National Semiconductor

DM54LS90/DM74LS90, DM54LS92/DM74LS92, DM54LS93/DM74LS93 Decade, Divide by 12, 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, divide-by-six for the LS92, 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, divide-by-twelve, 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

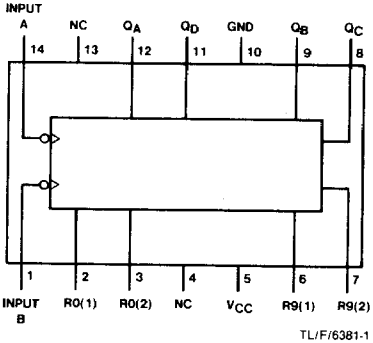
- Typical power dissipation 45 mW
- Count frequency 42 MHz

Absolute Maximum Ratings (Note 1)

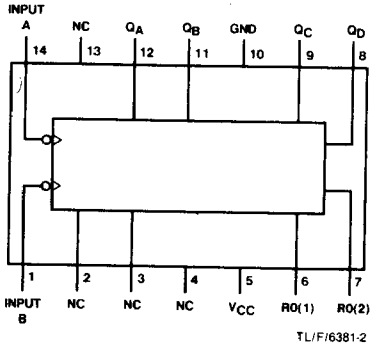
Supply Voltage	7V
Input Voltage (Reset)	7V
Input Voltage (A or B)	5.5V
Storage Temperature Range	−65°C to 150°C

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.

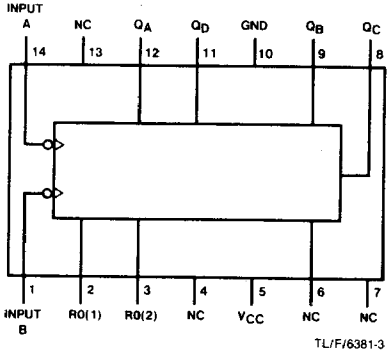
Connection Diagrams (Dual-In-Line Packages)



54LS90 (J) 74LS90 (N)



54LS92 (J) 74LS92 (N)



54LS93 (J) 74LS93 (N)

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

LS92
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	H	L	L	L
7	H	L	L	H
8	H	L	H	L
9	H	L	H	H
10	H	H	L	L
11	H	H	L	H

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			

LS92, 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.

Recommended Operating Conditions

Sym	Parameter		DM54LS90			DM74LS90			Units
			Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			2			V
V_{IL}	Low Level Input Voltage				0.7			0.8	V
I_{OH}	High Level Output Current				−0.4			−0.4	mA
I_{OL}	Low Level Output Current				4			8	mA
f_{CLK}	Clock Frequency (Note 1)	A to Q_A	0		32	0		32	MHz
		B to Q_B	0		16	0		16	
f_{CLK}	Clock Frequency (Note 2)	A to Q_A	0		20	0		20	MHz
		B to Q_B	0		10	0		10	
t_W	Pulse Width (Note 1)	A	15			15			ns
		B	30			30			
		Reset	15			15			
t_W	Pulse Width (Note 2)	A	25			25			ns
		B	50			50			
		Reset	25			25			
t_{REL}	Reset Release Time (Note 1)		25			25			ns
t_{REL}	Reset Release Time (Note 2)		35			35			ns
T_A	Free Air Operating Temperature		−55		125	0		70	°C

Note 1: $C_L = 15$ pF and $R_L = 2$ kΩ.
Note 2: $C_L = 50$ pF and $R_L = 2$ kΩ.

'LS90 Electrical Characteristics

over recommended operating free air temperature (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	DM54	2.5	3.4		V
			DM74	2.7	3.4		
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max, V_{IL} = Max, V_{IH} = Min (Note 4)	DM54		0.25	0.4	V
			DM74		0.35	0.5	
		I_{OL} = 4 mA, V_{CC} = Min	DM74		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	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V	Reset			−0.4	mA
			A			−2.4	
			B			−3.2	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	DM54	−20		−100	mA
			DM74	−20		−100	
I_{CC}	Supply Current	V_{CC} = Max (Note 3)			9	15	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 RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

Note 4: Q_A outputs are tested at I_{OL} = 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 $T_A = 25°C$ (See Section 1 for Test Waveforms and Output Load)

