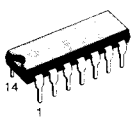
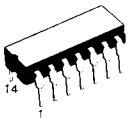
# LS290-DECADE COUNTER
# LS293-4-BIT BINARY COUNTER




**B1**
Plastic Package




**D1/D2**
Ceramic Package

**M1**
Micro Package

**C1**
Plastic Chip Carrier

ORDERING NUMBERS:

T54LSXXX D2
T74LSXXX D1
T74LSXXX B1
T74LSXXX C1
T74LSXXX M1

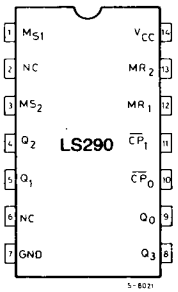
## DESCRIPTION

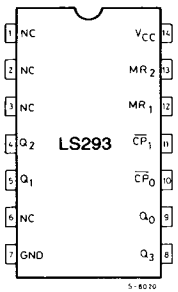
The T54LS/T74LS290 and T54LS/T74LS293 are high-speed 4-bit ripple type counters partitioned into two sections. Each counter has a divide-by-two section and either a divide-by-five (LS290) or divided-by-eight (LS293) section which are triggered by a HIGH-to-LOW transition on the clock inputs. Each section can be used separately or tied together (Q to $\overline{CP}$) to form BCD, Bi-quinary, or Modulo-16 counters. Both of the counters have a 2-input gated Master Reset (Clear), and the LS90 also has a 2-input gated Master Set (Preset 9).

- CORNER POWER PIN VERSION OF THE LS90 AND LS93
- LOW POWER CONSUMPTION... TYPICALLY 45mW
- HIGH CUNT RATES... TYPICALLY 50MHz
- CHOICE OF COUNTING MODES... BCD, BI-QUINARY, BINARY
- INPUT CLAMP DIODES LIMIT HIGH SPEED TERMINATION EFFECTS
- FULLY TTL AND CMOS COMPATIBLE

**PIN CONNECTION**
(top view)

DUAL IN LINE

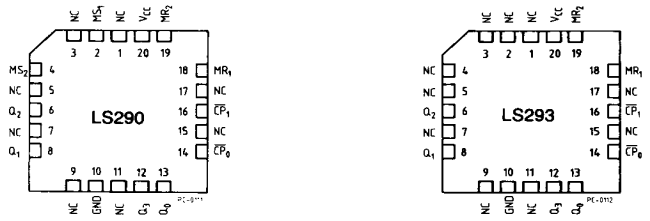



## PIN NAMES

| | |
|---|---|
| $\overline{CP}_0$ | Clock (Active LOW Going Edge) Input to ÷ 2 Section |
| $\overline{CP}_1$ | Clock (Active LOW Going Edge) Input to ÷ 5 Section (LS290) |
| $\overline{CP}_1$ | Clock (Active LOW Going Edge) Input to ÷ 8 Section (LS293) |
| $MR_1$, $MR_2$ | Master Reset (Clear) Inputs |
| $MR_1$, $MR_2$ | Master Reset (Preset-9 LS290) Inputs |
| $Q_0$ | Output from - 2 Section |
| $Q_1$,$Q_2$,$Q_3$ | Outputs from - 5 & - 8 Sections |

## CHIP CARRIER




NC = No Internal Connection

## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | −0.5 to 7 | V |
| $V_I$ | Input Voltage, for $\overline{CP}$ | −0.5 to 5.5 | V |
| $V_O$ | Output Voltage, Applied to Output | −0.5 to 10 | V |
| $I_I$ | Input Current, Into Inputs | −30 to 5 | mA |
| $I_O$ | Output Current, Into Outputs | 50 | mA |

Stresses in excess of those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions in excess of those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

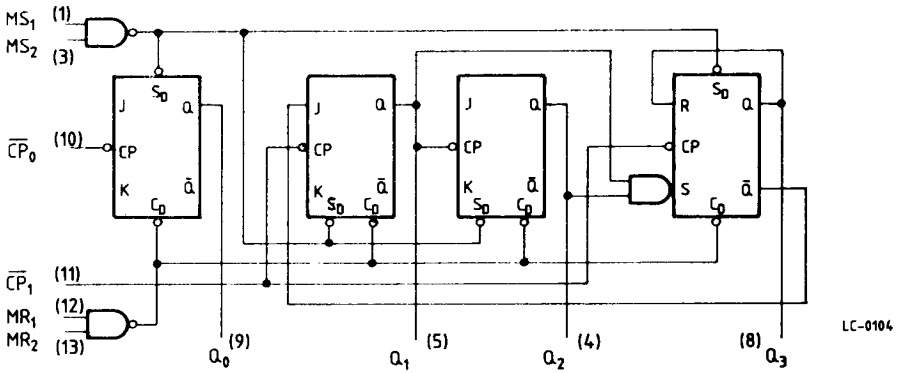
## GUARANTEED OPERATING RANGES

| Part Numbers | Supply Voltage | | | Temperature |
|---|---|---|---|---|
| | Min | Typ | Max | |
| T54LS290/293D2 | 4.5 V | 5.0 V | 5.5 V | −55°C to +125°C |
| T74LS290/293XX | 4.75 V | 5.0 V | 5.25 V | 0°C to +70°C |

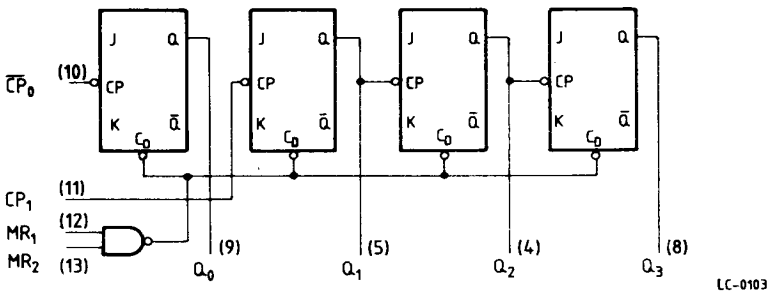
XX = package type.

## LOGIC DIAGRAMS

LS290

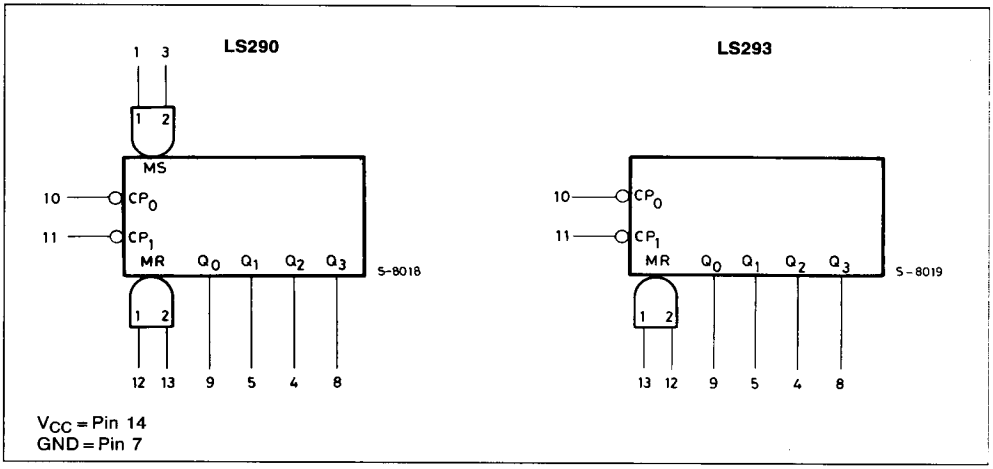



LS293




$V_{CC}$ = Pin 14
GND = Pin 7
( ) = Pin numbers

## LOGIC SYMBOL




$V_{CC}$ = Pin 14
GND = Pin 7

## FUNCTIONAL DESCRIPTION

The LS290 and LS293 are 4-bit ripple type Decade, and 4-bit Binary counters respectively. Each device consists of four master/slave flip-flops which are internally connected to provide a divide-by-two section and divide-by-five (LS290) or divide-by-eight (LS293) section. Each section has a separate clock input which initiates state changes of the counter on the HIGH-to-LOW clock transition. State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes. The $Q_0$ output of each device is designed and specified to drive the rated fan-out plus the $\overline{CP}_1$ input of the device.

A gated AND asynchronous Master Reset ($MR_1 \bullet MR_2$) is provided on both counters which overrides the clocks and resets (clears) all the flip-flops. A gated AND asynchronous master Set ($MS_1 \bullet MS_2$) is provided on the LS290 which overrides the clocks and the MR inputs and sets the outputs to nine (HLLH).

Since the output from the divide-by-two section is not internally connected to the succeding stages, the devices may be operated in various counting modes:

**LS290**

A. BCD Decade (8421) Counter - the $\overline{CP}_1$ input must be externally connected to the $Q_0$ output. The $\overline{CP}_0$ input receives the incoming count and BCD count sequence is produced.

B. Symmetrical Bi-quinary Divide-By-Ten Counter - The $Q_3$ output must be externally connected to the $\overline{CP}_0$ input. The input count is then applied to the $\overline{CP}_1$ input and a divide-by-ten square is obtained at output $Q_0$.

C. Divide-By-Two and Divide-By-Five Counter - No external interconnections are required. The first flip-flop is used as a binary element for the divide-by-two function ($\overline{CP}_0$ as the input and $Q_0$ as the output). The $\overline{CP}_1$ input is used to obtain binary divide-by-five operation at the $Q_3$ output.

**LS293**

A. 4-Bit Ripple Counter - The output $Q_0$ must be externally connected to input $\overline{CP}_1$. The input count pulses are applied to input $\overline{CP}_0$. Simultaneous division of 2, 4, 8, and 16 are performed at the $Q_0$, $Q_1$, $Q_2$ and $Q_3$ outputs as shown in the truth table.

B. 3-Bit Ripple Counter - The input count pulses are applied to input $\overline{CP}_1$. Simultaneous frequency divisions of 2,4, and 8 are available at the $Q_0$, $Q_1$, $Q_2$, and $Q_3$ outputs. Independent use of the first flip-flop is available if the reset function coincides with reset of the 3-bit ripple-through counter.

## TRUTH TABLES

**LS290**
**BCD COUNT SEQUENCE**

| COUNT | OUTPUT | | | |
|---|---|---|---|---|
| | $Q_0$ | $Q_1$ | $Q_2$ | $Q_3$ |
| 0 | L | L | L | L |
| 1 | H | L | L | L |
| 2 | L | H | L | L |
| 3 | H | H | L | L |
| 4 | L | L | H | L |
| 5 | H | L | H | L |
| 6 | L | H | H | L |
| 7 | H | H | H | L |
| 8 | L | L | L | H |
| 9 | H | L | L | H |

NOTE: Output $Q_0$ is connected to input $CP_1$ for BCD count.

**LS290**
**MODE SELECTION**

| RESET/SET INPUTS | | | | OUTPUTS | | | |
|---|---|---|---|---|---|---|---|
| $MR_1$ | $MR_2$ | $MS_1$ | $MS_2$ | $Q_0$ | $Q_1$ | $Q_2$ | $Q_3$ |
| H | H | L | X | L | L | L | L |
| H | H | X | L | L | L | L | L |
| X | X | H | H | H | L | L | H |
| L | X | L | X | Count | | | |
| X | L | X | L | Count | | | |
| L | X | X | L | Count | | | |
| X | L | L | X | Count | | | |

**LS293**
**TRUTH TABLE**

| COUNT | OUTPUT | | | |
|---|---|---|---|---|
| | $Q_0$ | $Q_1$ | $Q_2$ | $Q_3$ |
| 0 | L | L | L | L |
| 1 | H | L | L | L |
| 2 | L | H | L | L |
| 3 | H | H | L | L |
| 4 | L | L | H | L |
| 5 | H | L | H | L |
| 6 | L | H | H | L |
| 7 | H | H | H | L |
| 8 | L | L | L | H |
| 9 | H | L | L | H |
| 10 | L | H | L | H |
| 11 | H | H | L | H |
| 12 | L | L | H | H |
| 13 | H | L | H | H |
| 14 | L | H | H | H |
| 15 | H | H | H | H |

NOTE: Output $Q_0$ is connected to input $CP_1$.

