TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic

TC74VCX2125FT,TC74VCX2125FK

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

The TC74VCX2125FT/FK is a high-performance CMOS quad bus buffer. 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 device requires the 3-state control input $\overline{\text{OE}}$ to be set high to place the output into the 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 resistos on outputs.
- Low-voltage operation: V_{CC} = 1.8 to 3.6 V
- High-speed operation: t_{pd} = 3.7 ns (max) (V_{CC} = 3.0 to 3.6 V)
  - : t_{pd} = 4.8 ns (max) (V_{CC} = 2.3 to 2.7 V)
  - : t_{pd} = 9.6 ns (max) (V_{CC} = 1.8 V)
- Output current: I_{OH}/I_{OL} = ±12 mA (min) (V_{CC} = 3.0 V)
  - : I_{OH}/I_{OL} = ±8 mA (min) (V_{CC} = 2.3 V)
  - : I_{OH}/I_{OL} = ±4 mA (min) (V_{CC} = 1.8 V)
- Latch-up performance: −300 mA
- ESD performance: Machine model ≥ ±200 V
  - Human body model ≥ ±2000 V
- Package: TSSOP and VSSOP (US)
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs

TC74VCX2125FT
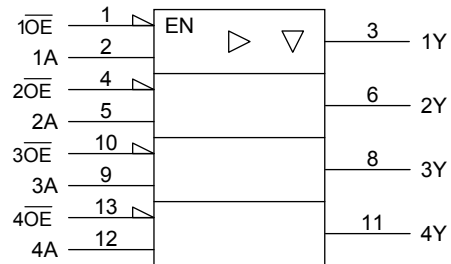

TSSOP14-P-0044-0.65A

TC74VCX2125FK
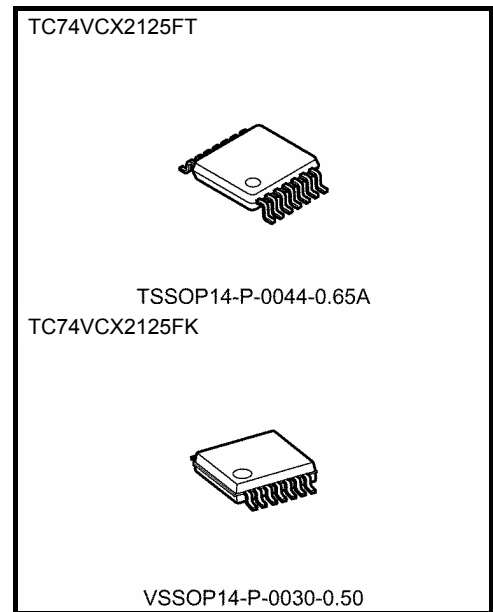
VSSOP14-P-0030-0.50

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

Pin Assignment (top view)
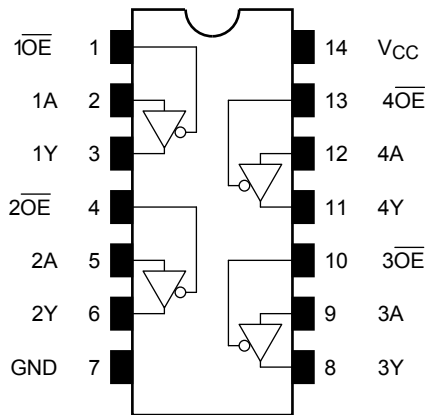
IEC Logic Symbol

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}	1.8 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 VCC 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	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$_{OH}$ = −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		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 (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	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$_{OH}$ = −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	
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 (Ta = −40 to 85°C, 1.8 V $\leqq$ 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	$0.7 \times V_{CC}$	—	V
	L-level	V_{IL}	—		1.8 to 2.3	—	$0.2 \times V_{CC}$	
Output voltage	H-level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100\ \mu A$	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}	$I_{OL} = 100\ \mu A$	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		1.8	—	20.0	μA
			$V_{CC} \leqq (V_{IN}, V_{OUT}) \leqq 3.6$ V		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
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.8	1.0	9.6	ns
			2.5 ± 0.2	0.8	4.8	
			3.3 ± 0.3	0.6	3.7	
3-state output enable time	t_{pZL} t_{PZH}	Figure 1, Figure 3	1.8	1.0	9.8	ns
			2.5 ± 0.2	0.8	5.1	
			3.3 ± 0.3	0.6	4.1	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	1.8	1.0	8.1	ns
			2.5 ± 0.2	0.8	4.5	
			3.3 ± 0.3	0.6	4.1	
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 (Ta = 25°C, input: t_r = t_f = 2.0 ns, C_L = 30 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 (Ta = 25°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_{OUT}	—	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:

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

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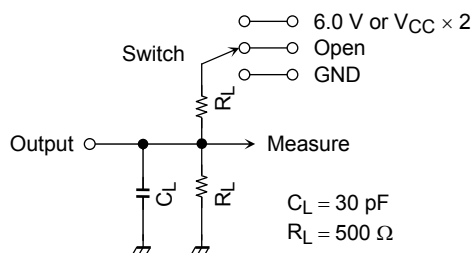
Parameter	Switch	
t_{pLH}, t_{pHL}	Open	
t_{pLZ}, t_{pZL}	6.0 V $V_{CC} \times 2$	@V_{CC} = 3.3 ± 0.3 V @V_{CC} = 2.5 ± 0.2 V @V_{CC} = 1.8 V
t_{pHZ}, t_{pZH}	GND	

