

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74VHC164F, TC74VHC164FN, TC74VHC164FT, TC74VHC164FK

### 8-Bit Shift Register (S-IN, P-OUT)

The TC74VHC164 is an advanced high speed CMOS 8-BIT SERIAL-IN PARALLEL-OUT SHIFT REGISTER fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

It consists of a serial-in, parallel-out 8-bit shift register with a CLOCK input and an overriding CLEAR input.

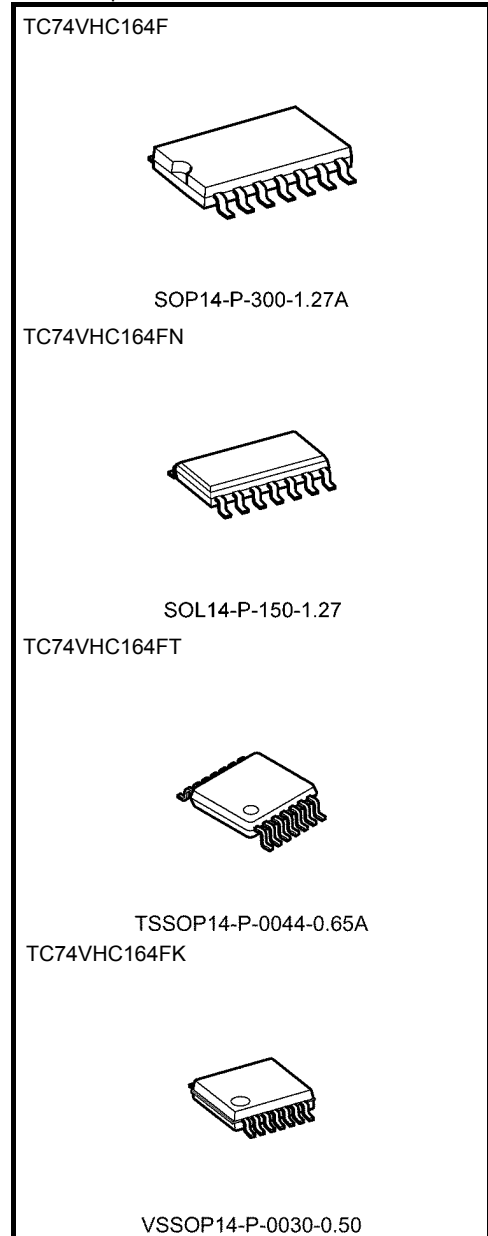
Two serial data inputs (A, B) are provided so that one may be used as a data enable.

An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

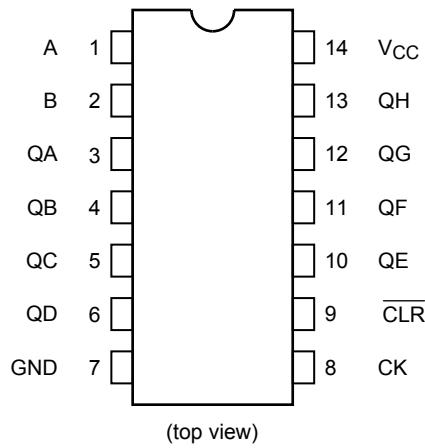
- High speed:  $f_{max} = 175$  MHz (typ.) at  $V_{CC} = 5$  V
- Low power dissipation:  $I_{CC} = 4$   $\mu$ A (max) at  $T_a = 25^\circ$ C
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC} (opr) = 2$  to 5.5 V
- Low noise:  $V_{OLP} = 0.8$  V (max)
- Pin and function compatible with 74ALS164

Note: xxxFN (JEDEC SOP) is not available in Japan.

