

CMOS Digital Integrated Circuits Silicon Monolithic

# TC74AC164FT

## 1. Functional Description

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

## 2. General

The TC74AC164FT is an advanced high speed CMOS 8-BIT SERIAL-IN PARALLEL-OUT SHIFT REGISTER fabricated with silicon gate and double-layer metal wiring 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 a serial-in, parallel-out 8-bit shift register with a CLOCK input and an overriding  $\overline{\text{CLEAR}}$  input.

Two serial data inputs (A, B) are provided so that one may be used as a data enable.

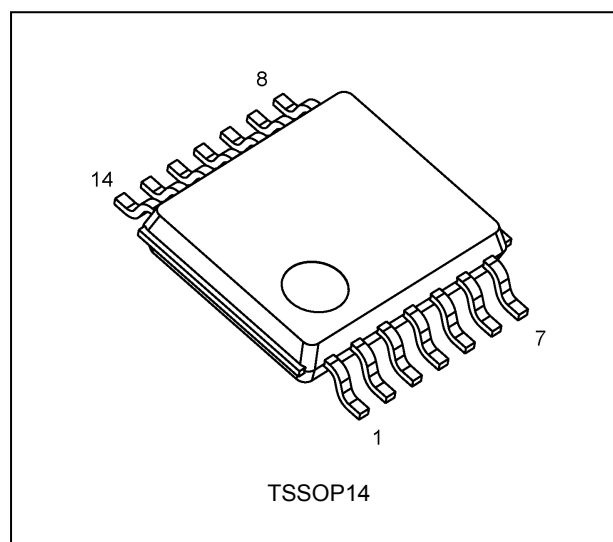
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 1)
- (2) High speed:  $f_{MAX} = 170$  MHz (typ.) at  $V_{CC} = 5.0$  V
- (3) Low power dissipation:  $I_{CC} = 8.0$   $\mu$ A (max) at  $T_a = 25$  °C
- (4) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- (5) Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 4.5$  V)
- (6) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (7) Wide operating voltage range:  $V_{CC(opr)} = 2.0$  V to  $5.5$  V
- (8) Pin and function compatible with 74F164

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2022.

