

## TC74VHC165F, TC74VHC165FN, TC74VHC165FT, TC74VHC165FK

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

The TC74VHC165 is an advanced high speed CMOS 8-BIT PARALLEL/SERIAL-IN, SERIAL-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 parallel-in or serial-in, serial-out 8-bit shift register with a gated clock input. When the  $\overline{\text{SHIFT/LOAD}}$  input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting with each clock pulse.

When the  $\overline{\text{SHIFT/LOAD}}$  input is held low, the parallel data is loaded synchronously into the register at positive going transition of the clock pulse.

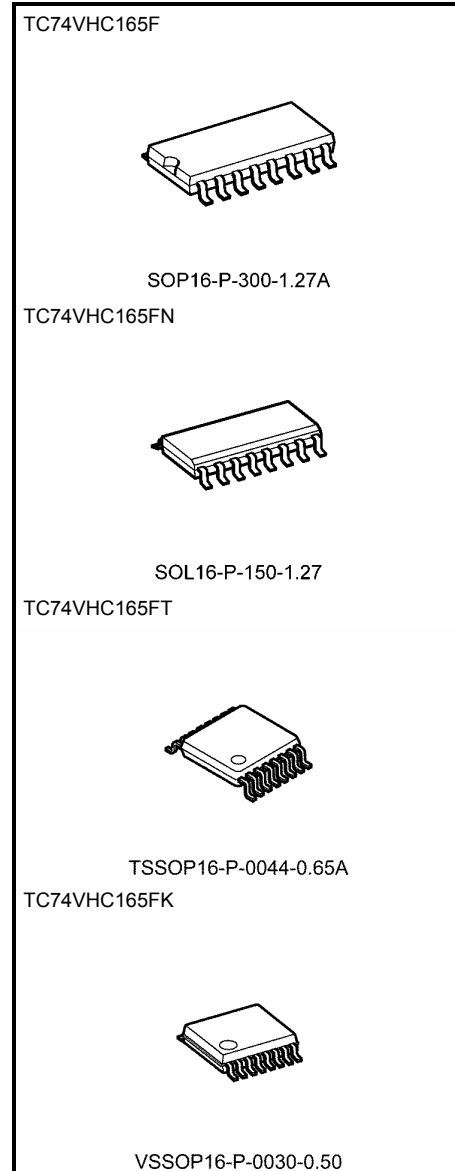
The CK-INH input should be shifted high only when the CK input is held high.

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 on two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

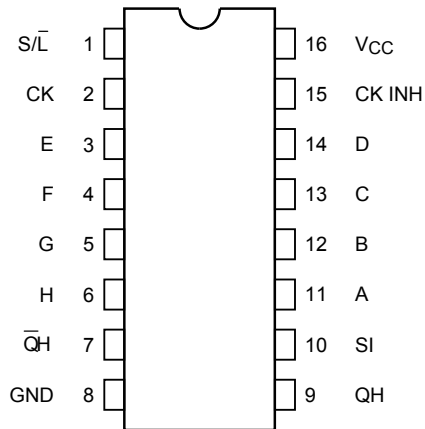
- High speed:  $f_{\text{max}} = 150 \text{ MHz}$  (typ.) at  $V_{\text{CC}} = 5 \text{ V}$
- Low power dissipation:  $I_{\text{CC}} = 4 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays:  $t_{\text{pLH}} \approx t_{\text{pHL}}$
- Wide operating voltage range:  $V_{\text{CC}} (\text{opr}) = 2 \text{ V to } 5.5 \text{ V}$
- Pin and function compatible with 74ALS165

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

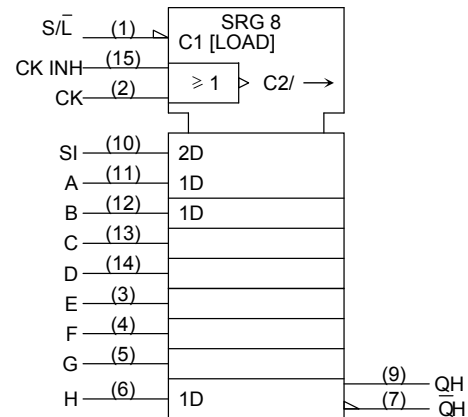


Weight  
 SOP16-P-300-1.27A: 0.18 g (typ.)  
 SOL16-P-150-1.27: 0.13 g (typ.)  
 TSSOP16-P-0044-0.65A: 0.06 g (typ.)  
 VSSOP16-P-0030-0.50: 0.02 g (typ.)

