TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74LCX374F,TC74LCX374FT,TC74LCX374FK

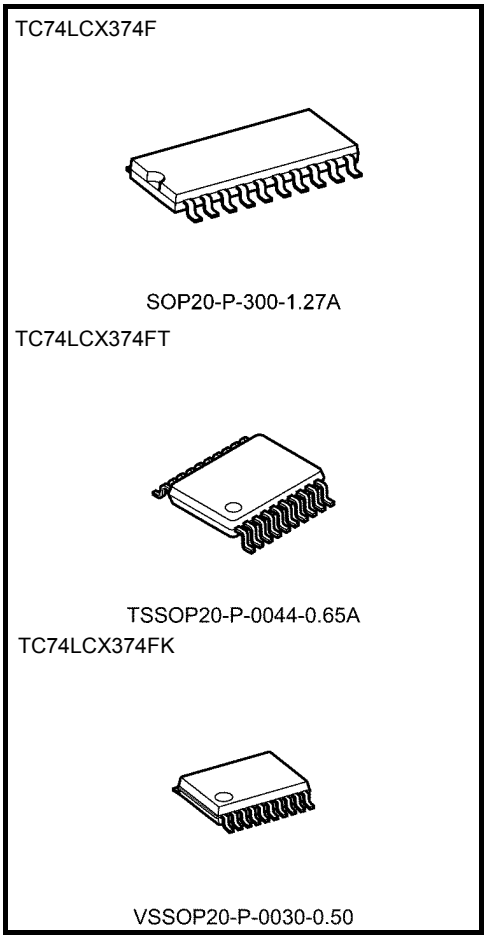
Low-Voltage Octal D-Type Flip-Flop with 5-V Tolerant Inputs and Outputs

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) V_{CC} 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.



Weight

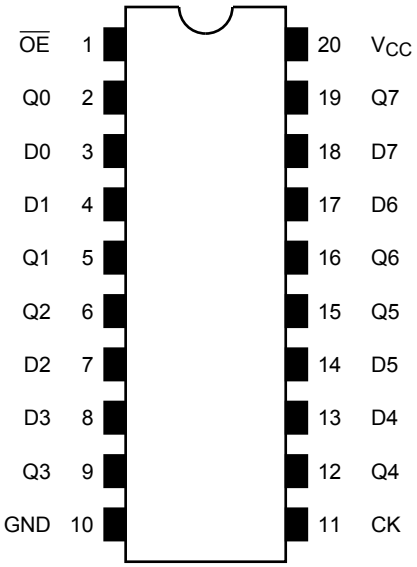
SOP20-P-300-1.27A	: 0.22 g (typ.)
TSSOP20-P-0044-0.65A	: 0.08 g (typ.)
VSSOP20-P-0030-0.50	: 0.03 g (typ.)

Features

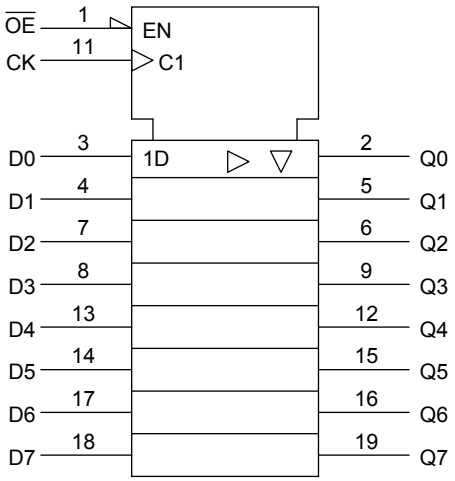
- Low-voltage operation: V_{CC} = 1.65 to 3.6 V
- High-speed operation: t_{pd} = 8.5 ns (max) (V_{CC} = 3.0 to 3.6 V)
- Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)
- Latch-up performance: >±500 mA
- Available in JEITA SOP, TSSOP and VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 374 type

