

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7MZ574FK

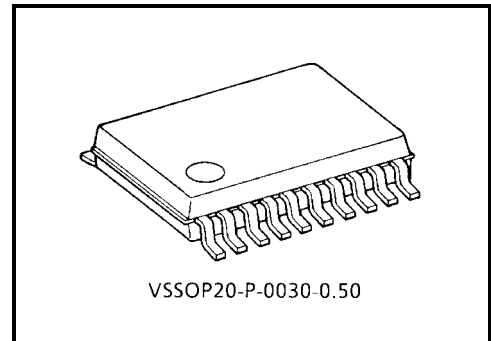
## Low Voltage Octal D-Type Flip-Flop with 5 V Tolerant Inputs and Outputs

The TC7MZ574FK is a high performance CMOS octal D-type flip flop. Designed for use in 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5 V supply environment for both inputs and outputs.

This 8 bit D-type flip-flop is controlled by a clock input (CK) and an output enable input ( $\overline{OE}$ ). When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

All inputs are equipped with protection circuits against static discharge.

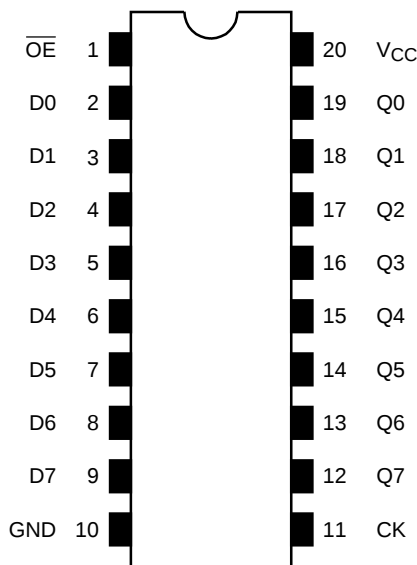


Weight: 0.03 g (typ.)

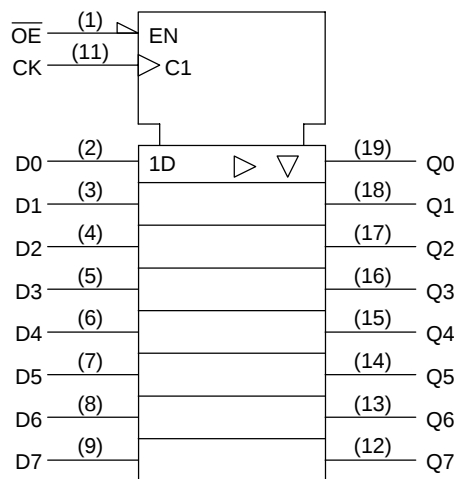
### Features

- Low voltage operation:  $V_{CC} = 2.0\sim 3.6\text{ V}$
- High speed operation:  $t_{pd} = 8.5\text{ ns (max)}$  ( $V_{CC} = 3.0\sim 3.6\text{ V}$ )
- Output current:  $|I_{OH}|/I_{OL} = 24\text{ mA (min)}$  ( $V_{CC} = 3.0\text{ V}$ )
- Latch-up performance:  $\pm 500\text{ mA}$
- Package: VSSOP (US20)
- Power down protection is provided on all inputs and outputs.
- Pin and function compatible with the 74 series (74AC/VHC/HCF/ALS/LS etc.) 574 type.

