

# 74HC164D

## 1. Functional Description

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

## 2. General

The 74HC164D is a high speed CMOS 8-BIT SERIAL-IN PARALLEL-OUT SHIFT REGISTER fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

It consists of a serial-in, parallel-out 8-bit shift register with a CK input and an overriding  $\overline{\text{CLR}}$  input.

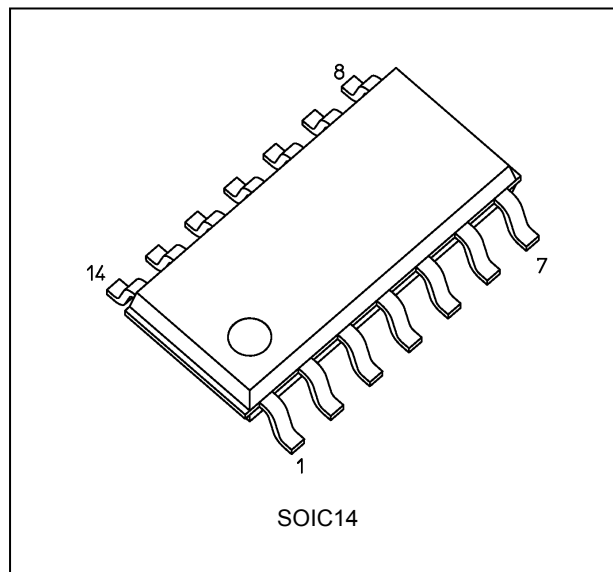
Two serial data inputs (A, B) are provided so that one may be used as a data enable.

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

## 3. Features

- (1) High speed:  $f_{\text{MAX}} = 58 \text{ MHz}$  (typ.) at  $V_{\text{CC}} = 5 \text{ V}$
- (2) Low power dissipation:  $I_{\text{CC}} = 4.0 \mu\text{A}$  (max) at  $T_a = 25 \text{ }^\circ\text{C}$
- (3) Balanced propagation delays:  $t_{\text{PLH}} \approx t_{\text{PHL}}$
- (4) Wide operating voltage range:  $V_{\text{CC(opr)}} = 2.0 \text{ to } 6.0 \text{ V}$

