

## TC74LCX74F, TC74LCX74FN, TC74LCX74FT, TC74LCX74FK

### Low-Voltage Dual D-Type Flip-Flop with 5-V Tolerant Inputs and Outputs

The TC74LCX74 is a high-performance CMOS D-type flip-flop. 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.

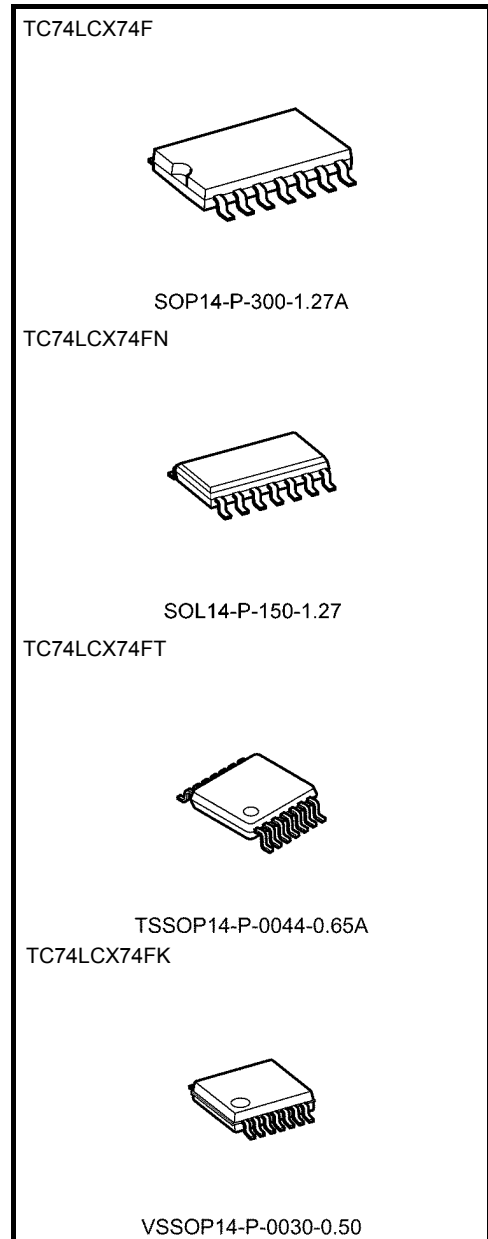
The signal level applied to the D input is transferred to Q output during the positive going transition of the CK pulse. CLR and PR are independent of the CK and are accomplished by setting the appropriate input low.

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:  $t_{pd} = 7.0$  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 JEDEC SOP, JEITA SOP, TSSOP and VSSOP (US)
- Power-down protection is provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 74 type

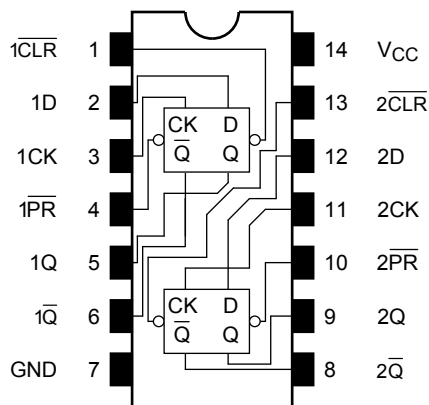
Note: xxxFN (JEDEC SOP) is not available in Japan.



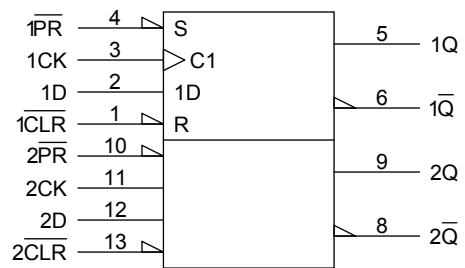
|                      |                 |
|----------------------|-----------------|
| Weight               |                 |
| SOP14-P-300-1.27A    | : 0.18 g (typ.) |
| SOL14-P-150-1.27     | : 0.12 g (typ.) |
| TSSOP14-P-0044-0.65A | : 0.06 g (typ.) |
| VSSOP14-P-0030-0.50  | : 0.02 g (typ.) |

