

TC74VHC165F, 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 C²MOS 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 SHIFT/LOAD input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting with each clock pulse.

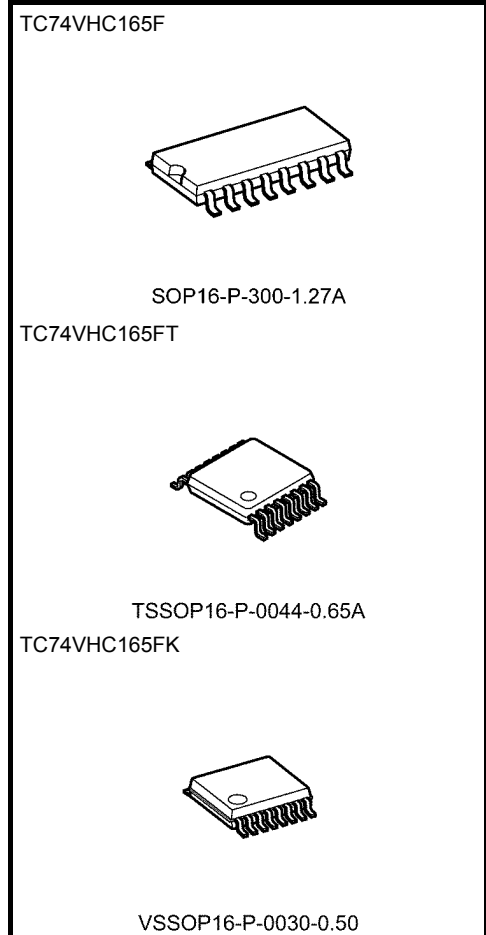
When the SHIFT/LOAD input is held low, the parallel data is loaded synchronously into the register at positive going transition of the clock pulse.

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: $f_{max} = 150$ MHz (typ.) at $V_{CC} = 5$ V
- Low power dissipation: $I_{CC} = 4$ μ 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: $V_{CC} (opr) = 2$ V to 5.5 V
- Pin and function compatible with 74ALS165



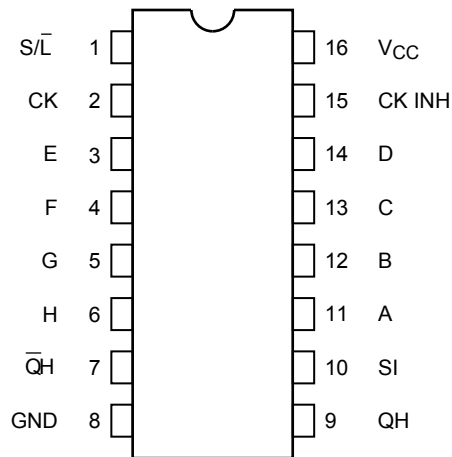
Weight

SOP16-P-300-1.27A: 0.18 g (typ.)

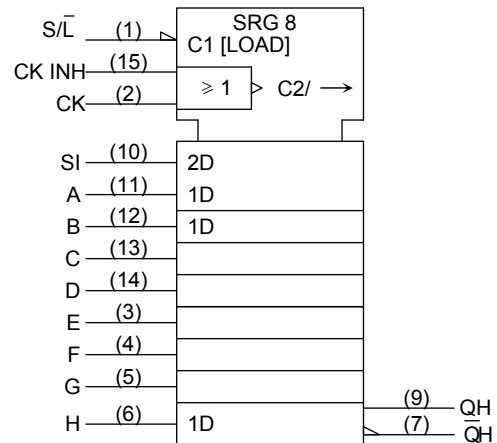
TSSOP16-P-0044-0.65A: 0.06 g (typ.)

VSSOP16-P-0030-0.50: 0.02 g (typ.)

