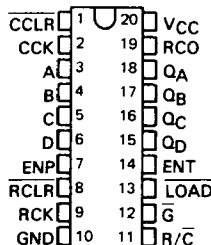


# TYPES SN54LS690 THRU SN54LS693, SN74LS690 THRU SN74LS693 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

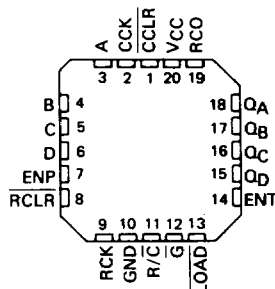
D2423, JANUARY 1981

- 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

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



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



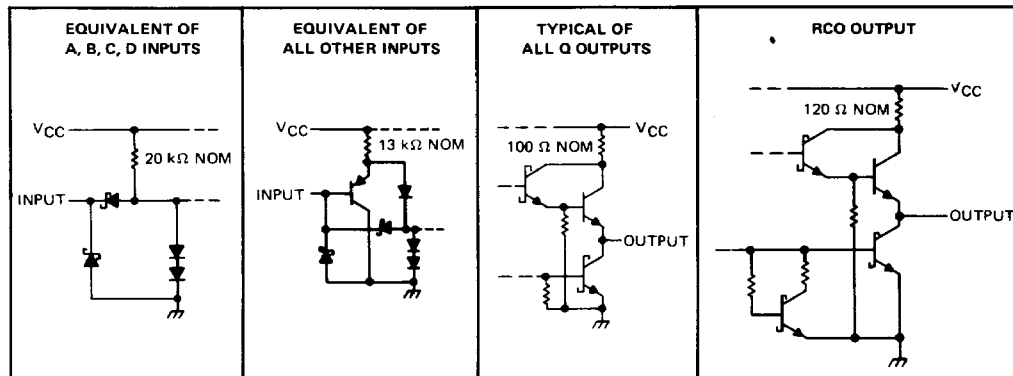
## description

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/C, selects the counter when low or the register when high for the three-state outputs, QA, QB, QC, and QD. These outputs are rated at 12 and 24 milliamperes (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 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



## 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.

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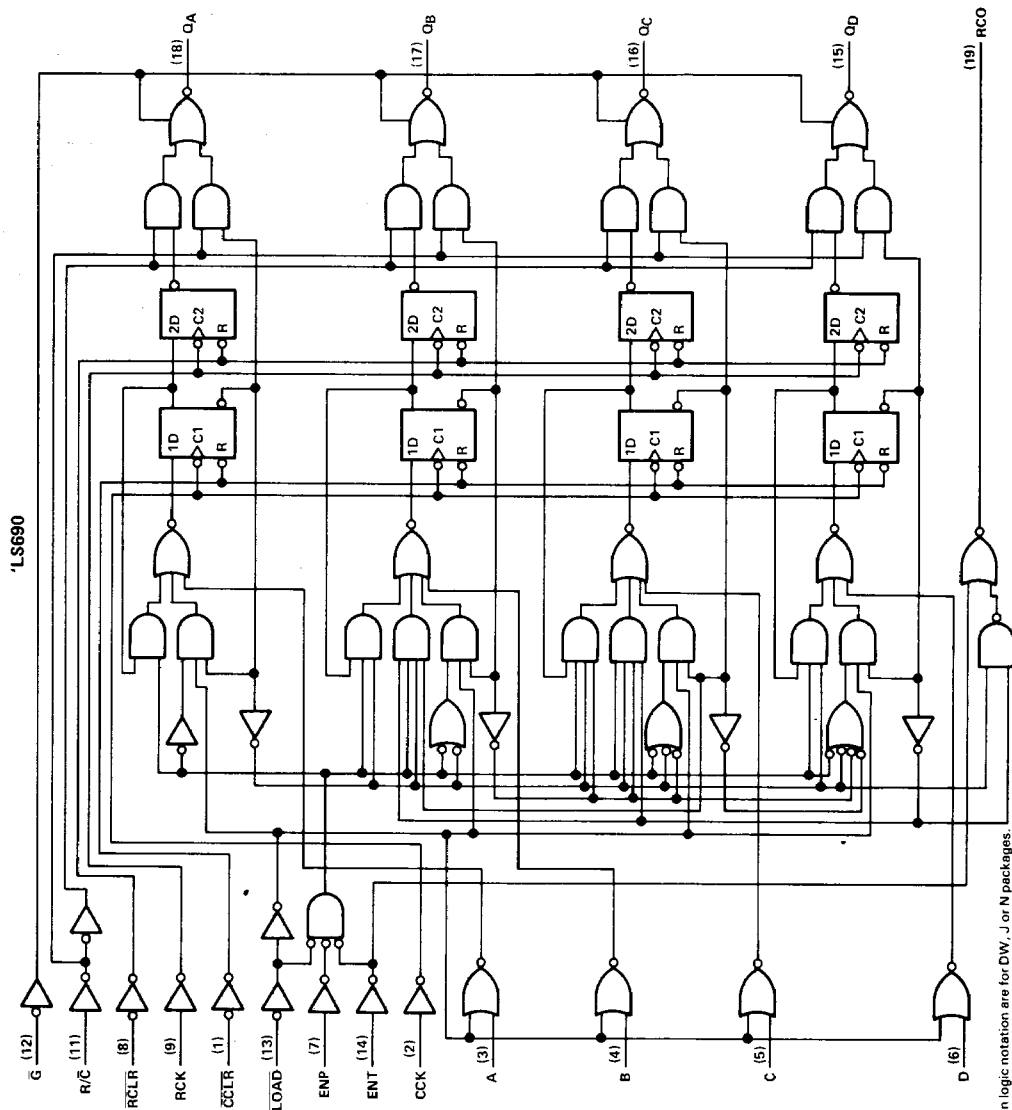
3-1303

