

# 74VHC374FT

## 1. Functional Description

- Octal D-Type Flip Flop with 3-State Outputs

## 2. General

The 74VHC374FT is an advanced high speed CMOS OCTAL FLIP-FLOP with 3-STATE OUTPUT 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.

This 8-bit D-type flip-flop is controlled by a clock input (CK) and an output enable input ( $\overline{OE}$ ).

When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

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.

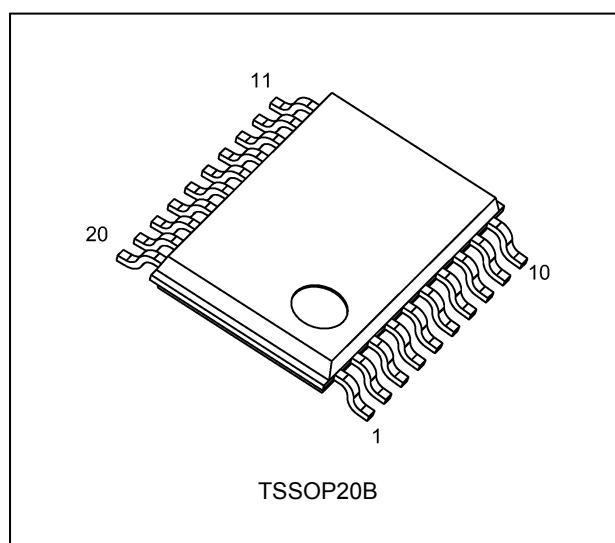
This circuit prevents device destruction due to mismatched supply and input voltages.

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125^{\circ}\text{C}$
- (3) High speed:  $f_{MAX} = 185$  MHz (typ.) at  $V_{CC} = 5.0$  V
- (4) Low power dissipation:  $I_{CC} = 4.0$   $\mu\text{A}$  (max) at  $T_a = 25^{\circ}\text{C}$
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to  $5.5$  V
- (9) Low noise:  $V_{OLP} = 0.8$  V (max)
- (10) Pin and function compatible with the 74 series  
(74AC/HC/AHC/LV etc.) 374 type.

