'290, 'LS290 . . . DECADE COUNTERS
'293, 'LS293 . . . 4-BIT BINARY COUNTERS

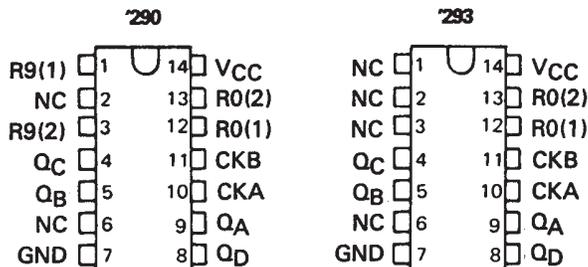- GND and V_{CC} on Corner Pins
  (Pins 7 and 14 Respectively)

description

The SN54290/SN74290, SN54LS290/SN74LS290, SN54293/SN74293, and SN54LS293/SN74LS293 counters are electrically and functionally identical to the SN5490A/SN7490A, SN54LS90/SN74LS90, SN5493A/SN7493A, and SN54LS93/SN74LS93, respectively. Only the arrangement of the terminals has been changed for the '290, 'LS290, '293, and 'LS293.
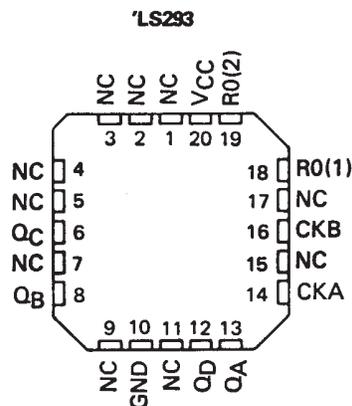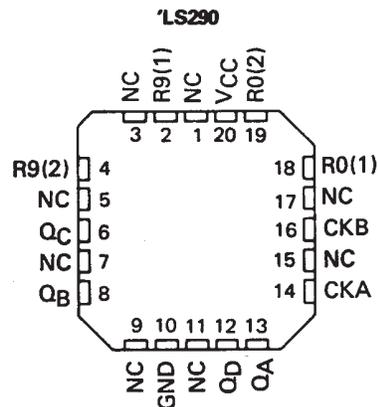
Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the '290 and 'LS290 and divide-by-eight for the '293 and 'LS293.

All of these counters have a gated zero reset and the '290 and 'LS290 also have gated set-to-nine inputs for use in BCD nine's complement applications.

To use the maximum count length (decade 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 '290 and 'LS290 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.

SN54290, SN54LS290, SN54293,
SN54LS293 . . . J OR W PACKAGE
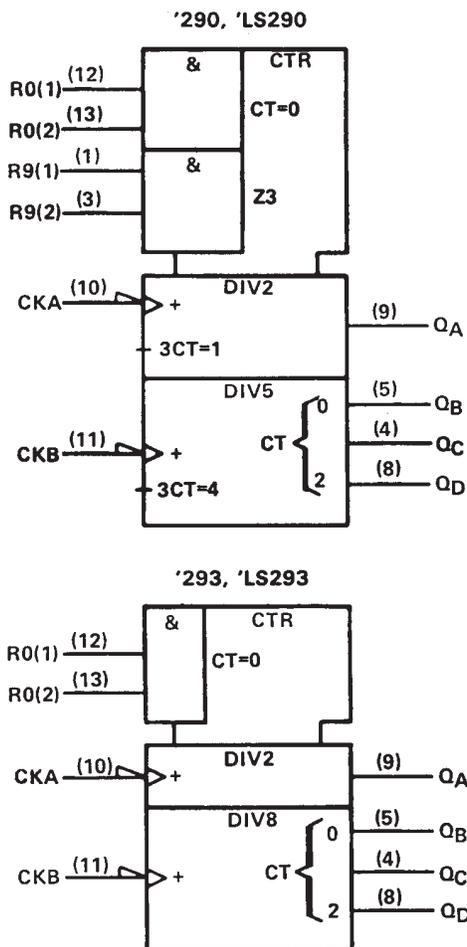SN74290, SN74293 . . . N PACKAGE
SN74LS290, SN74LS293 . . . D OR N PACKAGE
(TOP VIEW)