Pin Assignment (top view)



IEC Logic Symbol

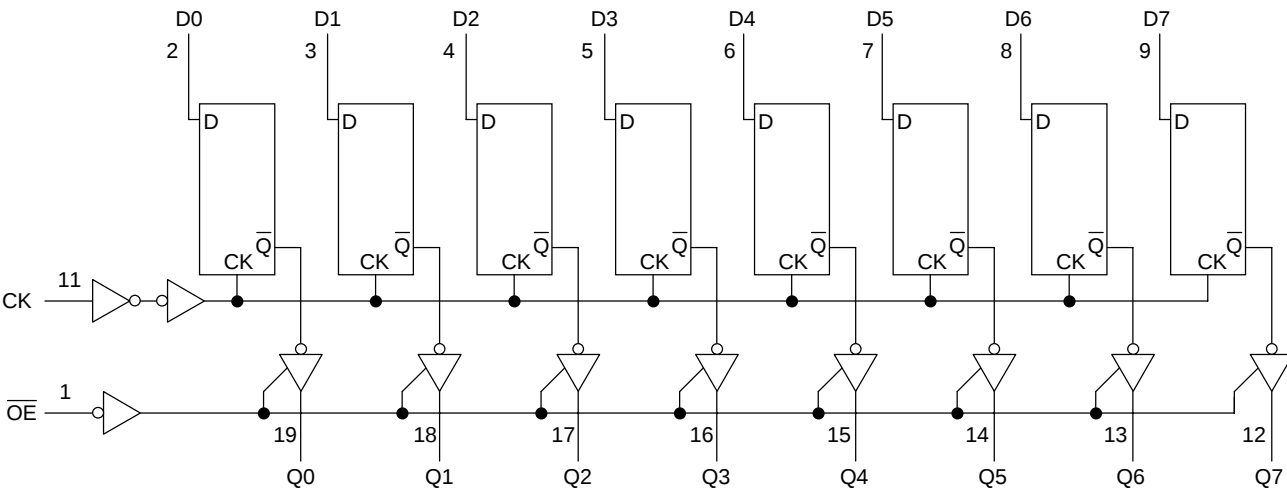


Truth Table

| Inputs          |    |   | Outputs |
|-----------------|----|---|---------|
| $\overline{OE}$ | CK | D |         |
| H               | X  | X | Z       |
| L               |    | X | $Q_n$   |
| L               |    | L | L       |
| L               |    | H | H       |

X: Don't care  
Z: High impedance  
 $Q_n$ : No change

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           | $V_{OUT}$        | -0.5~7.0 (Note1)             | V    |
|                             |                  | -0.5~ $V_{CC} + 0.5$ (Note2) |      |
| Input diode current         | $I_{IK}$         | -50                          | mA   |
| Output diode current        | $I_{OK}$         | ±50 (Note3)                  | mA   |
| DC output current           | $I_{OUT}$        | ±50                          | mA   |
| Power dissipation           | $P_D$            | 180                          | mW   |
| DC $V_{CC}$ /ground current | $I_{CC}/I_{GND}$ | ±100                         | mA   |
| Storage temperature         | $T_{stg}$        | -65~150                      | °C   |

Note1: Output in off-state

Note2: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

## Recommended Operating Conditions

| Characteristics          | Symbol          | Rating              | Unit |
|--------------------------|-----------------|---------------------|------|
| Supply voltage           | $V_{CC}$        | 2.0~3.6             | V    |
|                          |                 | 1.5~3.6 (Note4)     |      |
| Input voltage            | $V_{IN}$        | 0~5.5               | V    |
| Output voltage           | $V_{OUT}$       | 0~5.5 (Note5)       | V    |
|                          |                 | 0~ $V_{CC}$ (Note6) |      |
| Output current           | $I_{OH}/I_{OL}$ | ±24 (Note7)         | mA   |
|                          |                 | ±12 (Note8)         |      |
| Operating temperature    | $T_{opr}$       | -40~85              | °C   |
| Input rise and fall time | $dt/dv$         | 0~10 (Note9)        | ns/V |

