

## TC74LCX04F, TC74LCX04FT, TC74LCX04FK

### Low-Voltage Hex Inverter with 5-V Tolerant Inputs and Outputs

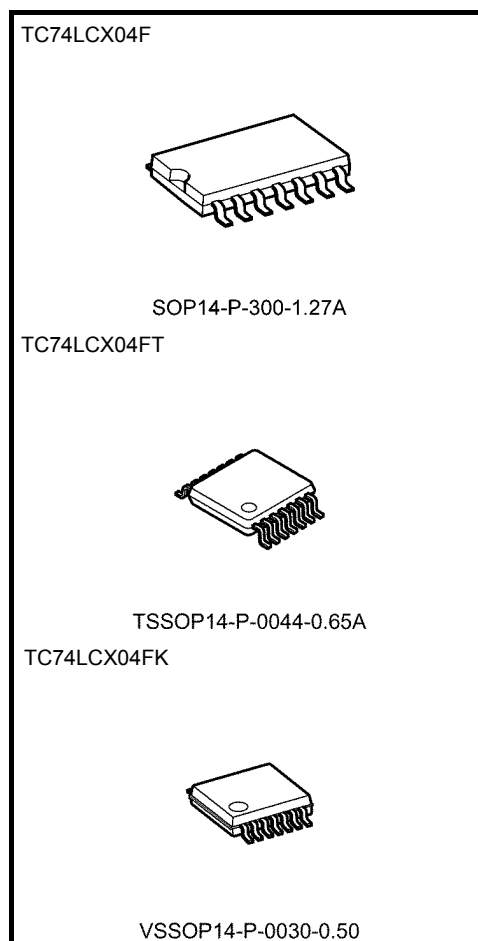
The TC74LCX04 is a high-performance CMOS inverter. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5-V supply environment for inputs.

All inputs are equipped with protection circuits against static discharge.

### Features

- Low-voltage operation:  $V_{CC} = 1.65$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 5.2$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Latch-up performance:  $>\pm 500$  mA
- Available in JEITA SOP, TSSOP and VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 04 type

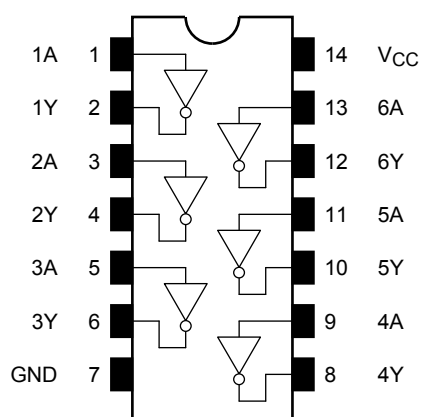


#### WWeight

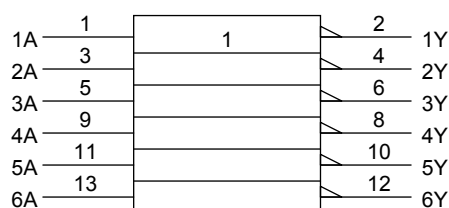
|                      |                 |
|----------------------|-----------------|
| SOP14-P-300-1.27A    | : 0.18 g (typ.) |
| TSSOP14-P-0044-0.65A | : 0.06 g (typ.) |
| VSSOP14-P-0030-0.50  | : 0.02 g (typ.) |

Note: The Electrical Characteristics of  $V_{CC}=1.8\pm 0.15$ V is only applicable for products which manufactured from January 2009 onward.

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

| Inputs | Outputs |
|--------|---------|
| A      | Y       |
| L      | H       |
| H      | L       |

## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol           | Rating                          | Unit |
|-----------------------------|------------------|---------------------------------|------|
| Power supply voltage        | $V_{CC}$         | -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         | $I_{IK}$         | -50                             | mA   |
| Output diode current        | $I_{OK}$         | $\pm 50$ (Note 4)               | mA   |
| DC output current           | $I_{OUT}$        | $\pm 50$                        | mA   |
| Power dissipation           | $P_D$            | 180                             | mW   |
| DC $V_{CC}$ /ground current | $I_{CC}/I_{GND}$ | $\pm 100$                       | mA   |
| 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:  $V_{CC} = 0$  V

