

**SN54390, SN54LS390, SN54393, SN54LS393,
SN74390, SN74LS390, SN74393, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS**

OCTOBER 1976 — REVISED MARCH 1988

- Dual Versions of the Popular '90A, 'LS90 and '93A, 'LS93
- '390, 'LS390 . . . Individual Clocks for A and B Flip-Flops Provide Dual ÷ 2 and ÷ 5 Counters
- '393, 'LS393 . . . Dual 4-Bit Binary Counter with Individual Clocks
- All Have Direct Clear for Each 4-Bit Counter
- Dual 4-Bit Versions Can Significantly Improve System Densities by Reducing Counter Package Count by 50%
- Typical Maximum Count Frequency . . . 35 MHz
- Buffered Outputs Reduce Possibility of Collector Commutation

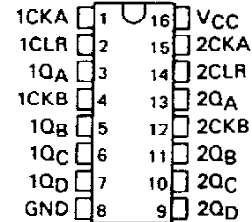
description

Each of these monolithic circuits contains eight master-slave flip-flops and additional gating to implement two individual four-bit counters in a single package. The '390 and 'LS390 incorporate dual divide-by-two and divide-by-five counters, which can be used to implement cycle lengths equal to any whole and/or cumulative multiples of 2 and/or 5 up to divide-by-100. When connected as a bi-quinary counter, the separate divide-by-two circuit can be used to provide symmetry (a square wave) at the final output stage. The '393 and 'LS393 each comprise two independent four-bit binary counters each having a clear and a clock input. N-bit binary counters can be implemented with each package providing the capability of divide-by-256. The '390, 'LS390, '393, and 'LS393 have parallel outputs from each counter stage so that any submultiple of the input count frequency is available for system-timing signals.

Series 54 and Series 54LS circuits are characterized for operation over the full military temperature range of -55°C to 125°C; Series 74 and Series 74LS circuits are characterized for operation from 0°C to 70°C.

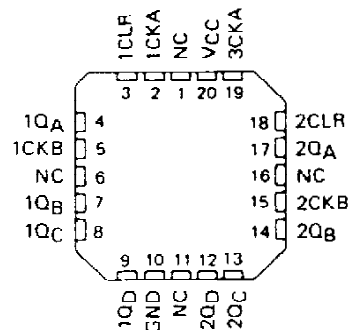
SN54390, SN54LS390 . . . J OR W PACKAGE
SN74390 . . . N PACKAGE
SN74LS390 . . . D OR N PACKAGE

(TOP VIEW)



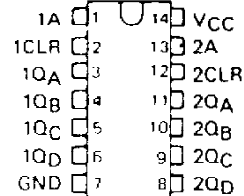
SN64LS390 . . . FK PACKAGE

(TOP VIEW)



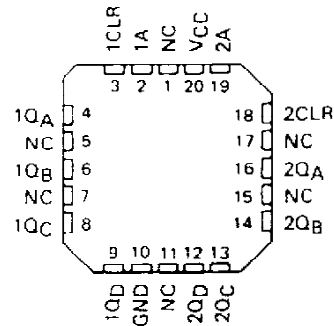
SN54393, SN54LS393 . . . J OR W PACKAGE
SN74393 . . . N PACKAGE
SN74LS393 . . . D OR N PACKAGE

(TOP VIEW)



SN54LS393 . . . FK PACKAGE

(TOP VIEW)



NC - No internal connection

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SN54390, SN54LS390, SN54393, SN54LS393, SN74390, SN74LS390, SN74393, SN74LS393 DUAL 4-BIT DECADE AND BINARY COUNTERS

'390, 'LS390
BCD COUNT SEQUENCE
(EACH COUNTER)
(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

FUNCTION TABLES
'390, 'LS390
BI-QUINARY (5-2)
(EACH COUNTER)
(See Note B)

