National Semiconductor

# DM74LS390 Dual 4-Bit Decade Counter

## General Description

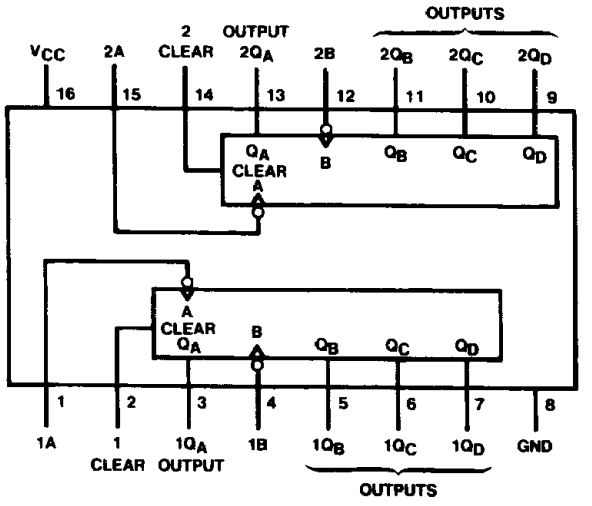
Each of these monolithic circuits contains eight master-slave flip-flops and additional gating to implement two individual four-bit counters in a single package. The 'LS390 incorporates dual divide-by-two and divide-by-five counters, which can be used to implement cycle lengths equal to any whole and/or cumulative multiples of 2 and/or 5 up to divide-by-100. When connected as a bi-quinary counter, the separate divide-by-two circuit can be used to provide symmetry (a square wave) at the final output stage. The 'LS390 has parallel outputs from each counter stage so that any submultiple of the input count frequency is available for system-timing signals.

## Features

- Dual version of the popular 'LS90
- 'LS390 . . . individual clocks for A and B flip-flops provide dual ÷ 2 and ÷ 5 counters
- Direct clear for each 4-bit counter
- Dual 4-bit version can significantly improve system densities by reducing counter package count by 50%
- Typical maximum count frequency . . . 35 MHz
- Buffered outputs reduce possibility of collector commutation

## Connection Diagram

**Dual-In-Line Package**

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**Order Number DM74LS390M or DM74LS390N**
**See NS Package Number M16A or N16E**

## Function Tables

**BCD Count Sequence**
**(Each Counter)**
**(See Note A)**

| Count | Outputs | | | |
|---|---|---|---|---|
| | $Q_D$ | $Q_C$ | $Q_B$ | $Q_A$ |
| 0 | L | L | L | L |
| 1 | L | L | L | H |
| 2 | L | L | H | L |
| 3 | L | L | H | H |
| 4 | L | H | L | L |
| 5 | L | H | L | H |
| 6 | L | H | H | L |
| 7 | L | H | H | H |
| 8 | H | L | L | L |
| 9 | H | L | L | H |

**Bi-Quinary (5-2)**
**(Each Counter)**
**(See Note B)**

| Count | Outputs | | | |
|---|---|---|---|---|
| | $Q_A$ | $Q_D$ | $Q_C$ | $Q_B$ |
| 0 | L | L | L | L |
| 1 | L | L | L | H |
| 2 | L | L | H | L |
| 3 | L | L | H | H |
| 4 | L | H | L | L |
| 5 | H | L | L | L |
| 6 | H | L | L | H |
| 7 | H | L | H | L |
| 8 | H | L | H | H |
| 9 | H | H | L | L |

**Note A:** Output $Q_A$ is connected to input B for BCD count.

**Note B:** Output $Q_D$ is connected to input A for Bi-quinary count.

**Note C:** H = High Level, L = Low Level.

## Absolute Maximum Ratings (Note)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.**

| | |
|---|---|
| Supply Voltage | 7V |
| Input Voltage | |
| Clear | 7V |
| A or B | 5.5V |
| Operating Free Air Temperature Range | |
| DM74LS | 0°C to +70°C |
| Storage Temperature Range | −65°C to +150°C |

