

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74VHCT240AF, TC74VHCT240AFT, TC74VHCT240AFK TC74VHCT244AF, TC74VHCT244AFT, TC74VHCT244AFK

### Octal Bus Buffer

TC74VHCT240AF/AFT/AFK  
Inverted, 3-State Outputs

TC74VHCT244AF/AFT/AFK  
Non-Inverted, 3-State Outputs

The TC74VHCT240A and 244A are advanced high speed CMOS OCTAL BUS BUFFERS fabricated with silicon gate 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.

The TC74VHCT240A is an inverting 3-state buffer having two active-low output enables. The TC74VHCT244A is a non-inverting 3-state buffer, and has two active-low output enables.

These devices are designed to be used with 3-state memory address drivers, etc.

The input voltage are compatible with TTL output voltage.

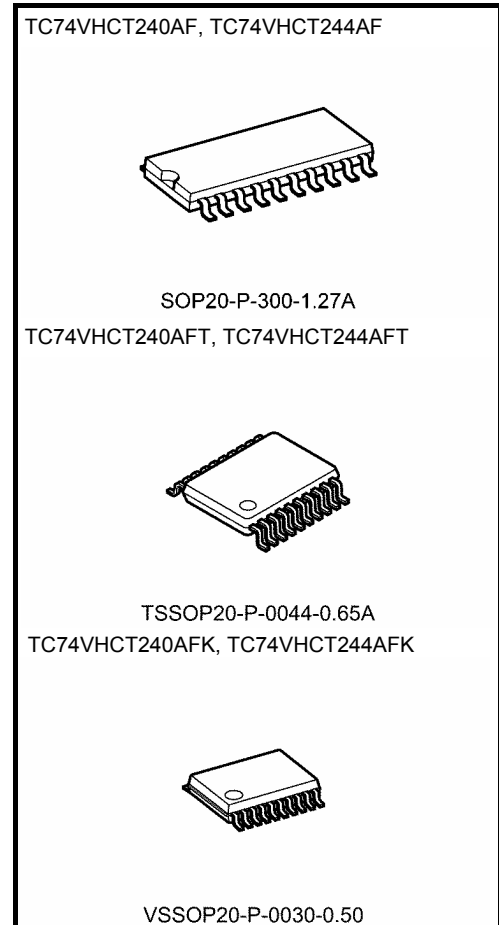
These devices may be used as a level converter for interfacing 3.3 V to 5 V system.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output <sup>(Note)</sup> pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

Note: Output in off-state

### Features

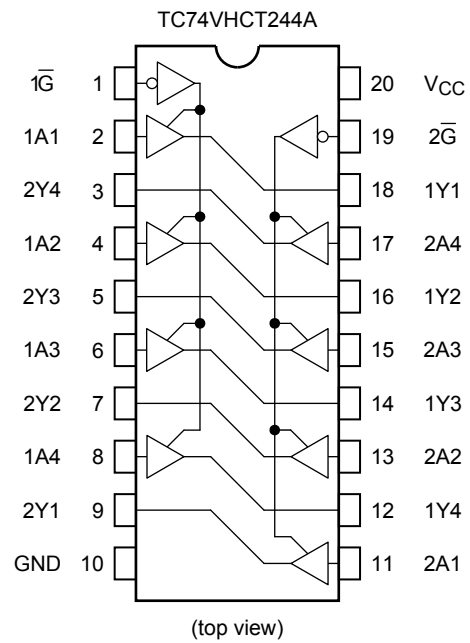
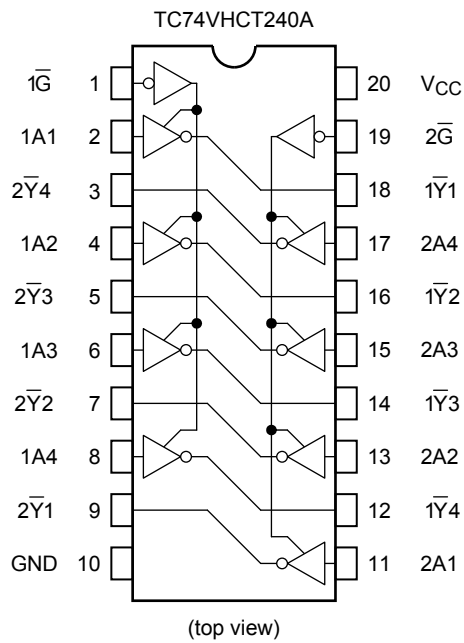
- High speed:  $t_{pd} = 6.1$  ns (typ.) at  $V_{CC} = 5$  V
- Low power dissipation:  $I_{CC} = 4$   $\mu$ A (max) at  $T_a = 25^\circ$ C
- Compatible with TTL outputs:  $V_{IL} = 0.8$  V (max)  
 $V_{IH} = 2.0$  V (min)
- Power down protection is provided on all inputs and outputs
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Low noise:  $V_{OLP} = 1.0$  V (max)
- Pin and function compatible with the 74 series (74AC/HC/F/ALS/LS etc.) 240/244 type.



