

TC74VCX125FT, TC74VCX125FK

Low-Voltage Quad Bus Buffer with 3.6-V Tolerant Inputs and Outputs

The TC74VCX125FT/FK is a high-performance CMOS quad bus buffer which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5V, 1.8V, 2.5V or 3.3V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

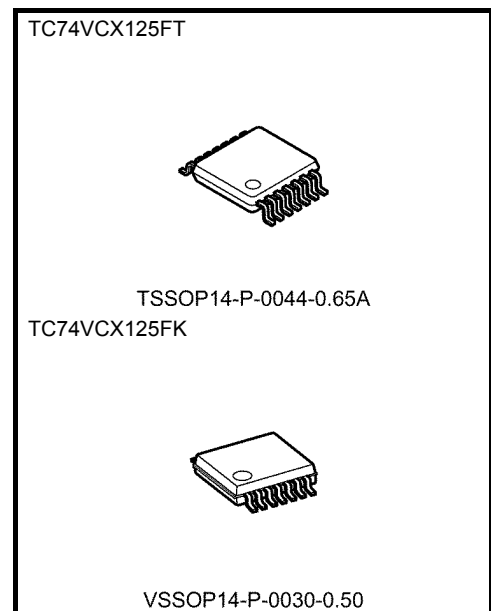
It is also designed with overvoltage tolerant inputs and outputs up to 3.6 V.

This device requires the 3-state control input $\overline{OE}$ to be set high to place the output into the high impedance state.

All inputs are equipped with protection circuits against static discharge.

Features

- Low-voltage operation: $V_{CC} = 1.2$ to 3.6 V
- High-speed operation: $t_{pd} = 2.8$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 3.4$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
: $t_{pd} = 6.8$ ns (max) ($V_{CC} = 1.65$ to 1.95 V)
: $t_{pd} = 13.6$ ns (max) ($V_{CC} = 1.4$ to 1.6 V)
: $t_{pd} = 34.0$ ns (max) ($V_{CC} = 1.2$ V)
- Output current: $I_{OH}/I_{OL} = \pm 24$ mA (min) ($V_{CC} = 3.0$ V)
: $I_{OH}/I_{OL} = \pm 18$ mA (min) ($V_{CC} = 2.3$ V)
: $I_{OH}/I_{OL} = \pm 6$ mA (min) ($V_{CC} = 1.65$ V)
: $I_{OH}/I_{OL} = \pm 2$ mA (min) ($V_{CC} = 1.4$ 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.

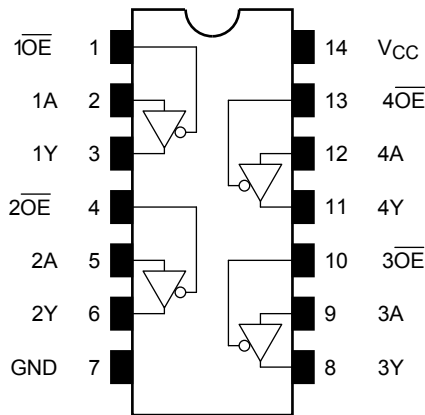


Weight

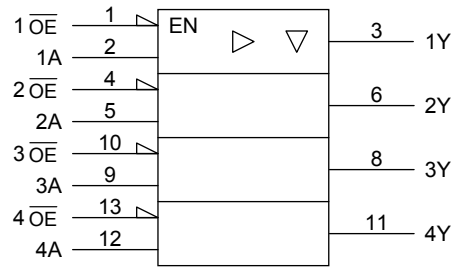
TSSOP14-P-0044-0.65A	: 0.06 g (typ.)
VSSOP14-P-0030-0.50	: 0.02 g (typ.)

Start of commercial production
1999-07

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

Inputs		Outputs
$\overline{OE}$	A	Y
H	X	Z
L	L	L
L	H	H

X: Don't care

Z: High impedance

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	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}	1.2 to 3.6	V
Input voltage	V_{IN}	-0.3 to 3.6	V
Output voltage	V_{OUT}	0 to 3.6 (Note 2)	V
		0 to V_{CC} (Note 3)	
Output current	I_{OH}/I_{OL}	± 24 (Note 4)	mA
		± 18 (Note 5)	
		± 6 (Note 6)	
		± 2 (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: OFF state

Note 3: High or low state

Note 4: $V_{CC} = 3.0$ to 3.6 V

Note 5: $V_{CC} = 2.3$ to 2.7 V

Note 6: $V_{CC} = 1.65$ to 1.95 V

Note 7: $V_{CC} = 1.4$ to 1.6 V

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

Electrical Characteristics

DC Characteristics ($T_a = -40$ to 85°C , $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

