

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC7MZ574FK

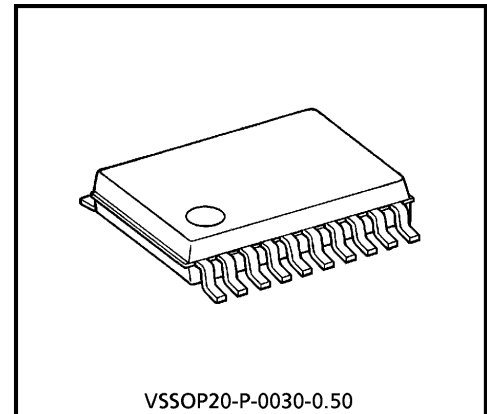
## LOW VOLTAGE OCTAL D-TYPE FLIP-FLOP WITH 5 V TOLERANT INPUTS AND OUTPUTS

The TC7MZ574 is a high performance CMOS OCTAL D-TYPE FLIP FLOP. Designed for use in 3.3 Volt systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V)  $V_{CC}$  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.



VSSOP20-P-0030-0.50

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 :  $\pm 500\text{ mA}$
- Available in VSSOP (US20)
- Power down protection is provided on all inputs and outputs.
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 574 type.

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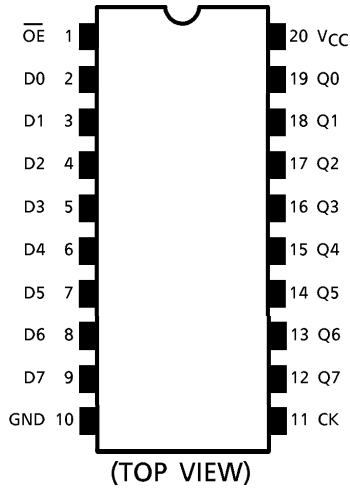
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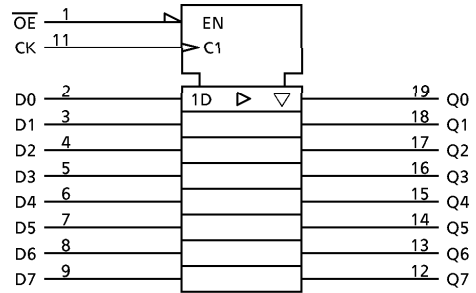
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**Pin Assignment**



**IEC Logic Symbol**

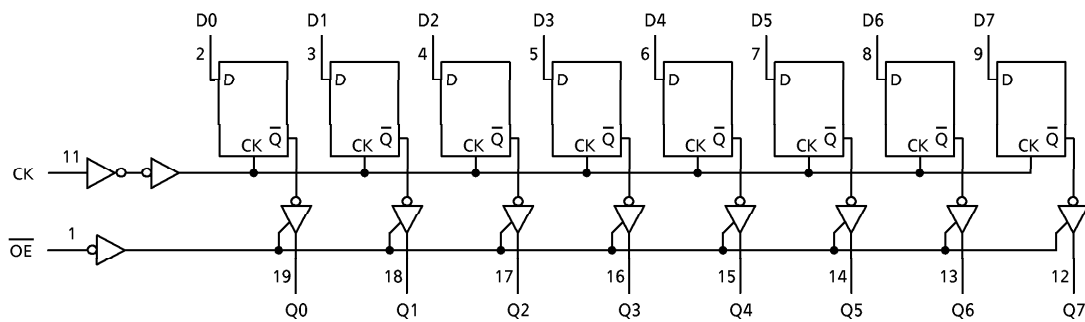


**Truth Table**

| INPUTS          |    |   | OUTPUTS |
|-----------------|----|---|---------|
| $\overline{OE}$ | CK | D |         |
| H               | X  | X | Z       |
| L               |    | X | Qn      |
| L               |    | L | L       |
| L               |    | H | H       |

- X : Don't Care
- Z : High Impedance
- Qn : No change

**System Diagram**



## Maximum Ratings

| PARAMETER                   | 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 (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           | $P_D$            | 180                           | mW   |
| DC $V_{CC}$ /Ground Current | $I_{CC}/I_{GND}$ | ±100                          | mA   |
| Storage Temperature         | $T_{stg}$        | -65~150                       | °C   |