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

## Pin Assignment (top view)



## IEC Logic Symbol



## Truth Table

| Inputs |    |   |    | Outputs        |                 | Function  |
|--------|----|---|----|----------------|-----------------|-----------|
| CLR    | PR | D | CK | Q              | Q̄              |           |
| L      | H  | X | X  | L              | H               | Clear     |
| H      | L  | X | X  | H              | L               | Preset    |
| L      | L  | X | X  | H              | H               | —         |
| H      | H  | L | ↑  | L              | H               | —         |
| H      | H  | H | ↑  | H              | L               | —         |
| H      | H  | X | ↓  | Q <sub>n</sub> | Q̄ <sub>n</sub> | No change |

X: Don't care

## Absolute Maximum Ratings (Note 1)

| Characteristics                    | Symbol                            | Rating                                 | Unit |
|------------------------------------|-----------------------------------|--|------|
| Power supply voltage               | V <sub>CC</sub>                   | -0.5 to 7.0                            | V    |
| DC input voltage                   | V <sub>IN</sub>                   | -0.5 to 7.0                            | V    |
| DC output voltage                  | V <sub>OUT</sub>                  | -0.5 to 7.0 (Note 2)                   | V    |
|                                    |                                   | -0.5 to V <sub>CC</sub> + 0.5 (Note 3) |      |
| Input diode current                | I <sub>IK</sub>                   | -50                                    | mA   |
| Output diode current               | I <sub>OK</sub>                   | ±50 (Note 4)                           | mA   |
| DC output current                  | I <sub>OUT</sub>                  | ±50                                    | mA   |
| Power dissipation                  | P <sub>D</sub>                    | 180                                    | mW   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub> /I <sub>GND</sub> | ±100                                   | mA   |
| Storage temperature                | T <sub>stg</sub>                  | -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<sub>CC</sub> = 0 V

Note 3: High or low state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 4: V<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

## 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              | $^{\circ}C$ |
| 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

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                                       | V <sub>CC</sub> (V)       | Min                   | Max                   | Unit |      |
|---------------------------------------|---------|------------------|--|---------------------------|-----------------------|-----------------------|------|------|
|                                       |         |                  |  |                           |                       |                       |      |      |
| 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>IH</sub> or 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> or V <sub>IL</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            | 1.65 to 3.6               | —                     | 500                   |      |      |

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

| Characteristics  | Symbol                                   | Test Condition     | V <sub>CC</sub> (V) | Min  | Max  | Unit |
|--|--|--------------------|---------------------|------|------|------|
|  |  |                    |                     |      |      |      |
| Maximum clock frequency  | f <sub>max</sub>                         | Figure 1, Figure 2 | 1.8 ± 0.15          | 50   | —    | MHz  |
|  |  |                    | 2.5 ± 0.2           | 100  | —    |      |
|  |  |                    | 2.7                 | 100  | —    |      |
|  |  |                    | 3.3 ± 0.3           | 150  | —    |      |
| Propagation delay time<br>(CK-Q, $\bar{Q}$ )                         | t <sub>pLH</sub><br>t <sub>pHL</sub>     | Figure 1, Figure 2 | 1.8 ± 0.15          | —    | 22.0 | ns   |
|  |  |                    | 2.5 ± 0.2           | —    | 9.0  |      |
|  |  |                    | 2.7                 | —    | 8.0  |      |
|  |  |                    | 3.3 ± 0.3           | 1.5  | 7.0  |      |
| Propagation delay time<br>( $\bar{CLR}$ , $\bar{PR}$ -Q, $\bar{Q}$ ) | t <sub>pLH</sub><br>t <sub>pHL</sub>     | Figure 1, Figure 4 | 1.8 ± 0.15          | —    | 22.0 | ns   |
|  |  |                    | 2.5 ± 0.2           | —    | 9.0  |      |
|  |  |                    | 2.7                 | —    | 8.0  |      |
|  |  |                    | 3.3 ± 0.3           | 1.5  | 7.0  |      |
| Minimum pulse width<br>(CK)  | t <sub>w</sub> (H)<br>t <sub>w</sub> (L) | Figure 1, Figure 2 | 1.8 ± 0.15          | 10.0 | —    | ns   |
|  |  |                    | 2.5 ± 0.2           | 5.0  | —    |      |
|  |  |                    | 2.7                 | 3.3  | —    |      |
|  |  |                    | 3.3 ± 0.3           | 3.3  | —    |      |
| Minimum pulse width<br>( $\bar{CLR}$ , $\bar{PR}$ )                  | t <sub>w</sub> (L)                       | Figure 1, Figure 4 | 1.8 ± 0.15          | 10.0 | —    | ns   |
|  |  |                    | 2.5 ± 0.2           | 5.0  | —    |      |
|  |  |                    | 2.7                 | 3.6  | —    |      |
|  |  |                    | 3.3 ± 0.3           | 3.3  | —    |      |
| Minimum setup time   | t <sub>s</sub>                           | Figure 1, Figure 2 | 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 <sub>h</sub>                           | Figure 1, Figure 2 | 1.8 ± 0.15          | 1.5  | —    | ns   |
|  |  |                    | 2.5 ± 0.2           | 1.5  | —    |      |
|  |  |                    | 2.7                 | 1.5  | —    |      |
|  |  |                    | 3.3 ± 0.3           | 1.5  | —    |      |
| Minimum removal time   | t <sub>rem</sub>                         | Figure 1, Figure 3 | 1.8 ± 0.15          | 10.0 | —    | ns   |
|  |  |                    | 2.5 ± 0.2           | 5.0  | —    |      |
|  |  |                    | 2.7                 | 3.0  | —    |      |
|  |  |                    | 3.3 ± 0.3           | 2.5  | —    |      |
| 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: tr = tf = 2.5 ns, CL = 50 pF, RL = 500 Ω)**

