

## TC74LCX374F, TC74LCX374FT, TC74LCX374FK

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

The TC74LCX374 is a high-performance CMOS octal D-type flip-flop. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

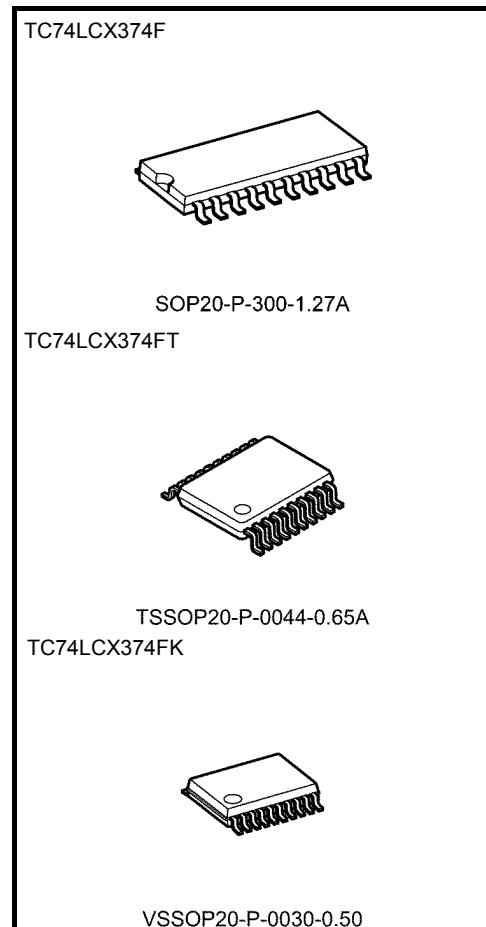
The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5-V supply environment for both inputs and outputs.

This 8 bit D-type flip-flop is controlled by a clock input (CK) and an output enable input ( $\overline{OE}$ ). When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

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:  $t_{pd} = 8.5$  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.) 374 type

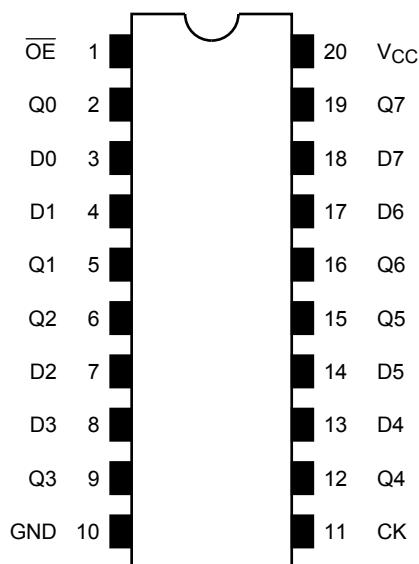


#### Weight

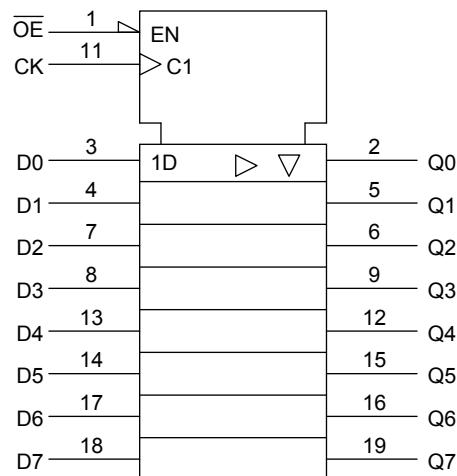
SOP20-P-300-1.27A	: 0.22 g (typ.)
TSSOP20-P-0044-0.65A	: 0.08 g (typ.)
VSSOP20-P-0030-0.50	: 0.03 g (typ.)

