

# 74VHC174FT

## 1. Functional Description

- Hex D-Type Flip-Flop with Clear

## 2. General

The 74VHC174FT is an advanced high speed CMOS HEX D-TYPE FLIP FLOP 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.

Information signals applied to D inputs are transferred to the Q output on the positive going edge of the clock pulse. When the  $\overline{\text{CLR}}$  input is held low, the Q output are in the low logic level independent of the other inputs.

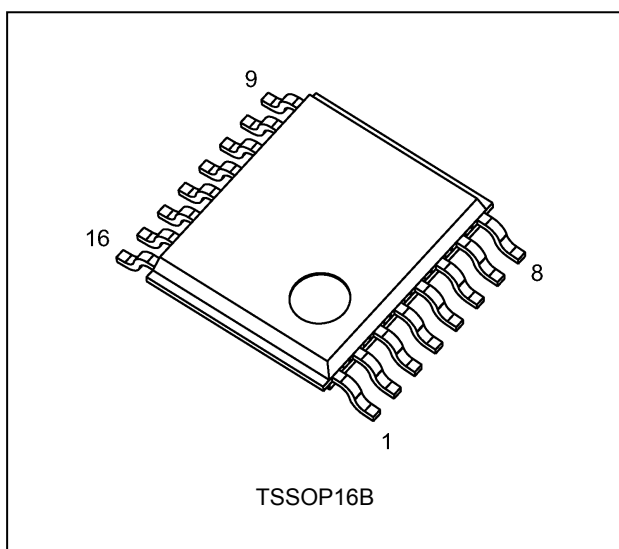
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input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

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{\text{opr}} = -40$  to  $125\text{ }^{\circ}\text{C}$
- (3) High speed:  $f_{\text{MAX}} = 175\text{ MHz}$  (typ.) at  $V_{\text{CC}} = 5\text{ V}$
- (4) Low power dissipation:  $I_{\text{CC}} = 4.0\text{ }\mu\text{A}$  (max) at  $T_a = 25^{\circ}\text{C}$
- (5) High noise immunity:  $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{\text{PLH}} \approx t_{\text{PHL}}$
- (8) Wide operating voltage range:  $V_{\text{CC(opr)}} = 2.0\text{ V}$  to  $5.5\text{ V}$
- (9) Low noise:  $V_{\text{OLP}} = 0.8\text{ V}$  (max)
- (10) Pin and function compatible with 74ALS174.

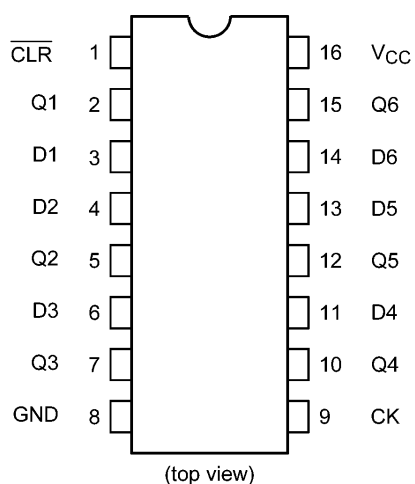
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

