

# TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

D2423, JANUARY 1981

- 4-Bit Counters/Registers
- Multiplexed Outputs for Counter or Latched Data
- 3-State Outputs Drive Bus Lines Directly
- 'LS690 . . . Decade Counter, Direct Clear
- 'LS691 . . . Binary Counter, Direct Clear
- 'LS692 . . . Decade Counter, Synchronous Clear
- 'LS693 . . . Binary Counter, Synchronous Clear

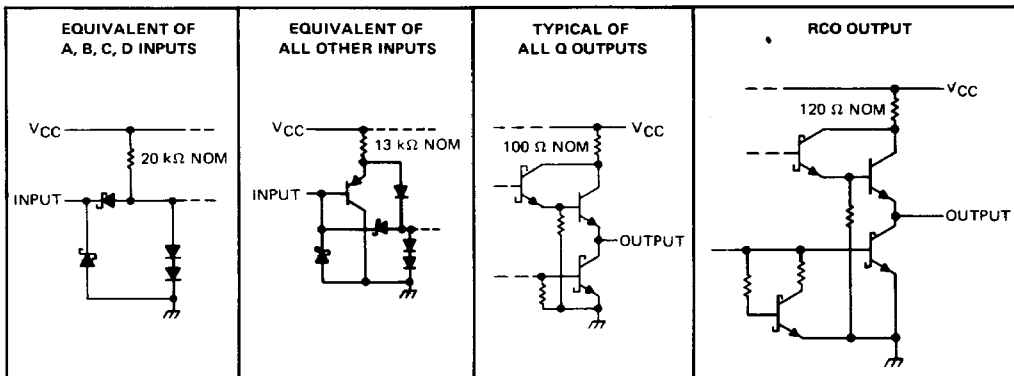
## description

These low-power Schottky LSI devices incorporate synchronous counters, four-bit D-type registers, and quadruple two-line to one-line multiplexers with three-state outputs in a single 20-pin package. The counters can be programmed from the data inputs and have enable P inputs and enable T inputs and a ripple-carry output for easy expansion. The register/counter select input,  $R/\bar{C}$ , selects the counter when low or the register when high for the three-state outputs,  $Q_A$ ,  $Q_B$ ,  $Q_C$ , and  $Q_D$ . These outputs are rated at 12 and 24 milliampères (54LS/74LS) for good bus-driving performance.

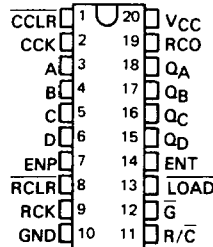
Individual clock and clear inputs are provided for both the counter and the register. Both clock inputs are positive-edge triggered: The clear line is active low and is asynchronous on the 'LS690 and 'LS691, synchronous on the 'LS692 and 'LS693. Loading of the counter is accomplished when  $\overline{LOAD}$  is taken low and a positive-transition occurs on the counter clock CCK.

Expansion is easily accomplished by connecting RCO of the first stage to ENT of the second stage, etc. All ENP inputs can be tied common and used as a master enable or disable control.

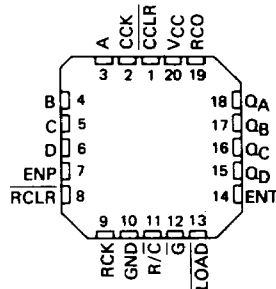
## schematics of inputs and outputs



SN54LS690 THRU SN54LS693 . . . J PACKAGE  
SN74LS690 THRU SN74LS693 . . . DW, J OR N PACKAGE  
(TOP VIEW)



SN54LS690 THRU SN54LS693 . . . FK PACKAGE  
SN74LS690 THEU SN74LS693 . . . FN PACKAGE  
(TOP VIEW)



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### PRODUCTION DATA

This document contains information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS  
INSTRUMENTS