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

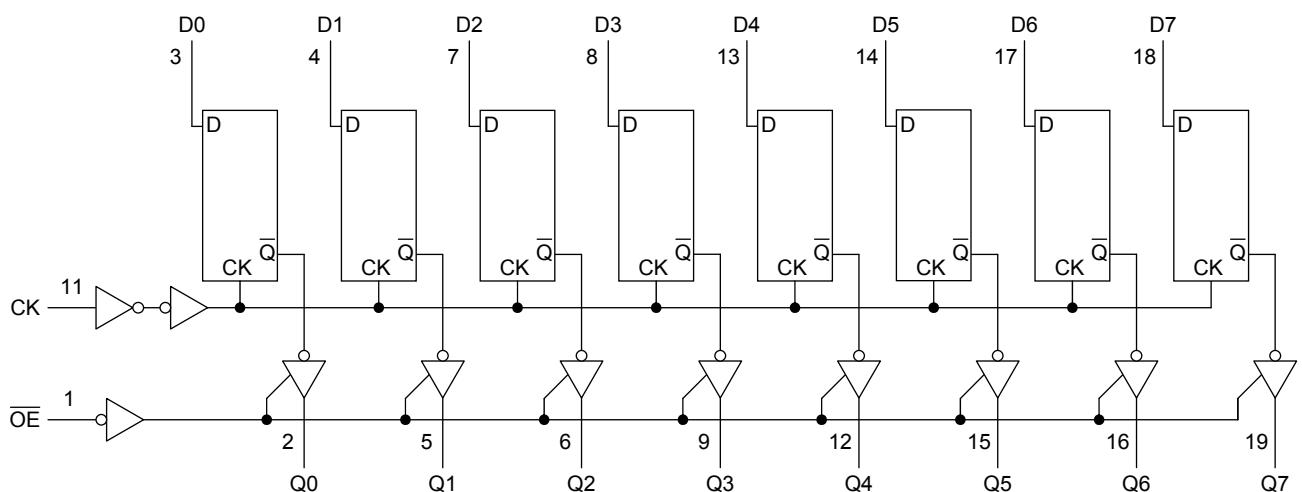
Inputs			Outputs
OE	CK	D	
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

X: Don't care

Z: High impedance

Qn: No change

## System Diagram



**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: Output in OFF state

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 <sub>CC</sub>	1.65 to 3.6	V
		1.5 to 3.6 (Note 2)	
Input voltage	V <sub>IN</sub>	0 to 5.5	V
Output voltage	V <sub>OUT</sub>	0 to 5.5 (Note 3)	V
		0 to V <sub>CC</sub> (Note 4)	
Output current	I <sub>OH</sub> /I <sub>OL</sub>	±24 (Note 5)	mA
		±12 (Note 6)	
Operating temperature	T <sub>opr</sub>	−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<sub>CC</sub> or GND.

Note 2: Data retention only

Note 3: Output in OFF state

Note 4: High or low state

Note 5: V<sub>CC</sub> = 3.0 to 3.6 V

Note 6: V<sub>CC</sub> = 2.7 to 3.0 V

Note 7: V<sub>IN</sub> = 0.8 to 2.0 V, V<sub>CC</sub> = 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	V	
				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	
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</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> /V <sub>OUT</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	
			1.8±0.15	50	—		
Maximum clock frequency	f <sub>max</sub>	Figure 1, Figure 2	2.5±0.2	100	—	MHz	
			2.7	100	—		
			3.3±0.3	150	—		
			1.8±0.15	—	30.0		
Propagation delay time (CK-Q)	t <sub>pLH</sub>	Figure 1, Figure 2	2.5±0.2	—	10.5	ns	
			2.7	—	9.5		
	t <sub>pHL</sub>		3.3±0.3	1.5	8.5		
			1.8±0.15	—	34.0		
Output enable time	t <sub>pZL</sub>	Figure 1, Figure 3	2.5±0.2	—	17.0	ns	
			2.7	—	9.5		
	t <sub>pZH</sub>		3.3±0.3	1.5	8.5		
			1.8±0.15	—	32.0		
Output disable time	t <sub>pLZ</sub>	Figure 1, Figure 3	2.5±0.2	—	16.0	ns	
			2.7	—	8.5		
	t <sub>pHZ</sub>		3.3±0.3	1.5	7.5		
			1.8±0.15	12.0	—		
Minimum pulse width (CK)	t <sub>w</sub> (H)	Figure 1, Figure 2	2.5±0.2	6.0	—	ns	
			2.7	4.0	—		
	t <sub>w</sub> (L)		3.3±0.3	3.3	—		
			1.8±0.15	10.0	—		
Minimum setup time	t <sub>s</sub>	Figure 1, Figure 2	2.5±0.2	5.0	—	ns	
			2.7	2.5	—		
			3.3±0.3	2.5	—		
			1.8±0.15	1.5	—		
Minimum hold time	t <sub>h</sub>	Figure 1, Figure 2	2.5±0.2	1.5	—	ns	
			2.7	1.5	—		
			3.3±0.3	1.5	—		
			1.8±0.15	1.5	—		
Output to output skew	t <sub>osLH</sub>		2.7	—	—	ns	
			3.3±0.3	—	1.0		

Note: Parameter guaranteed by design.

