

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74HC393AP, TC74HC393AF

Dual Binary Counter

The TC74HC393A is a high speed CMOS 4-BIT BINARY COUNTER fabricated with silicon gate C²MOS 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.

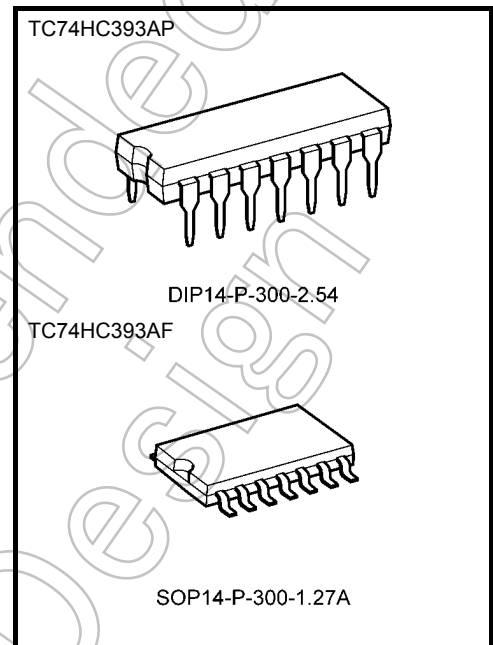
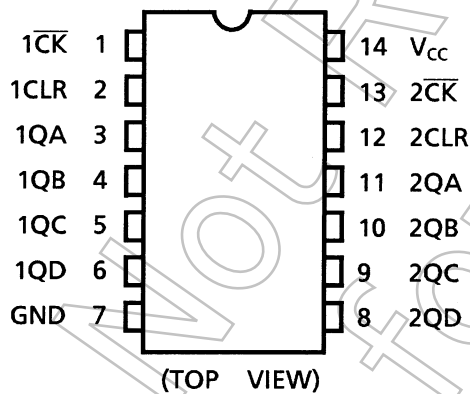
This device changes state on the negative going transition of the CK pulse. The counter can be reset to "0" (QA to QD = "L") by a high at the CLR input regardless of other inputs.

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

Features

- High speed: $f_{max} = 72 \text{ MHz (typ.) at } V_{CC} = 5 \text{ V}$
- Low power dissipation: $I_{CC} = 4 \mu\text{A (max) at } T_a = 25^\circ\text{C}$
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: $|I_{OH}| = I_{OL} = 4 \text{ mA (min)}$
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC} \text{ (opr.)} = 2 \text{ to } 6 \text{ V}$
- Pin and function compatible with 74LS393

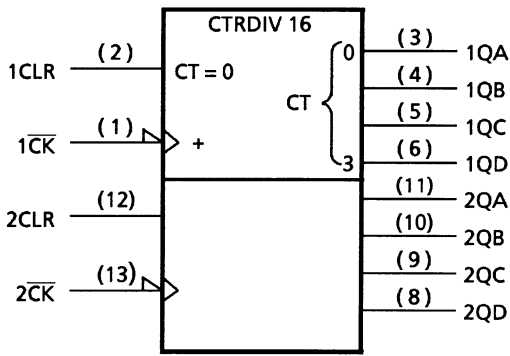
Pin Assignment



| | |
|-------------------|-----------------|
| Weight | |
| DIP14-P-300-2.54 | : 0.96 g (typ.) |
| SOP14-P-300-1.27A | : 0.18 g (typ.) |

