

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74VHC595F, TC74VHC595FT, TC74VHC595FK

### 8-Bit Shift Register/Latch (3-state)

The TC74VHC595 is an advanced high speed 8-BIT SHIFT REGISTER/LATCH 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.

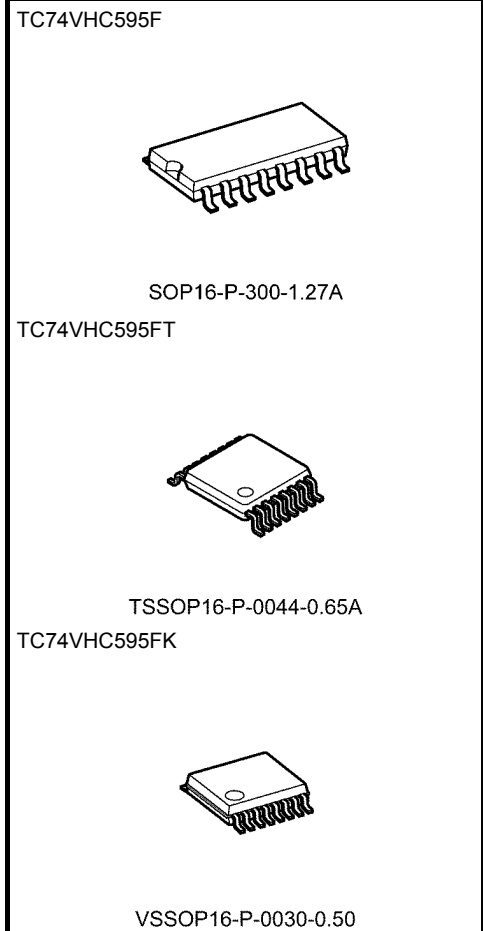
The TC74VHC595 contains an 8-bit static shift register which feeds an 8-bit storage register.

Shift operation is accomplished on the positive going transition of the SCK input. The output register is loaded with the contents of the shift register on the positive going transition of the RCK input. Since RCK and SCK signal are independent, parallel outputs can be held stable during the shift operation. And, since the parallel outputs are 3-state, it can be directly connected to 8-bit bus. This register can be used in serial-to-parallel conversion, data receivers, etc.

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 V 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

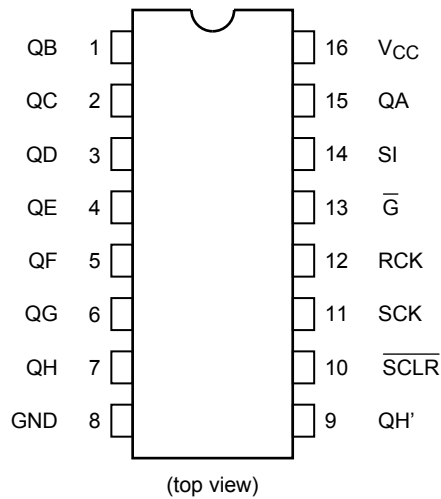
- High speed:  $f_{max} = 185 \text{ MHz (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 4 \mu\text{A (max)}$  at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Power down protection is provided on all inputs.
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC} \text{ (opr)} = 2 \text{ V to } 5.5 \text{ V}$
- Low noise:  $V_{OLP} = 1.0 \text{ V (max)}$
- Pin and function compatible with 74ALS595



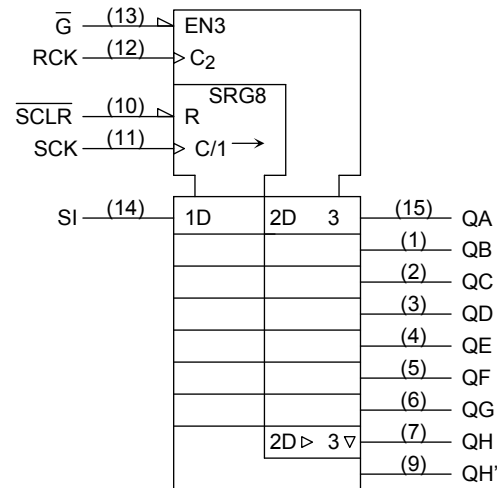
Weight	
SOP16-O-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)
VSSOP16-P-0030-0.50	: 0.02 g (typ.)