(tosLH = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, tosHL = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

Dynamic Switching Characteristics ( $T_a = 25^\circ C$ , input:  $t_r = t_f = 2.5$  ns,  $C_L = 50$  pF,  $R_L = 500 \Omega$ )

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

Capacitive Characteristics ( $T_a = 25^\circ C$ )

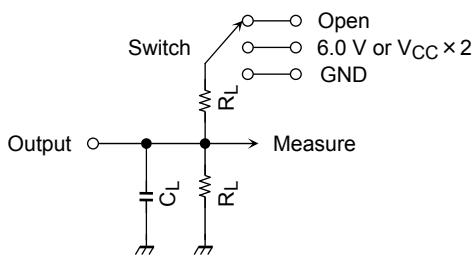
Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
Input capacitance	$C_{IN}$	—	3.3	7	pF
Output capacitance	$C_{OUT}$	—	3.3	8	pF
Power dissipation capacitance	$C_{PD}$	$f_{IN} = 10$ MHz (Note)	3.3	25	pF

Note:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption.

Average operating current can be obtained by the equation:

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

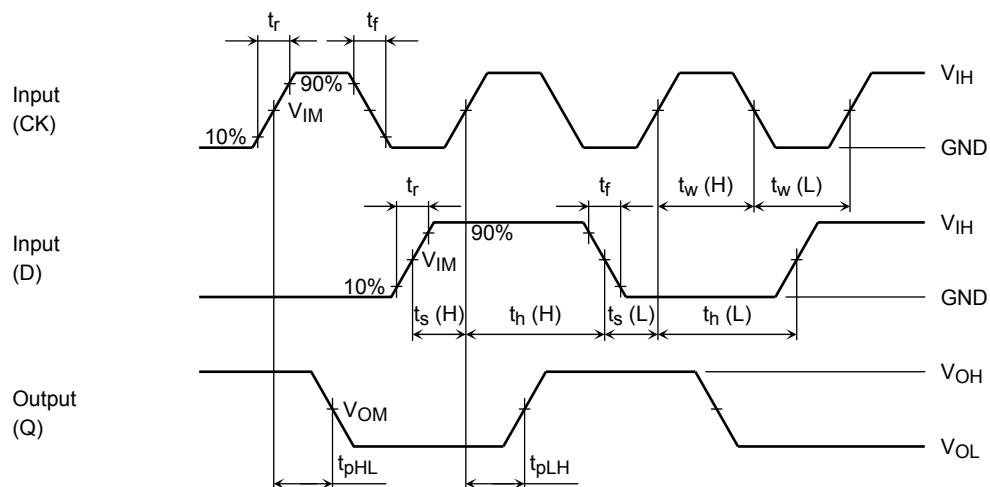
## AC Test Circuit



Parameter	Switch
$t_{pLH}, t_{pHL}$	Open
$t_{pLZ}, t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V
	@ $V_{CC} = 2.7$ V
$t_{pHZ}, t_{pZH}$	$V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2$ V
	@ $V_{CC} = 1.8 \pm 0.15$ V
$t_{pHZ}, t_{pZH}$	GND