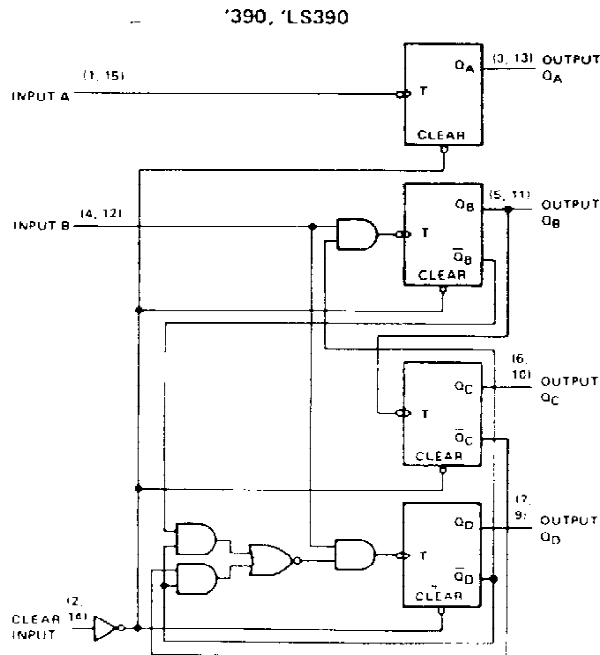
COUNT	OUTPUT			
	Q _A	Q _D	Q _C	Q _B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

'393, 'LS393
COUNT SEQUENCE
(EACH COUNTER)

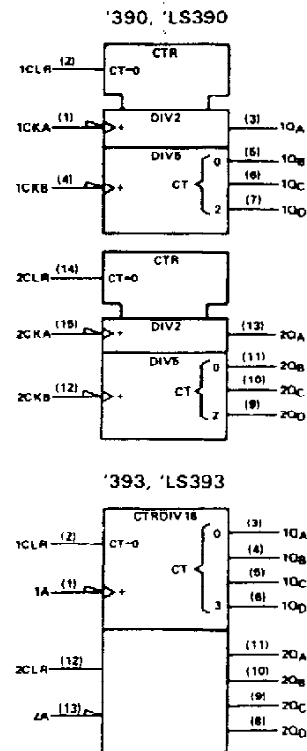
COUNT	OUTPUT			
	Q _D	Q _C	Q _B	Q _A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

- 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. H = high level, L = low level.

logic diagrams (positive logic)



logic symbols †



† These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

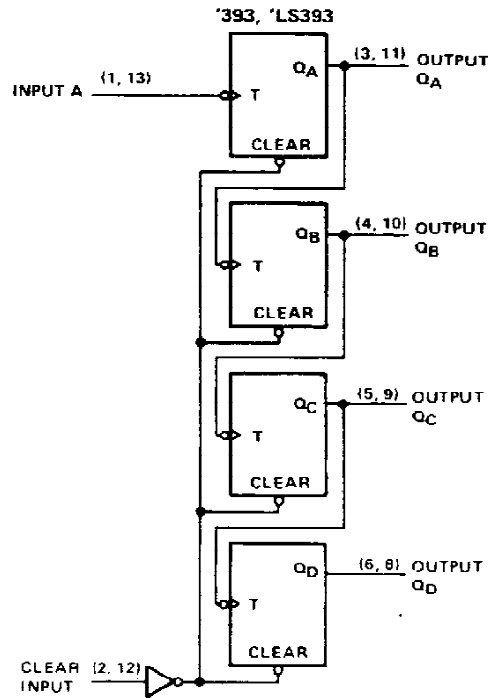
Pin numbers shown are for D, J, N, and W packages.

