

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74AC374P, TC74AC374F, TC74AC374FT TC74AC534P, TC74AC534F

Octal D-Type Flip-Flop with 3-state Output

|                 |               |
|-----------------|---------------|
| TC74AC374P/F/FT | Non-Inverting |
| TC74AC534P/F    | Inverting     |

The TC74AC374 and TC74AC534 are advanced high speed CMOS OCTAL FLIP-FLOPS fabricated with silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology.

They achieve the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

These 8-bit D-type flip-flops are controlled by a clock input (CK) and a output enable input ( $\overline{OE}$ ).

When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

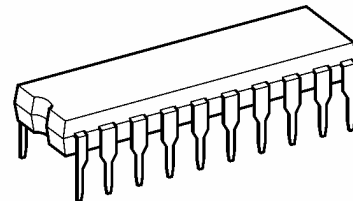
The TC74AC374 has non-inverting outputs, and TC74AC534 has inverting outputs.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### Features

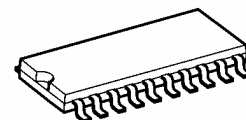
- High speed:  $f_{max} = 200$  MHz (typ.) at  $V_{CC} = 5$  V
- Low power dissipation:  $I_{CC} = 8$   $\mu$ A (max) at  $T_a = 25^\circ$ C
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- Symmetrical output impedance:  $|I_{OH}| = I_{OL} = 24$  mA (min)  
Capability of driving 50  $\Omega$  transmission lines.
- Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- Wide operating voltage range:  $V_{CC}$  (opr) = 2 to 5.5 V
- Pin and function compatible with 74F374/534

TC74AC374P, TC74AC534P



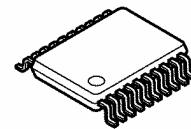
DIP20-P-300-2.54A

TC74AC374F, TC74AC534F



SOP20-P-300-1.27A

TC74AC374FT



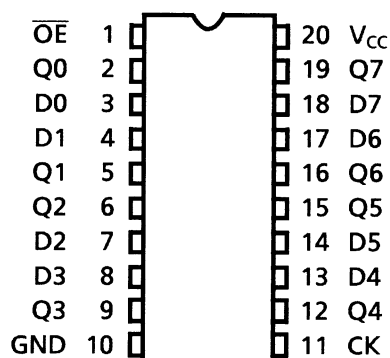
TSSOP20-P-0044-0.65A

### Weight

|                      |                 |
|----------------------|-----------------|
| DIP20-P-300-2.54A    | : 1.30 g (typ.) |
| SOP20-P-300-1.27A    | : 0.22 g (typ.) |
| TSSOP20-P-0044-0.65A | : 0.08 g (typ.) |

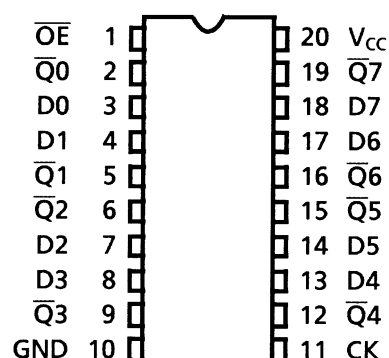
## Pin Assignment

### TC74AC374



(TOP VIEW)

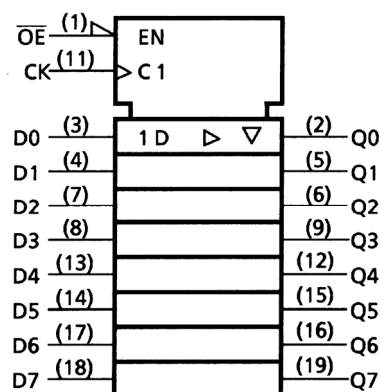
### TC74AC534



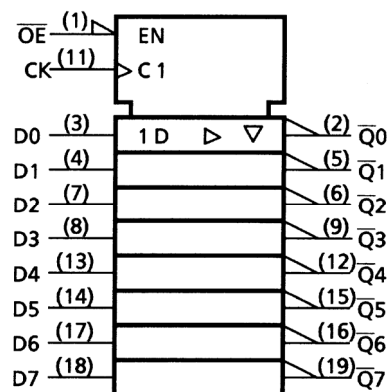
(TOP VIEW)