## 4. Packaging

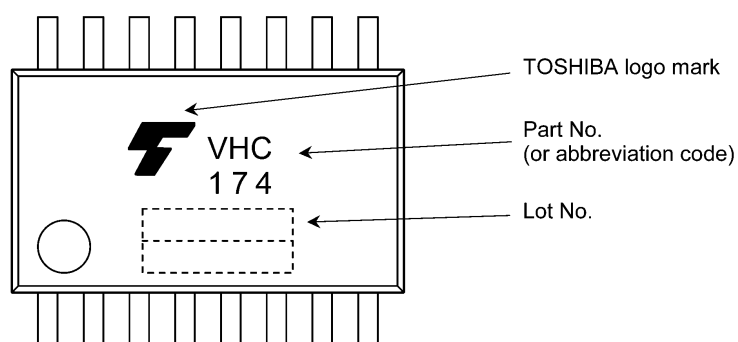


Start of commercial production  
2014-11

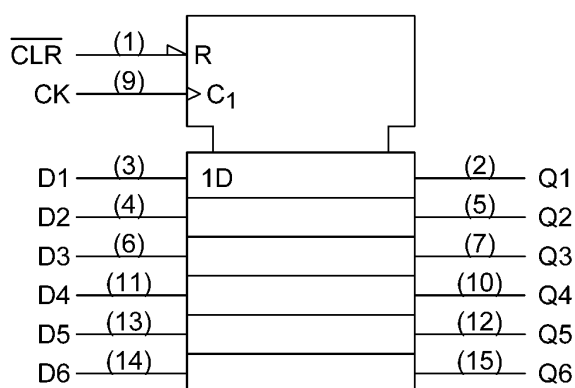
## 5. Pin Assignment






## 6. Marking



## 7. IEC Logic Symbol

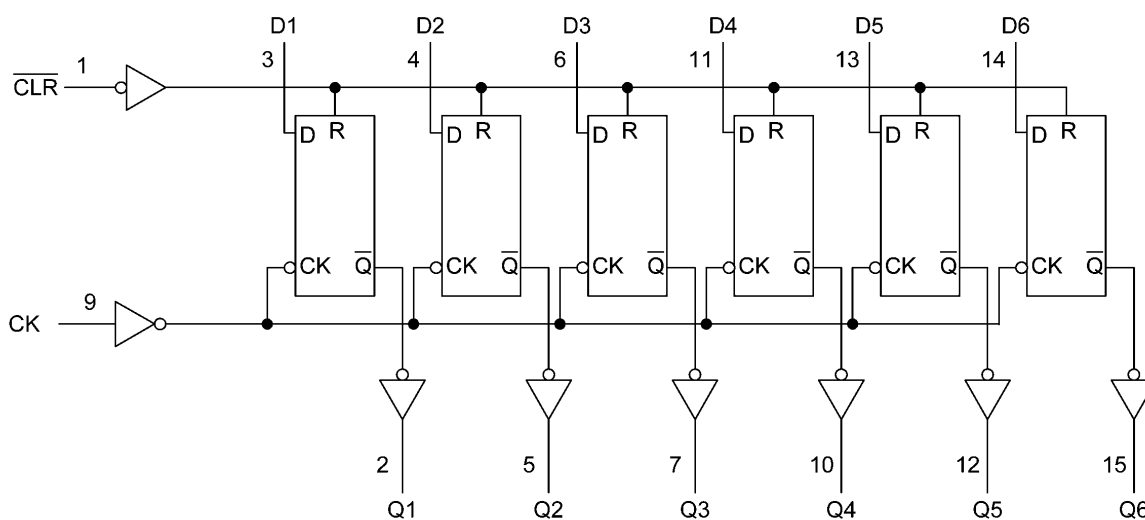


## 8. Truth Table

Inputs			Output	Function
$\overline{\text{CLR}}$	D	CK	Q	
L	X	X	L	Clear
H	L		L	—
H	H		H	—
H	X		Q <sub>n</sub>	No Change

X: Don't care

## 9. System Diagram



## 10. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 7.0	V
Input voltage	$V_{IN}$		-0.5 to 7.0	V
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
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 1)	180	mW
Storage temperature	$T_{stg}$		-65 to 150	°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).

Note 1: 180 mW in the range of  $T_a = -40$  to  $85$  °C. From  $T_a = 85$  to  $125$  °C a derating factor of  $-3.25$  mW/°C shall be applied until 50 mW.

## 11. Operating Ranges (Note)

Characteristics	Symbol	Test Condition	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 125	°C
Input rise and fall times	$dt/dv$	$V_{CC} = 3.3 \pm 0.3$ V	0 to 100	ns/V
		$V_{CC} = 5 \pm 0.5$ V	0 to 20	

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.

## 12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^{\circ}\text{C}$ )

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

12.2. DC Characteristics (Unless otherwise specified,  $T_a = -40\text{ to }85\text{ }^{\circ}\text{C}$ )

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

12.3. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ )

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.40	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.70	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	0.55	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.55	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	$\pm 2.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	80.0	$\mu\text{A}$

#### 12.4. Timing Requirements (Unless otherwise specified, $T_a = 25^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum pulse width (CLR)	$t_{w(L)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	4.5	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	0.0	ns
			$5.0 \pm 0.5$	0.5	
Minimum removal time (CLR)	$t_{rem}$	—	$3.3 \pm 0.3$	3.0	ns
			$5.0 \pm 0.5$	2.5	