| Characteristics                  | Symbol | Test Condition         | VCC (V) | Typ. | Unit |
|----------------------------------|--------|------------------------|---------|------|------|
|                                  |        |                        |         |      |      |
| Quiet output maximum dynamic VOL | VOLP   | VIH = 3.3 V, VIL = 0 V | 3.3     | 0.8  | V    |
| Quiet output minimum dynamic VOL | VOLV   | VIH = 3.3 V, VIL = 0 V | 3.3     | 0.8  | V    |

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

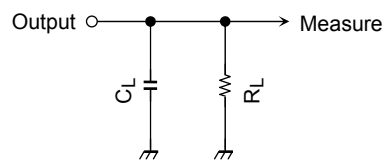
| Characteristics               | Symbol | Test Condition      | VCC (V) | Typ. | Unit |
|-------------------------------|--------|---------------------|---------|------|------|
|                               |        |                     |         |      |      |
| Input capacitance             | CIN    | —                   | 3.3     | 7    | pF   |
| Output capacitance            | COU    | —                   | 0       | 8    | pF   |
| Power dissipation capacitance | CPD    | fIN = 10 MHz (Note) | 3.3     | 25   | pF   |

Note: CPD 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:

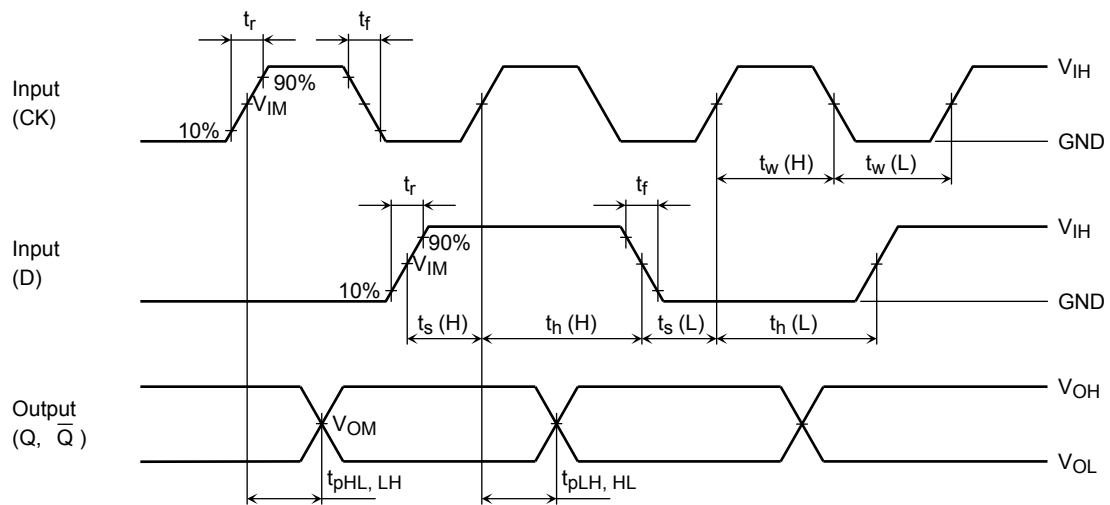
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2 \text{ (per bit)}$$