'290

R9(1)	1	14	V_{CC}
NC	2	13	R0(2)
R9(2)	3	12	R0(1)
Q_C	4	11	CKB
Q_B	5	10	CKA
NC	6	9	Q_A
GND	7	8	Q_D

'293

NC	1	14	V_{CC}
NC	2	13	R0(2)
NC	3	12	R0(1)
Q_C	4	11	CKB
Q_B	5	10	CKA
NC	6	9	Q_A
GND	7	8	Q_D

SN54LS290, SN54LS293 . . . FK PACKAGE
(TOP VIEW)

'LS290

Pins (top, left to right): NC(3), R9(1)(2), NC(1), V_{CC}(20), R0(2)(19)

R9(2)	4	18	R0(1)
NC	5	17	NC
Q_C	6	16	CKB
NC	7	15	NC
Q_B	8	14	CKA

Pins (bottom, 9 10 11 12 13): NC, GND, NC, Q_D, Q_A

'LS293

Pins (top, left to right): NC(3), NC(2), NC(1), V_{CC}(20), R0(2)(19)

NC	4	18	R0(1)
NC	5	17	NC
Q_C	6	16	CKB
NC	7	15	NC
Q_B	8	14	CKA

Pins (bottom, 9 10 11 12 13): NC, GND, NC, Q_D, Q_A

NC – No internal connection

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TEXAS
INSTRUMENTS

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logic symbols†

'290, 'LS290

'293, 'LS293

† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

TEXAS INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

'290, 'LS290 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

'290, 'LS290 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

'290, 'LS290 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			

'293, 'LS293 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			

'293, 'LS293 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

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

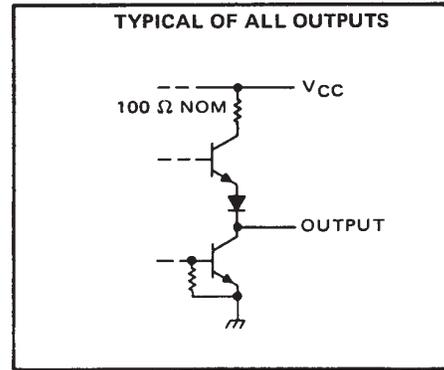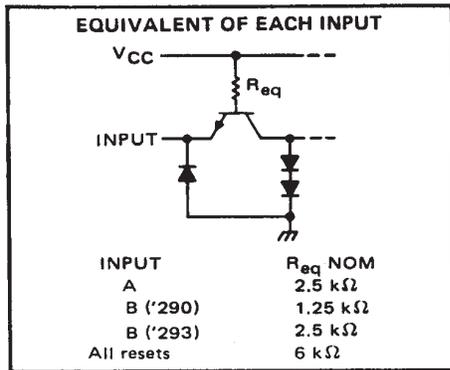## logic diagrams (positive logic)

