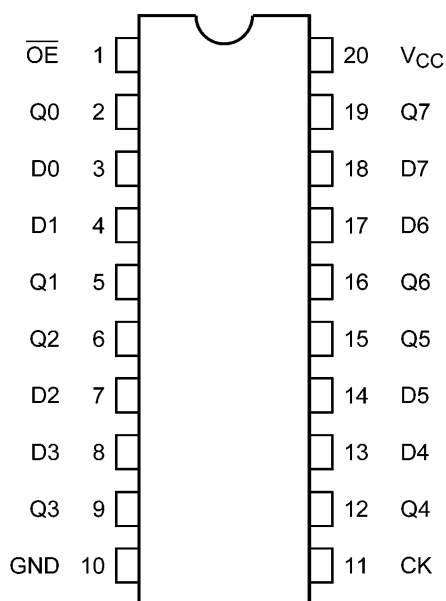
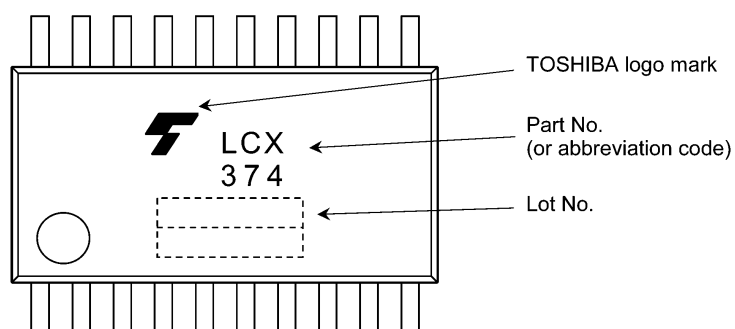


