

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

**TC7MP97FT, TC7MP97FK  
TC7MP98FT, TC7MP98FK****Low Voltage Triple Configurable Multiple Function Gate  
with 3.6 V Tolerant Inputs and Outputs**

The TC7MP97,98 is a high performance CMOS multiple Function Gate which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5 V, 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 over voltage tolerant inputs and outputs up to 3.6 V.

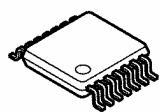
It independently consists of three circuits for Multiple Function Gate.

The output state is determined by seven patterns of 3-inputs.

The user can choose the functions of Multiplexer, AND, OR, NAND, Schmitt Inverter, and Schmitt Buffer.

All inputs are equipped with protection circuits against static discharge.

TC7MP97FT,TC7MP98FT

TSSOP14-P-0044-0.65A  
TC7MP97FK,TC7MP98FK

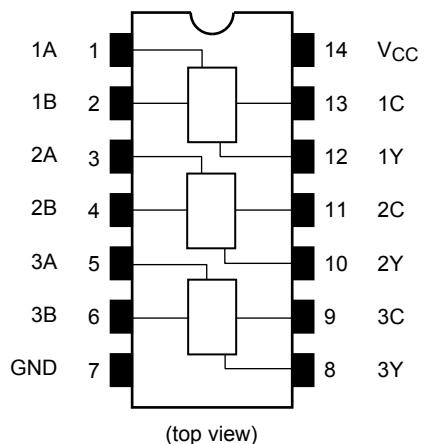
VSSOP14-P-0030-0.50

**Weight:**

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

**Features**

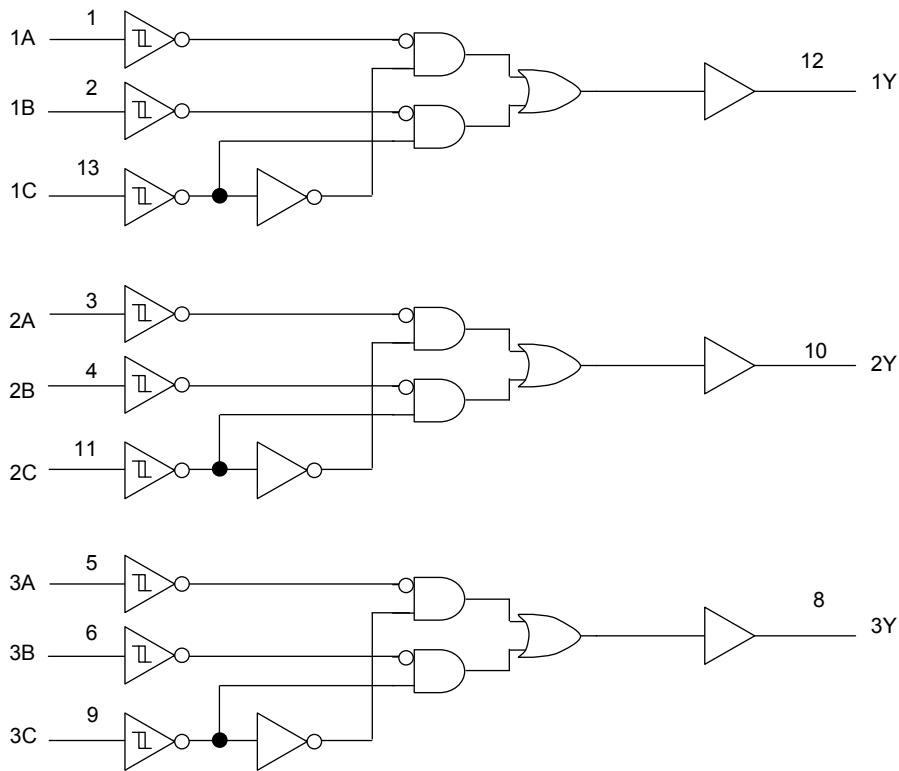
- Low-voltage operation :  $V_{CC} = 1.2$  to  $3.6$  V
- High-speed operation :  $t_{pd} = 8.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
:  $t_{pd} = 12.0$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)
- Output current :  $|IOH|/IOL = \pm 8$  mA (min) ( $V_{CC} = 3.0$  V)  
:  $|IOH|/IOL = \pm 4$  mA (min) ( $V_{CC} = 2.3$  V)  
:  $|IOH|/IOL = \pm 1.5$  mA (min) ( $V_{CC} = 1.65$  V)
- Latch-up performance :  $-300$  mA
- ESD performance : Machine model  $\geq \pm 200$  V  
Human body model  $\geq \pm 2000$  V
- Package : VSSOP14 (US14),TSSOP14
- Power-down protection is provided on all inputs and outputs