Note: *The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.*

## Recommended Operating Conditions

| Symbol | Parameter | | DM74LS390 | | | Units |
|---|---|---|---|---|---|---|
| | | | Min | Nom | Max | |
| $V_{CC}$ | Supply Voltage | | 4.75 | 5 | 5.25 | V |
| $V_{IH}$ | High Level Input Voltage | | 2 | | | V |
| $V_{IL}$ | Low Level Input Voltage | | | | 0.8 | V |
| $I_{OH}$ | High Level Output Current | | | | −0.4 | mA |
| $I_{OL}$ | Low Level Output Current | | | | 8 | mA |
| $f_{CLK}$ | Clock Frequency (Note 1) | A to $Q_A$ | 0 | | 25 | MHz |
| | | B to $Q_B$ | 0 | | 20 | |
| $f_{CLK}$ | Clock Frequency (Note 2) | A to $Q_A$ | 0 | | 20 | MHz |
| | | B to $Q_B$ | 0 | | 15 | |
| $t_W$ | Pulse Width (Note 1) | A | 20 | | | ns |
| | | B | 25 | | | |
| | | Clear High | 20 | | | |
| $t_{REL}$ | Clear Release Time (Notes 3 & 4) | | 25 ↓ | | | ns |
| $T_A$ | Free Air Operating Temperature | | 0 | | 70 | °C |

**Note 1:** $C_L$ = 15 pF, $R_L$ = 2 kΩ, $T_A$ = 25°C and $V_{CC}$ = 5V.

**Note 2:** $C_L$ = 50 pF, $R_L$ = 2 kΩ, $T_A$ = 25°C and $V_{CC}$ = 5V.

**Note 3:** The symbol (↓) indicates the falling edge of the clear pulse is used for reference.

**Note 4:** $T_A$ = 25°C and $V_{CC}$ = 5V.

## Electrical Characteristics over recommended operating free air temperature range (unless otherwise noted)

| Symbol | Parameter | Conditions | | Min | Typ (Note 1) | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_I$ | Input Clamp Voltage | $V_{CC}$ = Min, $I_I$ = −18 mA | | | | −1.5 | V |
| $V_{OH}$ | High Level Output Voltage | $V_{CC}$ = Min, $I_{OH}$ = Max<br>$V_{IL}$ = Max, $V_{IH}$ = Min | | 2.7 | 3.4 | | V |
| $V_{OL}$ | Low Level Output Voltage | $V_{CC}$ = Min, $I_{OL}$ = Max<br>$V_{IL}$ = Max, $V_{IH}$ = Min | | | 0.35 | 0.5 | V |
| | | $I_{OL}$ = 4 mA, $V_{CC}$ = Min | | | 0.25 | 0.4 | |
| $I_I$ | Input Current @ Max Input Voltage | $V_{CC}$ = Max, $V_I$ = 7V | Clear | | | 0.1 | mA |
| | | $V_{CC}$ = Max<br>$V_I$ = 5.5V | A | | | 0.2 | |
| | | | B | | | 0.4 | |
| $I_{IH}$ | High Level Input Current | $V_{CC}$ = Max<br>$V_I$ = 2.7V | Clear | | | 20 | μA |
| | | | A | | | 40 | |
| | | | B | | | 80 | |

## Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted) (Continued)

| Symbol | Parameter | Conditions | | Min | Typ (Note 1) | Max | Units |
|---|---|---|---|---|---|---|---|
| $I_{IL}$ | Low Level Input Current | $V_{CC}$ = Max, $V_I$ = 0.4V | Clear | | | −0.4 | mA |
| | | | A | | | −1.6 | |
| | | | B | | | −2.4 | |
| $I_{OS}$ | Short Circuit Output Current | $V_{CC}$ = Max (Note 2) | DM74 | −20 | | −100 | mA |
| $I_{CC}$ | Supply Current | $V_{CC}$ = Max (Note 3) | | | 15 | 26 | mA |