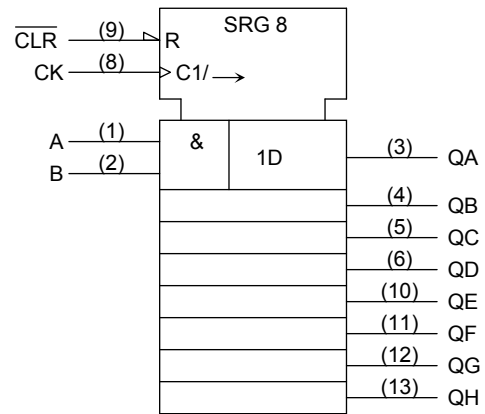


Weight	
SOP14-P-300-1.27A	: 0.18 g (typ.)
SOL14-P-150-1.27	: 0.12 g (typ.)
TSSOP14-P-0044-0.65A	: 0.06 g (typ.)
VSSOP14-P-0030-0.50	: 0.02 g (typ.)

## Pin Assignment



## IEC Logic Symbol



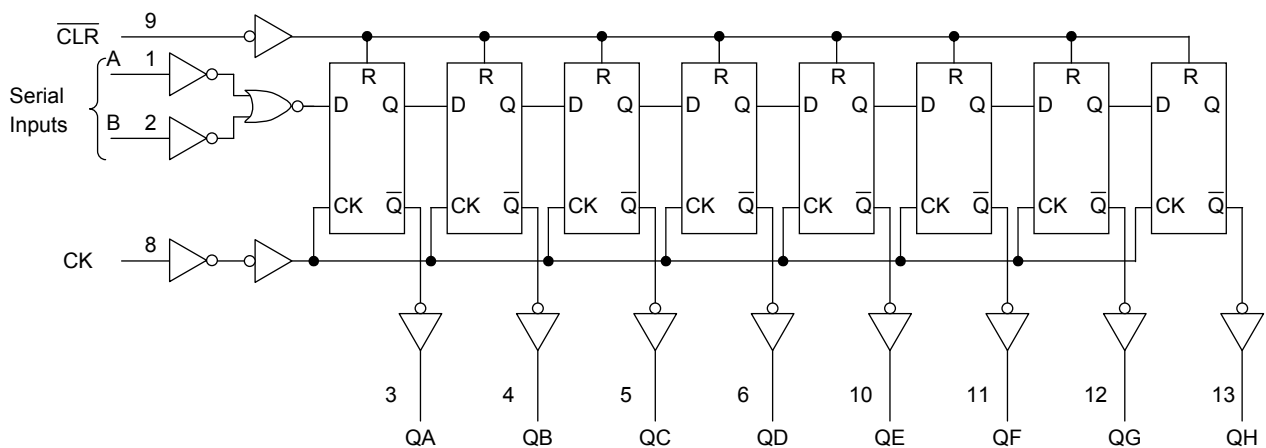
## Truth Table

Inputs				Outputs			
$\overline{\text{CLR}}$	CK	Serial IN		QA	QB	...	QH
		A	B				
L	X	X	X	L	L	...	L
H		X	X	No Change			
H		L	X	L	QA <sub>n</sub>	...	QG <sub>n</sub>
H		X	L	L	QA <sub>n</sub>	...	QG <sub>n</sub>
H		H	H	H	QA <sub>n</sub>	...	QG <sub>n</sub>