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

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

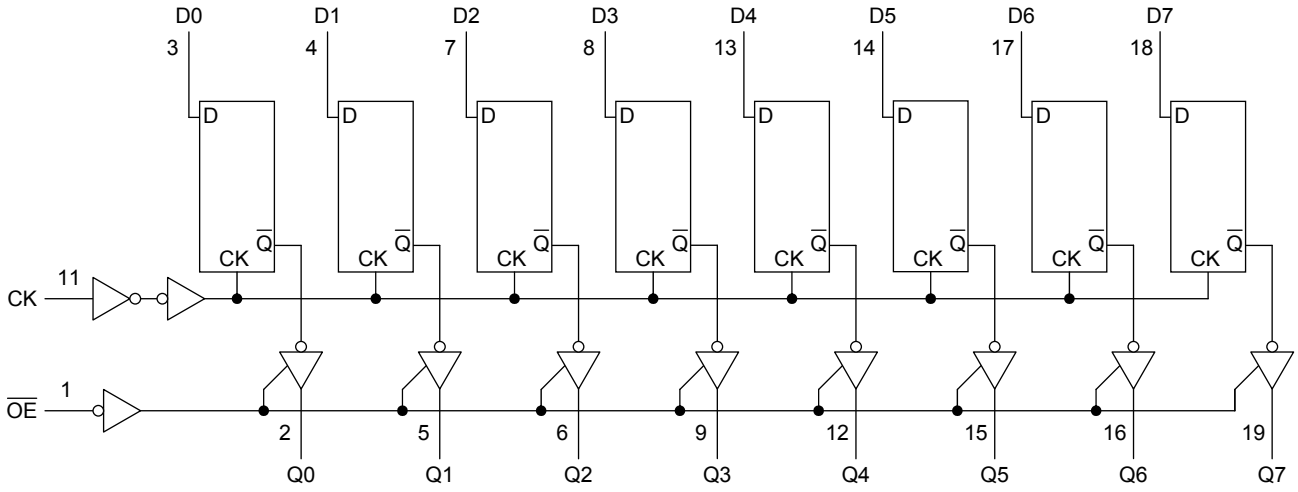
Inputs			Outputs
$\overline{OE}$	CK	D	
H	X	X	Z
L	↓	X	Qn
L	↑	L	L
L	↑	H	H

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_{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}	±50 (Note 4)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	180	mW
DC V_{CC}/ground current	I_{CC}/I_{GND}	±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: 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
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}	±24 (Note 5)	mA
		±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: Output in OFF state

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_{CC} (V)	Min	Max	Unit
Input voltage	H-level	V_{IH}	—		1.65 to 2.3	$V_{CC} \times 0.9$	—	V
					2.3 to 2.7	1.7	—	
					2.7 to 3.6	2.0	—	
	L-level	V_{IL}	—		1.65 to 2.3	—	$V_{CC} \times 0.1$	
					2.3 to 2.7	—	0.7	
					2.7 to 3.6	—	0.8	
Output voltage	H-level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100$ μA	1.65 to 3.6	$V_{CC} - 0.2$	—	V
				$I_{OH} = -4$ mA	1.65	1.05	—	
				$I_{OH} = -8$ mA	2.3	1.7	—	
				$I_{OH} = -12$ mA	2.7	2.2	—	
				$I_{OH} = -18$ mA	3.0	2.4	—	
				$I_{OH} = -24$ mA	3.0	2.2	—	
	L-level	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100$ μA	1.65 to 3.6	—	0.2	
				$I_{OL} = 4$ mA	1.65	—	0.45	
				$I_{OL} = 8$ mA	2.3	—	0.7	
				$I_{OL} = 12$ mA	2.7	—	0.4	
				$I_{OL} = 16$ mA	3.0	—	0.4	
				$I_{OL} = 24$ mA	3.0	—	0.55	
Input leakage current		I_{IN}	$V_{IN} = 0$ to 5.5 V		1.65 to 3.6	—	±5.0	μA
3-state output OFF state current		I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 5.5 V		1.65 to 3.6	—	±5.0	μA
Power-off leakage current		I_{OFF}	$V_{IN}/V_{OUT} = 5.5$ V		0	—	10.0	μA
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC}$ or GND		1.65 to 3.6	—	10.0	μA
			$V_{IN}/V_{OUT} = 3.6$ to 5.5 V		1.65 to 3.6	—	±10.0	
Increase in I_{CC} per input		ΔI_{CC}	$V_{IH} = V_{CC} - 0.6$ V		2.7 to 3.6	—	500	

