

## SYNCHRONOUS PRESETTABLE UP/DOWN 4-BIT BINARY COUNTER

### DESCRIPTION

The M74LS193P is a semiconductor integrated circuit containing a synchronous hexadecimal (4-bit binary) up/down counter with direct reset and preset.

### FEATURES

- Special clock for up count, down count
- Asynchronous preset input provided
- Direct reset input provided
- Cascade connection easily made
- High-speed counting ( $f_{max}=38\text{MHz}$  typical)
- Wide operating temperature range ( $T_a=-20\sim+75^\circ\text{C}$ )

### APPLICATION

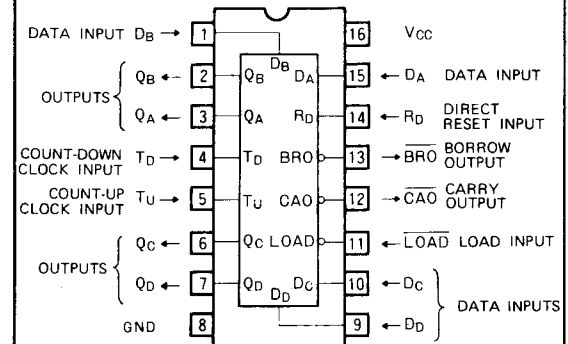
General purpose, for use in industrial and consumer equipment.

### FUNCTIONAL DESCRIPTION

This device comes with special count-up clock input  $T_U$  and count-down clock input  $T_D$  used independently for count-up and count-down applications. For count-up, the count pulse number appears as a 4-bit pure binary code in outputs  $Q_A$ ,  $Q_B$ ,  $Q_C$  and  $Q_D$  in synchronization with the count pulses by setting load input  $\overline{\text{LOAD}}$  and  $T_D$  to high, applying the count pulses to  $T_U$  while for count-down,  $\overline{\text{LOAD}}$  and  $T_U$  are set high and the count pulses are applied to  $T_D$ . Counting is performed when  $T_U$  or  $T_D$  changes from low to high.

Presetting is performed regardlessly of the count pulse. When data are applied to data inputs  $D_A$ ,  $D_B$ ,  $D_C$  and  $D_D$  and  $\overline{\text{LOAD}}$  is set low, the  $D_A$ ,  $D_B$ ,  $D_C$  and  $D_D$  signals

### PIN CONFIGURATION (TOP VIEW)



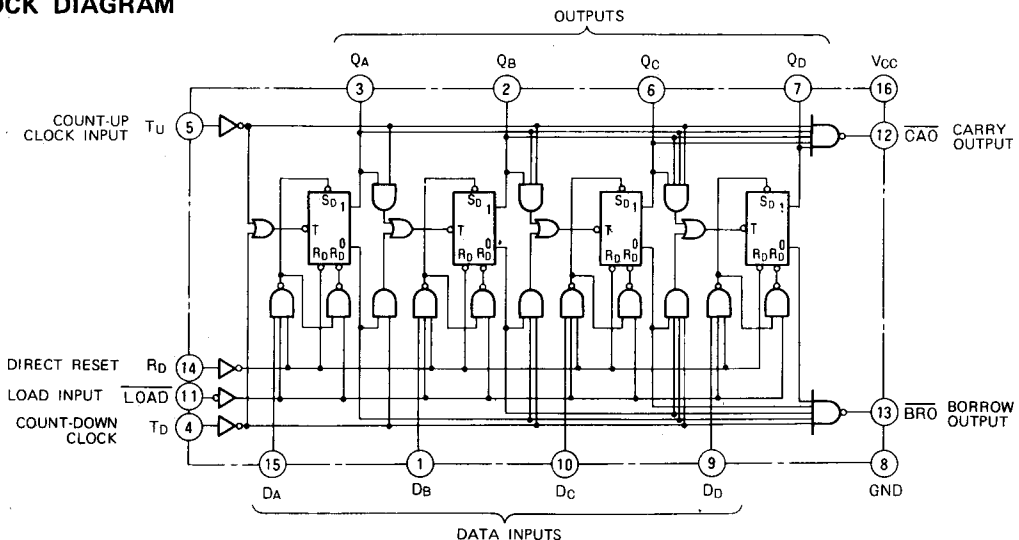
Outline 16P4

appear in the  $Q_A$ ,  $Q_B$ ,  $Q_C$ , and  $Q_D$  outputs, respectively, regardless of the status of the  $T_U$  and  $T_D$  signals, thereby presetting the counter.

