CMOS Digital Integrated Circuits Silicon Monolithic

74VHC164FT

1. Functional Description

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

2. General

The 74VHC164FT is an advanced high speed CMOS 8-BIT SERIAL-IN PARALLEL-OUT SHIFT REGISTER fabricated with silicon gate C^2MOS technology.

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

It consists of 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.

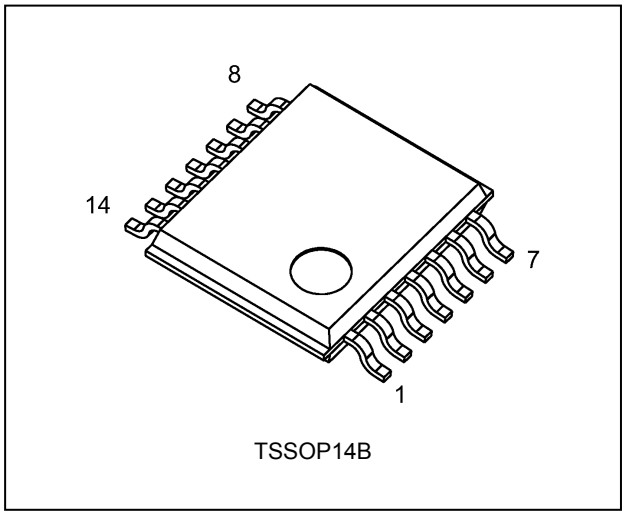
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input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

3. Features

(1) AEC-Q100 (Rev. H) (Note 1)
(2) Wide operating temperature range: T_{opr} = -40 to 125 °C
(3) High speed: f_{MAX} = 175 MHz (typ.) at V_{CC} = 5 V
(4) Low power dissipation: I_{CC} = 4.0 μA (max) at T_a = 25 °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 (AC/HC/AHC etc.) 164 type.

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

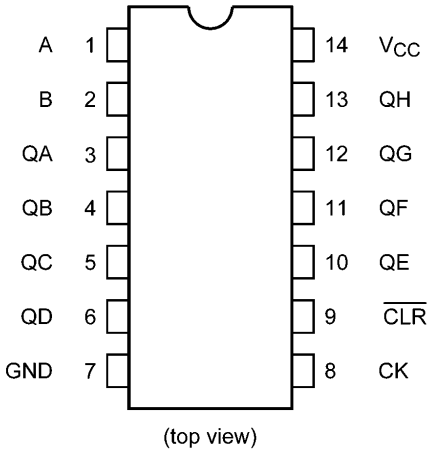
4. Packaging



TSSOP14B

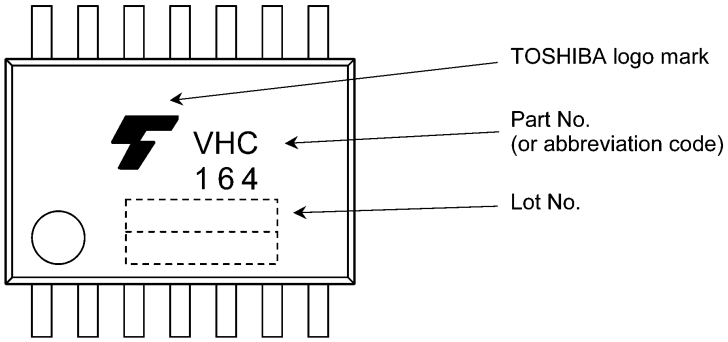
Start of commercial production
2013-05

5. Pin Assignment

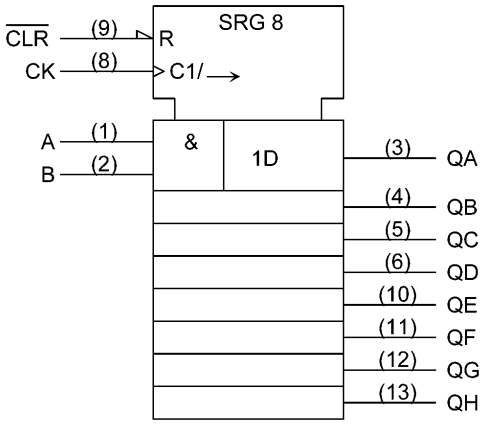


(top view)