#### 12.5. Timing Requirements (Unless otherwise specified, $T_a = -40$ to $85^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum pulse width (CLR)	$t_{w(L)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	6.0	ns
			$5.0 \pm 0.5$	4.5	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	0.0	ns
			$5.0 \pm 0.5$	0.5	
Minimum removal time (CLR)	$t_{rem}$	—	$3.3 \pm 0.3$	3.0	ns
			$5.0 \pm 0.5$	2.5	

#### 12.6. Timing Requirements (Unless otherwise specified, $T_a = -40$ to $125^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum pulse width (CLR)	$t_{w(L)}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	6.0	ns
			$5.0 \pm 0.5$	4.5	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	0.0	ns
			$5.0 \pm 0.5$	0.5	
Minimum removal time (CLR)	$t_{rem}$	—	$3.3 \pm 0.3$	3.0	ns
			$5.0 \pm 0.5$	2.5	

### 12.7. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	—	7.2	11.0	ns
				50	—	9.7	14.5	
			$5.0 \pm 0.5$	15	—	4.9	7.2	
				50	—	6.4	9.2	
Propagation delay time (CLR-Q)	$t_{PHL}$		$3.3 \pm 0.3$	15	—	7.4	11.4	ns
				50	—	9.9	14.9	
			$5.0 \pm 0.5$	15	—	5.1	7.6	
				50	—	6.6	9.6	
Maximum clock frequency	$f_{MAX}$		$3.3 \pm 0.3$	15	95	150	—	MHz
				50	55	85	—	
			$5.0 \pm 0.5$	15	130	175	—	
				50	90	120	—	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	$3.3 \pm 0.3$	50	—	—	1.5	ns
			$5.0 \pm 0.5$	50	—	—	1.0	
Input capacitance	$C_{IN}$				—	4	10	pF
Power dissipation capacitance	$C_{PD}$	(Note 2)			—	29	—	pF

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

Note 2:  $C_{PD}$  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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/6 \text{ (per F/F)}$$

And the total  $C_{PD}$  when n pcs of flip flop operate can be gained by the following equation.

$$C_{PD} \text{ (total)} = 19 + 10 \times n$$

### 12.8. AC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	1.0	13.0	ns
				50	1.0	16.5	
			$5.0 \pm 0.5$	15	1.0	8.5	
				50	1.0	10.5	
Propagation delay time (CLR-Q)	$t_{PHL}$		$3.3 \pm 0.3$	15	1.0	13.5	ns
				50	1.0	17.0	
			$5.0 \pm 0.5$	15	1.0	9.0	
				50	1.0	11.0	
Maximum clock frequency	$f_{MAX}$		$3.3 \pm 0.3$	15	80	—	MHz
				50	50	—	
			$5.0 \pm 0.5$	15	110	—	
				50	80	—	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	$3.3 \pm 0.3$	50	—	1.5	ns
			$5.0 \pm 0.5$	50	—	1.0	
Input capacitance	$C_{IN}$				—	10	pF

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )



## 12.9. AC Characteristics

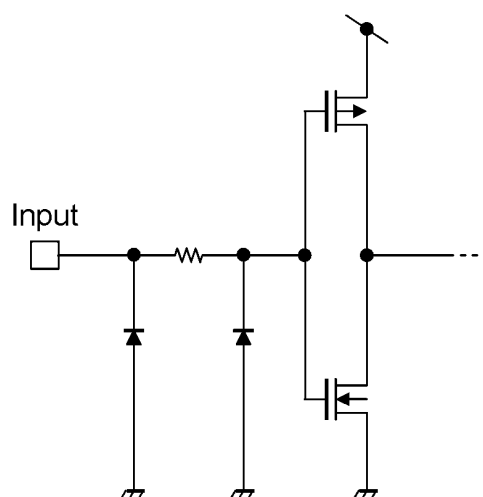
(Unless otherwise specified,  $T_a = -40$  to  $125\text{ }^{\circ}\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Note	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		$3.3 \pm 0.3$	15	1.0	15.0	ns
				50	1.0	18.5	
			$5.0 \pm 0.5$	15	1.0	9.5	
				50	1.0	11.5	
Propagation delay time (CLR-Q)	$t_{PHL}$		$3.3 \pm 0.3$	15	1.0	15.5	ns
				50	1.0	19.0	
			$5.0 \pm 0.5$	15	1.0	10.0	
				50	1.0	12.0	
Maximum clock frequency	$f_{MAX}$		$3.3 \pm 0.3$	15	75	—	MHz
				50	40	—	
			$5.0 \pm 0.5$	15	100	—	
				50	70	—	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	$3.3 \pm 0.3$	50	—	1.5	ns
			$5.0 \pm 0.5$	50	—	1.0	
Input capacitance	$C_{IN}$				—	10	pF