**LS293**
**MODE SELECTION**

| RESET INPUTS | | OUTPUTS | | | |
|---|---|---|---|---|---|
| $MR_1$ | $MR_2$ | $Q_0$ | $Q_1$ | $Q_2$ | $Q_3$ |
| H | H | L | L | L | L |
| L | H | Count | | | |
| H | L | Count | | | |
| L | L | Count | | | |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care

## DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE

| Symbol | Parameter | | Limits Min. | Limits Typ. | Limits Max. | Test Conditions (Note 1) | Units |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage | | 2.0 | | | Guaranteed input HIGH Voltage for all Inputs | V |
| $V_{IL}$ | Input LOW Voltage | 54 | | | 0.7 | Guaranteed input LOW Voltage for all Inputs | V |
| | | 74 | | | 0.8 | | |
| $V_{CD}$ | Input Clamp Diode Voltage | | | −0.65 | −1.5 | $V_{CC}$ = MIN, $I_{IN}$ = −18mA | V |
| $V_{OH}$ | Output HIGH Voltage | 54 | 2.5 | 3.4 | | $V_{CC}$ = MIN, $I_{OH}$ = −400μA, $V_{IN}$ = $V_{IH}$ or $V_{IL}$ per Truth Table | V |
| | | 74 | 2.7 | 3.4 | | | |
| $V_{OL}$ | Output LOW Voltage | 54,74 | | 0.25 | 0.4 | $I_{OL}$ = 4.0mA; $V_{CC}$ = MIN, $V_{IN}$ = $V_{IH}$ or $V_{IL}$ per Truth Table | V |
| | | 74 | | 0.35 | 0.5 | $I_{OL}$ = 8.0mA | |
| $I_{IH}$ | Input HIGH Current<br>MS, MR<br>$\overline{CP}_0$<br>$\overline{CP}_1$ (LS290)<br>$\overline{CP}_1$ (LS293) | | | | 20<br>40<br>80<br>40 | $V_{CC}$ = MAX, $V_{IN}$ = 2.7V | μA |
| | MR, MS<br>$\overline{CP}_0$, $\overline{CP}_1$ (LS293)<br>$\overline{CP}_1$ (LS290) | | | | 0.1<br>0.2<br>0.4 | $V_{CC}$ = MAX, $V_{IN}$ = 5.5V | mA |
| $I_{IL}$ | Input LOW Current<br>MS, MR<br>$\overline{CP}_0$<br>$\overline{CP}_1$ (LS290)<br>$\overline{CP}_1$ (LS293) | | | | −0.4<br>−2.4<br>−3.2<br>−1.6 | $V_{CC}$ = MAX, $V_{IN}$ = 0.4V | μA |
| $I_{OS}$ | Output Short Circuit Current (Note 2) | | −20 | | −100 | $V_{CC}$ = MAX, $V_{OUT}$ = 0V | mA |
| $I_{CC}$ | Power Supply Current | | | 9 | 15 | $V_{CC}$ = MAX | mA |

**Notes:**
1) Conditions for testing, not shown in the Table, are chosen to guarantee operation under "worst case" conditions.
2) Not more than one output should be shorted at a time.
3) Typical values are at $V_{CC}$ = 5.0V, $T_A$ = 25°C

## AC SET-UP REQUIREMENTS: $T_A$ = 25°C

| Symbol | Parameter | LS290 Min. | LS290 Max. | LS293 Min. | LS293 Max. | Test Conditions | | Units |
|---|---|---|---|---|---|---|---|---|
| $t_W$ | $\overline{CP}_0$ Pulse Width | 15 | | 15 | | Fig. 1 | $V_{CC}$ = 5.0V | ns |
| $t_W$ | $\overline{CP}_1$ Pulse Width | 30 | | 30 | | | | ns |
| $t_W$ | MS Pulse Width | 15 | | | | Figs. 2,3 | | ns |
| $t_W$ | MR Pulse Width | 15 | | 15 | | Fig. 2 | | ns |
| $t_{rec}$ | Recovery Time, MS to $\overline{CP}$ | 25 | | | | Fig. 2,3 | | ns |
| $t_{rec}$ | Recovery Time, MR to $\overline{CP}$ | 25 | | 25 | | Fig. 2 | | ns |

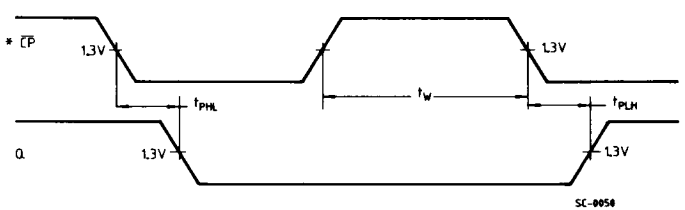
RECOVERY TIME ($t_{rec}$) - is defined as the minimum time required between the end of the reset pulse and the clock transition from HIGH to LOW in order to recognize and transfer HIGH data to Q outputs.

## AC CHARACTERISTICS: $T_A = 25°C$

| Symbol | Parameter | Limits | | | | Test Conditions | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LS290 | | LS293 | | | | |
| | | Min. | Max. | Min. | Max. | | | |
| $f_{MAX}$ | $\overline{CP}_0$ Input Count Frequency | 32 | | 32 | | Fig. 1 | $V_{CC} = 5.0V$<br>$C_L = 15pF$ | MHz |
| $f_{MAX}$ | $\overline{CP}_1$ Input Count Frequency | 16 | | 16 | | Fig. 1 | | MHz |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay,<br>$\overline{CP}_0$ Input to $Q_0$ Output | | 16<br>18 | | 16<br>18 | Fig. 1 | | ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay,<br>$\overline{CP}_1$ Input to $Q_1$ Output | | 16<br>21 | | 16<br>21 | | | ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay,<br>$\overline{CP}_1$ Input to $Q_2$ Output | | 32<br>35 | | 32<br>35 | | | ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay,<br>$\overline{CP}_1$ Input to $Q_3$ Output | | 32<br>35 | | 51<br>51 | | | ns |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay,<br>$\overline{CP}_0$ Input to $Q_3$ Output | | 48<br>50 | | 70<br>70 | | | ns |
| $t_{PLH}$ | MS Input to $Q_0$ and $Q_3$ Outputs | | 30 | | | Fig. 3 | | |
| $t_{PHL}$ | MS Input to $Q_1$ and $Q_2$ Outputs | | 40 | | | Fig. 2 | | |
| $t_{PHL}$ | MR Input to Any Output | | 40 | | 40 | Fig. 2 | | |

## AC WAVEFORMS

Fig. 1




* The number of the Clock Pulse Required between the $t_{PHL}$ and $t_{PLH}$ measurements can be determined from the Truth Table

## AC WAVEFORMS (continued)

Fig. 2

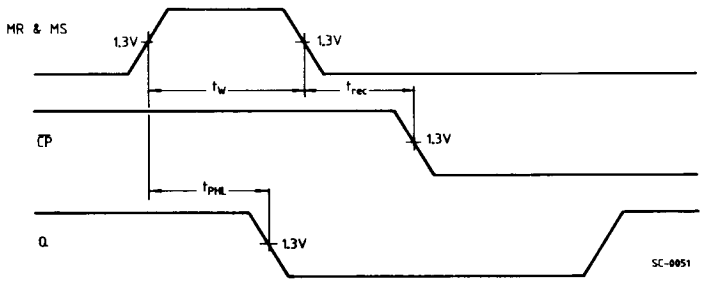



Fig. 3