

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.

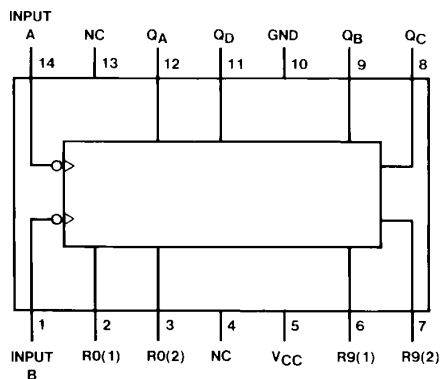
To use their maximum count length (decade or four bit binary), the B input is connected to the Q_A output. The input

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

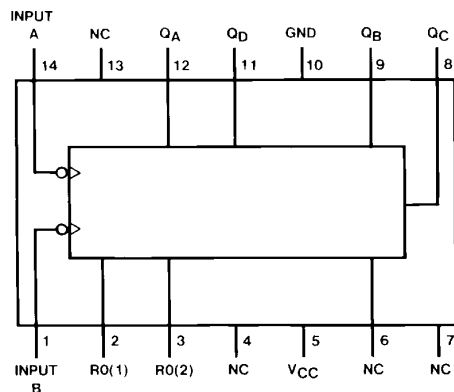
- Typical power dissipation 45 mW
- Count frequency 42 MHz

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	A			0.2	
		V _I = 5.5V	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	$V_{CC} = \text{Max}, V_I = 2.7\text{V}$	Reset		20	μA
			A		40	
			B		80	
I_{IL}	Low Level Input Current	$V_{CC} = \text{Max}, V_I = 0.4\text{V}$	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 $V_{CC} = 5\text{V}$, $T_A = 25^\circ\text{C}$.

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 $V_{CC} = 5\text{V}$ and $T_A = 25^\circ\text{C}$ (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	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, $R_L = 2$ k Ω , $T_A = 25^\circ\text{C}$ and $V_{CC} = 5\text{V}$.

Note 2: $C_L = 50$ pF, $R_L = 2$ k Ω , $T_A = 25^\circ\text{C}$ and $V_{CC} = 5\text{V}$.

'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	$V_{CC} = \text{Min}$, $I_I = -18$ mA				−1.5	V
V_{OH}	High Level Output Voltage	$V_{CC} = \text{Min}$, $I_{OH} = \text{Max}$ $V_{IL} = \text{Max}$, $V_{IH} = \text{Min}$		2.7	3.4		V
V_{OL}	Low Level Output Voltage	$V_{CC} = \text{Min}$, $I_{OL} = \text{Max}$ $V_{IL} = \text{Max}$, $V_{IH} = \text{Min}$ (Note 4)			0.35	0.5	V
		$I_{OL} = 4$ mA, $V_{CC} = \text{Min}$			0.25	0.4	
I_I	Input Current @Max Input Voltage	$V_{CC} = \text{Max}$, $V_I = 7\text{V}$	Reset			0.1	mA
		$V_{CC} = \text{Max}$ $V_I = 5.5\text{V}$	A			0.2	
			B			0.4	
I_{IH}	High Level Input Current	$V_{CC} = \text{Max}$ $V_I = 2.7\text{V}$	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 kΩ				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.

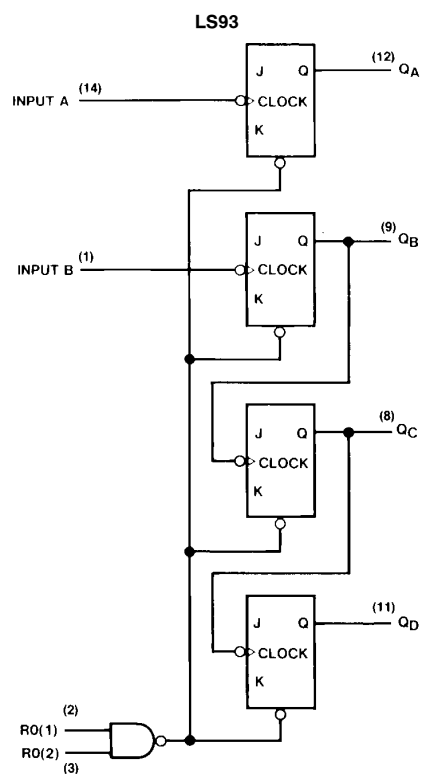
Note B: Output Q_D is connected to input A for bi-quinary count.

Note C: Output Q_A is connected to input B.

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

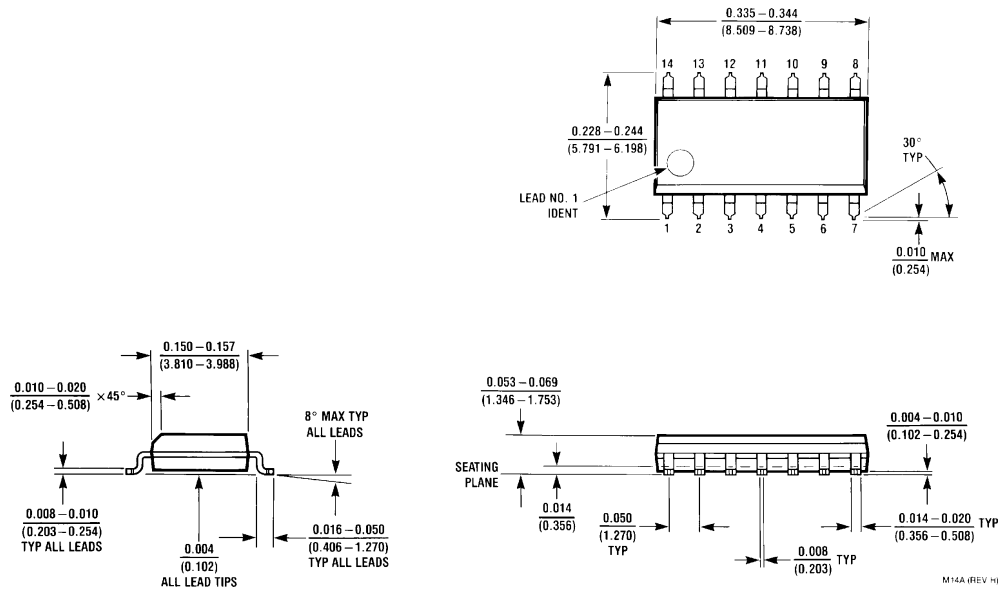
The diagram shows a 4-bit counter implemented with four LS90 J-K flip-flops. The inputs are R9(1), R9(2), INPUT A, INPUT B, R0(1), and R0(2). The outputs are Q_A (12), Q_B (9), Q_C (8), and Q_D (11). The flip-flops are connected in a cascaded manner, with the output of one flip-flop serving as the clock for the next. The J and K inputs of each flip-flop are connected to a common bus that is driven by the outputs of the flip-flops and the inputs R0(1) and R0(2). The clock inputs of the flip-flops are connected to a common bus that is driven by the outputs of the flip-flops and the inputs R9(1) and R9(2). The output of the first flip-flop (Q_A) is connected to the clock input of the second flip-flop (Q_B). The output of the second flip-flop (Q_B) is connected to the clock input of the third flip-flop (Q_C). The output of the third flip-flop (Q_C) is connected to the clock input of the fourth flip-flop (Q_D). The output of the fourth flip-flop (Q_D) is connected to the clock input of the first flip-flop (Q_A), forming a closed loop.

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





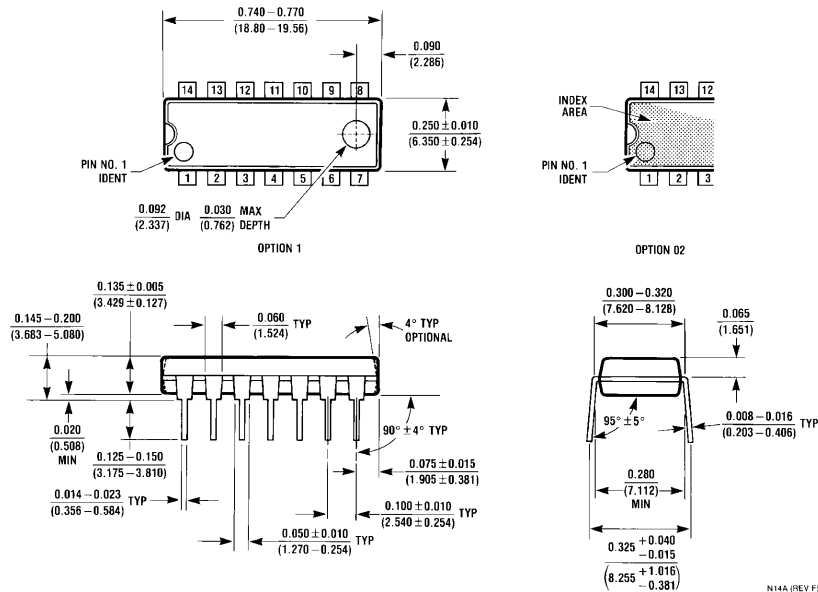
Physical Dimensions inches (millimeters)



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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