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# 74HC393D

## 1. Functional Description

- Dual Binary Counter

## 2. General

The 74HC393D is a high speed CMOS 4-BIT BINARY COUNTER 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 contains two independent counter circuits in one package, so that counting or frequency division of eight binary bits can be achieved with one IC.

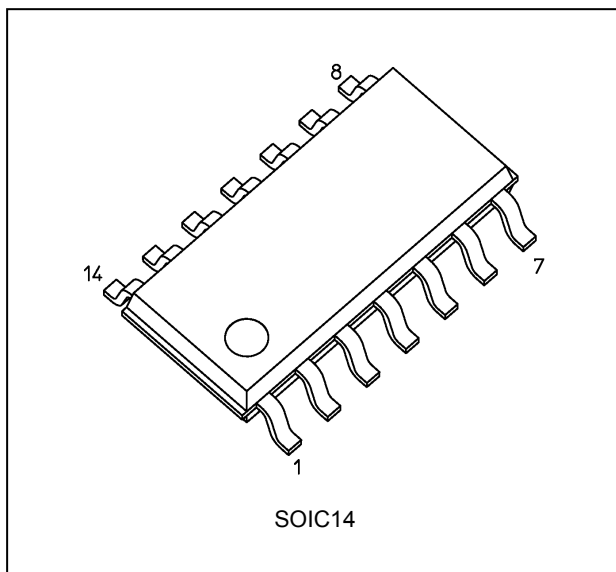
This device changes state on the negative going transition of the  $\overline{CK}$  pulse. The counter can be reset to "0" (QA to QD = "L") by a high at the CLR input regardless of other inputs.

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

## 3. Features

- (1) High speed:  $f_{MAX} = 72 \text{ MHz (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- (2) Low power dissipation:  $I_{CC} = 4.0 \mu\text{A (max)}$  at  $T_a = 25 \text{ }^\circ\text{C}$
- (3) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (4) Wide operating voltage range:  $V_{CC(opr)} = 2.0 \text{ V to } 6.0 \text{ V}$

