

TC74VCX2373FT, TC74VCX2373FK

Low-Voltage Octal D-Type Latch with 3.6-V Tolerant Inputs and Outputs

The TC74VCX2373 is a high-performance CMOS octal D-type latch. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

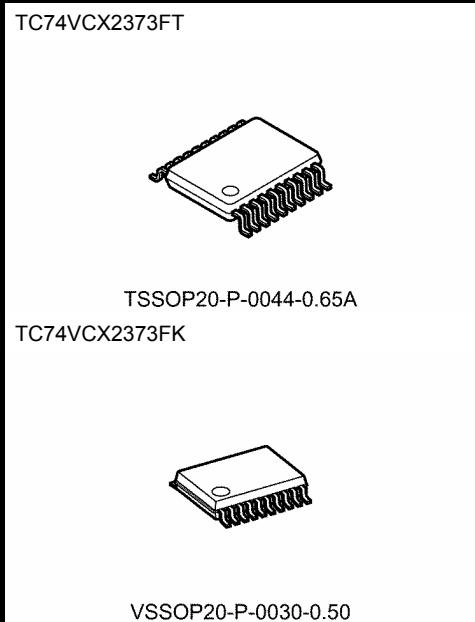
It is also designed with overvoltage tolerant inputs and outputs up to 3.6 V.

This 8 bit D-type latch is controlled by a latch enable input (LE) and a output enable input (\overline{OE}). When the \overline{OE} input is high, the eight outputs are in a high-impedance state. The 26- Ω series resistor helps reducing output overshoot and undershoot without external resistor.

All inputs are equipped with protection circuits against static discharge.

Features

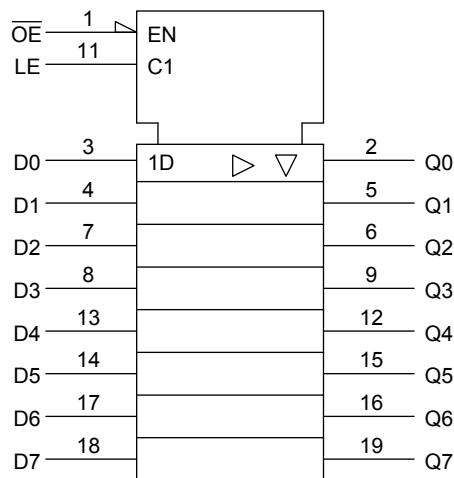
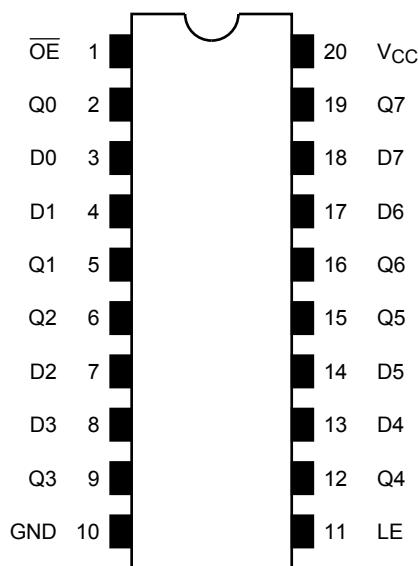
- 26- Ω series resistors on outputs.
- Low-voltage operation: $V_{CC} = 1.8$ to 3.6 V
- High-speed operation: $t_{pd} = 5.1$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 6.1$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
: $t_{pd} = 9.8$ ns (max) ($V_{CC} = 1.8$ V)
- Output current: $I_{OH}/I_{OL} = \pm 12$ mA (min) ($V_{CC} = 3.0$ V)
: $I_{OH}/I_{OL} = \pm 8$ mA (min) ($V_{CC} = 2.3$ V)
: $I_{OH}/I_{OL} = \pm 4$ mA (min) ($V_{CC} = 1.8$ V)
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200$ V
Human body model $\geq \pm 2000$ V
- Package: TSSOP and VSSOP (US)
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs



Weight
TSSOP20-P-0044-0.65A : 0.08 g (typ.)
VSSOP20-P-0030-0.50 : 0.03 g (typ.)