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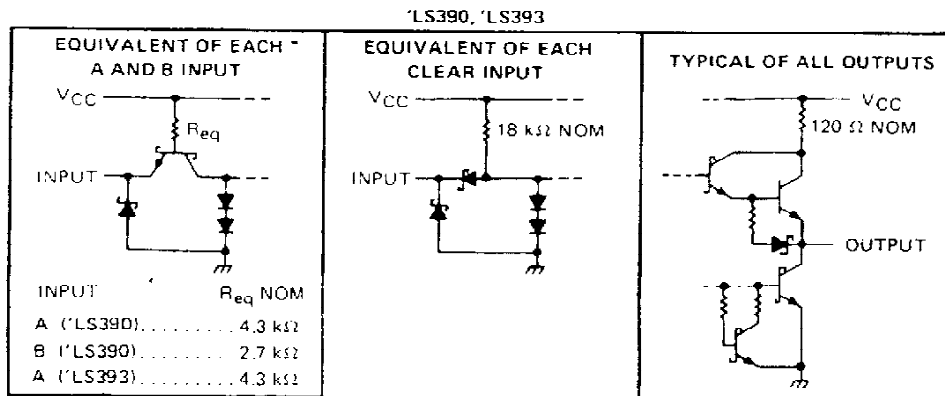
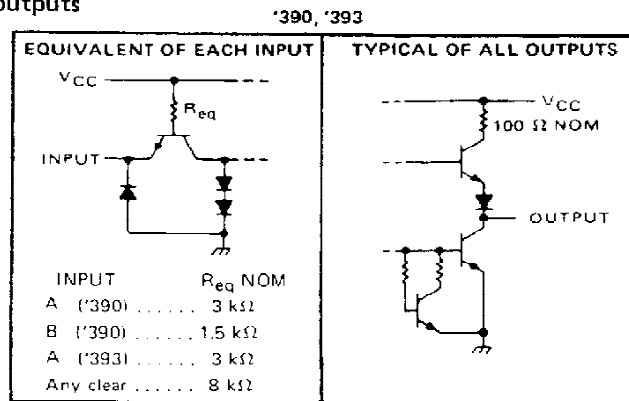
**SN54390, SN54LS390, SN54393, SN54LS393,
SN74390, SN74LS390, SN74393, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS**

logic diagrams (continued)



Pin numbers shown are for D, J, N and W packages.

schematics of inputs and outputs



SN54LS390, SN54LS393, SN74LS390, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS

switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS390			'LS393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A	$C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$, See Note 4 and Figure 2	25	35		25	35		MHz
	B	Q_B		12.5	20					
t_{PLH}	A	Q_A		12	20		12	20		ns
t_{PHL}				13	20		13	20		
t_{PLH}	A	Q_C of 'LS390		37	60		40	60		ns
t_{PHL}		Q_D of 'LS393		39	60		40	60		
t_{PLH}	B	Q_B		13	21					ns
t_{PHL}				14	21					
t_{PLH}	B	Q_C		24	39					ns
t_{PHL}				26	39					
t_{PLH}	B	Q_D		13	21					ns
t_{PHL}				14	21					
t_{PHL}	Clear	Any		24	39		24	39		ns

NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

SN54LS390, SN54LS393, SN74LS390, SN74LS393 DUAL 4-BIT DECADE AND BINARY COUNTERS

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

Supply voltage, V_{CC} (see Note 1)	7 V
Clear input voltage	7 V
Any A or B clock input voltage	5.5 V
Operating free-air temperature range: SN54LS390, SN54LS393	-55°C to 125°C
SN74LS390, SN74LS393	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54LS390 SN54LS393			SN74LS390 SN74LS393			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	μ A
Low-level output current, I_{OL}			4			8	mA
Count frequency, f_{count}	A input	0	25	0	25		MHz
	B input	0	12.5	0	12.5		
Pulse width, t_w	A input high or low	20		20			ns
	B input high or low	40		40			
	Clear high	20		20			
Clear inactive-state setup time, t_{su}		25 \dagger		25 \dagger			ns
Operating free-air temperature, T_A		-55	125		0	70	°C

\dagger The arrow indicates that the falling edge of the clock pulse is used for reference.

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

PARAMETER	TEST CONDITIONS [†]	SN54LS [‡]			SN74LS [‡]			UNIT
		MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	
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	$V_{CC} = \text{MIN}$, $I_I = -18 \text{ mA}$			-1.5			-1.5	V
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = V_{IL \text{ max}}$, $I_{OH} = -400 \mu\text{A}$	2.5	3.4		2.7	3.4		V
V_{OL} Low level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = 0.8 \text{ V}$,	$I_{OL} = 4 \text{ mA}$ [¶]	0.25	0.4	0.25	0.4		V
		$I_{OL} = 8 \text{ mA}$ [¶]			0.35	0.5		
I_I Input current at maximum input voltage	Clear			0.1		0.1		mA
	Input A	$V_{CC} = \text{MAX}$		0.2		0.2		
	Input B		$V_I = 5.5 \text{ V}$	0.4		0.4		
I_{IH} High-level input current	Clear		0.02		0.02		mA	
	Input A	$V_{CC} = \text{MAX}$, $V_I = 2.7 \text{ V}$		0.1		0.1		
	Input B			0.2		0.2		
I_{IL} Low-level input current	Clear		-0.4		-0.4		mA	
	Input A	$V_{CC} = \text{MAX}$, $V_I = 0.4 \text{ V}$		-1.6		-1.6		
	Input B			-2.4		-2.4		
I_{OS} Short-circuit output current [§]	$V_{CC} = \text{MAX}$	-20	-100	-20	-100		mA	
I_{CC} Supply current	$V_{CC} = \text{MAX}$, See Note 2	[¶] LS390	15	26	15	26	mA	
		[¶] LS393	15	26	15	26		