'290, 'LS290

'293, 'LS293
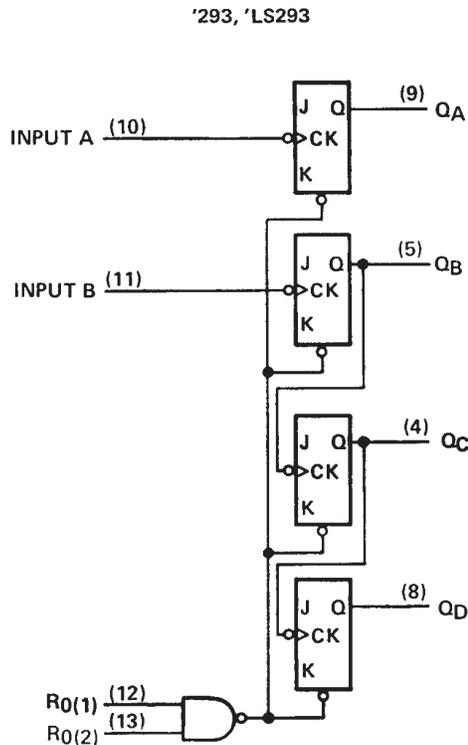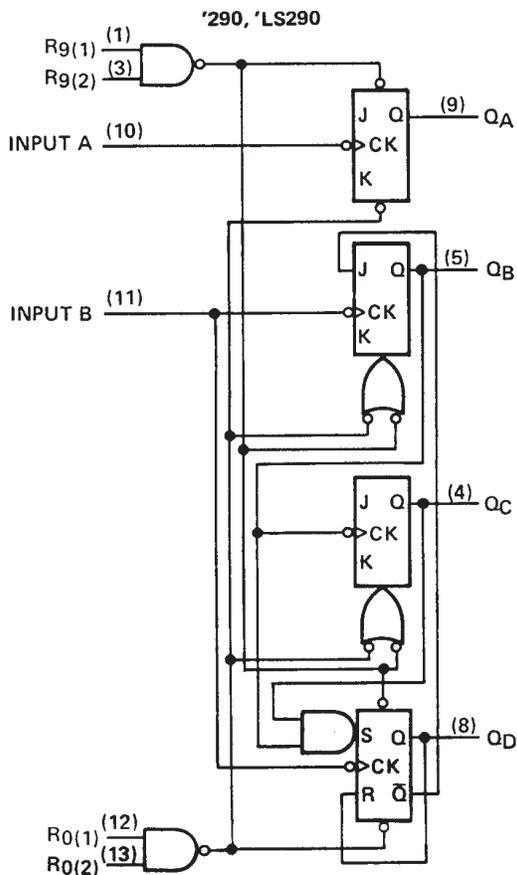
Pin numbers shown are for D, J, N, and W packages.
The J and K inputs shown without connection are for reference only and are functionally at a high level.

3

schematics of inputs and outputs

EQUIVALENT OF EACH INPUT

INPUT	R_{eq} NOM
A	2.5 kΩ
B ('290)	1.25 kΩ
B ('293)	2.5 kΩ
All resets	6 kΩ

TYPICAL OF ALL OUTPUTS

100 Ω NOM

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	5.5 V
Interemitter voltage (see Note 2)	5.5 V
Operating free-air temperature range: SN54' Circuits	−55°C to 125°C
SN74' Circuits	0°C to 70°C
Storage temperature range	−65°C to 150°C

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter transistor. For these circuits, this rating applies between the two R_0 inputs, and for the '290 circuit, it also applies between the two R9 inputs.

recommended operating conditions

		SN54'			SN74'			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}				−800			−800	μA
Low-level output current, I_{OL}				16			16	mA
Count frequency, f_{count}	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_{su}		25			25			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS[†]		'290 MIN	'290 TYP[‡]	'290 MAX	'293 MIN	'293 TYP[‡]	'293 MAX	UNIT
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.8			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = −12 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −800 µA		2.4	3.4		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA[¶]			0.2	0.4		0.2	0.4	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V				1			1	mA
I_{IH}	High-level input current	V_{CC} = MAX, V_I = 2.4 V	Any reset			40			40	µA
			A input			80			80	
			B input			120			80	
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.4 V	Any reset			−1.6			−1.6	mA
			A input			−3.2			−3.2	
			B input			−4.8			−3.2	
I_{OS}	Short-circuit output current[§]	V_{CC} = MAX	SN54'	−20		−57	−20		−57	mA
			SN74'	−18		−57	−18		−57	
I_{CC}	Supply current	V_{CC} = MAX, See Note 3			29	42		26	39	mA