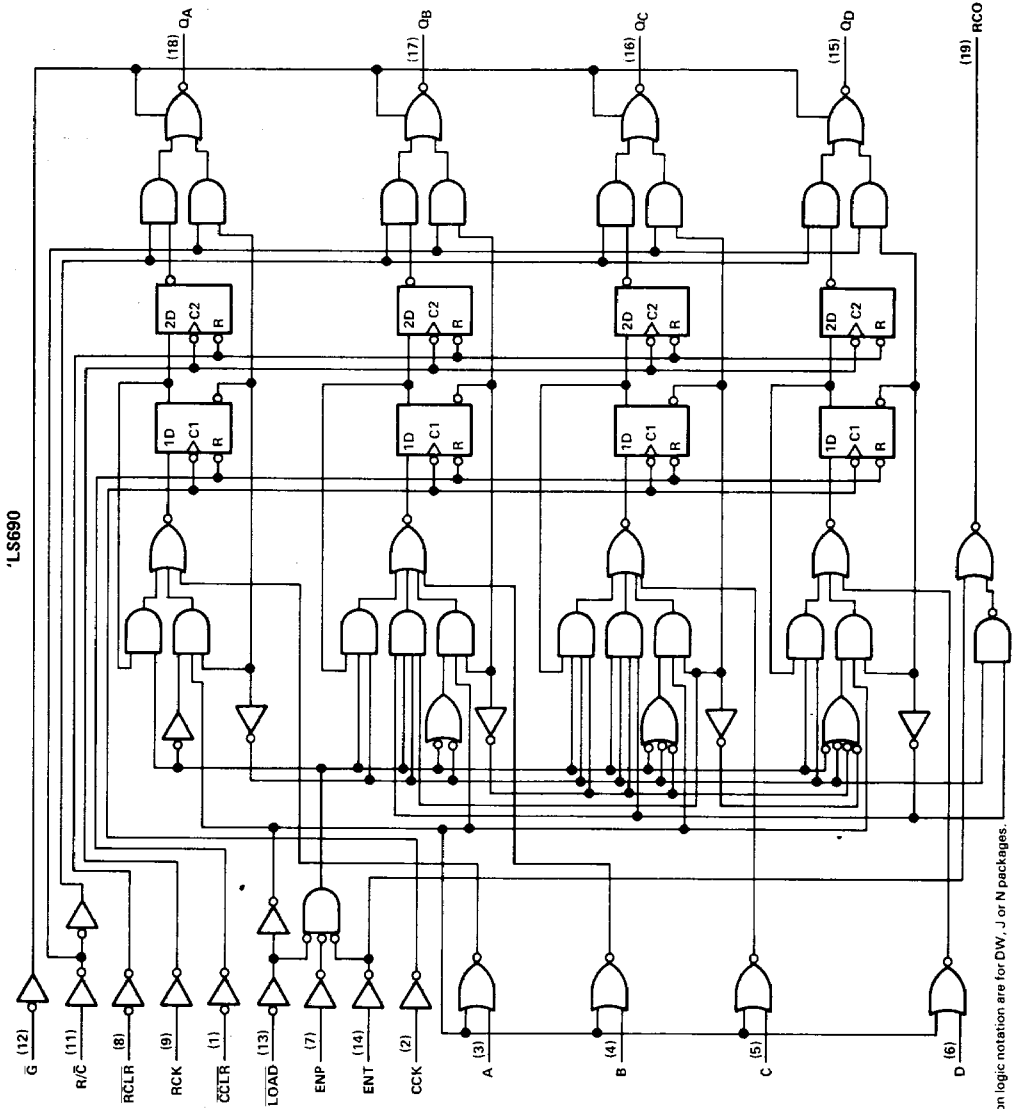
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**TYPE SN54LS690, SN74LS690**  
**SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS**  
**AND MULTIPLEXED 3-STATE OUTPUTS**

