

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MA2244FK

Low-Voltage Octal Bus Buffer with 3.6 V Tolerant Inputs and Outputs

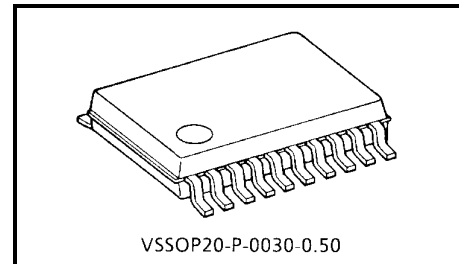
The TC7MA2244FK is a high performance CMOS octal bus buffer. Designed for use in 1.8 V, 2.5 V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

This device is non-inverting 3-state buffer having four active-low output enables. When the \overline{ST} input is high, the outputs are in a high impedance state. This device is designed to be used with 3-state memory address drivers, etc.

The 26 Ω series resistor helps reducing output overshoot and undershoot without external resistor.

All inputs are equipped with protection circuits against static discharge.



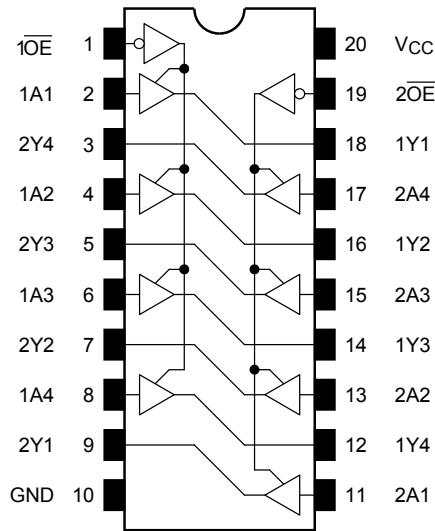
Weight: 0.03 g (typ.)

Features

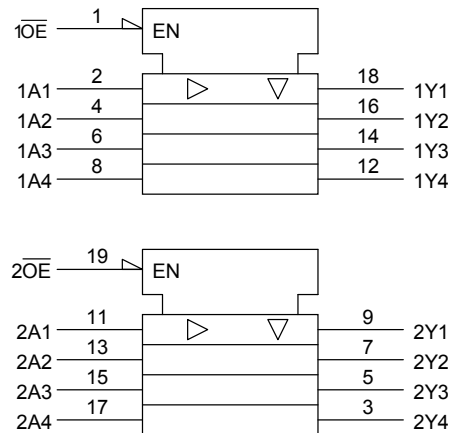
- 26 Ω series resistors on outputs.
- Low voltage operation: $V_{CC} = 1.8\sim 3.6$ V
- High speed operation: $t_{pd} = 4.4$ ns (max) ($V_{CC} = 3.0\sim 3.6$ V)
 $t_{pd} = 5.6$ ns (max) ($V_{CC} = 2.3\sim 2.7$ V)
 $t_{pd} = 9.8$ ns (max) ($V_{CC} = 1.8$ V)
- 3.6 V tolerant inputs and outputs.
- Output current: $I_{OH}/I_{OL} = \pm 12$ mA (min) ($V_{CC} = 3.0$ V)
 $I_{OH}/I_{OL} = \pm 8$ mA (min) ($V_{CC} = 2.3$ V)
 $I_{OH}/I_{OL} = \pm 4$ mA (min) ($V_{CC} = 1.8$ V)
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200$ V
Human body model $\geq \pm 2000$ V
- Package: VSSOP (US)
- Power down protection is provided on all inputs and outputs.
- Supports live insertion/withdrawal (*)

*: 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 Assignment (top view)



IEC Logic Level



Truth Table

| Inputs | | Outputs |
|-----------------|-------|---------|
| \overline{OE} | A_n | |
| L | L | L |
| L | H | H |
| H | X | Z |

X: Don't care

Z: High impedance

Absolute Maximum Ratings (Note 1)

| Characteristics | 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 2) | V |
| | | -0.5~ $V_{CC} + 0.5$ (Note 3) | |
| Input diode current | I_{IK} | -50 | mA |
| Output diode current | I_{OK} | ± 50 (Note 4) | 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 | $^{\circ}C$ |