(Note 1): Output in 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 Conditions

| PARAMETER                | SYMBOL          | RATING               | UNIT |
|--------------------------|-----------------|----------------------|------|
| Supply Voltage           | $V_{CC}$        | 2.0~3.6              | V    |
|                          |                 | 1.5~3.6 (Note 4)     |      |
| Input Voltage            | $V_{IN}$        | 0~5.5                | V    |
| Output Voltage           | $V_{OUT}$       | 0~5.5 (Note 5)       | V    |
|                          |                 | 0~ $V_{CC}$ (Note 6) |      |
| Output Current           | $I_{OH}/I_{OL}$ | ±24 (Note 7)         | mA   |
|                          |                 | ±12 (Note 8)         |      |
| Operating Temperature    | $T_{opr}$       | -40~85               | °C   |
| Input Rise And Fall Time | $dt/dv$         | 0~10 (Note 9)        | ns/V |

(Note 4): Data Retention Only

(Note 5): Output in Off-State

(Note 6): High or Low State

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

(Note 8):  $V_{CC} = 2.7\sim 3.0$  V

(Note 9):  $V_{IN} = 0.8\sim 2.0$  V,  $V_{CC} = 3.0$  V

**Electrical Characteristics**

DC characteristics (Ta = -40~85°C)

| PARAMETER                             |           | SYMBOL           | TEST CONDITION   |                           | V <sub>CC</sub> (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    |      |
| 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    |      |
|                                       |           |                  |  | 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>IIN</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    | μA   |

AC characteristics (Ta = -40~85°C)

| PARAMETER                     | SYMBOL                                   | TEST CONDITION | V <sub>CC</sub> (V) | Min | Max | UNIT |
|-------------------------------|--|----------------|---------------------|-----|-----|------|
|                               |  |                |                     |     |     |      |
| Maximum Clock Frequency       | f <sub>MAX</sub>                         | (Fig.1, 2)     | 2.7                 | —   | —   | MHz  |
|                               |  |                | 3.3 ± 0.3           | 150 | —   |      |
| Propagation Delay Time (CK-Q) | t <sub>pLH</sub><br>t <sub>pHL</sub>     | (Fig.1, 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>     | (Fig.1, 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>     | (Fig.1, 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) | (Fig.1, 2)     | 2.7                 | 3.3 | —   | ns   |
|                               |  |                | 3.3 ± 0.3           | 3.3 | —   |      |
| Minimum Set-Up Time           | t <sub>s</sub>                           | (Fig.1, 2)     | 2.7                 | 2.5 | —   | ns   |
|                               |  |                | 3.3 ± 0.3           | 2.5 | —   |      |
| Minimum Hold Time             | t <sub>h</sub>                           | (Fig.1, 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>   | (Note 10)      | 2.7                 | —   | —   | ns   |
|                               |  |                | 3.3 ± 0.3           | —   | 1.0 |      |

(Note 10): Parameter guaranteed by design.  
 (t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

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)

| PARAMETER                                    | SYMBOL           | TEST CONDITION                                 | V <sub>CC</sub> (V) | Typ. | UNIT |
|--|------------------|--|---------------------|------|------|
|  |                  |  |                     |      |      |
| 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    |

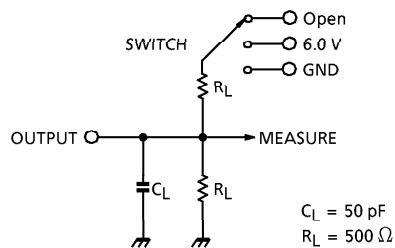
Capacitive Characteristics (Ta = 25°C)

| PARAMETER                     | 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 (Note 11) | 3.3                 | 25   | pF   |

(Note 11): 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<sub>CC (opr.)</sub> = C<sub>PD</sub> · V<sub>CC</sub> · f<sub>IN</sub> + I<sub>CC</sub> / 8 (per bit)

Test Circuit

Fig.1



| PARAMETER                         | SWITCH |
|-----------------------------------|--------|
| $t_{pLH}$ , $t_{pHL}$             | Open   |
| $t_{pLZ}$ , $t_{pZL}$             | 6.0 V  |
| $t_{pHZ}$ , $t_{pZH}$             | GND    |
| $t_w$ , $t_s$ , $t_h$ , $f_{MAX}$ | Open   |