Pin Assignment (top view)

IEC Logic Symbol



Truth Table

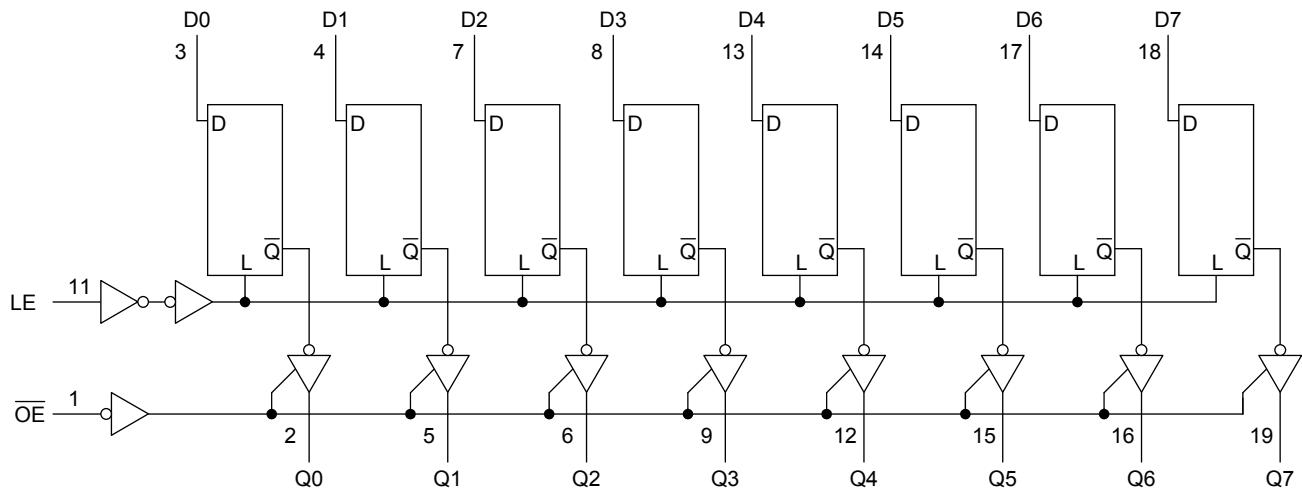
Inputs			Outputs
\overline{OE}	LE	D	
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

X: Don't care

Z: High impedance

Qn: Q outputs are latched at the time when the LE input is taken to a low logic level.

System Diagram



Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V _{CC}	−0.5 to 4.6	V
DC input voltage	V _{IN}	−0.5 to 4.6	V
DC output voltage	V _{OUT}	−0.5 to 4.6 (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 per supply pin	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: 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}	1.8 to 3.6	V
		1.2 to 3.6 (Note 2)	
Input voltage	V _{IN}	−0.3 to 3.6	V
Output voltage	V _{OUT}	0 to 3.6 (Note 3)	V
		0 to V _{CC} (Note 4)	
Output current	I _{OH} /I _{OL}	±12 (Note 5)	mA
		±8 (Note 6)	
		±4 (Note 7)	
Operating temperature	T _{opr}	−40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 8)	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: OFF state

Note 4: High or low state

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

Note 6: V_{CC} = 2.3 to 2.7 V

Note 7: V_{CC} = 1.8 V

Note 8: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = -40 to 85°C, 2.7 V < V_{CC} ≤ 3.6 V)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit	
Input voltage	H-level		—						
	L-level	V _{IL}	—		2.7 to 3.6	—	0.8	V	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.7 to 3.6	V _{CC} - 0.2	—		
				I _{OH} = -6 mA	2.7	2.2	—		
				I _{OH} = -8 mA	3.0	2.4	—		
				I _{OH} = -12 mA	3.0	2.2	—		
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.7 to 3.6	—	0.2		
				I _{OL} = 6 mA	2.7	—	0.4		
				I _{OL} = 8 mA	3.0	—	0.55		
				I _{OL} = 12 mA	3.0	—	0.8		
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		2.7 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 3.6 V		2.7 to 3.6	—	±10.0	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.7 to 3.6	—	20.0	μA	
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V		2.7 to 3.6	—	750		

DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ V_{CC} ≤ 2.7 V)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit	
Input voltage	H-level		—						
	L-level	V _{IL}	—		2.3 to 2.7	—	0.7	V	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3 to 2.7	V _{CC} - 0.2	—		
				I _{OH} = -4 mA	2.3	2.0	—		
				I _{OH} = -6 mA	2.3	1.8	—		
				I _{OH} = -8 mA	2.3	1.7	—		
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3 to 2.7	—	0.2		
				I _{OL} = 6 mA	2.3	—	0.4		
				I _{OL} = 8 mA	2.3	—	0.6		
				I _{OL} = 12 mA	2.3 to 2.7	—	0.8		
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		2.3 to 2.7	—	±10.0	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.3 to 2.7	—	20.0	μA	

DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ V_{CC} < 2.3 V)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit	
Input voltage	H-level	V _{IH}	—		1.8 to 2.3	0.7 × V _{CC}	—	V	
	L-level	V _{IL}	—		1.8 to 2.3	—	0.2 × V _{CC}		
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.8	V _{CC} - 0.2	—	V	
				I _{OH} = -4 mA	1.8	1.4	—		
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.8	—	0.2		
				I _{OL} = 4 mA	1.8	—	0.3		
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.8	—	±5.0	μA	
3-state output OFF state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		1.8	—	±10.0	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.8	—	20.0	μA	
					1.8	—	±20.0		

AC Characteristics (Ta = -40 to 85°C, input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500$ Ω) (Note 1)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
			1.8			
Propagation delay time (D-Q)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	6.1	
			3.3 ± 0.3	0.6	5.1	
Propagation delay time (LE-Q)	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	6.3	
			3.3 ± 0.3	0.6	5.1	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	1.8	1.5	9.8	ns
			2.5 ± 0.2	0.8	6.5	
			3.3 ± 0.3	0.6	5.0	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	1.8	1.5	7.7	ns
			2.5 ± 0.2	0.8	4.3	
			3.3 ± 0.3	0.6	3.9	
Minimum pulse width (LE)	t_w (H)	Figure 1, Figure 2	1.8	4.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum set-up time	t_s	Figure 1, Figure 2	1.8	2.5	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum hold time	t_h	Figure 1, Figure 2	1.8	1.0	—	ns
			2.5 ± 0.2	1.0	—	
			3.3 ± 0.3	1.0	—	
Output to output skew	t_{osLH} t_{osHL}	(Note 2)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

Note 1: For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.

Note 2: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

Dynamic Switching Characteristics ($T_a = 25^\circ\text{C}$, input: $t_r = t_f = 2.0 \text{ ns}$, $C_L = 30 \text{ pF}$)

Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V _{OL}	V _{OLP}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note)	1.8	0.15	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note)	2.5	0.25	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note)	3.3	0.35	
Quiet output minimum dynamic V _{OL}	V _{OLV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note)	1.8	-0.15	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note)	2.5	-0.25	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note)	3.3	-0.35	
Quiet output minimum dynamic V _{OH}	V _{OHV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note)	1.8	1.55	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note)	2.5	2.05	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note)	3.3	2.65	

Note: Parameter guaranteed by design.