[†] For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

[‡] All typical values are at $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ\text{C}$.

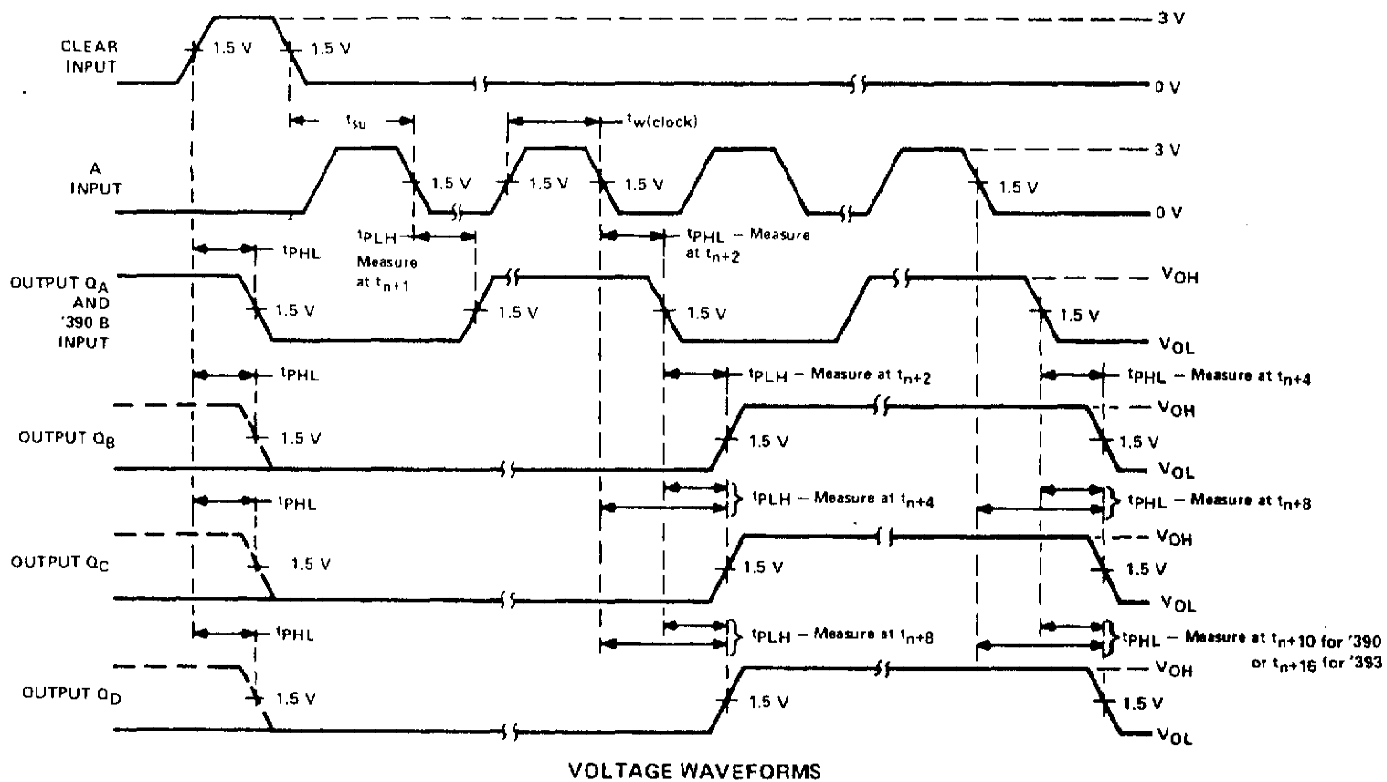
[§] Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

[¶] The Q_A outputs of the LS390 are tested at $I_{OL} = \text{MAX}$ plus the limit value for I_{IL} for the clock B input. This permits driving the clock B input while maintaining full fan-out capability.