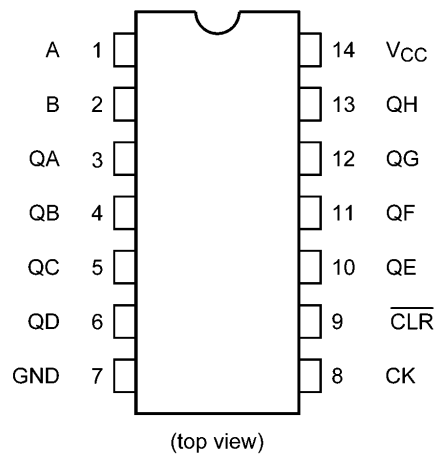
## 4. Packaging



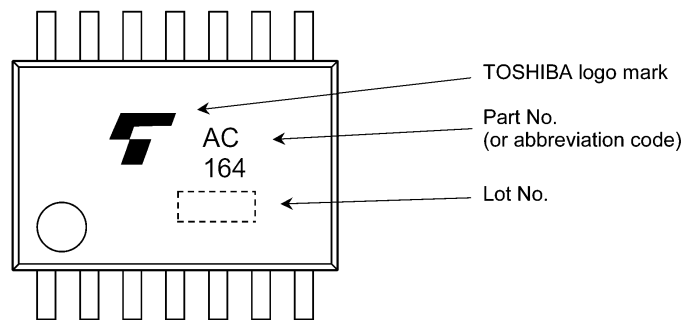
Start of commercial production

2022-04

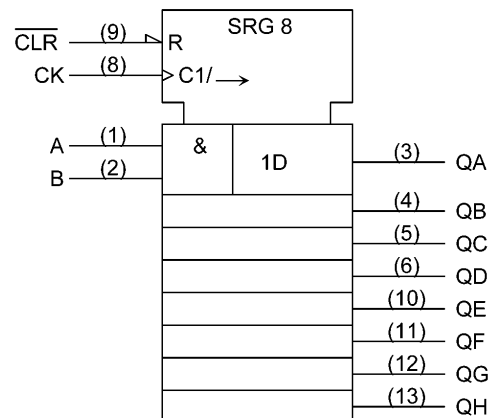
### 5. Pin Assignment







### 6. Marking



### 7. IEC Logic Symbol



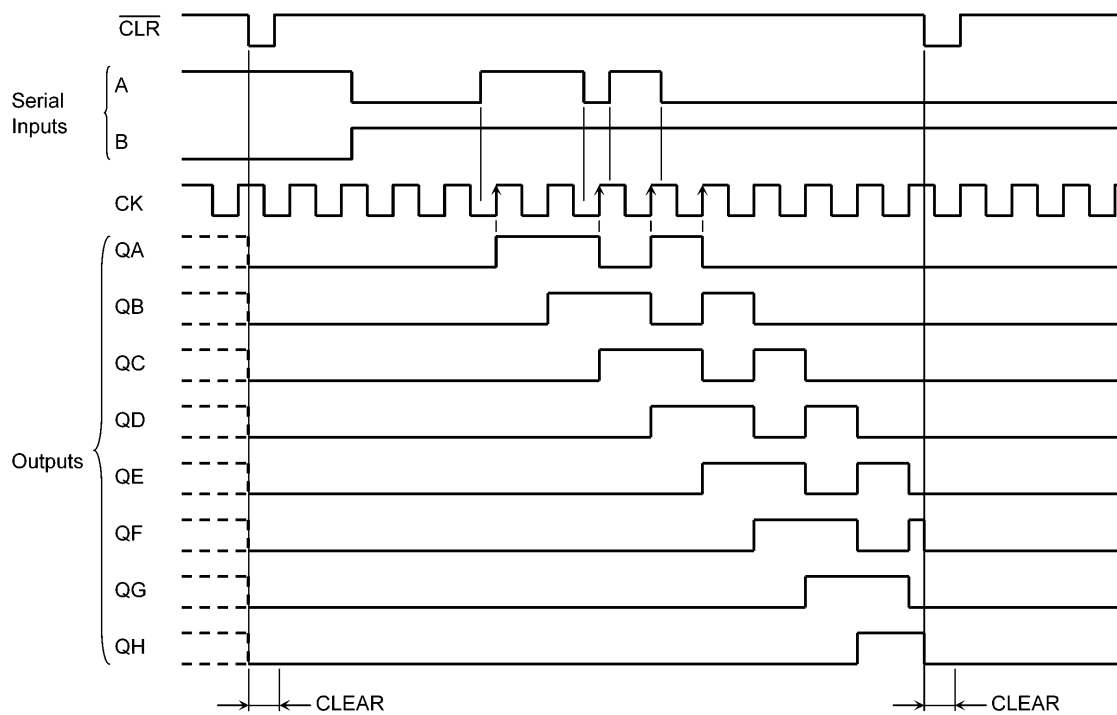
### 8. Truth Table

Inputs				Outputs			
$\overline{\text{CLR}}$	CK	Serial IN		QA	QB	...	QH
		A	B				
L	X	X	X	L	L	...	L
H		X	X	No Change			
H		L	X	L	QAn	...	QGn
H		X	L	L	QAn	...	QGn
H		H	H	H	QAn	...	QGn