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: Off-state

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Operating Ranges (Note 1)

| Characteristics | Symbol | Rating | Unit |
|--------------------------|-----------------|----------------------|------|
| Supply voltage | V_{CC} | 1.8~3.6 | V |
| | | 1.2~3.6 (Note 2) | |
| Input voltage | V_{IN} | -0.3~3.6 | V |
| Output voltage | V_{OUT} | 0~3.6 (Note 3) | V |
| | | 0~ V_{CC} (Note 4) | |
| Output current | I_{OH}/I_{OL} | ± 12 (Note 5) | mA |
| | | ± 8 (Note 6) | |
| | | ± 4 (Note 7) | |
| Operating temperature | T_{opr} | -40~85 | °C |
| Input rise and fall time | dt/dv | 0~10 (Note 8) | ns/V |

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either VCC or GND.

Note 2: Data retention only

Note 3: Off-state

Note 4: High or low state

Note 5: $V_{CC} = 3.0\sim 3.6$ V

Note 6: $V_{CC} = 2.3\sim 2.7$ V

Note 7: $V_{CC} = 1.8$ V

Note 8: $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics ($T_a = -40\sim 85^\circ\text{C}$, $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

| 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} | $I_{OH} = -100\ \mu\text{A}$ | 2.7~3.6 | $V_{CC} - 0.2$ | — | V |
| | | | | $I_{OH} = -6\ \text{mA}$ | 2.7 | 2.2 | — | |
| | | | | $I_{OH} = -8\ \text{mA}$ | 3.0 | 2.4 | — | |
| | | | | $I_{OH} = -12\ \text{mA}$ | 3.0 | 2.2 | — | |
| | Low level | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100\ \mu\text{A}$ | 2.7~3.6 | — | 0.2 | |
| | | | | $I_{OL} = 6\ \text{mA}$ | 2.7 | — | 0.4 | |
| | | | | $I_{OL} = 8\ \text{mA}$ | 3.0 | — | 0.55 | |
| | | | | $I_{OL} = 12\ \text{mA}$ | 3.0 | — | 0.8 | |
| Input leakage current | I_{IN} | $V_{IN} = 0\sim 3.6$ V | 2.7~3.6 | — | ± 5.0 | μA | | |
| 3-state output off-state current | I_{OZ} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0\sim 3.6$ V | 2.7~3.6 | — | ± 10.0 | μA | | |
| Power off leakage current | I_{OFF} | $V_{IN}, V_{OUT} = 0\sim 3.6$ V | 0 | — | 10.0 | μA | | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | 2.7~3.6 | — | 20.0 | μA | | |
| | | $V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6$ V | 2.7~3.6 | — | ± 20.0 | | | |
| | ΔI_{CC} | $V_{IH} = V_{CC} - 0.6$ V (per input) | 2.7~3.6 | — | 750 | | | |

DC Characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|----------------------------------|------------|------------------|--|---------------------------|---------|-----------------------|-------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 2.3~2.7 | 1.6 | — | V |
| | Low level | V _{IL} | — | | 2.3~2.7 | — | 0.7 | |
| Output voltage | High 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} = -4 mA | 2.3 | 2.0 | — | |
| | | | | I _{OH} = -6 mA | 2.3 | 1.8 | — | |
| | | | | I _{OH} = -8 mA | 2.3 | 1.7 | — | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.3~2.7 | — | 0.2 | |
| | | | | I _{OL} = 6 mA | 2.3 | — | 0.4 | |
| I _{OL} = 8 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 | |