## IEC Logic Symbol

### TC74AC374



### TC74AC534



## Truth Table

| Inputs |    |   | Outputs        |                 |
|--------|----|---|----------------|-----------------|
| OE     | CK | D | Q (374)        | Q̄ (534)        |
| H      | X  | X | Z              | Z               |
| L      |    | X | Q <sub>n</sub> | Q̄ <sub>n</sub> |
| L      |    | L | L              | H               |
| L      |    | H | H              | L               |

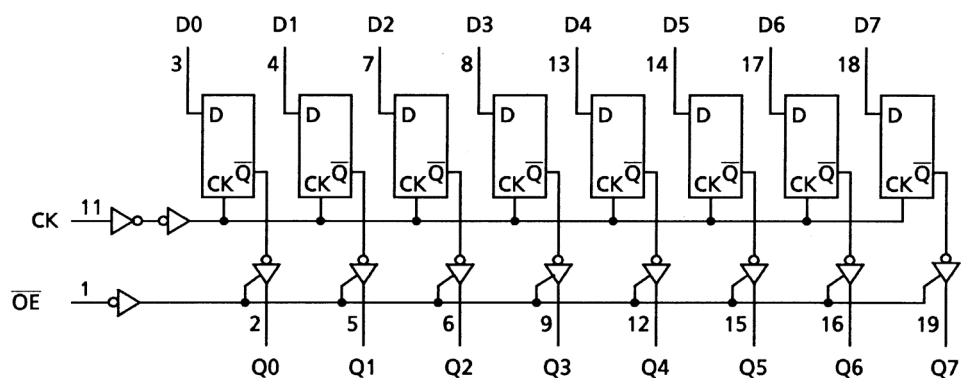
X: Don't care

Z: High impedance

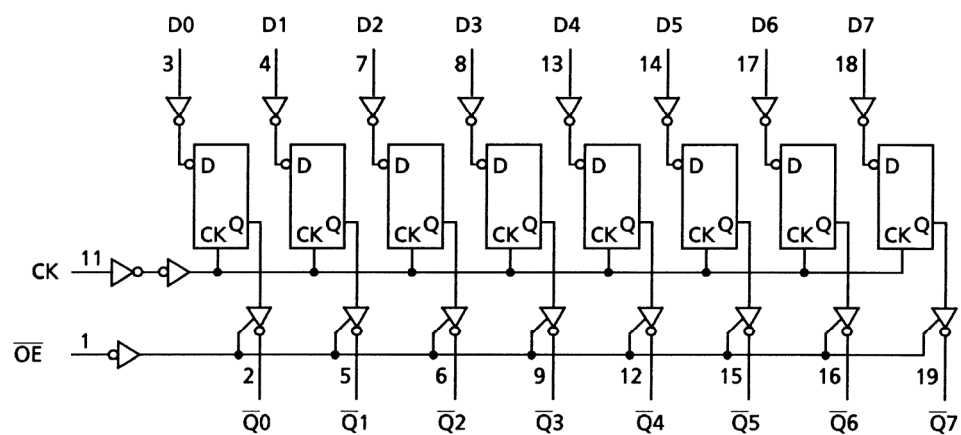
Q<sub>n</sub> (Q̄<sub>n</sub>): No change

