TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7MZ573FK

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

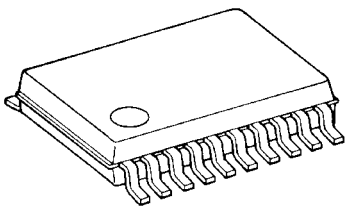
The TC7MZ573FK is a high performance CMOS octal D-type latch. Designed for use in 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

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

This 8 bit D-type latch is controlled by a latch enable input (LE) 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.



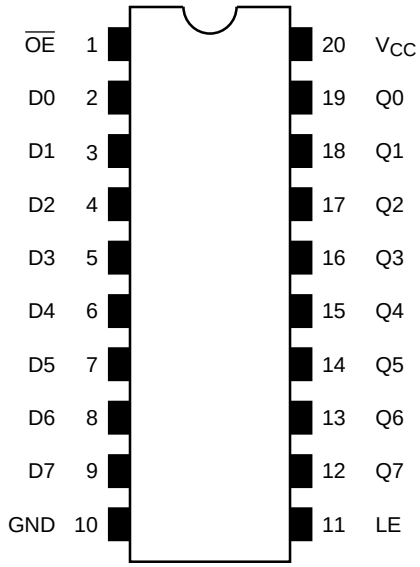
VSSOP20-P-0030-0.50

Weight: 0.03 g (typ.)

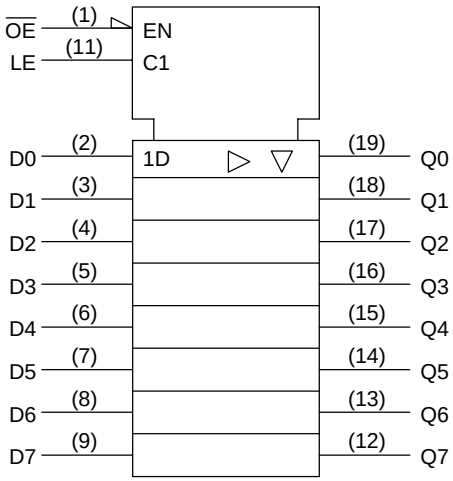
## Features

- Low voltage operation: $V_{CC}$ = 2.0~3.6 V
- High speed operation: $t_{pd}$ = 8.0 ns (max) ($V_{CC}$ = 3.0~3.6 V)
- Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) ($V_{CC}$ = 3.0 V)
- Latch-up performance: ±500 mA
- Package: 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.) 573 type.

## Pin Assignment (top view)




## IEC Logic Symbol




## Truth Table

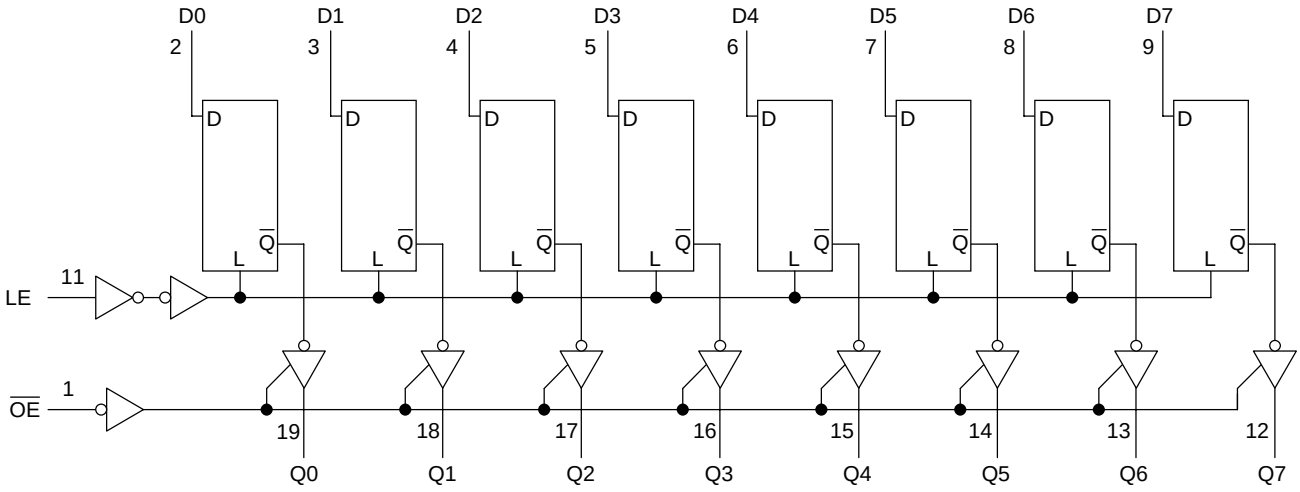
| Inputs | | | Outputs |
|---|---|---|---|
| $\overline{OE}$ | LE | D | |
| H | X | X | Z |
| L | L | X | $Q_n$ |
| L | H | L | L |
| L | H | H | H |