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

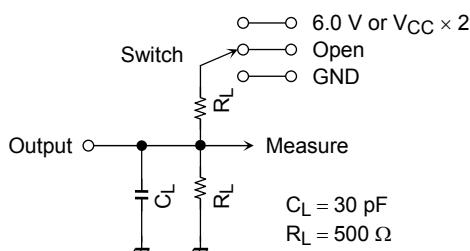
Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
Input capacitance	C _{IN}	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C _O	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note)	1.8, 2.5, 3.3	20	pF

Note: C_{PD} 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:

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

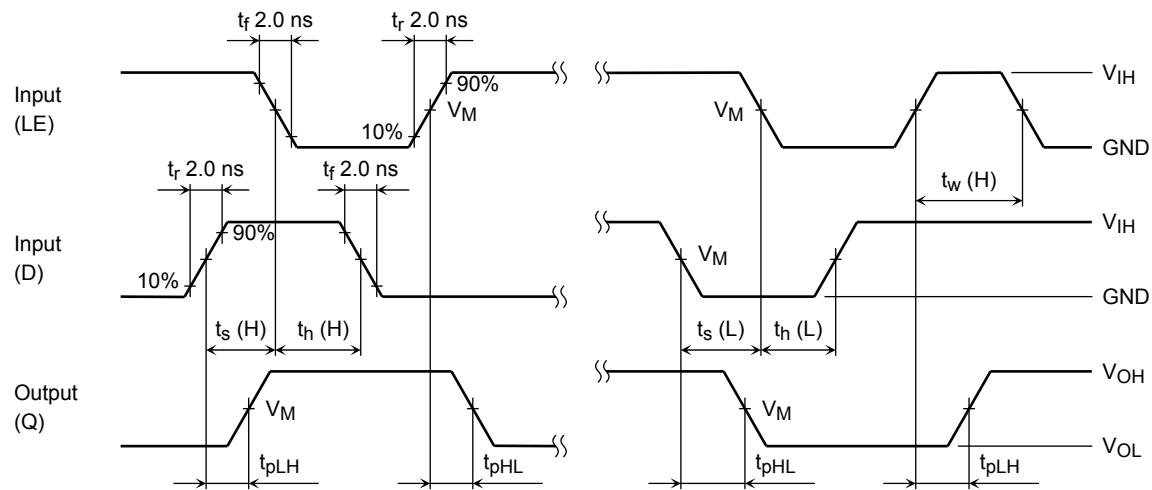
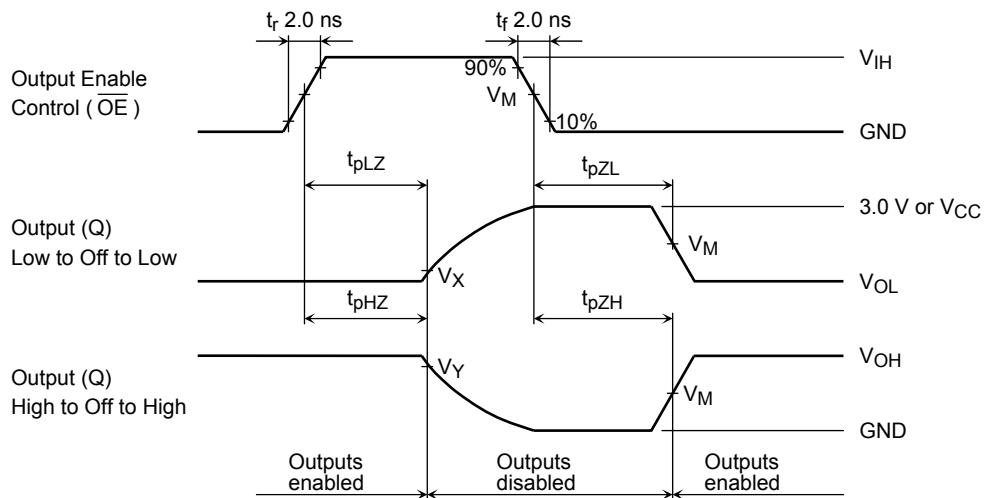
AC Test Circuit