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TTL DEVICES

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

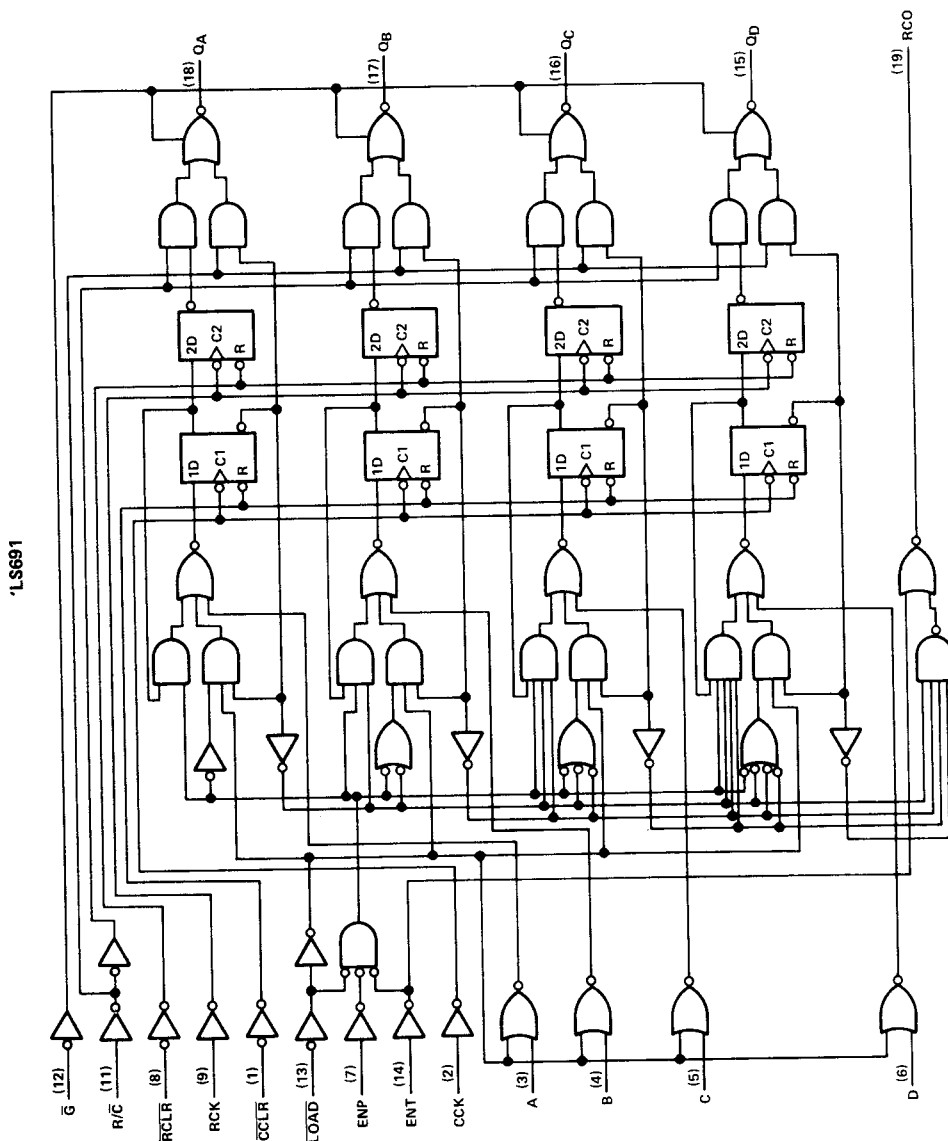
logic diagrams



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)