NOTE 2: I_{CC} is measured with all outputs open, both clear inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

**SN54390, SN54393, SN74390, SN74393
DUAL 4-BIT DECADE AND BINARY COUNTERS**

PARAMETER MEASUREMENT INFORMATION



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

FIGURE 1

SN54390, SN54393, SN74390, SN74393
DUAL 4-BIT DECADE AND BINARY COUNTERS

switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'390			'393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A	$C_L = 15\text{ pF}$, $R_L = 400\ \Omega$, See Note 3 and Figure 1	25	35		25	35	MHz	
	B	Q_B		20	30					
t_{PLH}	A	Q_A		12	20		12	20	ns	
t_{PHL}				13	20		13	20		
t_{PLH}	A	Q_C of '390 Q_D of '393		37	60		40	60	ns	
t_{PHL}				39	60		40	60		
t_{PLH}	B	Q_B		13	21				ns	
t_{PHL}				14	21					
t_{PLH}	B	Q_C		24	39				ns	
t_{PHL}				26	39					
t_{PLH}	B	Q_D		13	21				ns	
t_{PHL}				14	21					
t_{PHL}	Clear	Any		24	39		24	39	ns	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

SN54390, SN54393, SN74390, SN74393 DUAL 4-BIT DECADE AND BINARY COUNTERS

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
Operating free-air temperature range: SN54390, SN54393	-55°C to 125°C
SN74390, SN74393	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54390 SN54393			SN74390 SN74393			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	μ A
Low-level output current, I_{OL}			16			16	mA
Count frequency, f_{count}	A input	0	25	0		25	MHz
	B input	0	20	0		20	
Pulse width, t_w	A input high or low	20		20			ns
	B input high or low	25		25			
	Clear high	20		20			
Clear inactive-state setup time, t_{su}	25 \downarrow			25 \downarrow			ns
Operating free-air temperature, T_A	-55		125	0		70	°C

\downarrow The arrow indicates that the falling edge of the clock pulse is used for reference.

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

PARAMETER	TEST CONDITIONS [†]	'390			'393			UNIT
		MIN	TYP [‡]	MAX	MIN	TYP [‡]	MAX	
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	$V_{CC} = \text{MIN.}$ $I_I = -12 \text{ mA}$			-1.5			-1.5	V
V_{OH} High-level output voltage	$V_{CC} = \text{MIN.}$ $V_{IH} = 2 \text{ V,}$ $V_{IL} = 0.8 \text{ V,}$ $I_{OH} = -800 \mu\text{A}$	2.4	3.4		2.4	3.4		V
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN.}$ $V_{IH} = 2 \text{ V,}$ $V_{IL} = 0.8 \text{ V,}$ $I_{OL} = 16 \text{ mA}^{\ddagger}$		0.2	0.4		0.2	0.4	V
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX.}$ $V_I = 5.5 \text{ V}$			1			1	mA
I_{IH} High-level input current	Clear			40			40	μ A
	Input A	$V_{CC} = \text{MAX.}$ $V_I = 2.4 \text{ V}$		80		80		
	Input B			120				
I_{IL} Low-level input current	Clear	$V_{CC} = \text{MAX.}$ $V_I = 0.4 \text{ V}$		-1		-1	mA	
	Input A			-3.2		-3.2		
	Input B			-4.8				
I_{OS} Short-circuit output current [§]	$V_{CC} = \text{MAX}$	SN54'	-20	-57	-20	-57	mA	
		SN74'	-18	-57	-18	-57		
I_{CC} Supply current	$V_{CC} = \text{MAX.}$ See Note 2		42	69		38	64	mA