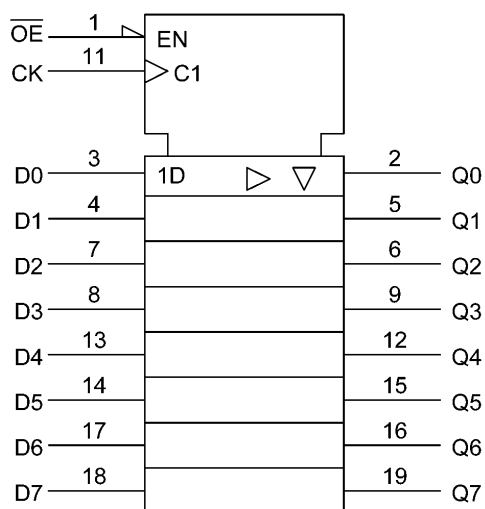
5. Pin Assignment






6. Marking



7. IEC Logic Symbol

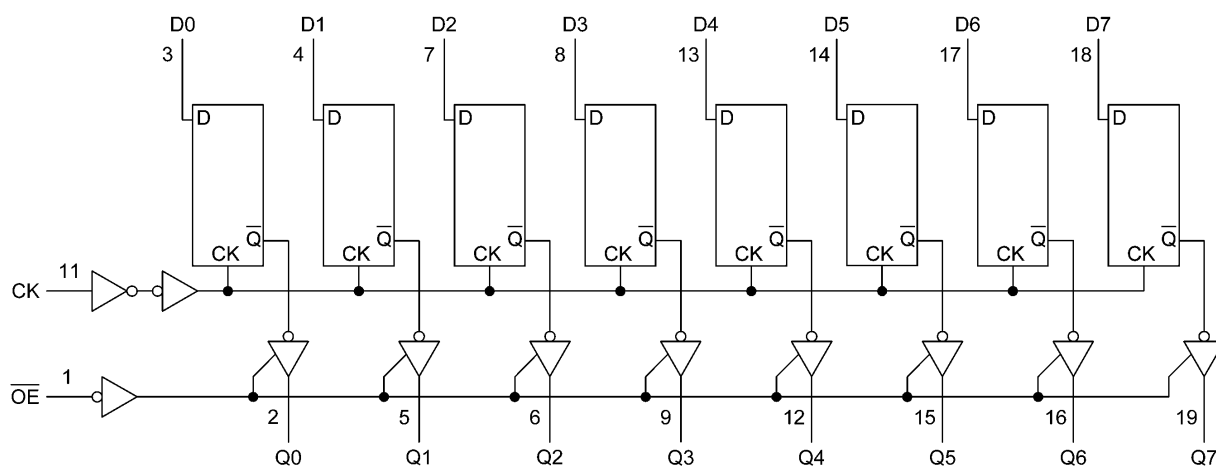


8. Truth Table

| 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

9. System Diagram



10. Absolute Maximum Ratings (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|--------------------------|------------------|----------|------------------------|--------------------|
| Supply voltage | V_{CC} | | -0.5 to 6.5 | V |
| Input voltage | V_{IN} | | -0.5 to 6.5 | V |
| Output voltage | V_{OUT} | (Note 1) | -0.5 to 6.5 | V |
| | | (Note 2) | -0.5 to $V_{CC} + 0.5$ | |
| Input diode current | I_{IK} | | -50 | mA |
| Output diode current | I_{OK} | (Note 3) | ± 50 | mA |
| Output current | I_{OUT} | | ± 50 | mA |
| Power dissipation | P_D | | 180 | mW |
| V_{CC} /ground current | I_{CC}/I_{GND} | | ± 100 | mA |
| Storage temperature | T_{stg} | | -65 to 150 | $^{\circ}\text{C}$ |

Note: 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 1: Output in OFF state.

Note 2: High (H) or Low (L) state. I_{OUT} absolute maximum rating must be observed.

Note 3: $V_{OUT} < \text{GND}$, $V_{OUT} > V_{CC}$

11. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|---------------------------|------------------|----------|---------------|--------------------|
| Supply voltage | V_{CC} | | 1.65 to 3.6 | V |
| | | (Note 1) | 1.5 to 3.6 | |
| Input voltage | V_{IN} | | 0 to 5.5 | V |
| Output voltage | V_{OUT} | (Note 2) | 0 to 5.5 | V |
| | | (Note 3) | 0 to V_{CC} | |
| Output current | I_{OH}, I_{OL} | (Note 4) | ± 24 | mA |
| | I_{OH}, I_{OL} | (Note 5) | ± 12 | |
| Operating temperature | T_{opr} | | -40 to 85 | $^{\circ}\text{C}$ |
| Input rise and fall times | dt/dv | (Note 6) | 0 to 10 | ns/V |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V_{CC} or GND.

Note 1: Data retention only.

Note 2: Output in OFF state.

Note 3: High or low state

Note 4: $V_{CC} = 3.0$ to 3.6 V

Note 5: $V_{CC} = 2.7$ to 3.0 V

Note 6: $V_{IN} = 0.8$ to 2.0 V, $V_{CC} = 3.0$ V

12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85\text{ }^{\circ}\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit |
|--|-----------------|--|------------------------------------|--------------|---------------------|---------------------|---------------|
| High-level input voltage | V_{IH} | — | | 1.65 to 2.3 | $V_{CC} \times 0.9$ | — | V |
| | | | | 2.3 to 2.7 | 1.7 | — | |
| | | | | 2.7 to 3.6 | 2.0 | — | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 2.3 | — | $V_{CC} \times 0.1$ | |
| | | | | 2.3 to 2.7 | — | 0.7 | |
| | | | | 2.7 to 3.6 | — | 0.8 | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100\text{ }\mu\text{A}$ | 1.65 to 3.6 | $V_{CC} - 0.2$ | — | V |
| | | | $I_{OH} = -4\text{ mA}$ | 1.65 | 1.05 | — | |
| | | | $I_{OH} = -8\text{ mA}$ | 2.3 | 1.7 | — | |
| | | | $I_{OH} = -12\text{ mA}$ | 2.7 | 2.2 | — | |
| | | | $I_{OH} = -18\text{ mA}$ | 3.0 | 2.4 | — | |
| | | | $I_{OH} = -24\text{ mA}$ | 3.0 | 2.2 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100\text{ }\mu\text{A}$ | 1.65 to 3.6 | — | 0.2 | |
| | | | $I_{OL} = 4\text{ mA}$ | 1.65 | — | 0.45 | |
| | | | $I_{OL} = 8\text{ mA}$ | 2.3 | — | 0.7 | |
| | | | $I_{OL} = 12\text{ mA}$ | 2.7 | — | 0.4 | |
| | | | $I_{OL} = 16\text{ mA}$ | 3.0 | — | 0.4 | |
| | | | $I_{OL} = 24\text{ mA}$ | 3.0 | — | 0.55 | |
| Input leakage current | I_{IN} | $V_{IN} = 0$ to 5.5 V | | 1.65 to 3.6 | — | ± 5.0 | μA |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 5.5 V | | 1.65 to 3.6 | — | ± 5.0 | μA |
| Power-OFF leakage current | I_{OFF} | $V_{IN}/V_{OUT} = 5.5\text{ V}$ | | 0 | — | 10.0 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 1.65 to 3.6 | — | 10.0 | μA |
| | | $V_{IN}/V_{OUT} = 3.6$ to 5.5 V | | 1.65 to 3.6 | — | ± 10.0 | |
| Quiescent supply current | ΔI_{CC} | $V_{IH} = V_{CC} - 0.6\text{ V}$ (per input) | | 2.7 to 3.6 | — | 500 | |