Start of commercial production
1986-11

IEC Logic Symbol

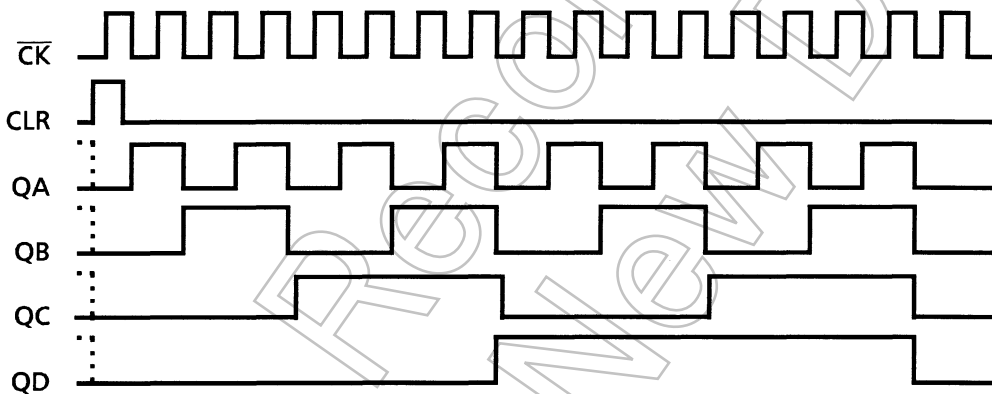


Truth Table

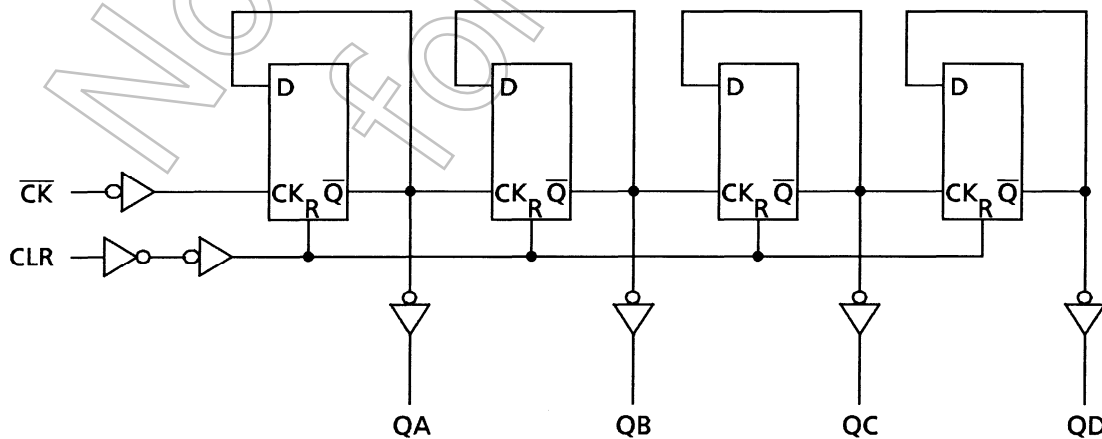
| Inputs | | Outputs | | | |
|-----------------|-----|-----------|----|----|----|
| \overline{CK} | CLR | QA | QB | QC | QD |
| X | H | L | L | L | L |
| | L | Count Up | | | |
| | L | No Change | | | |

X: Don't care

Timing Chart



System Diagram



Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|------------------------------|-------------|
| Supply voltage range | V_{CC} | -0.5 to 7 | V |
| DC input voltage | V_{IN} | -0.5 to $V_{CC} + 0.5$ | V |
| DC 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 |
| DC output current | I_{OUT} | ± 25 | mA |
| DC V_{CC} /ground current | I_{CC} | ± 50 | mA |
| Power dissipation | P_D | 500 (DIP) (Note 2)/180 (SOP) | mW |
| Storage temperature | T_{stg} | -65 to 150 | $^{\circ}C$ |

Note 1: 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 2: 500 mW in the range of $T_a = -40$ to $65^{\circ}C$. From $T_a = 65$ to $85^{\circ}C$ a derating factor of -10 mW/ $^{\circ}C$ shall be applied until 300 mW.

Operating Ranges (Note)

| Characteristics | Symbol | Rating | Unit |
|--------------------------|------------|---|-------------|
| Supply voltage | V_{CC} | 2 to 6 | 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 | $^{\circ}C$ |
| Input rise and fall time | t_r, t_f | 0 to 1000 ($V_{CC} = 2.0$ V) 0 to 500 ($V_{CC} = 4.5$ V) 0 to 400 ($V_{CC} = 6.0$ V) | ns |

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.

