

74HC166D

1. Functional Description

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

2. General

The 74HC166D is a high speed CMOS 8-BIT PARALLEL/SERIAL-IN, SERIAL-OUT SHIFT REGISTER fabricated with silicon gate C²MOS technology.

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

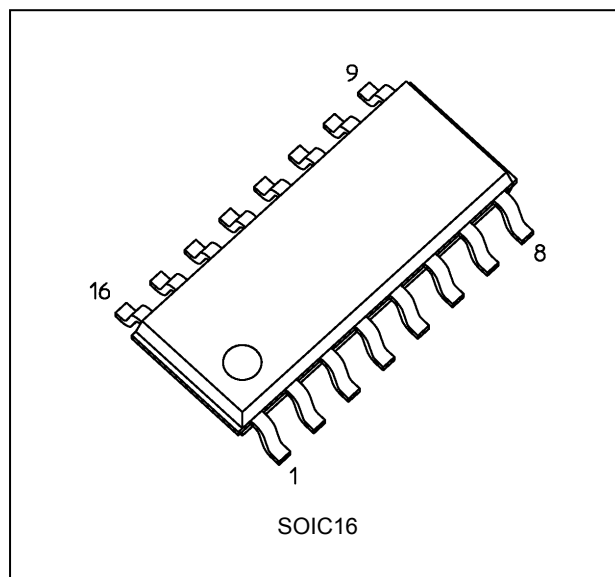
It consists of parallel-in or serial-in, serial-out 8-bit shift register with a gated clock input and an overriding clear input. The parallel-in or serial-in modes are controlled by the $\overline{\text{SHIFT/LOAD}}$ input. When the $\overline{\text{SHIFT/LOAD}}$ input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting on each clock pulse. When held low, the parallel data inputs are enabled and synchronous loading occurs on the next clock pulse. Clocking is accomplished on the low-to-high transition of the clock pulse. The CK-INH input should be shifted high only while the CK input is held high. A direct clear input overrides all other inputs, including the clock, and sets all the flip-flops to zero. Functional details are shown in the truth table and the timing charts.

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

3. Features

- (1) High speed: $f_{\text{MAX}} = 57 \text{ MHz}$ (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: $V_{\text{CC(opr)}} = 2.0 \text{ V to } 6.0 \text{ V}$