Pin Assignment



IEC Logic Symbol



Truth Table

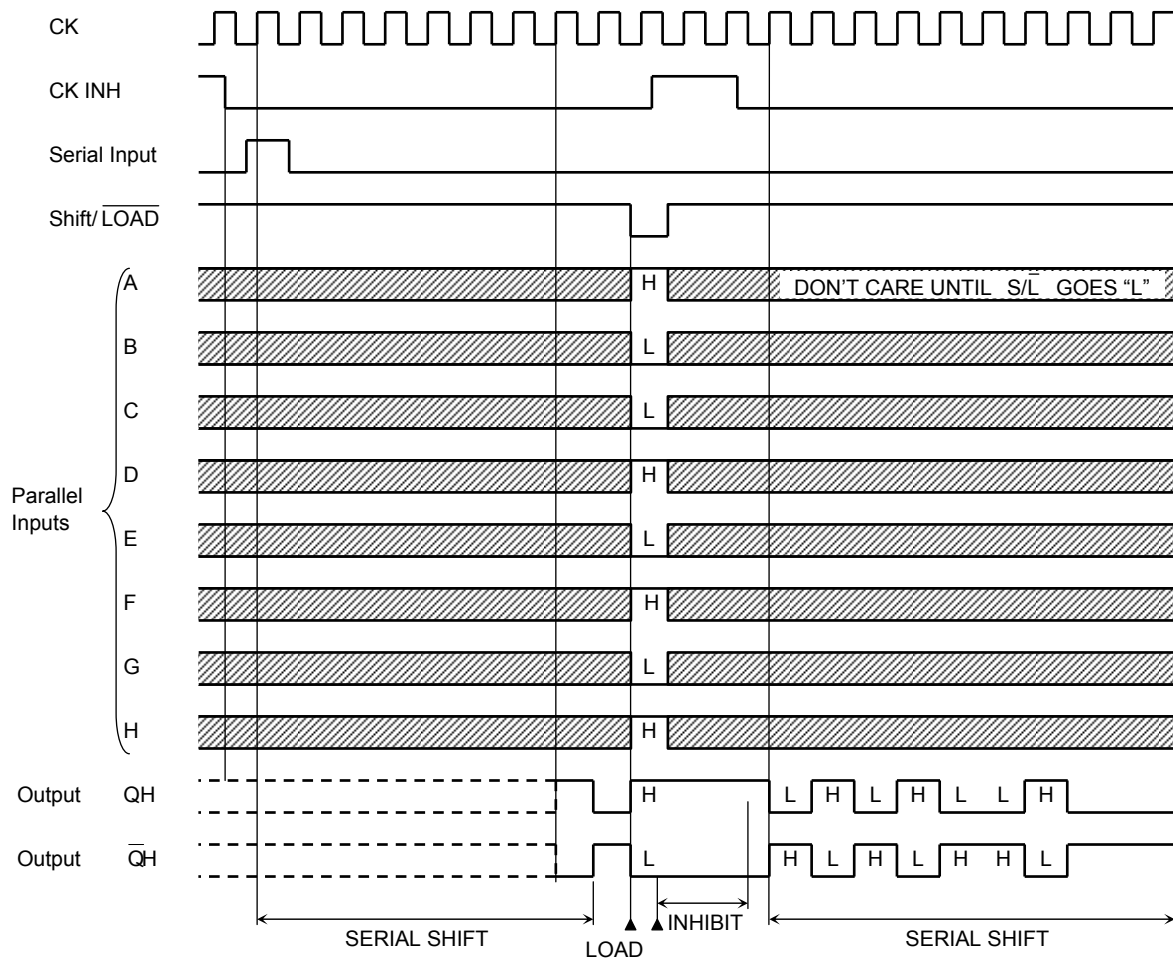
Inputs					Internal Outputs		Outputs	
SHIFT/ LOAD	CK INH	CK	SERIAL IN	PARALLEL A.....H	QA	QB	QH	\overline{QH}
L	X	X	X	a.....h	a	b	h	\overline{h}
H	L	\uparrow	H	X	H	QA _n	QG _n	$\overline{QG_n}$
H	L	\uparrow	L	X	L	QA _n	QG _n	$\overline{QG_n}$
H	\uparrow	L	H	X	H	QA _n	QG _n	$\overline{QG_n}$
H	\uparrow	L	L	X	L	QA _n	QG _n	$\overline{QG_n}$
H	X	H	X	X	No Change			
H	H	X	X	X	No Change			