Note4: Data retention only

Note5: Output in off-state

Note6: High or low state

Note7:  $V_{CC} = 3.0\sim 3.6$  V

Note8:  $V_{CC} = 2.7\sim 3.0$  V

Note9:  $V_{IN} = 0.8\sim 2.0$  V,  $V_{CC} = 3.0$  V

**Electrical Characteristics**
**DC Characteristics (Ta = -40~85°C)**

| Characteristics                       |            | Symbol           | Test Condition                                                                     |                           | V <sub>CC</sub> (V) | Min                   | Max  | Unit |
|---------------------------------------|------------|------------------|------------------------------------------------------------------------------------|---------------------------|---------------------|-----------------------|------|------|
| Input voltage                         | High level | V <sub>IH</sub>  | —                                                                                  |                           | 2.7~3.6             | 2.0                   | —    | V    |
|                                       | Low level  | V <sub>IL</sub>  | —                                                                                  |                           | 2.7~3.6             | —                     | 0.8  |      |
| Output voltage                        | High 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                   | —    |      |
|                                       | Low 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  |      |
|                                       |            |                  |                                                                                    | I <sub>OL</sub> = 12 mA   | 2.7                 | —                     | 0.4  |      |
|                                       |            |                  |                                                                                    | I <sub>OL</sub> = 16 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> = 0~5.5 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><br>V <sub>OUT</sub> = 0~5.5 V | 2.7~3.6                   | —                   | ±5.0                  | μA   |      |
| Power off leakage current             |            | I <sub>OFF</sub> | V <sub>IN</sub> /V <sub>OUT</sub> = 5.5 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                   | —                   | 10.0                  | μA   |      |
|                                       |            |                  | V <sub>IN</sub> /V <sub>OUT</sub> = 3.6~5.5 V                                      | 2.7~3.6                   | —                   | ±10.0                 |      |      |
| 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                   | —                   | 500                   |      |      |

## AC Characteristics (Ta = -40~85°C)

| Characteristics               | Symbol                                   | Test Condition     | V <sub>CC</sub> (V) | Min | Max | Unit |
|-------------------------------|------------------------------------------|--------------------|---------------------|-----|-----|------|
|                               |                                          |                    |                     |     |     |      |
| Maximum clock frequency       | f <sub>max</sub>                         | Figure 1, Figure 2 | 2.7                 | —   | —   | MHz  |
|                               |                                          |                    | 3.3 ± 0.3           | 150 | —   |      |
| Propagation delay time (CK-Q) | t <sub>pLH</sub><br>t <sub>pHL</sub>     | Figure 1, Figure 2 | 2.7                 | —   | 9.5 | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 1.5 | 8.5 |      |
| Output enable time            | t <sub>pZL</sub><br>t <sub>pZH</sub>     | Figure 1, Figure 3 | 2.7                 | —   | 9.5 | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 1.5 | 8.5 |      |
| Output disable time           | t <sub>pLZ</sub><br>t <sub>pHZ</sub>     | Figure 1, Figure 3 | 2.7                 | —   | 7.0 | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 1.5 | 6.5 |      |
| Minimum pulse width (CK)      | t <sub>w</sub> (H)<br>t <sub>w</sub> (L) | Figure 1, Figure 2 | 2.7                 | 3.3 | —   | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 3.3 | —   |      |
| Minimum set-up time           | t <sub>s</sub>                           | Figure 1, Figure 2 | 2.7                 | 2.5 | —   | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 2.5 | —   |      |
| Minimum hold time             | t <sub>h</sub>                           | Figure 1, Figure 2 | 2.7                 | 1.5 | —   | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | 1.5 | —   |      |
| Output to output skew         | t <sub>osLH</sub><br>t <sub>osHL</sub>   | (Note10)           | 2.7                 | —   | —   | ns   |
|                               |                                          |                    | 3.3 ± 0.3           | —   | 1.0 |      |

Note10: This parameter is guaranteed by design.