[†]For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
[‡]All typical values are at V_{CC} = 5 V, T_A = 25°C.
[§]Not more than one output should be shorted at a time.
[¶]Q_A outputs are tested at I_{OL} = 16 mA plus the limit value of I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.
NOTE 3: I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER[#]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'290 MIN	'290 TYP	'290 MAX	'293 MIN	'293 TYP	'293 MAX	UNIT
f_{max}	A	Q_A		32	42		32	42		MHz
	B	Q_B		16			16			
t_{PLH}	A	Q_A			10	16		10	16	ns
t_{PHL}					12	18		12	18	
t_{PLH}	A	Q_D			32	48		46	70	ns
t_{PHL}					34	50		46	70	
t_{PLH}	B	Q_B	C_L = 15 pF, R_L = 400 Ω, See Note 4		10	16		10	16	ns
t_{PHL}					14	21		14	21	
t_{PLH}	B	Q_C			21	32		21	32	ns
t_{PHL}					23	35		23	35	
t_{PLH}	B	Q_D			21	32		34	51	ns
t_{PHL}					23	35		34	51	
t_{PHL}	Set-to-0	Any			26	40		26	40	ns
t_{PLH}	Set-to-9	Q_A, Q_D			20	30				ns
t_{PHL}		Q_B, Q_C			26	40				

[#]f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS

schematics of inputs and outputs

EQUIVALENT OF EACH RESET INPUT	EQUIVALENT OF A AND B INPUTS	TYPICAL OF ALL OUTPUTS

NOMINAL VALUES

INPUT	R1	R2	R3
A	10 kΩ	10 kΩ	10 kΩ
B ('LS290)	6.7 kΩ	6.7 kΩ	5 kΩ
B ('LS293)	15 kΩ	15 kΩ	10 kΩ

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 5) . . . . 7 V
Input voltage: R inputs . . . . 7 V
               A and B inputs . . . . 5.5 V
Operating free-air temperature range: SN54LS290, SN54LS293 . . . . −55°C to 125°C
                            SN74LS290, SN74LS293 . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 5: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS'			SN74LS'			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}	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	30			30			
Reset inactive-state setup time, t_{su}		25			25			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

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

PARAMETER			TEST CONDITIONS†		SN54LS' MIN	TYP‡	MAX	SN74LS' MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max, I_{OH} = −400 µA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max	I_{OL} = 4 mA¶		0.25	0.4		0.25	0.4	V
				I_{OL} = 8 mA¶					0.35	0.5	
I_I	Input current at maximum input voltage	Any reset	V_{CC} = MAX, V_I = 7 V				0.1			0.1	mA
		A input					0.2			0.2	
		B of 'LS290	V_{CC} = MAX, V_I = 5.5 V				0.4			0.4	
		B of 'LS293					0.2			0.2	
I_{IH}	High-level input current	Any reset					20			20	µA
		A input	V_{CC} = MAX, V_I = 2.7 V				40			40	
		B of 'LS290					80			80	
		B of 'LS293					40			40	
I_{IL}	Low-level input current	Any reset					−0.4			−0.4	mA
		A input	V_{CC} = MAX, V_I = 0.4 V				−2.4			−2.4	
		B of 'LS290					−3.2			−3.2	
		B of 'LS293					−1.6			−1.6	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−20		−100	−20		−100	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 3	'LS290		9	15		9	15	mA
				'LS293		9	15		9	15	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
¶Q_A 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.
NOTE 3: I_{CC} is measured with all outputs open, both R_0 inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER#	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS290 MIN	TYP	MAX	'LS293 MIN	TYP	MAX	UNIT
f_{max}	A	Q_A		32	42		32	42		MHz
	B	Q_B		16			16			
t_{PLH}	A	Q_A			10	16		10	16	ns
t_{PHL}					12	18		12	18	
t_{PLH}	A	Q_D			32	48		46	70	ns
t_{PHL}					34	50		46	70	
t_{PLH}	B	Q_B	C_L = 15 pF, R_L = 2 kΩ, See Note 4		10	16		10	16	ns
t_{PHL}					14	21		14	21	
t_{PLH}	B	Q_C			21	32		21	32	ns
t_{PHL}					23	35		23	35	
t_{PLH}	B	Q_D			21	32		34	51	ns
t_{PHL}					23	35		34	51	
t_{PHL}	Set-to-0	Any			26	40		26	40	ns
t_{PLH}	Set-to-9	Q_A, Q_D			20	30				ns
t_{PHL}		Q_B, Q_C			26	40				

#f_{max} = maximum count frequency
t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

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