

DM74LS90/DM74LS93 Decade and Binary Counters

General Description

Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the 'LS90 and divide-by-eight for the 'LS93.

All of these counters have a gated zero reset and the LS90 also has gated set-to-nine inputs for use in BCD nine's complement applications.

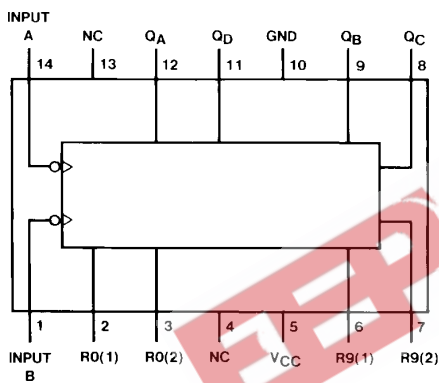
To use their maximum count length (decade or four bit binary), the B input is connected to the Q_A output. The input

count pulses are applied to input A and the outputs are as described in the appropriate truth table. A symmetrical divide-by-ten count can be obtained from the 'LS90 counters by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A .

Features

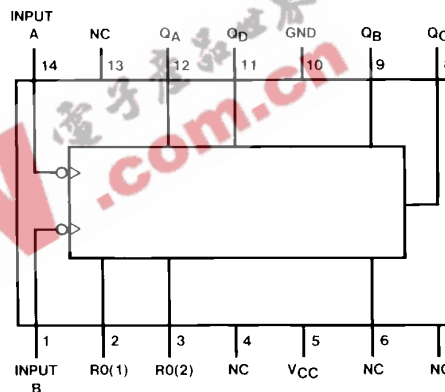
- Typical power dissipation 45 mW
- Count frequency 42 MHz

Connection Diagrams (Dual-In-Line Packages)



TL/F/6381-1

Order Number DM74LS90M or DM74LS90N
See NS Package Number M14A or N14A



TL/F/6381-2

Order Number DM74LS93M or DM74LS93N
See NS Package Number M14A or N14A

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 (Reset) | 7V |
| Input Voltage (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 | DM74LS90 | | | 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 | 32 | MHz |
| | | B to Q _B | 0 | 16 | |
| f _{CLK} | Clock Frequency (Note 2) | A to Q _A | 0 | 20 | MHz |
| | | B to Q _B | 0 | 10 | |
| t _w | Pulse Width (Note 1) | A | 15 | | ns |
| | | B | 30 | | |
| | | Reset | 15 | | |
| t _w | Pulse Width (Note 2) | A | 25 | | ns |
| | | B | 50 | | |
| | | Reset | 25 | | |
| t _{REL} | Reset Release Time (Note 1) | 25 | | | ns |
| t _{REL} | Reset Release Time (Note 2) | 35 | | | 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.

'LS90 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 V _{IL} = Max, V _{IH} = Min | 2.7 | 3.4 | | V |
| V _{OL} | Low Level Output Voltage | V _{CC} = Min, I _{OL} = Max V _{IL} = Max, V _{IH} = Min (Note 4) | | 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 | Reset | | 0.1 | mA |
| | | V _{CC} = Max V _I = 5.5V | A | | 0.2 | |
| | | | B | | 0.4 | |

'LS90 Electrical Characteristics

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

| Symbol | Parameter | Conditions | Min | Typ (Note 1) | Max | Units |
|----------|------------------------------|-----------------------------------|-------|-----------------|------|---------|
| I_{IH} | High Level Input Current | $V_{CC} = \text{Max}, V_I = 2.7V$ | Reset | | 20 | μA |
| | | | A | | 40 | |
| | | | B | | 80 | |
| I_{IL} | Low Level Input Current | $V_{CC} = \text{Max}, V_I = 0.4V$ | Reset | | -0.4 | mA |
| | | | A | | -2.4 | |
| | | | B | | -3.2 | |
| I_{OS} | Short Circuit Output Current | $V_{CC} = \text{Max}$ (Note 2) | -20 | | -100 | mA |
| I_{CC} | Supply Current | $V_{CC} = \text{Max}$ (Note 3) | | 9 | 15 | mA |

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

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 RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

Note 4: Q_A outputs are tested at $I_{OL} = \text{Max}$ plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