logic diagrams

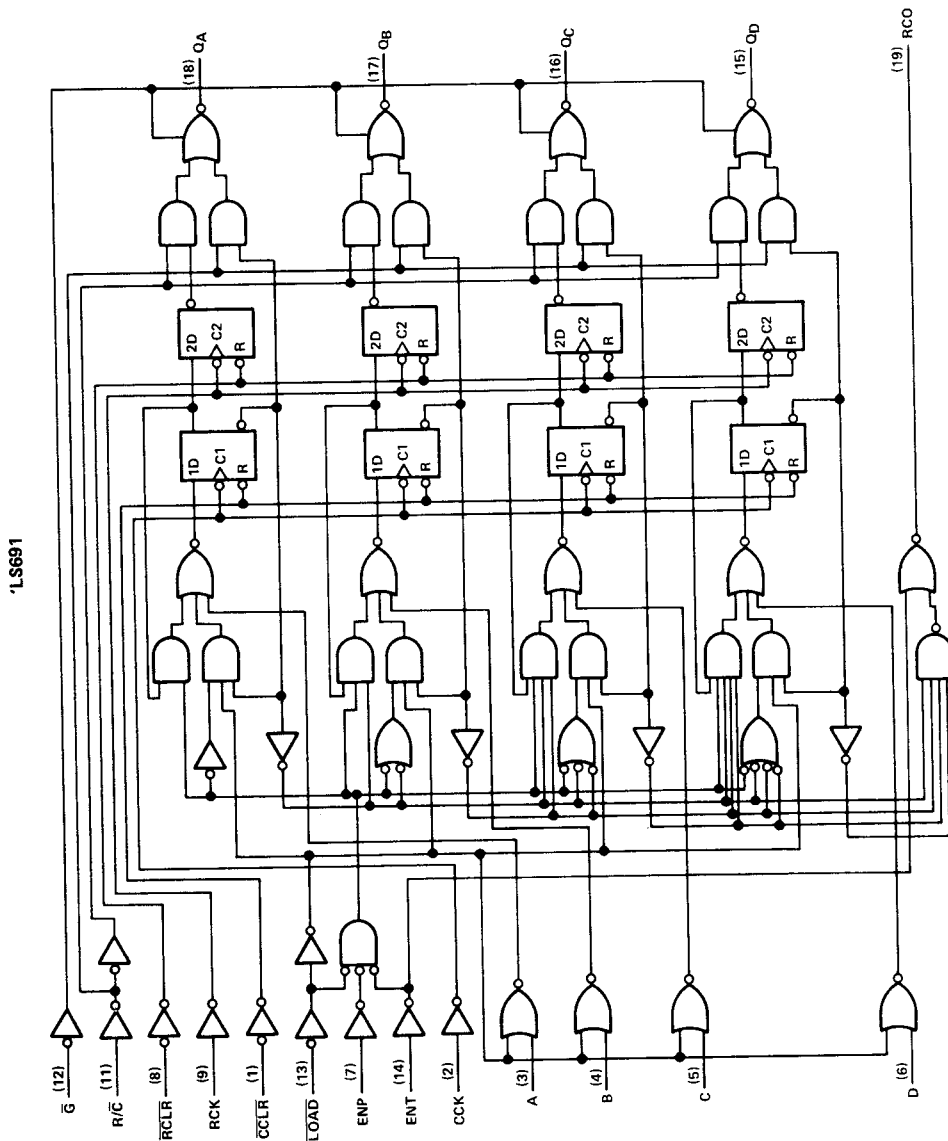
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Pin numbers shown on logic notation are for DW, J or N packages.

TYPE SN54LS691, SN74LS691  
 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS  
 AND MULTIPLEXED 3-STATE OUTPUTS

logic diagrams (continued)