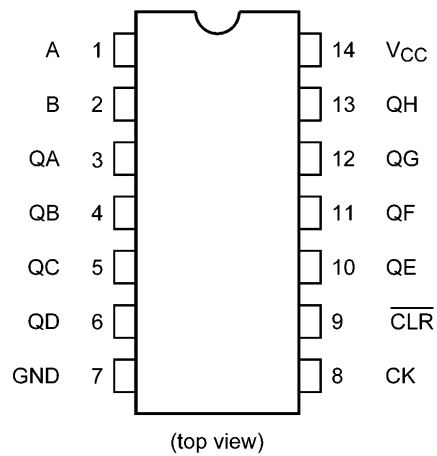
## 4. Packaging



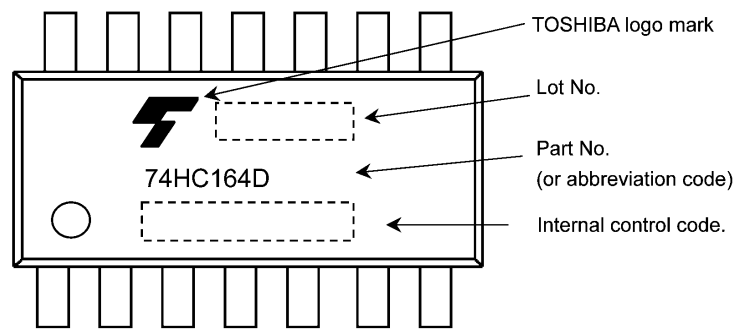
Start of commercial production

2016-02

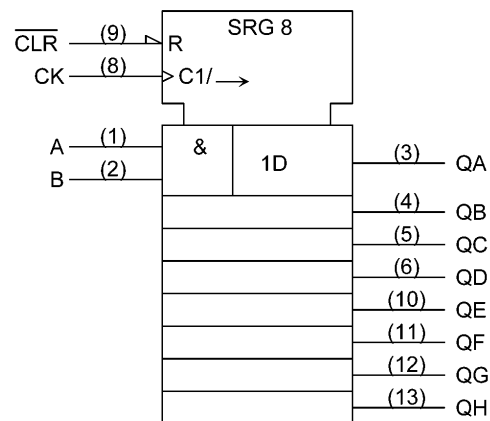
**5. Pin Assignment**







**6. Marking**



**7. IEC Logic Symbol**



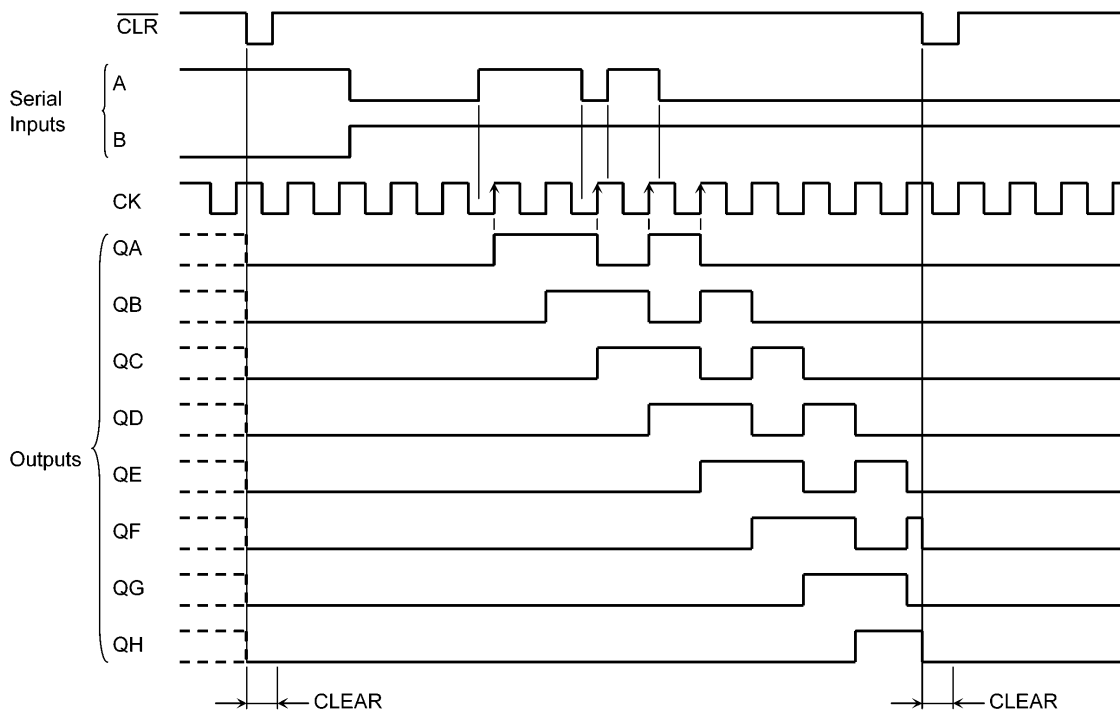
**8. Truth Table**

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

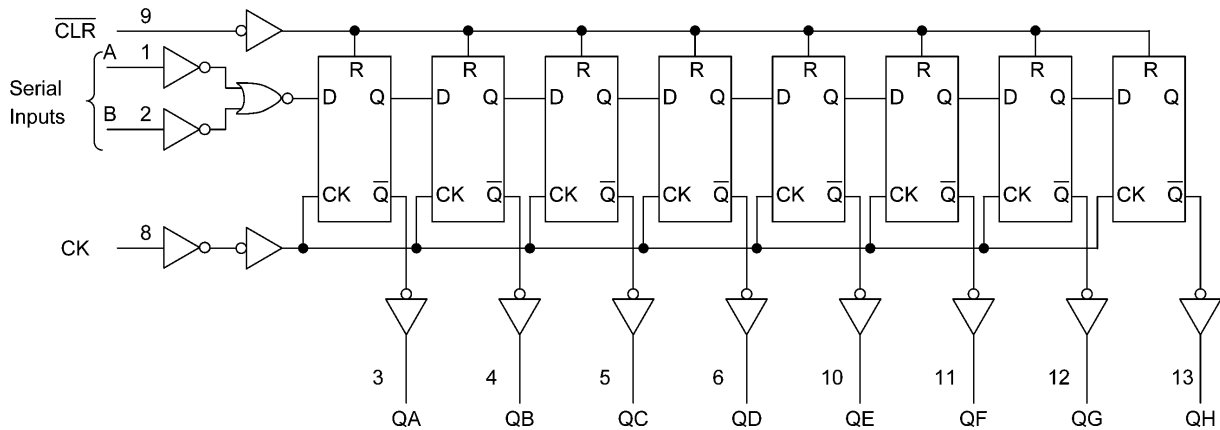
X: Don't care

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	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 1)	500	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).

Note 1:  $P_D$  derates linearly with -8 mW/ $^{\circ}C$  above 85  $^{\circ}C$

**12. Operating Ranges (Note)**

Characteristics	Symbol	Test Condition	Rating	Unit
Supply voltage	$V_{CC}$	—	2.0 to 6.0	V
Input voltage	$V_{IN}$	—	0 to $V_{CC}$	V
Output voltage	$V_{OUT}$	—	0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	—	-40 to 125	$^{\circ}C$
Input rise and fall times	$t_r, t_f$	—	0 to 50	$\mu s$

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.

**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	
				4.5	3.15	—	—		
				6.0	4.20	—	—		
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.50	V	
				4.5	—	—	1.35		
				6.0	—	—	1.80		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V	
				4.5	4.4	4.5	—		
			6.0	5.9	6.0	—			
			$I_{OH} = -4\text{ mA}$		4.5	4.18	4.31		—
$I_{OH} = -5.2\text{ mA}$		6.0	5.68	5.80	—				
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V	
				4.5	—	0.0	0.1		
				6.0	—	0.0	0.1		
			$I_{OL} = 4\text{ mA}$		4.5	—	0.17		0.26
			$I_{OL} = 5.2\text{ mA}$		6.0	—	0.18		0.26
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	$\pm 0.1$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	4.0	$\mu\text{A}$	

**13.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  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	
				4.5	3.15	—		