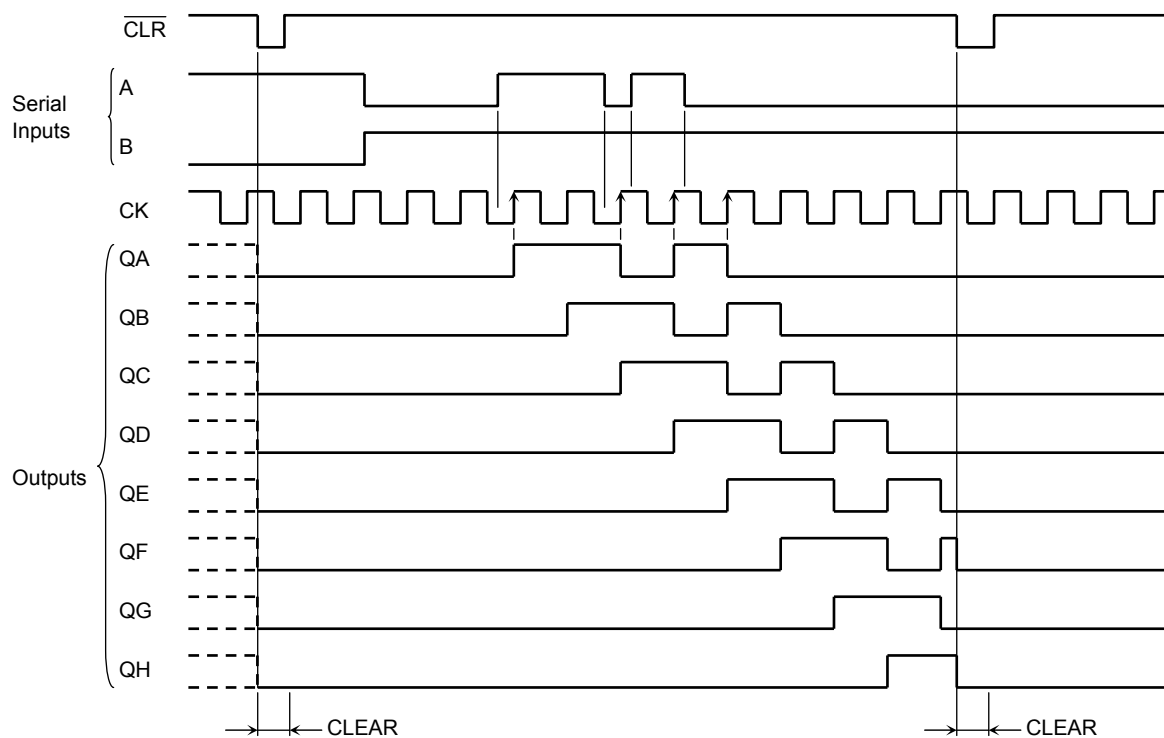
X: Don't care

QA<sub>n</sub> to QG<sub>n</sub>: The level of QA to QG, respectively, before the most recent positive edge of the clock.

## System Diagram



## Timing Chart



## Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-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 $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	-20	mA
Output diode current	$I_{OK}$	$\pm 20$	mA
DC output current	$I_{OUT}$	$\pm 25$	mA
DC $V_{CC}$ /ground current	$I_{CC}$	$\pm 75$	mA
Power dissipation	$P_D$	180	mW
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

Note: 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).

## Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2.0 to 5.5	V
Input voltage	$V_{IN}$	0 to 5.5	V
Output voltage	$V_{OUT}$	0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 100 ( $V_{CC} = 3.3 \pm 0.3$ V) 0 to 20 ( $V_{CC} = 5 \pm 0.5$ V)	ns/V

Note: 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.

## Electrical Characteristics

### DC Characteristics

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$T_a = 25^\circ\text{C}$			$T_a = -40$ to $85^\circ\text{C}$		Unit	
				Min	Typ.	Max	Min	Max		
High-level input voltage	$V_{IH}$	—	2.0 3.0 to 5.5	1.50 $V_{CC} \times 0.7$	— —	— —	1.50 $V_{CC} \times 0.7$	— —	V	
Low-level input voltage	$V_{IL}$	—	2.0 3.0 to 5.5	— —	— —	0.50 $V_{CC} \times 0.3$	— —	0.50 $V_{CC} \times 0.3$	V	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50 \mu\text{A}$	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5	— — —	1.9 2.9 4.4	— — —	V
			$I_{OH} = -4 \text{ mA}$	3.0 4.5	2.58 3.94	— —	— —	2.48 3.80	— —	
			$I_{OH} = -8 \text{ mA}$	3.0 4.5	— —	— —	— —	— —	— —	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu\text{A}$	2.0 3.0 4.5	— — —	0.0 0.0 0.0	0.1 0.1 0.1	— — —	0.1 0.1 0.1	V
			$I_{OL} = 4 \text{ mA}$	3.0 4.5	— —	— —	0.36 0.36	— —	0.44 0.44	
			$I_{OL} = 8 \text{ mA}$	3.0 4.5	— —	— —	0.36 0.36	— —	0.44 0.44	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5 \text{ V}$ or GND	0 to 5.5	—	—	$\pm 0.1$	—	$\pm 1.0$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	4.0	—	40.0	$\mu\text{A}$	