**AC Test Circuit**

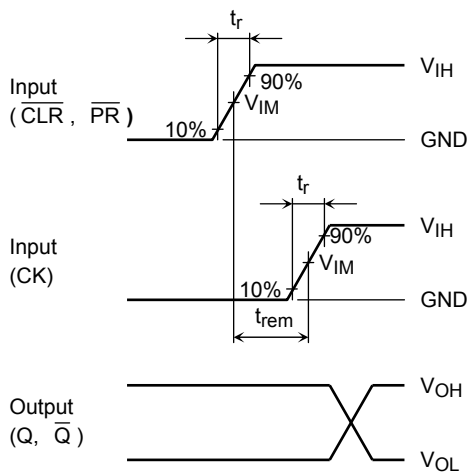


**Figure 1**

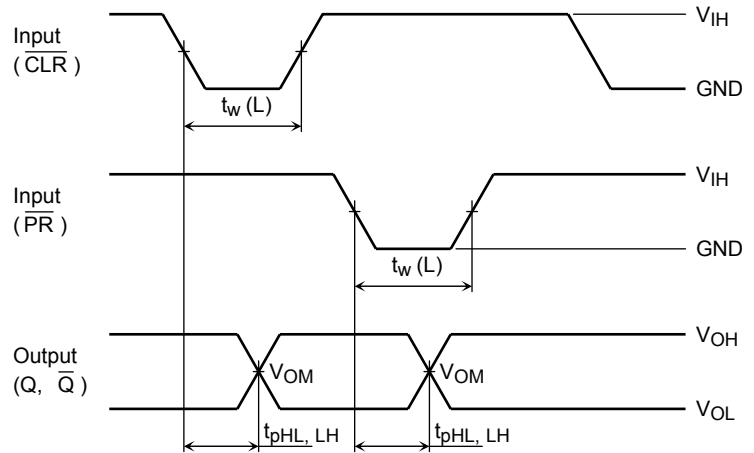
**AC Waveform**



**Figure 2  $t_{pLH}$ ,  $t_{pHL}$ ,  $t_w$ ,  $t_s$ ,  $t_h$**



**Figure 3  $t_{rem}$**



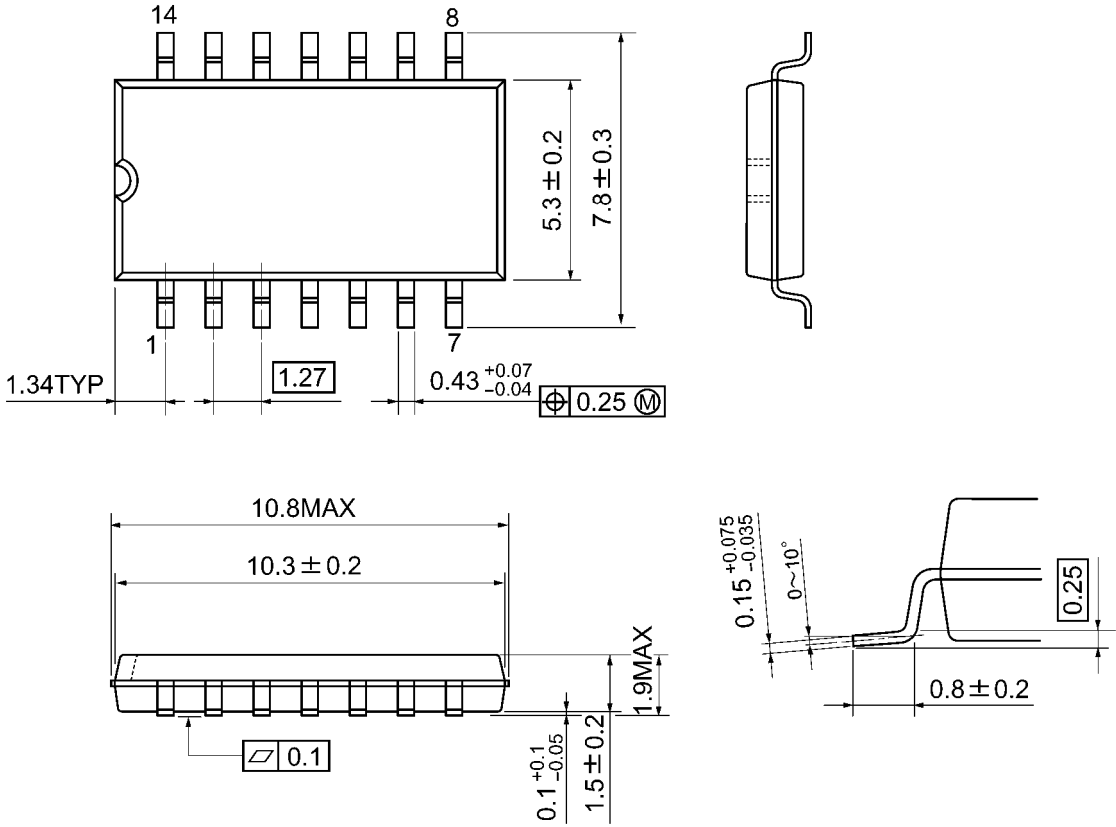
**Figure 4  $t_{pLH}$ ,  $t_{pHL}$**

|        | Symbol     | $V_{CC}$                |                 |                  |