AC Characteristics (Ta = –40 to 85°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Maximum clock frequency	f_{max}	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)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8±0.15	—	30.0	ns
			2.5±0.2	—	10.5	
			2.7	—	9.5	
			3.3 ± 0.3	1.5	8.5	
Output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	1.8±0.15	—	34.0	ns
			2.5±0.2	—	17.0	
			2.7	—	9.5	
			3.3 ± 0.3	1.5	8.5	
Output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	1.8±0.15	—	32.0	ns
			2.5±0.2	—	16.0	
			2.7	—	8.5	
			3.3 ± 0.3	1.5	7.5	
Minimum pulse width (CK)	t_w (H) t_w (L)	Figure 1, Figure 2	1.8±0.15	12.0	—	ns
			2.5±0.2	6.0	—	
			2.7	4.0	—	
			3.3 ± 0.3	3.3	—	
Minimum setup time	t_s	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_h	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	—	
Output to output skew	t_{osLH} t_{osHL}	(Note)	2.7	—	—	ns
			3.3 ± 0.3	—	1.0	

Note: Parameter guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

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

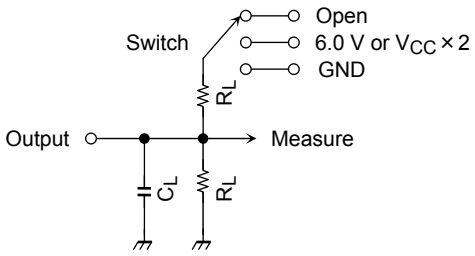
Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.8	V
Quiet output minimum dynamic V_{OL}	$\|V_{OLV}\|$	V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.8	V

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (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:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8$ (per bit)