Start of commercial production  
1992-05

## Pin Assignment



## IEC Logic Symbol

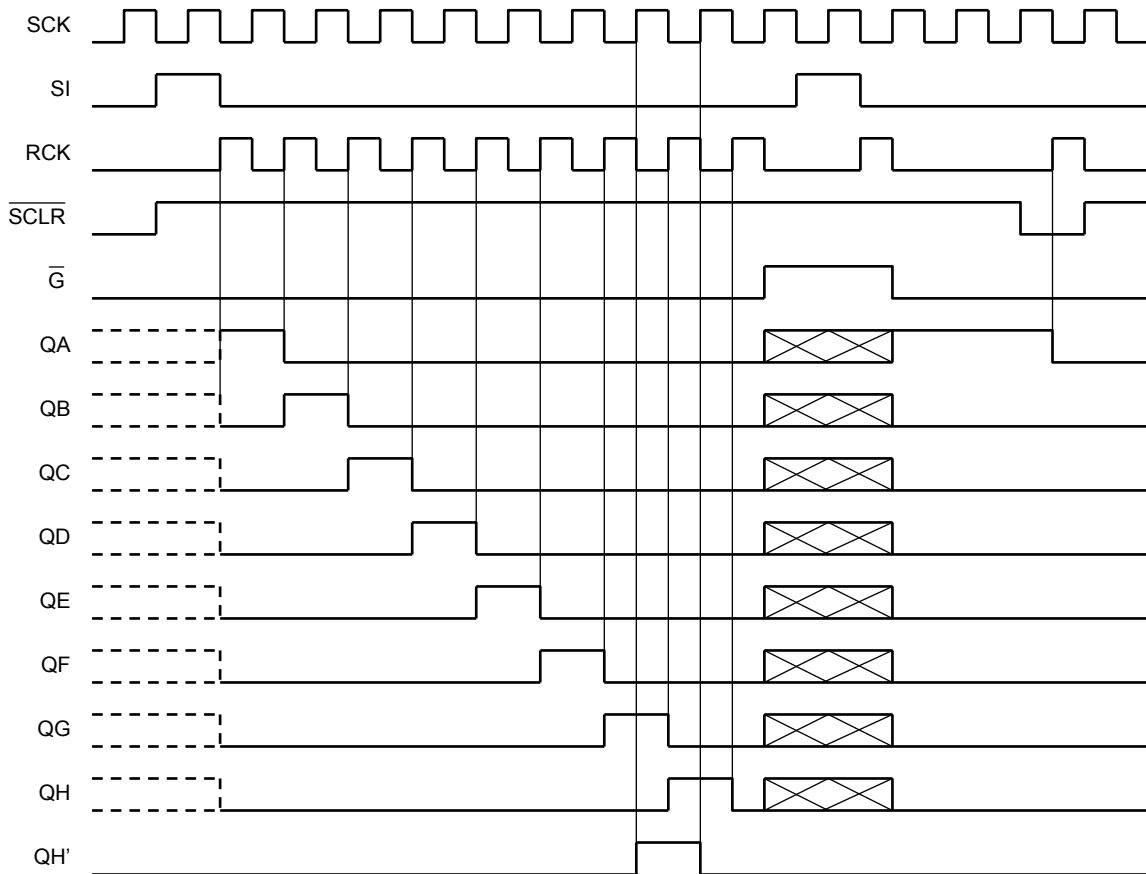


## Truth Table

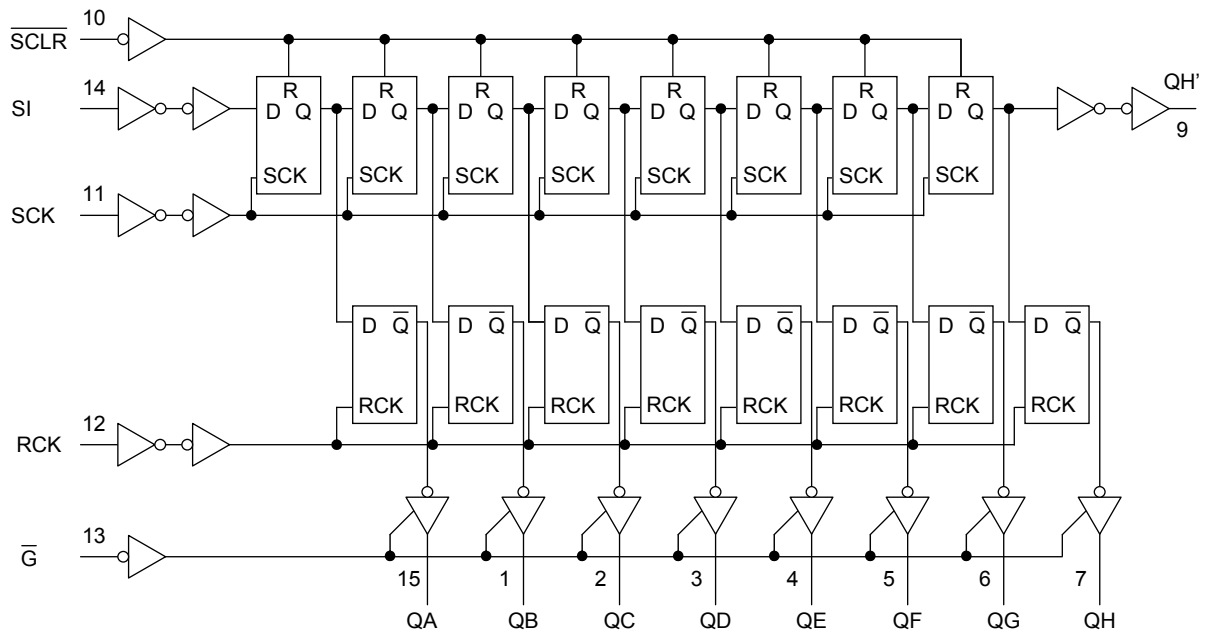
Inputs					Function
SI	SCK	SCLR	RCK	G-bar	
X	X	X	X	H	QA thru QH outputs disable
X	X	X	X	L	QA thru QH outputs enable
X	X	L	X	X	Shift register is cleared.
L		H	X	X	First stage of S.R. becomes "L". Other stages store the data of previous stage, respectively.
H		H	X	X	First stage of S.R. becomes "H". Other stages store the data of previous stage, respectively.
X		H	X	X	State of S.R. is not changed.
X	X	X		X	S.R. data is stored into storage register.
X	X	X		X	Storage register stage is not changed.

X: Don't care

**Timing Chart**



**System Diagram**



## 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	$^{\circ}C$
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 <sub>CC</sub> (V)	Ta = 25°C			Ta = -40 to 85°C		Unit	
				Min	Typ.	Max	Min	Max		
High-level input voltage	V <sub>IH</sub>	—	2.0 3.0 to 5.5	1.50 V <sub>CC</sub> × 0.7	— —	— —	1.50 V <sub>CC</sub> × 0.7	— —	V	
Low-level input voltage	V <sub>IL</sub>	—	2.0 3.0 to 5.5	— —	— —	0.50 V <sub>CC</sub> × 0.3	— —	0.50 V <sub>CC</sub> × 0.3	V	
High-level output voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -50 μA	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 <sub>OH</sub> = -4 mA	3.0	2.58	—	—	2.48	—	
			I <sub>OH</sub> = -8 mA	4.5	3.94	—	—	3.80	—	
Low-level output voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 50 μA	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 <sub>OL</sub> = 4 mA	3.0	—	—	0.36	—	0.44	
			I <sub>OL</sub> = 8 mA	4.5	—	—	0.36	—	0.44	
3-state output off-state current	I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = V <sub>CC</sub> or GND	5.5	—	—	±0.25	—	±2.50	μA	
Input leakage current	I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND	0 to 5.5	—	—	±0.1	—	±1.0	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	5.5	—	—	4.0	—	40.0	μA	

