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

SDLS107 – 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

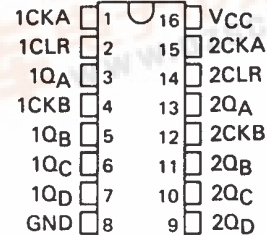- Buffered Outputs Reduce Possibility of Collector Commutation

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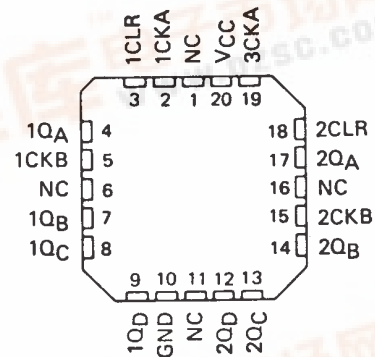
Series 54 and Series 54LS circuits are characterized for operation over the full military temperature range of −55°C to 125°C; Series 74 and Series 74LS circuits are characterized for operation from 0°C to 70°C.

SN54390, SN54LS390 . . . J OR W PACKAGE
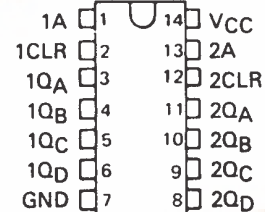SN74390 . . . N PACKAGE
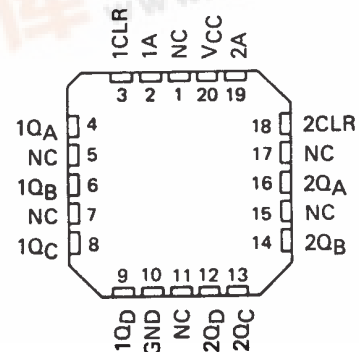SN74LS390 . . . D OR N PACKAGE
(TOP VIEW)

1CKA	1	16	VCC
1CLR	2	15	2CKA
1QA	3	14	2CLR
1CKB	4	13	2QA
1QB	5	12	2CKB
1QC	6	11	2QB
1QD	7	10	2QC
GND	8	9	2QD

SN54LS390 . . . FK PACKAGE
(TOP VIEW)

Top: 1CLR 1CKA NC VCC 3CKA
Pins: 3 2 1 20 19

1QA	4	18	2CLR
1CKB	5	17	2QA
NC	6	16	NC
1QB	7	15	2CKB
1QC	8	14	2QB

Bottom pins: 9 10 11 12 13
Bottom: 1QD GND NC 2QD 2QC

SN54393, SN54LS393 . . . J OR W PACKAGE
SN74393 . . . N PACKAGE
SN74LS393 . . . D OR N PACKAGE
(TOP VIEW)

1A	1	14	VCC
1CLR	2	13	2A
1QA	3	12	2CLR
1QB	4	11	2QA
1QC	5	10	2QB
1QD	6	9	2QC
GND	7	8	2QD

SN54LS393 . . . FK PACKAGE
(TOP VIEW)

Top: 1CLR 1A NC VCC 2A
Pins: 3 2 1 20 19

1QA	4	18	2CLR
NC	5	17	NC
1QB	6	16	2QA
NC	7	15	NC
1QC	8	14	2QB

Bottom pins: 9 10 11 12 13
Bottom: 1QD GND NC 2QD 2QC

NC - No internal connection

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TEXAS INSTRUMENTS

FUNCTION TABLES

'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

'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.
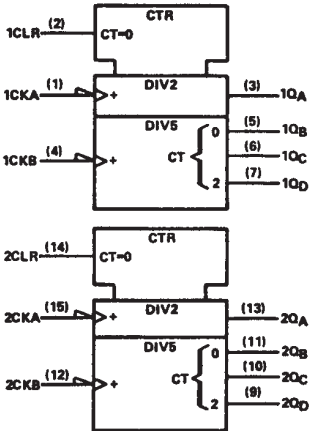C. H = high level, L = low level.
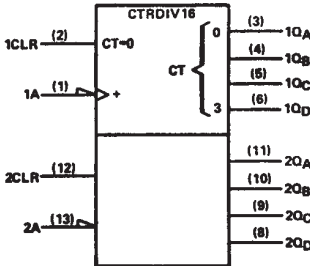
logic diagrams (positive logic)