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 |
|--------------------------|-----------------|------------------------|------|
| Power supply voltage     | $V_{CC}$        | 1.65 to 3.6            | V    |
|                          |                 | 1.5 to 3.6 (Note 2)    |      |
| Input voltage            | $V_{IN}$        | 0 to 5.5               | V    |
| Output voltage           | $V_{OUT}$       | 0 to 5.5 (Note 3)      | V    |
|                          |                 | 0 to $V_{CC}$ (Note 4) |      |
| Output current           | $I_{OH}/I_{OL}$ | $\pm 24$ (Note 5)      | mA   |
|                          |                 | $\pm 12$ (Note 6)      |      |
| Operating temperature    | $T_{opr}$       | -40 to 85              | °C   |
| Input rise and fall time | dt/dv           | 0 to 10 (Note 7)       | 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: Data retention only

Note 3:  $V_{CC} = 0$  V

Note 4: High or low state ( However, it can not exceed  $I_{OUT}$  of absolute maximum ratings. )

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

Note 6:  $V_{CC} = 2.7$  to 3.0 V

Note 7:  $V_{IN} = 0.8$  to 2.0 V,  $V_{CC} = 3.0$  V

**Electrical Characteristics**
**DC Characteristics (Ta = -40 to 85°C)**

| Characteristics                       |         | Symbol           | Test Condition                            |                           | Min                   | Max                   | Unit |   |
|---------------------------------------|---------|------------------|-------------------------------------------|---------------------------|-----------------------|-----------------------|------|---|
|                                       |         |                  | V <sub>CC</sub> (V)                       |                           |                       |                       |      |   |
| Input voltage                         | H-level | V <sub>IH</sub>  | —                                         | 1.65 to 2.3               | V <sub>CC</sub> × 0.9 | —                     | V    |   |
|                                       |         |                  |                                           | 2.3 to 2.7                | 1.7                   | —                     |      |   |
|                                       |         |                  |                                           | 2.7 to 3.6                | 2.0                   | —                     |      |   |
|                                       | L-level | V <sub>IL</sub>  | —                                         | 1.65 to 2.3               | —                     | V <sub>CC</sub> × 0.1 |      |   |
|                                       |         |                  |                                           | 2.3 to 2.7                | —                     | 0.7                   |      |   |
|                                       |         |                  |                                           | 2.7 to 3.6                | —                     | 0.8                   |      |   |
| Output voltage                        | H-level | V <sub>OH</sub>  | V <sub>IN</sub> = V <sub>IL</sub>         | I <sub>OH</sub> = -100 μA | 1.65 to 3.6           | V <sub>CC</sub> -0.2  | —    | V |
|                                       |         |                  |                                           | I <sub>OH</sub> = -4 mA   | 1.65                  | 1.05                  | —    |   |
|                                       |         |                  |                                           | I <sub>OH</sub> = -8 mA   | 2.3                   | 1.7                   | —    |   |
|                                       |         |                  |                                           | I <sub>OH</sub> = -12 mA  | 2.7                   | 2.2                   | —    |   |
|                                       |         |                  |                                           | I <sub>OH</sub> = -18 mA  | 3.0                   | 2.4                   | —    |   |
|                                       |         |                  |                                           | I <sub>OH</sub> = -24 mA  | 3.0                   | 2.2                   | —    |   |
|                                       | L-level | V <sub>OL</sub>  | V <sub>IN</sub> = V <sub>IH</sub>         | I <sub>OL</sub> = 100 μA  | 1.65 to 3.6           | —                     | 0.2  |   |
|                                       |         |                  |                                           | I <sub>OL</sub> = 4 mA    | 1.65                  | —                     | 0.45 |   |
|                                       |         |                  |                                           | I <sub>OL</sub> = 8 mA    | 2.3                   | —                     | 0.7  |   |
|                                       |         |                  |                                           | I <sub>OL</sub> = 12 mA   | 2.7                   | —                     | 0.4  |   |
|                                       |         |                  |                                           | I <sub>OL</sub> = 16 mA   | 3.0                   | —                     | 0.4  |   |
|                                       |         |                  |                                           | I <sub>OL</sub> = 24 mA   | 3.0                   | —                     | 0.55 |   |
| Input leakage current                 |         | I <sub>IN</sub>  | V <sub>IN</sub> = 0 to 5.5 V              | 1.65 to 3.6               | —                     | ±5.0                  | μA   |   |
| Power-off leakage current             |         | I <sub>OFF</sub> | V <sub>IN</sub> /V <sub>OUT</sub> = 5.5 V | 0                         | —                     | 10.0                  | μA   |   |
| Quiescent supply current              |         | I <sub>CC</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or GND  | 1.65 to 3.6               | —                     | 10.0                  | μA   |   |
|                                       |         |                  | V <sub>IN</sub> = 3.6 to 5.5 V            | 1.65 to 3.6               | —                     | ±10.0                 |      |   |
| Increase in I <sub>CC</sub> per input |         | ΔI <sub>CC</sub> | V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V | 2.7 to 3.6                | —                     | 500                   |      |   |