|--------|------------|-------------------------|-----------------|------------------|
|        |            | $3.3 \pm 0.3 V$<br>2.7V | $2.5 \pm 0.2 V$ | $1.8 \pm 0.15 V$ |
| 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             |
|        | $R_L$      | 500Ω                    | 500Ω            | 1kΩ              |

Package Dimensions

SOP14-P-300-1.27A

Unit: mm



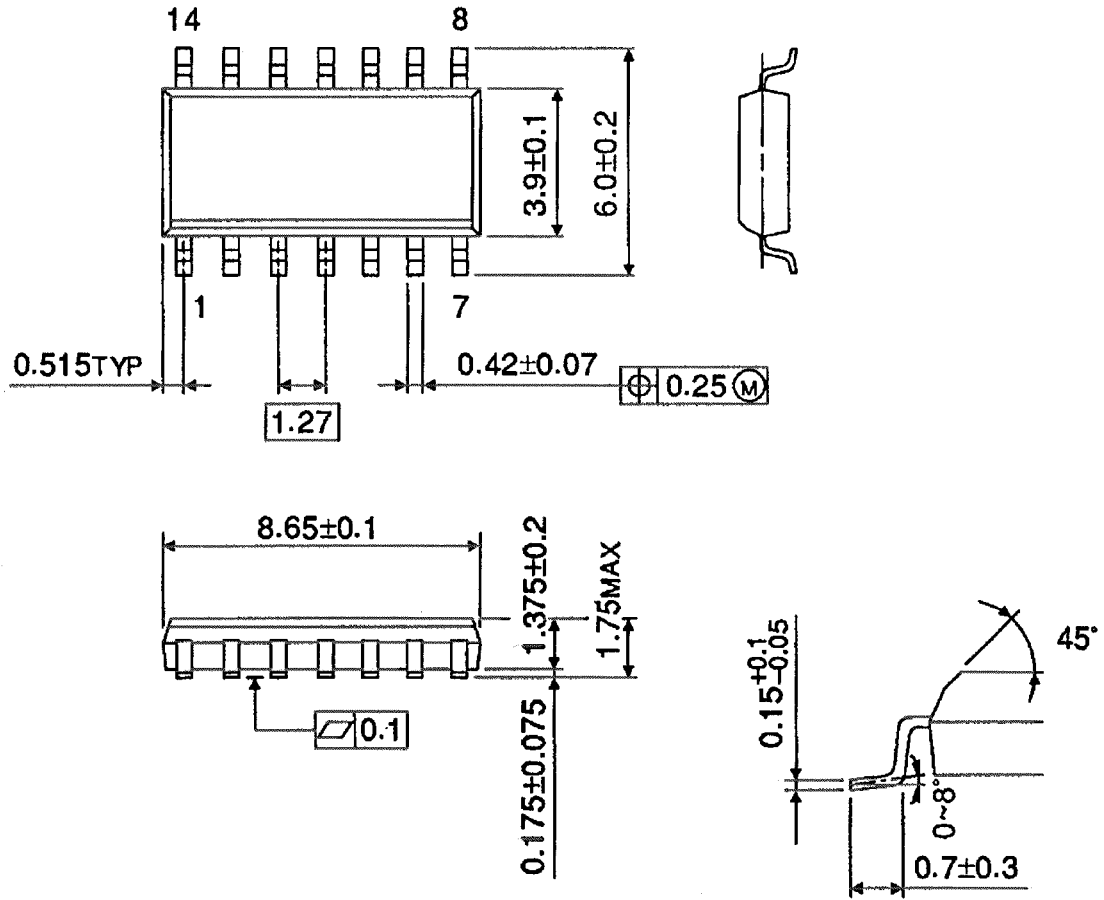
Weight: 0.18 g (typ.)