**Pin Assignment (top view)****Truth Table**

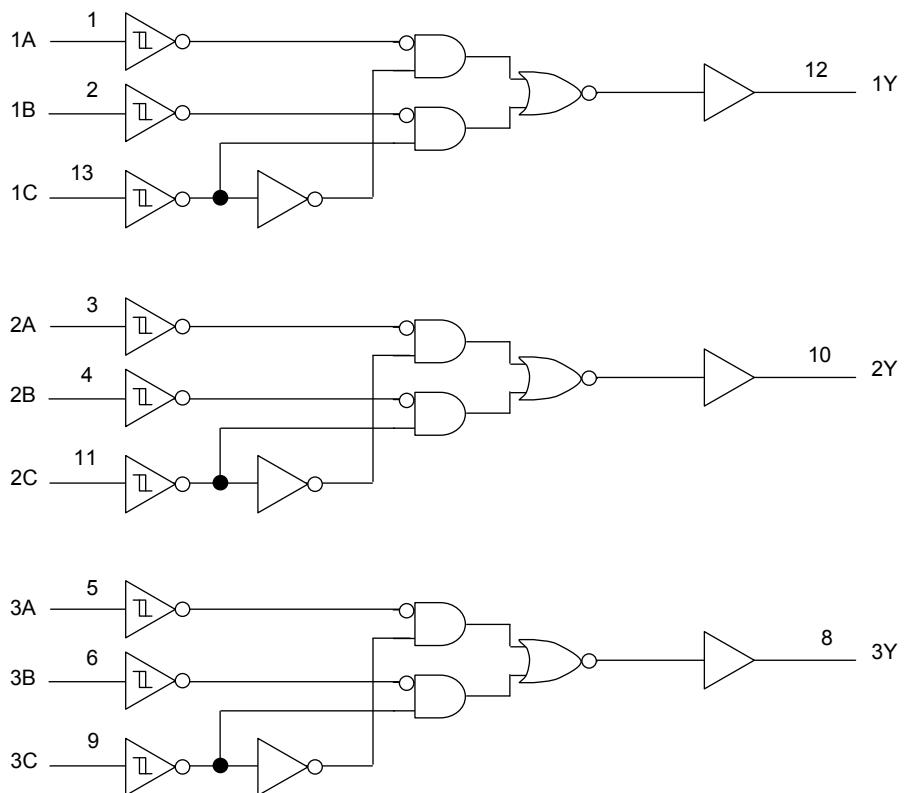
INPUTS			OUTPUT	
			TC7MP97	TC7MP98
A	B	C	Y	Y
L	L	L	L	H
L	L	H	L	H
L	H	L	H	L
L	H	H	L	H
H	L	L	L	H
H	L	H	H	L
H	H	L	H	L
H	H	H	H	L

**System Diagram**

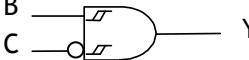
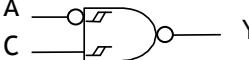
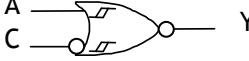
TC7MP97



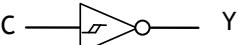
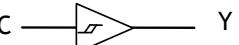
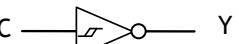
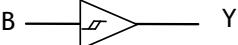
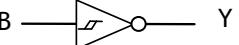
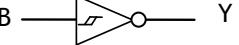
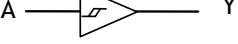
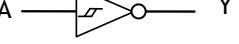
TC7MP98



## Logic configurations(1/2)

Function	Input Condition	TC7MP97 Logic symbol	TC7MP98 Logic symbol	FUNCTION TABLE																																										
MP97 AND	A=INPUT B=L-Level			<table border="1"> <tr> <td rowspan="2">A</td> <td rowspan="2">B</td> <td rowspan="2">C</td> <td colspan="2">Y</td> </tr> <tr> <td>97</td> <td>98</td> </tr> <tr> <td>L</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>L</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>H</td> <td>L</td> </tr> </table>	A	B	C	Y		97	98	L	L	L	L	H	L	L	H	L	H	H	L	L	L	H	H	L	H	H	L															
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Y=OUTPUT																																														