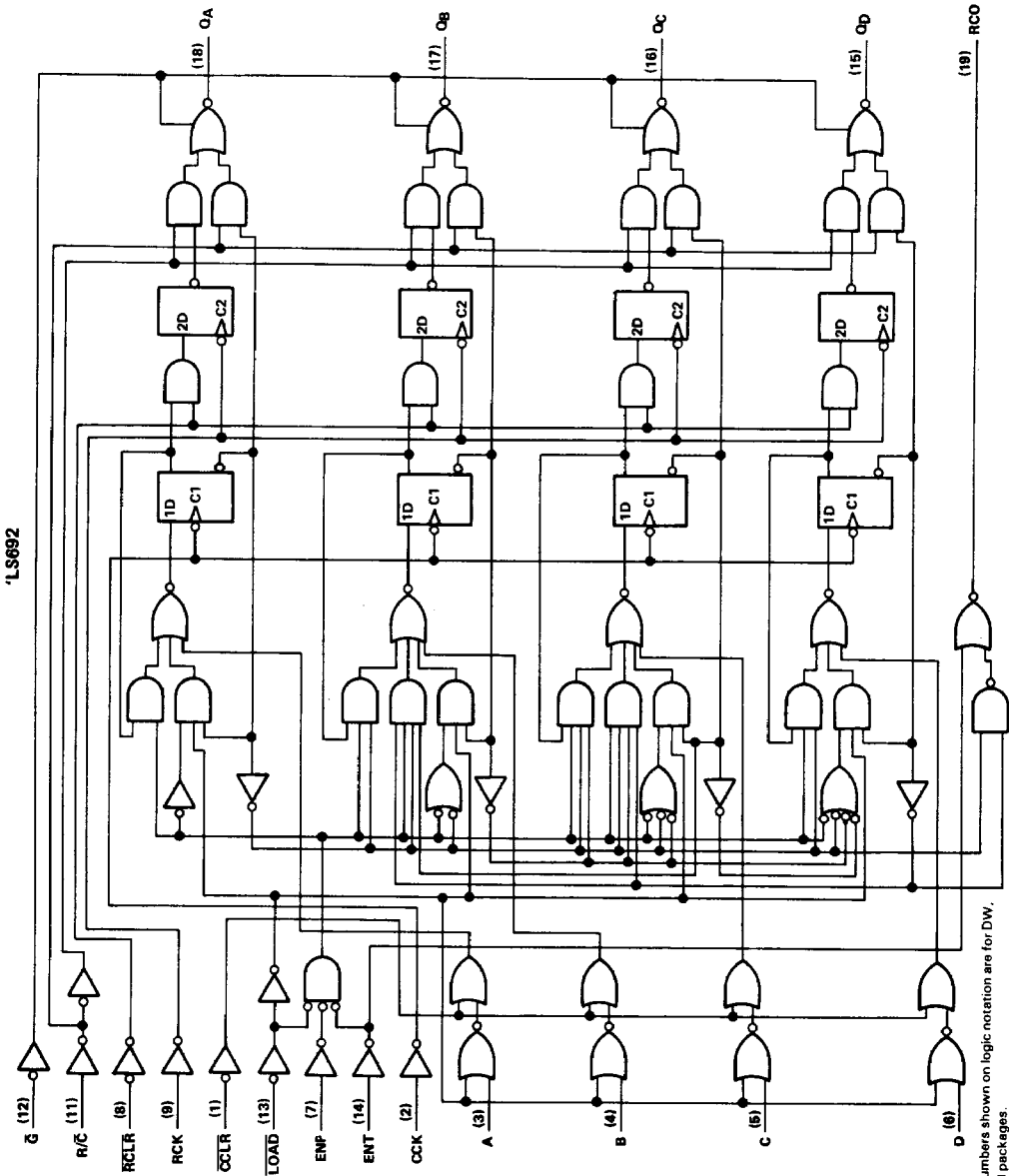


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**TYPE SN54LS692, SN74LS692**  
**SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS**  
**AND MULTIPLEXED 3-STATE OUTPUTS**

logic diagrams (continued)