Reset can be performed by setting the direct reset input  $R_D$  high which sets  $Q_A = Q_B = Q_C = Q_D$  low irrespective of the status of the other inputs.

Low appears in the carry output  $\overline{\text{CAO}}$  during count-up when 15 appears in  $Q_A$ ,  $Q_B$ ,  $Q_C$  and  $Q_D$  and when  $T_U$  is low, while low appears in output  $\overline{\text{BRO}}$  when 0 appears in the outputs and when  $T_D$  is low.  $\overline{\text{CAO}}$  and  $\overline{\text{BRO}}$  should be connected to  $T_U$  and  $T_D$  of the next stage for cascade connection. (Refer to the application example.)

### BLOCK DIAGRAM



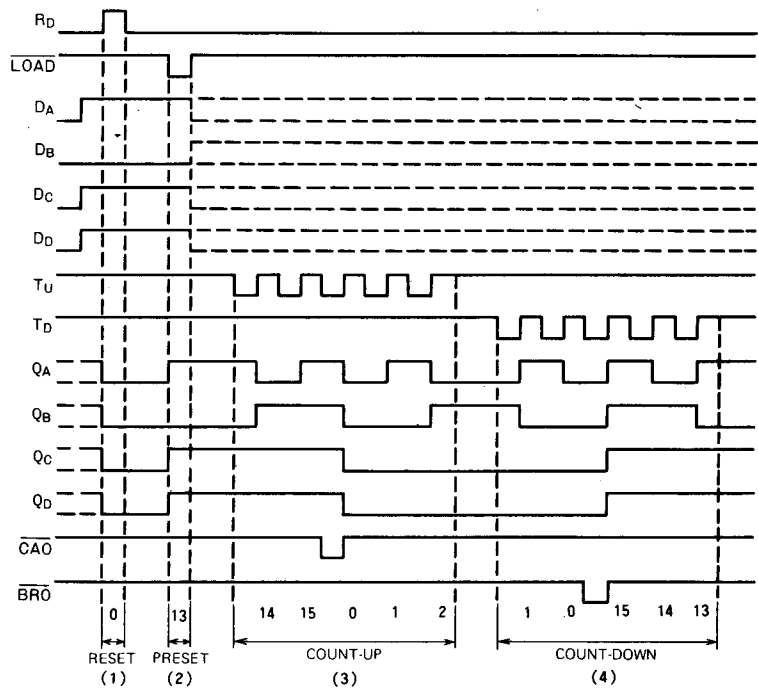
SYNCHRONOUS PRESETTABLE UP/DOWN 4-BIT BINARY COUNTER

FUNCTION TABLE (Note 1)

| R <sub>D</sub> | LOAD | T <sub>U</sub> | T <sub>D</sub> | Q <sub>A</sub> | Q <sub>B</sub> | Q <sub>C</sub> | Q <sub>D</sub> | CAO | BR0 |
|----------------|------|----------------|----------------|----------------|----------------|----------------|----------------|-----|-----|
| H              | X    | X              | X              | L              | L              | L              | L              | H   | H*  |
| L              | L    | X              | X              | D <sub>A</sub> | D <sub>B</sub> | D <sub>C</sub> | D <sub>D</sub> | H*  | H*  |
| L              | H    | H              | H              | Inhibit        |                |                |                | H*  | H*  |
| L              | H    | ↑              | H              | Count-up       |                |                |                | H*  | H*  |
| L              | H    | H              | ↑              | Count-down     |                |                |                | H*  | H*  |

Note 1    ↑ : Transition from low to high  
          \* : Normally high but low appears in accordance with the following  
          CAO = Q<sub>A</sub> · Q<sub>B</sub> · Q<sub>C</sub> · Q<sub>D</sub> · T<sub>U</sub> ..... Count-up  
          BR0 = Q<sub>A</sub> · Q<sub>B</sub> · Q<sub>C</sub> · Q<sub>D</sub> · T<sub>D</sub> ..... Count-down  
          X : Irrelevant

OPERATION TIMING DIAGRAM



Details of timing diagram  
(1) Reset  
(2) Preset to 13  
(3) Count-up 14, 15, 0, 1, 2  
(4) Count-down 1, 0, 15, 14, 13