X: Don't care

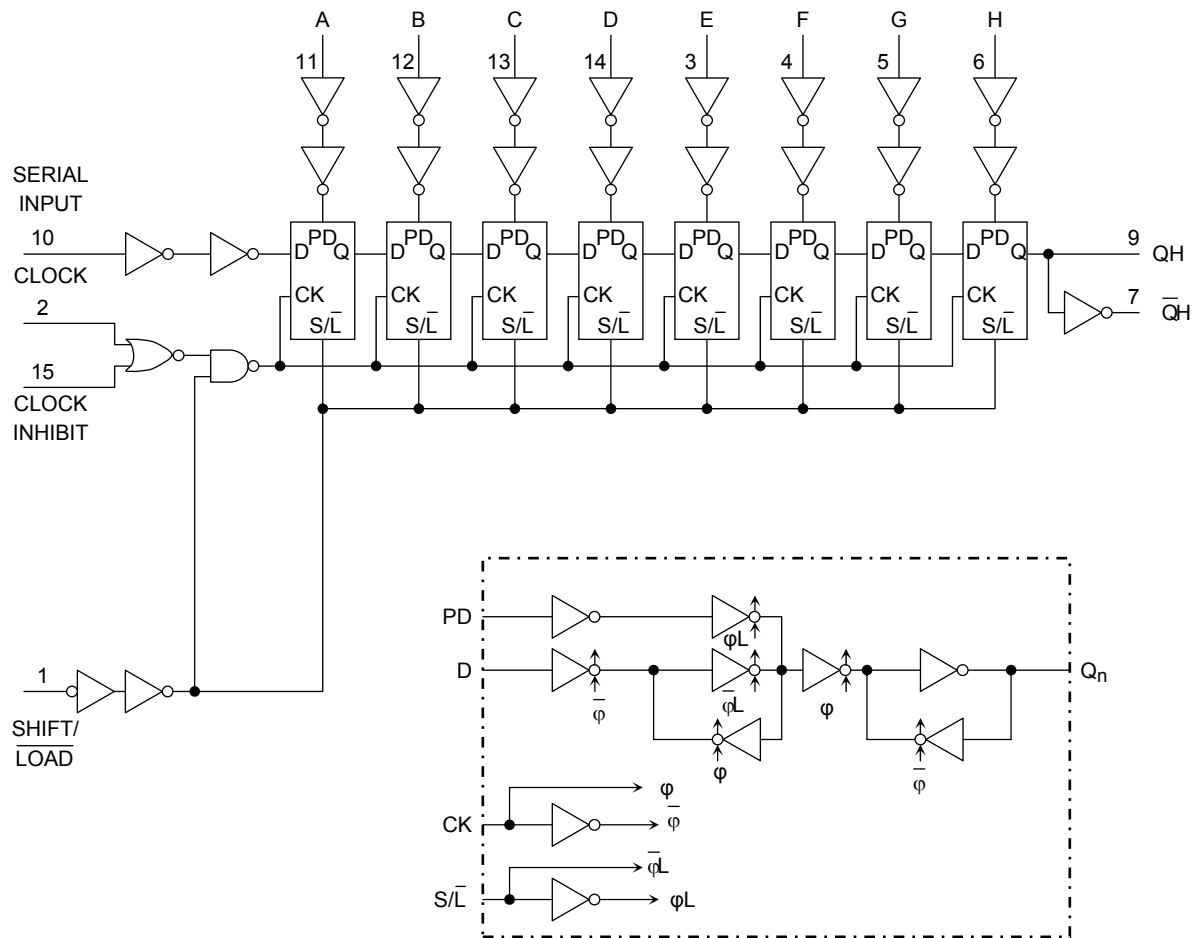
a.....h: The level of steady state input voltage at inputs A through H respectively