## Pin Assignment



## IEC Logic Symbol



## Truth Table

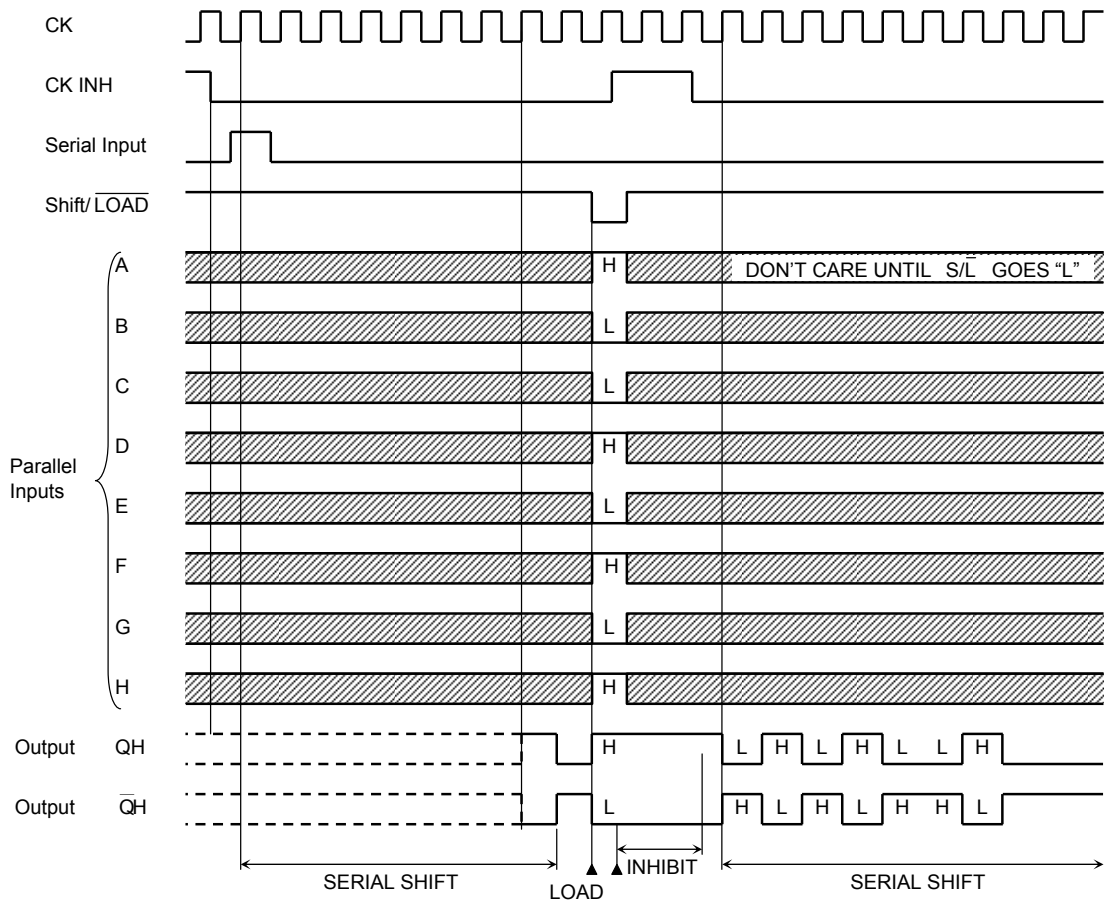
Inputs					Internal Outputs		Outputs	
SHIFT/LOAD	CK INH	CK	SERIAL IN	PARALLEL A.....H	QA	QB	QH	$\bar{Q}H$
L	X	X	X	a.....h	a	b	h	$\bar{h}$
H	L		H	X	H	QA <sub>n</sub>	QG <sub>n</sub>	$\bar{Q}G_n$
H	L		L	X	L	QA <sub>n</sub>	QG <sub>n</sub>	$\bar{Q}G_n$
H		L	H	X	H	QA <sub>n</sub>	QG <sub>n</sub>	$\bar{Q}G_n$
H		L	L	X	L	QA <sub>n</sub>	QG <sub>n</sub>	$\bar{Q}G_n$
H	X	H	X	X	No Change			
H	H	X	X	X	No Change			