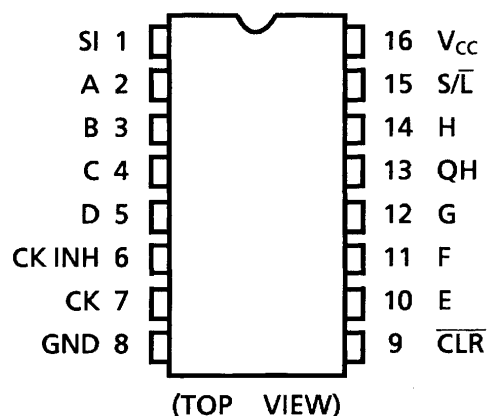
4. Packaging



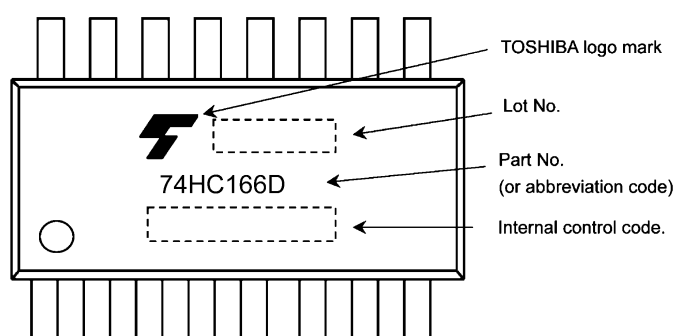
Start of commercial production

2016-05

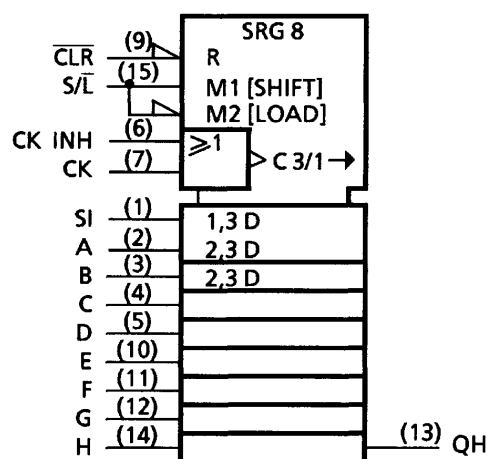
5. Pin Assignment



6. Marking



7. IEC Logic Symbol



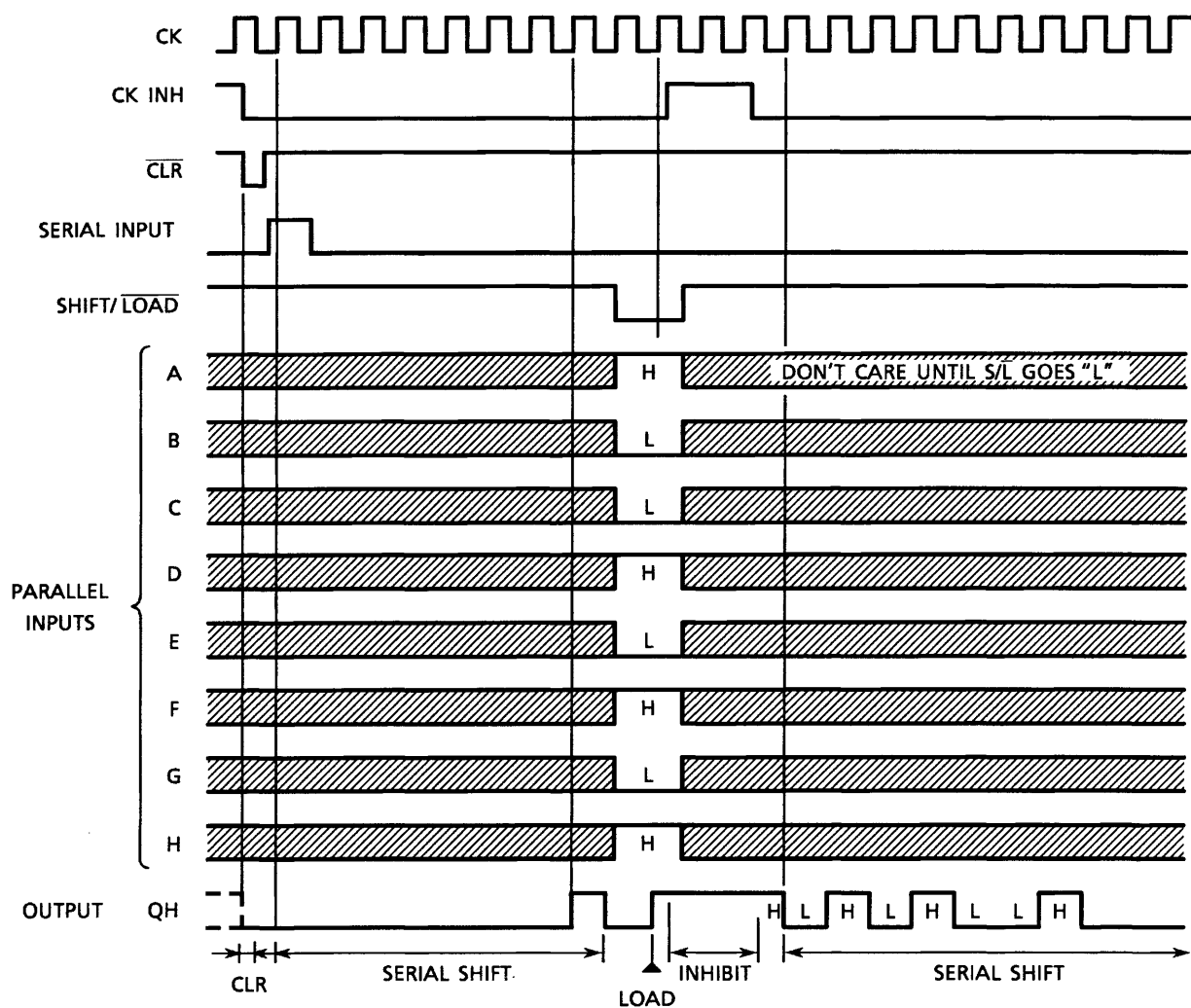
8. Truth Table

Inputs						Internal Outputs		Output
$\overline{\text{CLR}}$	SHIFT/LOAD	CK INH	CK	SERIAL IN	PARALLEL A.....H	QA	QB	QH
L	X	X	X	X	X	L	L	L
H	X	X	$\downarrow$	X	X	No Change		
H	L	L	$\uparrow$	X	a.....h	a	b	h
H	H	L	$\uparrow$	H	X	H	QAn	QGn
H	H	L	$\uparrow$	L	X	L	QAn	QGn
H	X	H	X	X	X	No Change		