QA_n to QG_n: 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}	± 20	mA
DC output current	I_{OUT}	± 25	mA
DC V_{CC} /ground current	I_{CC}	± 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 V_{CC} or GND.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		$T_a = 25^\circ\text{C}$			$T_a = -40$ 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}	$I_{OH} = -50 \mu\text{A}$	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	2.58	—	—	2.48	—	
			$I_{OH} = -8 \text{ mA}$	4.5	3.94	—	—	3.80	—	
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	—	—	0.36	—	0.44	
			$I_{OL} = 8 \text{ mA}$	4.5	—	—	0.36	—	0.44	
Input leakage current	I_{IN}	$V_{IN} = 5.5 \text{ V}$ or GND	0 to 5.5	—	—	± 0.1	—	± 1.0	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ 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
			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 5.0 ± 0.5	7.5 5.0	9.0 6.0	ns	
Minimum set-up time (PI- S/\bar{L})	t_s	—	3.3 ± 0.3 5.0 ± 0.5	7.5 5.0	8.5 5.0	ns	
Minimum set-up time (SI-CK, CK INH)	t_s	—	3.3 ± 0.3 5.0 ± 0.5	5.0 4.0	6.0 4.0	ns	
Minimum set-up time (S/\bar{L} -CK, CK INH)	t_s	—	3.3 ± 0.3 5.0 ± 0.5	5.0 4.0	6.0 4.0	ns	
Minimum hold time (PI- S/\bar{L})	t_h	—	3.3 ± 0.3 5.0 ± 0.5	0.5 1.0	0.5 1.0	ns	
Minimum hold time (SI-CK, CK INH)	t_h	—	3.3 ± 0.3 5.0 ± 0.5	0.0 0.5	0.0 0.5	ns	
Minimum hold time (S/\bar{L} -CK, CK INH)	t_h	—	3.3 ± 0.3 5.0 ± 0.5	0.0 0.5	0.0 0.5	ns	
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: $t_r = t_f = 3 \text{ ns}$)

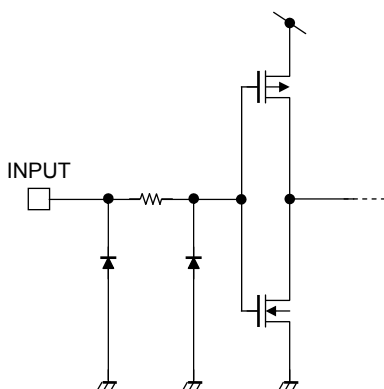
Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
		V _{CC} (V)	C _L (pF)	Min	Typ.	Max	Min	Max		
Propagation delay time (CK, CK INH-QH, \bar{Q} H)	t _{pLH}	—	3.3 ± 0.3	15	—	9.9	15.4	1.0	18.0	ns
				50	—	12.4	18.9	1.0	21.5	
	5.0 ± 0.5		15	—	6.6	9.9	1.0	11.5		
			50	—	8.1	11.9	1.0	13.5		
Propagation delay time (S/L-QH, \bar{Q} H)	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, \bar{Q} H)	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 _{IN}	—		—	4	10	—	10	pF	
Power dissipation capacitance	C _{PD}	(Note)		—	50	—	—	—	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:

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

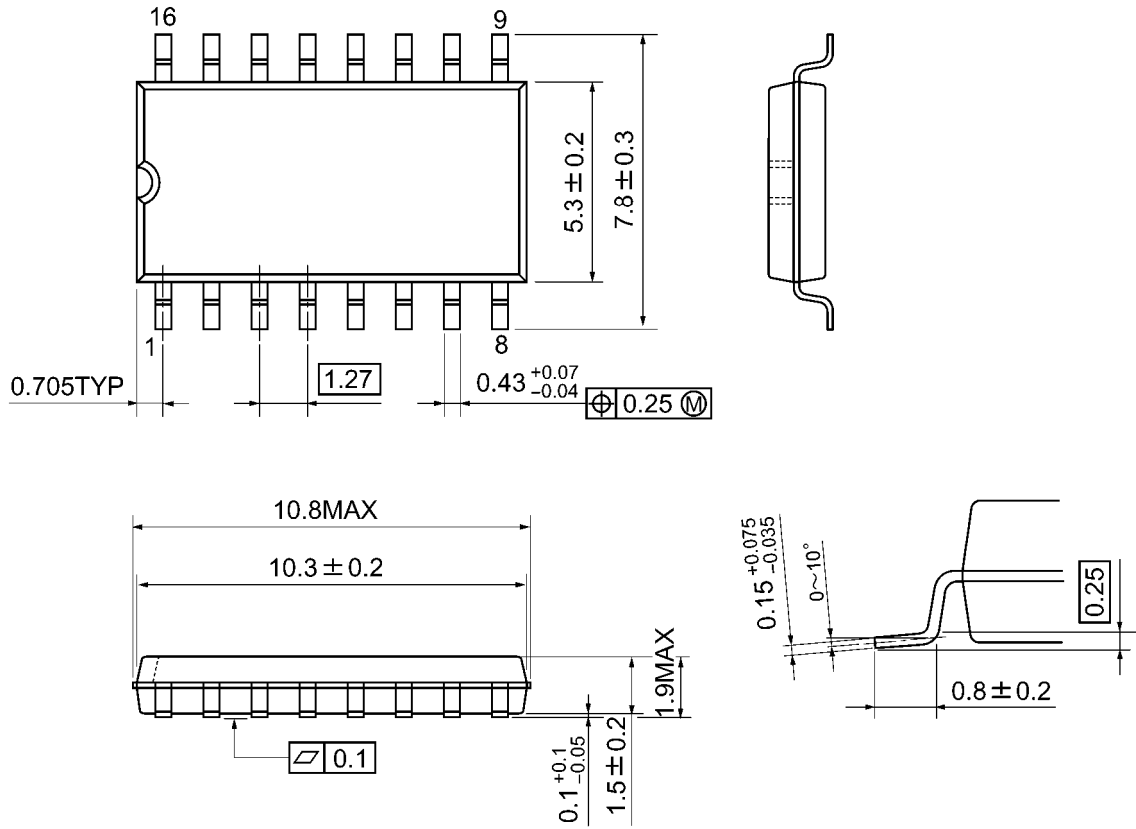
Input Equivalent Circuit



Package Dimensions

SOP16-P-300-1.27A

Unit: mm

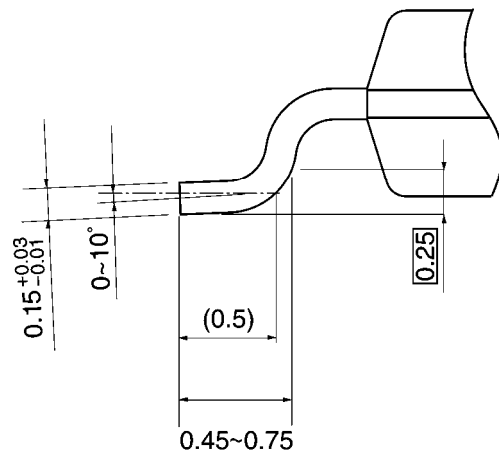
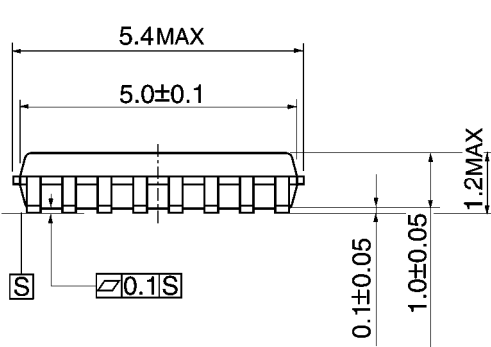
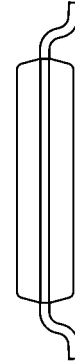
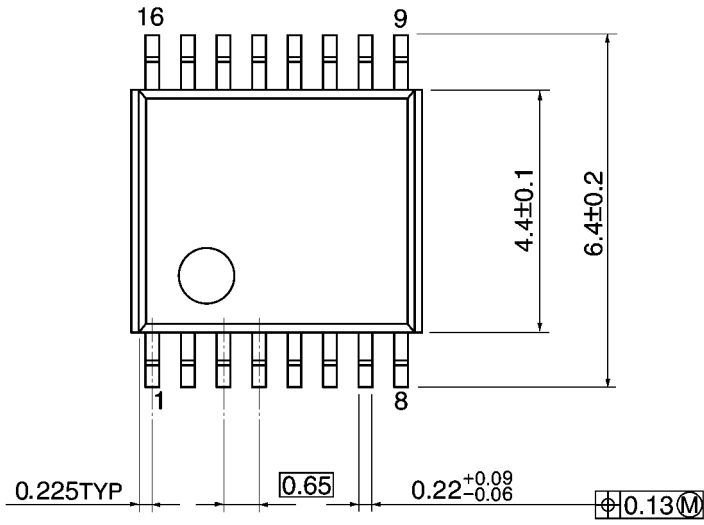