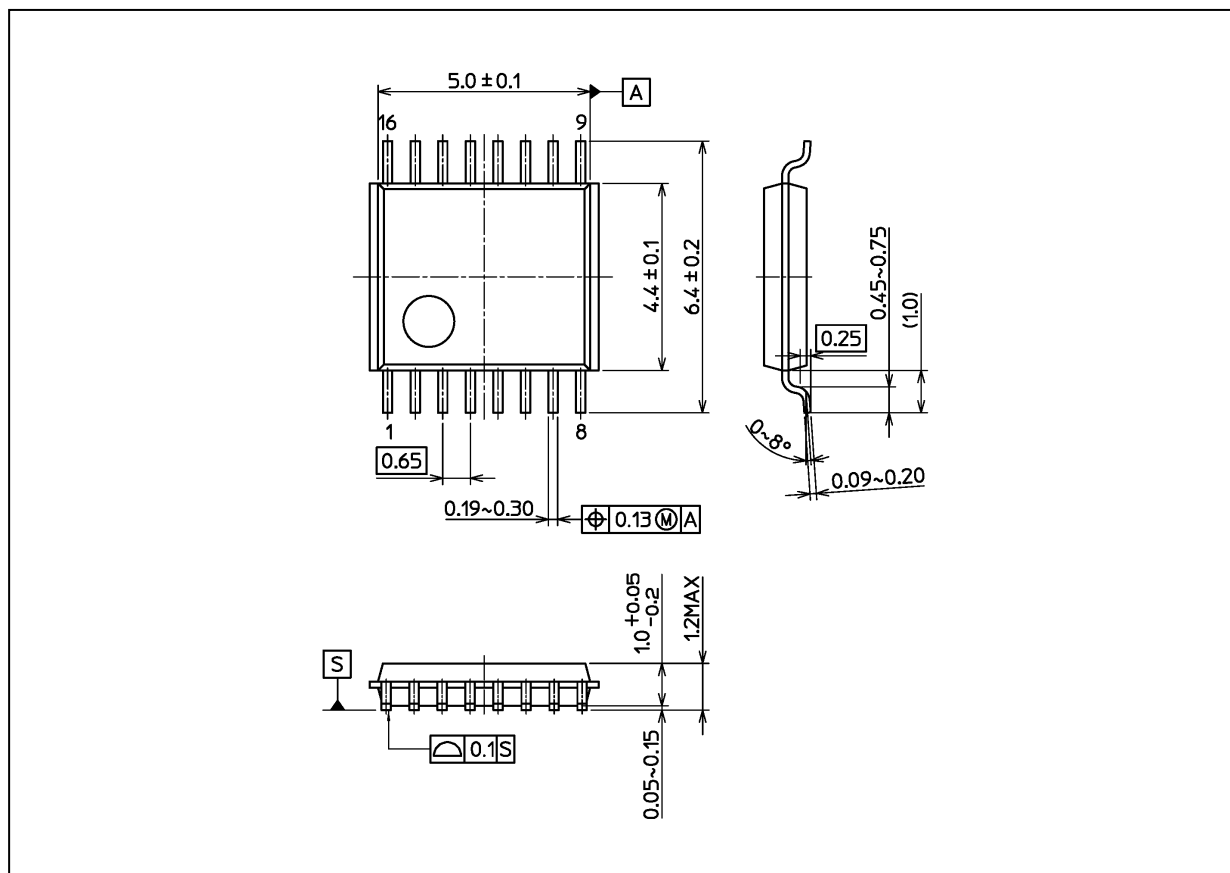
Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )12.10. Noise Characteristics (Unless otherwise specified,  $T_a = 25^{\circ}\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Max	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50\text{ pF}$	5.0	0.4	0.8	V
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50\text{ pF}$	5.0	-0.4	-0.8	V
Minimum high-level dynamic input voltage	$V_{IHD}$	$C_L = 50\text{ pF}$	5.0	—	3.5	V
Maximum low-level dynamic input voltage	$V_{ILD}$	$C_L = 50\text{ pF}$	5.0	—	1.5	V

## 13. Internal Equivalent Circuit



Unit: mm



Weight: 0.055 g (typ.)

Package Name(s)
Nickname: TSSOP16B

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