Figure 1

## AC Waveform

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

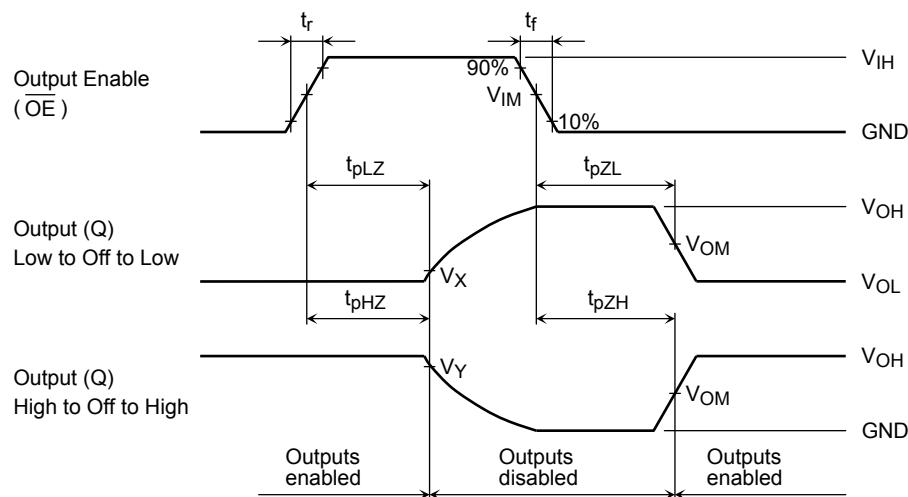


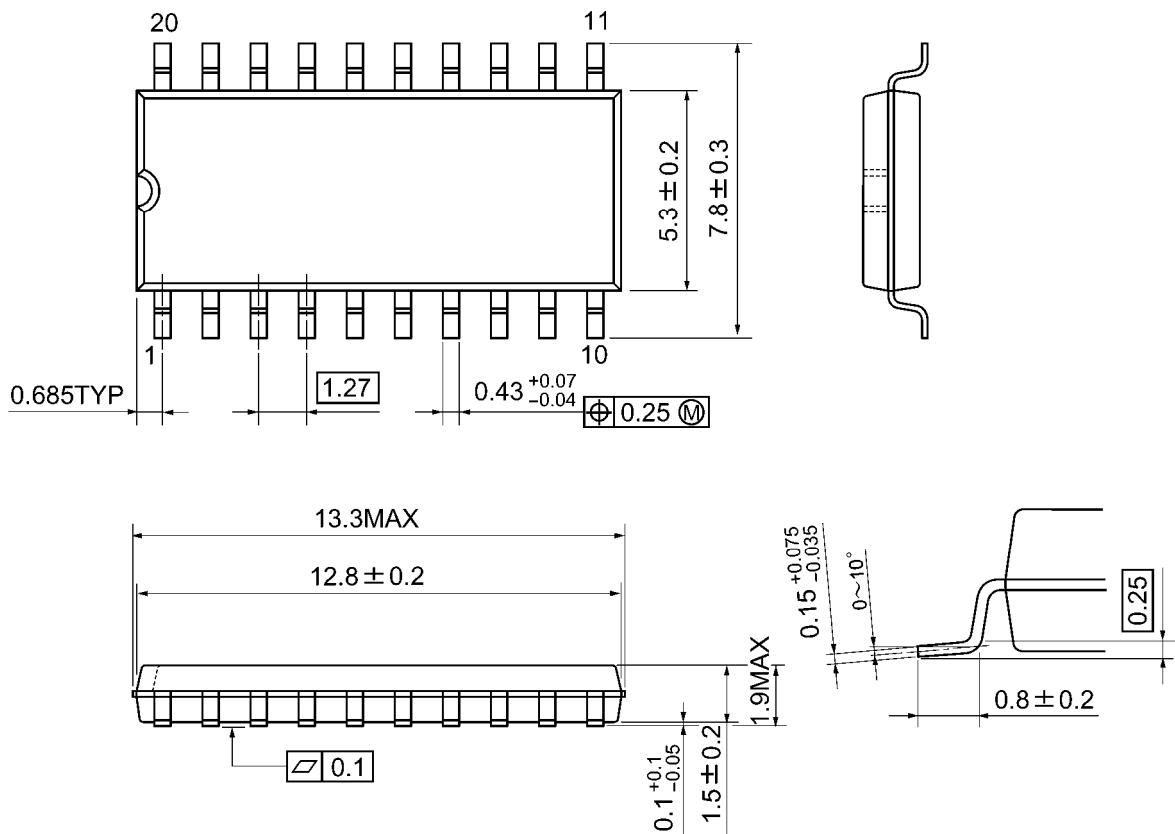
Figure 3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