X: Don't care

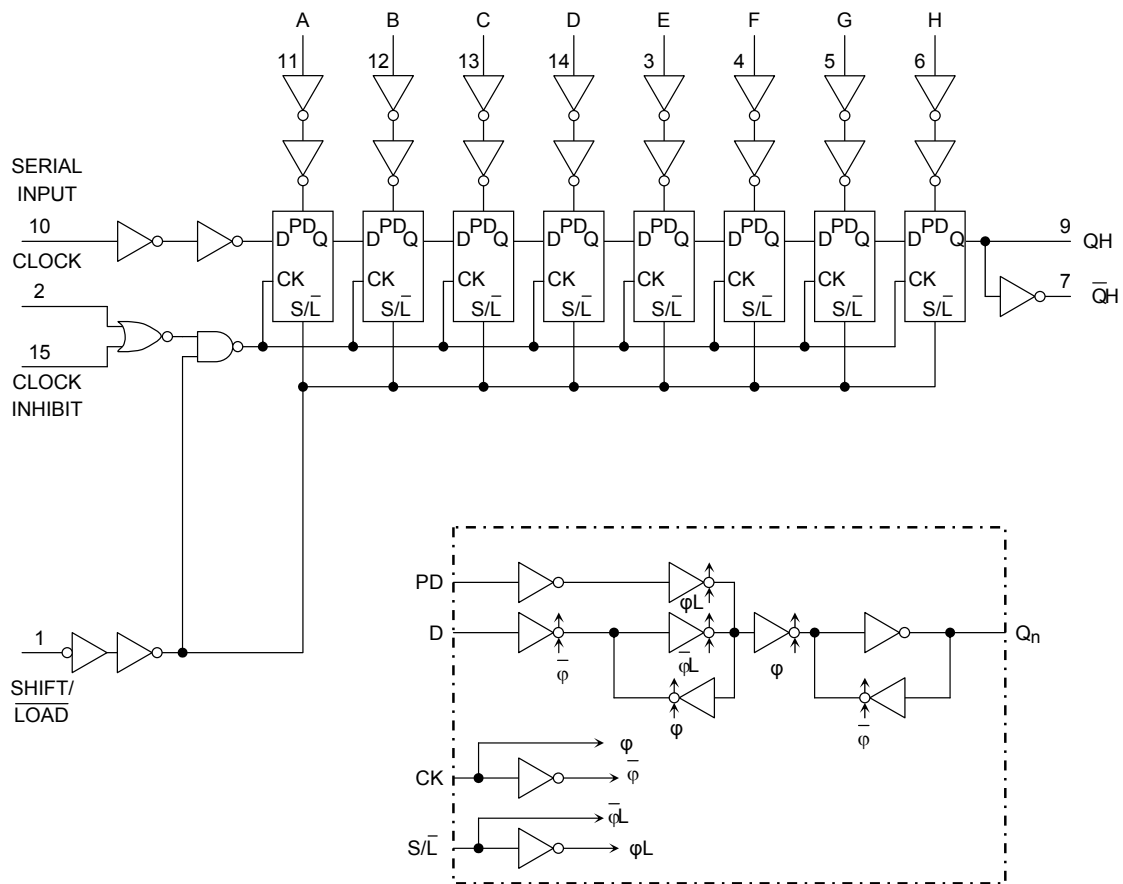
a.....h: The level of steady state input voltage at inputs A through H respectively

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

**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	$I_{CC}$	$\pm 50$	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 VCC or GND.

