

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74VHCT540AF, TC74VHCT540AFT, TC74VHCT540AFK TC74VHCT541AF, TC74VHCT541AFT, TC74VHCT541AFK

### Octal Bus Buffer

TC74VHCT540AF/AFT/AFK  
Inverted, 3-State Outputs  
TC74VHCT541AF/AFT/AFK  
Non-Inverted, 3-State Outputs

The TC74VHCT540A and 541A 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 TC74VHCT540A is an inverting type and, the TC74VHCT541A is a non-inverting type.

When either  $\overline{G1}$  or  $\overline{G2}$  are high, the terminal outputs are in the high-impedance state.

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.

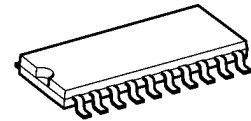
Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output (Note) pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

Note: Output in off-state

### Features

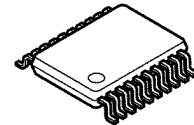
- High speed:  $t_{pd} = 5.4 \text{ ns (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 4 \mu\text{A (max)}$  at  $T_a = 25^\circ\text{C}$
- Compatible with TTL inputs:  $V_{IL} = 0.8 \text{ V (max)}$   
 $V_{IH} = 2.0 \text{ V (min)}$
- Power down protection is provided on all inputs and outputs
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Low noise:  $V_{OLP} = 1.5 \text{ V (max)}$
- Pin and function compatible with the 74 series (74AC/HC/F/ALS/LS etc.) 540/541 type.

TC74VHCT540AF, TC74VHCT541AF



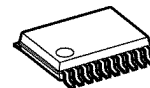
SOP20-P-300-1.27A

TC74VHCT540AFT, TC74VHCT541AFT



TSSOP20-P-0044-0.65A

TC74VHCT540AFK, TC74VHCT541AFK



VSSOP20-P-0030-0.50

Weight

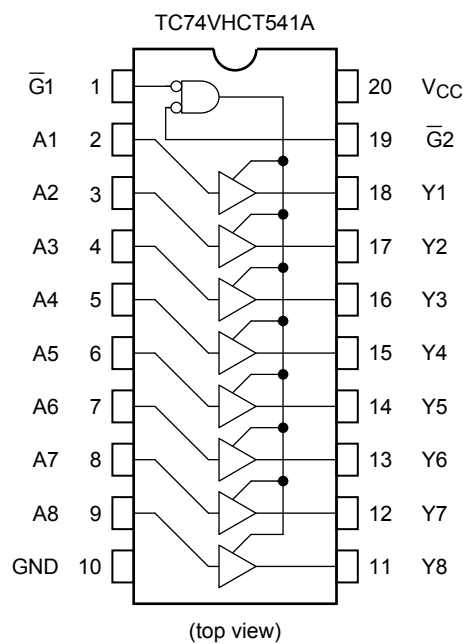
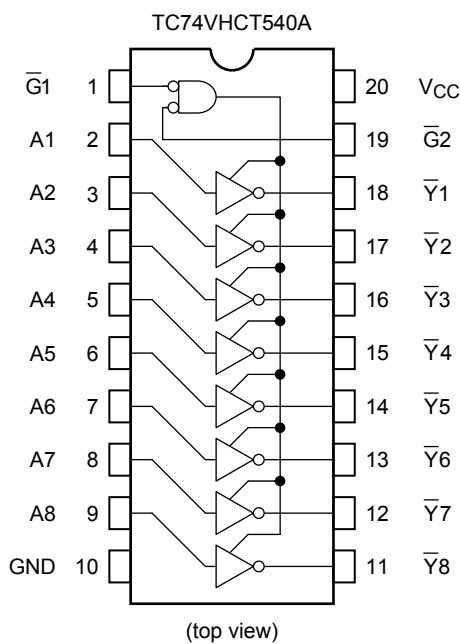
SOP20-P-300-1.27A: 0.22 g (typ.)

TSSOP20-P-0044-0.65A: 0.08 g (typ.)

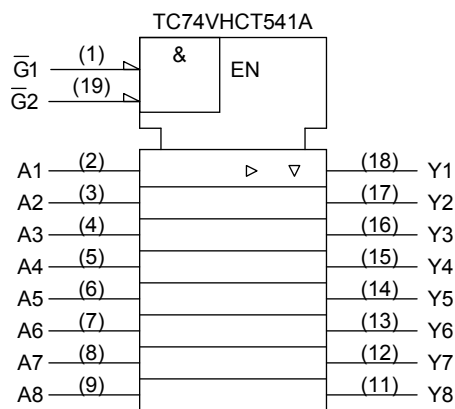
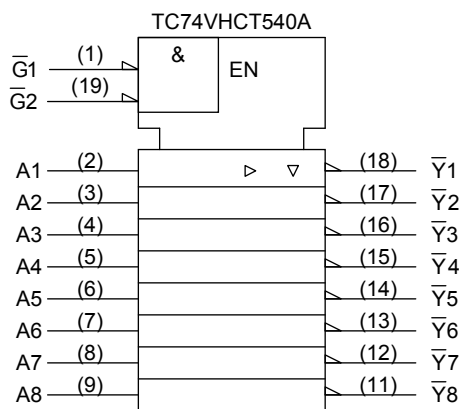
VSSOP20-P-0030-0.50: 0.03 g (typ.)