'LS90 Switching Characteristics

at $V_{CC} = 5V$ and $T_A = 25^\circ C$ (See Section 1 for Test Waveforms and Output Load)

| Symbol | Parameter | From (Input) To (Output) | $R_L = 2 k\Omega$ | | | | Units |
|-----------|---|-----------------------------|-------------------|-----|---------------|-----|-------|
| | | | $C_L = 15 pF$ | | $C_L = 50 pF$ | | |
| | | | Min | Max | Min | Max | |
| f_{MAX} | Maximum Clock Frequency | A to Q_A | 32 | | 20 | | MHz |
| | | B to Q_B | 16 | | 10 | | |
| t_{PLH} | Propagation Delay Time Low to High Level Output | A to Q_A | | 16 | | 20 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | A to Q_A | | 18 | | 24 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | A to Q_D | | 48 | | 52 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | A to Q_D | | 50 | | 60 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_B | | 16 | | 23 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_B | | 21 | | 30 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_C | | 32 | | 37 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_C | | 35 | | 44 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_D | | 32 | | 36 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_D | | 35 | | 44 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | SET-9 to Q_A, Q_D | | 30 | | 35 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | SET-9 to Q_B, Q_C | | 40 | | 48 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | SET-0 to Any Q | | 40 | | 52 | ns |

Recommended Operating Conditions

| Symbol | Parameter | | DM74LS93 | | | 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 | | 32 | MHz |
| | | B to Q _B | 0 | | 16 | |
| f _{CLK} | Clock Frequency (Note 2) | A to Q _A | 0 | | 20 | |
| | | B to Q _B | 0 | | 10 | |
| t _w | Pulse Width (Note 1) | A | 15 | | | ns |
| | | B | 30 | | | |
| | | Reset | 15 | | | |
| t _w | Pulse Width (Note 2) | A | 25 | | | ns |
| | | B | 50 | | | |
| | | Reset | 25 | | | |
| t _{REL} | Reset Release Time (Note 1) | | 25 | | | ns |
| t _{REL} | Reset Release Time (Note 2) | | 35 | | | 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.

'LS93 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 V _{IL} = Max, V _{IH} = Min | 2.7 | 3.4 | | V |
| V _{OL} | Low Level Output Voltage | V _{CC} = Min, I _{OL} = Max V _{IL} = Max, V _{IH} = Min (Note 4) | | 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 | Reset | | 0.1 | mA |
| | | V _{CC} = Max V _I = 5.5V | A | | 0.2 | |
| | | | B | | 0.4 | |
| I _{IH} | High Level Input Current | V _{CC} = Max V _I = 2.7V | Reset | | 20 | μA |
| | | | A | | 40 | |
| | | | B | | 80 | |

'LS93 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 | $V_{CC} = \text{Max}, V_I = 0.4V$ | Reset | | | -0.4 | mA |
| | | | A | | | -2.4 | |
| | | | B | | | -1.6 | |
| I_{OS} | Short Circuit Output Current | $V_{CC} = \text{Max}$ (Note 2) | -20 | | -100 | mA | |
| I_{CC} | Supply Current | $V_{CC} = \text{Max}$ (Note 3) | | 9 | 15 | mA | |

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

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 RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

Note 4: Q_A outputs are tested at $I_{OL} = \text{max}$ plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

'LS93 Switching Characteristics

at $V_{CC} = 5V$ and $T_A = 25^\circ C$ (See Section 1 for Test Waveforms and Output Load)

| Symbol | Parameter | From (Input) To (Output) | $R_L = 2 k\Omega$ | | | | Units |
|-----------|---|-----------------------------|-------------------|-----|---------------|-----|-------|
| | | | $C_L = 15 pF$ | | $C_L = 50 pF$ | | |
| | | | Min | Max | Min | Max | |
| f_{MAX} | Maximum Clock Frequency | A to Q_A | 32 | | 20 | | MHz |
| | | B to Q_B | 16 | | 10 | | |
| t_{PLH} | Propagation Delay Time Low to High Level Output | A to Q_A | | 16 | | 20 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | A to Q_A | | 18 | | 24 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | A to Q_D | | 70 | | 85 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | A to Q_D | | 70 | | 90 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_B | | 16 | | 23 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_B | | 21 | | 30 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_C | | 32 | | 37 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_C | | 35 | | 44 | ns |
| t_{PLH} | Propagation Delay Time Low to High Level Output | B to Q_D | | 51 | | 60 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | B to Q_D | | 51 | | 70 | ns |
| t_{PHL} | Propagation Delay Time High to Low Level Output | SET-0 to Any Q | | 40 | | 52 | ns |