**Package Dimensions (Note)**

SOL14-P-150-1.27

Unit : mm



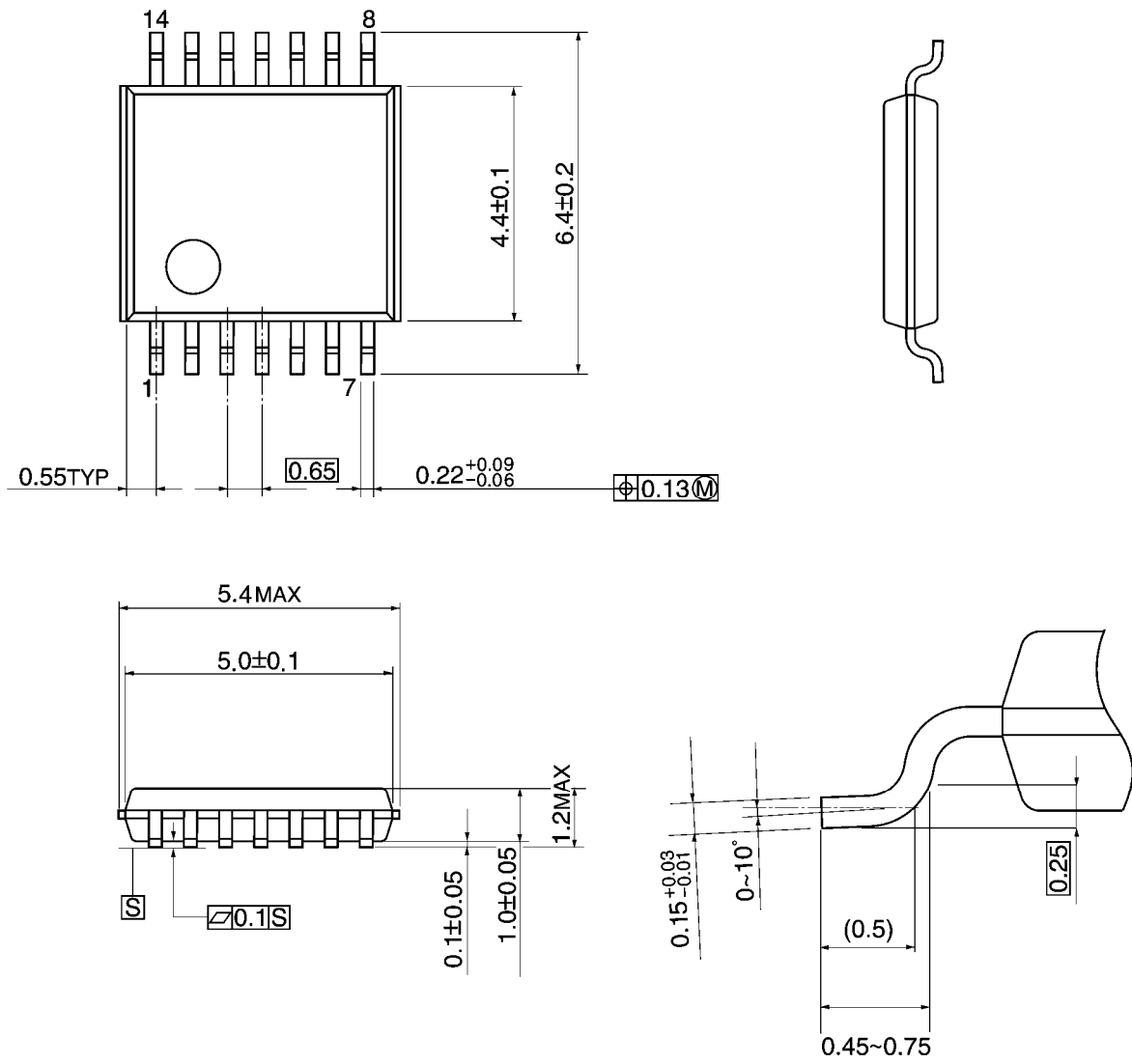
Note: This package is not available in Japan.