## Timing Requirements (input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40 to 85°C	Unit
			V <sub>CC</sub> (V)	Typ.	Limit	
Minimum pulse width (CK)	$t_w$ (L)	—	3.3 ± 0.3	—	5.0	ns
	$t_w$ (H)		5.0 ± 0.5	—	5.0	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_w$ (L)	—	3.3 ± 0.3 5.0 ± 0.5	— —	5.0 5.0	ns
Minimum set-up time	$t_s$	—	3.3 ± 0.3	—	5.0	ns
			5.0 ± 0.5	—	4.5	
Minimum hold time	$t_h$	—	3.3 ± 0.3	—	0.0	ns
			5.0 ± 0.5	—	1.0	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	—	3.3 ± 0.3 5.0 ± 0.5	— —	2.5 2.5	ns

## AC Characteristics (input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit		
			V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Typ.	Max		Min	Max
Propagation delay time (CK-Q)	$t_{pLH}$	—	3.3 ± 0.3	15	—	8.4	12.8	1.0	15.0	ns
				50	—	10.9	16.3	1.0	18.5	
	5.0 ± 0.5		15	—	5.8	9.0	1.0	10.5		
			50	—	7.3	11.0	1.0	12.5		
Propagation delay time ( $\overline{\text{CLR}}-Q$ )	$t_{pHL}$	—	3.3 ± 0.3	15	—	8.3	12.8	1.0	15.0	ns
				50	—	10.8	16.3	1.0	18.5	
			5.0 ± 0.5	15	—	5.2	8.6	1.0	10.0	
				50	—	6.7	10.6	1.0	12.0	
Maximum clock frequency	$f_{max}$	—	3.3 ± 0.3	15	80	125	—	65	—	MHz
				50	50	75	—	45	—	
			5.0 ± 0.5	15	125	175	—	105	—	
				50	85	115	—	75	—	
Input capacitance	C <sub>IN</sub>	—	—	—	4	10	—	10	pF	
Power dissipation capacitance	C <sub>PD</sub>	(Note)	—	—	76	—	—	—	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:

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

## Noise Characteristics (input: $t_r = t_f = 3$ ns)

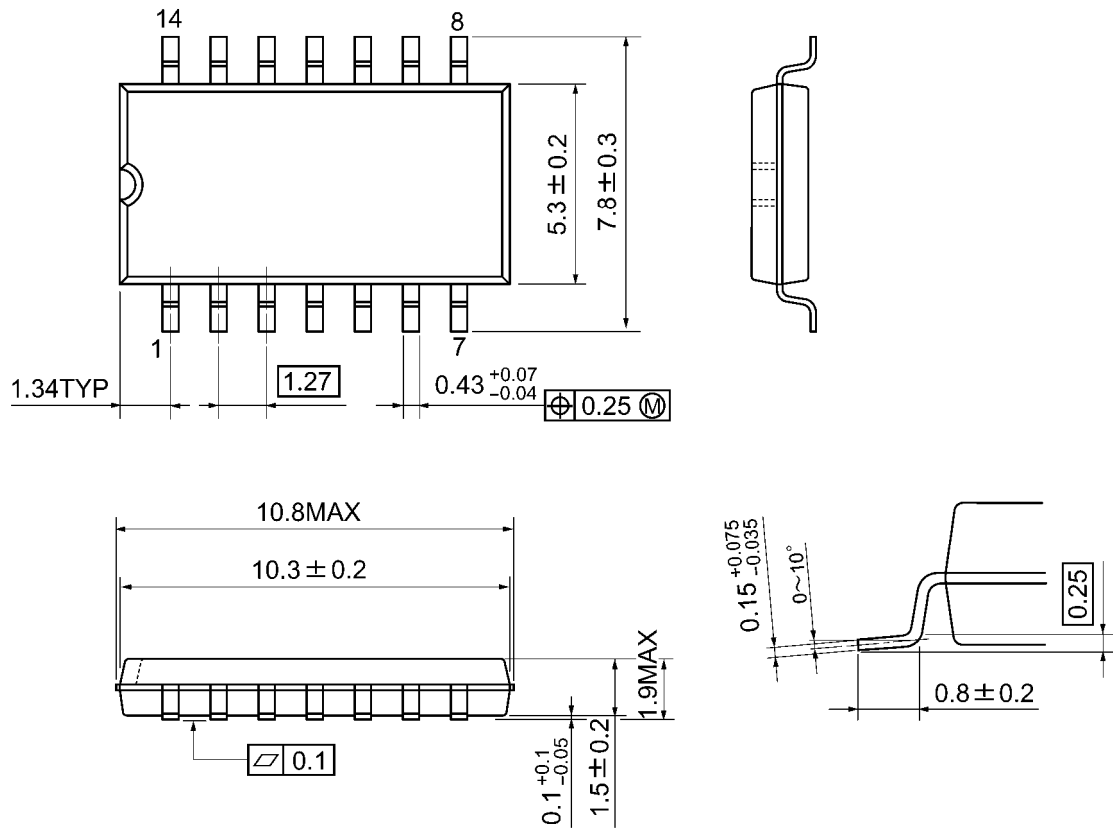
Characteristics	Symbol	Test Condition	Ta = 25°C		Unit	
			V <sub>CC</sub> (V)	Typ.		Max
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	C <sub>L</sub> = 50 pF	5.0	0.5	0.8	V
Quiet output minimum dynamic V <sub>OL</sub>	V <sub>OLV</sub>	C <sub>L</sub> = 50 pF	5.0	-0.5	-0.8	V
Minimum high level dynamic input voltage	V <sub>IHD</sub>	C <sub>L</sub> = 50 pF	5.0	—	3.5	V
Maximum low level dynamic input voltage	V <sub>ILD</sub>	C <sub>L</sub> = 50 pF	5.0	—	1.5	V