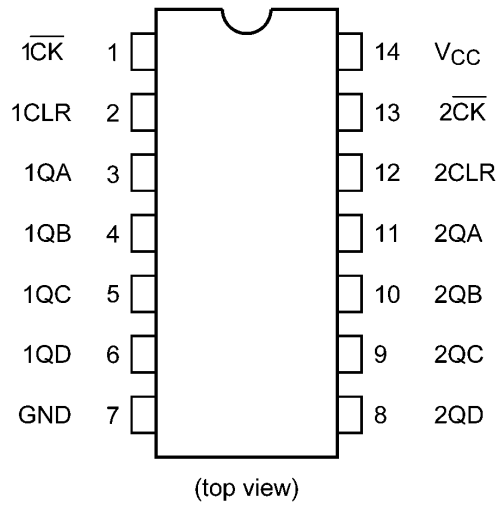
## 4. Packaging



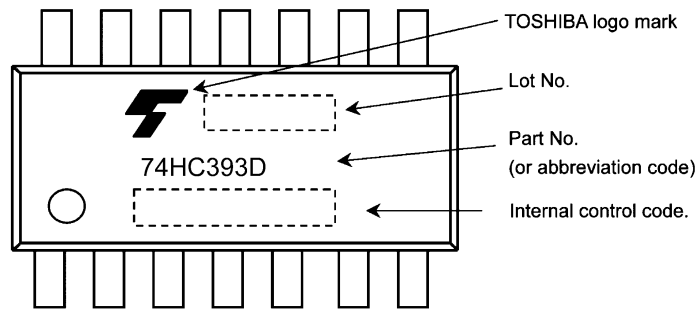
Start of commercial production

2016-05

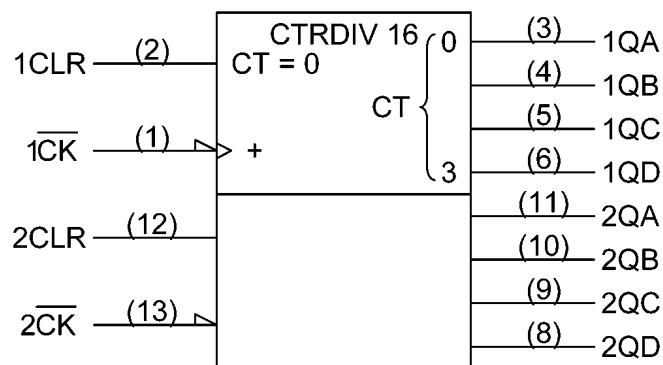
**5. Pin Assignment**



**6. Marking**



**7. IEC Logic Symbol**

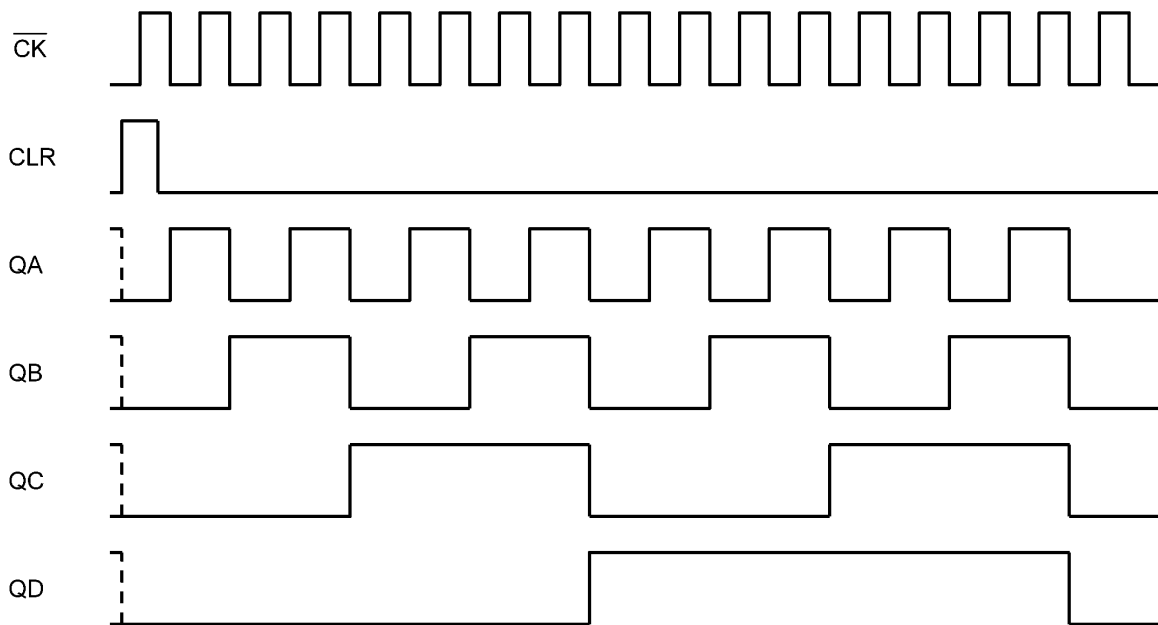


**8. Truth Table**

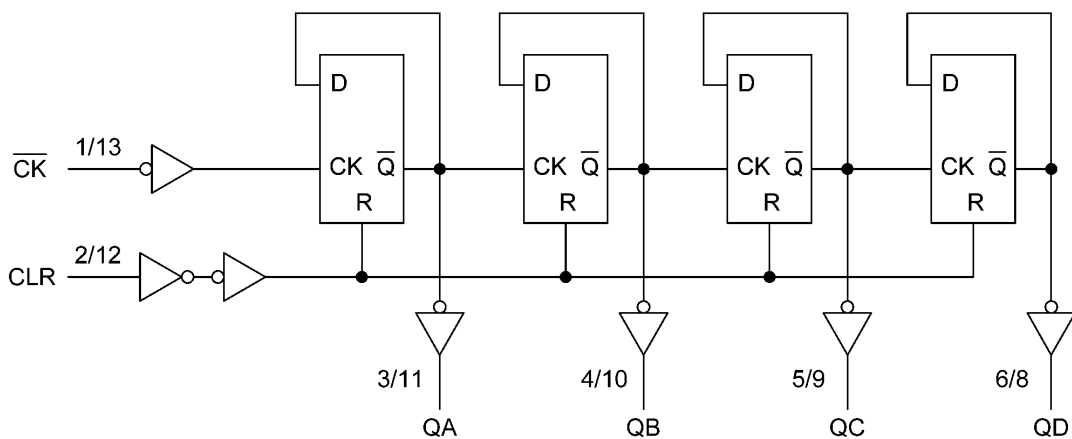
Inputs		Outputs			
$\overline{\text{CK}}$	CLR	QA	QB	QC	QD
X	H	L	L	L	L
	L	Count up			
	L	No change			