	Symbol	V <sub>CC</sub>		
		3.3 ± 0.3 V 2.7V	2.5 ± 0.2 V	1.8 ± 0.15 V
Input	V <sub>IH</sub>	2.7V	V <sub>CC</sub>	V <sub>CC</sub>
	V <sub>IM</sub>	1.5V	V <sub>CC</sub> /2	V <sub>CC</sub> /2
	t <sub>r</sub> , t <sub>f</sub>	2.5ns	2.0ns	2.0ns
Output	V <sub>OM</sub>	1.5V	V <sub>OH</sub> /2	V <sub>OH</sub> /2
	V <sub>X</sub>	V <sub>OL</sub> + 0.3V	V <sub>OL</sub> + 0.15V	V <sub>OL</sub> + 0.15V
	V <sub>Y</sub>	V <sub>OH</sub> - 0.3V	V <sub>OH</sub> - 0.15V	V <sub>OH</sub> - 0.15V
Load	C <sub>L</sub>	50pF	30pF	30pF
	R <sub>L</sub>	500 Ω	500 Ω	1k Ω

**Package Dimensions**

SOP20-P-300-1.27A

Unit: mm

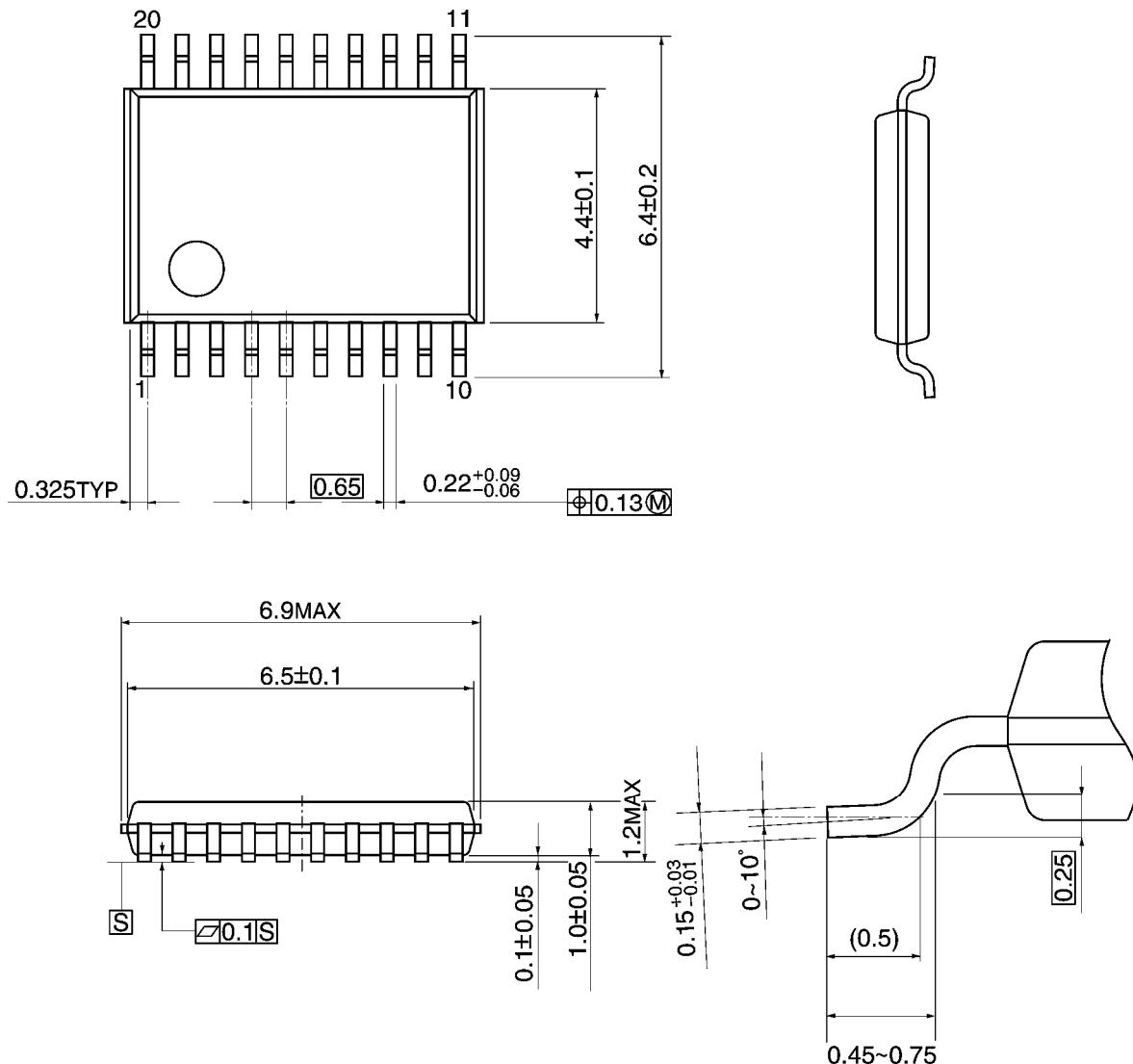


Weight: 0.22 g (typ.)

**Package Dimensions**

TSSOP20-P-0044-0.65A

Unit: mm

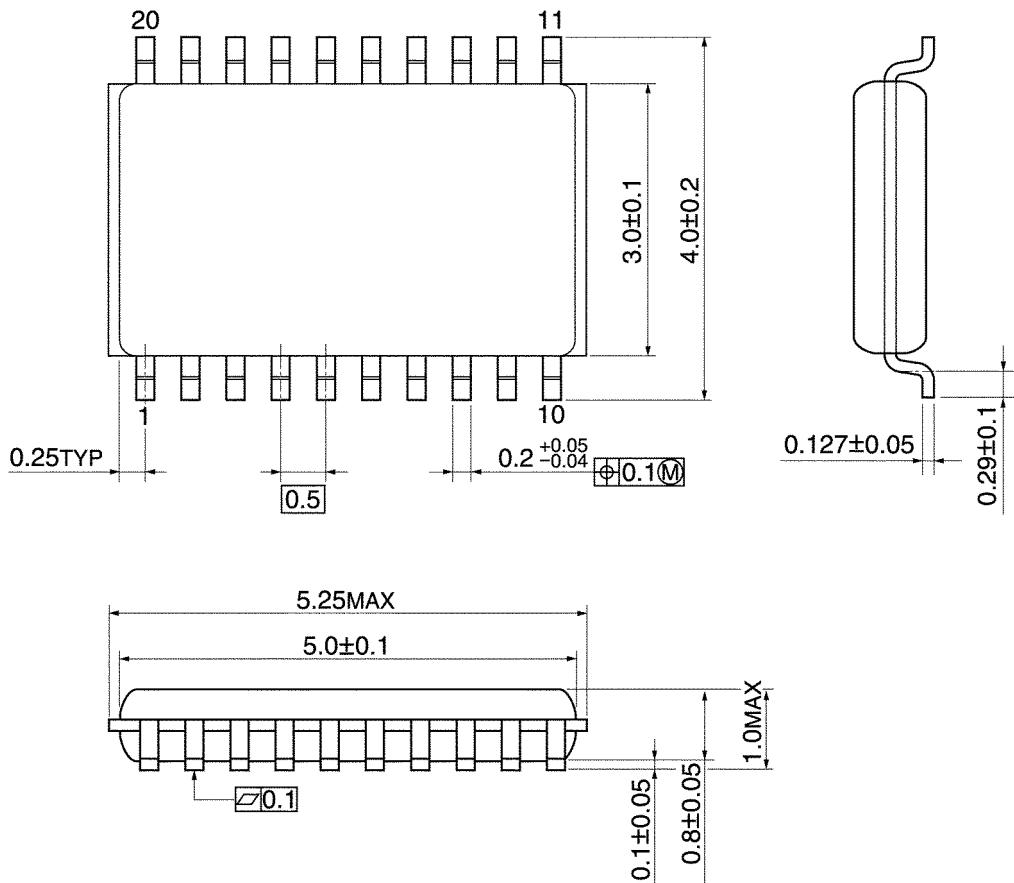


Weight: 0.08 g (typ.)

**Package Dimensions**

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)

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