## Package Dimensions

SOP14-P-300-1.27A

Unit: mm

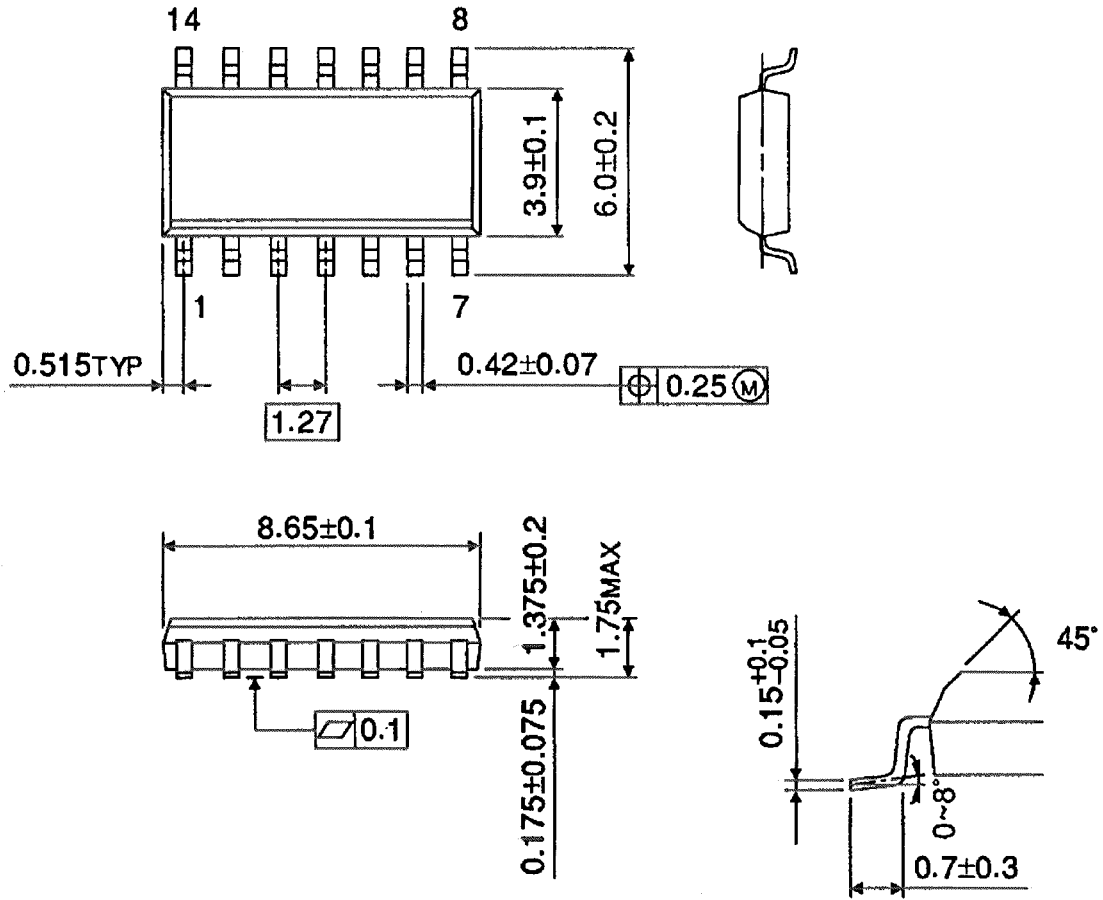


Weight: 0.18 g (typ.)

Package Dimensions (Note)

SOL14-P-150-1.27

Unit : mm



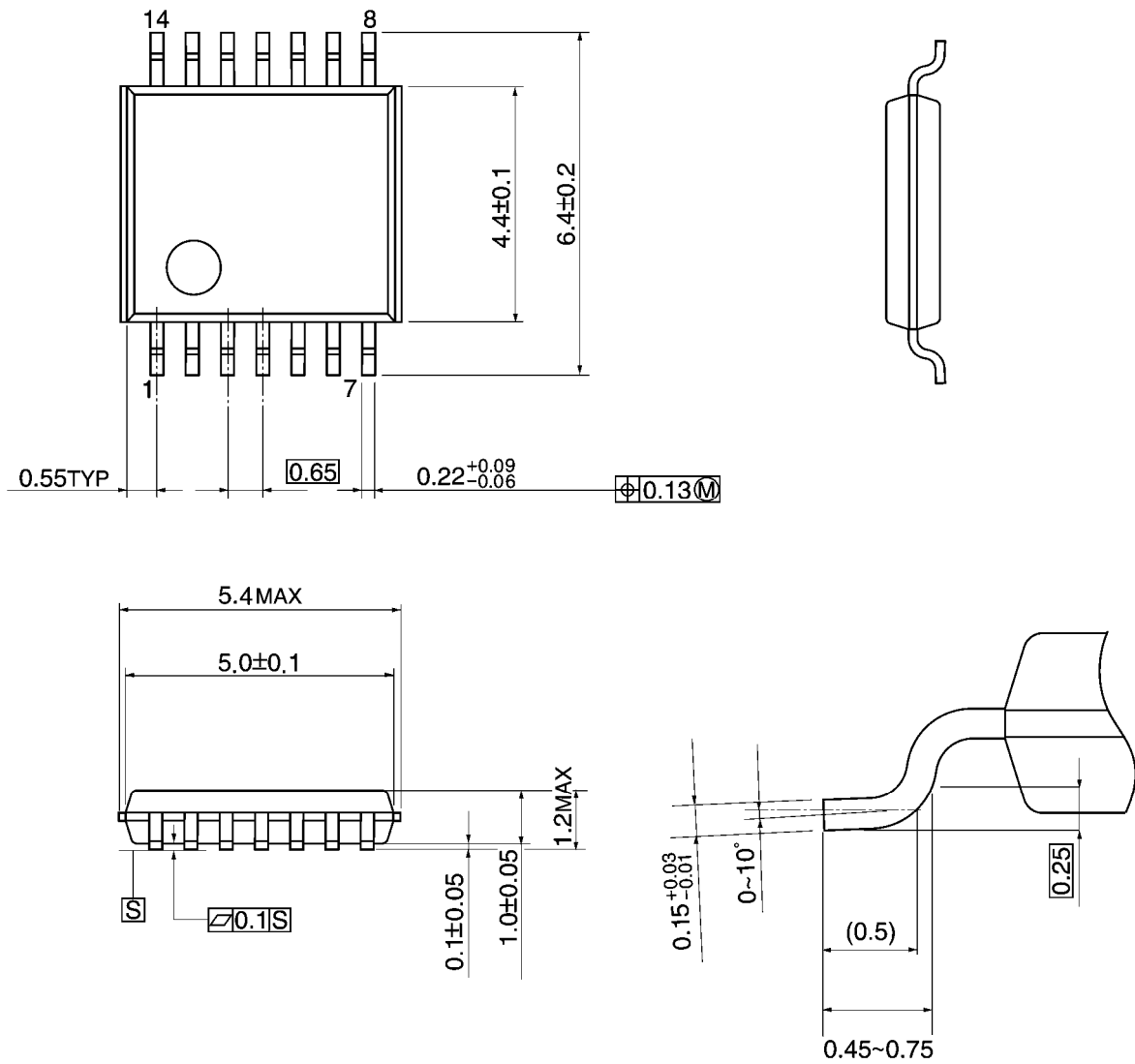
Note: This package is not available in Japan.

