DESCRIPTION

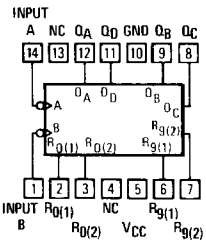
Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the 'LS90, divide-by-six for the 'LS92, and divide-by-eight for the 'LS93.

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

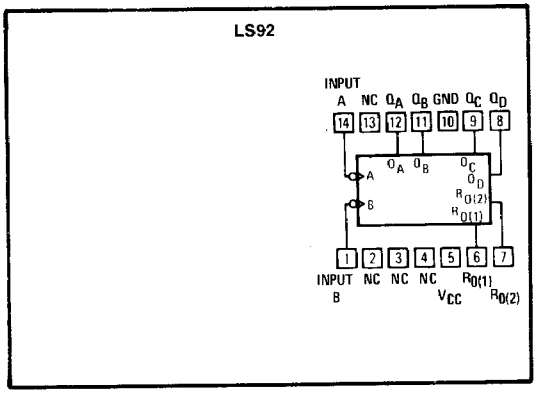
To use their maximum count length (decade, divide-by-twelve, or four-bit binary) of these counters, the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the appropriate function table. A symmetrical divide-by-ten count can be obtained 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.

PIN-OUT DIAGRAMS

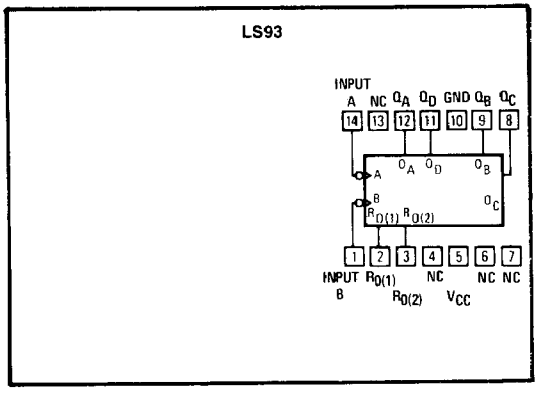
LS90



LS92



LS93



RAYTHEON

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 FUNCTION TABLE

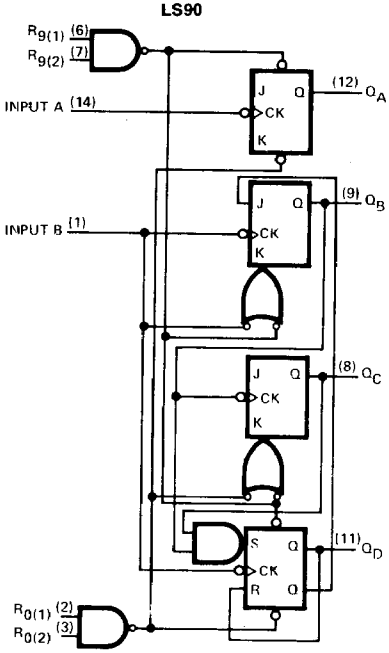
RESET INPUTS				OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

LS93
RESET/COUNT FUNCTION TABLE

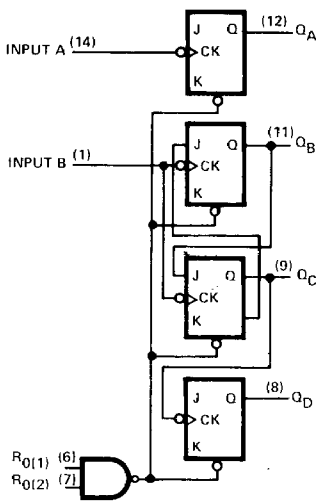
RESET INPUTS		OUTPUT			
$R_{0(1)}$	$R_{0(2)}$	Q_D	Q_C	Q_B	Q_A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

NOTES:
A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. Output Q_A is connected to input B.
D. H = high level, L = low level, X = irrelevant