6. Marking



7. IEC Logic Symbol



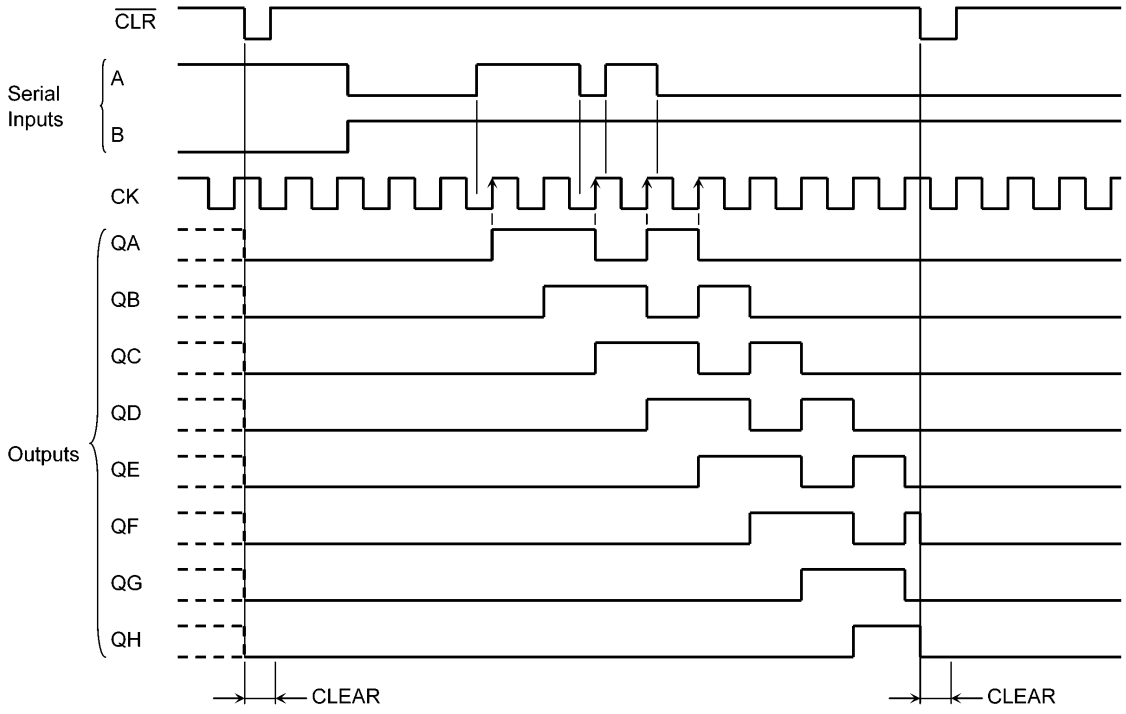
8. Truth Table

Inputs				Outputs			
$\overline{CLR}$	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

