

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74LCX74F, 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.

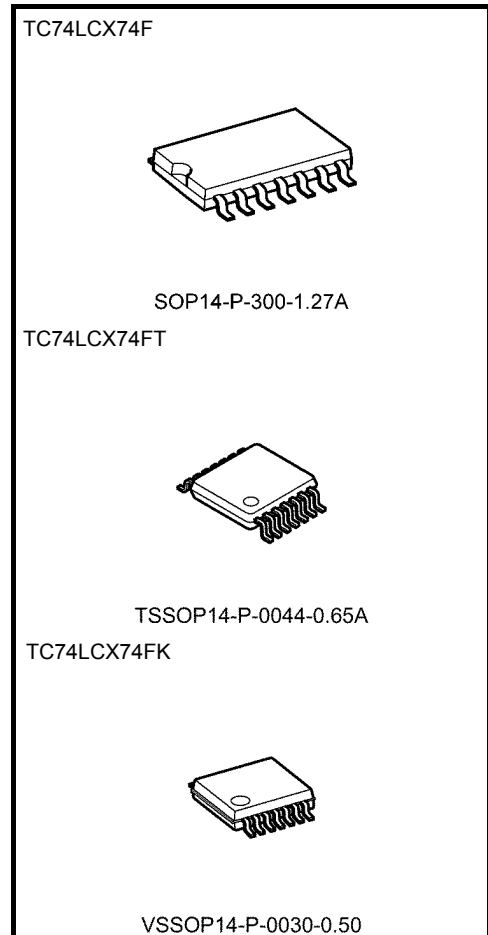
The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5-V supply environment for inputs.

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 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

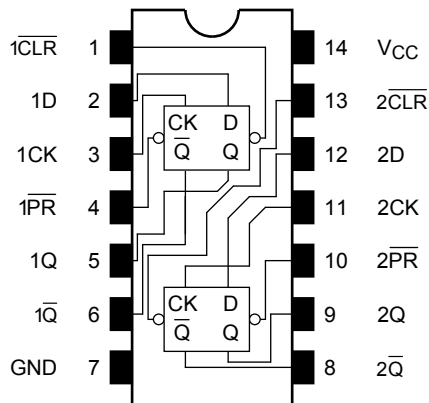


#### Weight

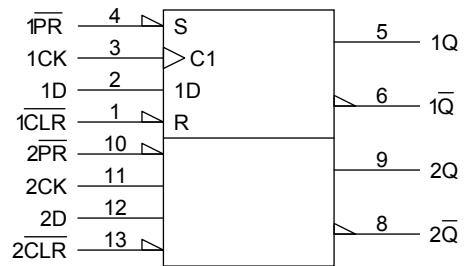
SOP14-P-300-1.27A	: 0.18 g (typ.)
TSSOP14-P-0044-0.65A	: 0.06 g (typ.)
VSSOP14-P-0030-0.50	: 0.02 g (typ.)

Note: The Electrical Characteristics of  $V_{CC}=1.8\pm 0.15V$  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	Q <sup>-</sup>	
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>	Q <sub>n</sub> <sup>-</sup>	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	°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 (CK-Q, $\bar{Q}$ )	t <sub>pLH</sub> 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 ( $\bar{CLR}$ , $\bar{PR}$ -Q, $\bar{Q}$ )	t <sub>pLH</sub> 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 (CK)	t <sub>w</sub> (H) 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 ( $\bar{CLR}$ , $\bar{PR}$ )	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>	(Note)	2.7	—	—	ns
	t <sub>osHL</sub>		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)**

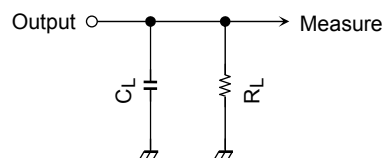
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	3.3	7	pF
Output capacitance	COU	—	0	8	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note)	3.3	25	pF

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:

