

## 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.

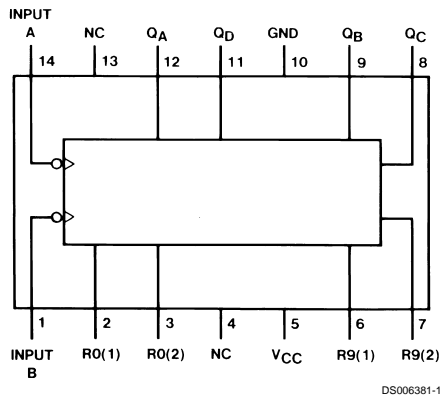
To use their maximum count length (decade or four bit binary), the B input is connected to the  $Q_A$  output. The input

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

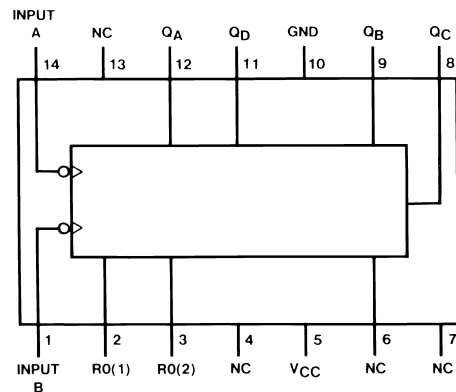
- Typical power dissipation 45 mW
- Count frequency 42 MHz

### Connection Diagrams (Dual-In-Line Packages)



DS006381-1

Order Number DM74LS90M or DM74LS90N  
See Package Number M14A or N14A



DS006381-2

Order Number DM74LS93M or DM74LS93N  
See Package Number M14A or N14A

## Absolute Maximum Ratings (Note 1)

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

## Recommended Operating Conditions

Symbol	Parameter	DM74LS90			Units
		Min	Nom	Max	
V <sub>CC</sub>	Supply Voltage	4.75	5	5.25	V
V <sub>IH</sub>	High Level Input Voltage	2			V
V <sub>IL</sub>	Low Level Input Voltage			0.8	V
I <sub>OH</sub>	High Level Output Current			-0.4	mA
I <sub>OL</sub>	Low Level Output Current			8	mA
f <sub>CLK</sub>	Clock Frequency (Note 2)	A to Q <sub>A</sub>	0	32	MHz
		B to Q <sub>B</sub>	0	16	
f <sub>CLK</sub>	Clock Frequency (Note 3)	A to Q <sub>A</sub>	0	20	MHz
		B to Q <sub>B</sub>	0	10	
t <sub>w</sub>	Pulse Width (Note 2)	A	15		ns
		B	30		
		Reset	15		
t <sub>w</sub>	Pulse Width (Note 3)	A	25		ns
		B	50		
		Reset	25		
t <sub>REL</sub>	Reset Release Time (Note 2)	25			ns
t <sub>REL</sub>	Reset Release Time (Note 3)	35			ns
T <sub>A</sub>	Free Air Operating Temperature	0		70	°C

**Note 1:** 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.

**Note 2:** C<sub>L</sub> = 15 pF, R<sub>L</sub> = 2 kΩ, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

**Note 3:** C<sub>L</sub> = 50 pF, R<sub>L</sub> = 2 kΩ, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

## 'LS90 Electrical Characteristics

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

Symbol	Parameter	Conditions	Min	Typ (Note 4)	Max	Units
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>	High Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max V <sub>IL</sub> = Max, V <sub>IH</sub> = Min	2.7	3.4		V
V <sub>OL</sub>	Low Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max V <sub>IL</sub> = Max, V <sub>IH</sub> = Min (Note 7)		0.35	0.5	V
		I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min		0.25	0.4	
I <sub>I</sub>	Input Current @ Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V	Reset		0.1	mA
		V <sub>CC</sub> = Max V <sub>I</sub> = 5.5V	A		0.2	
			B		0.4	
I <sub>IH</sub>	High Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V	Reset		20	μA
			A		40	
			B		80	

## 'LS90 Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Min	Typ (Note 4)	Max	Units
$I_{IL}$	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 5)	-20		-100	mA
$I_{CC}$	Supply Current	$V_{CC} = \text{Max}$ (Note 4)		9	15	mA

**Note 4:** All typicals are at  $V_{CC} = 5V, T_A = 25^\circ C$ .

**Note 5:** Not more than one output should be shorted at a time, and the duration should not exceed one second.

**Note 6:**  $I_{CC}$  is measured with all outputs open, both RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

**Note 7:**  $Q_A$  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  $T_A = 25^\circ C$

Symbol	Parameter	From (Input) To (Output)	$R_L = 2\text{ k}\Omega$				Units
			$C_L = 15\text{ pF}$		$C_L = 50\text{ pF}$		
			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 <sub>CC</sub>	Supply Voltage	4.75	5	5.25	V	
V <sub>IH</sub>	High Level Input Voltage	2			V	
V <sub>IL</sub>	Low Level Input Voltage			0.8	V	
I <sub>OH</sub>	High Level Output Current			-0.4	mA	
I <sub>OL</sub>	Low Level Output Current			8	mA	
f <sub>CLK</sub>	Clock Frequency (Note 8)	A to Q <sub>A</sub>	0		32	MHz
		B to Q <sub>B</sub>	0		16	
f <sub>CLK</sub>	Clock Frequency (Note 9)	A to Q <sub>A</sub>	0		20	
		B to Q <sub>B</sub>	0		10	
t <sub>w</sub>	Pulse Width (Note 8)	A	15			ns
		B	30			
		Reset	15			
t <sub>w</sub>	Pulse Width (Note 9)	A	25			ns
		B	50			
		Reset	25			
t <sub>REL</sub>	Reset Release Time (Note 8)	25			ns	
t <sub>REL</sub>	Reset Release Time (Note 9)	35			ns	
T <sub>A</sub>	Free Air Operating Temperature	0		70	°C	

**Note 8:** C<sub>L</sub> = 15 pF, R<sub>L</sub> = 2 kΩ, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

**Note 9:** C<sub>L</sub> = 50 pF, R<sub>L</sub> = 2 kΩ, T<sub>A</sub> = 25°C and V<sub>CC</sub> = 5V.

## 'LS93 Electrical Characteristics

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

Symbol	Parameter	Conditions	Min	Typ (Note 10)	Max	Units
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = Min, I <sub>I</sub> = -18 mA			-1.5	V
V <sub>OH</sub>	High Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OH</sub> = Max V <sub>IL</sub> = Max, V <sub>IH</sub> = Min	2.7	3.4		V
V <sub>OL</sub>	Low Level Output Voltage	V <sub>CC</sub> = Min, I <sub>OL</sub> = Max V <sub>IL</sub> = Max, V <sub>IH</sub> = Min (Note 13)		0.35	0.5	V
		I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min		0.25	0.4	
I <sub>I</sub>	Input Current @Max Input Voltage	V <sub>CC</sub> = Max, V <sub>I</sub> = 7V	Reset		0.1	mA
		V <sub>CC</sub> = Max V <sub>I</sub> = 5.5V	A		0.2	
			B		0.4	
I <sub>IH</sub>	High Level Input Current	V <sub>CC</sub> = Max V <sub>I</sub> = 2.7V	Reset		20	μA
			A		40	
			B		80	
I <sub>IL</sub>	Low Level Input Current	V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V	Reset		-0.4	mA
			A		-2.4	
			B		-1.6	
I <sub>OS</sub>	Short Circuit Output Current	V <sub>CC</sub> = Max (Note 11)	-20		-100	mA
I <sub>CC</sub>	Supply Current	V <sub>CC</sub> = Max (Note 12)		9	15	mA

**Note 10:** All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

**Note 11:** Not more than one output should be shorted at a time, and the duration should not exceed one second.

**Note 12:** I<sub>CC</sub> is measured with all outputs open, both RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

**Note 13:** Q<sub>A</sub> outputs are tested at I<sub>OL</sub> = max plus the limit value of I<sub>IL</sub> for the B input. This permits driving the B input while maintaining full fan-out capability.

## 'LS93 Switching Characteristics

at  $V_{CC} = 5V$  and  $T_A = 25^\circ C$

Symbol	Parameter	From (Input) To (Output)	$R_L = 2\text{ k}\Omega$				Units
			$C_L = 15\text{ pF}$		$C_L = 50\text{ pF}$		
			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

(Note 14)

Count	Output			
	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
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

### LS93 Count Sequence

(Note 16)

Count	Output			
	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
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 Bi-Quinary (5-2)

(Note 15)

Count	Output			
	Q <sub>A</sub>	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>
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 14:** Output Q<sub>A</sub> is connected to input B for BCD count.