Figure 1

AC Waveform
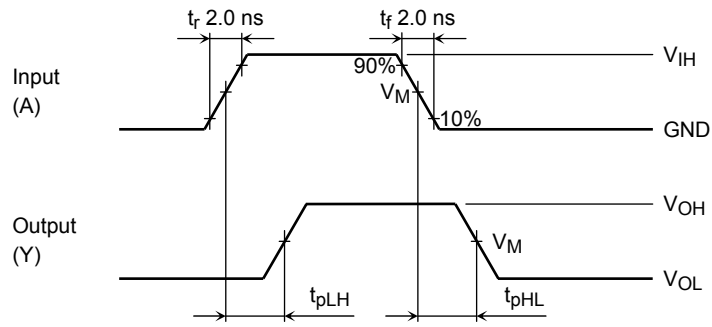
Figure 2 t_{pLH}, t_{pHL}
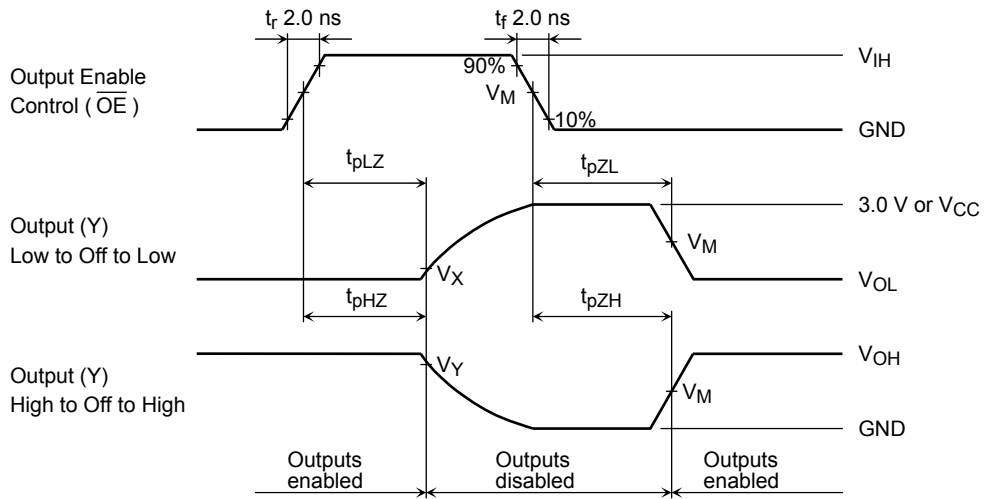
Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 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	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V
V_Y	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V

Package Dimensions

TSSOP14-P-0044-0.65A

Unit: mm

14   8

4.4±0.1

6.4±0.2

1   7

0.55TYP

0.65

$0.22^{+0.09}_{-0.06}$

⊕ 0.13 Ⓜ

5.4MAX

5.0±0.1

1.2MAX

0.1±0.05

1.0±0.05

S

0.1 S

$0.15^{+0.03}_{-0.01}$

0~10°

(0.5)