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

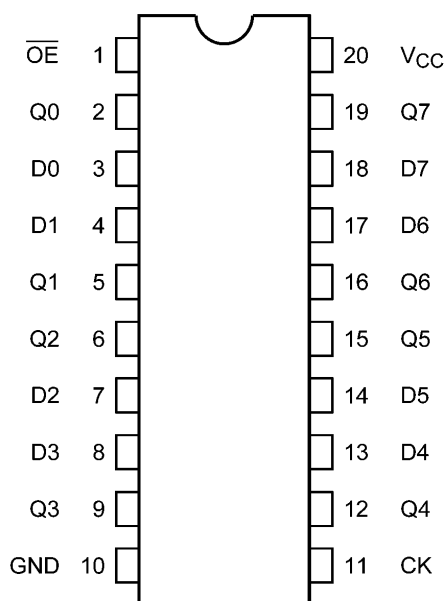
## 4. Packaging



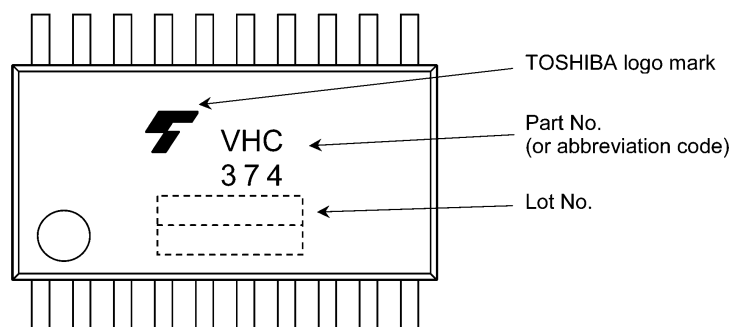
Start of commercial production

2014-03

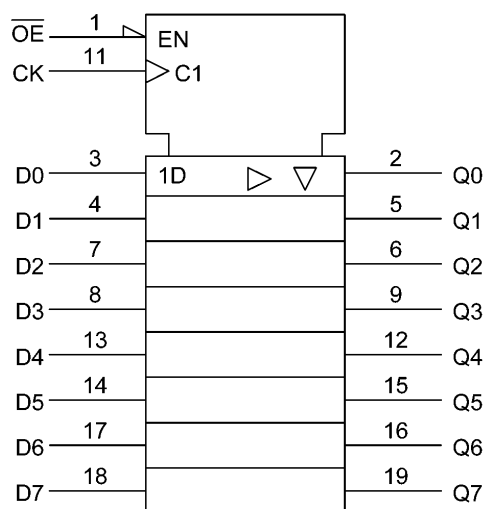
## 5. Pin Assignment






## 6. Marking



## 7. IEC Logic Symbol

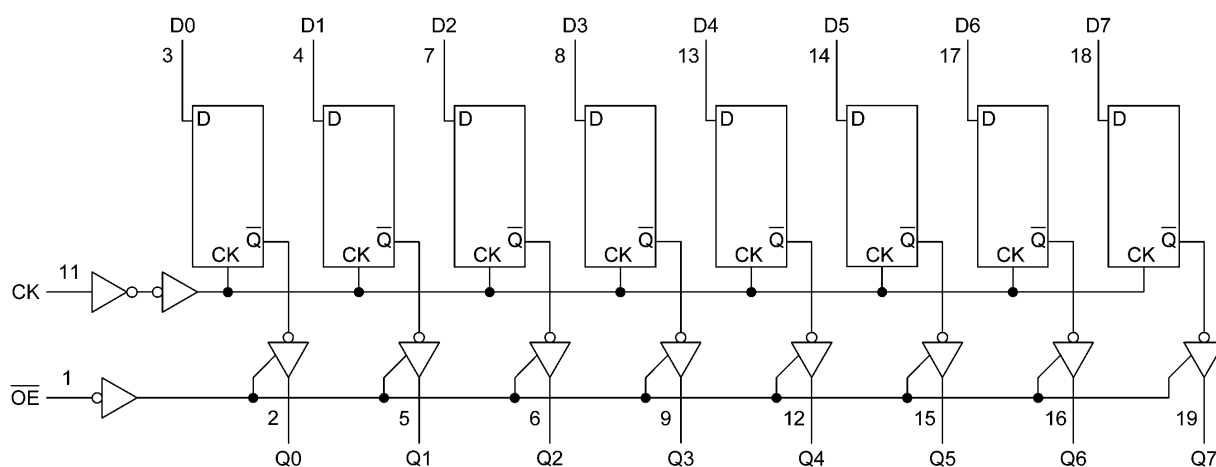


## 8. Truth Table

Inputs			Output
$\overline{OE}$	CK	D	
H	X	X	Z
L		X	$Q_n$
L		L	L
L		H	H

X: Don't care  
 Z: High impedance  
 $Q_n$ : No change

## 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	$I_{CC}$		$\pm 75$	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
		$V_{CC} = 5.0 \pm 0.5$ 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	$V_{OH}$	$V_{IN} = V_{IH}$ 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	$V_{OL}$	$V_{IN} = V_{IH}$ 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	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = V_{CC}$ or GND		5.5	—	—	$\pm 0.25$	$\mu\text{A}$
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	$I_{CC}$	$V_{IN} = V_{CC}$ 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	$V_{OH}$	$V_{IN} = V_{IH}$ 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	$V_{OL}$	$V_{IN} = V_{IH}$ 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	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = V_{CC}$ or GND		5.5	—	$\pm 2.50$	$\mu\text{A}$
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	$I_{CC}$	$V_{IN} = V_{CC}$ 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	$V_{OH}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.40	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.70	—	
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	—	0.55	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.55	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$ $V_{OUT} = V_{CC} \text{ or GND}$		5.5	—	$\pm 10.0$	$\mu\text{A}$
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	$I_{CC}$	$V_{IN} = V_{CC} \text{ or GND}$		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 setup time	$t_s$	—	$3.3 \pm 0.3$	4.5	ns
			$5.0 \pm 0.5$	3.0	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	2.0	ns
			$5.0 \pm 0.5$	2.0	