Electrical Characteristics

DC Characteristics

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = -40 to 85°C | | Unit | |
|---------------------------|-----------------|--|--------------------------|-----------|------|------|------------------|------|------|-----|
| | | | | VCC (V) | Min | Typ. | Max | Min | | Max |
| High-level input voltage | V _{IH} | — | | 2.0 | 1.50 | — | — | 1.50 | — | V |
| | | | | 4.5 | 3.15 | — | — | 3.15 | — | |
| | | | | 6.0 | 4.20 | — | — | 4.20 | — | |
| Low-level input voltage | V _{IL} | — | | 2.0 | — | — | 0.50 | — | 0.50 | V |
| | | | | 4.5 | — | — | 1.35 | — | 1.35 | |
| | | | | 6.0 | — | — | 1.80 | — | 1.80 | |
| High-level output voltage | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -20 μA | 2.0 | 1.9 | 2.0 | — | 1.9 | — | V |
| | | | | 4.5 | 4.4 | 4.5 | — | 4.4 | — | |
| | | | | 6.0 | 5.9 | 6.0 | — | 5.9 | — | |
| | | | | 4.5 | 4.18 | 4.31 | — | 4.13 | — | |
| | | | | 6.0 | 5.68 | 5.80 | — | 5.63 | — | |
| Low-level output voltage | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 20 μA | 2.0 | — | 0.0 | 0.1 | — | 0.1 | V |
| | | | | 4.5 | — | 0.0 | 0.1 | — | 0.1 | |
| | | | | 6.0 | — | 0.0 | 0.1 | — | 0.1 | |
| | | | | 4.5 | — | 0.17 | 0.26 | — | 0.33 | |
| | | | | 6.0 | — | 0.18 | 0.26 | — | 0.33 | |
| Input leakage current | I _{IN} | V _{IN} = V _{CC} or GND | | 6.0 | — | — | ±0.1 | — | ±1.0 | μA |
| Quiescent supply current | I _{CC} | V _{IN} = V _{CC} or GND | | 6.0 | — | — | 4.0 | — | 40.0 | μA |

Timing Requirements (input: t_r = t_f = 6 ns)

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | Ta = -40 to 85°C | Unit | |
|---------------------------|--|----------------|--|-----------|------|------------------|------|-------|
| | | | | VCC (V) | Typ. | Limit | | Limit |
| Minimum pulse width (CK) | t _W (H) t _W (L) | — | | 2.0 | — | 75 | 95 | ns |
| | | | | 4.5 | — | 15 | 19 | |
| | | | | 6.0 | — | 13 | 16 | |
| Minimum pulse width (CLR) | t _W (H) | — | | 2.0 | — | 75 | 95 | ns |
| | | | | 4.5 | — | 15 | 19 | |
| | | | | 6.0 | — | 13 | 16 | |
| Minimum removal time | t _{rem} | — | | 2.0 | — | 25 | 30 | ns |
| | | | | 4.5 | — | 5 | 6 | |
| | | | | 6.0 | — | 5 | 5 | |
| Clock frequency | f | — | | 2.0 | — | 6 | 5 | MHz |
| | | | | 4.5 | — | 32 | 27 | |
| | | | | 6.0 | — | 38 | 32 | |

AC Characteristics ($C_L = 15\text{ pF}$, $V_{CC} = 5\text{ V}$, $T_a = 25^\circ\text{C}$, 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 (\overline{CK} -QA) | t_{pLH} t_{pHL} | — | — | 12 | 20 | ns |
| Propagation delay time (\overline{CK} -QB) | t_{pLH} t_{pHL} | — | — | 16 | 31 | ns |
| Propagation delay time (\overline{CK} -QC) | t_{pLH} t_{pHL} | — | — | 21 | 38 | ns |
| Propagation delay time (\overline{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 |