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

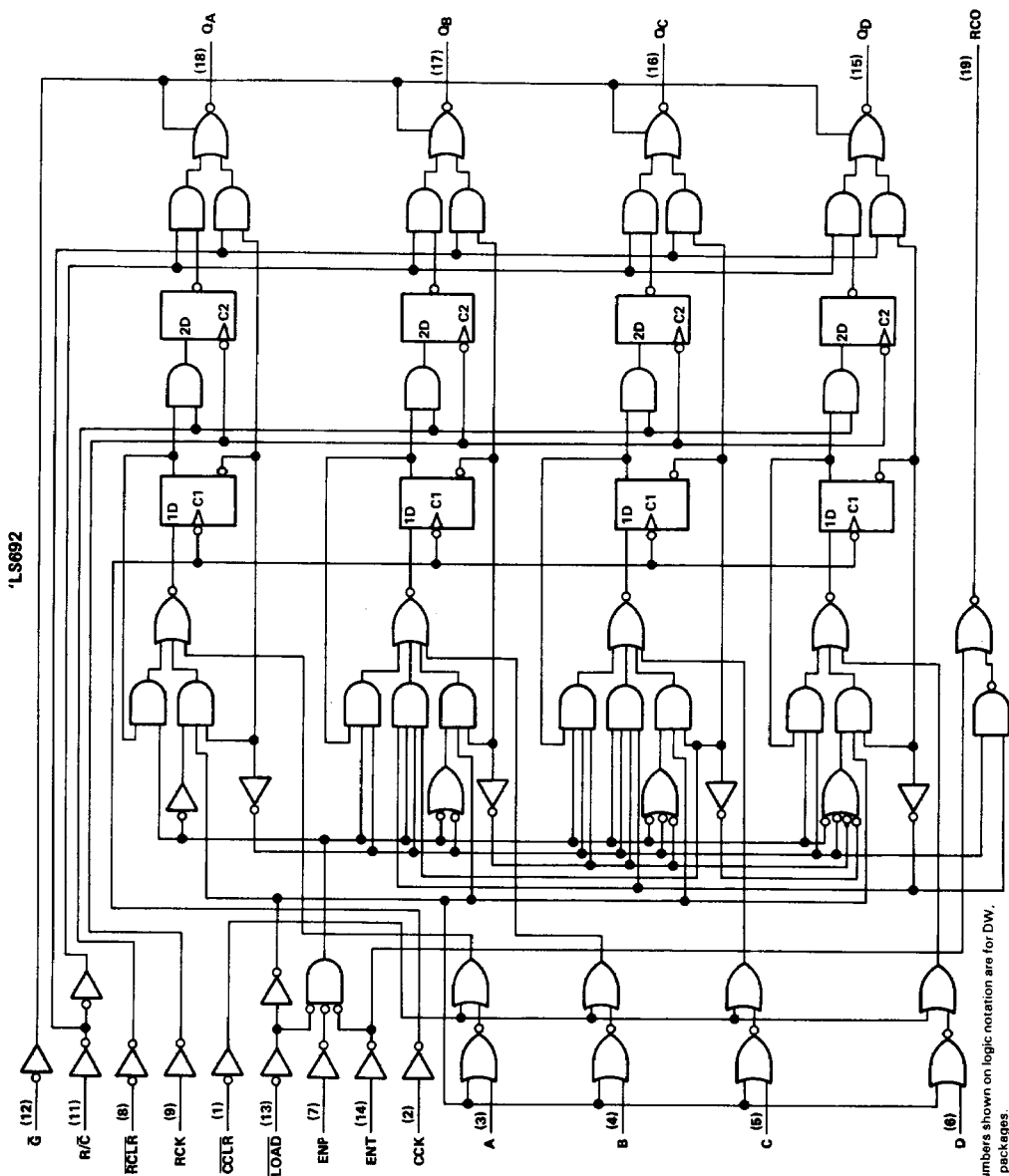
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TTL DEVICES

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

logic diagrams (continued)