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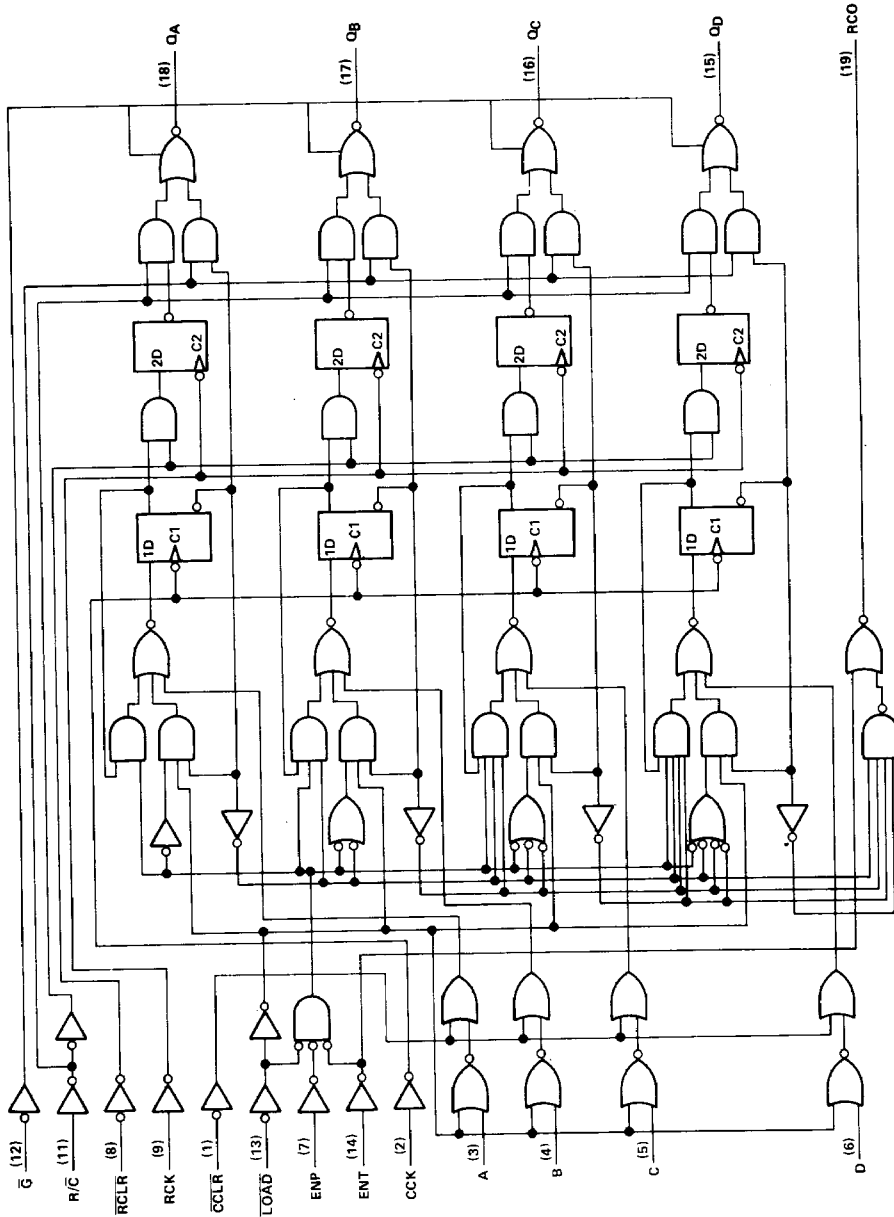


Pin numbers shown on logic notation are for DW, J or N packages.

TYPE SN54LS693, SN74LS693  
 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS  
 AND MULTIPLEXED 3-STATE OUTPUTS

logic diagrams (continued)

'LS693

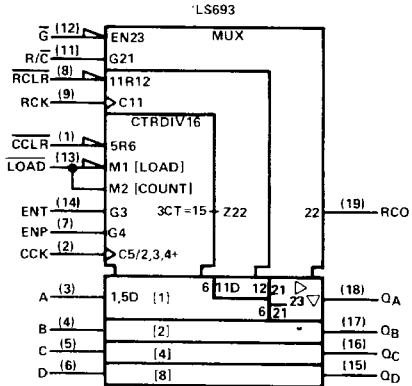
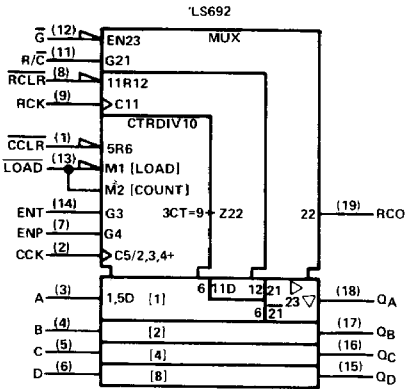
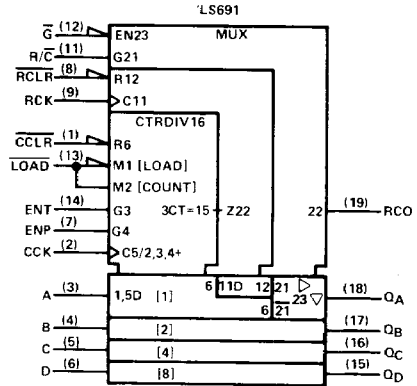
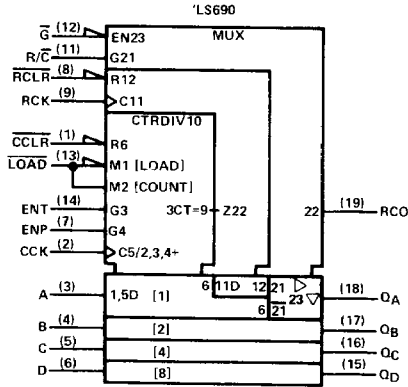


Pin numbers shown on logic notation are for DW, J or N packages.