## Timing Requirements (input: $t_r = t_f = 3 \text{ ns}$ )

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C	Unit
			V <sub>CC</sub> (V)	Typ.	Limit	Limit	
Minimum pulse width (SCK, RCK)	$t_w$ (H)	—	3.3 ± 0.3	—	5.0	5.0	ns
	$t_w$ (L)		5.0 ± 0.5	—	5.0	5.0	
Minimum pulse width ( $\overline{\text{SCLR}}$ )	$t_w$ (L)	—	3.3 ± 0.3	—	5.0	5.0	ns
Minimum set-up time (SI-SCK)	$t_s$	—	3.3 ± 0.3	—	3.5	3.5	ns
			5.0 ± 0.5	—	3.0	3.0	
Minimum set-up time (SCK-RCK)	$t_s$	—	3.3 ± 0.3	—	8.0	8.5	ns
Minimum set-up time ( $\overline{\text{SCLR}}$ -RCK)	$t_s$	—	3.3 ± 0.3	—	8.0	9.0	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum hold time (SI-SCK)	$t_h$	—	3.3 ± 0.3	—	1.5	1.5	ns
Minimum hold time (SCK-RCK)	$t_h$	—	3.3 ± 0.3	—	0	0	ns
			5.0 ± 0.5	—	0	0	
Minimum hold time ( $\overline{\text{SCLR}}$ -RCK)	$t_h$	—	3.3 ± 0.3	—	0	0	ns
Minimum removal time ( $\overline{\text{SCLR}}$ )	$t_{rem}$	—	3.3 ± 0.3	—	3.0	3.0	ns
			5.0 ± 0.5	—	2.5	2.5	

## 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 (SCK-QH')	t <sub>pLH</sub>	—	3.3 ± 0.3	15	—	8.8	13.0	1.0	15.0	ns
				50	—	11.3	16.5	1.0	18.5	
	5.0 ± 0.5		15	—	6.2	8.2	1.0	9.4		
			50	—	7.7	10.2	1.0	11.4		
Propagation delay time (SCLR-QH')	t <sub>pHL</sub>	—	3.3 ± 0.3	15	—	8.4	12.8	1.0	13.7	ns
				50	—	10.9	16.3	1.0	17.2	
			5.0 ± 0.5	15	—	5.9	8.0	1.0	9.1	
				50	—	7.4	10.0	1.0	11.1	
Propagation delay time (RCK-Q <sub>n</sub> )	t <sub>pLH</sub>	—	3.3 ± 0.3	15	—	7.7	11.9	1.0	13.5	ns
				50	—	10.2	15.4	1.0	17.0	
	5.0 ± 0.5		15	—	5.4	7.4	1.0	8.5		
			50	—	6.9	9.4	1.0	10.5		
Output enable time	t <sub>pZL</sub>	R <sub>L</sub> = 1 kΩ	3.3 ± 0.3	15	—	7.5	11.5	1.0	13.5	ns
				50	—	9.0	15.0	1.0	17.0	
	5.0 ± 0.5		15	—	4.8	8.6	1.0	10.0		
			50	—	8.3	10.6	1.0	12.0		
Output disable time	t <sub>pLZ</sub>	R <sub>L</sub> = 1 kΩ	3.3 ± 0.3	50	—	12.1	15.7	1.0	16.2	ns
			5.0 ± 0.5	50	—	7.6	10.3	1.0	11.0	
Maximum clock frequency	f <sub>max</sub>	—	3.3 ± 0.3	15	80	150	—	70	—	MHz
				50	55	130	—	50	—	
			5.0 ± 0.5	15	135	185	—	115	—	
				50	95	155	—	85	—	
Input capacitance	C <sub>IN</sub>	—		—	4	10	—	10	pF	
Output capacitance	C <sub>OUT</sub>	—		—	6	—	—	—	pF	
Power dissipation capacitance	C <sub>PD</sub>	(Note)		—	87	—	—	—	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.

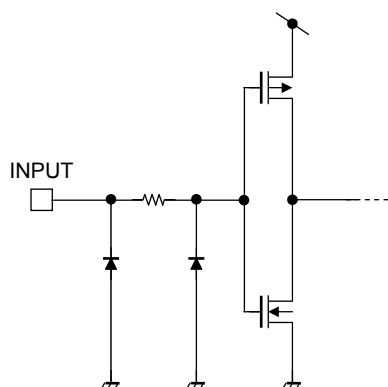
Average operating current can be obtained by the equation:

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

## Noise Characteristics (input: $t_r = t_f = 3 \text{ ns}$ )

Characteristics	Symbol	Test Condition	Ta = 25°C			Unit
			V <sub>CC</sub> (V)	Typ.	Limit	
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	C <sub>L</sub> = 50 pF	5.0	0.8	1.0	V
Quiet output minimum dynamic V <sub>OL</sub>	V <sub>OLV</sub>	C <sub>L</sub> = 50 pF	5.0	-0.8	-1.0	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