3 TTL DEVICES

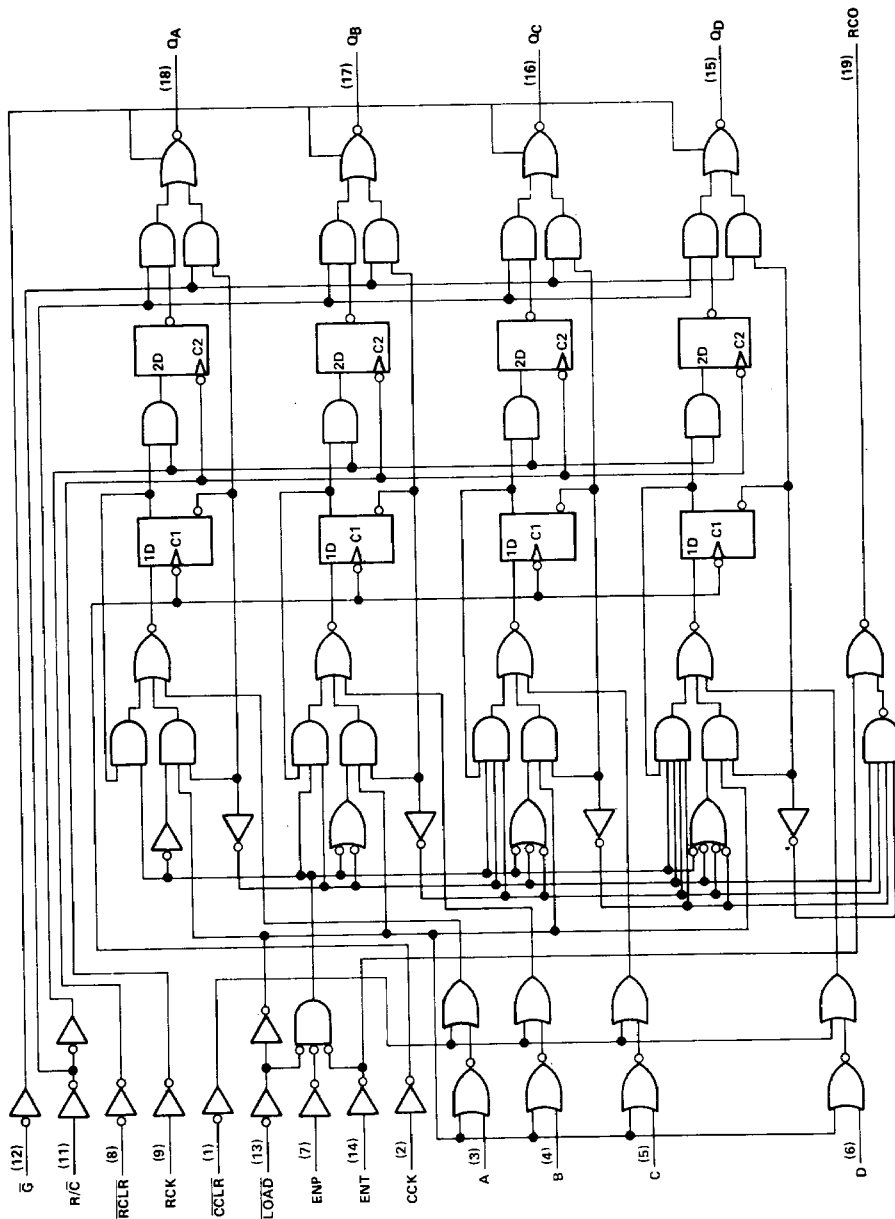


Pin numbers shown on logic notation are for DW, J or N packages.

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

logic diagrams (continued)