## Electrical Characteristics

### DC Characteristics

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit		
			$V_{CC}$ (V)	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 $V_{IL}$	$I_{OH} = -50 \mu A$	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
			$I_{OH} = -4$ mA	3.0	2.58	—	—	2.48	—	
			$I_{OH} = -8$ mA	4.5	3.94	—	—	3.80	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50 \mu A$	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
			$I_{OL} = 4$ mA	3.0	—	—	0.36	—	0.44	
			$I_{OL} = 8$ mA	4.5	—	—	0.36	—	0.44	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5$ V or GND	0 to 5.5	—	—	$\pm 0.1$	—	$\pm 1.0$	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	4.0	—	40.0	$\mu A$	

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

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40 to 85°C		Unit
			VCC (V)	Limit	Limit	Limit	
Minimum pulse width (CK, CK INH)	$t_w(L)$	—	3.3 ± 0.3	6.0	7.0	ns	
	$t_w(H)$		5.0 ± 0.5	4.0	4.0		
Minimum pulse width ( $S/\bar{L}$ )	$t_w(L)$	—	3.3 ± 0.3	7.5	9.0	ns	
			5.0 ± 0.5	5.0	6.0		
Minimum set-up time (PI- $S/\bar{L}$ )	$t_s$	—	3.3 ± 0.3	7.5	8.5	ns	
			5.0 ± 0.5	5.0	5.0		
Minimum set-up time (SI-CK, CK INH)	$t_s$	—	3.3 ± 0.3	5.0	6.0	ns	
			5.0 ± 0.5	4.0	4.0		
Minimum set-up time ( $S/\bar{L}$ -CK, CK INH)	$t_s$	—	3.3 ± 0.3	5.0	6.0	ns	
			5.0 ± 0.5	4.0	4.0		
Minimum hold time (PI- $S/\bar{L}$ )	$t_h$	—	3.3 ± 0.3	0.5	0.5	ns	
			5.0 ± 0.5	1.0	1.0		
Minimum hold time (SI-CK, CK INH)	$t_h$	—	3.3 ± 0.3	0.0	0.0	ns	
			5.0 ± 0.5	0.5	0.5		
Minimum hold time ( $S/\bar{L}$ -CK, CK INH)	$t_h$	—	3.3 ± 0.3	0.0	0.0	ns	
			5.0 ± 0.5	0.5	0.5		
Minimum removal time (CK INH-CK) (CK-CK INH)	$t_{rem}$	—	3.3 ± 0.3	5.0	5.0	ns	
			5.0 ± 0.5	3.5	3.5		

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

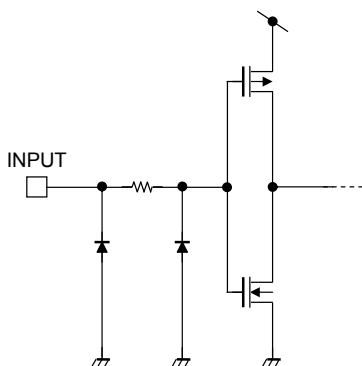
Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit		
			V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Typ.	Max		Min	Max
Propagation delay time (CK, CK INH-QH, $\overline{QH}$ )	$t_{pLH}$	—	3.3 ± 0.3	15	—	9.9	15.4	1.0	18.0	ns
				50	—	12.4	18.9	1.0	21.5	
	5.0 ± 0.5		15	—	6.6	9.9	1.0	11.5		
			50	—	8.1	11.9	1.0	13.5		
Propagation delay time (S/L-QH, $\overline{QH}$ )	$t_{pLH}$	—	3.3 ± 0.3	15	—	9.9	15.8	1.0	18.5	ns
				50	—	12.4	19.3	1.0	22.0	
	5.0 ± 0.5		15	—	6.7	9.9	1.0	11.5		
			50	—	8.2	11.9	1.0	13.5		
Propagation delay time (H-QH, $\overline{QH}$ )	$t_{pLH}$	—	3.3 ± 0.3	15	—	9.2	14.1	1.0	16.5	ns
				50	—	11.7	17.6	1.0	20.0	
	5.0 ± 0.5		15	—	5.9	9.0	1.0	10.5		
			50	—	7.4	11.0	1.0	12.5		
Maximum clock frequency	$f_{max}$	—	3.3 ± 0.3	15	65	85	—	55	—	MHz
				50	60	105	—	50	—	
			5.0 ± 0.5	15	110	150	—	90	—	
				50	95	130	—	85	—	
Input capacitance	C <sub>IN</sub>	—	—	4	10	—	10	pF		
Power dissipation capacitance	C <sub>PD</sub>	(Note)	—	50	—	—	—	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:

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

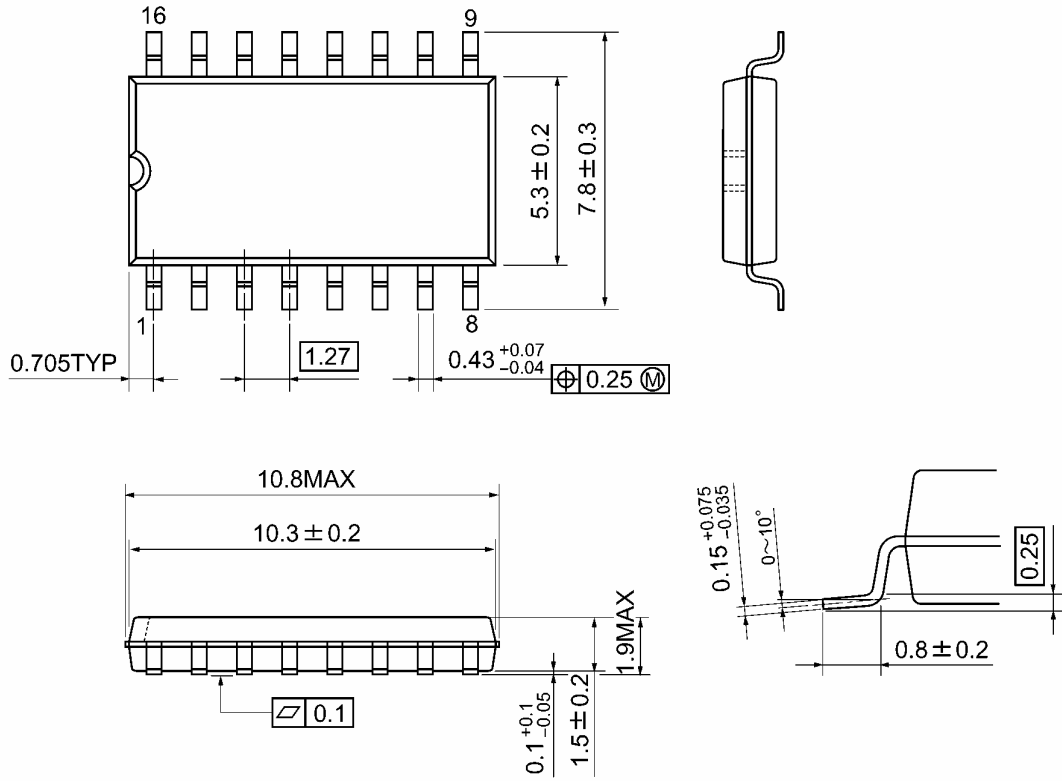
## Input Equivalent Circuit



## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