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# TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

logic symbols



Pin numbers shown on logic notation are for DW, J or N packages.

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# TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage	7 V
Off-state output voltage	5.5 V
Operating free-air temperature range: SN54LS690 thru SN54LS693	-55°C to 125°C
SN74LS690 thru SN74LS693	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

		SN54LS'			SN74LS'			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage	0.7			0.8			V
$I_{OH}$	High-level output current	Q		-1	-2.6		mA	
		RCO		-0.4	-0.4		mA	
$I_{OL}$	Low-level output current	Q		12	24		mA	
		RCO		4	8		mA	
$f_{clock}$	Clock frequency	CCK		0	20	0	20	MHz
		RCK		0	20	0	20	MHz
$t_w$	Pulse duration	CCK high or low		25	25		ns	
		RCK high or low		25	25			
		'LS690, 'LS691		RCLR low	20	20		
				CCLR low	20	20		
$t_{su}$	Setup time before CCK ↑	A thru D		30	30		ns	
		ENP or ENT		30	30			
		LOAD ↓		30	30			
		'LS692, 'LS693		CCLR ↑	40	40		
		'LS690, 'LS691		CCLR ↑ inactive	25	25		
$t_{su}$	Setup time before RCK ↑	CCK ↑ (see Note 2)		30	30		ns	
		'LS690, 'LS691		RCLR ↑ inactive	25	25		
		'LS692, 'LS693		RCLR ↓	20	20		
$t_h$	Hold time	Any input from CCK ↑ or RCK ↑		0	0		ns	
$T_A$	Operating free-air temperature	-55		125	0		70	°C

NOTE 2: This set up time ensures the register will see stable data from the counter outputs. The clocks may be tied together in which case the register state will be one clock pulse behind the counter.

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# TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

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

PARAMETER		TEST CONDITIONS†		SN54LS'		SN74LS'		UNIT	
				MIN	TYP‡	MAX	MIN		TYP‡
$V_{IK}$	Any Q	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$		-1.5		-1.5		V	
$V_{OH}$	Any Q	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = \text{MAX}$	$I_{OH} = -1 \text{ mA}$	2.4	3.1			V	
	Any Q		$I_{OH} = -2.6 \text{ mA}$			2.4	3.1		
	RCO		$I_{OH} = -0.4 \text{ mA}$	2.5	3.2	2.7	3.2		
$V_{OL}$	Any Q	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = \text{MAX}$	$I_{OL} = 12 \text{ mA}$	0.25		0.4	0.25	0.4	V
	Any Q		$I_{OL} = 24 \text{ mA}$				0.35	0.5	
	RCO		$I_{OL} = 4 \text{ mA}$	0.25		0.4	0.25	0.4	
	RCO		$I_{OL} = 8 \text{ mA}$				0.35	0.5	
$I_{OZH}$	Any Q	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX},$ $V_O = 2.7 \text{ V}$		20		20		$\mu\text{A}$	
$I_{OZL}$	Any Q	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX},$ $V_O = 0.4 \text{ V}$		-20		-20		$\mu\text{A}$	
$I_I$		$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$		0.1		0.1		mA	
$I_{IH}$		$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$		20		20		$\mu\text{A}$	
$I_{IL}$	A thru D	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$		-0.4		-0.4		mA	
	All others			-0.2		-0.2			
$I_{OS}\S$	Any Q	$V_{CC} = \text{MAX}, V_O = 0 \text{ V}$		-30	-130	-30	-130	mA	
	RCO			-20	-100	-20	-100		
$I_{CCH}$		$V_{CC} = \text{MAX},$ All outputs open	See Note 3	46	65	46	65	mA	
$I_{CCL}$	See Note 4		48	70	48	70			
$I_{CCZ}$	See Note 5		48	70	48	70			

† 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 short-circuit should not exceed one second.