				6.0	4.20	—		
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V	
				4.5	—	1.35		
				6.0	—	1.80		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	—	V	
				4.5	4.4	—		
			6.0	5.9	—			
			$I_{OH} = -4\text{ mA}$		4.5	4.13		—
$I_{OH} = -5.2\text{ mA}$		6.0	5.63	—				
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.1	V	
				4.5	—	0.1		
				6.0	—	0.1		
			$I_{OL} = 4\text{ mA}$		4.5	—		0.33
			$I_{OL} = 5.2\text{ mA}$		6.0	—		0.33
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	40.0	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition		$V_{CC}$ (V)	Min	Max	Unit
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				4.5	3.15	—	
				6.0	4.20	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				4.5	—	1.35	
				6.0	—	1.80	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20$ $\mu$ A	2.0	1.9	—	V
				4.5	4.4	—	
				6.5	5.9	—	
			$I_{OH} = -4$ mA	4.5	3.7	—	
				6.0	5.2	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20$ $\mu$ A	2.0	—	0.1	V
				4.5	—	0.1	
				6.0	—	0.1	
			$I_{OL} = 4$ mA	4.5	—	0.4	
				6.0	—	0.4	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu$ A
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	160	$\mu$ A

**13.4. Timing Requirements (Unless otherwise specified,  $T_a = 25$  °C, Input:  $t_r = t_f = 6$  ns)**

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	2.0	75	ns
			4.5	15	
			6.0	13	
Minimum pulse width ( $\overline{CLR}$ )	$t_{w(L)}$	—	2.0	80	ns
			4.5	16	
			6.0	14	
Minimum setup time (A, B)	$t_s$	—	2.0	50	ns
			4.5	10	
			6.0	9	
Minimum hold time (A, B)	$t_h$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Minimum removal time ( $\overline{CLR}$ )	$t_{rem}$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Clock frequency	f	—	2.0	6	MHz
			4.5	31	
			6.0	36	