Weight: 0.12 g (typ.)

**Package Dimensions**

TSSOP14-P-0044-0.65A

Unit: mm

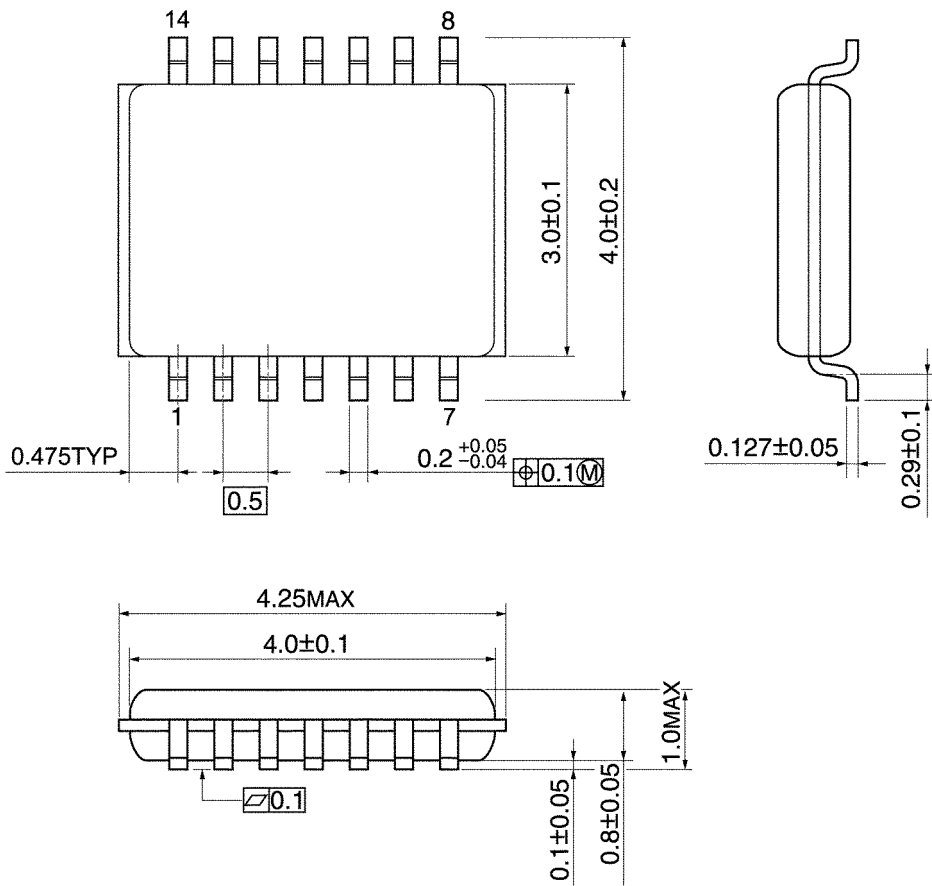


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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