X: Don't care

**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	$P_D$		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).

**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 85	°C
Input rise and fall times	$t_r, t_f$	$V_{CC} = 2.0\text{ V}$	0 to 1000	ns
		$V_{CC} = 4.5\text{ V}$	0 to 500	
		$V_{CC} = 6.0\text{ V}$	0 to 400	

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	—	
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	—	
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. 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)	$t_{w(H)}$	—	2.0	—	75	ns
			4.5	—	15	
			6.0	—	13	
Minimum removal time	$t_{rem}$	—	2.0	—	25	ns
			4.5	—	5	
			6.0	—	5	
Clock frequency	f	—	2.0	—	6	MHz
			4.5	—	32	
			6.0	—	38	

**13.4. Timing Requirements (Unless otherwise specified,  $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ , 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)	$t_{w(H)}$	—	2.0	95	ns
			4.5	19	
			6.0	16	
Minimum removal time	$t_{rem}$	—	2.0	30	ns
			4.5	6	
			6.0	5	
Clock frequency	f	—	2.0	5	MHz
			4.5	27	
			6.0	32	

**13.5. 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	Note	Test Condition	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$		—	—	4	8	ns
Propagation delay time (CK-QA)	$t_{PLH}, t_{PHL}$		—	—	12	20	ns
Propagation delay time (CK-QB)	$t_{PLH}, t_{PHL}$		—	—	16	31	ns
Propagation delay time (CK-QC)	$t_{PLH}, t_{PHL}$		—	—	21	38	ns
Propagation delay time (CK-QD)	$t_{PLH}, t_{PHL}$		—	—	25	46	ns
Propagation delay time (CLR-Qn)	$t_{PHL}$		—	—	15	26	ns
Maximum clock frequency	$f_{MAX}$		—	35	72	—	MHz

**13.6. AC Characteristics (Unless otherwise specified, C<sub>L</sub> = 50 pF, T<sub>a</sub> = 25 °C, Input: t<sub>r</sub> = t<sub>f</sub> = 6 ns)**

Characteristics	Symbol	Note	Test Condition	V <sub>CC</sub> (V)	Min	Typ.	Max	Unit
Output transition time	t <sub>TLH</sub> , t <sub>THL</sub>		—	2.0	—	25	75	ns
				4.5	—	7	15	
				6.0	—	6	13	
Propagation delay time (CK-QA)	t <sub>PLH</sub> , t <sub>PHL</sub>		—	2.0	—	45	120	ns
				4.5	—	15	24	
				6.0	—	13	20	
Propagation delay time (CK-QB)	t <sub>PLH</sub> , t <sub>PHL</sub>		—	2.0	—	60	180	ns
				4.5	—	20	36	
				6.0	—	17	31	
Propagation delay time (CK-QC)	t <sub>PLH</sub> , t <sub>PHL</sub>		—	2.0	—	80	220	ns
				4.5	—	25	44	
				6.0	—	21	37	
Propagation delay time (CK-QD)	t <sub>PLH</sub> , t <sub>PHL</sub>		—	2.0	—	100	260	ns
				4.5	—	30	52	
				6.0	—	26	44	
Propagation delay time (CLR-Qn)	t <sub>PHL</sub>		—	2.0	—	55	150	ns
				4.5	—	18	30	
				6.0	—	15	26	
Maximum clock frequency	f <sub>MAX</sub>		—	2.0	6	22	—	MHz
				4.5	32	67	—	
				6.0	38	77	—	
Input capacitance	C <sub>IN</sub>		—	—	5	10	pF	
Power dissipation capacitance	C <sub>PD</sub>	(Note 1)	—	—	40	—	pF	

Note 1: C<sub>PD</sub> 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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/2 \text{ (per circuit)}$$