- NOTES: 3.  $I_{CCH}$  is measured after two 0-V to 4.5-V to 0-V pulses have been applied to CCK and RCK while  $\bar{G}$  is grounded and all other inputs are at 4.5 V.
4.  $I_{CCL}$  is measured after two 0-V to 4.5-V to 0-V pulses have been applied to CCK and RCK while all other inputs are grounded.
5.  $I_{CCZ}$  is measured after two 0-V to 4.5-V to 0-V pulses have been applied to CCK and RCK while  $\bar{G}$  is at 4.5 V and all other inputs are grounded.

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**TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693  
SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS  
AND MULTIPLEXED 3-STATE OUTPUTS**

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{ C}$  (see note 6)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS690, 'LS691		'LS692, 'LS693		UNIT	
				MIN	TYP	MAX	MIN		TYP
$t_{PLH}$	CCK $\uparrow$	RCO	$R_L = 2\text{ k}\Omega$ , $C_L = 15\text{ pF}$	23	40	23	40	ns	
$t_{PHL}$				23	40	23	40		
$t_{PLH}$	ENT	RCO		13	20	13	20	ns	
$t_{PHL}$				13	20	13	20		
$t_{PLH}$	CCK $\uparrow$	Q	$R_L = 667\ \Omega$ , $C_L = 45\text{ pF}$	12	20	12	20	ns	
$t_{PHL}$				17	25	17	25		
$t_{PLH}$	RCK $\uparrow$	Q		12	20	12	20	ns	
$t_{PHL}$				17	25	17	25		
$t_{PHL}$	CCLR $\downarrow$	Q		23	40			ns	
$t_{PHL}$	RCLR $\downarrow$	Q		20	30			ns	
$t_{PLH}$	$R/\bar{C}$	Q		16	25	16	25	ns	
$t_{PHL}$				16	25	16	25		
$t_{PZH}$	$\bar{G}_1$	Q		19	30	19	30	ns	
$t_{PZL}$				19	30	19	30		
$t_{PHZ}$	$\bar{G}_1$	Q		$R_L = 667\ \Omega$ , $C_L = 5\text{ pF}$	17	30	17	30	ns
$t_{PLZ}$					17	30	17	30	

NOTE 6: See General Information Section for load circuits and voltage waveforms.

$t_{PLH}$   $\equiv$  Propagation delay time, low-to-high-level output

$t_{PHL}$   $\equiv$  Propagation delay time, high-to-low-level output

$t_{PZH}$   $\equiv$  Output enable time to high level

$t_{PZL}$   $\equiv$  Output enable time to low level

$t_{PHZ}$   $\equiv$  Output disable time from high level

$t_{PLZ}$   $\equiv$  Output disable time from low level

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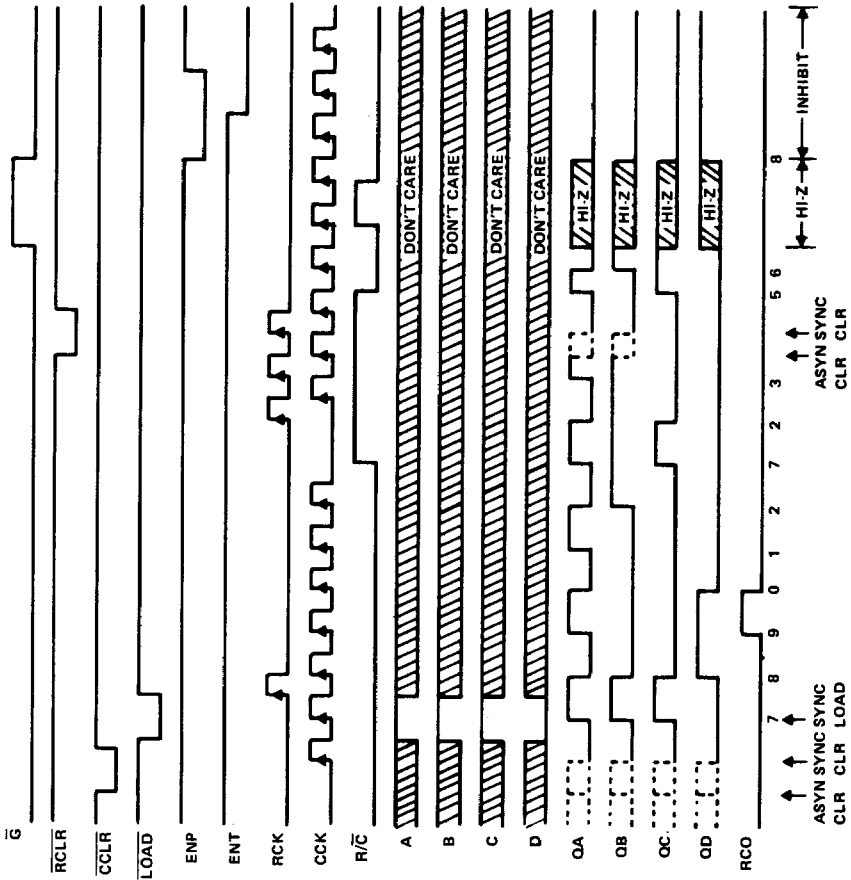
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**TYPES SN54LS690, SN54LS692, SN74LS690, SN74LS692**  
**SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS**  
**AND MULTIPLEXED 3-STATE OUTPUTS**