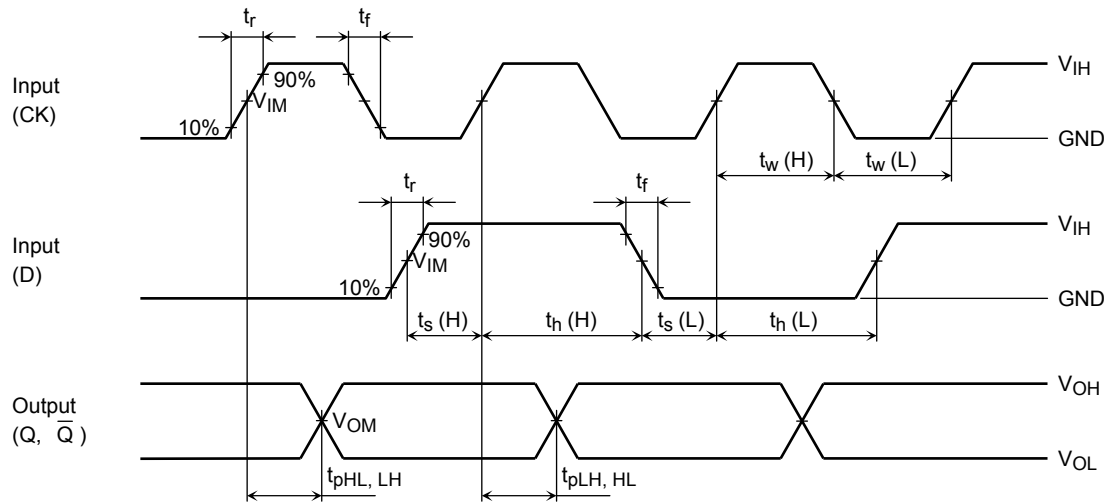
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2 \text{ (per bit)}$$