## System Diagram

### TC74AC374



### TC74AC534



## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol    | Rating                             | Unit |
|-----------------------------|-----------|------------------------------------|------|
| Supply voltage range        | $V_{CC}$  | -0.5 to 7.0                        | V    |
| DC input voltage            | $V_{IN}$  | -0.5 to $V_{CC} + 0.5$             | V    |
| DC output voltage           | $V_{OUT}$ | -0.5 to $V_{CC} + 0.5$             | V    |
| Input diode current         | $I_{IK}$  | $\pm 20$                           | mA   |
| Output diode current        | $I_{OK}$  | $\pm 50$                           | mA   |
| DC output current           | $I_{OUT}$ | $\pm 50$                           | mA   |
| DC $V_{CC}$ /ground current | $I_{CC}$  | $\pm 200$                          | mA   |
| Power dissipation           | $P_D$     | 500 (DIP) (Note 2)/180 (SOP/TSSOP) | mW   |
| Storage temperature         | $T_{stg}$ | -65 to 150                         | °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: 500 mW in the range of  $T_a = -40$  to  $65^\circ\text{C}$ . From  $T_a = 65$  to  $85^\circ\text{C}$  a derating factor of  $-10\text{ mW}/^\circ\text{C}$  should be applied up to 300 mW.

## Operating Ranges (Note)

| Characteristics          | Symbol    | Rating                                                                                    | Unit |
|--------------------------|-----------|-------------------------------------------------------------------------------------------|------|
| Supply voltage           | $V_{CC}$  | 2.0 to 5.5                                                                                | V    |
| Input voltage            | $V_{IN}$  | 0 to $V_{CC}$                                                                             | V    |
| Output voltage           | $V_{OUT}$ | 0 to $V_{CC}$                                                                             | V    |
| Operating temperature    | $T_{opr}$ | -40 to 85                                                                                 | °C   |
| Input rise and fall time | $dt/dV$   | 0 to 100 ( $V_{CC} = 3.3 \pm 0.3\text{ V}$ )<br>0 to 20 ( $V_{CC} = 5 \pm 0.5\text{ V}$ ) | ns/V |

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

## Electrical Characteristics

### DC Characteristics

| Characteristics                  | Symbol          | Test Condition                                                                                    |                          | Ta = 25°C           |                      |                   | Ta = -40 to 85°C     |                      | Unit |
|----------------------------------|-----------------|---------------------------------------------------------------------------------------------------|--------------------------|---------------------|----------------------|-------------------|----------------------|----------------------|------|
|                                  |                 |                                                                                                   |                          | V <sub>CC</sub> (V) | Min                  | Typ.              | Max                  | Min                  | Max  |
| High-level input voltage         | V <sub>IH</sub> | —                                                                                                 |                          | 2.0<br>3.0<br>5.5   | 1.50<br>2.10<br>3.85 | —<br>—<br>—       | —<br>—<br>—          | 1.50<br>2.10<br>3.85 | V    |
| Low-level input voltage          | V <sub>IL</sub> | —                                                                                                 |                          | 2.0<br>3.0<br>5.5   | —<br>—<br>—          | —<br>—<br>—       | 0.50<br>0.90<br>1.65 | —<br>—<br>—          | V    |
| High-level output voltage        | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                              | I <sub>OH</sub> = -50 µA | 2.0<br>3.0<br>4.5   | 1.9<br>2.9<br>4.4    | 2.0<br>3.0<br>4.5 | —<br>—<br>—          | 1.9<br>2.9<br>4.4    | V    |
|                                  |                 |                                                                                                   |                          | 3.0<br>4.5<br>5.5   | 2.58<br>3.94<br>—    | —<br>—<br>—       | —<br>—<br>—          | 2.48<br>3.80<br>3.85 |      |
|                                  |                 |                                                                                                   |                          | —                   | —                    | —                 | —                    | —                    |      |
|                                  |                 |                                                                                                   | I <sub>OL</sub> = -4 mA  | 3.0                 | 2.58                 | —                 | —                    | 2.48                 |      |
|                                  |                 |                                                                                                   | I <sub>OL</sub> = -24 mA | 4.5                 | 3.94                 | —                 | —                    | 3.80                 |      |
| Low-level output voltage         | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                              | I <sub>OL</sub> = 50 µA  | 2.0<br>3.0<br>4.5   | —<br>—<br>—          | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1    | —<br>—<br>—          | V    |
|                                  |                 |                                                                                                   |                          | 3.0<br>4.5<br>5.5   | —<br>—<br>—          | —<br>—<br>—       | 0.36<br>0.36<br>—    | —<br>—<br>—          |      |
|                                  |                 |                                                                                                   |                          | —                   | —                    | —                 | —                    | —                    |      |
|                                  |                 |                                                                                                   | I <sub>OL</sub> = 12 mA  | 3.0                 | —                    | —                 | 0.36                 | —                    |      |
|                                  |                 |                                                                                                   | I <sub>OL</sub> = 24 mA  | 4.5                 | —                    | —                 | 0.36                 | —                    |      |
| 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> = V <sub>CC</sub> or GND |                          | 5.5                 | —                    | —                 | ±0.5                 | —                    | µA   |
| Input leakage current            | I <sub>IN</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                          |                          | 5.5                 | —                    | —                 | ±0.1                 | —                    | µA   |
| Quiescent supply current         | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                          |                          | 5.5                 | —                    | —                 | 8.0                  | —                    | µA   |