## Logic configurations(2/2)

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MP97 Schmitt INV	A=L-Level B=H-Level C=INPUT Y=OUTPUT			<table border="1"> <thead> <tr> <th>A</th><th>B</th><th>C</th><th colspan="2">Y</th></tr> <tr> <th colspan="3"></th><th>97</th><th>98</th></tr> </thead> <tbody> <tr> <td>L</td><td>H</td><td>L</td><td>H</td><td>L</td></tr> <tr> <td>L</td><td>H</td><td>H</td><td>L</td><td>H</td></tr> </tbody> </table>	A	B	C	Y					97	98	L	H	L	H	L	L	H	H	L	H
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**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	$I_{IK}$	-20	mA
Output diode current	$I_{OK}$	$\pm 20$ (Note 4)	mA
DC output current	$I_{OUT}$	$\pm 25$	mA
Power dissipation	$P_D$	180	mW
DC $V_{CC}$ /ground current	$I_{CC}/I_{GND}$	$\pm 25$	mA
Storage temperature	$T_{STG}$	-65~150	°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:  $V_{CC} = 0$  V

Note 3: High or Low state.  $I_{OUT}$  absolute rating must be observed.

Note 4:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

**Operating Ranges (Note 1)**

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	1.2~3.6	V
Input voltage	$V_{IN}$	-0.3~3.6	V
Output voltage	$V_{OUT}$	0~3.6 (Note 2)	V
		0~ $V_{CC}$ (Note 3)	
Output current	$I_{OH}/I_{OL}$	$\pm 8.0$ (Note 4)	mA
		$\pm 4.0$ (Note 5)	
		$\pm 1.5$ (Note 6)	
Operating temperature	$T_{opr}$	-40~85	°C

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:  $V_{CC} = 0$  V

Note 3: High or low state

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

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

Note 6:  $V_{CC} = 1.65\sim 1.8$  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>P</sub>	—	1.2		1.10	V			
				1.4		1.20				
				1.65		1.35				
				2.3		1.70				
				3.0		2.00				
				3.6		2.20				
	L-level	V <sub>N</sub>	—	1.2	0.10		V			
				1.4	0.20					
				1.65	0.30					
				2.3	0.50					
				3.0	0.70					
				3.6	0.80					
Hysteresis voltage		V <sub>H</sub>	—	1.2	0.2	0.9	V			
				1.4	0.2	0.9				
				1.65	0.2	0.95				
				2.3	0.3	1.0				
				3.0	0.3	1.2				
				3.6	0.3	1.2				
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	1.2~1.3	V <sub>CC</sub> - 0.1	V			
				I <sub>OH</sub> = -500 µA	1.4~1.6	V <sub>CC</sub> - 0.2				
				I <sub>OH</sub> = -1.5 mA	1.65~1.95	V <sub>CC</sub> - 0.3				
				I <sub>OH</sub> = -4.0 mA	2.3~2.7	V <sub>CC</sub> - 0.4				
				I <sub>OH</sub> = -8.0 mA	3.0~3.6	2.40				
	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	1.2~1.3	—	V			
				I <sub>OL</sub> = 500 µA	1.4~1.6	—				
				I <sub>OL</sub> = 3.0 mA	1.65~1.95	—				
				I <sub>OL</sub> = 4.0 mA	2.3~2.7	—				
				I <sub>OL</sub> = 8.0 mA	3.0~3.6	—				
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		1.2~3.6	—	±5.0	µA		
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	µA		
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.2~3.6	—	20.0	µA		
			V <sub>CC</sub> ≤ V <sub>IN</sub> ≤ 3.6 V		1.2~3.6	—	±20.0			
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7~3.6	—	750			

AC Characteristics (Ta = -40 to 85°C, input:  $t_r = t_f = 3.0$  ns)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
			1.8 ± 0.15			
Propagation delay time (A, B,C-Y)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2 CL = 10pF, R <sub>L</sub> = 1M Ω	2.5 ± 0.2	0.8	10.0	ns
			3.3 ± 0.3	0.6	7.0	
			1.8 ± 0.15	1.0	23.0	ns
	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2 CL = 15pF, R <sub>L</sub> = 1M Ω	2.5 ± 0.2	0.8	11.0	
			3.3 ± 0.3	0.6	7.7	
			1.8 ± 0.15	1.0	27.0	ns
	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2 CL = 30pF, R <sub>L</sub> = 1M Ω	2.5 ± 0.2	0.8	12.0	
			3.3 ± 0.3	0.6	8.5	

Dynamic Switching Characteristics (Ta = 25°C, input:  $t_r = t_f = 3.0$  ns, C<sub>L</sub> = 30 pF)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
			1.8		
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic V <sub>OL</sub>	V <sub>OLV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	-0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	-0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	-0.8	
Quiet output minimum dynamic V <sub>OH</sub>	V <sub>OHV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	1.5	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	1.9	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	2.2	

Note: Parameter guaranteed by design.

## Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
			1.8, 2.5, 3.3		
Input capacitance	C <sub>IN</sub>	—	6	pF	
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note)	1.8, 2.5, 3.3	30	pF

Note: C<sub>PD</sub> 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:

$$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

## AC Test Circuit

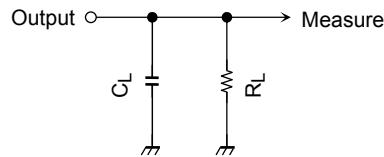
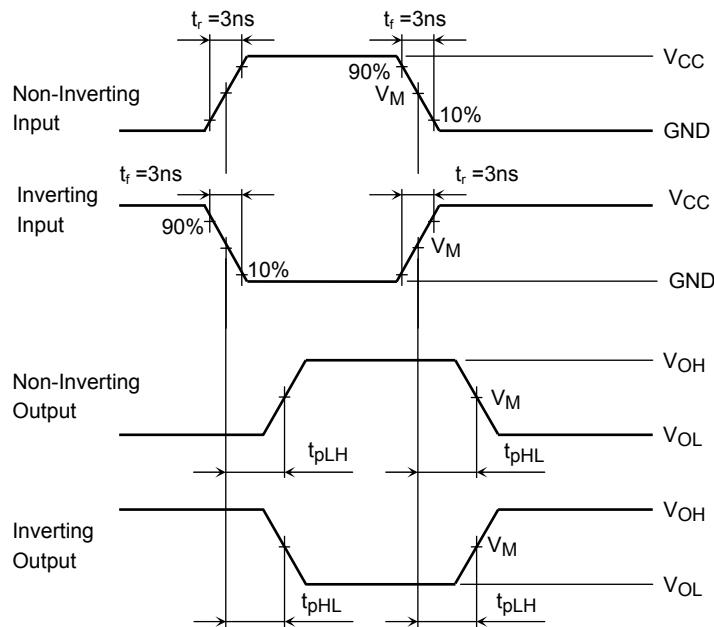


Figure 1

## AC Waveform



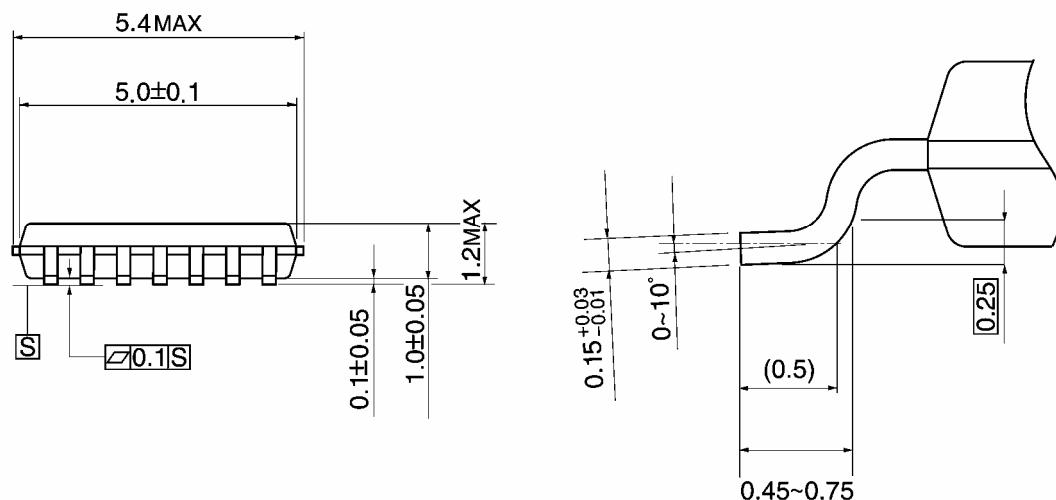
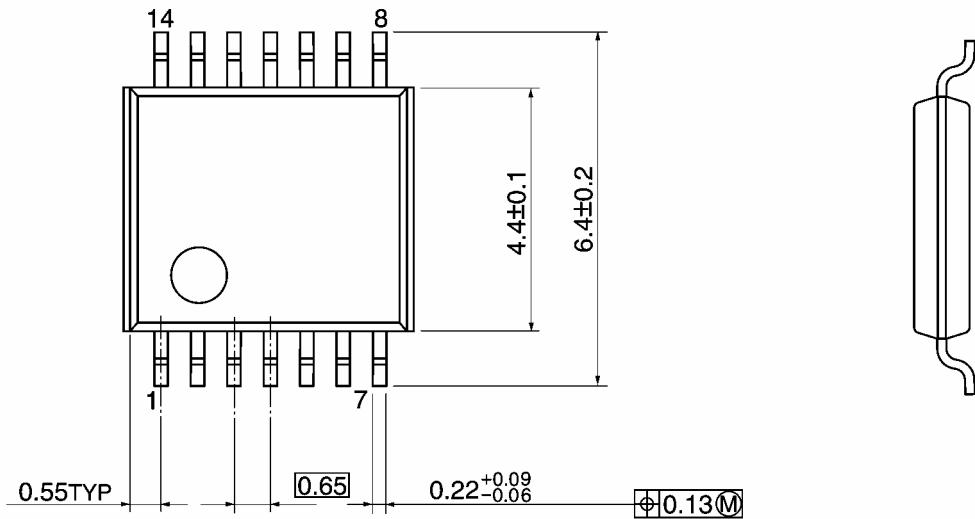
Symbol	$V_{CC}$		
	$3.3 \pm 0.3$ V	$2.5 \pm 0.2$ V	$1.8 V \pm 0.15$ V
$V_{IN}$	$V_{CC}$	$V_{CC}$	$V_{CC}$
$V_M$	$1.5$ V	$V_{CC}/2$	$V_{CC}/2$