Characteristics		Symbol	Test Condition		Min	Max	Unit	
				V _{CC} (V)				
Input voltage	H-level	V _{IH}	—		2.7 to 3.6	2.0	—	V
	L-level	V _{IL}	—		2.7 to 3.6	—	0.8	
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	—	V
				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	2.7 to 3.6	—	0.2	
				I _{OL} = 12 mA	2.7	—	0.4	
				I _{OL} = 18 mA	3.0	—	0.4	
				I _{OL} = 24 mA	3.0	—	0.55	
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	2.7 to 3.6	—	20.0	μA	
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V	2.7 to 3.6	—	±20.0		
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} − 0.6 V	2.7 to 3.6	—	750		

DC Characteristics ($T_a = -40$ to 85°C , $2.3\text{ V} \leq V_{CC} \leq 2.7\text{ V}$)

Characteristics		Symbol	Test Condition		Min	Max	Unit	
				V _{CC} (V)				
Input voltage	H-level	V _{IH}	—		2.3 to 2.7	1.6	—	V
	L-level	V _{IL}	—		2.3 to 2.7	—	0.7	
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	—	V
				I _{OH} = −6 mA	2.3	2.0	—	
				I _{OH} = −12 mA	2.3	1.8	—	
				I _{OH} = −18 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} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
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	2.3 to 2.7	—	20.0	μA	
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V	2.3 to 2.7	—	±20.0		

DC Characteristics ($T_a = -40$ to 85°C , $1.65\text{ V} \leq V_{CC} < 2.3\text{ V}$)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	H-level	V _{IH}	—		1.65 to 2.3	0.65 × V _{CC}	—	V
	L-level	V _{IL}	—		1.65 to 2.3	—	0.2 × V _{CC}	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	1.65 to 2.3	V _{CC} − 0.2	—	V
				I _{OH} = −6 mA	1.65	1.25	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.65 to 2.3	—	0.2	
				I _{OL} = 6 mA	1.65	—	0.3	
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.65 to 2.3	—	±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		1.65	—	±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		1.65 to 2.3	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.65 to 2.3	—	±20.0	

DC Characteristics ($T_a = -40$ to 85°C , $1.4\text{ V} \leq V_{CC} < 1.65\text{ V}$)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	H-level	V _{IH}	—		1.4 to 1.65	0.65 × V _{CC}	—	V
	L-level	V _{IL}	—		1.4 to 1.65	—	0.05 × V _{CC}	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = −100 μA	1.4 to 1.65	V _{CC} − 0.2	—	V
				I _{OH} = −2 mA	1.4	1.05	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.4 to 1.65	—	0.05	
				I _{OL} = 2 mA	1.4	—	0.35	
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.4 to 1.65	—	±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		1.4 to 1.65	—	±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		1.4 to 1.65	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.4 to 1.65	—	±20.0	

DC Characteristics ($T_a = -40$ to 85°C , $1.2\text{ V} \leq V_{CC} < 1.4\text{ V}$)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	H-level	V _{IH}	—		1.2 to 1.4	$0.8 \times V_{CC}$	—	V
	L-level	V _{IL}	—		1.2 to 1.4	—	$0.05 \times V_{CC}$	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.2	$V_{CC} - 0.1$	—	V
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.2	—	0.05	
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.2	—	± 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		1.2	—	± 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		1.2	—	20.0	μA
			$V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6\text{ V}$		1.2	—	± 20.0	

AC Characteristics ($T_a = -40$ to 85°C , input: $t_r = t_f = 2.0\text{ ns}$) (Note 1)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$		1.2	3.0	34.0	ns
					1.5 ± 0.1	2.0	13.6	
			$C_L = 30\text{ pF}$, $R_L = 500\ \Omega$		1.8 ± 0.15	1.5	6.8	
					2.5 ± 0.2	0.8	3.4	
					3.3 ± 0.3	0.6	2.8	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$		1.2	3.0	41.0	ns
					1.5 ± 0.1	2.0	16.4	
			$C_L = 30\text{ pF}$, $R_L = 500\ \Omega$		1.8 ± 0.15	1.5	8.2	
					2.5 ± 0.2	0.8	4.1	
					3.3 ± 0.3	0.6	3.5	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$		1.2	3.0	34.0	ns
					1.5 ± 0.1	2.0	13.6	
			$C_L = 30\text{ pF}$, $R_L = 500\ \Omega$		1.8 ± 0.15	1.5	6.8	
					2.5 ± 0.2	0.8	3.8	
					3.3 ± 0.3	0.6	3.5	
Output to output skew	t_{osLH} t_{osHL}	(Note 2)	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$		1.2	—	1.5	ns
					1.5 ± 0.1	—	1.5	
			$C_L = 30\text{ pF}$, $R_L = 500\ \Omega$		1.8 ± 0.15	—	0.5	
					2.5 ± 0.2	—	0.5	
					3.3 ± 0.3	—	0.5	