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

| Characteristics | | Symbol | Test Condition | | VCC (V) | Min | Max | Unit |
|----------------------------------|------------|------------------|--|---------------------------|---------|-----------------------|-----------------------|------|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | | 1.8~2.3 | 0.7 × V _{CC} | — | V |
| | Low level | V _{IL} | — | | 1.8~2.3 | — | 0.2 × V _{CC} | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.8 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -4 mA | 1.8 | 1.4 | — | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.8 | — | 0.2 | |
| | | | | I _{OL} = 4 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: tr = tf = 2.0 ns, CL = 30 pF, RL = 500 Ω)

| Characteristics | Symbol | Test Condition | VCC (V) | Min | Max | Unit |
|------------------------|--|--------------------|-----------|-----|-----|------|
| | | | | | | |
| Propagation delay time | t _{pLH} t _{pHL} | Figure 1, Figure 2 | 1.8 | 1.5 | 9.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 5.6 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.4 | |
| 3-state output enable | t _{pZL} t _{pZH} | Figure 1, Figure 3 | 1.8 | 1.5 | 9.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 6.5 | |
| | | | 3.3 ± 0.3 | 0.6 | 5.0 | |
| 3-state output disable | t _{pLZ} t _{pHZ} | Figure 1, Figure 3 | 1.8 | 1.5 | 7.2 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 3.9 | |
| | | | 3.3 ± 0.3 | 0.6 | 3.6 | |
| Output to output skew | t _{osLH} t _{osHL} | (Note) | 1.8 | — | 0.5 | ns |
| | | | 2.5 ± 0.2 | — | 0.5 | |
| | | | 3.3 ± 0.3 | — | 0.5 | |

For CL = 50 pF, add approximately 300 ps to the AC maximum specification.

Note: 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: tr = tf = 2.0 ns, CL = 30 pF)

| Characteristics | Symbol | Test Condition | VCC (V) | Typ. | Unit |
|----------------------------------|--------|---|---------|-------|------|
| | | | | | |
| Quiet output maximum dynamic VOL | VOLP | V _{IH} = 1.8 V, V _{IL} = 0 V (Note) | 1.8 | 0.15 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note) | 2.5 | 0.25 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note) | 3.3 | 0.35 | |
| Quiet output minimum dynamic VOL | VOLV | V _{IH} = 1.8 V, V _{IL} = 0 V (Note) | 1.8 | -0.15 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note) | 2.5 | -0.25 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note) | 3.3 | -0.35 | |
| Quiet output minimum dynamic VOH | VOHV | V _{IH} = 1.8 V, V _{IL} = 0 V (Note) | 1.8 | 1.55 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note) | 2.5 | 2.05 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note) | 3.3 | 2.65 | |

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

| Characteristics | 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) | 1.8, 2.5, 3.3 | 20 | pF |

Note: 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:

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

AC Test Circuit

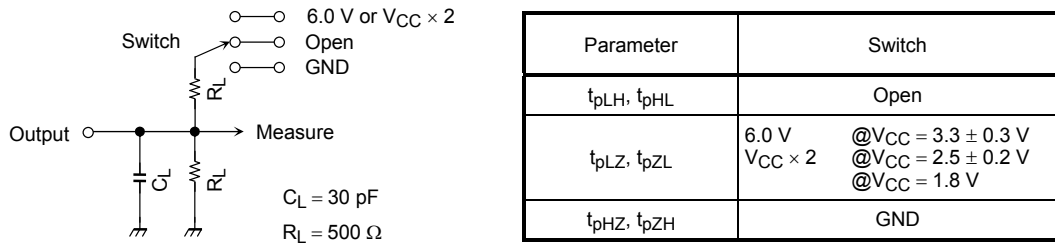


Figure 1

AC Waveform

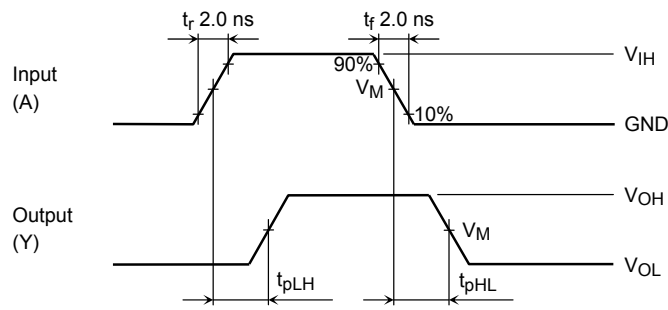


Figure 2 t_{pLH}, t_{pHL}

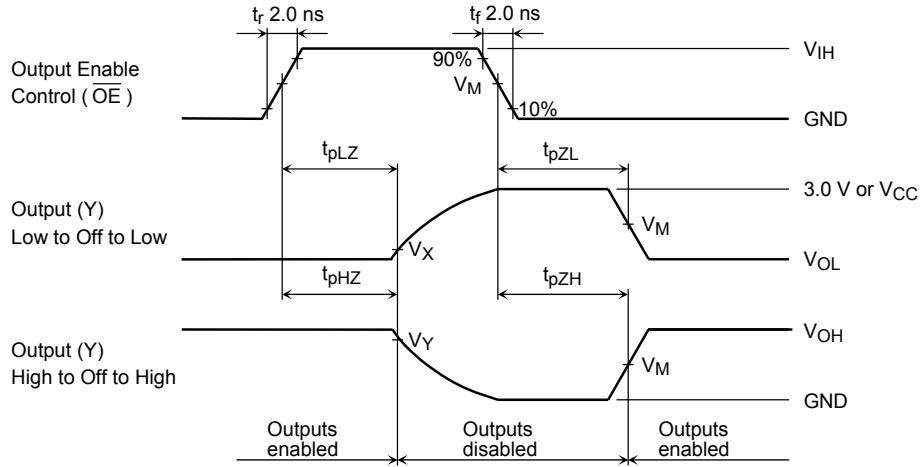


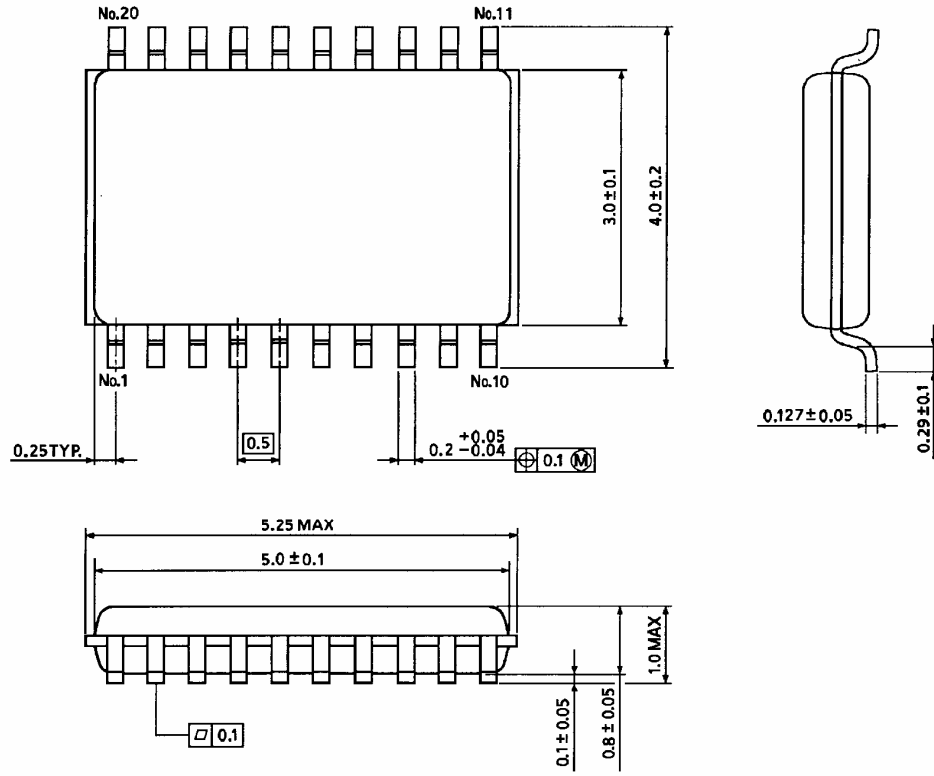
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

| Symbol | V_{CC} | | |
|----------|--------------------------|---------------------------|---------------------------|
| | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | 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 | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ |
| V_Y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |

Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)

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20070701-EN GENERAL

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