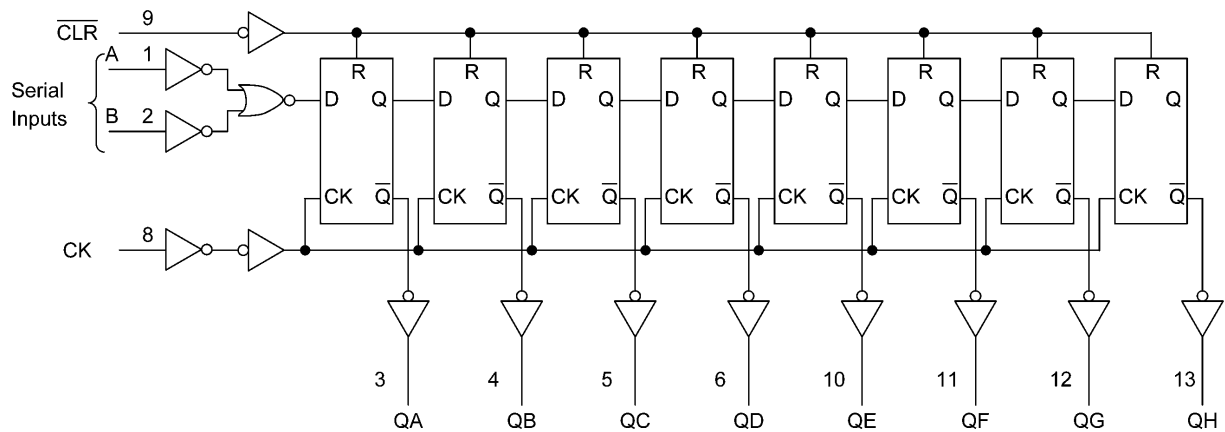
X: Don't care

QAn to QGn: The level of QA to QG, respectively, before the most recent positive edge of the CK.

### 9. Timing Diagrams



### 10. System Diagram



### 11. 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 $V_{CC} + 0.5$	V
Output voltage	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$		$\pm 20$	mA
Output diode current	$I_{OK}$		$\pm 50$	mA
Output current	$I_{OUT}$		$\pm 50$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 200$	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.

### 12. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	$V_{CC}$			2.0 to 5.5	V
Input voltage	$V_{IN}$			0 to $V_{CC}$	V
Output voltage	$V_{OUT}$			0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	(Note 1)		-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.

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2022.

### 13. Electrical Characteristics

#### 13.1. 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	2.10	—	—		
			5.5	3.85	—	—		
Low-level input voltage	$V_{IL}$	—	2.0	—	—	0.50	V	
			3.0	—	—	0.90		
			5.5	—	—	1.65		
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	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.58	—	—	
				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	
			$I_{OL} = 12\text{ mA}$	3.0	—	—	0.36	
				4.5	—	—	0.36	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	$\pm 0.1$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	5.5	—	—	8.0	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition	Note	$V_{CC}$ (V)	Min	Max	Unit		
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V		
				3.0	2.10	—			
				5.5	3.85	—			
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V		
				3.0	—	0.90			
				5.5	—	1.65			
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	—		
			$I_{OH} = -4\text{ mA}$		4.5	4.4	—		
					$I_{OH} = -24\text{ mA}$	3.0	2.48		—
						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		
			$I_{OL} = 12\text{ mA}$		3.0	—	0.44		
					$I_{OL} = 24\text{ mA}$	4.5	—		0.44
						$I_{OL} = 75\text{ mA}$ (Note 1)	5.5		—
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		5.5	—	$\pm 1.0$	$\mu\text{A}$		
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	40.0	$\mu\text{A}$		

Note 1: This spec indicates the capability of driving  $50\text{ }\Omega$  transmission lines.  
One output should be tested within a 10 ms maximum duration.

### 13.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125$ °C)

Characteristics	Symbol	Test Condition		Note	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—			2.0	1.50	—	V	
					3.0	2.10	—		
					5.5	3.85	—		
Low-level input voltage	$V_{IL}$	—			2.0	—	0.50	V	
					3.0	—	0.90		
					5.5	—	1.65		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50$ $\mu$ A		2.0	1.9	—	V	
					3.0	2.9	—		
					4.5	4.4	—		
					$I_{OH} = -4$ mA	3.0	2.48		—
					$I_{OH} = -24$ mA	4.5	3.70		—
$I_{OH} = -50$ mA	(Note 1)	5.5	3.85	—					
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50$ $\mu$ A		2.0	—	0.1	V	
					3.0	—	0.1		
					4.5	—	0.1		
					$I_{OL} = 12$ mA	3.0	—		0.44
					$I_{OL} = 24$ mA	4.5	—		0.50
$I_{OL} = 50$ mA	(Note 1)	5.5	—	1.65					
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND			5.5	—	$\pm 1.0$	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND			5.5	—	80.0	$\mu$ A	

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2022.