0.25

0.45~0.75
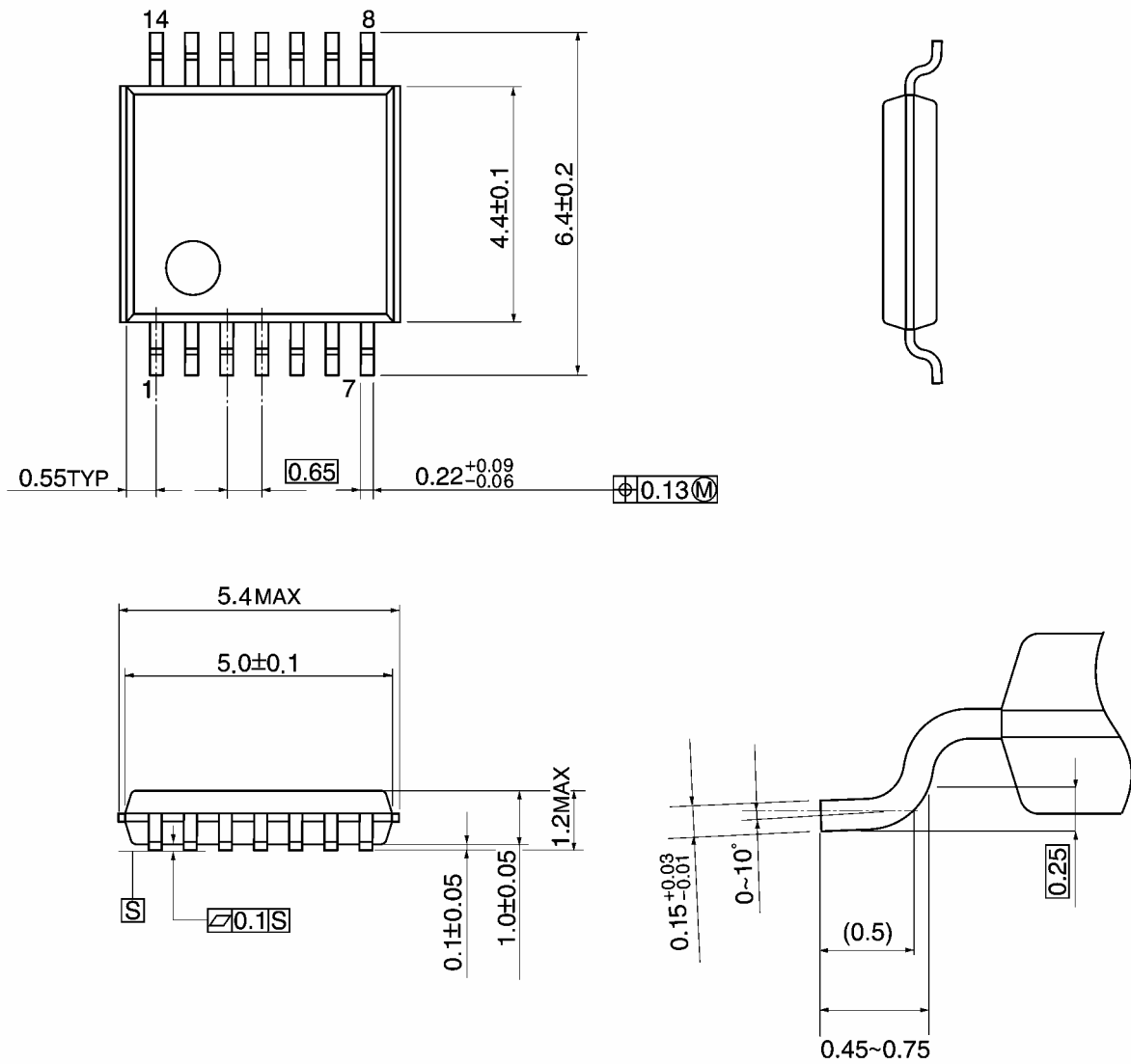
Weight: 0.06 g (typ.)

Package Dimensions

VSSOP14-P-0030-0.50   Unit: mm
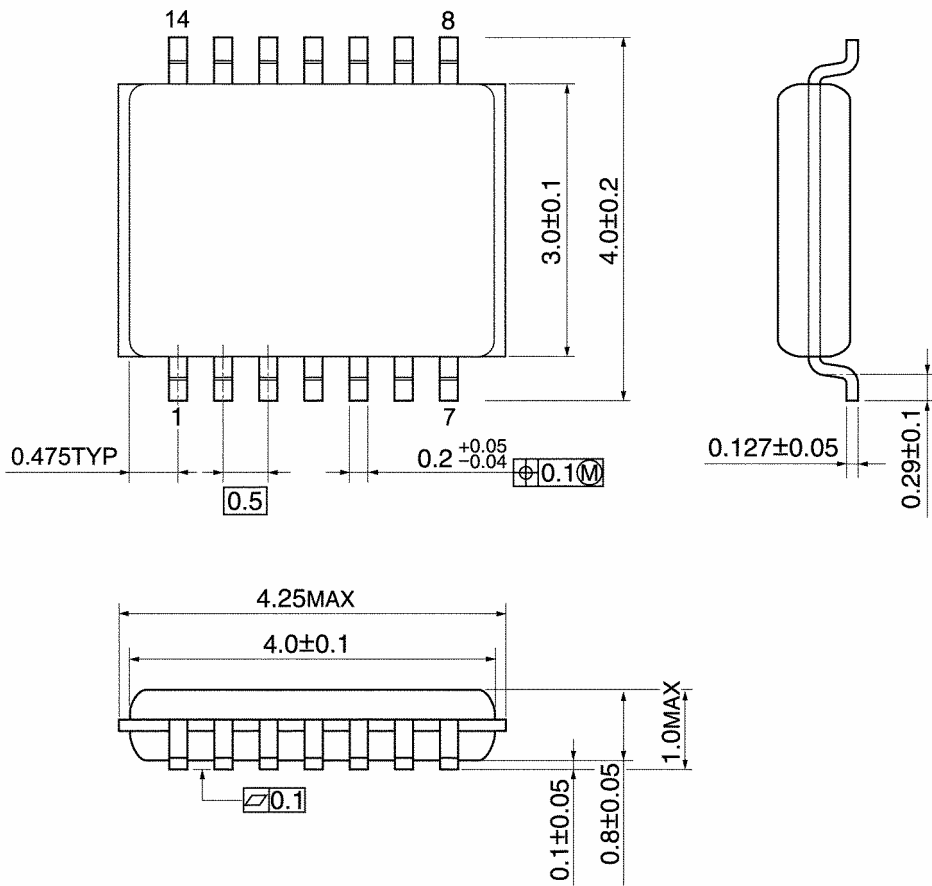
Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE