

54/74192

54LS/74LS192

UP/DOWN DECADE COUNTER

(With Separate Up/Down Clocks)

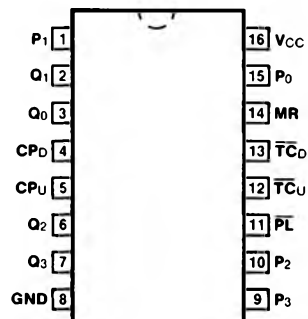
DESCRIPTION — The '192 is an up/down BCD decade (8421) counter. Separate Count Up and Count Down Clocks are used and in either counting mode the circuits operate synchronously. The outputs change state synchronous with the LOW-to-HIGH transitions on the clock inputs.

Separate Terminal Count Up and Terminal Count Down outputs are provided which are used as the clocks for a subsequent stage without extra logic, thus simplifying multistage counter designs. Individual preset inputs allow the circuits to be used as programmable counters. Both the Parallel Load (PL) and the Master Reset (MR) inputs asynchronously override the clocks.

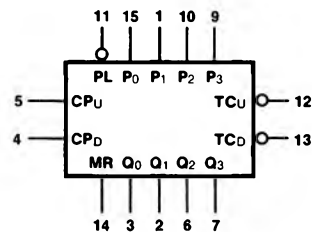
ORDERING CODE: See Section 9

| PKGS | PIN OUT | COMMERCIAL GRADE | MILITARY GRADE | PKG TYPE |
|-----------------|---------|---|---|----------|
| | | $V_{CC} = +5.0\text{ V} \pm 5\%$, $T_A = 0^\circ\text{C to } +70^\circ\text{C}$ | $V_{CC} = +5.0\text{ V} \pm 10\%$, $T_A = -55^\circ\text{C to } +125^\circ\text{C}$ | |
| Plastic DIP (P) | A | 74192PC, 74LS192PC | | 9B |
| Ceramic DIP (D) | A | 74192DC, 74LS192DC | 54192DM, 54LS192DM | 6B |
| Flatpak (F) | A | 74192FC, 74LS192FC | 54192FM, 54LS192FM | 4L |

CONNECTION DIAGRAM PINOUT A



LOGIC SYMBOL



$V_{CC} = \text{Pin } 16$
 $GND = \text{Pin } 8$

INPUT LOADING/FAN-OUT: See Section 3 for U.L. definitions

| PIN NAMES | DESCRIPTION | 54/74 (U.L.) HIGH/LOW | 54/74LS (U.L.) HIGH/LOW |
|-----------------------------------|---|--------------------------|----------------------------|
| CP _U | Count Up Clock Input (Active Rising Edge) | 1.0/1.0 | 0.5/0.25 |
| CP _D | Count Down Clock Input (Active Rising Edge) | 1.0/1.0 | 0.5/0.25 |
| MR | Asynchronous Master Reset Input (Active HIGH) | 1.0/1.0 | 0.5/0.25 |
| $\overline{\text{PL}}$ | Asynchronous Parallel Load Input (Active LOW) | 1.0/1.0 | 0.5/0.25 |
| P ₀ — P ₃ | Parallel Data Inputs | 1.0/1.0 | 0.5/0.25 |
| Q ₀ — Q ₃ | Flip-flop Outputs | 20/10 | 10/5.0 (2.5) |
| $\overline{\text{TC}}_{\text{D}}$ | Terminal Count Down (Borrow) Output (Active LOW) | 20/10 | 10/5.0 (2.5) |
| $\overline{\text{TC}}_{\text{U}}$ | Terminal Count Up (Carry) Output (Active LOW) | 20/10 | 10/5.0 (2.5) |

FUNCTIONAL DESCRIPTION — The '192 and '193 are asynchronously presettable decade and 4-bit binary synchronous up/down (reversible) counters. The operating modes of the '192 decade counter and the '193 binary counter are identical, with the only difference being the count sequences as noted in the State Diagram. Each circuit contains four master/slave flip-flops, with internal gating and steering logic to provide master reset, individual preset, count up and count down operations.