Note 1: This spec indicates the capability of driving  $50$   $\Omega$  transmission lines.  
One output should be tested within a  $10$  ms maximum duration.

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	9.0	ns
			$5.0 \pm 0.5$	—	5.0	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_{w(L)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	9.0	ns
			$5.0 \pm 0.5$	—	5.0	
Minimum setup time	$t_s$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	7.0	ns
			$5.0 \pm 0.5$	—	4.0	
Minimum hold time	$t_h$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	1.0	ns
			$5.0 \pm 0.5$	—	1.0	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	8.5	ns
			$5.0 \pm 0.5$	—	5.0	

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	10.0	ns
			$5.0 \pm 0.5$	—	6.0	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_{w(L)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	10.0	ns
			$5.0 \pm 0.5$	—	6.0	
Minimum setup time	$t_s$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	7.0	ns
			$5.0 \pm 0.5$	—	4.0	
Minimum hold time	$t_h$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	1.0	ns
			$5.0 \pm 0.5$	—	1.0	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	8.5	ns
			$5.0 \pm 0.5$	—	5.0	

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	10.0	ns
			$5.0 \pm 0.5$	—	6.0	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_{w(L)}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	10.0	ns
			$5.0 \pm 0.5$	—	6.0	
Minimum setup time	$t_s$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	7.0	ns
			$5.0 \pm 0.5$	—	4.0	
Minimum hold time	$t_h$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	1.0	ns
			$5.0 \pm 0.5$	—	1.0	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	$3.3 \pm 0.3$	—	8.5	ns
			$5.0 \pm 0.5$	—	5.0	

Note: Operating Range spec of  $T_{opr} = -40\text{ }^\circ\text{C}$  to  $125\text{ }^\circ\text{C}$  is applicable only for the products which manufactured after April 2022.

### 13.7. 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)	Min	Typ.	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$		$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	—	9.6	16.3	ns
				5.0 ± 0.5	—	6.6	9.8	
Propagation delay time ( $\overline{\text{CLR}}$ -Q)	$t_{PHL}$		$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	—	8.0	15.4	ns
				5.0 ± 0.5	—	6.0	11.0	
Maximum clock frequency	$f_{MAX}$		$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	45	100	—	MHz
				5.0 ± 0.5	80	150	—	
Input capacitance	$C_{IN}$		—	—	5	10	pF	
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	—	110	—	pF	

Note 1:  $C_{PD}$  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.

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

### 13.8. 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	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	1.0	18.6	ns
			5.0 ± 0.5	1.0	11.2	
Propagation delay time ( $\overline{\text{CLR}}$ -Q)	$t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	1.0	17.5	ns
			5.0 ± 0.5	1.0	12.5	
Maximum clock frequency	$f_{MAX}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	45	—	MHz
			5.0 ± 0.5	80	—	
Input capacitance	$C_{IN}$	—	—	—	10	pF