**AC Test Circuit**

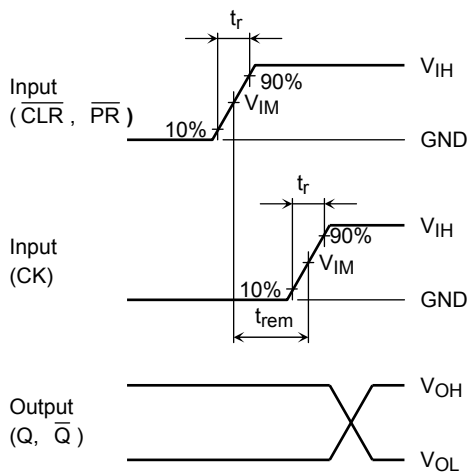


**Figure 1**

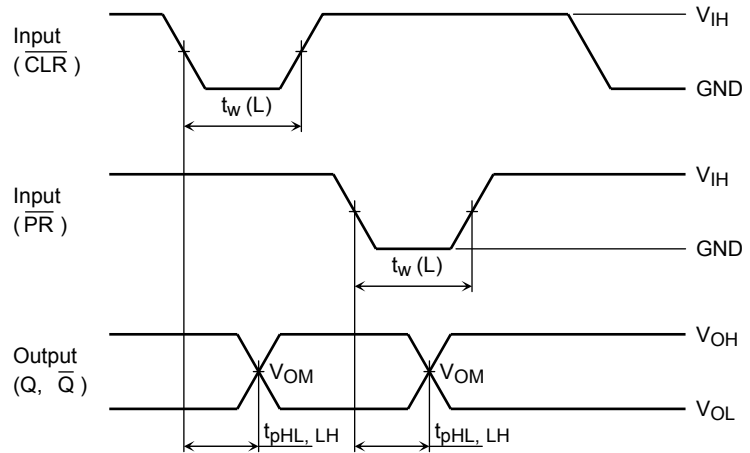
**AC Waveform**



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



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



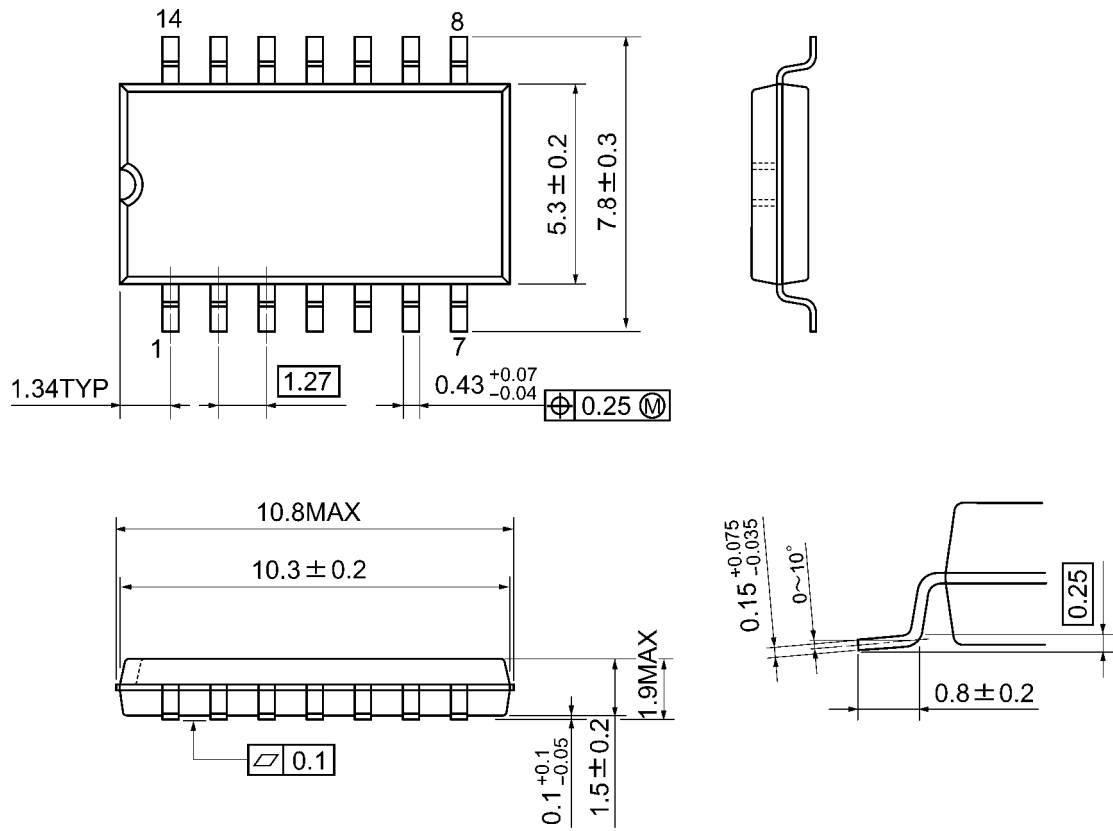
**Figure 4**  $t_{pLH}$ ,  $t_{pHL}$

	Symbol	$V_{CC}$		
		$3.3 \pm 0.3 V$ 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



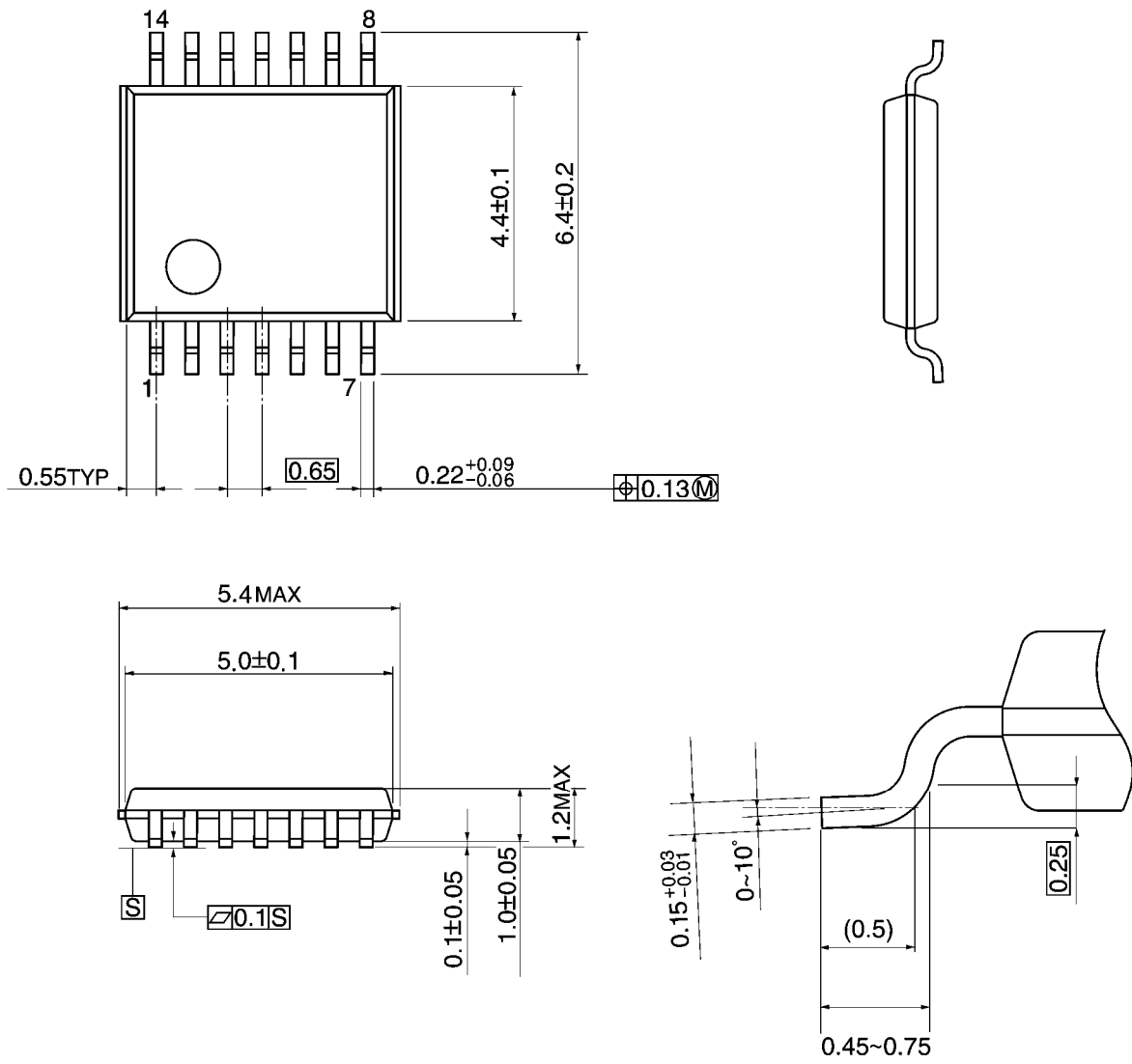
Weight: 0.18 g (typ.)