'390, 'LS390
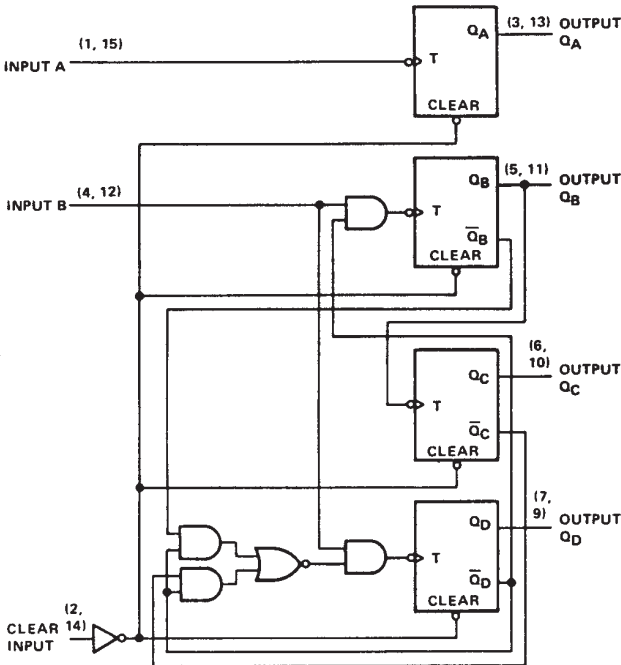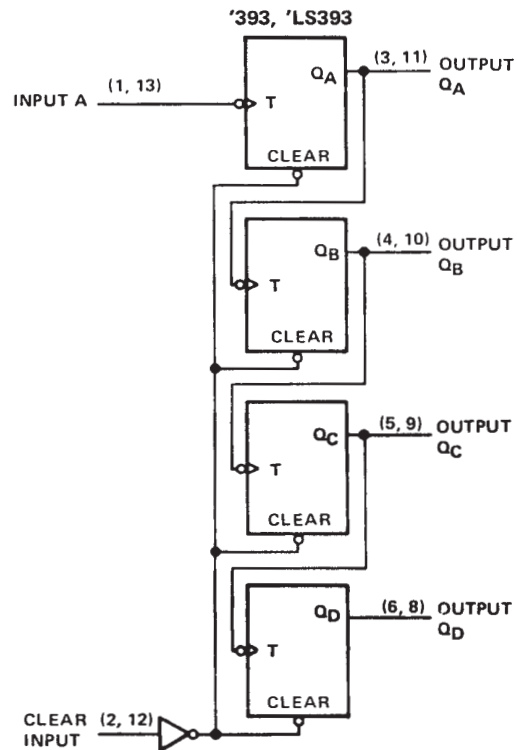

logic symbols†

'390, 'LS390

'393, 'LS393

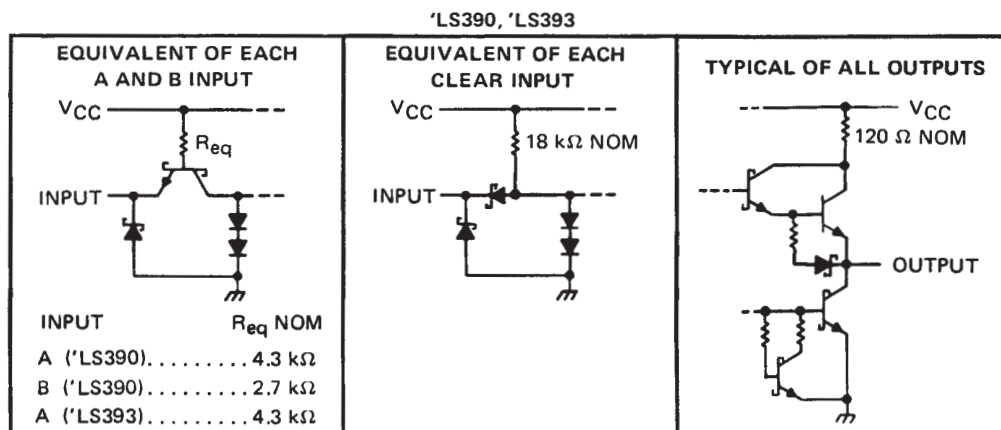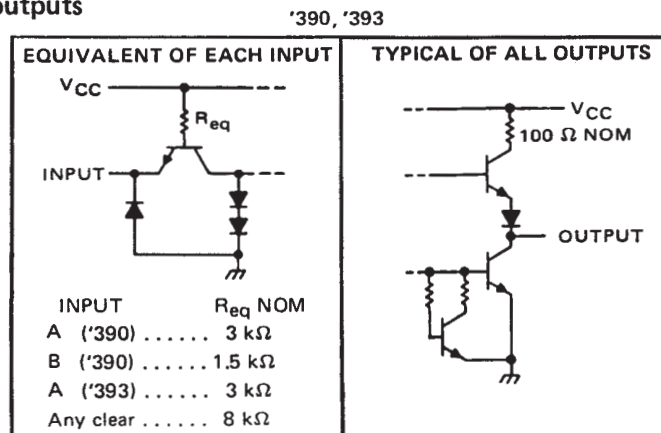†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