Note 1: For $C_L = 50\text{ pF}$, 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 (Ta = 25°C, input: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output minimum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note)	1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	1.9	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	2.2	

Note: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Output capacitance	CO	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note)	1.8, 2.5, 3.3	20	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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/4 \text{ (per bit)}$$

AC Test Circuit

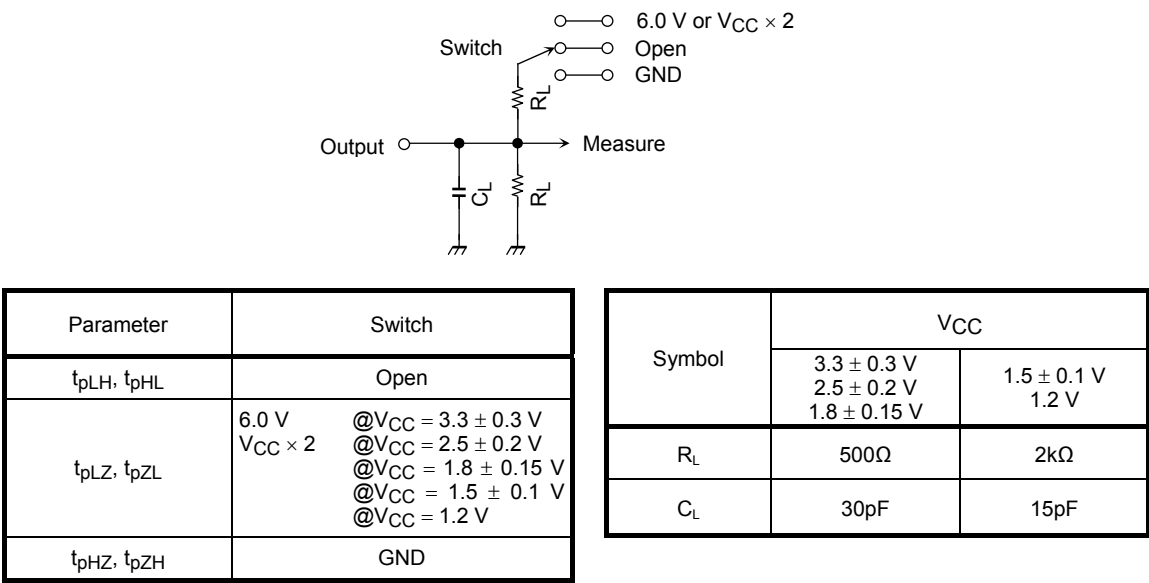


Figure 1

AC Waveform

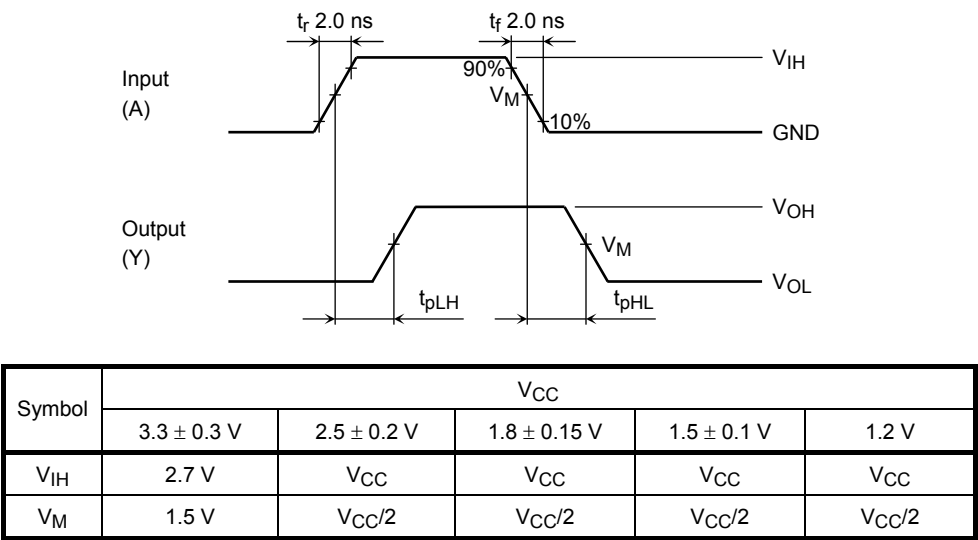


Figure 2 t_{pLH}, t_{pHL}

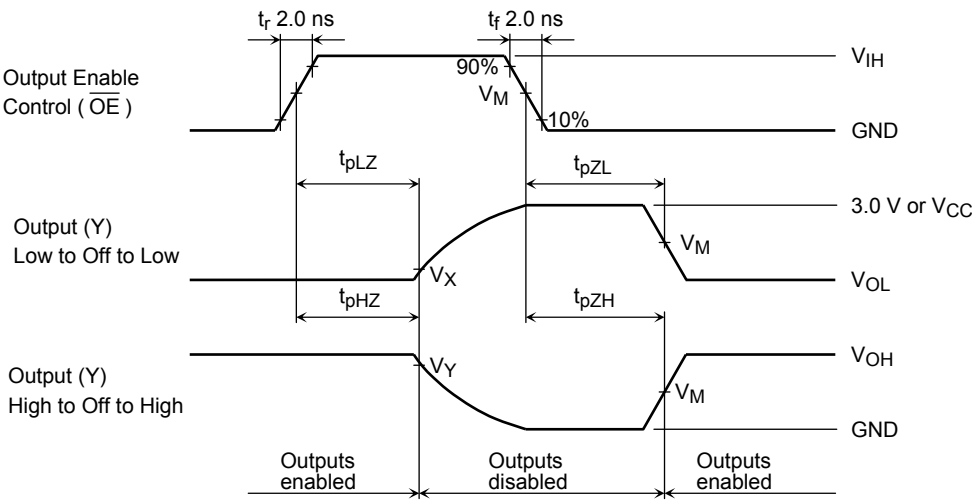


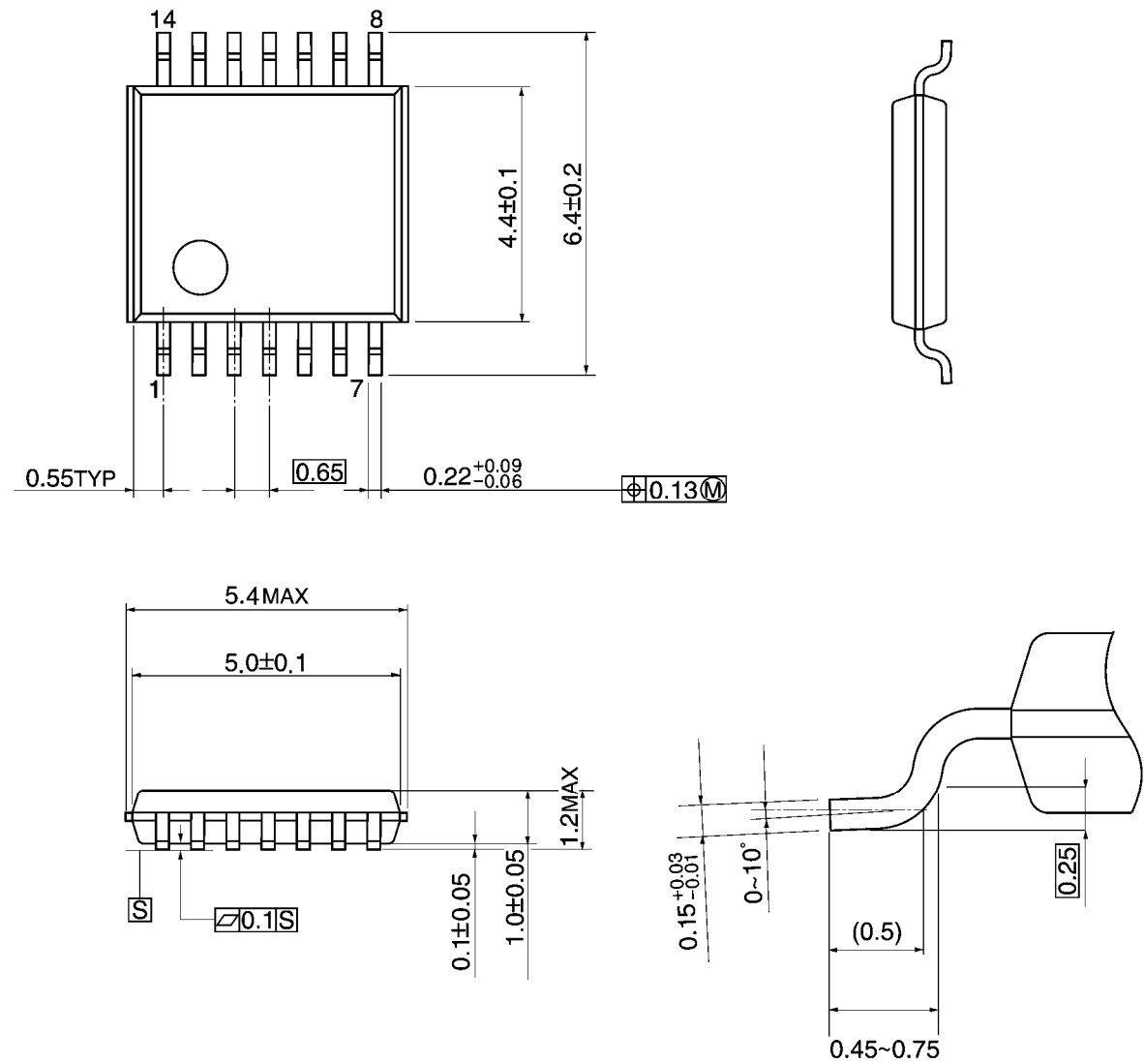
Figure 3 t_{PLZ} , t_{PHZ} , t_{PZL} , t_{PZH}