Parameter	From (Input) To (Output)	$R_L = 2\ k\Omega$						Units
		$C_L = 15$ pF			$C_L = 50$ pF			
		Min	Typ	Max	Min	Typ	Max	
f_{MAX} Maximum Clock Frequency	A to Q_A	32	42		20	30		MHz
	B to Q_B	16			10			
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_A		10	16		13	20	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_A		12	18		18	24	ns
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_D		32	48		35	52	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_D		34	50		40	60	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_B		10	16		15	23	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_B		14	21		20	30	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_C		21	32		25	37	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_C		23	35		25	44	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_D		21	32		24	36	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_D		23	35		29	44	ns
t_{PLH} Propagation Delay Time Low to High Level Output	SET-9 to Q_A, Q_D		20	30		23	35	ns
t_{PHL} Propagation Delay Time High to Low Level Output	SET-9 to Q_B, Q_C		26	40		32	48	ns
t_{PHL} Propagation Delay Time High to Low Level Output	SET-0 to Any Q		26	40		35	52	ns

Recommended Operating Conditions

Sym	Parameter		DM54LS92			DM74LS92			Units
			Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			2			V
V_{IL}	Low Level Input Voltage				0.7			0.8	V
I_{OH}	High Level Output Current				−0.4			−0.4	mA
I_{OL}	Low Level Output Current				4			8	mA
f_{CLK}	Clock Frequency (Note 1)	A to Q_A	0		32	0		32	MHz
		B to Q_B	0		16	0		16	
f_{CLK}	Clock Frequency (Note 2)	A to Q_A	0		20	0		20	
		B to Q_B	0		10	0		10	
t_W	Pulse Width (Note 1)	A	15			15			ns
		B	30			30			
		Reset	15			15			
t_W	Pulse Width (Note 2)	A	25			25			ns
		B	50			50			
		Reset	25			25			
t_{REL}	Reset Release Time (Note 1)		25			25			ns
t_{REL}	Reset Release Time (Note 2)		35			35			ns
T_A	Free Air Operating Temperature		−55		125	0		70	°C

Note 1: $C_L = 15$ pF and $R_L = 2$ kΩ.
Note 2: $C_L = 50$ pF and $R_L = 2$ kΩ.

'LS92 Electrical Characteristics

over recommended operating free air temperature (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	DM54	2.5	3.4		V
			DM74	2.7	3.4		
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max, V_{IL} = Max, V_{IH} = Min (Note 4)	DM54		0.25	0.4	V
			DM74		0.35	0.5	
		I_{OL} = 4 mA, V_{CC} = Min	DM74		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	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V	Reset			−0.4	mA
			A			−2.4	
			B			−3.2	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	DM54	−20		−100	mA
			DM74	−20		−100	
I_{CC}	Supply Current With	V_{CC} = Max (Note 3)			9	15	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 RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

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

'LS92 Switching Characteristics

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

Parameter	From (Input) To (Output)	$R_L = 2\ k\Omega$						Units
		$C_L = 15$ pF			$C_L = 50$ pF			
		Min	Typ	Max	Min	Typ	Max	
f_{MAX} Maximum Clock Frequency	A to Q_A	32	42		20	30		MHz
	B to Q_B	16			10			
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_A		10	16		13	20	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_A		12	18		18	24	ns
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_D		32	48		35	52	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_D		34	50		40	60	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_B		10	16		15	23	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_B		14	21		20	30	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_C		10	16		13	20	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_C		14	21		20	30	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_D		21	32		24	36	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_D		23	35		29	44	ns
t_{PHL} Propagation Delay Time High to Low Level Output	SET-0 to Any Q		26	40		35	52	ns

Recommended Operating Conditions

Sym	Parameter		DM54LS93			DM74LS93			Units
			Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			2			V
V_{IL}	Low Level Input Voltage				0.7			0.8	V
I_{OH}	High Level Output Current				−0.4			−0.4	mA
I_{OL}	Low Level Output Current				4			8	mA
f_{CLK}	Clock Frequency (Note 1)	A to Q_A	0		32	0		32	MHz
		B to Q_B	0		16	0		16	
f_{CLK}	Clock Frequency (Note 2)	A to Q_A	0		20	0		20	
		B to Q_B	0		10	0		10	
t_W	Pulse Width (Note 1)	A	15			15			ns
		B	30			30			
		Reset	15			15			
t_W	Pulse Width (Note 2)	A	25			25			ns
		B	50			50			
		Reset	25			25			
t_{REL}	Reset Release Time (Note 1)		25			25			ns
t_{REL}	Reset Release Time (Note 2)		35			35			ns
T_A	Free Air Operating Temperature		−55		125	0		70	°C

Note 1: $C_L = 15$ pF and $R_L = 2$ kΩ.
Note 2: $C_L = 50$ pF and $R_L = 2$ kΩ.