AC Test Circuit



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

Figure 1

AC Waveform

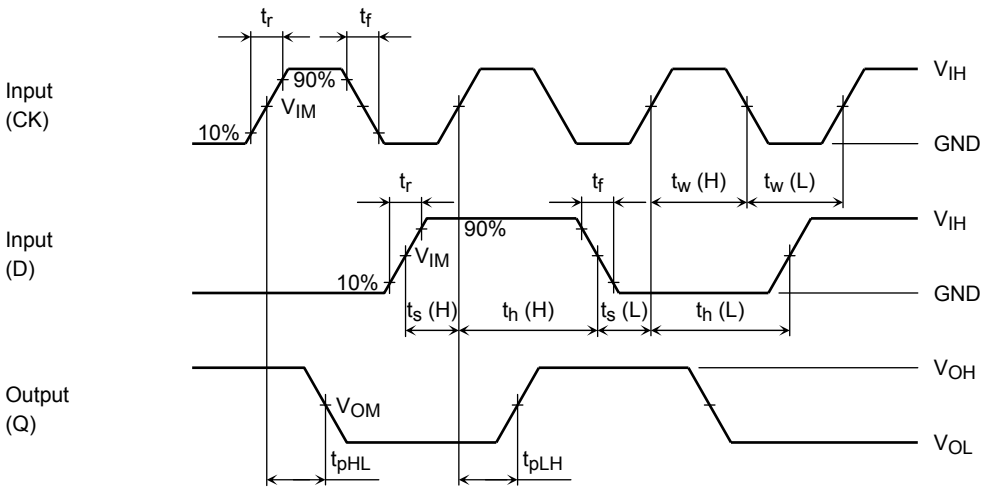


Figure 2 t_{pLH}, t_{pHL}, t_w, t_s, t_h

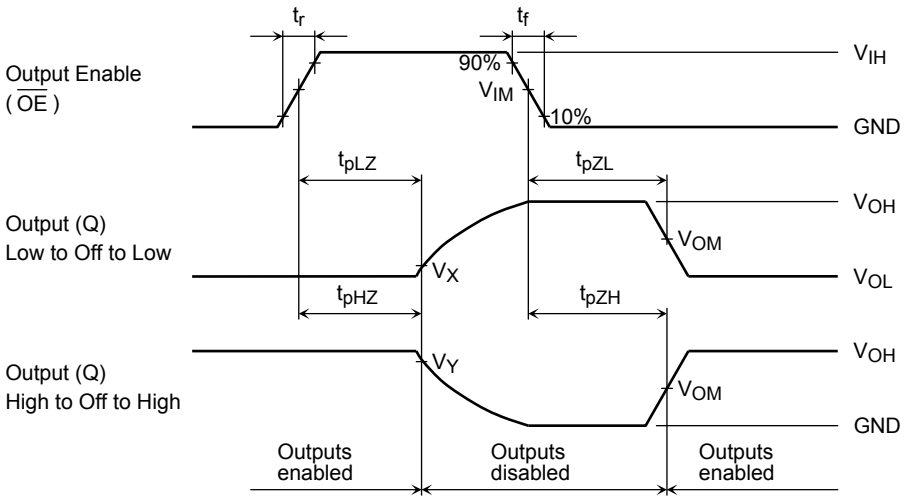
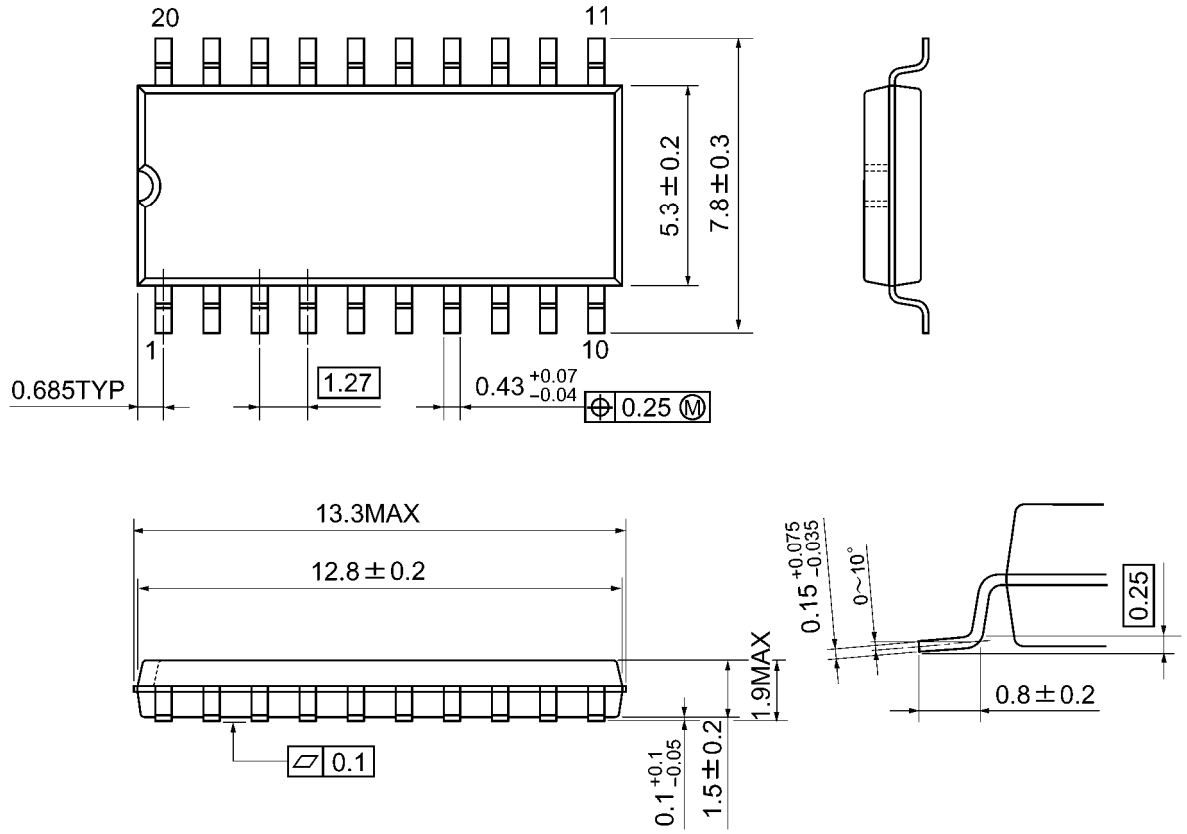