## Input Equivalent Circuit

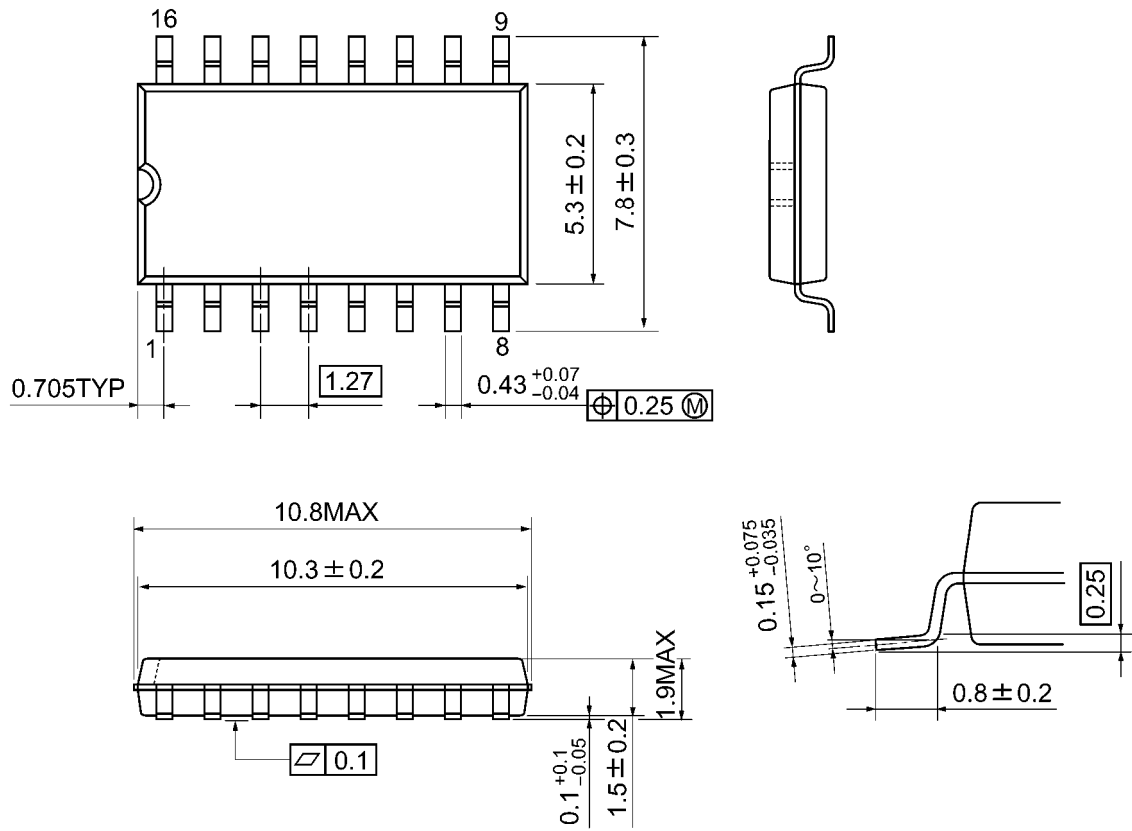




**Package Dimensions**

SOP16-P-300-1.27A

Unit: mm

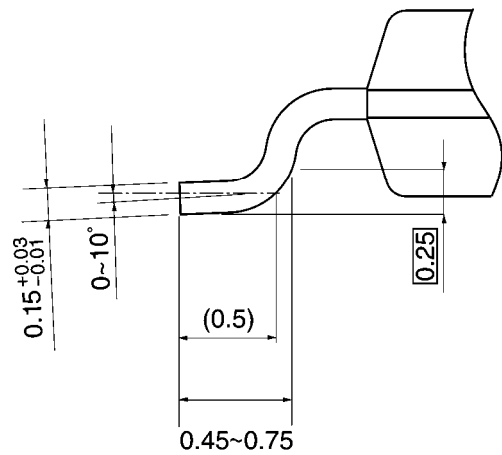
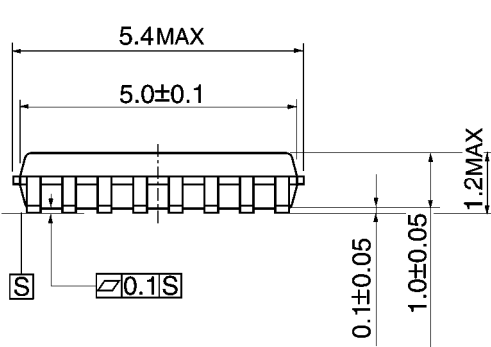
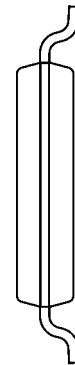
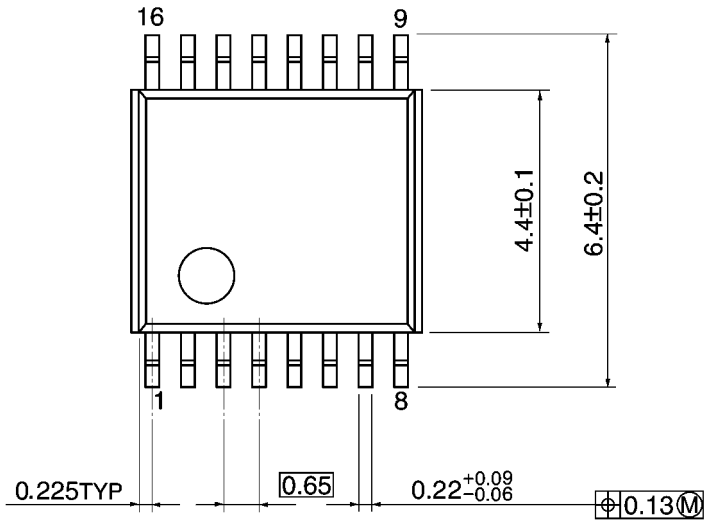