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

Figure 1

AC Waveform

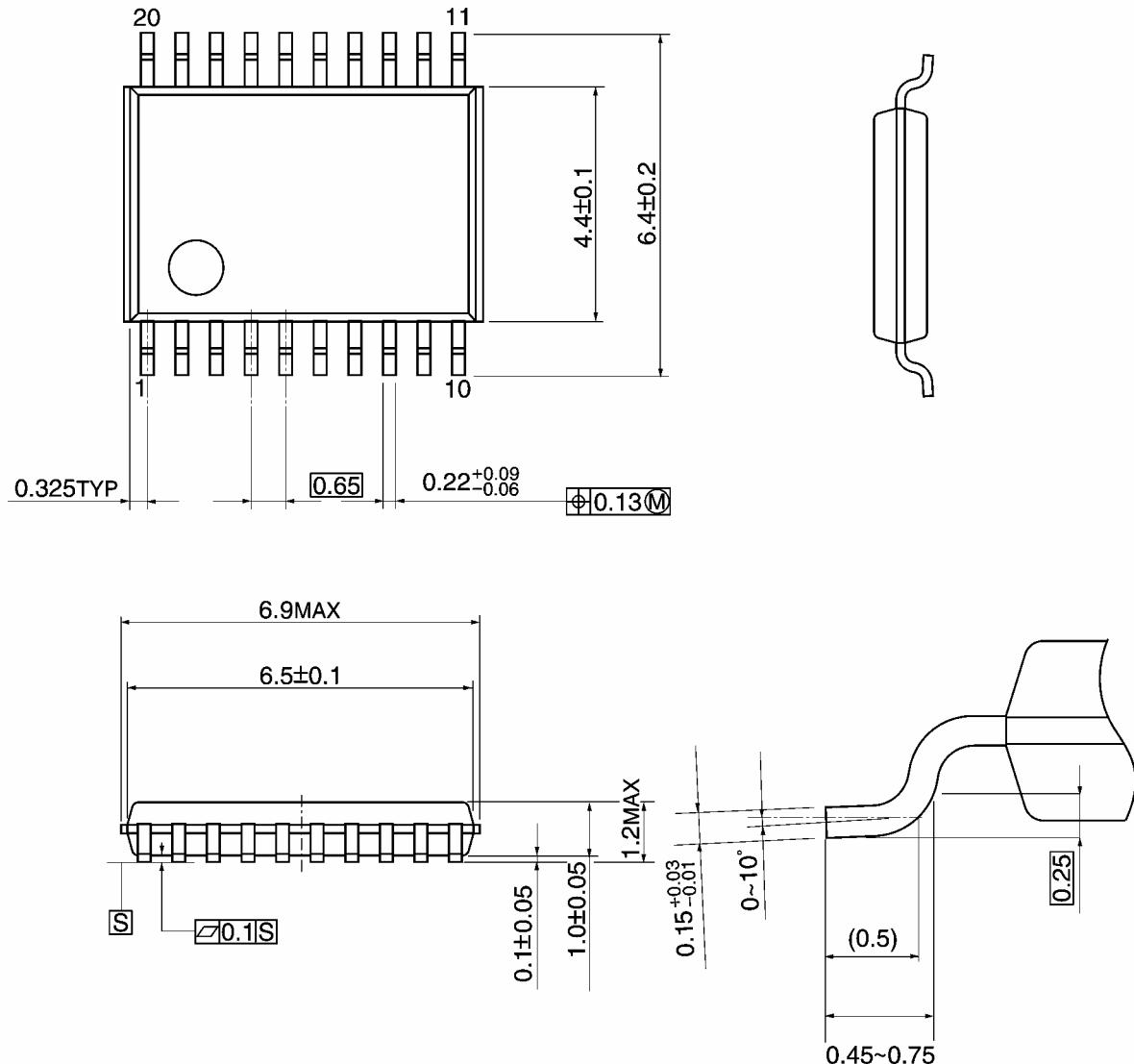
Figure 2 t_{pLH} , t_{pHL} , t_w , t_s , t_h Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