Each flip-flop contains JK feedback from slave to master such that a LOW-to-HIGH transition on its T input causes the slave, and thus the Q output to change state. Synchronous switching, as opposed to ripple counting, is achieved by driving the steering gates of all stages from a common Count Up line and a common Count Down line, thereby causing all state changes to be initiated simultaneously. A LOW-to-HIGH transition on the Count Up input will advance the count by one; a similar transition on the Count Down input will decrease the count by one. While counting with one clock input, the other should be held HIGH. Otherwise, the circuit will either count by twos or not at all, depending on the state of the first flip-flop, which cannot toggle as long as either Clock input is LOW.

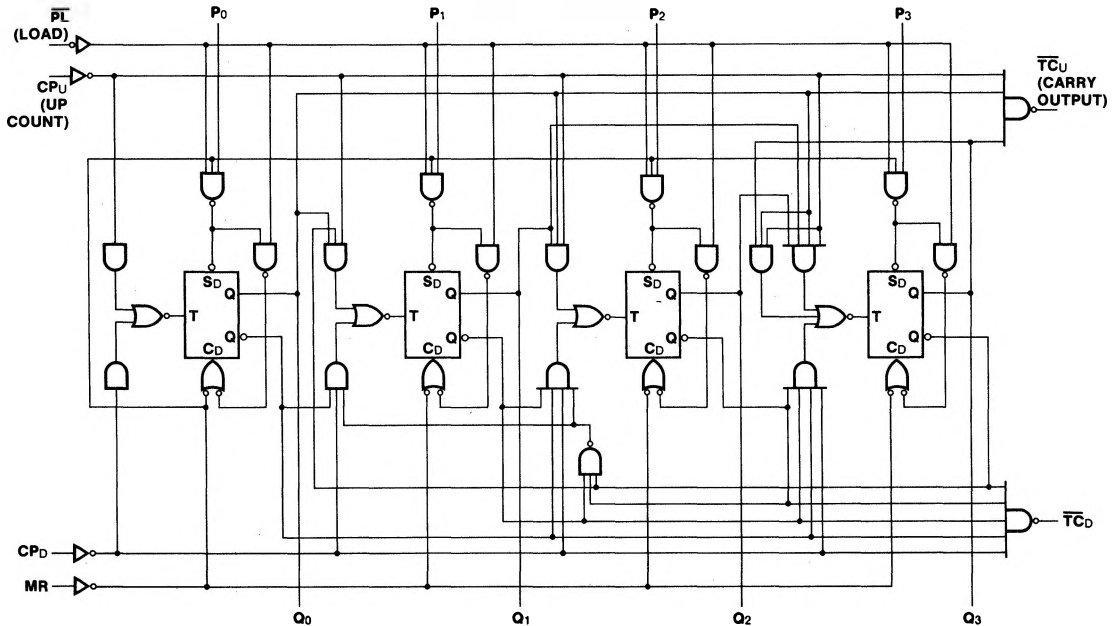
The Terminal Count Up (\overline{TC}_U) and Terminal Count Down (\overline{TC}_D) outputs are normally HIGH. When a circuit has reached the maximum count state (9 for the '192, 15 for the '193), the next HIGH-to-LOW transition of the Count Up Clock will cause \overline{TC}_U to go LOW. \overline{TC}_U will stay LOW until CP_U goes HIGH again, thus effectively repeating the Count Up Clock, but delayed by two gate delays. Similarly, the \overline{TC}_D output will go LOW when the circuit is in the zero state and the Count Down Clock goes LOW. Since the \overline{TC} outputs repeat the clock waveforms, they can be used as the clock input signals to the next higher order circuit in a multistage counter.

$$\overline{TC}_U = Q_0 \cdot Q_3 \cdot \overline{CP}_U$$

$$\overline{TC}_D = \overline{Q}_0 \cdot \overline{Q}_1 \cdot \overline{Q}_2 \cdot \overline{Q}_3 \cdot \overline{CP}_D$$

Each circuit has an asynchronous parallel load capability permitting the counter to be preset. When the Parallel Load (\overline{PL}) and the Master Reset (\overline{MR}) inputs are LOW, information present on the Parallel Data inputs ($P_0 - P_3$) is loaded into the counter and appears on the outputs regardless of the conditions of the clock inputs. A HIGH signal on the Master Reset input will disable the preset gates, override both Clock inputs, and latch each Q output in the LOW state. If one of the Clock inputs is LOW during and after a reset or load operation, the next LOW-to-HIGH transition of that Clock will be interpreted as a legitimate signal and will be counted.