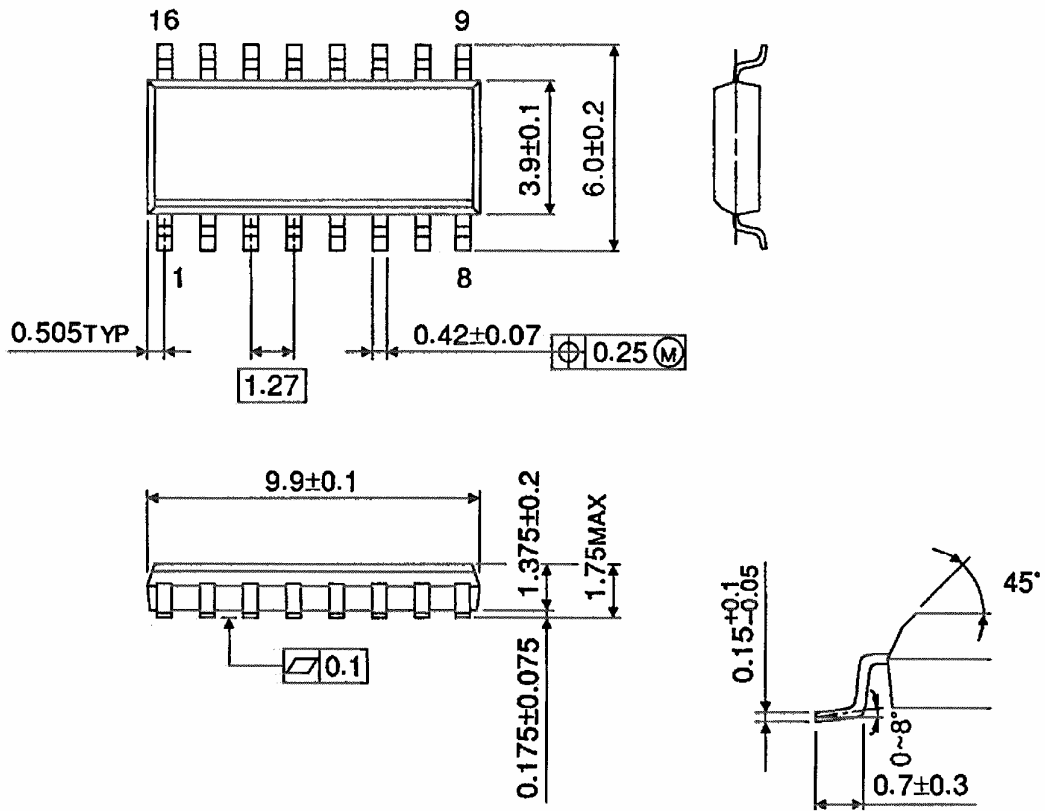
Weight: 0.18 g (typ.)



## Package Dimensions (Note)

SOL16-P-150-1.27

Unit : mm



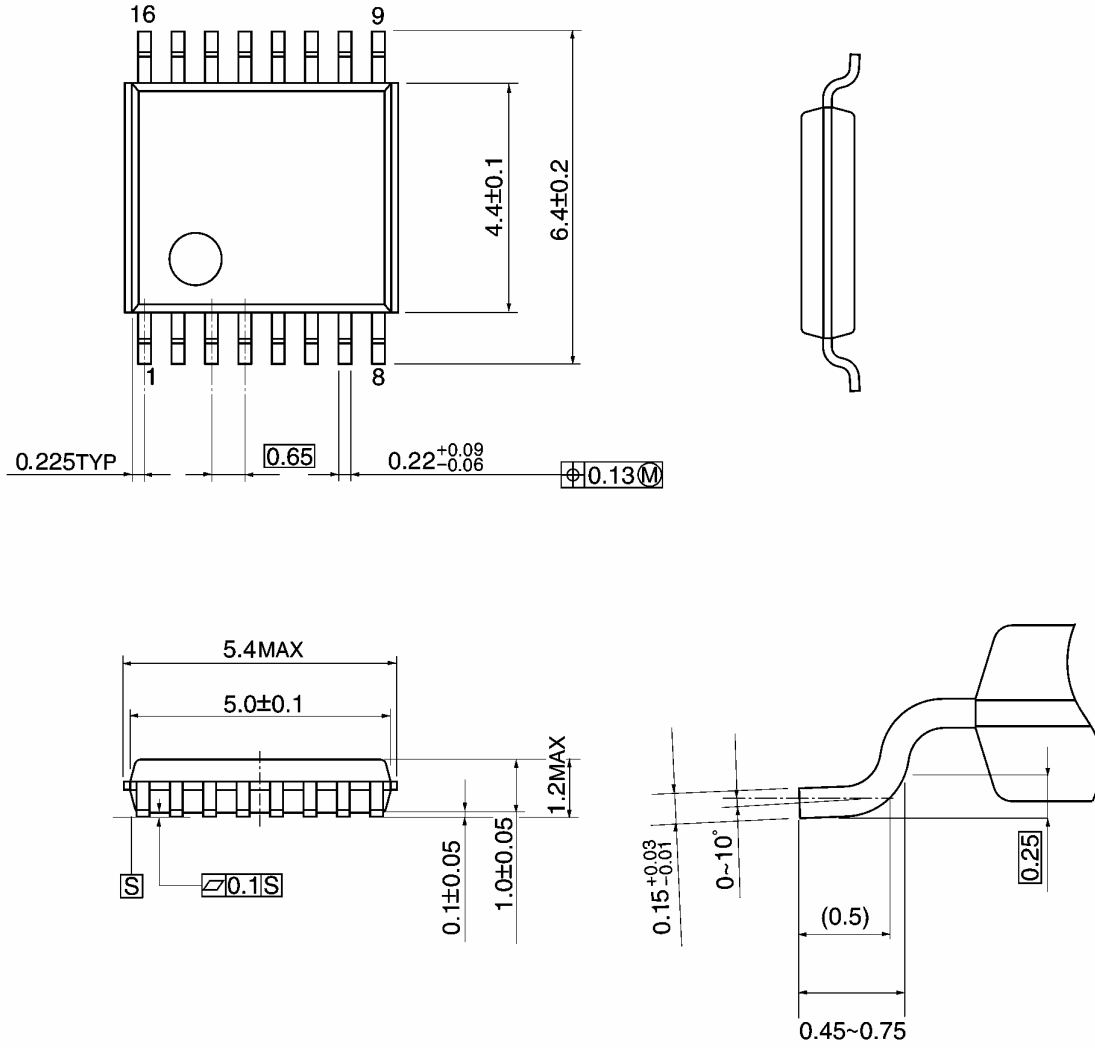
Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

## Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

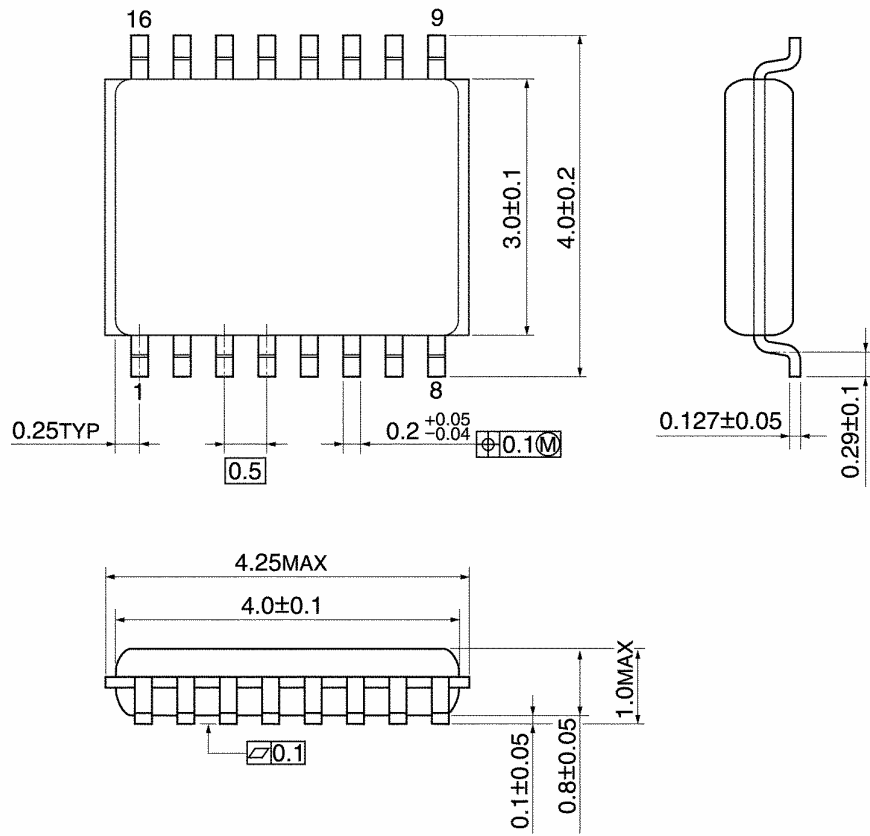


Weight: 0.06 g (typ.)

## Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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20070701-EN GENERAL

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