'LS93 Electrical Characteristics

over recommended operating free air temperature (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	DM54	2.5	3.4		V
			DM74	2.7	3.4		
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max, V_{IL} = Max, V_{IH} = Min (Note 4)	DM54		0.25	0.4	V
			DM74		0.35	0.5	
		I_{OL} = 4 mA, V_{CC} = Min	DM74		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	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V	Reset			−0.4	mA
			A			−2.4	
			B			−3.2	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	DM54	−20		−100	mA
			DM74	−20		−100	
I_{CC}	Supply Current With	V_{CC} = Max (Note 3)			9	15	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 RO inputs grounded following momentary connection to 4.5V and all other inputs grounded.

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

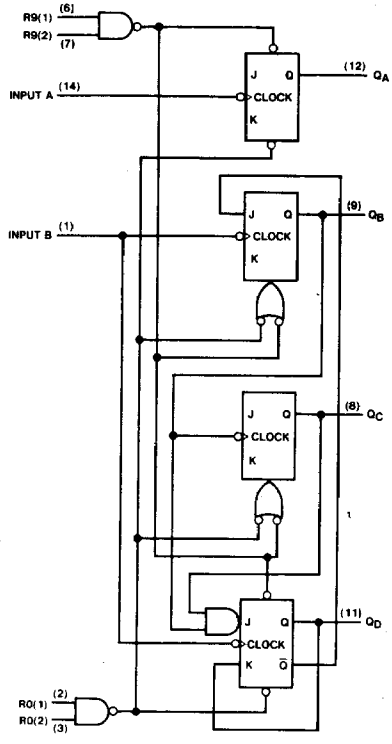
'LS93 Switching Characteristics

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

Parameter	From (Input) To (Output)	$R_L = 2\ k\Omega$						Units
		$C_L = 15$ pF			$C_L = 50$ pF			
		Min	Typ	Max	Min	Typ	Max	
f_{MAX} Maximum Clock Frequency	A to Q_A	32	42		20	30		MHz
	B to Q_B	16			10			
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_A		10	16		13	20	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_A		12	18		18	24	ns
t_{PLH} Propagation Delay Time Low to High Level Output	A to Q_D		46	70		55	85	ns
t_{PHL} Propagation Delay Time High to Low Level Output	A to Q_D		46	70		60	90	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_B		10	16		15	23	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_B		14	21		20	30	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_C		21	32		25	37	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_C		23	35		29	44	ns
t_{PLH} Propagation Delay Time Low to High Level Output	B to Q_D		34	51		40	60	ns
t_{PHL} Propagation Delay Time High to Low Level Output	B to Q_D		34	51		46	70	ns
t_{PHL} Propagation Delay Time High to Low Level Output	SET-0 to Any Q		26	40		35	52	ns

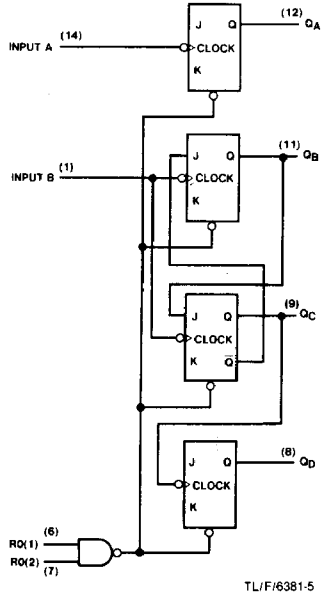
Logic Diagrams

LS90



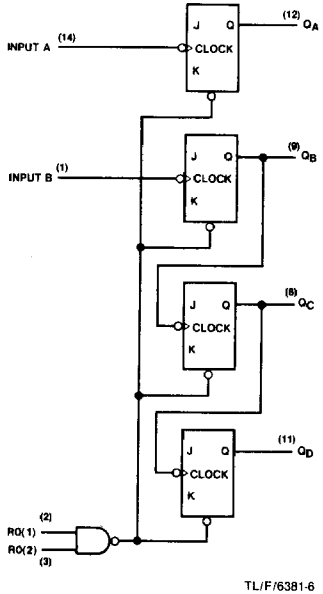
TL/F/6381-4

LS92



TL/F/6381-5

LS93



TL/F/6381-6

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