'LS693



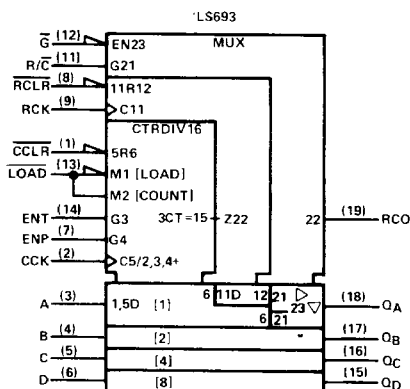
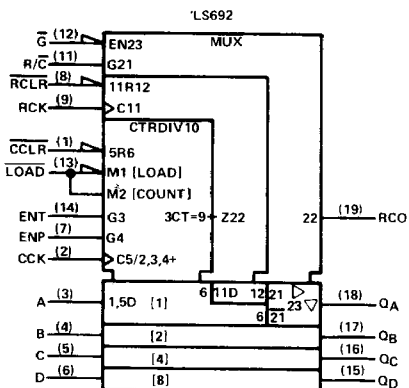
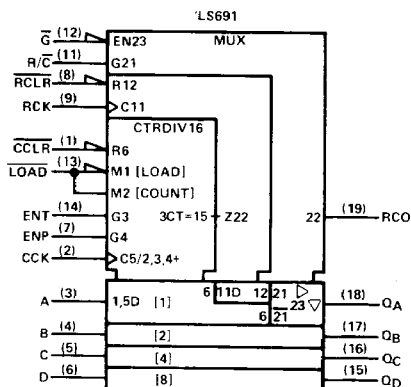
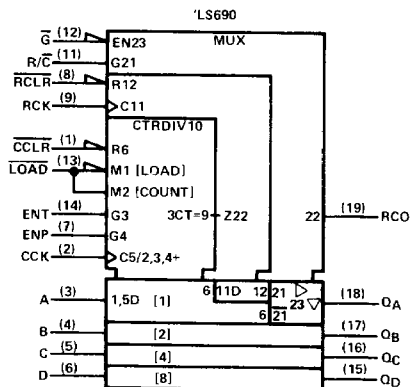
Pin numbers shown on logic notation are for DW, J or N packages.

3

TTL DEVICES

# 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.

# **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      |     |      |      |
| $t_{su}$    | Setup time before CCK ↑        | CCLR low                      | 20      |     |      | 20      |     |      | ns   |
|             |                                | A thru D                      | 30      |     |      | 30      |     |      |      |
|             |                                | ENP or ENT                    | 30      |     |      | 30      |     |      |      |
|             |                                | LOAD ↓                        | 30      |     |      | 30      |     |      |      |
|             |                                | 'LS692, 'LS693                | 40      |     |      | 40      |     |      |      |
|             |                                | 'LS690, 'LS691                |         |     |      |         |     |      |      |
| $t_{su}$    | Setup time before RCK ↑        | CCLR ↑ inactive               | 25      |     |      | 25      |     |      | ns   |
|             |                                | CCK ↑ (see Note 2)            | 30      |     |      | 30      |     |      |      |
|             |                                | 'LS690, 'LS691                |         |     |      |         |     |      |      |
|             |                                | RCLR ↑ inactive               | 25      |     |      | 25      |     |      |      |
| $t_h$       | 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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TTL DEVICES

# 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‡ | MAX  |               |
| $V_{IK}$  | 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 |               |
| $I_{OS}$  | Any Q      | $V_{CC} = \text{MAX}, V_O = 0 \text{ V}$                                              |                            | -30     |      | -130 | -30     |      | -130 | mA            |
|           | RCO        |                                                                                       |                            | -20     |      | -100 | -20     |      | -100 |               |
| $I_{CCH}$ |            | $V_{CC} = \text{MAX},$<br>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.

3

TTL DEVICES

# **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<br>(INPUT)     | TO<br>(OUTPUT) | TEST CONDITIONS                                | 'LS690, 'LS691                                |     |     | 'LS692, 'LS693 |     |     | UNIT |    |
|------------------|---------------------|----------------|------------------------------------------------|-----------------------------------------------|-----|-----|----------------|-----|-----|------|----|
|                  |                     |                |                                                | MIN                                           | TYP | MAX | MIN            | TYP | MAX |      |    |
| t <sub>PLH</sub> | CCK1                | RCO            | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 15 pF  |                                               | 23  | 40  |                | 23  | 40  | ns   |    |
| t <sub>PHL</sub> |                     |                |                                                |                                               | 23  | 40  |                | 23  | 40  |      |    |
| t <sub>PLH</sub> | ENT                 | RCO            |                                                |                                               | 13  | 20  |                | 13  | 20  | ns   |    |
| t <sub>PHL</sub> |                     |                |                                                |                                               | 13  | 20  |                | 13  | 20  |      |    |
| t <sub>PLH</sub> | CCK1                | Q              | R <sub>L</sub> = 667 Ω, C <sub>L</sub> = 45 pF |                                               | 12  | 20  |                | 12  | 20  | ns   |    |
| t <sub>PHL</sub> |                     |                |                                                |                                               | 17  | 25  |                | 17  | 25  |      |    |
| t <sub>PLH</sub> | RCK1                | Q              |                                                |                                               | 12  | 20  |                | 12  | 20  | ns   |    |
| t <sub>PHL</sub> |                     |                |                                                |                                               | 17  | 25  |                | 17  | 25  |      |    |
| t <sub>PHL</sub> | $\overline{CCLR}_1$ | Q              |                                                |                                               | 23  | 40  |                |     |     | ns   |    |
| t <sub>PHL</sub> | $\overline{RCLR}_1$ | Q              |                                                |                                               | 20  | 30  |                |     |     | ns   |    |
| t <sub>PLH</sub> | R/ $\overline{C}$   | Q              |                                                |                                               | 16  | 25  |                | 16  | 25  | ns   |    |
| t <sub>PHL</sub> |                     |                |                                                |                                               | 16  | 25  |                | 16  | 25  |      |    |
| t <sub>PZH</sub> | $\overline{G}_1$    | Q              |                                                | R <sub>L</sub> = 667 Ω, C <sub>L</sub> = 5 pF |     | 19  | 30             |     | 19  | 30   | ns |
| t <sub>PZL</sub> |                     |                |                                                |                                               |     | 19  | 30             |     | 19  | 30   |    |
| t <sub>PHZ</sub> | $\overline{G}_1$    | Q              |                                                |                                               | 17  | 30  |                | 17  | 30  | ns   |    |
| t <sub>PLZ</sub> |                     |                |                                                |                                               | 17  | 30  |                | 17  | 30  |      |    |