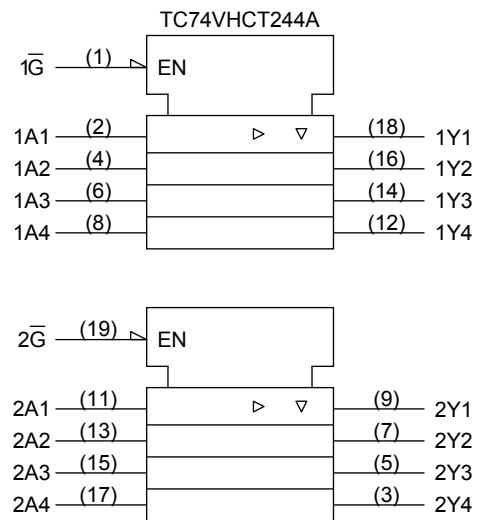
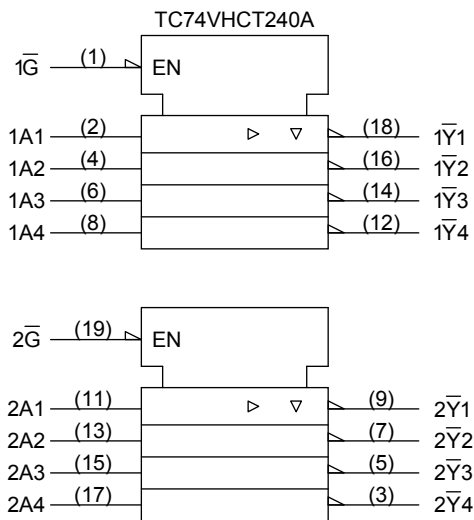
#### Weight

|                      |                 |
|----------------------|-----------------|
| SOP20-P-300-1.27A    | : 0.22 g (typ.) |
| TSSOP20-P-0044-0.65A | : 0.08 g (typ.) |
| VSSOP20-P-0030-0.50  | : 0.03 g (typ.) |

## Pin Assignment



## IEC Logic Symbol



## Truth Table

| Inputs    |       | Outputs |             |
|-----------|-------|---------|-------------|
| $\bar{G}$ | $A_n$ | $Y_n$   | $\bar{Y}_n$ |
| L         | L     | L       | H           |
| L         | H     | H       | L           |
| H         | X     | Z       | Z           |

X: Don't care

Z: High impedance

$Y_n$ : TC74VHCT244A

$\bar{Y}_n$ : TC74VHCT240A

## 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 7.0                     | V           |
| DC output voltage           | $V_{OUT}$ | -0.5 to 7.0 (Note 2)            | V           |
|                             |           | -0.5 to $V_{CC} + 0.5$ (Note 3) |             |
| Input diode current         | $I_{IK}$  | -20                             | mA          |
| Output diode current        | $I_{OK}$  | $\pm 20$ (Note 4)               | mA          |
| DC output current           | $I_{OUT}$ | $\pm 25$                        | mA          |
| DC $V_{CC}$ /ground current | $I_{CC}$  | $\pm 75$                        | mA          |
| Power dissipation           | $P_D$     | 180                             | mW          |
| Storage temperature         | $T_{stg}$ | -65 to 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: Output in 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           | $V_{CC}$  | 4.5 to 5.5             | V           |
| Input voltage            | $V_{IN}$  | 0 to 5.5               | V           |
| Output voltage           | $V_{OUT}$ | 0 to 5.5 (Note 2)      | V           |
|                          |           | 0 to $V_{CC}$ (Note 3) |             |
| Operating temperature    | $T_{opr}$ | -40 to 85              | $^{\circ}C$ |
| Input rise and fall time | $dt/dV$   | 0 to 20                | 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  $V_{CC}$  or  $GND$ .