**AC Characteristics (Ta = -40 to 85°C)**

| Characteristics        | Symbol                                 | Test Condition     | V <sub>CC</sub> (V) | Min | Max  | Unit |
|------------------------|----------------------------------------|--------------------|---------------------|-----|------|------|
|                        |                                        |                    |                     |     |      |      |
| Propagation delay time | t <sub>pLH</sub><br>t <sub>pHL</sub>   | Figure 1, Figure 2 | 1.8 ± 0.15          | —   | 20.0 | ns   |
|                        |                                        |                    | 2.5 ± 0.2           | —   | 7.0  |      |
|                        |                                        |                    | 2.7                 | —   | 6.0  |      |
|                        |                                        |                    | 3.3 ± 0.3           | 1.5 | 5.2  |      |
| Output to output skew  | t <sub>osLH</sub><br>t <sub>osHL</sub> | (Note)             | 2.7                 | —   | —    | ns   |
|                        |                                        |                    | 3.3 ± 0.3           | —   | 1.0  |      |

Note: Parameter guaranteed by design.  
 (t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

**Dynamic Switching Characteristics (Ta = 25°C, input: t<sub>r</sub> = t<sub>f</sub> = 2.5 ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω)**

| Characteristics                              | Symbol           | Test Condition                                 | V <sub>CC</sub> (V) | Typ. | Unit |
|----------------------------------------------|------------------|------------------------------------------------|---------------------|------|------|
|                                              |                  |                                                |                     |      |      |
| Quiet output maximum dynamic V <sub>OL</sub> | V <sub>OLP</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3                 | 0.8  | V    |
| Quiet output minimum dynamic V <sub>OL</sub> | V <sub>OLV</sub> | V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V | 3.3                 | 0.8  | V    |

**Capacitive Characteristics (Ta = 25°C)**

| Characteristics               | Symbol           | Test Condition                  | V <sub>CC</sub> (V) | Typ. | Unit |
|-------------------------------|------------------|---------------------------------|---------------------|------|------|
|                               |                  |                                 |                     |      |      |
| Input capacitance             | C <sub>IN</sub>  | —                               | 3.3                 | 7    | pF   |
| Output capacitance            | C <sub>OUT</sub> | —                               | 0                   | 8    | pF   |
| Power dissipation capacitance | C <sub>PD</sub>  | f <sub>IN</sub> = 10 MHz (Note) | 3.3                 | 25   | pF   |

Note: 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:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per gate)}$$