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

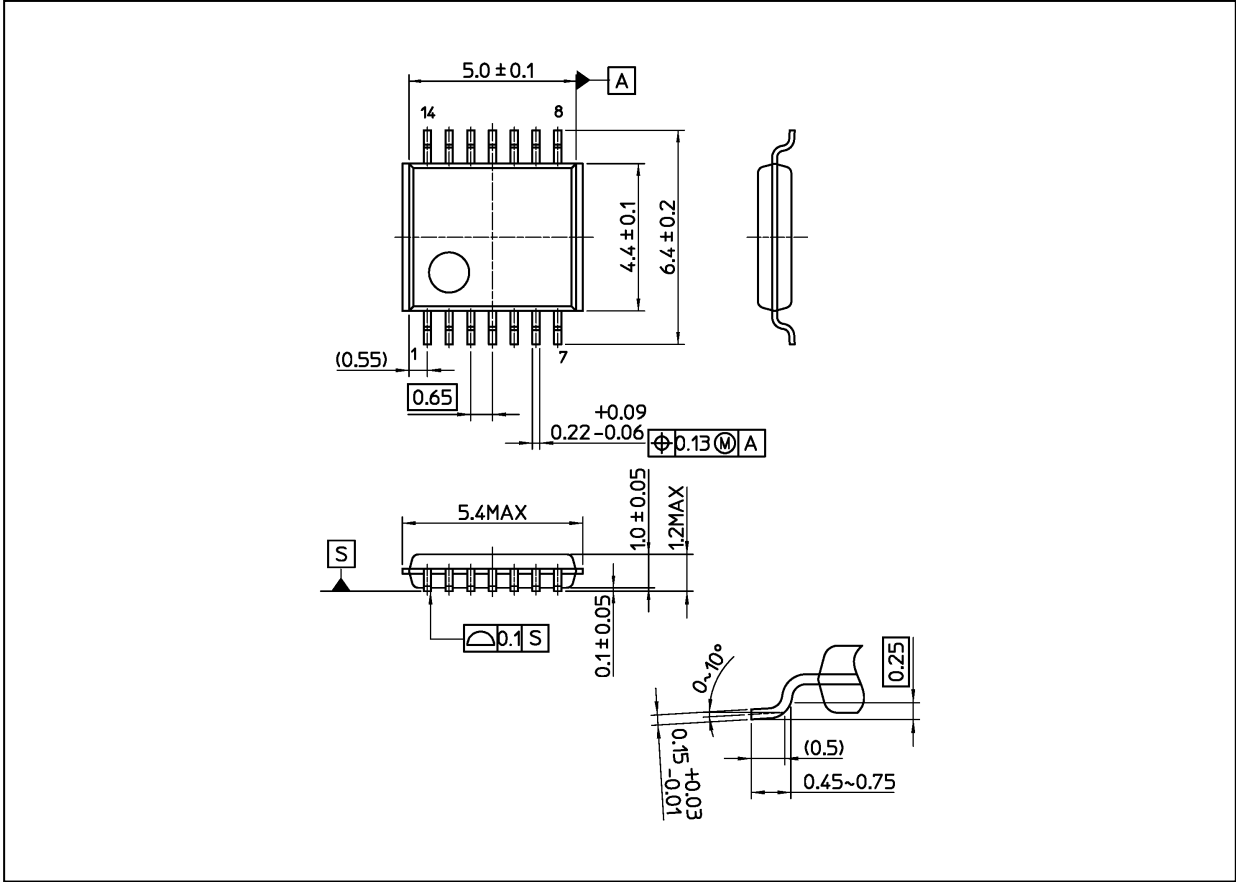
Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time (CK-Q)	$t_{PLH}, t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	1.0	20.2	ns
			5.0 ± 0.5	1.0	12.2	
Propagation delay time ( $\overline{\text{CLR}}$ -Q)	$t_{PHL}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	1.0	18.9	ns
			5.0 ± 0.5	1.0	13.5	
Maximum clock frequency	$f_{MAX}$	$C_L = 50\text{pF}$ $R_L = 500\Omega$	3.3 ± 0.3	45	—	MHz
			5.0 ± 0.5	80	—	
Input capacitance	$C_{IN}$	—	—	—	10	pF

Note: Operating Range spec of  $T_{opr} = -40\text{ }^\circ\text{C}$  to  $125\text{ }^\circ\text{C}$  is applicable only for the products which manufactured after April 2022.



Package Dimensions

Unit: mm



Weight: 0.06 g (typ.)

Package Name(s)
Nickname: TSSOP14

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