X: Don't care

Z: High impedance

$Q_n$: 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 | $V_{OUT}$ | −0.5~7.0 (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: $V_{CC}$ = 3.0~3.6 V

Note8: $V_{CC}$ = 2.7~3.0 V

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

## Electrical Characteristics

### DC Characteristics (Ta = −40~85°C)

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | — | | 2.7~3.6 | 2.0 | — | V |
| | Low level | $V_{IL}$ | — | | 2.7~3.6 | — | 0.8 | |
| Output voltage | High 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 | — | |
| | Low 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 | |
| | | | | $I_{OL}$ = 16 mA | 3.0 | — | 0.4 | |
| | | | | $I_{OL}$ = 24 mA | 3.0 | — | 0.55 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 0~5.5 V | | 2.7~3.6 | — | ±5.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = 0~5.5 V | | 2.7~3.6 | — | ±5.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$/$V_{OUT}$ = 5.5 V | | 0 | — | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 2.7~3.6 | — | 10.0 | μA |
| | | | $V_{IN}$/$V_{OUT}$ = 3.6~5.5 V | | 2.7~3.6 | — | ±10.0 | |
| Increase in $I_{CC}$ per input | | $\Delta I_{CC}$ | $V_{IH}$ = $V_{CC}$ − 0.6 V | | 2.7~3.6 | — | 500 | |

## AC Characteristics (Ta = –40~85°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Propagation delay time (D-Q) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 2.7 | — | 9.0 | ns |
| | | | 3.3 ± 0.3 | 1.5 | 8.0 | |
| Propagation delay time (LE-Q) | $t_{pLH}$ $t_{pHL}$ | Figure 1, Figure 2 | 2.7 | — | 9.5 | ns |
| | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output enable time | $t_{pZL}$ $t_{pZH}$ | Figure 1, Figure 3 | 2.7 | — | 9.5 | ns |
| | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output disable time | $t_{pLZ}$ $t_{pHZ}$ | Figure 1, Figure 3 | 2.7 | — | 7.0 | ns |
| | | | 3.3 ± 0.3 | 1.5 | 6.5 | |
| Minimum pulse width (LE) | $t_{w\ (H)}$ | Figure 1, Figure 2 | 2.7 | 3.3 | — | ns |
| | | | 3.3 ± 0.3 | 3.3 | — | |
| Minimum set-up time | $t_s$ | Figure 1, Figure 2 | 2.7 | 2.5 | — | ns |
| | | | 3.3 ± 0.3 | 2.5 | — | |
| Minimum hold time | $t_h$ | Figure 1, Figure 2 | 2.7 | 1.5 | — | ns |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Output to output skew | $t_{osLH}$ $t_{osHL}$ | (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: $t_r = t_f = 2.5$ ns, $C_L = 50$ pF, $R_L = 500\ \Omega$)