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

logic diagrams (continued)

'393, 'LS393

INPUT A (1, 13) — T Q_A — (3, 11) OUTPUT Q_A

CLEAR

T Q_B — (4, 10) OUTPUT Q_B

CLEAR

T Q_C — (5, 9) OUTPUT Q_C

CLEAR

T Q_D — (6, 8) OUTPUT Q_D

CLEAR

CLEAR INPUT (2, 12)

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

schematics of inputs and outputs

'390, '393

EQUIVALENT OF EACH INPUT	TYPICAL OF ALL OUTPUTS
V_{CC} — R_{eq} INPUT INPUT R_{eq} NOM A ('390) ...... 3 kΩ B ('390) ...... 1.5 kΩ A ('393) ...... 3 kΩ Any clear ...... 8 kΩ	V_{CC} 100 Ω NOM OUTPUT

'LS390, 'LS393

EQUIVALENT OF EACH A AND B INPUT	EQUIVALENT OF EACH CLEAR INPUT	TYPICAL OF ALL OUTPUTS
V_{CC} — R_{eq} INPUT INPUT R_{eq} NOM A ('LS390)........4.3 kΩ B ('LS390)........2.7 kΩ A ('LS393)........4.3 kΩ	V_{CC} 18 kΩ NOM INPUT	V_{CC} 120 Ω NOM OUTPUT

SN54390, SN54LS390, SN54393, SN54LS393
SN74390, SN74LS390, SN74393, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS
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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	μA
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↓			25↓			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

↓ 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} = 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	Clear	V_{CC} = MAX, V_I = 2.4 V			40			40	μA
		Input A				80			80	
		Input B				120				
I_{IL}	Low-level input current	Clear	V_{CC} = MAX, V_I = 0.4 V			−1			−1	mA
		Input A				−3.2			−3.2	
		Input B				−4.8				
I_{OS}	Short-circuit output current§	SN54'	V_{CC} = MAX	−20		−57	−20		−57	mA
		SN74'		−18		−57	−18		−57	
I_{CC}	Supply current		V_{CC} = 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 V, T_A = 25 °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 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.

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'390			'393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A		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	C_L = 15 pF,		37	60		40	60	ns
t_{PHL}			R_L = 400 Ω,		39	60		40	60	
t_{PLH}	B	Q_B	See Note 3		13	21				ns
t_{PHL}			and		14	21				
t_{PLH}	B	Q_C	Figure 1		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, SN54LS390, SN54393, SN54LS393
SN74390, SN74LS390, SN74393, SN74LS393
DUAL 4-BIT DECADE AND BINARY COUNTERS

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PARAMETER MEASUREMENT INFORMATION