Symbol	V_{CC}		
	$3.3 \pm 0.3\text{ V}$	$2.5 \pm 0.2\text{ V}$	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3\text{ V}$	$V_{OL} + 0.15\text{ V}$	$V_{OL} + 0.15\text{ V}$
V_Y	$V_{OH} - 0.3\text{ V}$	$V_{OH} - 0.15\text{ V}$	$V_{OH} - 0.15\text{ V}$

Package Dimensions

TSSOP20-P-0044-0.65A

Unit: mm

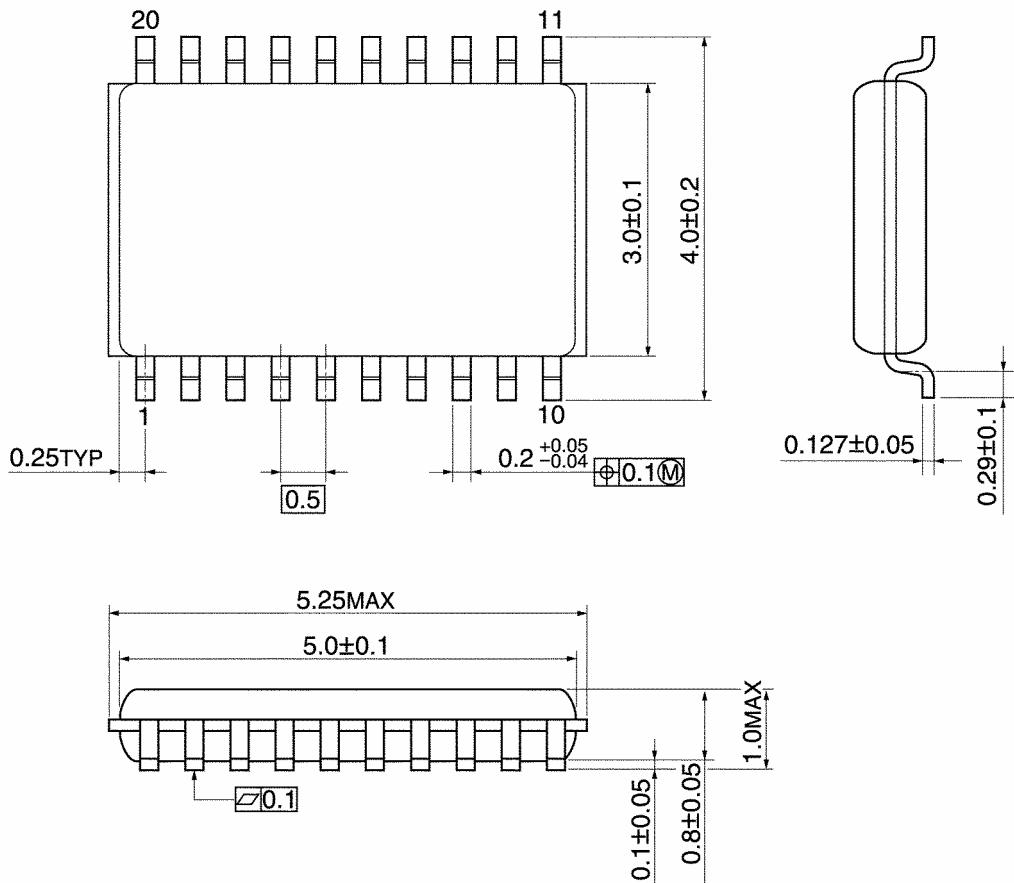


Weight: 0.08 g (typ.)

Package Dimensions

VSSOP20-P-0030-0.50

Unit: mm



Weight: 0.03 g (typ.)

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20070701-EN GENERAL

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