Function Tables

LS90
BCD Count Sequence
(See Note A)

| Count | Output | | | |
|-------|----------------|----------------|----------------|----------------|
| | 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 |

LS90
Bi-Quinary (5-2)
(See Note B)

| Count | Output | | | |
|-------|----------------|----------------|----------------|----------------|
| | 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 |

LS93
Count Sequence
(See Note C)

| Count | Output | | | |
|-------|----------------|----------------|----------------|----------------|
| | 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 |
| 10 | H | L | H | L |
| 11 | H | L | H | H |
| 12 | H | H | L | L |
| 13 | H | H | L | H |
| 14 | H | H | H | L |
| 15 | H | H | H | H |

LS90
Reset/Count Truth Table

| Reset Inputs | | | | Output | | | |
|--------------|-------|-------|-------|----------------|----------------|----------------|----------------|
| R0(1) | R0(2) | R9(1) | R9(2) | Q _D | Q _C | Q _B | Q _A |
| H | H | L | X | L | L | L | L |
| H | H | X | L | L | L | L | L |
| X | X | H | H | H | L | L | H |
| X | L | X | L | COUNT | | | |
| L | X | L | X | COUNT | | | |
| L | X | X | L | COUNT | | | |
| X | L | L | X | COUNT | | | |

LS93
Reset/Count Truth Table

| Reset Inputs | | Output | | | |
|--------------|-------|----------------|----------------|----------------|----------------|
| R0(1) | R0(2) | Q _D | Q _C | Q _B | Q _A |
| H | H | L | L | L | L |
| L | X | COUNT | | | |
| X | L | COUNT | | | |

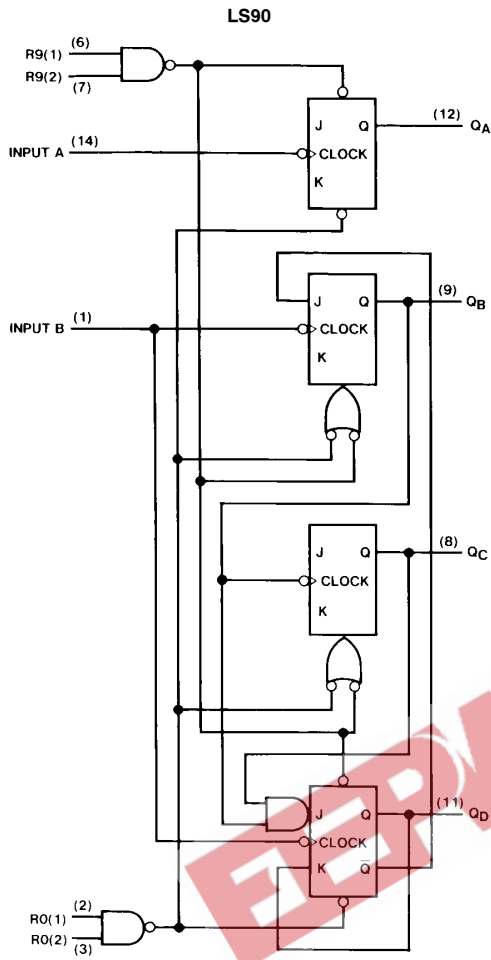
Note A: Output Q_A is connected to input B for BCD count.

Note B: Output Q_D is connected to input A for bi-quinary count.

Note C: Output Q_A is connected to input B.

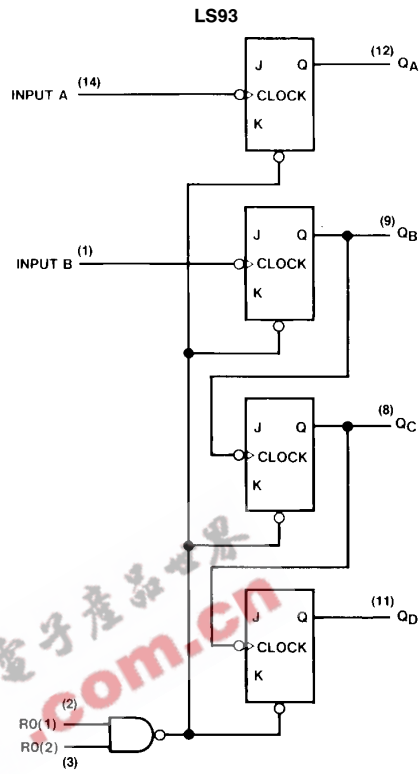
Note D: H = High Level, L = Low Level, X = Don't Care.