ABSOLUTE MAXIMUM RATINGS (T<sub>a</sub> = -20 ~ +75°C, unless otherwise noted)

| Symbol           | Parameter                                    | Conditions       | Limits                 | Unit |
|------------------|----------------------------------------------|------------------|------------------------|------|
| V <sub>CC</sub>  | Supply voltage                               |                  | -0.5 ~ +7              | V    |
| V <sub>I</sub>   | Input voltage                                |                  | -0.5 ~ +15             | V    |
| V <sub>O</sub>   | Output voltage                               | High-level state | -0.5 ~ V <sub>CC</sub> | V    |
| T <sub>opr</sub> | Operating free-air ambient temperature range |                  | -20 ~ +75              | °C   |
| T <sub>stg</sub> | Storage temperature range                    |                  | -65 ~ +150             | °C   |

SYNCHRONOUS PRESETTABLE UP/DOWN 4-BIT BINARY COUNTER

RECOMMENDED OPERATING CONDITIONS (Ta = -20 ~ +75°C, unless otherwise noted)

| Symbol | Parameter                 |            | Limits |     |      | Unit |
|--------|---------------------------|------------|--------|-----|------|------|
|        |                           |            | Min    | Typ | Max  |      |
| VCC    | Supply voltage            |            | 4.75   | 5   | 5.25 | V    |
| IOH    | High-level output current | VOH ≥ 2.7V | 0      |     | -400 | μA   |
| IOL    | Low-level output current  | VOL ≤ 0.4V | 0      |     | 4    | mA   |
|        |                           | VOL ≤ 0.5V | 0      |     | 8    | mA   |

ELECTRICAL CHARACTERISTICS (Ta = -20 ~ +75°C, unless otherwise noted)

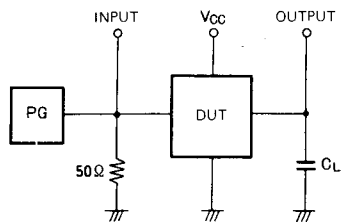
| Symbol | Parameter                             | Test conditions                                 | Limits |       |      | Unit |
|--------|---------------------------------------|-------------------------------------------------|--------|-------|------|------|
|        |                                       |                                                 | Min    | Typ * | Max  |      |
| VIH    | High-level input voltage              |                                                 | 2      |       |      | V    |
| VIL    | Low-level input voltage               |                                                 |        |       | 0.8  | V    |
| VIC    | Input clamp voltage                   | VCC = 4.75V, IIC = -18mA                        |        |       | -1.5 | V    |
| VOH    | High-level output voltage             | VCC = 4.75V, VI = 0.8V<br>VI = 2V, IOH = -400μA | 2.7    | 3.4   |      | V    |
| VOL    | Low-level output voltage              | VCC = 4.75V, IOL = 4mA                          |        | 0.25  | 0.4  | V    |
|        |                                       | VI = 0.8V, VI = 2V, IOL = 8mA                   |        | 0.35  | 0.5  | V    |
| IIH    | High-level input current              | VCC = 5.25V, VI = 2.7V                          |        |       | 20   | μA   |
|        |                                       | VCC = 5.25V, VI = 10V                           |        |       | 0.1  | mA   |
| II L   | Low-level input current               | VCC = 5.25V, VI = 0.4V                          |        |       | -0.4 | mA   |
| IOS    | Short-circuit output current (Note 2) | VCC = 5.25V, VO = 0V                            | -20    |       | -100 | mA   |
| ICC    | Supply current                        | VCC = 5.25V (Note 3)                            |        | 19    | 34   | mA   |

\* : All typical values are at VCC = 5V, Ta = 25°C.  
Note 2: All measurements should be done quickly and not more than one output should be shorted at a time.  
Note 3: ICC is measured with RD and LOAD at 0V and TU, TD, DA ~ DD at 4.5V

SWITCHING CHARACTERISTICS (VCC = 5V, Ta = 25°C, unless otherwise noted)