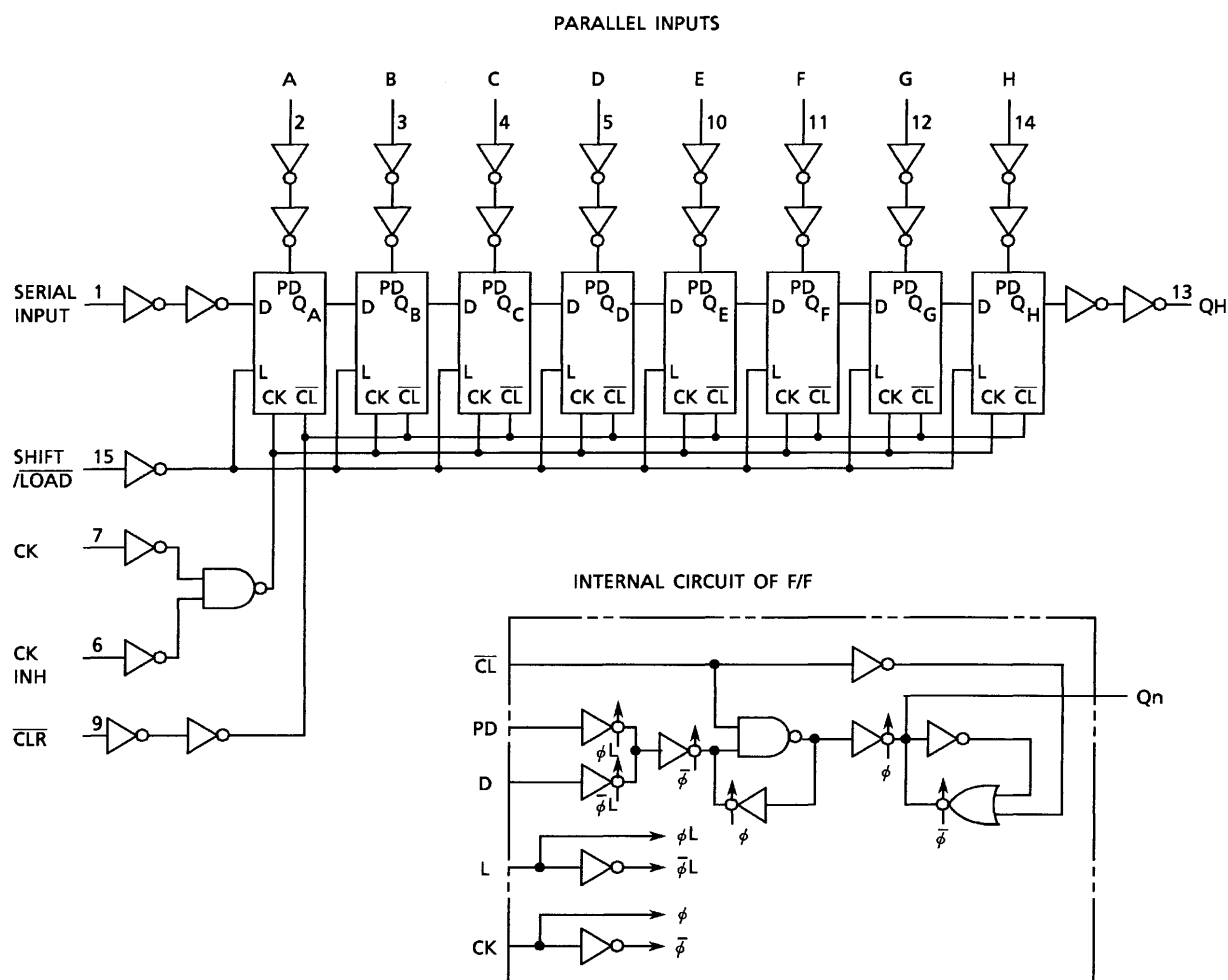
X: Don't care

a.....h: The level of steady state input voltage at inputs A through H respectively.

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}		± 20	mA
Output diode current	I_{OK}		± 20	mA
Output current	I_{OUT}		± 25	mA
V_{CC} /ground current	I_{CC}		± 50	mA
Power dissipation	P_D	(Note 1)	500	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: P_D derates linearly with -8 mW/°C above 85 °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	°C
Input rise and fall times	t_r, t_f	—	0 to 50	μs

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}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	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}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	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}	$V_{IN} = V_{CC} \text{ or } GND$		6.0	—	—	± 0.1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC} \text{ or } GND$		6.0	—	—	4.0	μA

13.2. 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
				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}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	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}	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	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}	$V_{IN} = V_{CC} \text{ or } GND$		6.0	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC} \text{ or } GND$		6.0	—	40.0	μA

13.3. 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
				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	—	
				6.5	5.9	—	
			$I_{OH} = -4\text{ mA}$	4.5	3.7	—	
			$I_{OH} = -5.2\text{ mA}$	6.0	5.2	—	
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	—	0.4	
			$I_{OL} = 5.2\text{ mA}$	6.0	—	0.4	
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND		6.0	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		6.0	—	160.0	μA