**13.5. Timing Requirements**  
 (Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 6$  ns)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	2.0	95	ns
			4.5	19	
			6.0	16	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_{w(L)}$	—	2.0	100	ns
			4.5	20	
			6.0	17	
Minimum setup time (A, B)	$t_s$	—	2.0	65	ns
			4.5	13	
			6.0	11	
Minimum hold time (A, B)	$t_h$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Clock frequency	f	—	2.0	5	MHz
			4.5	25	
			6.0	29	

**13.6. Timing Requirements**  
 (Unless otherwise specified,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 6$  ns)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	2.0	120	ns
			4.5	24	
			6.0	20	
Minimum pulse width ( $\overline{\text{CLR}}$ )	$t_{w(L)}$	—	2.0	120	ns
			4.5	24	
			6.0	20	
Minimum setup time (A, B)	$t_s$	—	2.0	90	ns
			4.5	18	
			6.0	15	
Minimum hold time (A, B)	$t_h$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Minimum removal time ( $\overline{\text{CLR}}$ )	$t_{rem}$	—	2.0	5	ns
			4.5	5	
			6.0	5	
Clock frequency	f	—	2.0	4	MHz
			4.5	20	
			6.0	24	

**13.7. AC Characteristics**

(Unless otherwise specified,  $C_L = 15 \text{ pF}$ ,  $V_{CC} = 5 \text{ V}$ ,  $T_a = 25 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	—	—	4	8	ns
Propagation delay time (CK-Qn)	$t_{PLH}, t_{PHL}$	—	—	15	27	
Propagation delay time ( $\overline{\text{CLR}}$ -Qn)	$t_{PHL}$	—	—	16	30	
Maximum clock frequency	$f_{MAX}$	—	33	58	—	MHz

**13.8. AC Characteristics**

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = 25 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	Note	$V_{CC}$ (V)	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$		2.0	—	25	75	ns
			4.5	—	7	15	
			6.0	—	6	13	
Propagation delay time (CK-Qn)	$t_{PLH}, t_{PHL}$		2.0	—	57	160	ns
			4.5	—	19	32	
			6.0	—	16	27	
Propagation delay time ( $\overline{\text{CLR}}$ -Qn)	$t_{PHL}$		2.0	—	60	175	ns
			4.5	—	20	35	
			6.0	—	17	30	
Maximum clock frequency	$f_{MAX}$		2.0	6	18	—	MHz
			4.5	31	53	—	
			6.0	36	62	—	
Input capacitance	$C_{IN}$		—	—	3	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	—	30	—	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.

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

**13.9. AC Characteristics**

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	
Propagation delay time (CK-Qn)	$t_{PLH}, t_{PHL}$	2.0	—	200	ns
		4.5	—	40	
		6.0	—	34	
Propagation delay time ( $\overline{\text{CLR}}$ -Qn)	$t_{PHL}$	2.0	—	220	ns
		4.5	—	44	
		6.0	—	37	
Maximum clock frequency	$f_{MAX}$	2.0	5	—	MHz
		4.5	25	—	
		6.0	29	—	