| Symbol | Parameter                                                                                                  | Test conditions     | Limits |     |     | Unit |
|--------|------------------------------------------------------------------------------------------------------------|---------------------|--------|-----|-----|------|
|        |                                                                                                            |                     | Min    | Typ | Max |      |
| fmax   | Maximum clock frequency                                                                                    |                     | 25     | 38  |     | MHz  |
| tPLH   | Low-to-high-level, high-to-low-level output propagation time, from input TU to output CA0                  | CL = 15 pF (Note 4) |        | 7   | 26  | ns   |
| tPHL   | Low-to-high-level, high-to-low-level output propagation time, from input TD to output BR0                  |                     |        | 14  | 24  | ns   |
| tPLH   | Low-to-high-level, high-to-low-level output propagation time, from input TU to outputs QA, QB, QC, QD      |                     |        | 7   | 24  | ns   |
| tPHL   | Low-to-high-level, high-to-low-level output propagation time, from input TD to outputs QA, QB, QC, QD      |                     |        | 19  | 24  | ns   |
| tPLH   | Low-to-high-level, high-to-low-level output propagation time, from inputs TU, TD to outputs QA, QB, QC, QD |                     |        | 20  | 38  | ns   |
| tPHL   | Low-to-high-level, high-to-low-level output propagation time, from inputs TU, TD to outputs QA, QB, QC, QD |                     |        | 17  | 47  | ns   |
| tPLH   | Low-to-high-level, high-to-low-level output propagation time, from input LOAD to outputs QA, QB, QC, QD    |                     |        | 24  | 40  | ns   |
| tPHL   | Low-to-high-level, high-to-low-level output propagation time, from input LOAD to outputs QA, QB, QC, QD    |                     |        | 20  | 40  | ns   |
| tPHL   | High-to-low-level output propagation time, from input RD to outputs QA, QB, QC, QD                         |                     |        | 12  | 35  | ns   |

Note 4: Measurement circuit



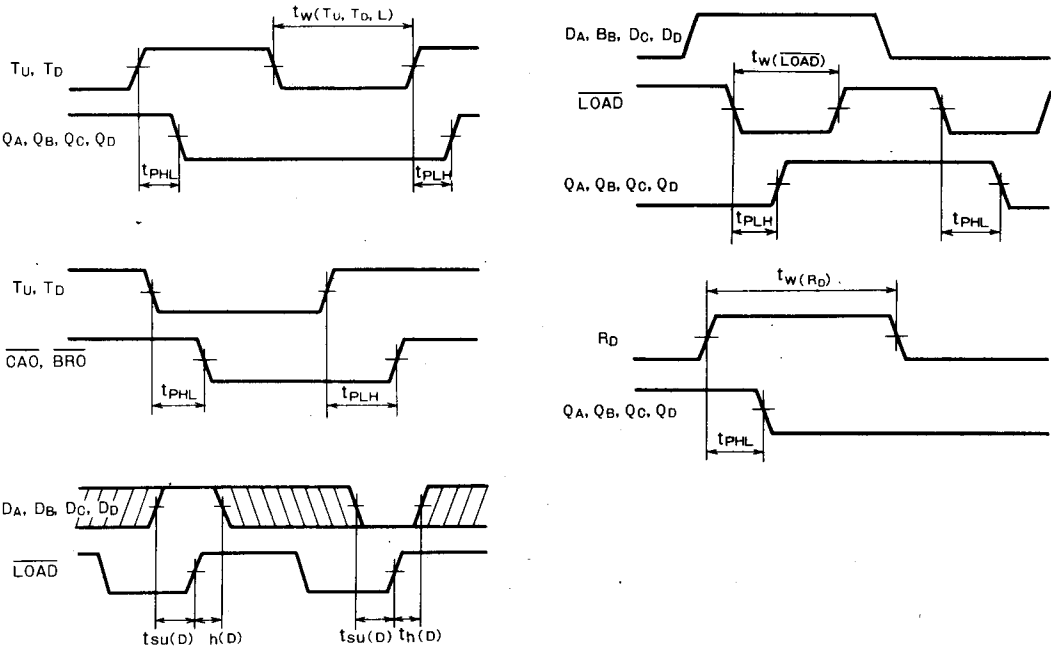
- (1) The pulse generator (PG) has the following characteristics:  
PRR = 1MHz, ti = 6ns, tf = 6ns, tw = 500ns, VP = 3VPp, ZO = 50Ω.  
(2) CL includes probe and jig capacitance

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TIMING REQUIREMENTS (V<sub>CC</sub>=5V, T<sub>a</sub>=25°C, unless otherwise noted)

| Symbol                            | Parameter                                         | Test conditions | Limits |     |     | Unit |
|-----------------------------------|---------------------------------------------------|-----------------|--------|-----|-----|------|
|                                   |                                                   |                 | Min    | Typ | Max |      |
| t <sub>w</sub> (T <sub>U</sub> L) | Clock input T <sub>U</sub> low pulse width        |                 | 20     | 14  |     | ns   |
| t <sub>w</sub> (T <sub>D</sub> L) | Clock input T <sub>D</sub> low pulse width        |                 | 20     | 18  |     | ns   |
| t <sub>w</sub> (LOAD)             | Load LOAD pulse width                             |                 | 20     | 11  |     | ns   |
| t <sub>w</sub> (R <sub>D</sub> )  | Direct reset R <sub>D</sub> pulse width           |                 | 20     | 4   |     | ns   |
| t <sub>su</sub> (D)               | Setup time D <sub>A</sub> ~D <sub>D</sub> to LOAD |                 | 20     | 4   |     | ns   |
| t <sub>h</sub> (D)                | Hold time D <sub>A</sub> ~D <sub>D</sub> to LOAD  |                 | 5      | -3  |     | ns   |