Not Recommended for New Designs

AC Characteristics (C_L = 50 pF, input: t_r = t_f = 6 ns)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Ta = 25°C | | | Ta = -40 to 85°C | | Unit |
|--|--------------------------------------|----------------|---------------------|-----------|------|-----|------------------|-----|------|
| | | | | Min | Typ. | Max | Min | Max | |
| Output transition time | t _{TLH} t _{THL} | — | 2.0 | — | 25 | 75 | — | 95 | ns |
| | | | 4.5 | — | 7 | 15 | — | 19 | |
| | | | 6.0 | — | 6 | 13 | — | 16 | |
| Propagation delay time (\overline{CK} -QA) | t _{pLH} t _{pHL} | — | 2.0 | — | 45 | 120 | — | 150 | ns |
| | | | 4.5 | — | 15 | 24 | — | 30 | |
| | | | 6.0 | — | 13 | 20 | — | 26 | |
| Propagation delay time (\overline{CK} -QB) | t _{pLH} t _{pHL} | — | 2.0 | — | 60 | 180 | — | 225 | ns |
| | | | 4.5 | — | 20 | 36 | — | 45 | |
| | | | 6.0 | — | 17 | 31 | — | 38 | |
| Propagation delay time (\overline{CK} -QC) | t _{pLH} t _{pHL} | — | 2.0 | — | 80 | 220 | — | 275 | ns |
| | | | 4.5 | — | 25 | 44 | — | 55 | |
| | | | 6.0 | — | 21 | 37 | — | 47 | |
| Propagation delay time (\overline{CK} -QD) | t _{pLH} t _{pHL} | — | 2.0 | — | 100 | 260 | — | 325 | ns |
| | | | 4.5 | — | 30 | 52 | — | 65 | |
| | | | 6.0 | — | 26 | 44 | — | 55 | |
| Propagation delay time (CLR-Qn) | t _{pHL} | — | 2.0 | — | 55 | 150 | — | 190 | ns |
| | | | 4.5 | — | 18 | 30 | — | 38 | |
| | | | 6.0 | — | 15 | 26 | — | 33 | |
| Maximum clock frequency | f _{max} | — | 2.0 | 6 | 22 | — | 5 | — | MHz |
| | | | 4.5 | 32 | 67 | — | 27 | — | |
| | | | 6.0 | 38 | 77 | — | 32 | — | |
| Input capacitance | C _{IN} | — | — | 5 | 10 | — | 10 | pF | |
| Power dissipation capacitance | C _{PD} (Note) | — | — | 40 | — | — | — | pF | |

Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

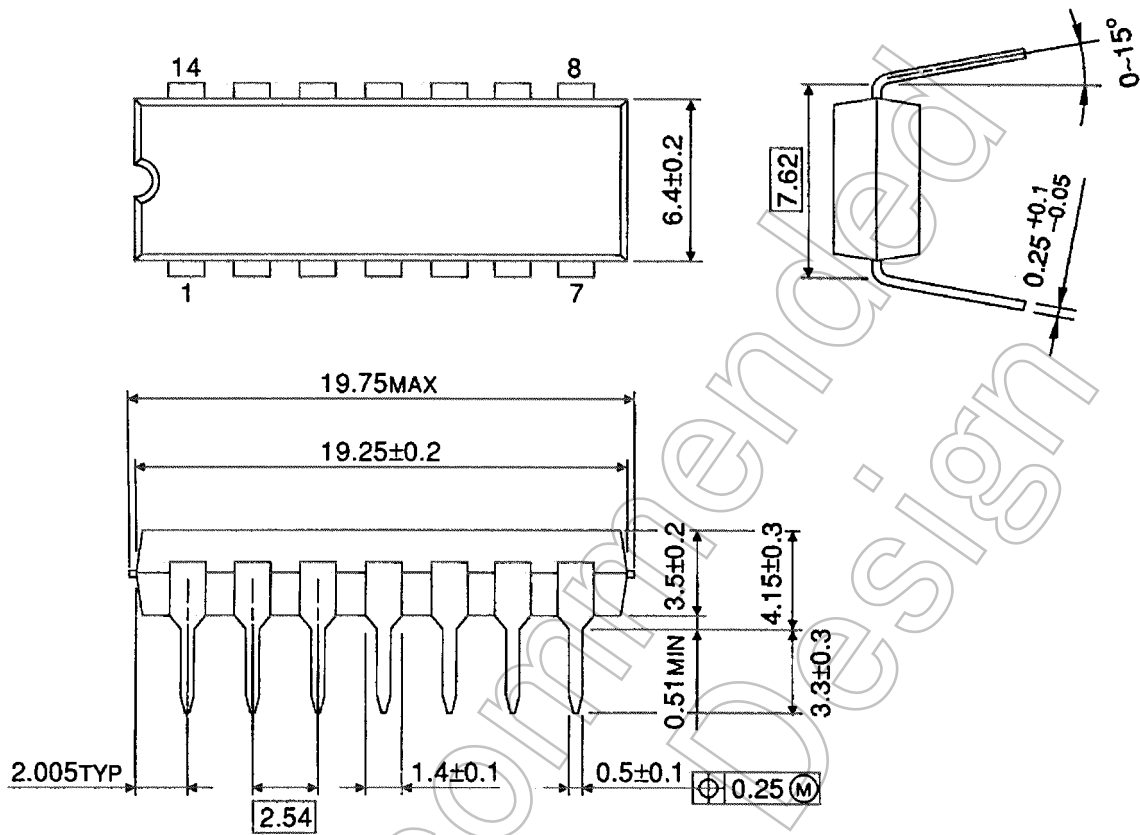
Average operating current can be obtained by the equation:

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

Package Dimensions

DIP14-P-300-2.54

Unit : mm



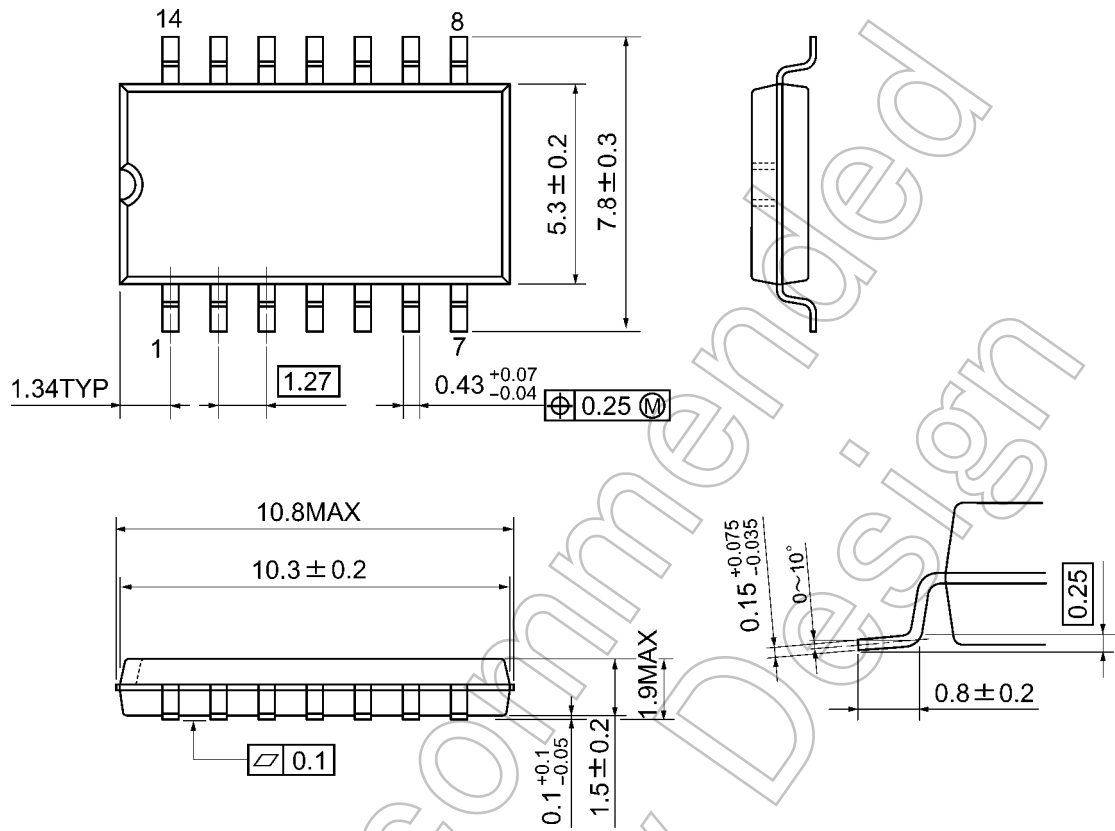
Weight: 0.96 g (typ.)

Not Recommended for New Design

Package Dimensions

SOP14-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

Not Recommended for New Design

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