Logic Diagrams



TL/F/6381-3

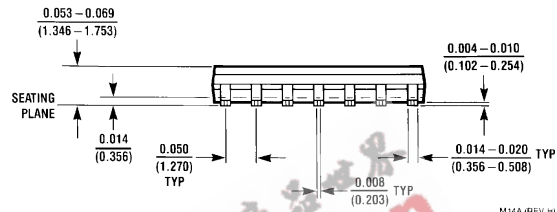
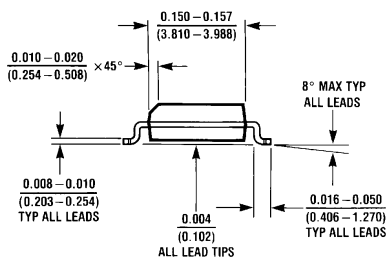
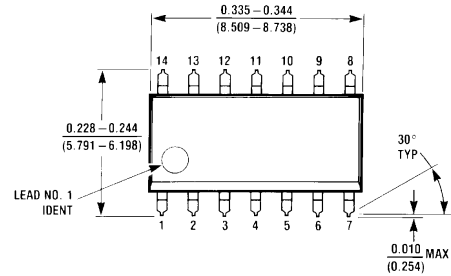
The J and K inputs shown without connection are for reference only and are functionally at a high level.



TL/F/6381-4

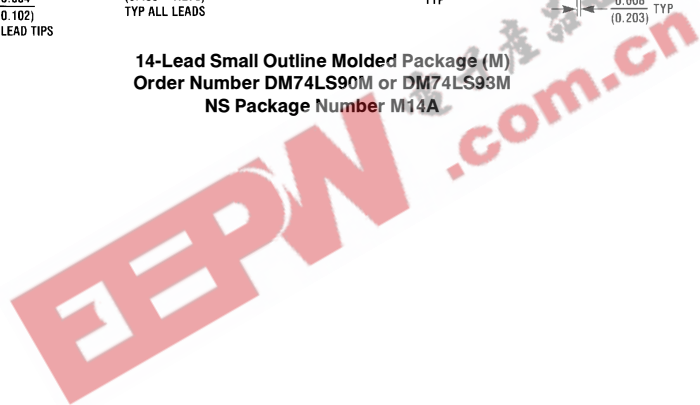
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Physical Dimensions inches (millimeters)

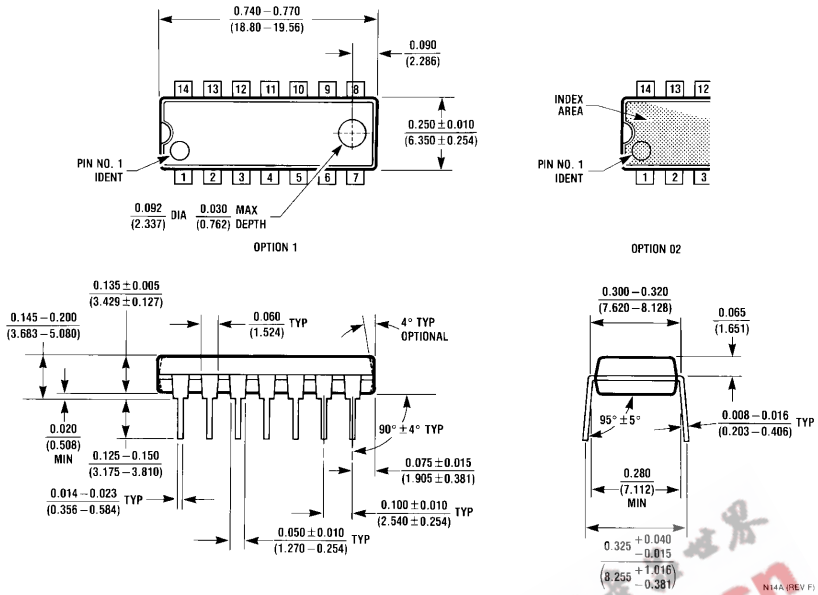


14-Lead Small Outline Molded Package (M)
 Order Number DM74LS90M or DM74LS93M
 NS Package Number M14A

M14A (REV H)



Physical Dimensions inches (millimeters) (Continued)



14-Lead Molded Dual-In-Line Package (N)
Order Number DM74LS90N or DM74LS93N
NS Package Number N14A

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