[†] For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

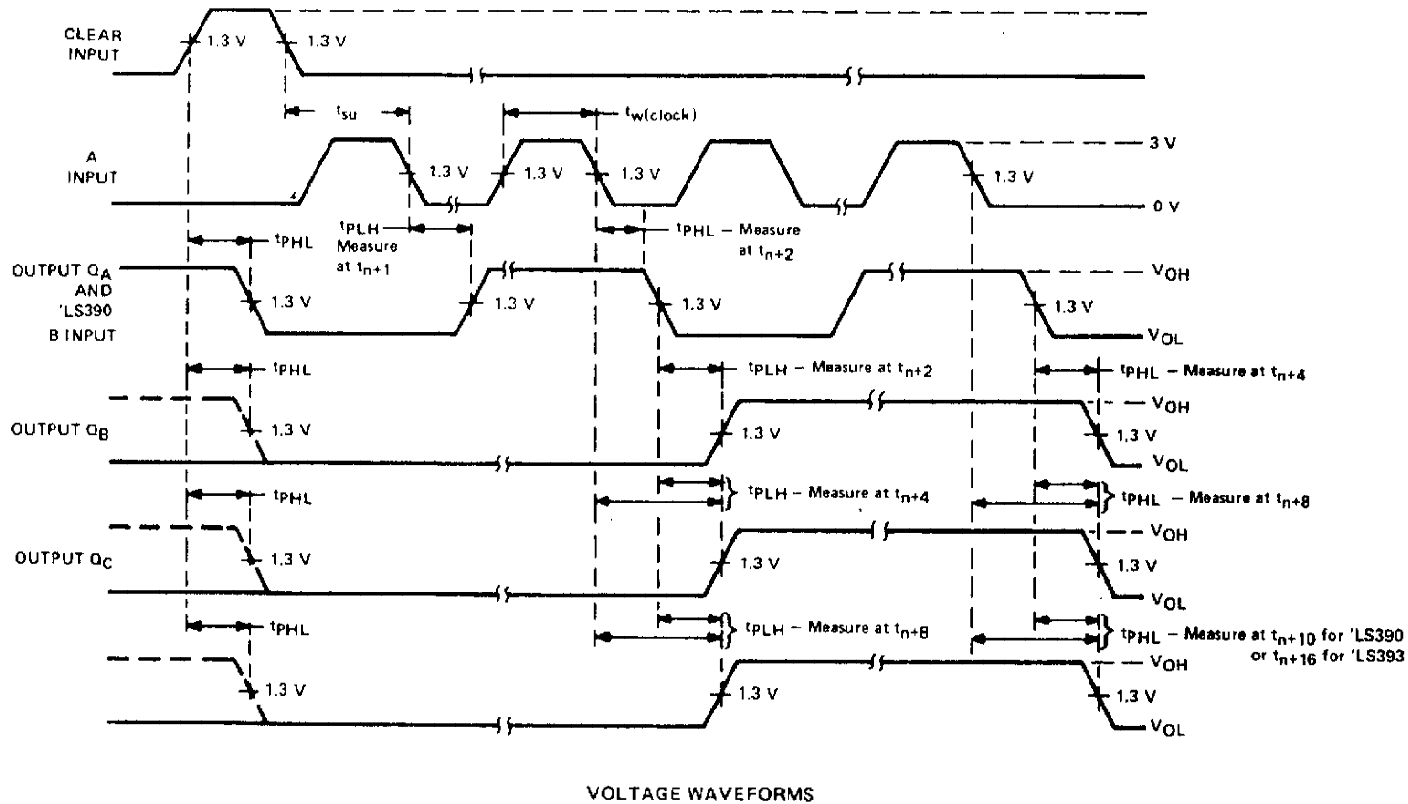
[‡] All typical values are at $V_{CC} = 5 \text{ V,}$ $T_A = 25^\circ\text{C.}$

[§] Not more than one output should be shorted at a time.

[¶] The Q_A outputs of the '390 are tested at $I_{OL} = 16 \text{ mA}$ plus the limit value for I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

NOTE 2: I_{CC} is measured with all outputs open, both clear inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.





NOTE A: Input pulses are supplied by a generator having the following characteristics $t_r \leq 15$ ns, $t_f \leq 6$ ns, PRR = 1 MHz, duty cycle = 50 %, $Z_{out} \approx 50$ ohms.

FIGURE 2

PARAMETER MEASUREMENT INFORMATION

SN64LS390, SN64LS393, SN74LS390, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS

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