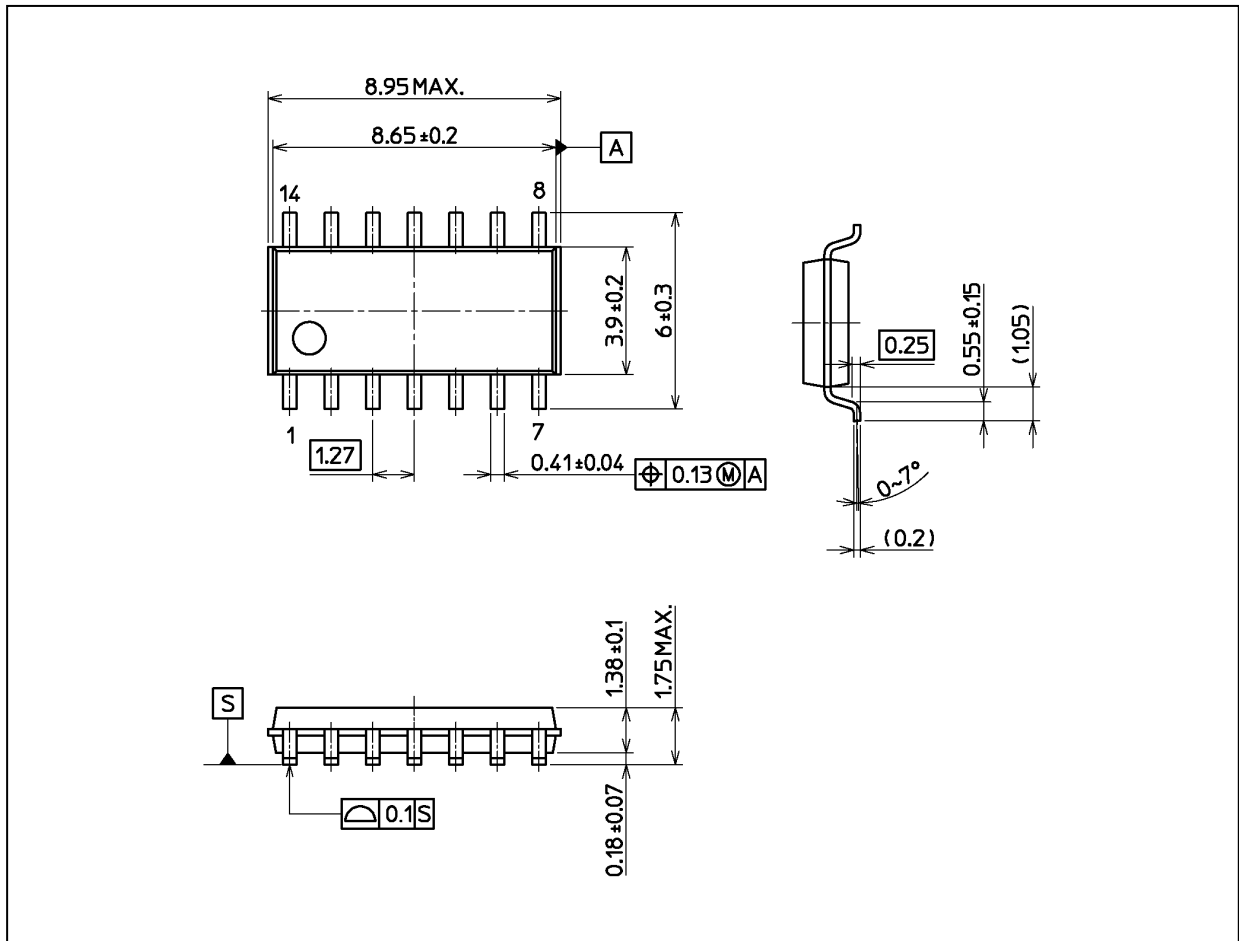
**13.7. AC Characteristics**

(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	Test Condition	$V_{CC}$ (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-QA)	$t_{PLH}, t_{PHL}$	—	2.0	—	150	ns
			4.5	—	30	
			6.0	—	26	
Propagation delay time (CK-QB)	$t_{PLH}, t_{PHL}$	—	2.0	—	225	ns
			4.5	—	45	
			6.0	—	38	
Propagation delay time (CK-QC)	$t_{PLH}, t_{PHL}$	—	2.0	—	275	ns
			4.5	—	55	
			6.0	—	47	
Propagation delay time (CK-QD)	$t_{PLH}, t_{PHL}$	—	2.0	—	325	ns
			4.5	—	65	
			6.0	—	55	
Propagation delay time (CLR-Qn)	$t_{PHL}$	—	2.0	—	190	ns
			4.5	—	38	
			6.0	—	33	
Maximum clock frequency	$f_{MAX}$	—	2.0	5	—	MHz
			4.5	27	—	
			6.0	32	—	
Input capacitance	$C_{IN}$	—		—	10	pF

Package Dimensions

Unit: mm



Weight: 0.13 g (typ.)

Package Name(s)
Nickname: SOIC14

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