13.4. Timing Requirements (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 6\text{ ns}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	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 (CLR)	$t_{w(L)}$	—	2.0	—	75	ns
			4.5	—	15	
			6.0	—	13	
Minimum setup time (SI, PI)	t_s	—	2.0	—	75	ns
			4.5	—	15	
			6.0	—	13	
Minimum setup time (S/L)	t_s	—	2.0	—	75	ns
			4.5	—	15	
			6.0	—	13	
Minimum hold time (SI, PI)	t_h	—	2.0	—	0	ns
			4.5	—	0	
			6.0	—	0	
Minimum hold time (S/L)	t_h	—	2.0	—	0	ns
			4.5	—	0	
			6.0	—	0	
Minimum removal time (CLR)	t_{rem}	—	2.0	—	50	ns
			4.5	—	10	
			6.0	—	9	
Clock frequency	f	—	2.0	—	6	MHz
			4.5	—	31	
			6.0	—	36	

13.5. Timing Requirements

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

Characteristics	Symbol	Test Condition	V_{CC} (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 (CLR)	$t_{w(L)}$	—	2.0	95	ns
			4.5	19	
			6.0	16	
Minimum setup time (SI, PI)	t_S	—	2.0	95	ns
			4.5	19	
			6.0	16	
Minimum setup time ($S/\bar{L}$)	t_S	—	2.0	95	ns
			4.5	19	
			6.0	16	
Minimum hold time (SI, PI)	t_h	—	2.0	0	ns
			4.5	0	
			6.0	0	
Minimum hold time ($S/\bar{L}$)	t_h	—	2.0	0	ns
			4.5	0	
			6.0	0	
Minimum removal time (CLR)	t_{rem}	—	2.0	65	ns
			4.5	13	
			6.0	11	
Clock frequency	f	—	2.0	5	MHz
			4.5	25	
			6.0	29	

13.6. Timing Requirements

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

Characteristics	Symbol	Test Condition	V_{CC} (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	2.0	110	ns
			4.5	22	
			6.0	19	
Minimum pulse width (CLR)	$t_{w(L)}$	—	2.0	110	ns
			4.5	22	
			6.0	19	
Minimum setup time (SI, PI)	t_s	—	2.0	110	ns
			4.5	22	
			6.0	19	
Minimum setup time ($S/\bar{L}$)	t_s	—	2.0	110	ns
			4.5	22	
			6.0	19	
Minimum hold time (SI, PI)	t_h	—	2.0	0	ns
			4.5	0	
			6.0	0	
Minimum hold time ($S/\bar{L}$)	t_h	—	2.0	0	ns
			4.5	0	
			6.0	0	
Minimum removal time (CLR)	t_{rem}	—	2.0	75	ns
			4.5	15	
			6.0	13	
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-QH)	t_{PLH}, t_{PHL}	—	—	16	26	ns
Propagation delay time (CLR-QH)	t_{PHL}	—	—	15	24	
Maximum clock frequency	f_{MAX}	—	33	57	—	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	$V_{CC} \text{ (V)}$	Min	Typ.	Max	Unit
Output transition time	t_{TLH}, t_{THL}		2.0	—	30	75	ns
			4.5	—	8	15	
			6.0	—	7	13	
Propagation delay time (CK-QH)	t_{PLH}, t_{PHL}		2.0	—	70	150	ns
			4.5	—	20	30	
			6.0	—	16	26	
Propagation delay time (CLR-QH)	t_{PHL}		2.0	—	60	135	ns
			4.5	—	18	27	
			6.0	—	14	23	
Maximum clock frequency	f_{MAX}		2.0	6	14	—	MHz
			4.5	31	50	—	
			6.0	36	63	—	
Input capacitance	C_{IN}		—	—	3	—	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—	—	11	—	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: $t_r = t_f = 6 \text{ ns}$)

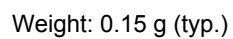
Characteristics	Symbol	$V_{CC} \text{ (V)}$	Min	Max	Unit
Output transition time	t_{TLH}, t_{THL}	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	
Propagation delay time (CK-QH)	t_{PLH}, t_{PHL}	2.0	—	190	ns
		4.5	—	38	
		6.0	—	32	
Propagation delay time (CLR-QH)	t_{PHL}	2.0	—	170	ns
		4.5	—	34	
		6.0	—	29	
Maximum 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	$V_{CC} \text{ (V)}$	Min	Max	Unit
Output transition time	t_{TLH}, t_{THL}	2.0	—	110	ns
		4.5	—	22	
		6.0	—	19	
Propagation delay time (CK-QH)	t_{PLH}, t_{PHL}	2.0	—	225	ns
		4.5	—	45	
		6.0	—	38	
Propagation delay time (CLR-QH)	t_{PHL}	2.0	—	205	ns
		4.5	—	41	
		6.0	—	35	
Maximum clock frequency	f_{MAX}	2.0	4	—	MHz
		4.5	20	—	
		6.0	24	—	

Unit: mm



Package Name(s)
Nickname: SOIC16

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