LOGIC DIAGRAM

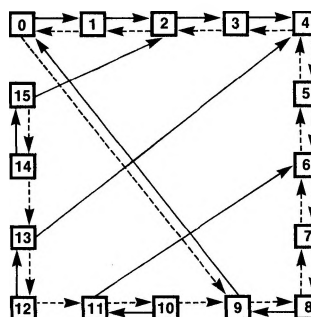


MODE SELECT TABLE

| MR | \overline{PL} | CP_U | CP_D | MODE |
|----|-----------------|------------|--------------|----------------|
| H | X | X | X | Reset (Asyn.) |
| L | L | X | X | Preset (Asyn.) |
| L | H | H | H | No Change |
| L | H | \uparrow | H | Count Up |
| L | H | H | \downarrow | Count Down |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

STATE DIAGRAM



DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

| SYMBOL | PARAMETER | 54/74 | | 54/74LS | | UNITS | CONDITIONS | |
|-----------------|------------------------------|-------|-----|---------|-----|-------|------------|--|
| | | Min | Max | Min | Max | | | |
| I _{OS} | Output Short Circuit Current | XM | -20 | -65 | -20 | -100 | mA | V _{CC} = Max |
| | | XC | -18 | -65 | -20 | -100 | | |
| I _{CC} | Power Supply Current | XM | 89 | | 34 | | mA | V _{CC} = Max; MR, \overline{PL} = Gnd Other Inputs = 4.5 V |
| | | XC | 102 | | 34 | | | |

AC CHARACTERISTICS: V_{CC} = +5.0 V, T_A = +25°C (See Section 3 for waveforms and load configurations)

| SYMBOL | PARAMETER | 54/74 | | 54/74LS | | UNITS | CONDITIONS |
|--------------------------------------|---|--|-----|------------------------|-----|-------|-----------------|
| | | C _L = 15 pF R _L = 400 Ω | | C _L = 15 pF | | | |
| | | Min | Max | Min | Max | | |
| f _{max} | Maximum Count Frequency | 25 | | 30 | | MHz | Figs. 3-1, 3-8 |
| t _{PLH} t _{PHL} | Propagation Delay CP _U or CP _D to Q _n | 38 47 | | 31 28 | | ns | |
| t _{PLH} t _{PHL} | Propagation Delay CP _U to \overline{TC}_U | 26 24 | | 16 21 | | ns | Figs. 3-1, 3-5 |
| t _{PLH} t _{PHL} | Propagation Delay CP _D to \overline{TC}_D | 24 24 | | 16 24 | | | |
| t _{PLH} t _{PHL} | Propagation Delay P _n to Q _n | | | 20 30 | | ns | Figs. 3-1, 3-5 |
| t _{PLH} t _{PHL} | Propagation Delay PL to Q _n | 40 40 | | 32 30 | | ns | Figs. 3-1, 3-16 |
| t _{PHL} | Propagation Delay, MR to Q _n | 35 | | 25 | | | |

AC OPERATING REQUIREMENTS: $V_{CC} = +5.0\text{ V}$, $T_A = +25^\circ\text{ C}$

| SYMBOL | PARAMETER | 54/74 | | 54/74LS | | UNITS | CONDITIONS |
|------------------------|--|-------|-----|---------|-----|-------|---|
| | | Min | Max | Min | Max | | |
| t_s (H) t_s (L) | Setup Time HIGH or LOW P_n to \overline{PL} | 20 | | 20 | | ns | Fig. 3-13 $CP_U = CP_D = \text{LOW}$ |
| t_h (H) t_h (L) | Hold Time HIGH or LOW P_n to \overline{PL} | 0 | | 3.0 | | | |
| t_w (L) | CP Pulse Width LOW | 20 | | 17 | | ns | Fig. 3-8 |
| t_w (L) | \overline{PL} Pulse Width LOW | 20 | | 20 | | ns | Fig. 3-16 |
| t_w (H) | MR Pulse Width HIGH | 20 | | 15 | | | |
| t_{rec} | Recovery Time, MR to CP | 6.0 | | 3.0 | | | |
| t_{rec} | Recovery Time, \overline{PL} to CP | 6.0 | | 10 | | | |