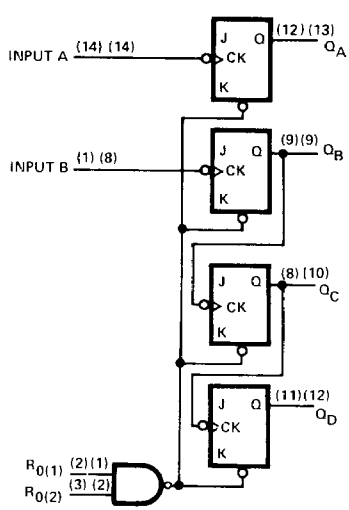
LS90



LS92



LS93



LOGIC DIAGRAMS

Recommended Operating Conditions

		9LS/54LS			9LS/74LS			Unit
		Min	Nom	Max	Min	Nom	Max	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				-400			-400	μA
Low-level output current, I_{OL}				4			8	mA
Count frequency, f_{count} (see Figure 1 on 2-46)	A input	0		32	0		32	MHz
	B input	0		16	0		16	
Pulse width, t_w	A input	15			15			ns
	B input	30			30			
	Reset inputs	15			15			
Reset inactive-state setup time, t_{setup}		25			25			ns
Operating free-air temperature, T_A		-55		125	0		70	°C

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS90/92			9LS/74LS90/92			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=-18mA				-1.5			-1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=-400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max,	I_{OL}=4mA¶		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA¶					0.35	0.5	
I_I	Any reset	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	A input	V_{CC}=MAX, V_I=5.5V				0.2			0.2	
	B input					0.4			0.4	
I_{IH}	Any reset	V_{CC}=MAX, V_I=2.7V				20			20	μA
	A input					40			40	
	B input					80			80	
I_{IL}	Any reset	V_{CC}=MAX, V_I=0.4V				-0.4			-0.4	mA
	A input					-2.4			-2.4	
	B input					-3.2			-3.2	
I_{OS}†		V_{CC}=MAX		-15		-100	-15		-100	mA
I_{CC}††		V_{CC}=MAX,	LS90		9	15		9	15	mA
			LS92		9	15		9	15	

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5V, and all other inputs grounded.

¶ Outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

Electrical Characteristics Over Recommended Free-Air Temperature Range (Unless Otherwise Noted)

Parameter		Test Conditions*		9LS/54LS93			9LS/74LS93			Unit
				Min	Typ**	Max	Min	Typ**	Max	
V_{IH}				2			2			V
V_{IL}						0.7			0.8	V
V_I		V_{CC}=MIN, I_I=−18mA				−1.5			−1.5	V
V_{OH}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max, I_{OH}=−400μA		2.5	3.4		2.7	3.4		V
V_{OL}		V_{CC}=MIN, V_{IH}=2V, V_{IL}=V_{IL}max	I_{OL}=4mA¶		0.25	0.4		0.25	0.4	V
			I_{OL}=8mA¶					0.35	0.5	
I_I	Any reset	V_{CC}=MAX, V_I=7V				0.1			0.1	mA
	A or B input	V_{CC}=MAX, V_I=5.5V				0.2			0.2	
I_{IH}	Any reset	V_{CC}=MAX, V_I=2.7V				20			20	μA
	A or B input					40			40	
I_{IL}	Any reset	V_{CC}=MAX, V_I=0.4V				−0.4			−0.4	mA
	A input					−2.4			−2.4	
	B input					−1.6			−1.6	
I_{OS}†		V_{CC}=MAX		−15		−100	−15		−100	mA
I_{CC}††		V_{CC}=MAX,			9	15		9	15	mA

*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

**All typical values are at V_{CC} = 5V, T_A = 25°C.

†Not more than one output should be shorted at a time.

†† I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5V, and all other inputs grounded.