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

	Symbol	V_{CC}		
		3.3 ± 0.3 V 2.7V	2.5 ± 0.2 V	1.8 ± 0.15 V
Input	V_{IH}	2.7V	V_{CC}	V_{CC}
	V_{IM}	1.5V	$V_{CC}/2$	$V_{CC}/2$
	tr,tf	2.5ns	2.0ns	2.0ns
Output	V_{OM}	1.5V	$V_{OH}/2$	$V_{OH}/2$
	V_X	V_{OL} +0.3V	V_{OL} +0.15V	V_{OL} +0.15V
	V_Y	V_{OH} -0.3V	V_{OH} -0.15V	V_{OH} -0.15V
Load	C_L	50pF	30pF	30pF
	R_L	500 Ω	500 Ω	1k Ω

Package Dimensions

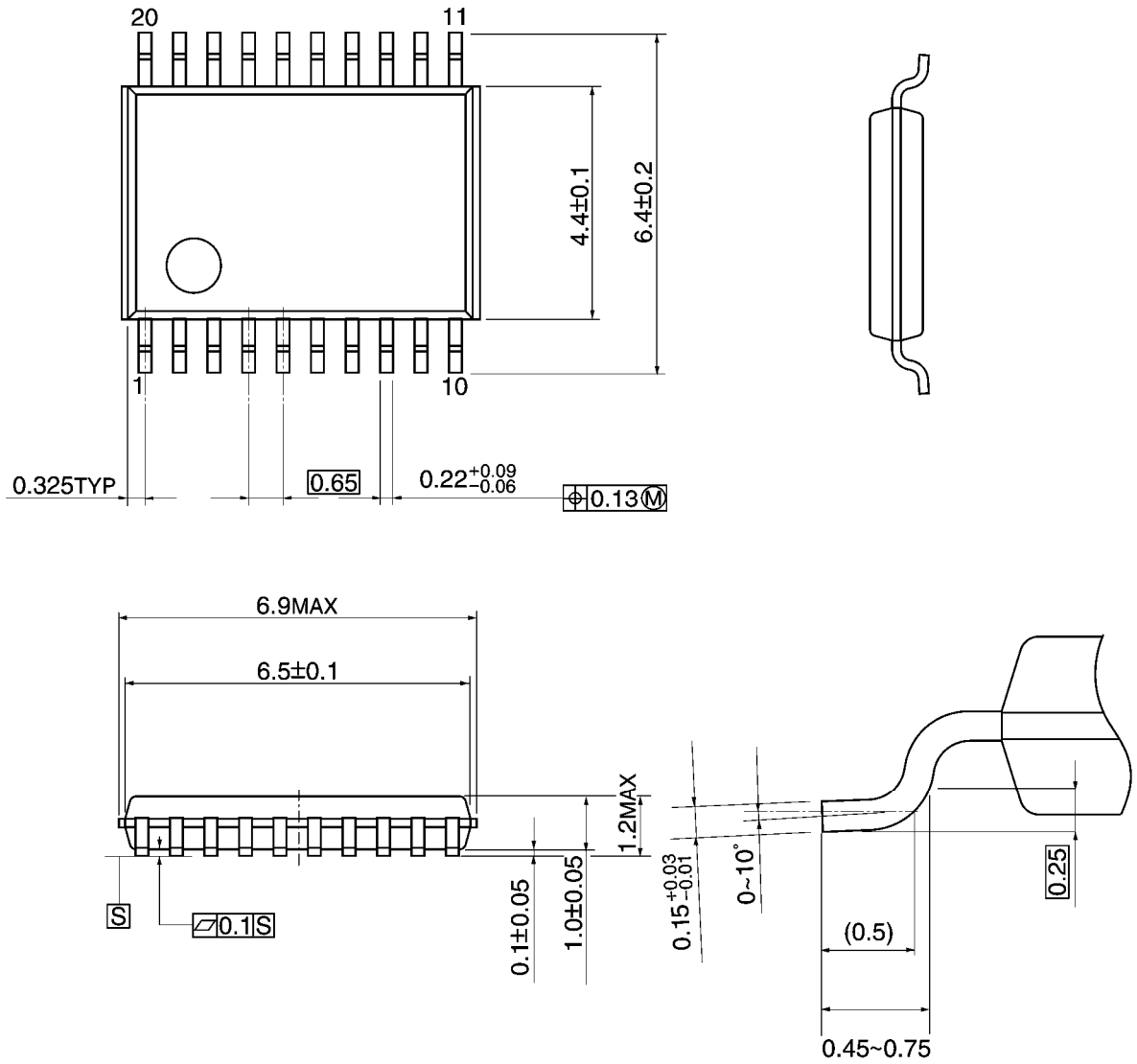
SOP20-P-300-1.27A Unit: mm



Weight: 0.22 g (typ.)

Package Dimensions

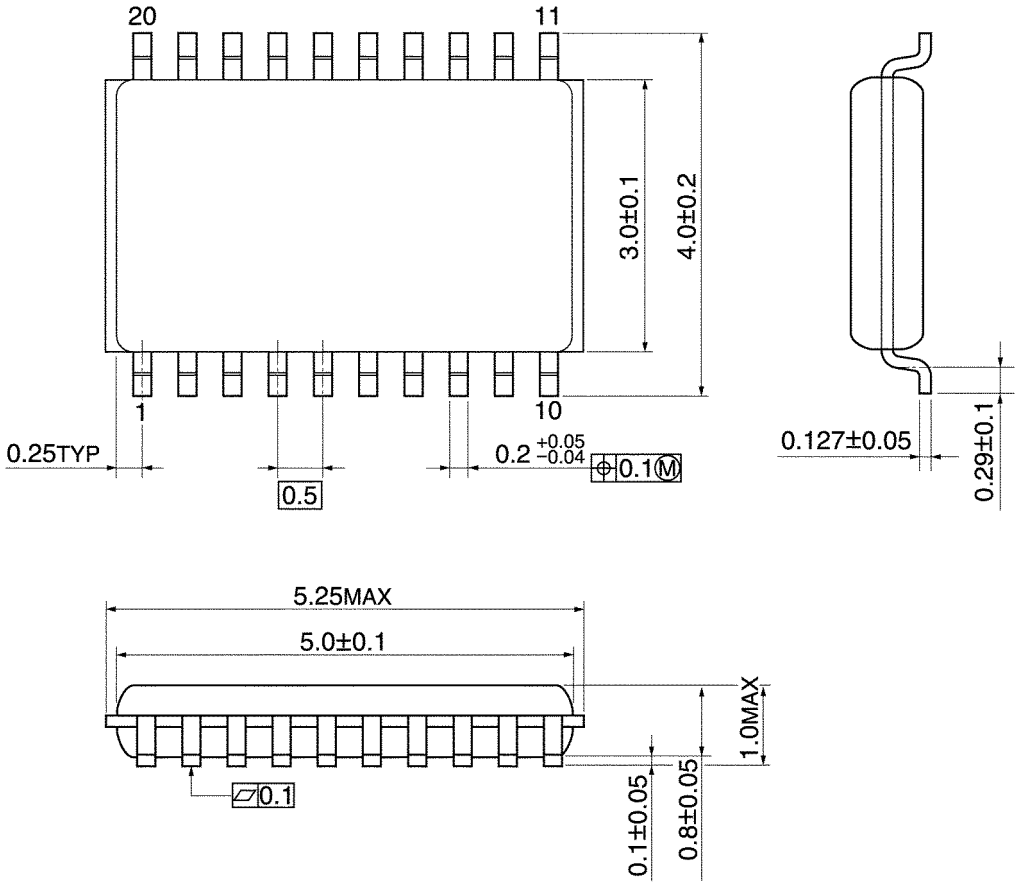
TSSOP20-P-0044-0.65A Unit: mm



Weight: 0.08 g (typ.)

Package Dimensions

VSSOP20-P-0030-0.50 Unit: mm



Weight: 0.03 g (typ.)

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