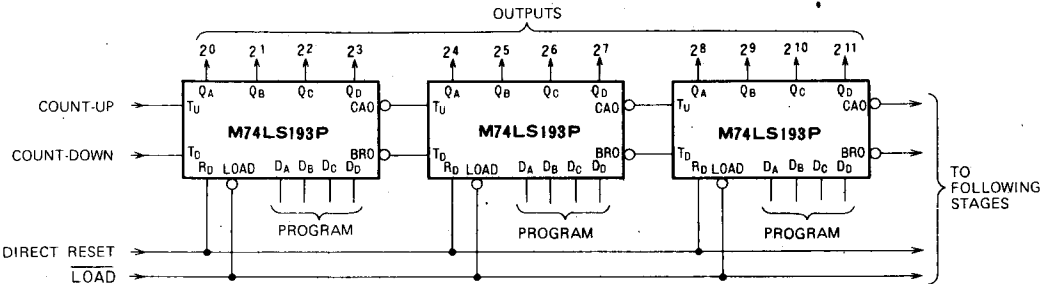
TIMING DIAGRAM (Reference level = 1.3V)



Note 5: The shaded areas indicate when the input is permitted to change for predictable output performance.

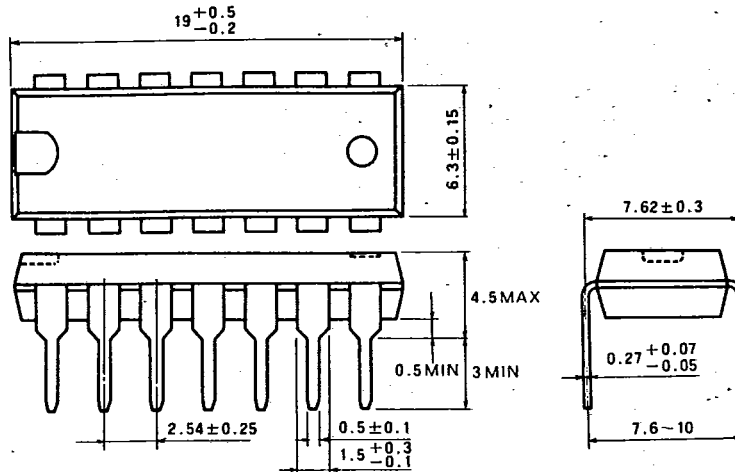
APPLICATION EXAMPLE

Asynchronous 2<sup>n</sup> counter



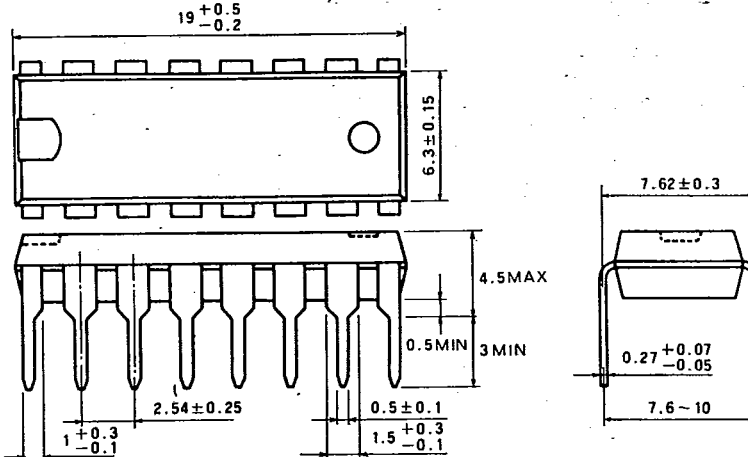
TYPE 14P4 14-PIN MOLDED PLASTIC DIL

Dimension in mm



TYPE 16P4 16-PIN MOLDED PLASTIC DIL

Dimension in mm



TYPE 20P4 20-PIN MOLDED PLASTIC DIL

Dimension in mm