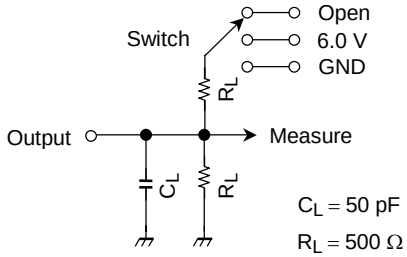
| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Quiet output maximum dynamic $V_{OL}$ | $V_{OLP}$ | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V | 3.3 | 0.8 | V |
| Quiet output minimum dynamic $V_{OL}$ | $\|V_{OLV}\|$ | $V_{IH}$ = 3.3 V, $V_{IL}$ = 0 V | 3.3 | 0.8 | V |

## Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | $V_{CC}$ (V) | Typ. | Unit |
|---|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | — | 3.3 | 7 | pF |
| Output capacitance | $C_{OUT}$ | — | 3.3 | 8 | pF |
| Power dissipation capacitance | $C_{PD}$ | $f_{IN}$ = 10 MHz (Note11) | 3.3 | 25 | pF |

Note11: $C_{PD}$ 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:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8$ (per bit)

## AC Test Circuit




| Parameter | Switch |
|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open |
| $t_{pLZ}$, $t_{pZL}$ | 6.0 V |
| $t_{pHZ}$, $t_{pZH}$ | GND |
| $t_w$, $t_s$, $t_h$ | Open |