Note 2: Output in off-state

Note 3: High or low state

## 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>    | —   |                          | 4.5 to 5.5          | 2.0  | —    | —                | 2.0  | —     | V   |
| Low-level input voltage          | V <sub>IL</sub>    | —   |                          | 4.5 to 5.5          | —    | —    | 0.8              | —    | 0.8   | 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 | 4.5                 | 4.40 | 4.50 | —                | 4.40 | —     | V   |
|                                  |                    |   | I <sub>OH</sub> = -8 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  | 4.5                 | —    | 0.0  | 0.10             | —    | 0.10  | V   |
|                                  |                    |   | I <sub>OL</sub> = 8 mA   | 4.5                 | —    | —    | 0.36             | —    | 0.44  |     |
| 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                 | —    | —    | ±0.25            | —    | ±2.50 | μA  |
| Input leakage current            | I <sub>IN</sub>    | V <sub>IN</sub> = 5.5 V or GND  |                          | 0 to 5.5            | —    | —    | ±0.1             | —    | ±1.0  | μA  |
| Quiescent supply current         | I <sub>CC</sub>    | V <sub>IN</sub> = V <sub>CC</sub> or GND  |                          | 5.5                 | —    | —    | 4.0              | —    | 40.0  | μA  |
|                                  | I <sub>CC(T)</sub> | Per input: V <sub>IN</sub> = 3.4 V<br>Other input: V <sub>CC</sub> or GND                         |                          | 5.5                 | —    | —    | 1.35             | —    | 1.50  | mA  |
| Output leakage current           | I <sub>OPD</sub>   | V <sub>OUT</sub> = 5.5 V  |                          | 0                   | —    | —    | 0.5              | —    | 5.0   | μA  |

## AC Characteristics (input: $t_r = t_f = 3$ ns)

| Characteristics                          | Symbol            | Test Condition        | Ta = 25°C           |                     |     | Ta = -40 to 85°C |      | Unit |      |     |
|--|-------------------|-----------------------|---------------------|---------------------|-----|------------------|------|------|------|-----|
|  |                   |                       | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min | Typ.             | Max  |      | Min  | Max |
| Propagation delay time<br>(TC74VHCT240A) | t <sub>pLH</sub>  | —                     | 5.0 ± 0.5           | 15                  | —   | 5.6              | 7.8  | 1.0  | 9.0  | ns  |
|  | t <sub>pHL</sub>  |                       |                     | 50                  | —   | 6.1              | 8.8  | 1.0  | 10.0 |     |
| Propagation delay time<br>(TC74VHCT244A) | t <sub>pLH</sub>  | —                     | 5.0 ± 0.5           | 15                  | —   | 5.4              | 7.4  | 1.0  | 8.5  | ns  |
|  | t <sub>pHL</sub>  |                       |                     | 50                  | —   | 5.9              | 8.4  | 1.0  | 9.5  |     |
| 3-state output enable time               | t <sub>pZL</sub>  | R <sub>L</sub> = 1 kΩ | 5.0 ± 0.5           | 15                  | —   | 7.7              | 10.4 | 1.0  | 12.0 | ns  |
|  | t <sub>pZH</sub>  |                       |                     | 50                  | —   | 8.2              | 11.4 | 1.0  | 13.0 |     |
| 3-state output disable time              | t <sub>pLZ</sub>  | R <sub>L</sub> = 1 kΩ | 5.0 ± 0.5           | 50                  | —   | 8.8              | 11.4 | 1.0  | 13.0 | ns  |
|  | t <sub>pHZ</sub>  |                       |                     | 50                  | —   | 8.8              | 11.4 | 1.0  | 13.0 |     |
| Output to output skew                    | t <sub>osLH</sub> | (Note 1)              | 5.0 ± 0.5           | 50                  | —   | —                | 1.0  | —    | 1.0  | ns  |
|  | t <sub>osHL</sub> |                       |                     | 50                  | —   | —                | 1.0  | —    | 1.0  |     |
| Input capacitance                        | C <sub>IN</sub>   | —                     | —                   | —                   | —   | 4                | 10   | —    | 10   | pF  |
| Output capacitance                       | C <sub>OUT</sub>  | —                     | —                   | —                   | —   | 9                | —    | —    | —    | pF  |
| Power dissipation capacitance (Note 2)   | C <sub>PD</sub>   | TC74VHCT240A          | —                   | —                   | —   | 19               | —    | —    | —    | pF  |
|  |                   | TC74VHCT244A          | —                   | —                   | —   | 18               | —    | —    | —    |     |