Weight: 0.12 g (typ.)

**Package Dimensions**

TSSOP14-P-0044-0.65A

Unit: mm

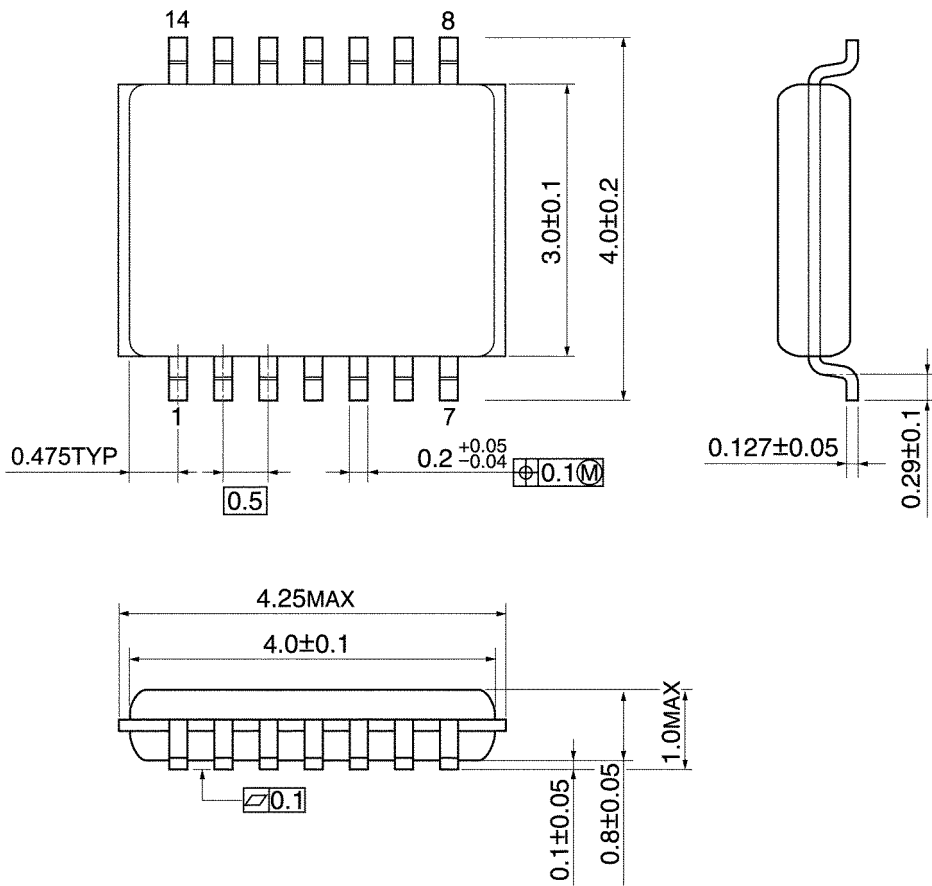


Weight: 0.06 g (typ.)

**Package Dimensions**

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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