12.2. AC Characteristics (Unless otherwise specified, $T_a = -40$ to $85\text{ }^\circ\text{C}$)

| Characteristics | Symbol | Note | Test Condition | V_{CC} (V) | Min | Max | Unit |
|-------------------------------|----------------------|----------|---|----------------|------|------|------|
| Maximum clock frequency | f_{MAX} | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | 50 | — | MHz |
| | | | | 2.5 ± 0.2 | 100 | — | |
| | | | | 2.7 | 100 | — | |
| | | | | 3.3 ± 0.3 | 150 | — | |
| Propagation delay time (CK-Q) | t_{PLH}, t_{PHL} | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | — | 30.0 | ns |
| | | | | 2.5 ± 0.2 | — | 10.5 | |
| | | | | 2.7 | — | 9.5 | |
| | | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output enable time | t_{PZL}, t_{PZH} | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.2, Table 12.6.1 | 1.8 ± 0.15 | — | 34.0 | ns |
| | | | | 2.5 ± 0.2 | — | 17.0 | |
| | | | | 2.7 | — | 9.5 | |
| | | | | 3.3 ± 0.3 | 1.5 | 8.5 | |
| Output disable time | t_{PLZ}, t_{PHZ} | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.2, Table 12.6.1 | 1.8 ± 0.15 | — | 32.0 | ns |
| | | | | 2.5 ± 0.2 | — | 16.0 | |
| | | | | 2.7 | — | 8.5 | |
| | | | | 3.3 ± 0.3 | 1.5 | 7.5 | |
| Minimum pulse width(CK) | $t_{w(L)}, t_{w(H)}$ | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | 12.0 | — | ns |
| | | | | 2.5 ± 0.2 | 6.0 | — | |
| | | | | 2.7 | 4.0 | — | |
| | | | | 3.3 ± 0.3 | 3.3 | — | |
| Minimum setup time | t_s | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | 10.0 | — | ns |
| | | | | 2.5 ± 0.2 | 5.0 | — | |
| | | | | 2.7 | 2.5 | — | |
| | | | | 3.3 ± 0.3 | 2.5 | — | |
| Minimum hold time | t_h | | See 12.5 AC Test Circuit, Table 12.5.1, Fig. 12.6.1, Table 12.6.1 | 1.8 ± 0.15 | 1.5 | — | ns |
| | | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | | 2.7 | 1.5 | — | |
| | | | | 3.3 ± 0.3 | 1.5 | — | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 2.7 | — | — | ns |
| | | | | 3.3 ± 0.3 | — | 1.0 | |

Note 1: Parameter guaranteed by design. ($t_{osLH} = |t_{PLHm} - t_{PLHn}|$, $t_{osHL} = |t_{PHLm} - t_{PHLn}|$)

12.3. Dynamic Switching Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 2.5\text{ ns}$, $C_L = 50\text{ pF}$, $R_L = 500\text{ }\Omega$)

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

12.4. Capacitive Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

| Characteristics | Symbol | Note | 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} | (Note 1) | $f_{IN} = 10\text{ MHz}$ | 3.3 | 25 | pF |

Note 1: 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.