**Package Dimensions**

TSSOP14-P-0044-0.65A

Unit: mm

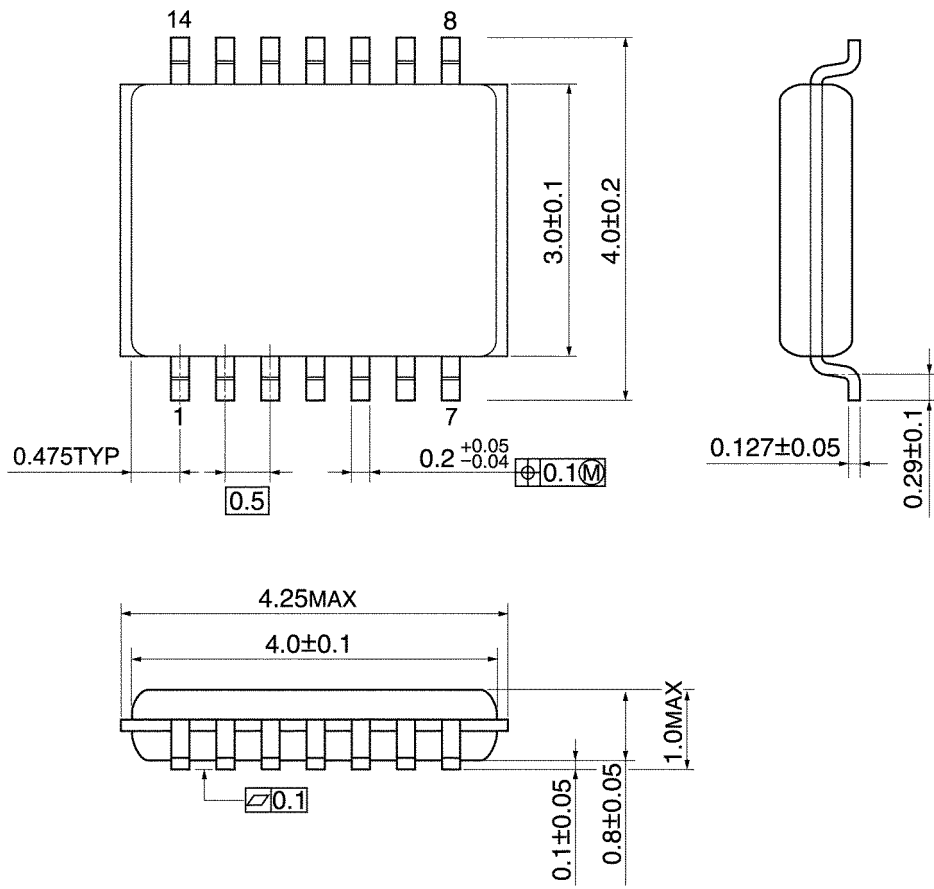


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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