Note 1: Parameter guaranteed by design.

$$t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|$$

Note 2: C<sub>PD</sub> 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:

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

## Noise Characteristics (input: $t_r = t_f = 3$ ns)

| Characteristics                              | Symbol           | Test Condition         | Ta = 25°C           |      |       | Unit |
|--|------------------|------------------------|---------------------|------|-------|------|
|  |                  |                        | V <sub>CC</sub> (V) | Typ. | Limit |      |
| Quiet output maximum dynamic V <sub>OL</sub> | V <sub>OLP</sub> | C <sub>L</sub> = 50 pF | 5.0                 | 0.8  | 1.0   | V    |
| Quiet output minimum dynamic V <sub>OL</sub> | V <sub>OLV</sub> | C <sub>L</sub> = 50 pF | 5.0                 | -0.8 | -1.0  | V    |
| Minimum high level dynamic input voltage     | V <sub>IHD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 2.0   | V    |
| Maximum low level dynamic input voltage      | V <sub>ILD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 0.8   | V    |

**Package Dimensions**

SOP20-P-300-1.27A

Unit: mm

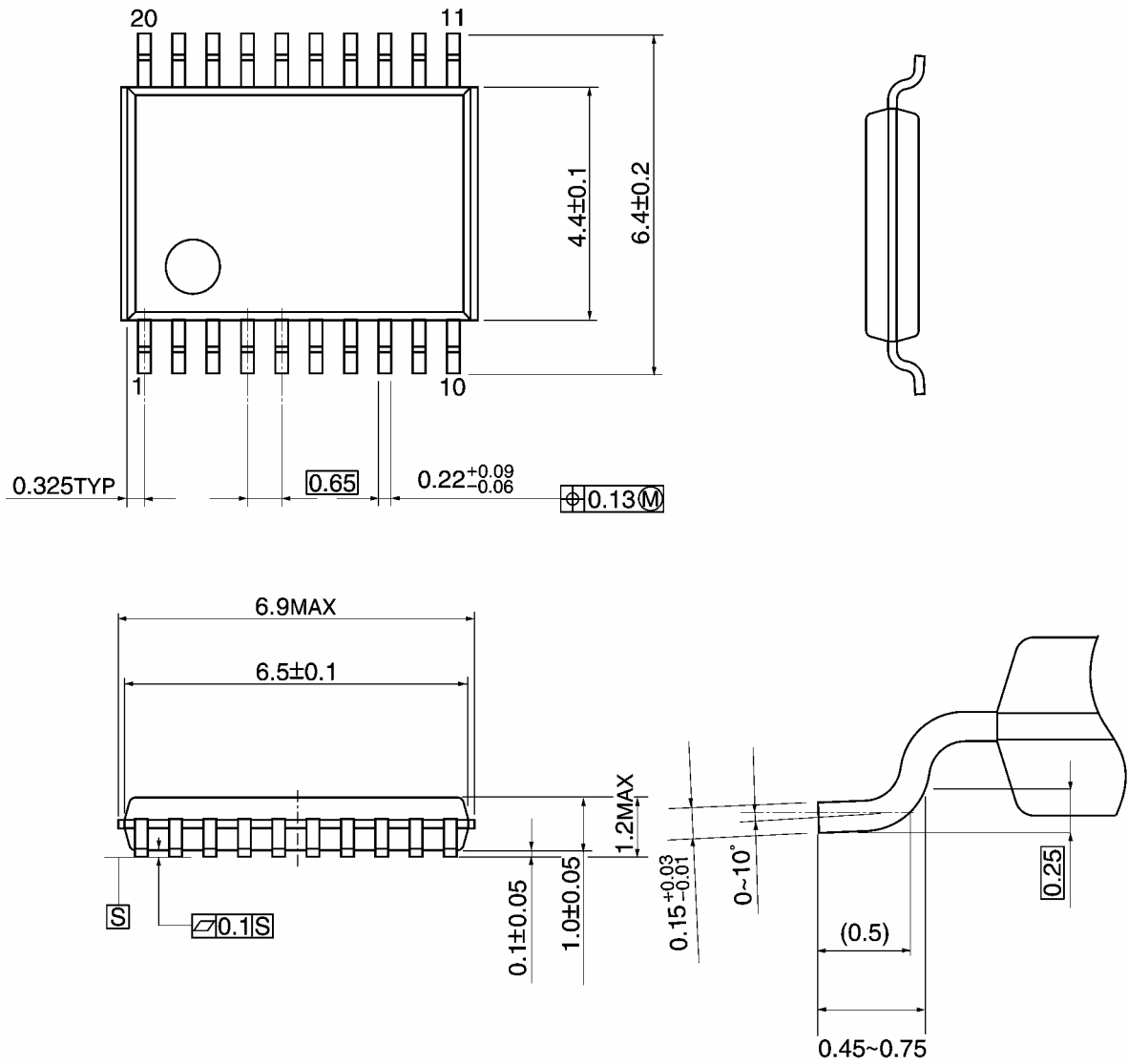


Weight: 0.22 g (typ.)

**Package Dimensions**

TSSOP20-P-0044-0.65A

Unit: mm

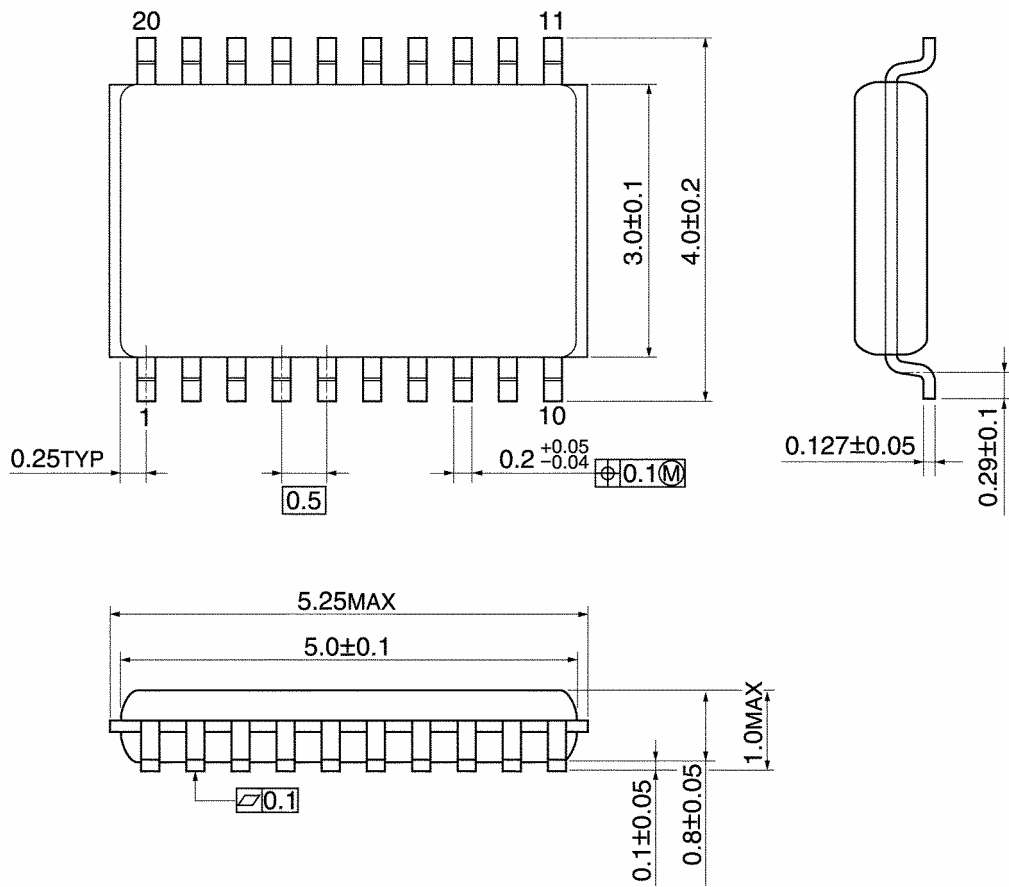


Weight: 0.08 g (typ.)

## 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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