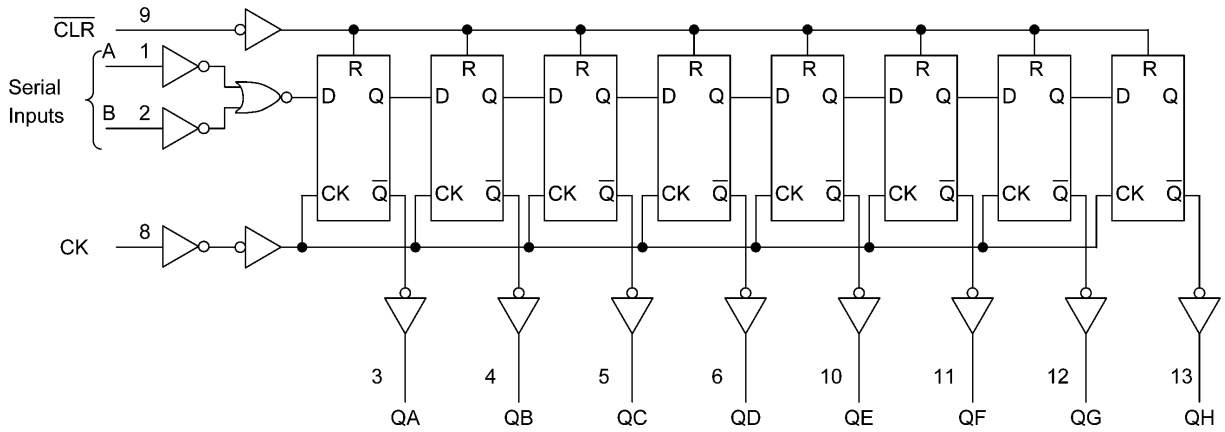
X: Don't care

QA_n to QG_n: 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 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}		±20	mA
Output current	I_{OUT}		±25	mA
V_{CC}/ground current	I_{CC}		±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.

12. 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 ± 0.3 V	0 to 100	ns/V
		V_{CC} = 5 ± 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.

13. Electrical Characteristics

13.1. DC Characteristics (Unless otherwise specified, T_a = 25 °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} × 0.7	—	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	V
				3.0 to 5.5	—	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
				4.5	4.4	4.5	—	
			I_{OH} = -4 mA	3.0	2.58	—	—	
			I_{OH} = -8 mA	4.5	3.94	—	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			I_{OL} = 4 mA	3.0	—	—	0.36	
			I_{OL} = 8 mA	4.5	—	—	0.36	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	—	±0.1	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	—	4.0	μA

13.2. DC Characteristics (Unless otherwise specified, T_a = -40 to 85 °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} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			I_{OH} = -4 mA	3.0	2.48	—	
			I_{OH} = -8 mA	4.5	3.80	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.44	
			I_{OL} = 8 mA	4.5	—	0.44	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	40.0	μA

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
				3.0 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.50	V
				3.0 to 5.5	—	V_{CC} × 0.3	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -50 μA	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			I_{OH} = -4 mA	3.0	2.40	—	
			I_{OH} = -8 mA	4.5	3.70	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			I_{OL} = 4 mA	3.0	—	0.55	
			I_{OL} = 8 mA	4.5	—	0.55	
Input leakage current	I_{IN}	V_{IN} = 5.5 V or GND		0 to 5.5	—	±2.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	80.0	μA

13.4. Timing Requirements (Unless otherwise specified, T_a = 25 °C, Input: t_r = t_f = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width ($\overline{CLR}$)	$t_{w(L)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_s	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	4.5	
Minimum hold time	t_h	—	3.3 ± 0.3	0.0	ns
			5.0 ± 0.5	1.0	
Minimum removal time ($\overline{CLR}$)	t_{rem}	—	3.3 ± 0.3	2.5	ns
			5.0 ± 0.5	2.5	

13.5. Timing Requirements (Unless otherwise specified, T_a = -40 to 85 °C, Input: t_r = t_f = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width ($\overline{CLR}$)	$t_{w(L)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_s	—	3.3 ± 0.3	6.0	ns
			5.0 ± 0.5	4.5	
Minimum hold time	t_h	—	3.3 ± 0.3	0.0	ns
			5.0 ± 0.5	1.0	
Minimum removal time ($\overline{CLR}$)	t_{rem}	—	3.3 ± 0.3	2.5	ns
			5.0 ± 0.5	2.5	

13.6. Timing Requirements (Unless otherwise specified, T_a = -40 to 125 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}$,$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width ($\overline{CLR}$)	$t_{w(L)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_S	—	3.3 ± 0.3	6.0	ns
			5.0 ± 0.5	4.5	
Minimum hold time	t_h	—	3.3 ± 0.3	0.0	ns
			5.0 ± 0.5	1.0	
Minimum removal time ($\overline{CLR}$)	t_{rem}	—	3.3 ± 0.3	3.5	ns
			5.0 ± 0.5	3.0	

13.7. AC Characteristics (Unless otherwise specified, T_a = 25 °C, Input: $t_r = t_f$ = 3 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 ± 0.3	15	—	8.4	12.8	ns
					50	—	10.9	16.3	
				5.0 ± 0.5	15	—	5.8	9.0	
					50	—	7.3	11.0	
Propagation delay time ($\overline{CLR}$-Q)	t_{PHL}		—	3.3 ± 0.3	15	—	8.3	12.8	ns
					50	—	10.8	16.3	
				5.0 ± 0.5	15	—	5.2	8.6	
					50	—	6.7	10.6	
Maximum clock frequency	f_{MAX}		—	3.3 ± 0.3	15	80	125	—	MHz
					50	50	75	—	
				5.0 ± 0.5	15	125	175	—	
					50	85	115	—	
Input capacitance	C_{IN}		—			—	4	10	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—			—	76	—	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 to 85 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (CK-Q)	t_{PLH},t_{PHL}	—	3.3 ± 0.3	15	1.0	15.0	ns
				50	1.0	18.5	
			5.0 ± 0.5	15	1.0	10.5	
				50	1.0	12.5	
Propagation delay time ($\overline{CLR}$-Q)	t_{PHL}	—	3.3 ± 0.3	15	1.0	15.0	ns
				50	1.0	18.5	
			5.0 ± 0.5	15	1.0	10.0	
				50	1.0	12.0	
Maximum clock frequency	f_{MAX}	—	3.3 ± 0.3	15	65	—	MHz
				50	45	—	
			5.0 ± 0.5	15	105	—	
				50	75	—	
Input capacitance	C_{IN}	—			—	10	pF

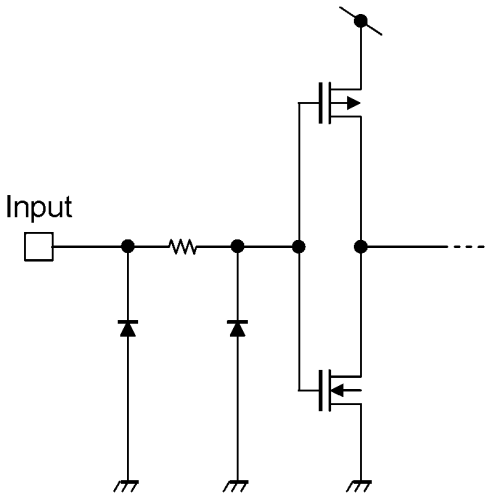
13.9. AC Characteristics
(Unless otherwise specified, T_a = -40 to 125 °C, Input: $t_r = t_f$ = 3 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (CK-Q)	t_{PLH},t_{PHL}	—	3.3 ± 0.3	15	1.0	17.0	ns
				50	1.0	20.5	
			5.0 ± 0.5	15	1.0	12.0	
				50	1.0	14.0	
Propagation delay time ($\overline{CLR}$-Q)	t_{PHL}	—	3.3 ± 0.3	15	1.0	17.0	ns
				50	1.0	20.5	
			5.0 ± 0.5	15	1.0	11.5	
				50	1.0	13.5	
Maximum clock frequency	f_{MAX}	—	3.3 ± 0.3	15	60	—	MHz
				50	40	—	
			5.0 ± 0.5	15	100	—	
				50	65	—	
Input capacitance	C_{IN}	—			—	10	pF