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

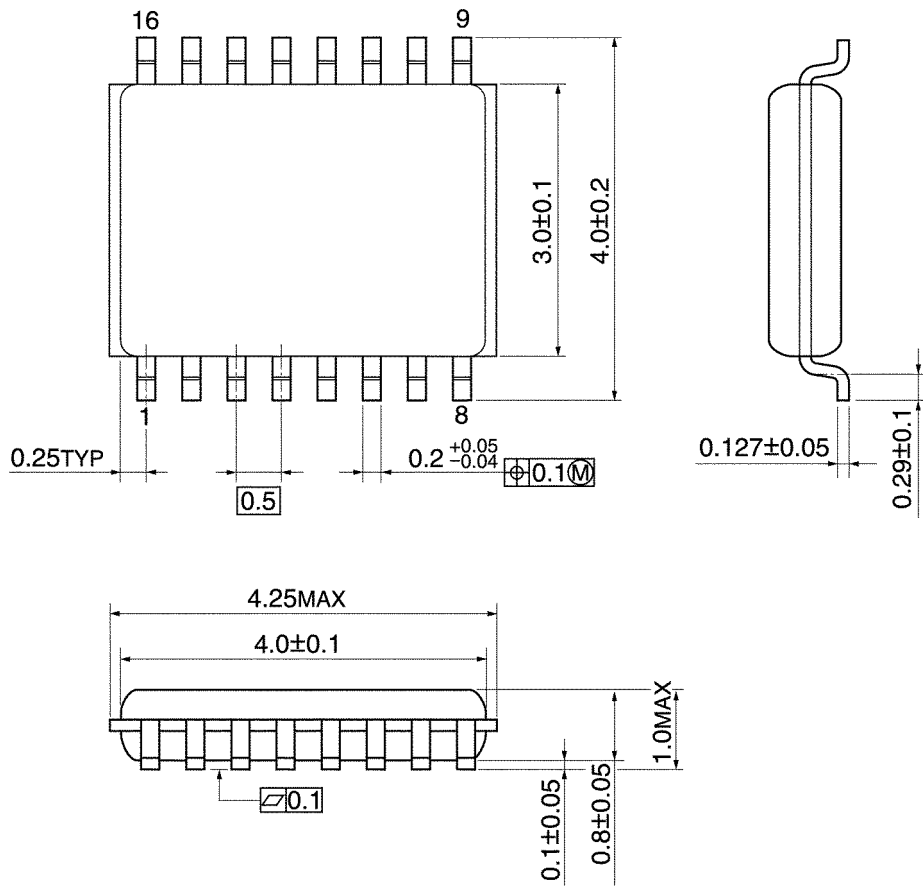


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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