AC Test Circuit

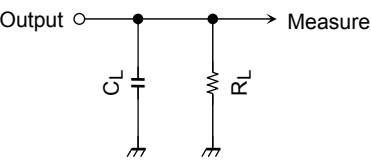


Figure 1

AC Waveform

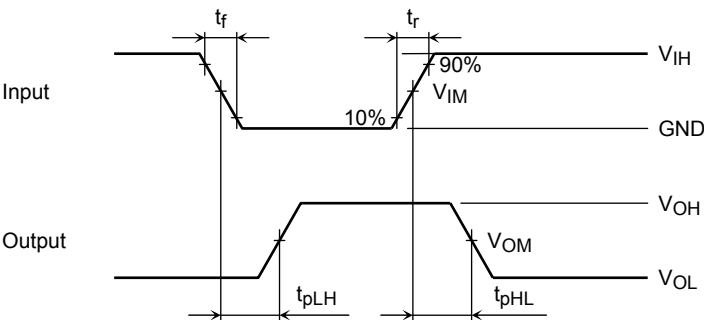


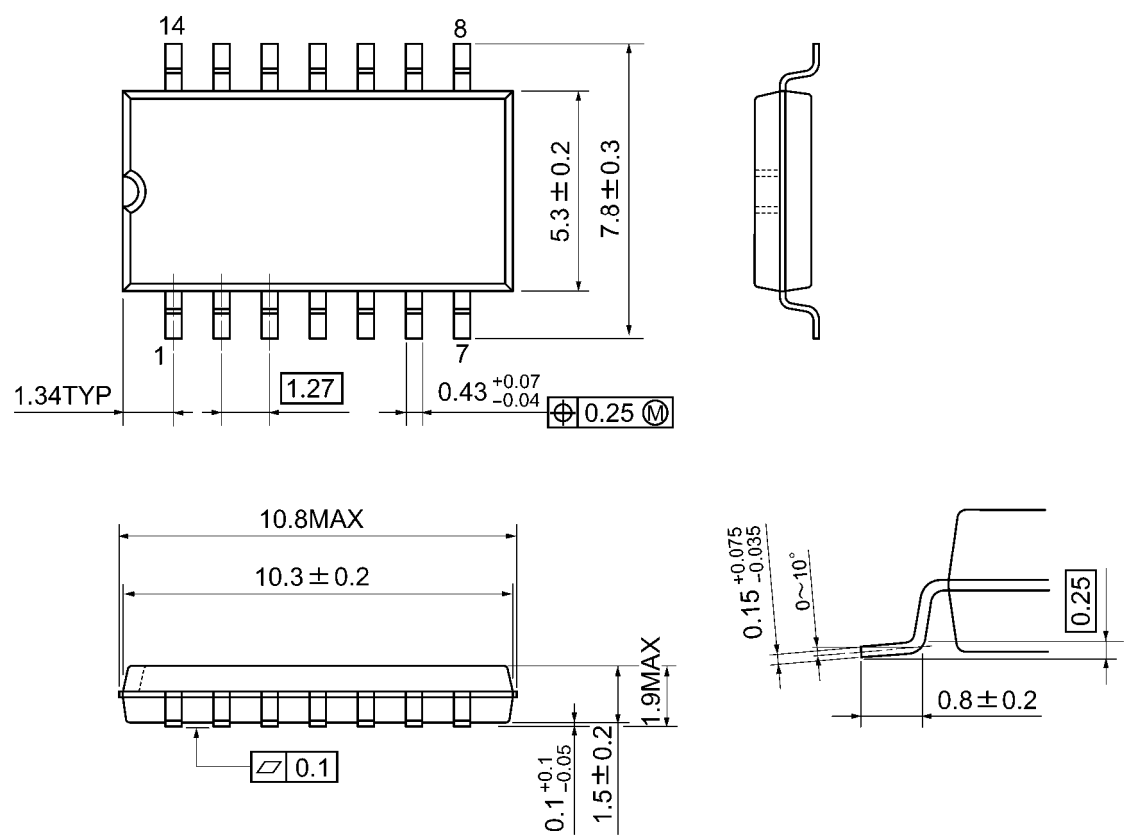
Figure 2  $t_{pLH}$ ,  $t_{pHL}$

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

Package Dimensions

SOP14-P-300-1.27A

Unit: mm