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

12.5. AC Test Circuit

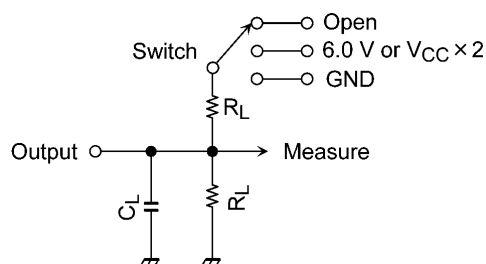


Table 12.5.1 Parameter for AC Test Circuit

| Parameter | Switch | Test Condition |
|-----------------------|-------------------|---------------------------|
| t_{PLH} , t_{PHL} | OPEN | — |
| t_{PLZ} , t_{PZL} | 6.0 V | $V_{CC} = 3.3 \pm 0.3$ V |
| | | $V_{CC} = 2.7$ V |
| | $V_{CC} \times 2$ | $V_{CC} = 2.5 \pm 0.2$ V |
| | | $V_{CC} = 1.8 \pm 0.15$ V |
| t_{PHZ} , t_{PZH} | GND | — |
| t_w , t_s , t_h | OPEN | — |

12.6. AC Waveform

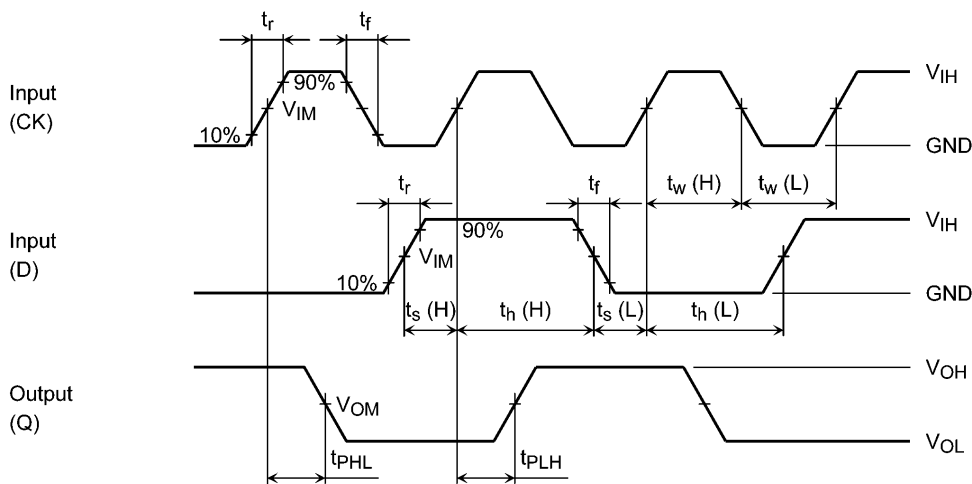


Fig. 12.6.1 t_{PLH} , t_{PHL} , t_w , t_s , t_h

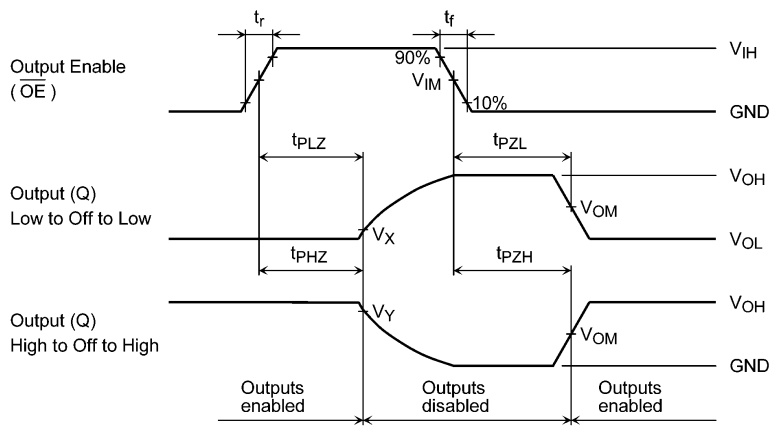


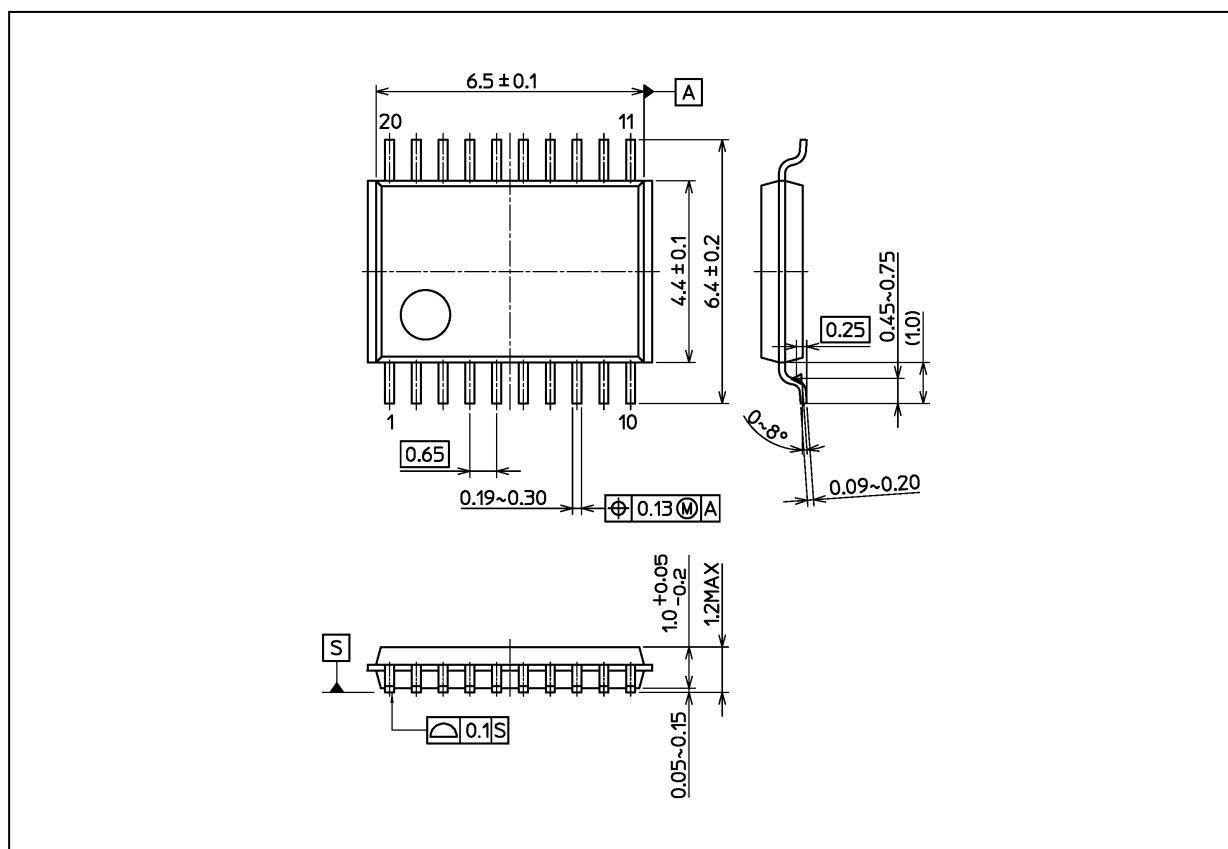
Fig. 12.6.2 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Table 12.6.1 AC Waveform Symbols

| | Symbol | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ $V_{CC} = 2.7 \text{ V}$ | $V_{CC} = 2.5 \pm 0.2 \text{ V}$ | $V_{CC} = 1.8 \pm 0.15 \text{ V}$ |
|--------|---------------|--|----------------------------------|-----------------------------------|
| Input | V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| | V_{IM} | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| | t_r , t_f | 2.5 ns | 2.0 ns | 2.0 ns |
| Output | V_{OM} | 1.5 V | $V_{OH}/2$ | $V_{OH}/2$ |
| | V_X | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ |
| | V_Y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |
| Load | C_L | 50 pF | 30 pF | 30 pF |
| | R_L | 500 Ω | 500 Ω | 1 k Ω |

Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

| Package Name(s) |
|--------------------|
| Nickname: TSSOP20B |

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