AC Waveform

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

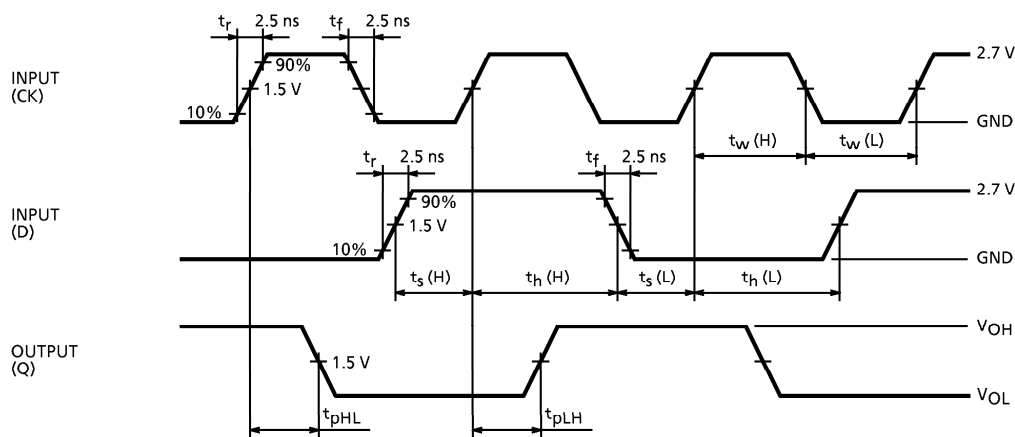
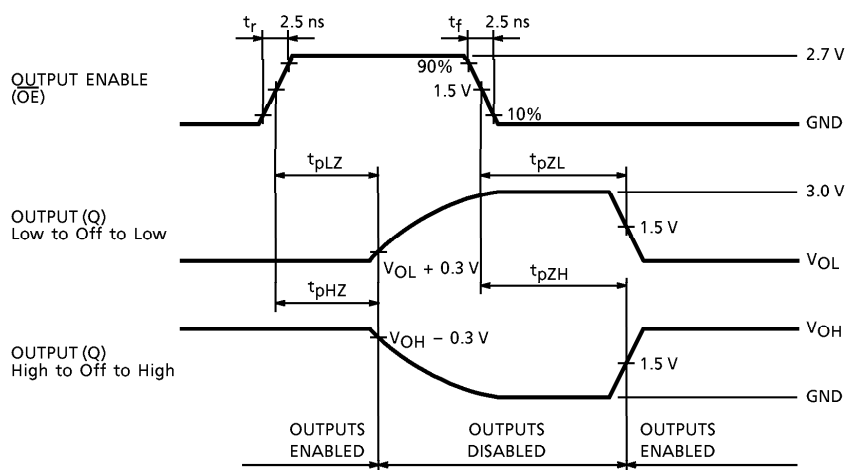
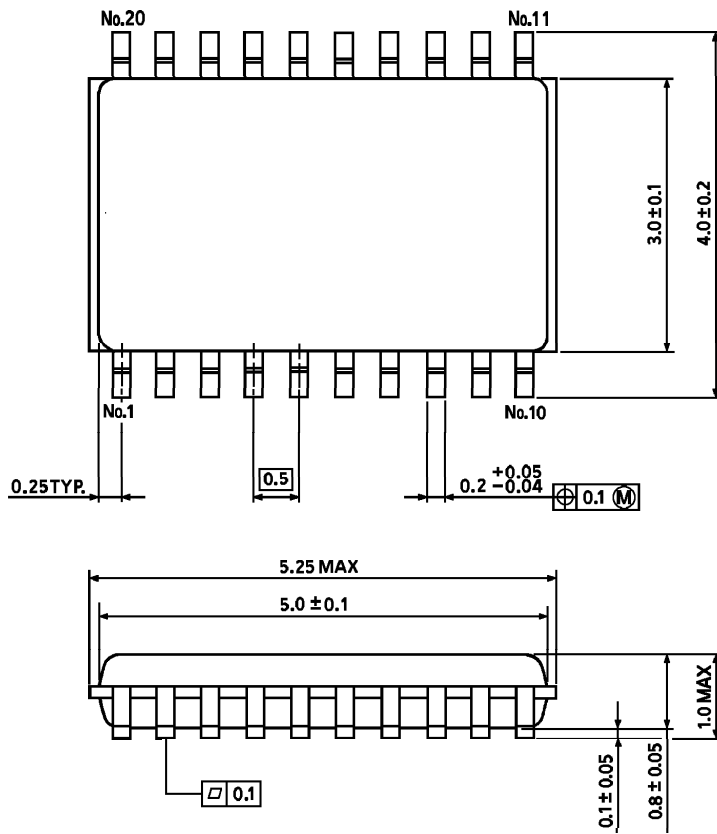


Fig.3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$



**PACKAGE DIMENSIONS**  
VSSOP20-P-0030-0.50

Unit : mm



Weight : 0.03 g (typ.)