MOTOROLA

SN54/74LS90
SN54/74LS92
SN54/74LS93

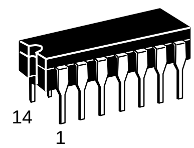
DECADE COUNTER; DIVIDE-BY-TWELVE COUNTER; 4-BIT BINARY COUNTER

The SN54/74LS90, SN54/74LS92 and SN54/74LS93 are high-speed 4-bit ripple type counters partitioned into two sections. Each counter has a divide-by-two section and either a divide-by-five (LS90), divide-by-six (LS92) or divide-by-eight (LS93) section which are triggered by a HIGH-to-LOW transition on the clock inputs. Each section can be used separately or tied together (Q to $\overline{CP}$) to form BCD, bi-quinary, modulo-12, or modulo-16 counters. All of the counters have a 2-input gated Master Reset (Clear), and the LS90 also has a 2-input gated Master Set (Preset 9).

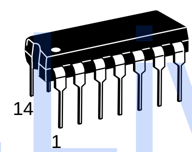
- Low Power Consumption . . . Typically 45 mW
- High Count Rates . . . Typically 42 MHz
- Choice of Counting Modes . . . BCD, Bi-Quinary, Divide-by-Twelve, Binary
- Input Clamp Diodes Limit High Speed Termination Effects

DECADE COUNTER; DIVIDE-BY-TWELVE COUNTER; 4-BIT BINARY COUNTER

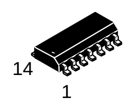
LOW POWER SCHOTTKY



J SUFFIX
CERAMIC
CASE 632-08



N SUFFIX
PLASTIC
CASE 646-06



D SUFFIX
SOIC
CASE 751A-02

ORDERING INFORMATION

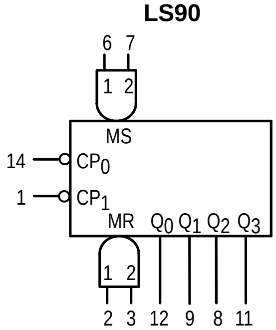
SN54LSXXJ	Ceramic
SN74LSXXN	Plastic
SN74LSXXD	SOIC

PIN NAMES		**LOADING** (Note a) HIGH	LOW
$\overline{CP_0}$	Clock (Active LOW going edge) Input to ÷2 Section	0.5 U.L.	1.5 U.L.
$\overline{CP_1}$	Clock (Active LOW going edge) Input to ÷5 Section (LS90), ÷6 Section (LS92)	0.5 U.L.	2.0 U.L.
$\overline{CP_1}$	Clock (Active LOW going edge) Input to ÷8 Section (LS93)	0.5 U.L.	1.0 U.L.
MR_1, MR_2	Master Reset (Clear) Inputs	0.5 U.L.	0.25 U.L.
MS_1, MS_2	Master Set (Preset-9, LS90) Inputs	0.5 U.L.	0.25 U.L.
Q_0	Output from ÷2 Section (Notes b & c)	10 U.L.	5 (2.5) U.L.
Q_1, Q_2, Q_3	Outputs from ÷5 (LS90), ÷6 (LS92), ÷8 (LS93) Sections (Note b)	10 U.L.	5 (2.5) U.L.

NOTES:
a. 1 TTL Unit Load (U.L.) = 40 µA HIGH/1.6 mA LOW.
b. The Output LOW drive factor is 2.5 U.L. for Military, (54) and 5 U.L. for commercial (74) Temperature Ranges.
c. The Q_0 Outputs are guaranteed to drive the full fan-out plus the $\overline{CP_1}$ input of the device.
d. To insure proper operation the rise (t_r) and fall time (t_f) of the clock must be less than 100 ns.

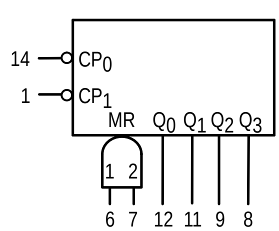
LOGIC SYMBOL

LS90



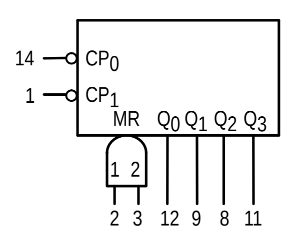
V_{CC} = PIN 5
GND = PIN 10
NC = PINS 4, 13

LS92



V_{CC} = PIN 5
GND = PIN 10
NC = PINS 2, 3, 4, 13

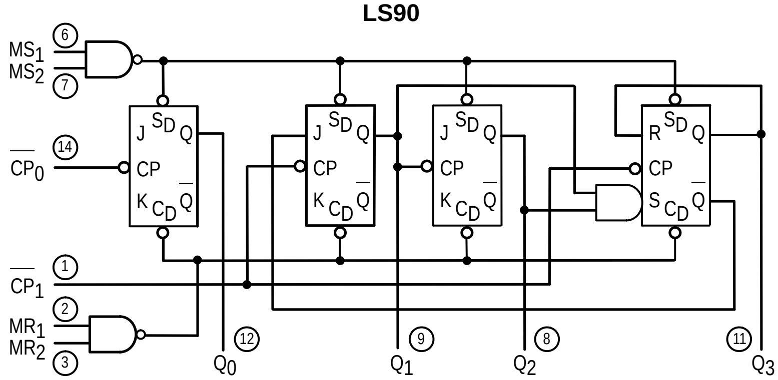
LS93



V_{CC} = PIN 5
GND = PIN 10
NC = PIN 4, 6, 7, 13

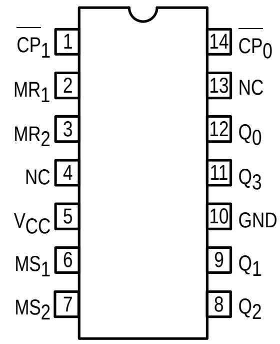
LOGIC DIAGRAM

LS90



○ = PIN NUMBERS
V_{CC} = PIN 5
GND = PIN 10

CONNECTION DIAGRAM
DIP (TOP VIEW)

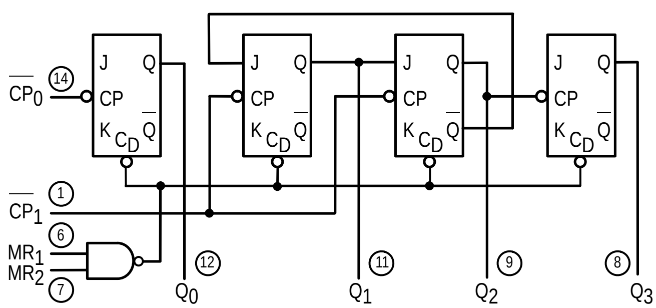


NC = NO INTERNAL CONNECTION

NOTE:
The Flatpak version has the same pinouts (Connection Diagram) as the Dual In-Line Package.

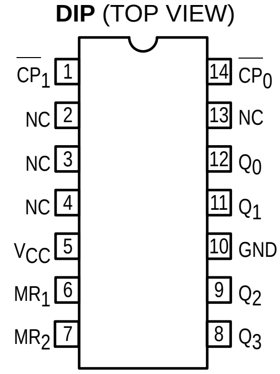
LOGIC DIAGRAM

LS92



○ = PIN NUMBERS
V_{CC} = PIN 5
GND = PIN 10

CONNECTION DIAGRAM
DIP (TOP VIEW)

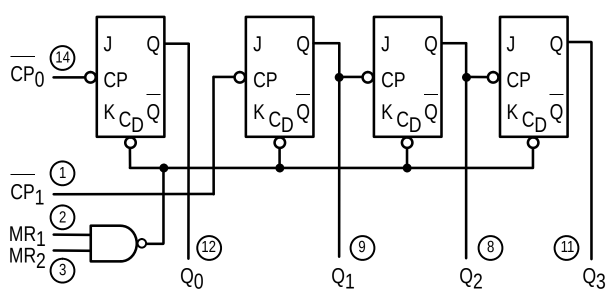


NC = NO INTERNAL CONNECTION

NOTE:
The Flatpak version has the same pinouts (Connection Diagram) as the Dual In-Line Package.

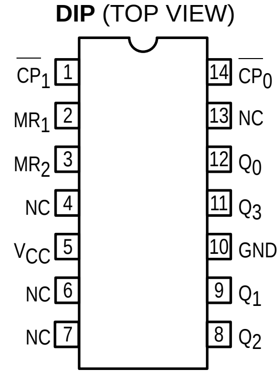
LOGIC DIAGRAM

LS93



○ = PIN NUMBERS
V_{CC} = PIN 5
GND = PIN 10

CONNECTION DIAGRAM
DIP (TOP VIEW)



NC = NO INTERNAL CONNECTION

NOTE:
The Flatpak version has the same pinouts (Connection Diagram) as the Dual In-Line Package.

FUNCTIONAL DESCRIPTION

The LS90, LS92, and LS93 are 4-bit ripple type Decade, Divide-By-Twelve, and Binary Counters respectively. Each device consists of four master/slave flip-flops which are internally connected to provide a divide-by-two section and a divide-by-five (LS90), divide-by-six (LS92), or divide-by-eight (LS93) section. Each section has a separate clock input which initiates state changes of the counter on the HIGH-to-LOW clock transition. State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used for clocks or strobes. The Q_0 output of each device is designed and specified to drive the rated fan-out plus the CP_1 input of the device.

A gated AND asynchronous Master Reset ($MR_1 \bullet MR_2$) is provided on all counters which overrides and clocks and resets (clears) all the flip-flops. A gated AND asynchronous Master Set ($MS_1 \bullet MS_2$) is provided on the LS90 which overrides the clocks and the MR inputs and sets the outputs to nine (HLLH).

Since the output from the divide-by-two section is not internally connected to the succeeding stages, the devices may be operated in various counting modes.

LS90

A. BCD Decade (8421) Counter — The $\overline{CP_1}$ input must be externally connected to the Q_0 output. The $\overline{CP_0}$ input receives the incoming count and a BCD count sequence is produced.

B. Symmetrical Bi-quinary Divide-By-Ten Counter — The Q_3 output must be externally connected to the CP_0 input. The input count is then applied to the CP_1 input and a divide-by-ten square wave is obtained at output Q_0.

C. Divide-By-Two and Divide-By-Five Counter — No external interconnections are required. The first flip-flop is used as a binary element for the divide-by-two function (CP_0 as the input and Q_0 as the output). The CP_1 input is used to obtain binary divide-by-five operation at the Q_3 output.

LS92

A. Modulo 12, Divide-By-Twelve Counter — The $\overline{CP_1}$ input must be externally connected to the Q_0 output. The $\overline{CP_0}$ input receives the incoming count and Q_3 produces a symmetrical divide-by-twelve square wave output.

B. Divide-By-Two and Divide-By-Six Counter —No external interconnections are required. The first flip-flop is used as a binary element for the divide-by-two function. The CP_1 input is used to obtain divide-by-three operation at the Q_1 and Q_2 outputs and divide-by-six operation at the Q_3 output.

LS93

A. 4-Bit Ripple Counter — The output Q_0 must be externally connected to input CP_1. The input count pulses are applied to input CP_0. Simultaneous divisions of 2, 4, 8, and 16 are performed at the Q_0, Q_1, Q_2, and Q_3 outputs as shown in the truth table.

B. 3-Bit Ripple Counter— The input count pulses are applied to input CP_1. Simultaneous frequency divisions of 2, 4, and 8 are available at the Q_1, Q_2, and Q_3 outputs. Independent use of the first flip-flop is available if the reset function coincides with reset of the 3-bit ripple-through counter.

LS90
MODE SELECTION

RESET/SET INPUTS				OUTPUTS			
MR_1	MR_2	MS_1	MS_2	Q_0	Q_1	Q_2	Q_3
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
L	X	L	X	Count			
X	L	X	L	Count			
L	X	X	L	Count			
X	L	L	X	Count			

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care

LS92 AND LS93
MODE SELECTION

RESET INPUTS		OUTPUTS			
MR_1	MR_2	Q_0	Q_1	Q_2	Q_3
H	H	L	L	L	L
L	H	Count			
H	L	Count			
L	L	Count			

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care

LS90
BCD COUNT SEQUENCE

COUNT	OUTPUT			
	Q_0	Q_1	Q_2	Q_3
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H

NOTE: Output Q_0 is connected to Input CP_1 for BCD count.

LS92
TRUTH TABLE

COUNT	OUTPUT			
	Q_0	Q_1	Q_2	Q_3
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	L	L	H
7	H	L	L	H
8	L	H	L	H
9	H	H	L	H
10	L	L	H	H
11	H	L	H	H

NOTE: Output Q_0 is connected to Input CP_1.

LS93
TRUTH TABLE

COUNT	OUTPUT			
	Q_0	Q_1	Q_2	Q_3
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

NOTE: Output Q_0 is connected to Input CP_1.

GUARANTEED OPERATING RANGES

Symbol	Parameter		Min	Typ	Max	Unit
V_{CC}	Supply Voltage	54 74	4.5 4.75	5.0 5.0	5.5 5.25	V
T_A	Operating Ambient Temperature Range	54 74	–55 0	25 25	125 70	°C
I_{OH}	Output Current — High	54, 74			–0.4	mA
I_{OL}	Output Current — Low	54 74			4.0 8.0	mA

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

Symbol	Parameter		Limits			Unit	Test Conditions	
			Min	Typ	Max			
V_{IH}	Input HIGH Voltage		2.0			V	Guaranteed Input HIGH Voltage for All Inputs	
V_{IL}	Input LOW Voltage	54			0.7	V	Guaranteed Input LOW Voltage for All Inputs	
		74			0.8			
V_{IK}	Input Clamp Diode Voltage			–0.65	–1.5	V	V_{CC} = MIN, I_{IN} = –18 mA	
V_{OH}	Output HIGH Voltage	54	2.5	3.5		V	V_{CC} = MIN, I_{OH} = MAX, V_{IN} = V_{IH} or V_{IL} per Truth Table	
		74	2.7	3.5		V		
V_{OL}	Output LOW Voltage	54, 74		0.25	0.4	V	I_{OL} = 4.0 mA	V_{CC} = V_{CC} MIN, V_{IN} = V_{IL} or V_{IH} per Truth Table
		74		0.35	0.5	V	I_{OL} = 8.0 mA	
I_{IH}	Input HIGH Current				20	µA	V_{CC} = MAX, V_{IN} = 2.7 V	
					0.1	mA	V_{CC} = MAX, V_{IN} = 7.0 V	
I_{IL}	Input LOW Current $\overline{MS}$, MR $\overline{CP}_0$ $\overline{CP}_1$ (LS90, LS92) CP_1 (LS93)				 –0.4 –2.4 –3.2 –1.6	mA	V_{CC} = MAX, V_{IN} = 0.4 V	
I_{OS}	Short Circuit Current (Note 1)		–20		–100	mA	V_{CC} = MAX	
I_{CC}	Power Supply Current				15	mA	V_{CC} = MAX	

Note 1: Not more than one output should be shorted at a time, nor for more than 1 second.

AC CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 V, C_L = 15 pF)

Symbol	Parameter	Limits									Unit
		LS90			LS92			LS93			
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
f_{MAX}	$\overline{CP}_0$ Input Clock Frequency	32			32			32			MHz
f_{MAX}	$\overline{CP}_1$ Input Clock Frequency	16			16			16			MHz
t_{PLH} t_{PHL}	Propagation Delay, $\overline{CP}_0$ Input to Q_0 Output		10 12	16 18		10 12	16 18		10 12	16 18	ns
t_{PLH} t_{PHL}	$\overline{CP}_0$ Input to Q_3 Output		32 34	48 50		32 34	48 50		46 46	70 70	ns
t_{PLH} t_{PHL}	$\overline{CP}_1$ Input to Q_1 Output		10 14	16 21		10 14	16 21		10 14	16 21	ns
t_{PLH} t_{PHL}	$\overline{CP}_1$ Input to Q_2 Output		21 23	32 35		10 14	16 21		21 23	32 35	ns
t_{PLH} t_{PHL}	$\overline{CP}_1$ Input to Q_3 Output		21 23	32 35		21 23	32 35		34 34	51 51	ns
t_{PLH}	MS Input to Q_0 and Q_3 Outputs		20	30							ns
t_{PHL}	MS Input to Q_1 and Q_2 Outputs		26	40							ns
t_{PHL}	MR Input to Any Output		26	40		26	40		26	40	ns

AC SETUP REQUIREMENTS (T_A = 25°C, V_{CC} = 5.0 V)

Symbol	Parameter	Limits						Unit
		LS90		LS92		LS93		
		Min	Max	Min	Max	Min	Max	
t_W	$\overline{CP}_0$ Pulse Width	15		15		15		ns
t_W	$\overline{CP}_1$ Pulse Width	30		30		30		ns
t_W	MS Pulse Width	15						ns
t_W	MR Pulse Width	15		15		15		ns
t_{rec}	Recovery Time MR to $\overline{CP}$	25		25		25		ns

RECOVERY TIME (t_{rec}) is defined as the minimum time required between the end of the reset pulse and the clock transition from HIGH-to-LOW in order to recognize and transfer HIGH data to the Q outputs

AC WAVEFORMS

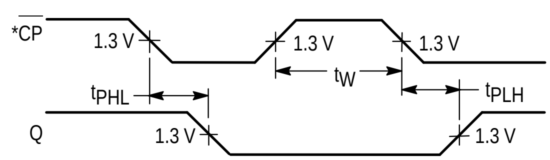


Figure 1

*The number of Clock Pulses required between the t_{PHL} and t_{PLH} measurements can be determined from the appropriate Truth Tables.

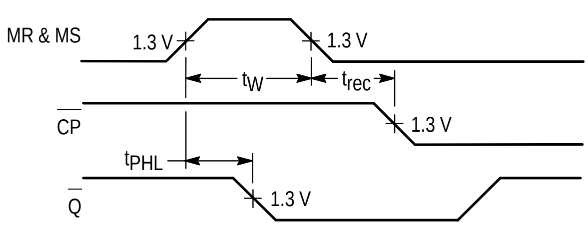


Figure 2

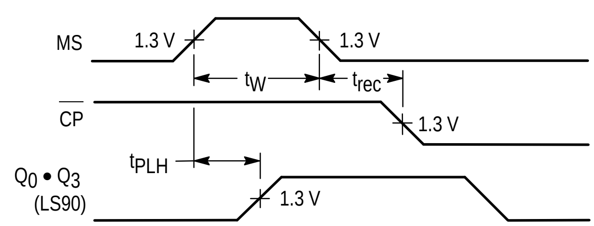


Figure 3