Start of commercial production  
1995-09

Pin Assignment



IEC Logic Symbol



Truth Table

| Inputs |        |                | Outputs        |                     |
|--------|--------|----------------|----------------|---------------------|
| G1-bar | G2-bar | A <sub>n</sub> | Y <sub>n</sub> | Y <sub>n</sub> -bar |
| H      | X      | X              | Z              | Z                   |
| X      | H      | X              | Z              | Z                   |
| L      | L      | H              | H              | L                   |
| L      | L      | L              | L              | H                   |

X: Don't care

Z: High impedance

Y<sub>n</sub>: VHCT541A

Y<sub>n</sub>-bar: VHCT540A

## 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                      | °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              | °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 =<br>-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>CCT</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<sub>r</sub> = t<sub>f</sub> = 3 ns)

| Characteristics                          | Symbol                                 | Test Condition        |                     |                     | Ta = 25°C |      |      | Ta =<br>-40 to 85°C |      | Unit |
|--|--|-----------------------|---------------------|---------------------|-----------|------|------|---------------------|------|------|
|  |  |                       | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min       | Typ. | Max  | Min                 | Max  |      |
| Propagation delay time<br>(TC74VHCT540A) | 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  |      |
| Propagation delay time<br>(TC74VHCT541A) | t <sub>pLH</sub>                       | —                     | 5.0 ± 0.5           | 15                  | —         | 5.0  | 6.9  | 1.0                 | 8.0  | ns   |
|  | t <sub>pHL</sub>                       |                       |                     | 50                  | —         | 5.5  | 7.9  | 1.0                 | 9.0  |      |
| 3-state output enable time               | t <sub>pZL</sub>                       | R <sub>L</sub> = 1 kΩ | 5.0 ± 0.5           | 15                  | —         | 8.3  | 11.3 | 1.0                 | 13.0 | ns   |
|  | t <sub>pZH</sub>                       |                       |                     | 50                  | —         | 8.8  | 12.3 | 1.0                 | 14.0 |      |
| 3-state output disable time              | t <sub>pLZ</sub><br>t <sub>pHZ</sub>   | R <sub>L</sub> = 1 kΩ | 5.0 ± 0.5           | 50                  | —         | 9.4  | 11.9 | 1.0                 | 13.5 | ns   |
| Output to output skew                    | t <sub>osLH</sub><br>t <sub>osHL</sub> | (Note 1)              | 5.0 ± 0.5           | 50                  | —         | —    | 1.0  | —                   | 1.0  | ns   |
| Input capacitance                        | C <sub>IN</sub>                        | —                     |                     |                     | —         | 4    | 10   | —                   | 10   | pF   |
| Output capacitance                       | C <sub>OUT</sub>                       | —                     |                     |                     | —         | 9    | —    | —                   | —    | pF   |
| Power dissipation capacitance            | C <sub>PD</sub>                        | (Note 2)              |                     |                     | —         | 19   | —    | —                   | —    | pF   |

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:

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

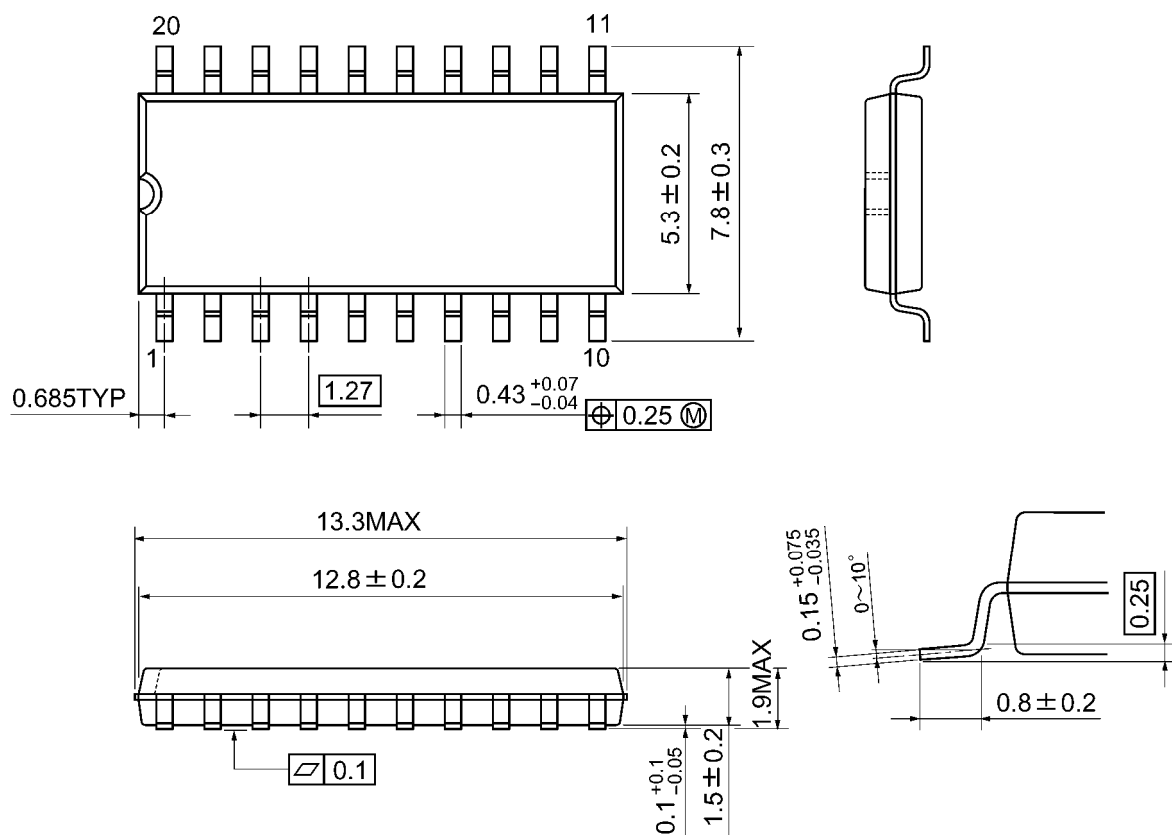
**Noise Characteristics (input:  $t_r = t_f = 3 \text{ ns}$ )**

| 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                 | 1.1  | 1.5   | V    |
| Quiet output minimum dynamic V <sub>OL</sub> | V <sub>OLV</sub> | C <sub>L</sub> = 50 pF | 5.0                 | -1.1 | -1.5  | 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