Note: This spec indicates the capability of driving 50 Ω transmission lines.

One output should be tested at a time for a 10 ms maximum duration.

## Timing Requirements (input: $t_r = t_f = 3 \text{ ns}$ )

| Characteristics             | Symbol    | Test Condition | V <sub>CC</sub> (V) | Ta = 25°C<br>Limit | Ta = -40 to 85°C<br>Limit | Unit |
|-----------------------------|-----------|----------------|---------------------|--------------------|---------------------------|------|
|                             |           |                |                     |                    |                           |      |
| Minimum pulse width<br>(CK) | $t_W$ (H) | —              | $3.3 \pm 0.3$       | 7.0                | 7.0                       | ns   |
|                             | $t_W$ (L) |                | $5.0 \pm 0.5$       | 5.0                | 5.0                       |      |
| Minimum set-up time         | $t_s$     | —              | $3.3 \pm 0.3$       | 9.0                | 9.0                       | ns   |
|                             |           |                | $5.0 \pm 0.5$       | 5.0                | 5.0                       |      |
| Minimum hold time           | $t_h$     | —              | $3.3 \pm 0.3$       | 0.0                | 0.0                       | ns   |
|                             |           |                | $5.0 \pm 0.5$       | 0.0                | 0.0                       |      |

## AC Characteristics (C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω, input: $t_r = t_f = 3 \text{ ns}$ )

| Characteristics                              | Symbol                    | Test Condition | Ta = 25°C           |     |      | Ta = -40 to 85°C |     | Unit |
|----------------------------------------------|---------------------------|----------------|---------------------|-----|------|------------------|-----|------|
|                                              |                           |                | V <sub>CC</sub> (V) | Min | Typ. | Max              | Min | Max  |
| Propagation delay time<br>(CK-Q, $\bar{Q}$ ) | $t_{pLH}$                 | —              | $3.3 \pm 0.3$       | —   | 8.5  | 15.8             | 1.0 | 18.0 |
|                                              | $t_{pHL}$                 |                | $5.0 \pm 0.5$       | —   | 6.1  | 8.7              | 1.0 | 10.0 |
| Output enable time                           | $t_{pZL}$                 | —              | $3.3 \pm 0.3$       | —   | 7.5  | 14.0             | 1.0 | 16.0 |
|                                              | $t_{pZH}$                 |                | $5.0 \pm 0.5$       | —   | 6.1  | 8.7              | 1.0 | 10.0 |
| Output disable time                          | $t_{pLZ}$                 | —              | $3.3 \pm 0.3$       | —   | 5.5  | 12.3             | 1.0 | 14.0 |
|                                              | $t_{pHZ}$                 |                | $5.0 \pm 0.5$       | —   | 4.7  | 7.0              | 1.0 | 8.0  |
| Maximum clock frequency                      | $f_{max}$                 | —              | $3.3 \pm 0.3$       | 55  | 120  | —                | 55  | —    |
|                                              |                           |                | $5.0 \pm 0.5$       | 100 | 160  | —                | 100 | —    |
| Input capacitance                            | C <sub>IN</sub>           | —              | —                   | —   | 5    | 10               | —   | 10   |
| Output capacitance                           | C <sub>OUT</sub>          | —              | —                   | —   | 10   | —                | —   | —    |
| Power dissipation capacitance                | C <sub>PD</sub><br>(Note) | —              | —                   | —   | 37   | —                | —   | —    |