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

## Dynamic Switching Characteristics

(Ta = 25°C, Input: t<sub>r</sub> = t<sub>f</sub> = 2.5 ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω)

| Characteristics              | Symbol          | Test Condition   |                                                | Typ. | Unit |   |
|------------------------------|-----------------|------------------|------------------------------------------------|------|------|---|
|                              |                 |                  | V <sub>CC</sub> (V)                            |      |      |   |
| Quiet output maximum dynamic | V <sub>OL</sub> | V <sub>OLP</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3  | 0.8  | V |
| Quiet output minimum dynamic | V <sub>OL</sub> | V <sub>OLV</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3  | 0.8  | V |

## Capacitive Characteristics (Ta = 25°C)

| Characteristics               | Symbol           | Test Condition                    | V <sub>CC</sub> (V) | Typ. | Unit |
|-------------------------------|------------------|-----------------------------------|---------------------|------|------|
|                               |                  |                                   |                     |      |      |
| Input capacitance             | C <sub>IN</sub>  | —                                 | 3.3                 | 7    | pF   |
| Output capacitance            | C <sub>OUT</sub> | —                                 | 3.3                 | 8    | pF   |
| Power dissipation capacitance | C <sub>PD</sub>  | f <sub>IN</sub> = 10 MHz (Note11) | 3.3                 | 25   | pF   |

Note11: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption.

Average operating current can be obtained by the equation:

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

AC Test Circuit

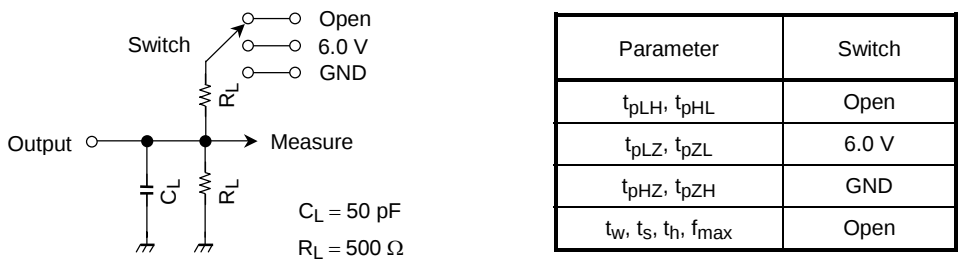


Figure 1

AC Waveform

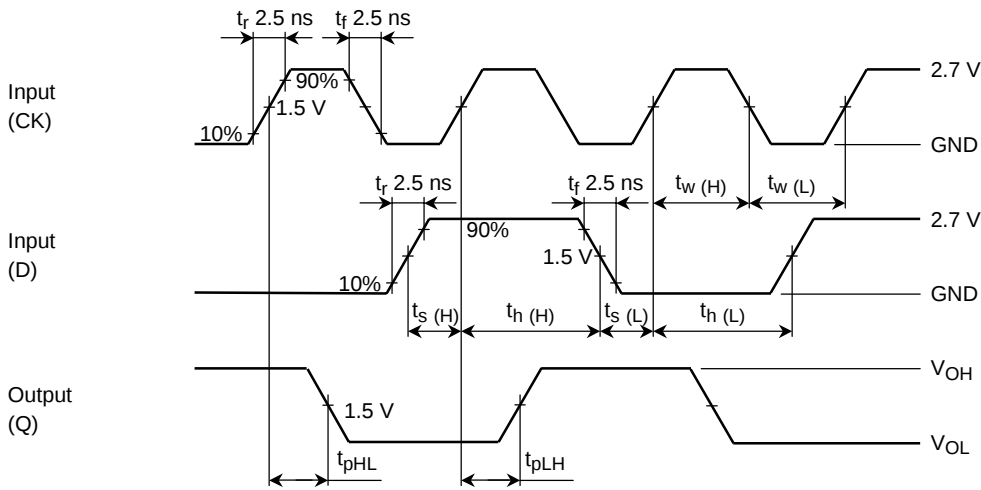


Figure 2  $t_{pLH}$ ,  $t_{pHL}$ ,  $t_w$ ,  $t_s$ ,  $t_h$

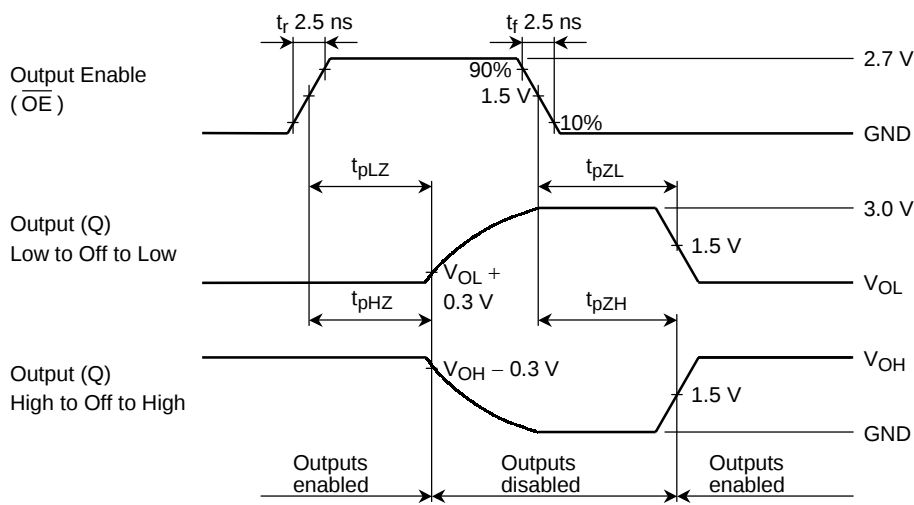
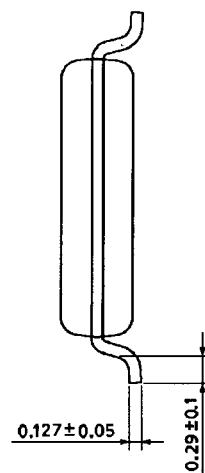
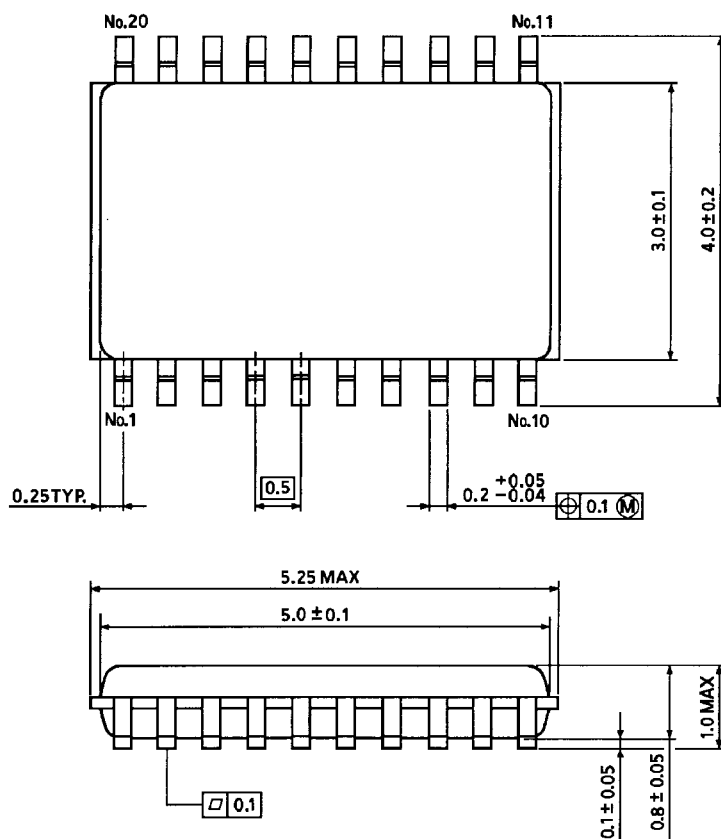


Figure 3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

## Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)

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