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

- $t_{PLH}$  = Propagation delay time, low-to-high-level output
- $t_{PHL}$  = Propagation delay time, high-to-low-level output
- $t_{PZH}$  = Output enable time to high level
- $t_{PZL}$  = Output enable time to low level
- $t_{PHZ}$  = Output disable time from high level
- $t_{PLZ}$  = Output disable time from low level

3

TTL DEVICES

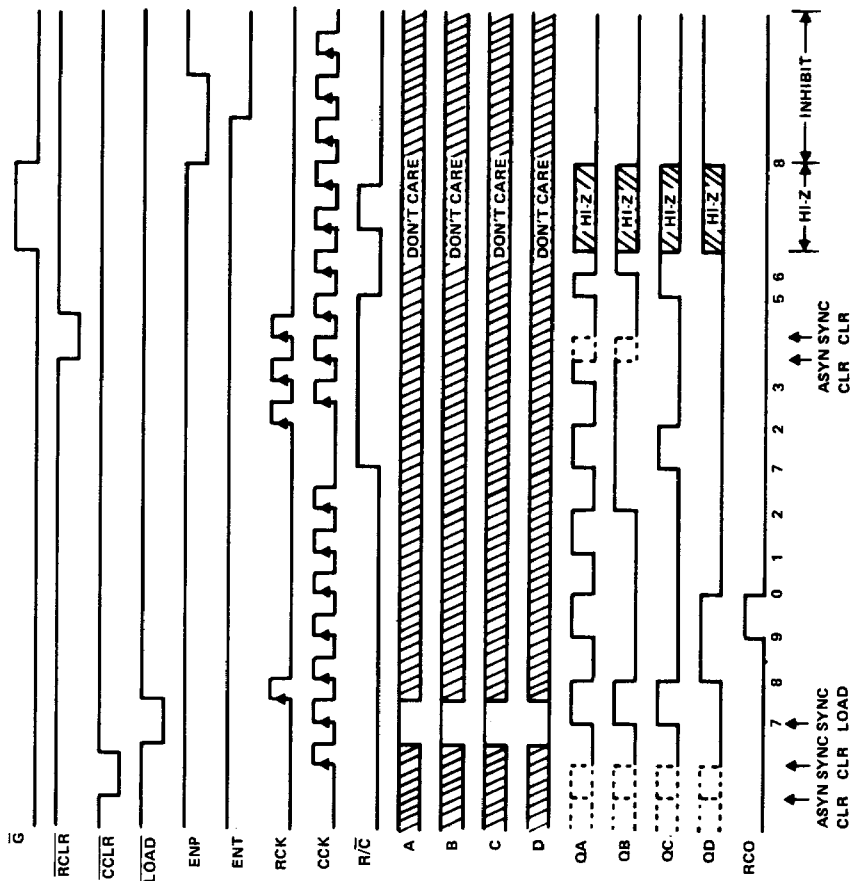
# TYPES SN54LS690, SN54LS692, SN74LS690, SN74LS692 SYNCHRONOUS COUNTERS WITH OUTPUT REGISTERS AND MULTIPLEXED 3-STATE OUTPUTS

typical operating sequences

3

TTL DEVICES

'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)