Note: 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:

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

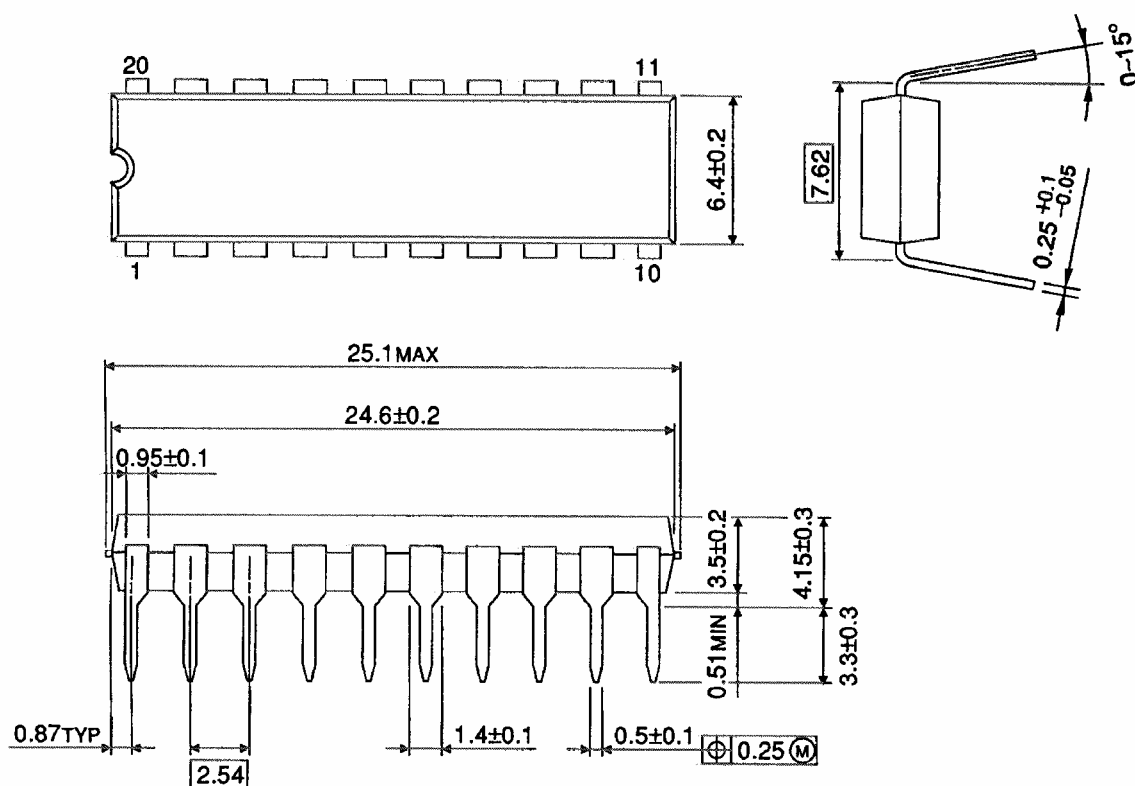
And the total C<sub>PD</sub> when n pcs. of F/F operate can be gained by the following equation:

$$C_{PD}(\text{total}) = 25 + 12 \cdot n$$

## Package Dimensions

DIP20-P-300-2.54A

Unit : mm

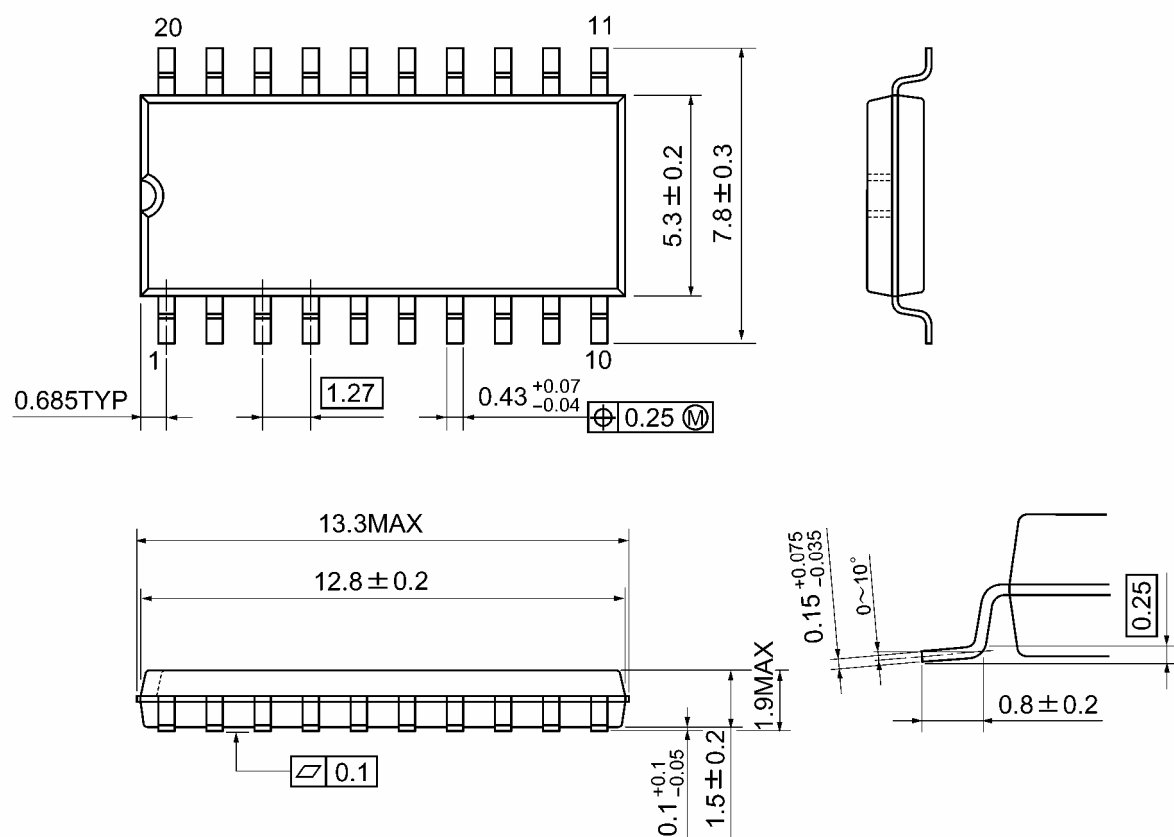


Weight: 1.30 g (typ.)