**Note 15:** Output Q<sub>D</sub> is connected to input A for bi-quinary count.

**Note 16:** Output Q<sub>A</sub> is connected to input B.

**Note 17:** H = High Level, L = Low Level, X = Don't Care.

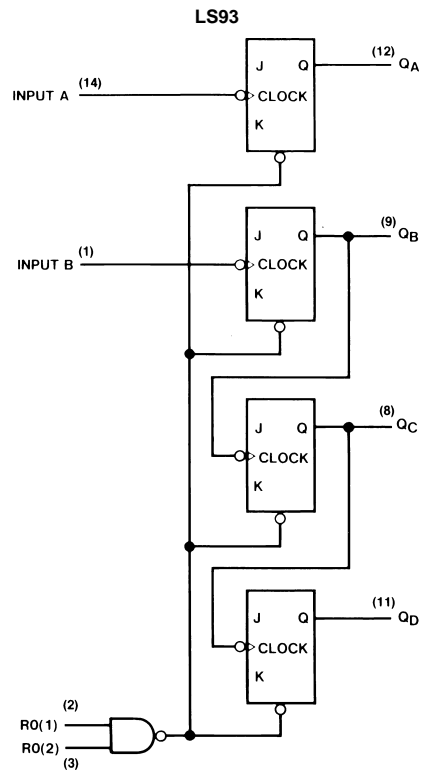
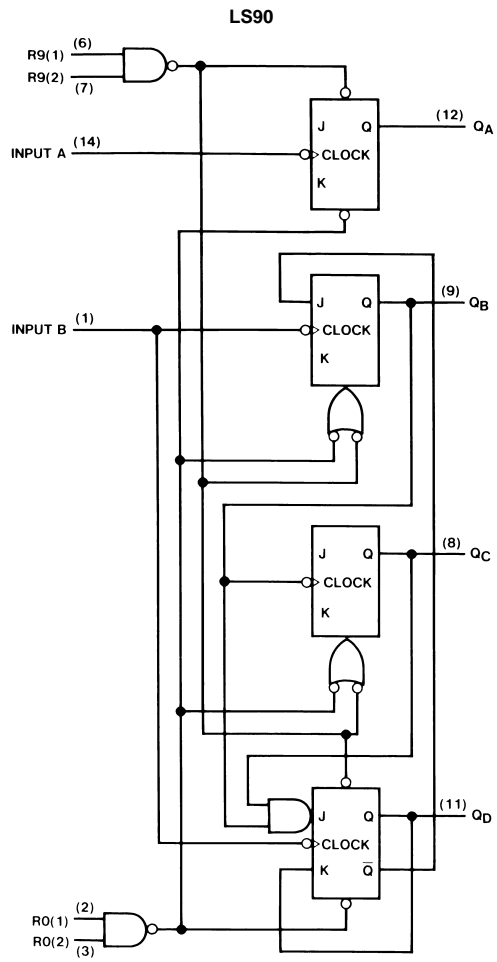
### LS90 Reset/Count Truth Table

Reset Inputs				Output			
R0(1)	R0(2)	R9(1)	R9(2)	Q <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
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 <sub>D</sub>	Q <sub>C</sub>	Q <sub>B</sub>	Q <sub>A</sub>
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

## Logic Diagrams

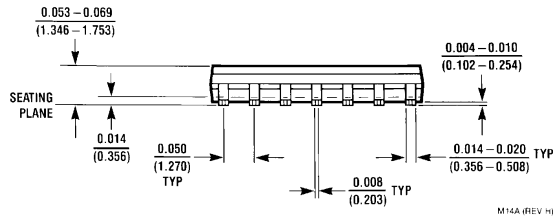
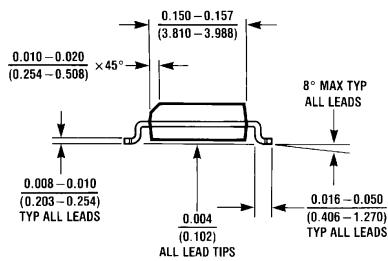
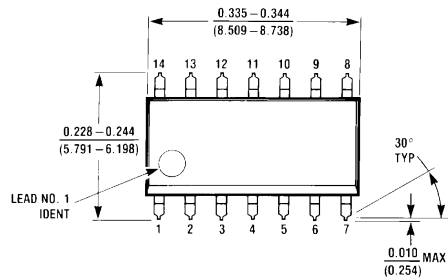


The J and K inputs shown without connection are for reference only and are functionally at a high level.



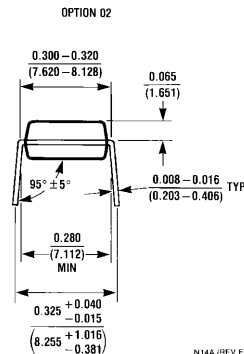
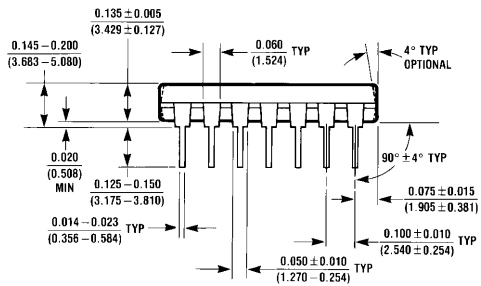
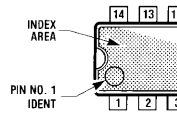
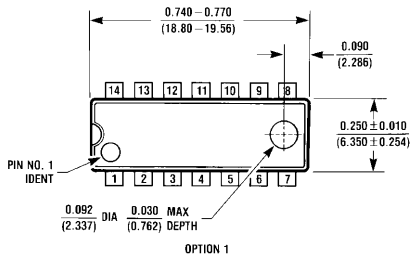


**Physical Dimensions** inches (millimeters) unless otherwise noted



M14A (REV H)

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



N14A (REV F)

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

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