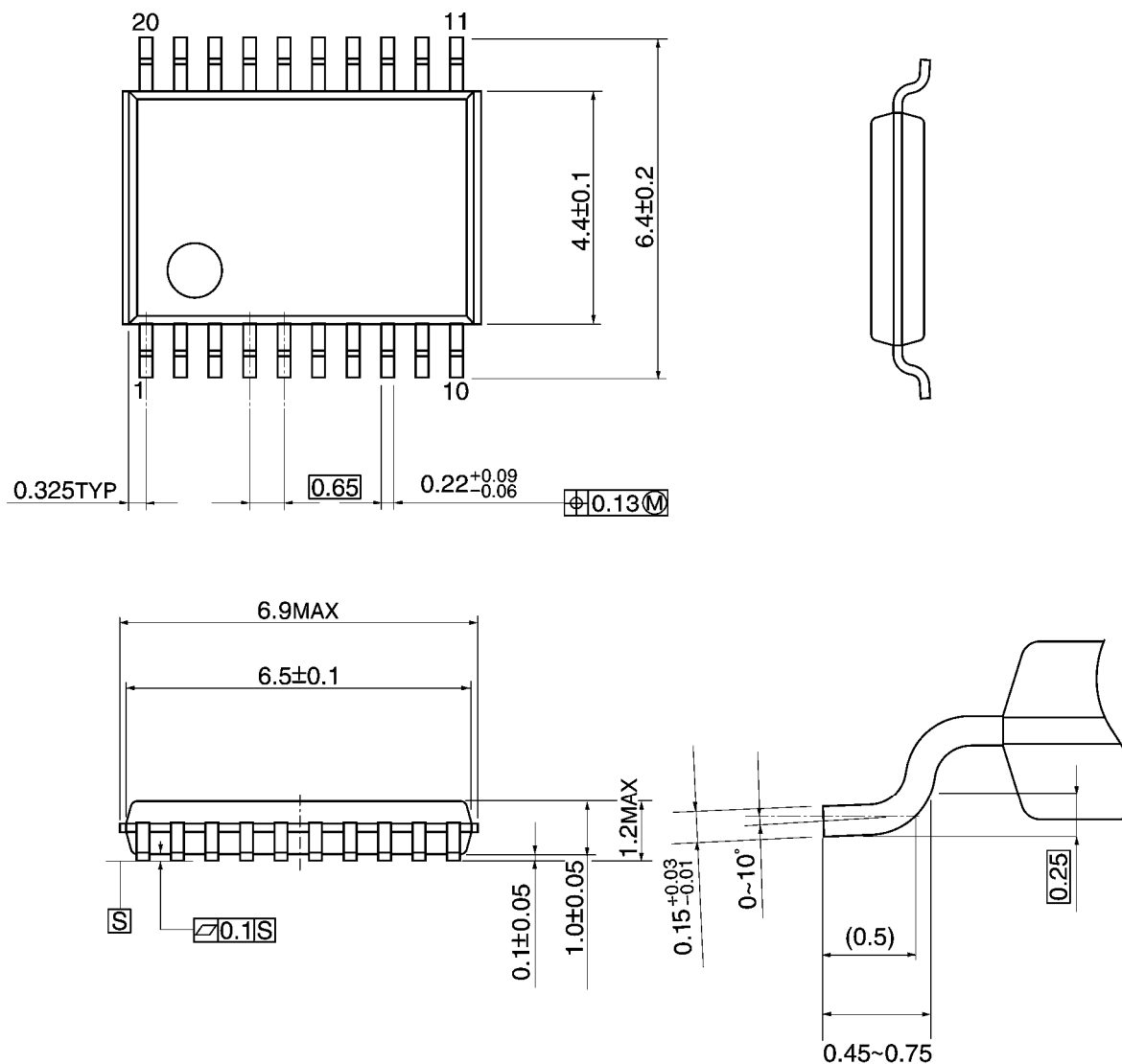


Weight: 0.22 g (typ.)

## Package Dimensions

TSSOP20-P-0044-0.65A

Unit: mm

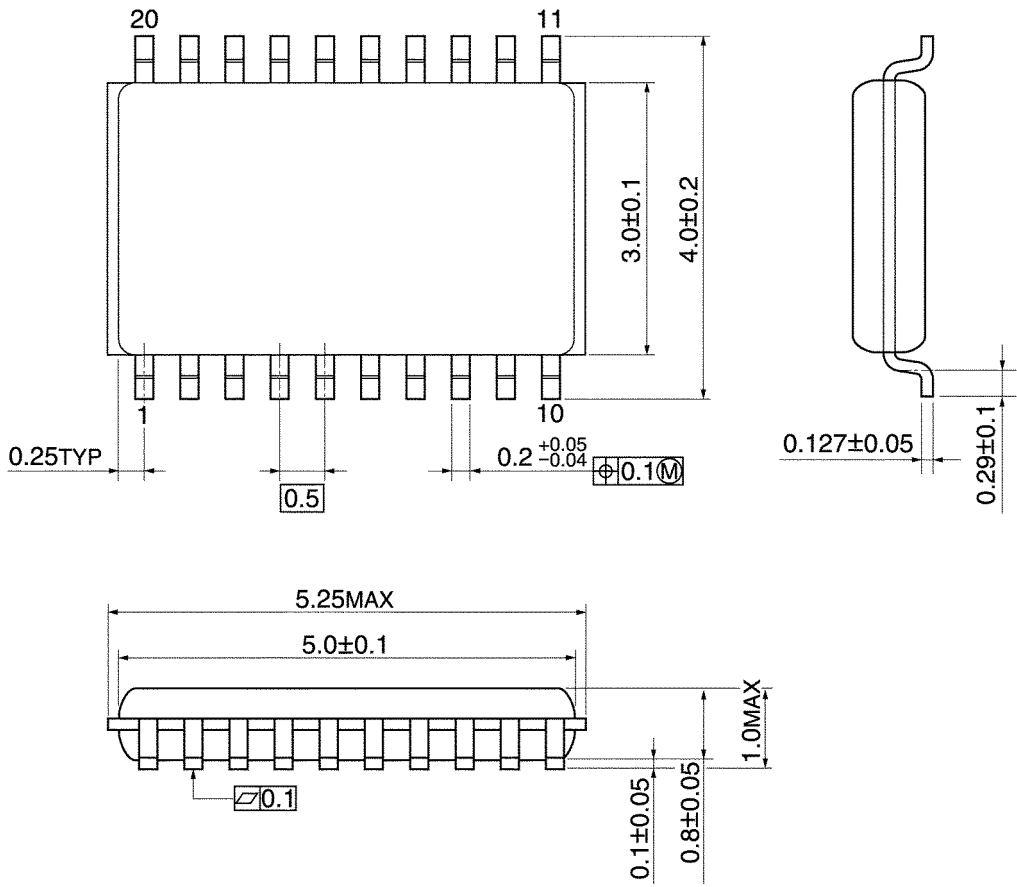


Weight: 0.08 g (typ.)

**Package Dimensions**

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)



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