¶ Outputs are tested at specified I_{OL} plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

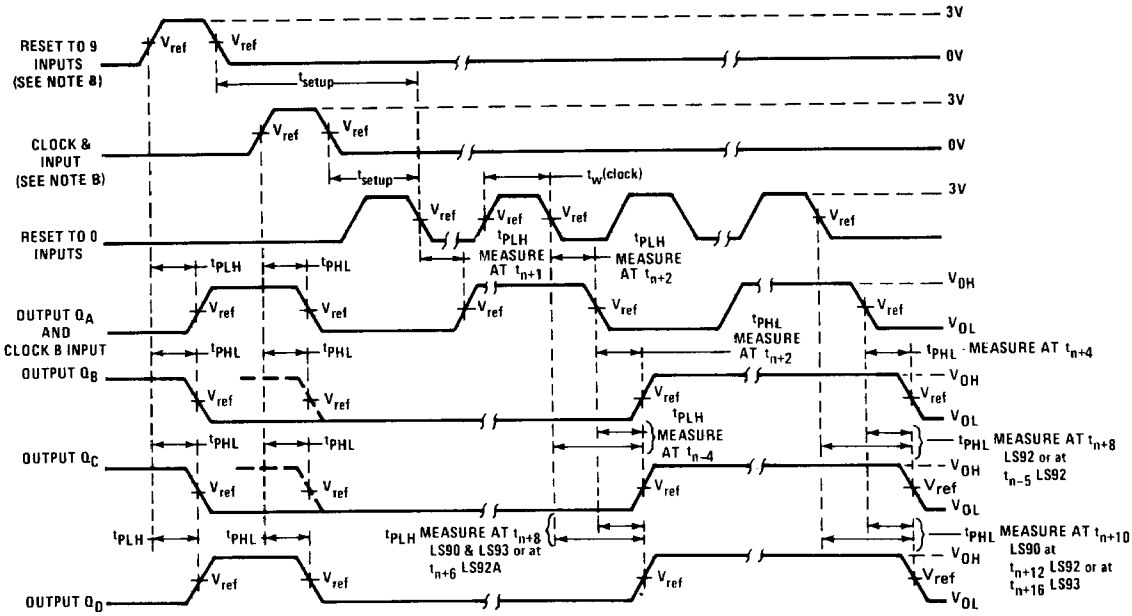
Parameter		From (input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 15pF, R_L = 2kΩ (See Fig. A, page 2-174 and Fig. 1, page 2-49)													
f_{max}	LS90	A	Q_A				32	42					MHz
		B	Q_B				16						
f_{max}	LS92	A	Q_A				32	42					MHz
		B	Q_B				16						
f_{max}	LS93	A	Q_A				32	42					MHz
		B	Q_B				16						
t_{PLH}	LS90	A	Q_A		13	20		10	16		13	20	ns
t_{PHL}					15	22		12	18		15	22	
t_{PLH}	LS92	A	Q_A		13	20		10	16		13	20	ns
t_{PHL}					15	22		12	18		15	22	
t_{PLH}	LS93	A	Q_A		13	20		10	16		13	20	ns
t_{PHL}					15	22		12	18		15	22	
t_{PLH}	LS90	A	Q_D		35	51		32	48		35	51	ns
t_{PHL}					37	56		34	50		37	56	
t_{PLH}	LS92	A	Q_D		35	54		32	48		35	54	ns
t_{PHL}					37	56		34	50		37	56	
t_{PLH}	LS93	A	Q_D		49	76		46	70		49	76	ns
t_{PHL}					49	76		46	70		49	76	
t_{PLH}	LS90	B	Q_B		13	20		10	16		13	20	ns
t_{PHL}					17	27		14	21		17	27	
t_{PLH}	LS92	B	Q_B		13	20		10	16		13	20	ns
t_{PHL}					17	27		14	21		17	27	
t_{PLH}	LS93	B	Q_B		13	20		10	16		13	20	ns
t_{PHL}					17	27		14	21		17	27	
t_{PLH}	LS90	B	Q_C		24	39		21	32		24	39	ns
t_{PHL}					27	42		23	35		27	42	
t_{PLH}	LS92	B	Q_C		13	20		10	16		13	20	ns
t_{PHL}					17	27		14	21		17	27	
t_{PLH}	LS93	B	Q_C		24	39		21	32		24	39	ns
t_{PHL}					27	41		23	35		27	41	
t_{PLH}	LS90	B	Q_D		24	39		21	32		24	39	ns
t_{PHL}					27	41		23	35		27	41	
t_{PLH}	LS92	B	Q_D		24	39		21	32		24	39	ns
t_{PHL}					27	41		23	35		27	41	
t_{PLH}	LS93	B	Q_D		38	57		34	51		38	57	ns
t_{PHL}					38	57		34	51		38	57	
t_{PHL}	LS90	Set-to-0	Any		30	47		26	40		30	47	ns
t_{PHL}	LS92	Set-to-0	Any		30	47		26	40		30	47	ns
t_{PHL}	LS93	Set-to-0	Any		30	47		26	40		30	47	ns
t_{PLH}	LS90	Set-to-9	Q_A, Q_D		24	35		20	30		24	35	ns
t_{PHL}			Q_B, Q_C		24	47		26	24		24	47	

Note: AC specification shown under −55°C and +125°C are for 9LS devices only. All 50pF specifications are for 9LS only.

Switching Characteristics, V_{CC} = 5V Over Recommended Free-Air Temperature Range

Parameter		From (Input)	To (output)	−55°C			+25°C			+125°C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Test Conditions: C_L = 50pF, R_L = 2kΩ (See Fig. A, page 2-174 and Fig. 1, page 2-49)													
t_{PLH}	LS90	A	Q_A		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS92	A	Q_A		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS93	A	Q_A		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS90	A	Q_D		39	56		36	52		39	56	ns
t_{PHL}					41	58		38	54		41	58	
t_{PLH}	LS92	A	Q_D		39	56		36	52		39	56	ns
t_{PHL}					41	58		38	54		41	58	
t_{PLH}	LS93	A	Q_D		53	82		50	78		53	82	ns
t_{PHL}					53	82		50	78		53	82	
t_{PLH}	LS90	B	Q_B		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS92	B	Q_B		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS93	B	Q_B		17	25		14	21		17	25	ns
t_{PHL}					41	27		16	23		19	27	
t_{PLH}	LS90	B	Q_C		29	41		26	37		29	41	ns
t_{PHL}					30	42		27	38		30	42	
t_{PLH}	LS92	B	Q_C		17	25		14	21		17	25	ns
t_{PHL}					19	27		16	23		19	27	
t_{PLH}	LS93	B	Q_C		29	41		26	37		29	41	ns
t_{PHL}					30	42		27	38		30	42	
t_{PLH}	LS90	B	Q_D		29	41		26	37		29	41	ns
t_{PHL}					30	42		27	38		30	42	
t_{PLH}	LS92	B	Q_D		29	41		26	37		29	41	ns
t_{PHL}					30	42		27	38		30	42	
t_{PLH}	LS93	B	Q_D		43	63		40	58		43	62	ns
t_{PHL}					43	62		40	58		43	62	
t_{PHL}	LS90	Set-to-0	Any		33	50		30	46		33	50	ns
t_{PHL}	LS92	Set-to-0	Any		33	50		30	46		33	50	ns
t_{PHL}	LS93	Set-to-0	Any		33	50		30	46		33	50	ns
t_{PLH}	LS90	Set-to-9	Q_A, Q_D		28	40		25	36		28	40	ns
t_{PHL}			Q_B, Q_C		33	49		30	45		33	49	

Note: AC specification shown under −55°C and +125°C are for 9LS devices only. All 50pF specifications are for 9LS only.



NOTES: A. Input pulses are supplied by a generator having the following characteristics: $t_r \leq 15ns$, $t_f \leq 5ns$, PRR = 1 MHz, duty cycle = 50%, Z_{out} = 50 ohms

B. Each reset input is tested separately with the other reset at 4.5V.

C. Reference waveforms are shown with dashed lines.

FIGURE 1. VOLTAGE WAVEFORMS