**Note 1:** All typicals are at $V_{CC}$ = 5V, $T_A$ = 25°C.

**Note 2:** Not more than one output should be shorted at a time, and the duration should not exceed one second.

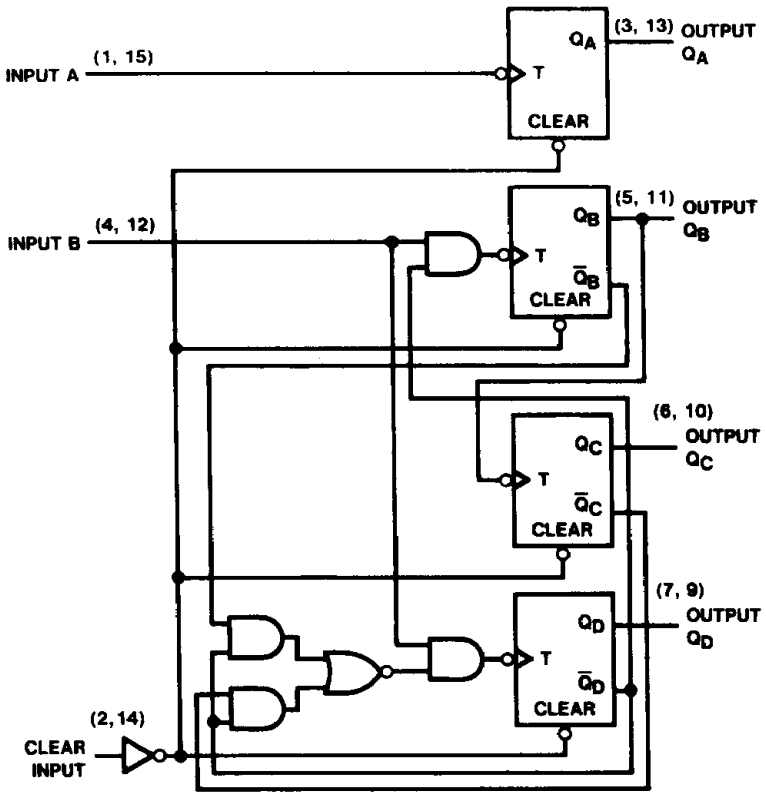
**Note 3:** $I_{CC}$ is measured with all outputs open, both CLEAR inputs grounded following momentary connection to 4.5 and all other inputs grounded.

## Switching Characteristics at $V_{CC}$ = 5V and $T_A$ = 25°C (See Section 1 for Test Waveforms and Output Load)

| Symbol | Parameter | From (Input) To (Output) | $R_L$ = 2 kΩ | | | | Units |
|---|---|---|---|---|---|---|---|
| | | | $C_L$ = 15 pF | | $C_L$ = 50 pF | | |
| | | | Min | Max | Min | Max | |
| $f_{MAX}$ | Maximum Clock Frequency | A to $Q_A$ | 25 | | 20 | | MHz |
| | | B to $Q_B$ | 20 | | 15 | | |
| $t_{PLH}$ | Propagation Delay Time Low to High Level Output | A to $Q_A$ | | 20 | | 24 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | A to $Q_A$ | | 20 | | 30 | ns |
| $t_{PLH}$ | Propagation Delay Time Low to High Level Output | A to $Q_C$ | | 60 | | 81 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | A to $Q_C$ | | 60 | | 81 | ns |
| $t_{PLH}$ | Propagation Delay Time Low to High Level Output | B to $Q_B$ | | 21 | | 27 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | B to $Q_B$ | | 21 | | 33 | ns |
| $t_{PLH}$ | Propagation Delay Time Low to High Level Output | B to $Q_C$ | | 39 | | 51 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | B to $Q_C$ | | 39 | | 54 | ns |
| $t_{PLH}$ | Propagation Delay Time Low to High Level Output | B to $Q_D$ | | 21 | | 27 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | B to $Q_D$ | | 21 | | 33 | ns |
| $t_{PHL}$ | Propagation Delay Time High to Low Level Output | Clear to Any Q | | 39 | | 45 | ns |

## Logic Diagram

'LS390

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