**Figure 1**

## AC Waveform

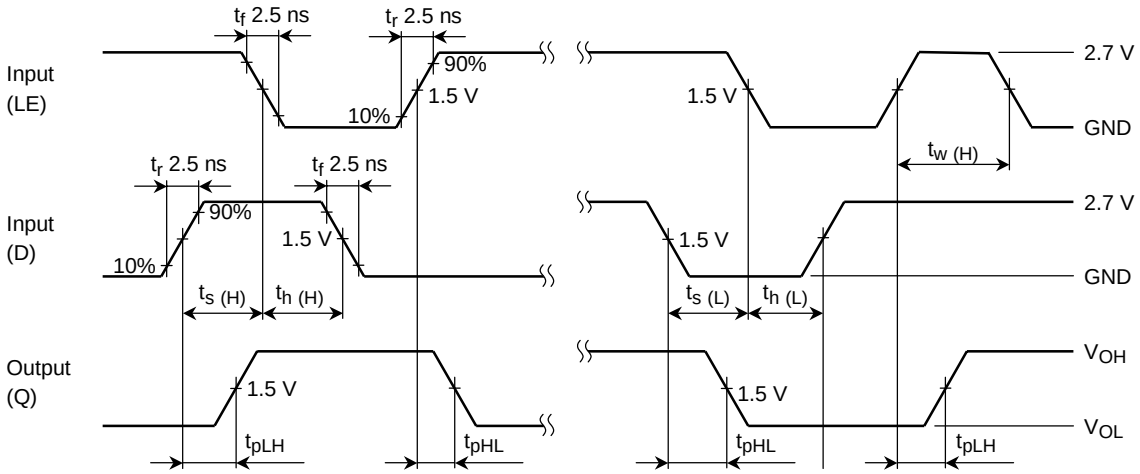



**Figure 2 $t_{pLH}$, $t_{pHL}$, $t_w$, $t_s$, $t_h$**

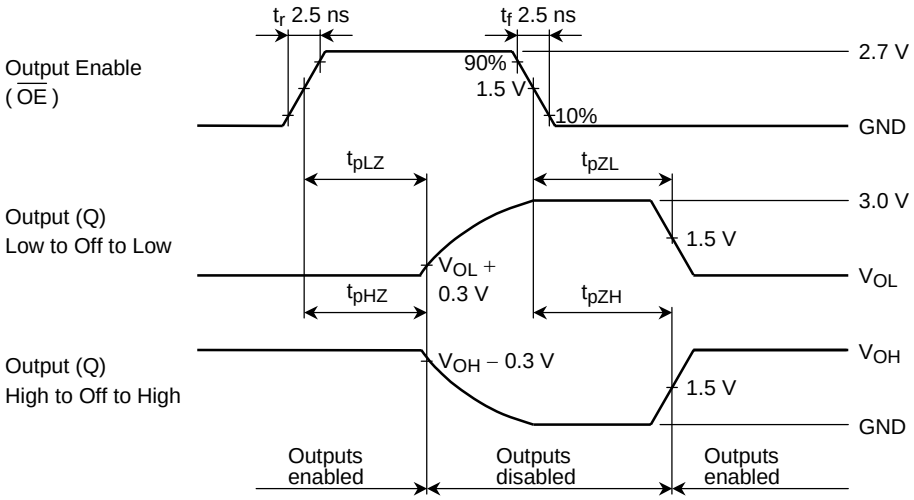
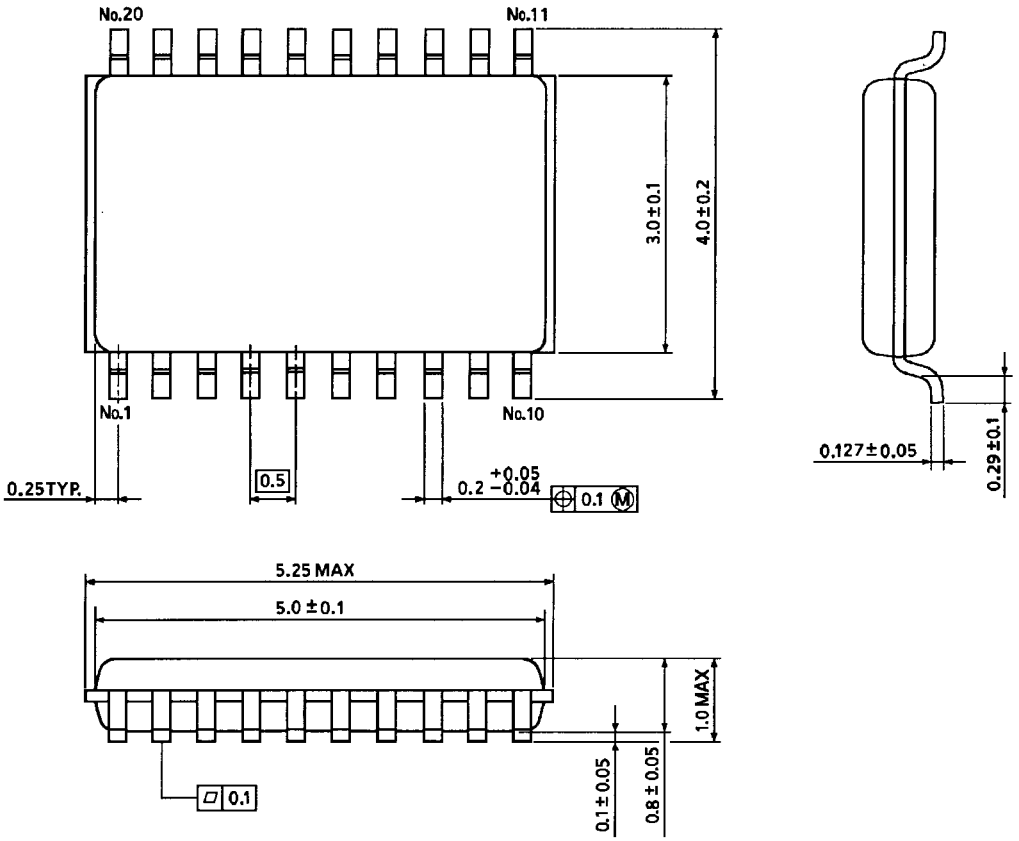



**Figure 3 $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$**

## Package Dimensions

VSSOP20-P-0030-0.50 Unit : mm




Weight: 0.03 g (typ.)

## RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.