Figure 2  $t_{pLH}$ ,  $t_{pHL}$

**Package Dimensions**

TSSOP14-P-0044-0.65A

Unit: mm

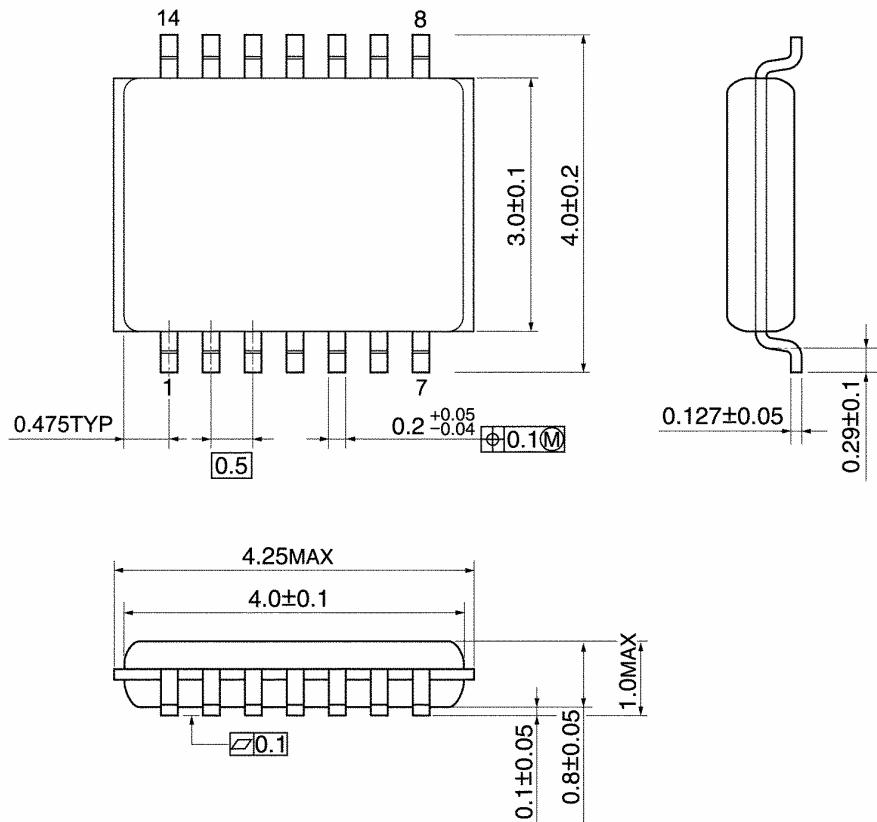


Weight: 0.06 g (typ.)

**Package Dimensions**

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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20070701-EN GENERAL

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