VOLTAGE WAVEFORMS
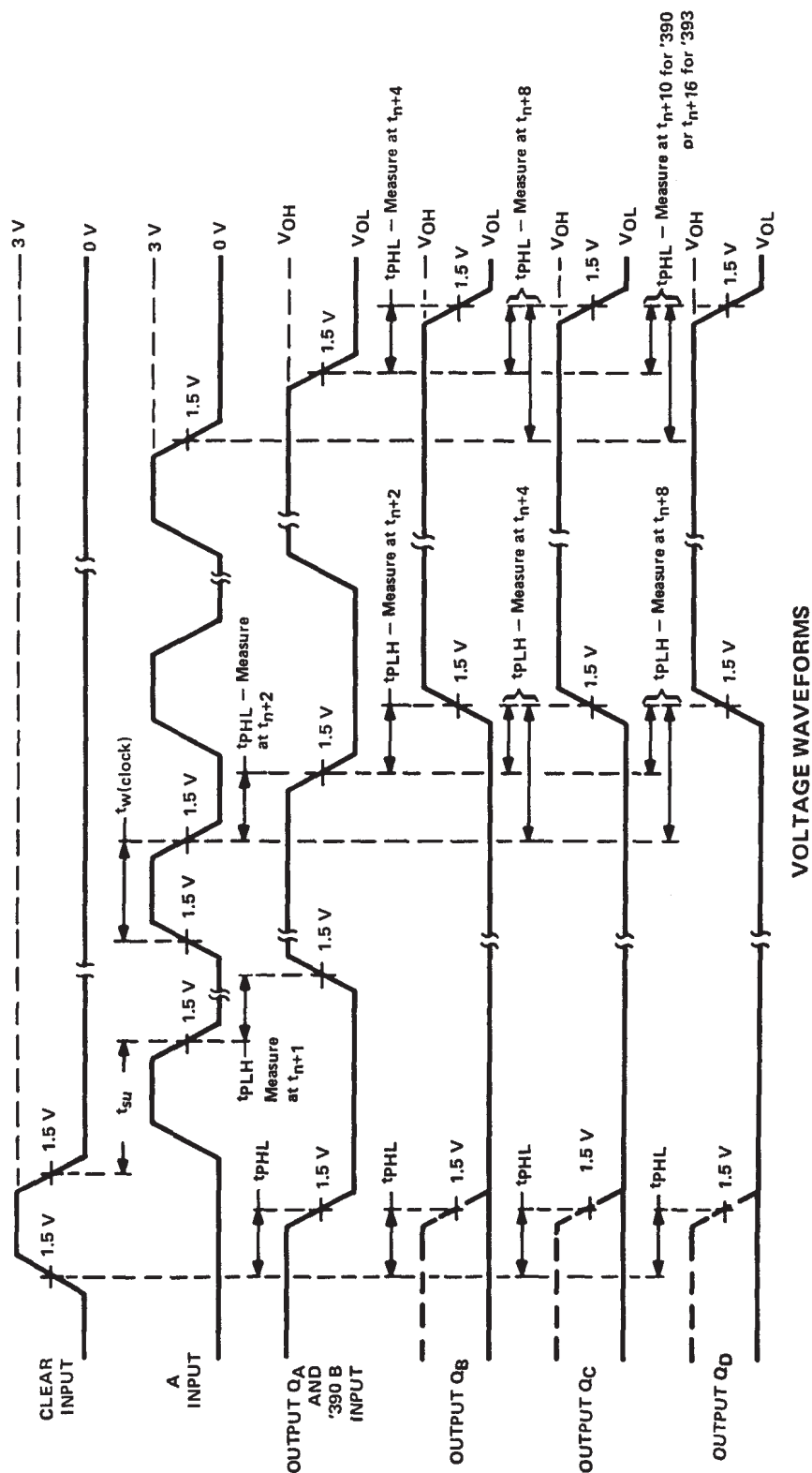
FIGURE 1

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

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	µA
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↓			25↓			ns
Operating free-air temperature, T_A			−55		125	0		70	°C

↓ 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} = 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} = 0.8 V,	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	Clear	V_{CC} = MAX	V_I = 7 V			0.1			0.1	mA
		Input A		V_I = 5.5 V			0.2			0.2	
		Input B					0.4			0.4	
I_{IH}	High-level input current	Clear	V_{CC} = MAX, V_I = 2.7 V				0.02			0.02	mA
		Input A					0.1			0.1	
		Input B					0.2			0.2	
I_{IL}	Low-level input current	Clear	V_{CC} = MAX, V_I = 0.4 V				−0.4			−0.4	mA
		Input A					−1.6			−1.6	
		Input B					−2.4			−2.4	
I_{OS}	Short-circuit output current[§]		V_{CC} = MAX		−20		−100	−20		−100	mA
I_{CC}	Supply current		V_{CC} = 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 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.

¶ The Q_A outputs of the 'LS390 are tested at I_{OL} = 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.

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS390			'LS393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A		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	C_L = 15 pF,		37	60		40	60	ns
t_{PHL}		Q_D of 'LS393	R_L = 2 kΩ,		39	60		40	60	
t_{PLH}	B	Q_B	See Note 4 and Figure 2		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.

PARAMETER MEASUREMENT INFORMATION

VOLTAGE WAVEFORMS

FIGURE 2

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.

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