | $3.3 \pm 0.3$       | 50                  | —         | 10.7 | 14.5 | 1.0           | 16.5 | ns   |
|                               |                          |                           | $5.0 \pm 0.5$       | 50                  | —         | 6.7  | 9.7  | 1.0           | 11.0 |      |
| Output to output skew         | $t_{osLH}$<br>$t_{osHL}$ | (Note1)                   | $3.3 \pm 0.3$       | 50                  | —         | —    | 1.5  | —             | 1.5  | ns   |
|                               |                          |                           | $5.0 \pm 0.5$       | 50                  | —         | —    | 1.0  | —             | 1.0  |      |
| Input capacitance             | C <sub>IN</sub>          | —                         | —                   | —                   | —         | 4    | 10   | —             | 10   | pF   |
| Output capacitance            | C <sub>OUT</sub>         | —                         | —                   | —                   | —         | 6    | —    | —             | —    | pF   |
| Power dissipation capacitance | C <sub>PD</sub>          | (Note2)                   | —                   | —                   | —         | 29   | —    | —             | —    | pF   |

Note1: This parameter is guaranteed by design.

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

Note2: 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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per latch)}$$

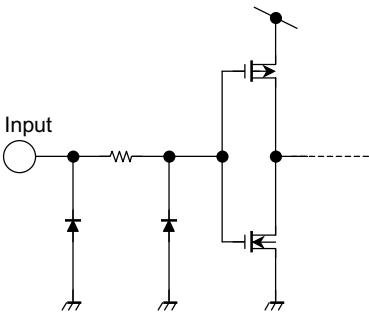
And the total C<sub>PD</sub> when n pcs of latch operate can be gained by the following equation:

$$C_{PD (total)} = 21 + 8 \cdot n$$

Noise Characteristics (Input:  $t_r = t_f = 3\text{ ns}$ )

| Characteristics  | Symbol           | Test Condition         | Ta = 25°C           |      |       | Unit |
|--|------------------|------------------------|---------------------|------|-------|------|
|  |                  |                        | V <sub>CC</sub> (V) | Typ. | Limit |      |
| Quiet output maximum dynamic V <sub>OL</sub>             | V <sub>OLP</sub> | C <sub>L</sub> = 50 pF | 5.0                 | 0.8  | 1.0   | V    |
| Quiet output minimum dynamic V <sub>OL</sub>             | V <sub>OLV</sub> | C <sub>L</sub> = 50 pF | 5.0                 | -0.8 | -1.0  | V    |
| Minimum high level dynamic input voltage V <sub>IH</sub> | V <sub>IHD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 3.5   | V    |
| Maximum low level dynamic input voltage V <sub>IL</sub>  | V <sub>ILD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 1.5   | V    |

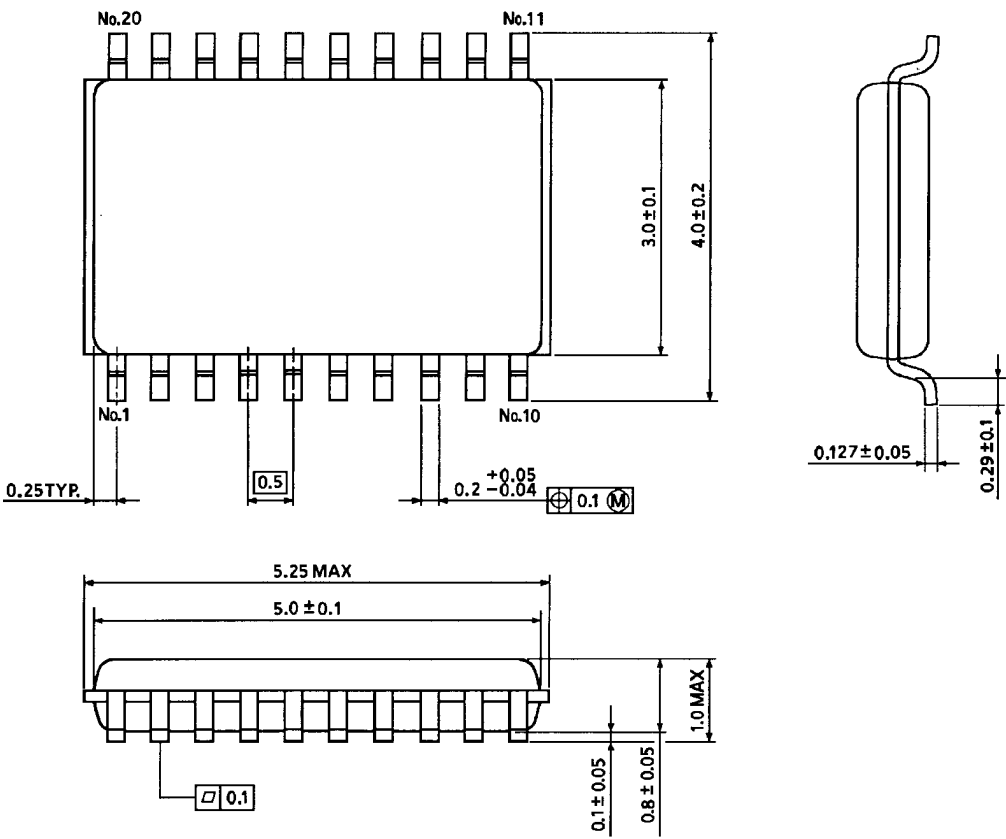
Input Equivalent Circuit



Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)