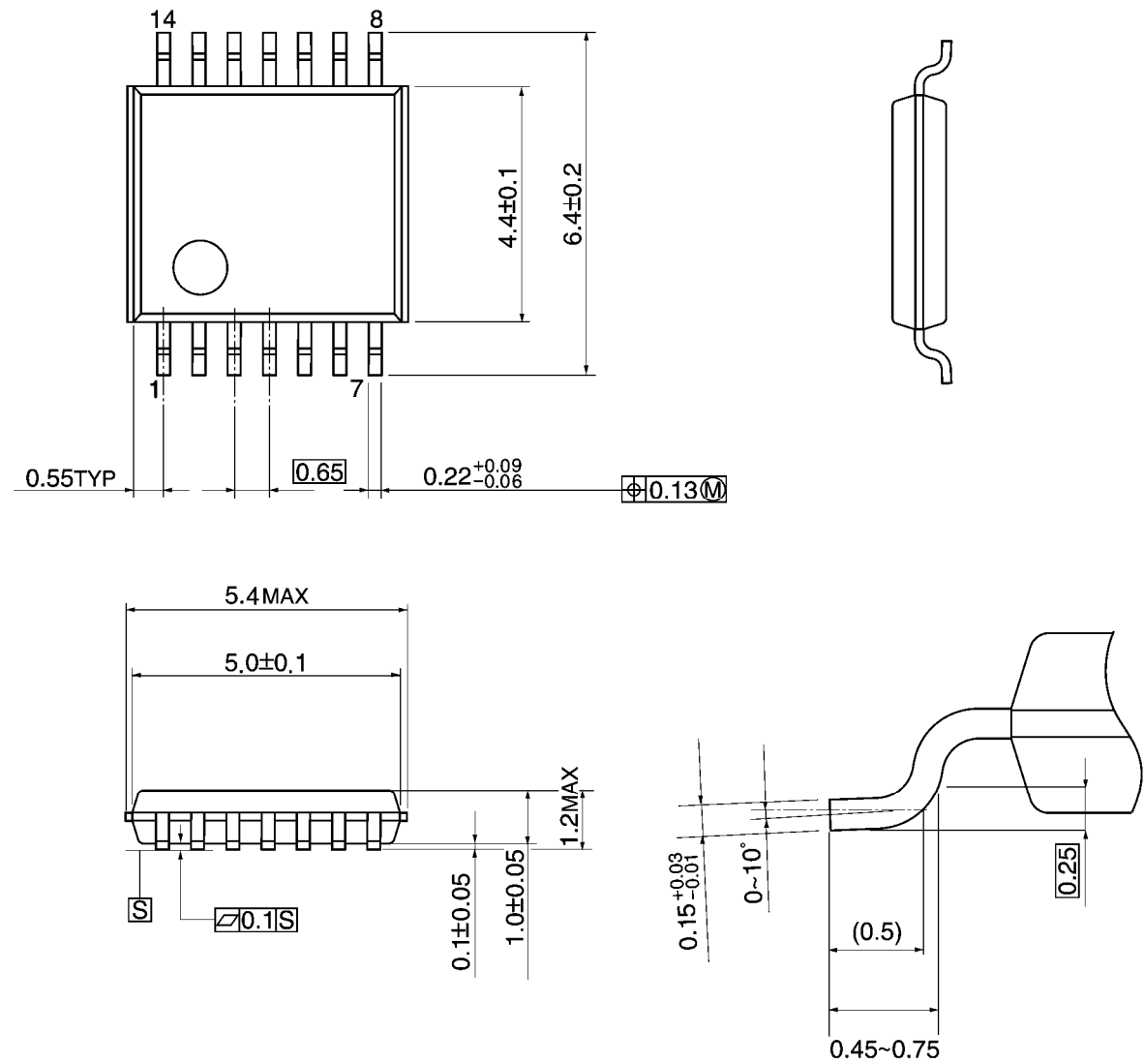


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP14-P-0044-0.65A

Unit: mm



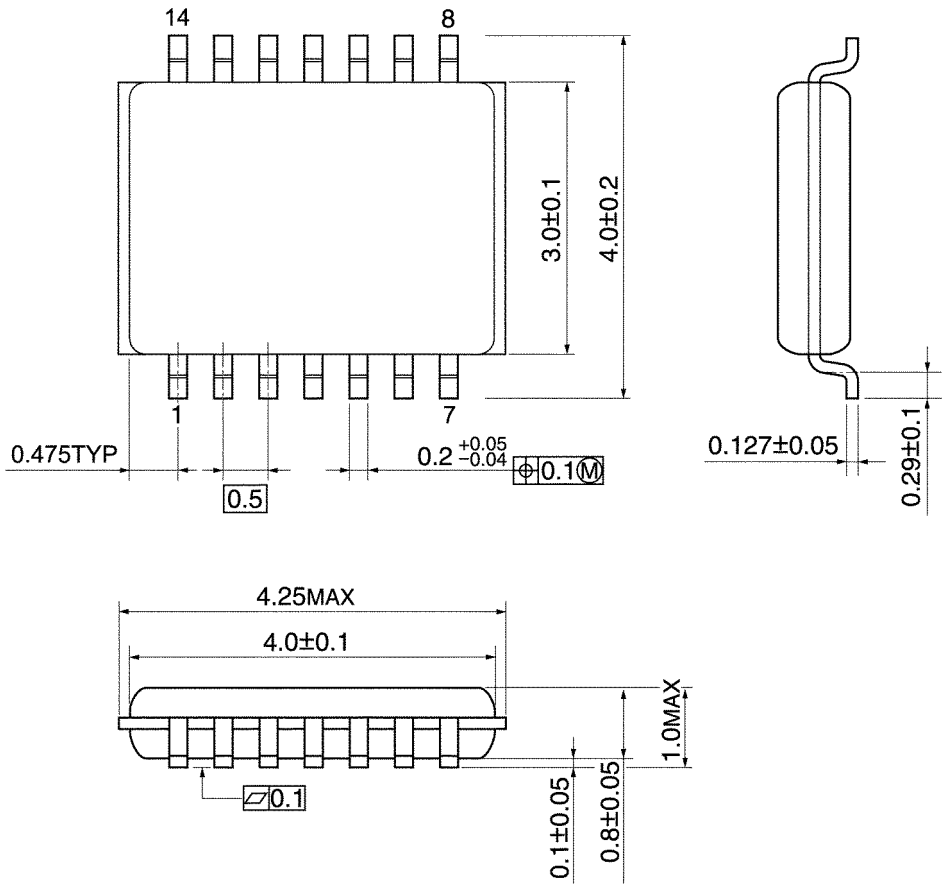
Weight: 0.06 g (typ.)



Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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