13.10. Noise Characteristics (Unless otherwise specified, T_a = 25 °C, Input: $t_r = t_f$ = 3 ns)

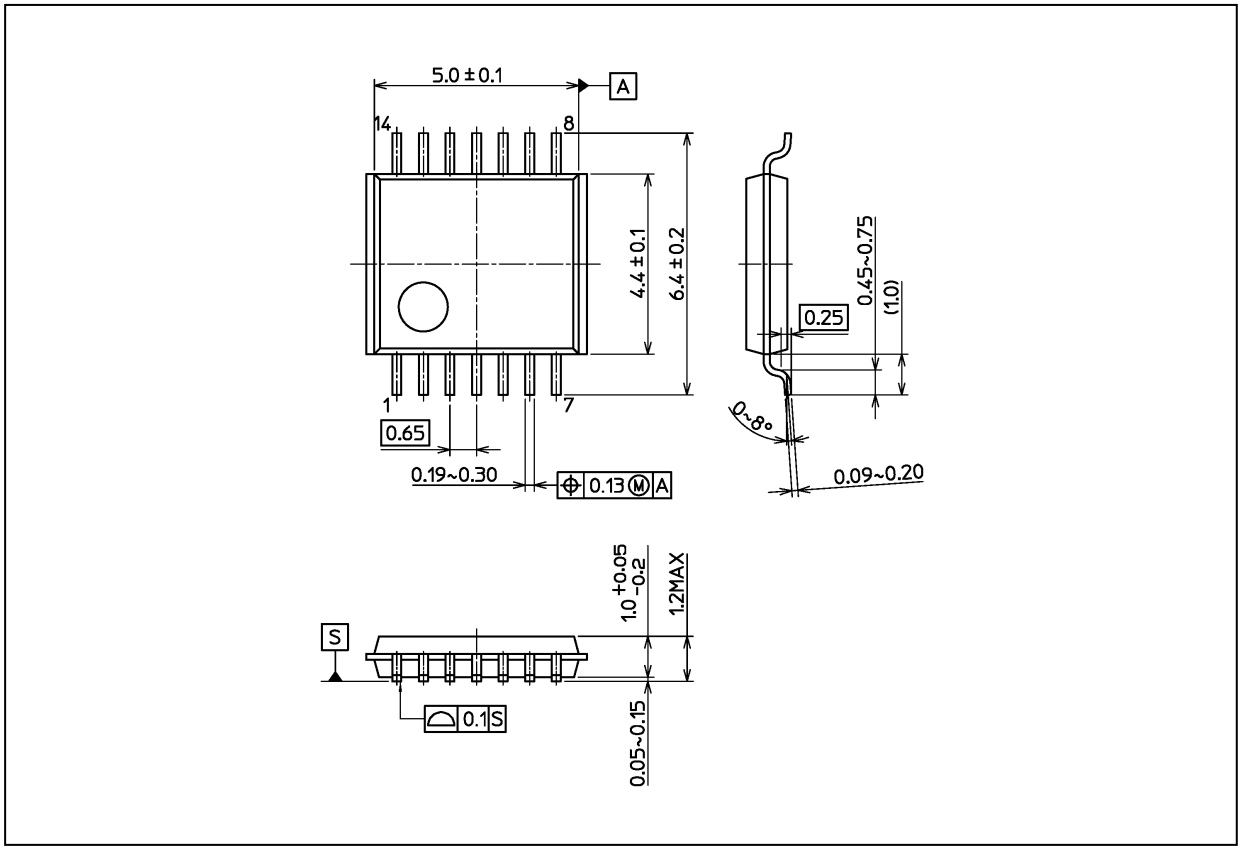
Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Limit	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	C_L = 50 pF	5.0	0.5	0.8	V
Quiet output minimum dynamic V_{OL}	V_{OLV}	C_L = 50 pF	5.0	-0.5	-0.8	V
Minimum high-level dynamic input voltage	V_{IHD}	C_L = 50 pF	5.0	—	3.5	V
Maximum low-level dynamic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

14. Internal Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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