## Package Dimensions

SOP20-P-300-1.27A

Unit: mm

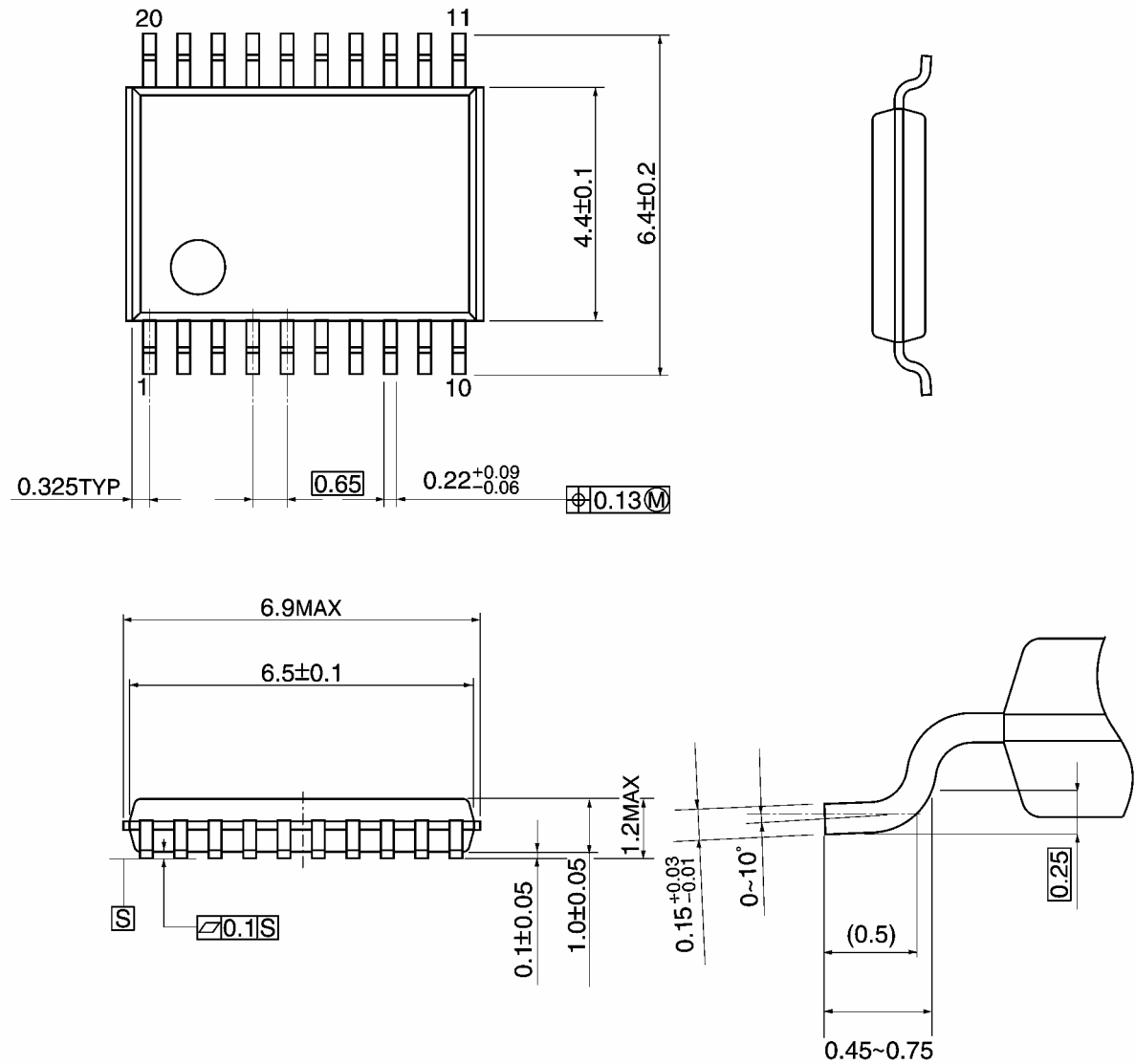


Weight: 0.22 g (typ.)

Package Dimensions

TSSOP20-P-0044-0.65A

Unit: mm



Weight: 0.08 g (typ.)

**RESTRICTIONS ON PRODUCT USE**

20070701-EN GENERAL

- The information contained herein is subject to change without notice.
- 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 shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patents or other rights of TOSHIBA or the third parties.
- Please contact your sales representative for product-by-product details in this document regarding RoHS compatibility. Please use these products in this document in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances. Toshiba assumes no liability for damage or losses occurring as a result of noncompliance with applicable laws and regulations.