typical operating sequences

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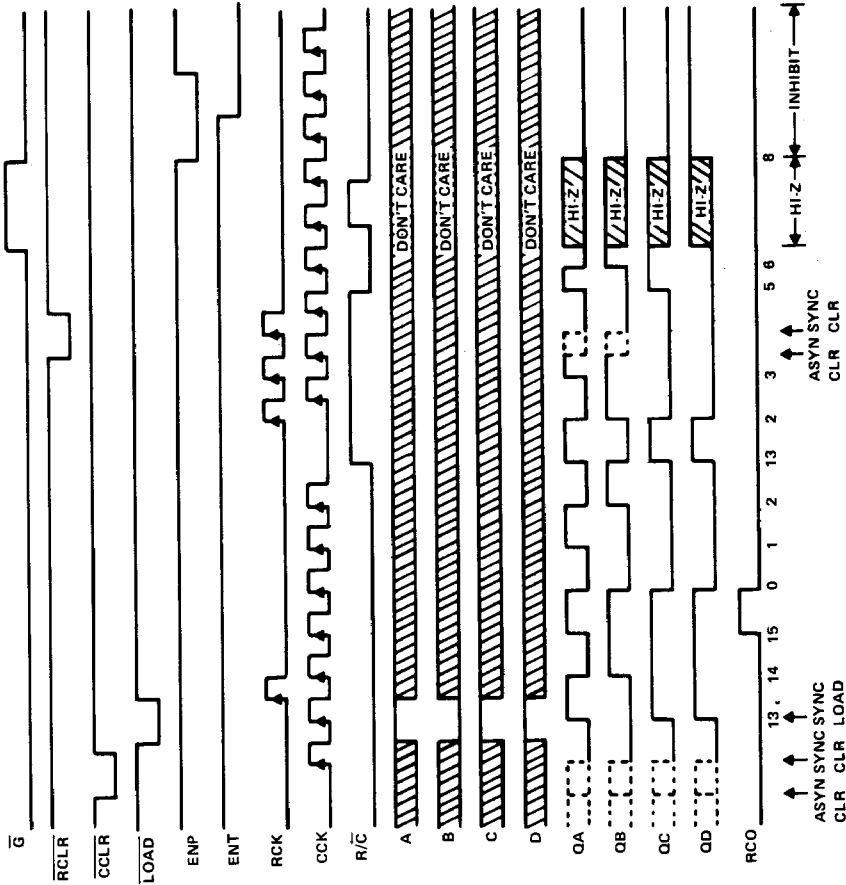
'LS690 DECADE COUNTER, Asynchronous Clear  
 'LS692 DECADE COUNTER, Synchronous Clear



TYPES SN54LS691, SN54LS693, SN74LS691, SN74LS693  
 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS  
 AND MULTIPLEXED 3-STATE OUTPUTS

typical operating sequences (continued)

'LS691 BINARY COUNTER, Asynchronous Clear  
 'LS693 BINARY COUNTER, Synchronous Clear



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