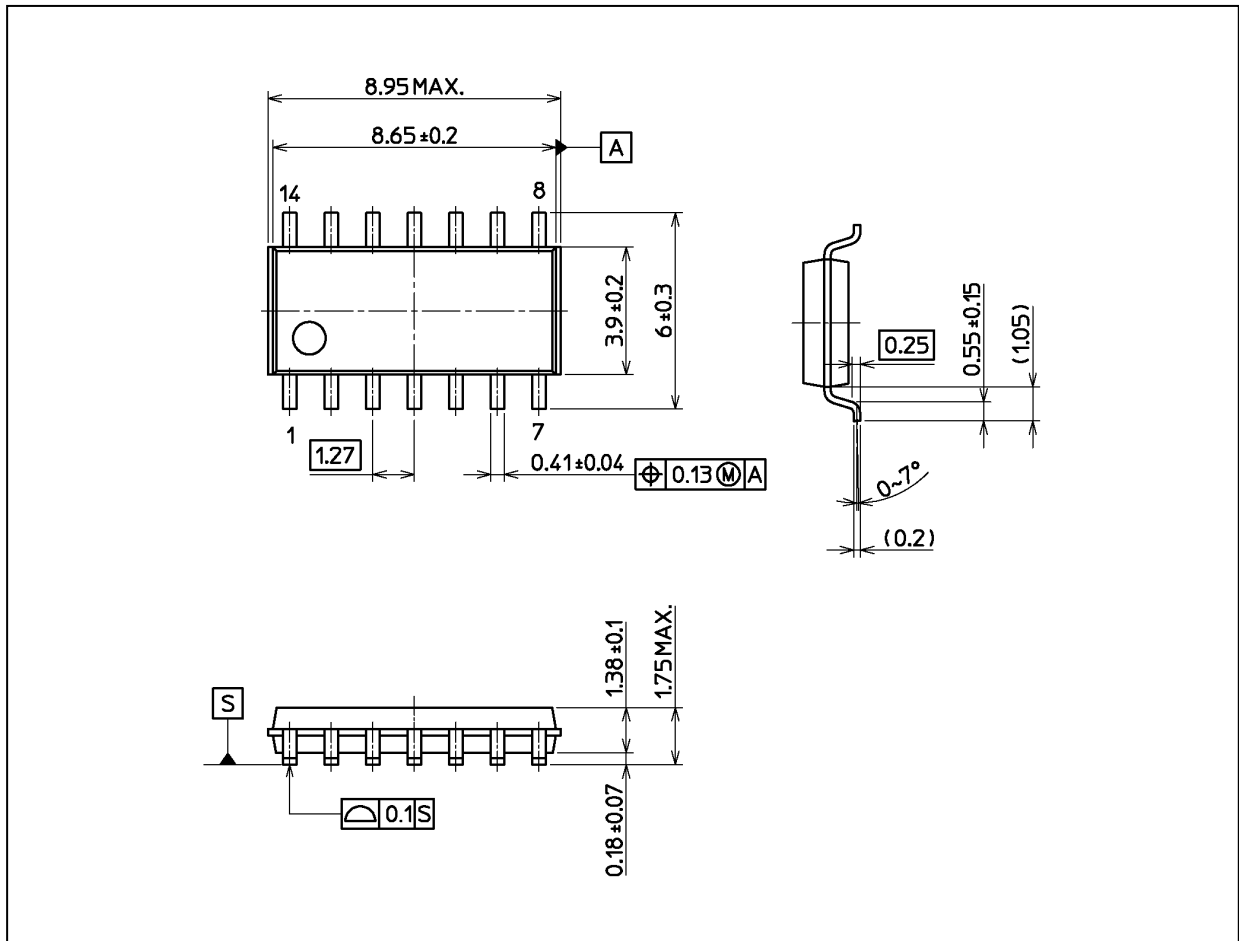
**13.10. AC Characteristics**

(Unless otherwise specified,  $C_L = 50 \text{ pF}$ ,  $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 6 \text{ ns}$ )

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	110	ns
		4.5	—	22	
		6.0	—	19	
Propagation delay time (CK-Qn)	$t_{PLH}, t_{PHL}$	2.0	—	240	ns
		4.5	—	48	
		6.0	—	41	
Propagation delay time ( $\overline{\text{CLR}}$ -Qn)	$t_{PHL}$	2.0	—	265	ns
		4.5	—	53	
		6.0	—	45	
Maximum clock frequency	$f_{MAX}$	2.0	4	—	MHz
		4.5	20	—	
		6.0	24	—	

Package Dimensions

Unit: mm



Weight: 0.13 g (typ.)

Package Name(s)
Nickname: SOIC14

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