**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)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	5.5	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	4.5	ns
			$5.0 \pm 0.5$	3.0	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	2.0	ns
			$5.0 \pm 0.5$	2.0	

**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)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	5.5	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	5.5	ns
			$5.0 \pm 0.5$	3.5	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	2.0	ns
			$5.0 \pm 0.5$	2.0	

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	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	8.1	12.7	ns
					50	—	10.6	16.2	
				$5.0 \pm 0.5$	15	—	5.4	8.1	
					50	—	6.9	10.1	
3-state output enable time	$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	—	7.1	11.0	ns
					50	—	9.6	14.5	
				$5.0 \pm 0.5$	15	—	5.1	7.6	
					50	—	6.6	9.6	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	50	—	10.2	14.0	ns
				$5.0 \pm 0.5$	50	—	6.1	8.8	
Maximum clock frequency	$f_{MAX}$		—	$3.3 \pm 0.3$	15	80	130	—	MHz
					50	55	85	—	
				$5.0 \pm 0.5$	15	130	185	—	
					50	85	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
Output capacitance	$C_{OUT}$		—			—	6	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 2)	—			—	32	—	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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8 \text{ (per F/F)}$$

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

$$C_{PD} \text{ (total)} = 20 + 12 \times n$$

## 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	Test Condition	$V_{CC}$ (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	
3-state output enable time	$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	13.0	ns
					50	1.0	16.5	
				$5.0 \pm 0.5$	15	1.0	9.0	
					50	1.0	11.0	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	50	1.0	16.0	ns
				$5.0 \pm 0.5$	50	1.0	10.0	
Maximum clock frequency	$f_{MAX}$		—	$3.3 \pm 0.3$	15	70	—	MHz
					50	50	—	
				$5.0 \pm 0.5$	15	110	—	
					50	75	—	
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:  $t_r = t_f = 3\text{ ns}$ )

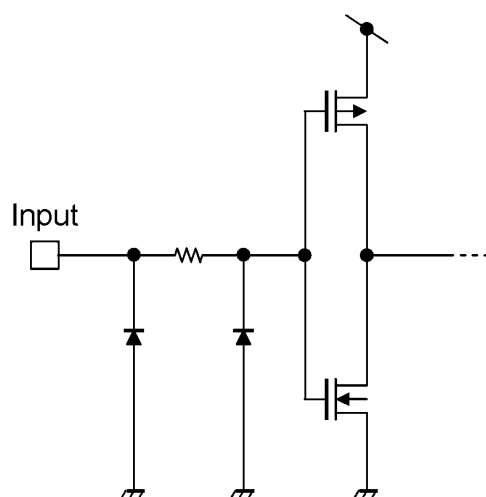
Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	1.0	17.0	ns
					50	1.0	20.5	
				$5.0 \pm 0.5$	15	1.0	11.0	
					50	1.0	13.0	
3-state output enable time	$t_{PZL}, t_{PZH}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	15	1.0	15.0	ns
					50	1.0	18.5	
				$5.0 \pm 0.5$	15	1.0	10.0	
					50	1.0	12.0	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		$R_L = 1\text{ k}\Omega$	$3.3 \pm 0.3$	50	1.0	17.5	ns
				$5.0 \pm 0.5$	50	1.0	11.0	
Maximum clock frequency	$f_{MAX}$		—	$3.3 \pm 0.3$	15	60	—	MHz
					50	40	—	
				$5.0 \pm 0.5$	15	100	—	
					50	65	—	
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:  $t_r = t_f = 3\text{ ns}$ )