Weight: 0.18 g (typ.)

**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm

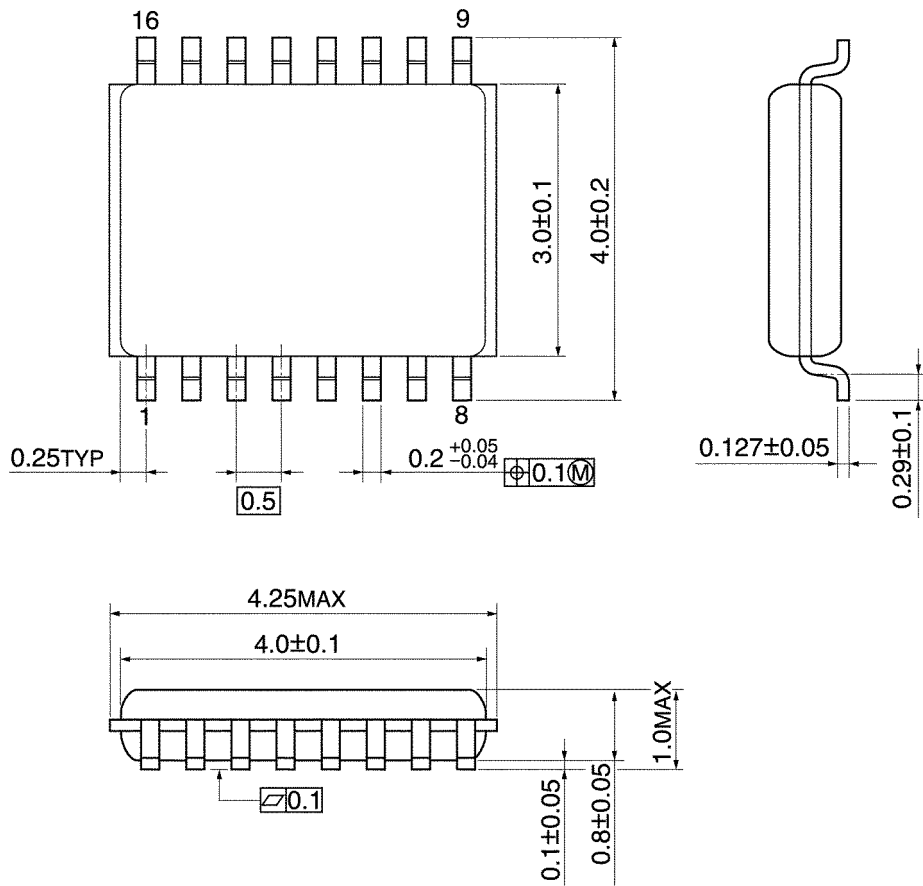


Weight: 0.06 g (typ.)

**Package Dimensions**

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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