Symbol	V_{CC}				
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \pm 0.15 \text{ V}$	$1.5 \pm 0.1 \text{ V}$	1.2 V
V_{IH}	2.7 V	V_{CC}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.1 \text{ V}$	$V_{OL} + 0.1 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.1 \text{ V}$	$V_{OH} - 0.1 \text{ V}$

Package Dimensions

TSSOP14-P-0044-0.65A

Unit: mm

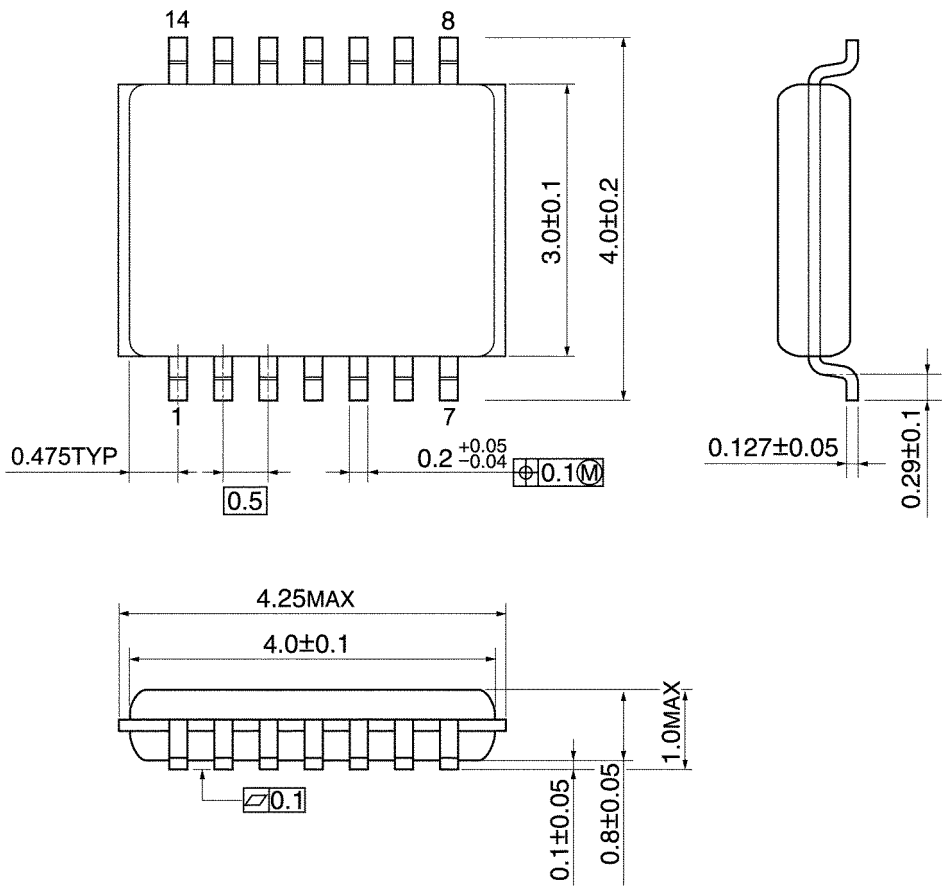


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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