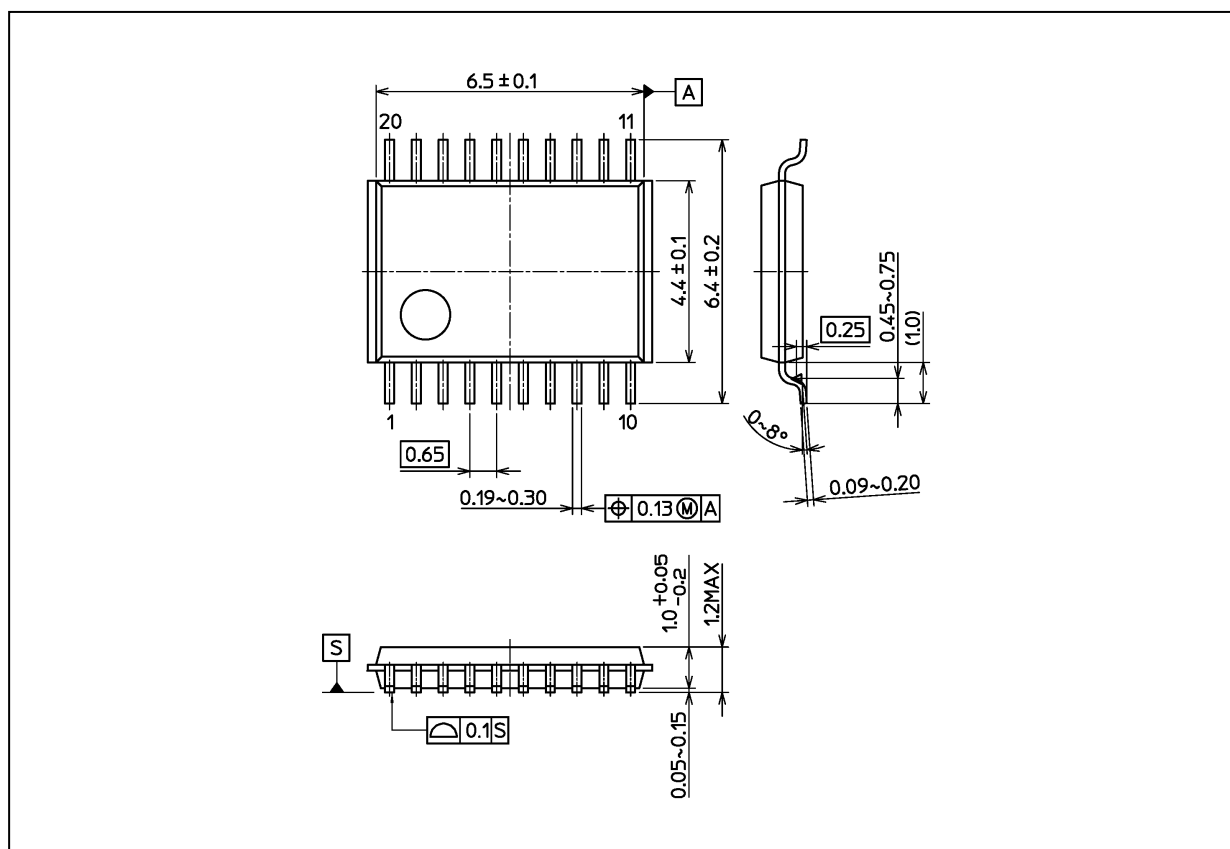
Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$C_L = 50\text{ pF}$	5.0	0.5	0.8	V
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$C_L = 50\text{ pF}$	5.0	-0.5	-0.8	V
Minimum high-level dynamic input voltage	$V_{IHD}$	$C_L = 50\text{ pF}$	5.0	—	3.5	V
Maximum low-level dynamic input voltage	$V_{ILD}$	$C_L = 50\text{ pF}$	5.0	—	1.5	V

## 13. Input Equivalent Circuit



## Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

Package Name(s)
Nickname: TSSOP20B

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