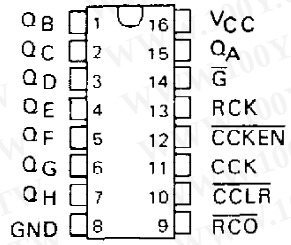
# SN54LS590, SN54LS591, SN74LS590, SN74LS591
# 8-BIT BINARY COUNTERS WITH OUTPUT REGISTERS

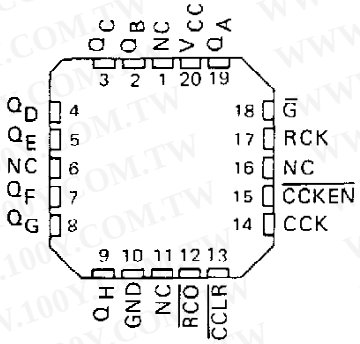
SDLS003 D2632, JANUARY 1981 – REVISED MARCH 1988

- 8-Bit Counter with Register
- Parallel Register Outputs
- Choice of 3-State ('LS590) or Open-Collector ('LS591) Register Outputs
- Guaranteed Counter Frequency: DC to 20 MHz

SN54LS590, SN54LS591 . . . J OR W PACKAGE
SN74LS590, SN74LS591 . . . N PACKAGE
(TOP VIEW)




SN54LS590, SN54LS591 . . . FK PACKAGE
(TOP VIEW)




NC – No internal connection

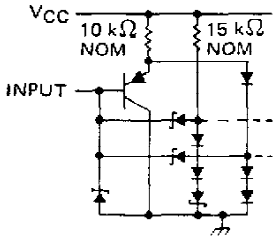
## description

These devices each contain an 8-bit binary counter that feeds an 8 bit storage register. The storage register has parallel outputs. Separate clocks are provided for both the binary counter and storage register. The binary counter features a direct clear input $\overline{CCLR}$ and a count enable input $\overline{CCKEN}$. For cascading, a ripple carry output $\overline{RCO}$ is provided. Expansion is easily accomplished for two stages by connecting $\overline{RCO}$ of the first stage to $\overline{CCKEN}$ of the second stage. Cascading for larger count chains can be accomplished by connecting $\overline{RCO}$ of each stage to CCK of the following stage.

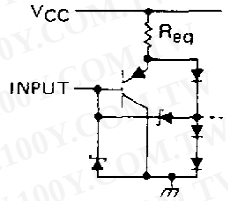
Both the counter and register clocks are positive-edge triggered. If the user wishes to connect both clocks together, the counter state will always be one count ahead of the register. Internal circuitry prevents clocking from the clock enable.

## schematics of inputs and outputs

EQUIVALENT OF CCK INPUT

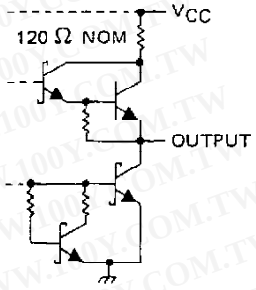



EQUIVALENT OF ALL OTHER INPUTS

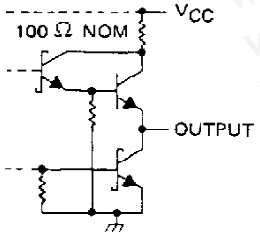



RCK: $R_{eq}$ = 10 kΩ NOM
ALL OTHER: $R_{eq}$ = 13 kΩ NOM

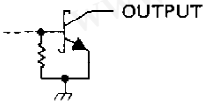
$\overline{RCO}$ OUTPUT



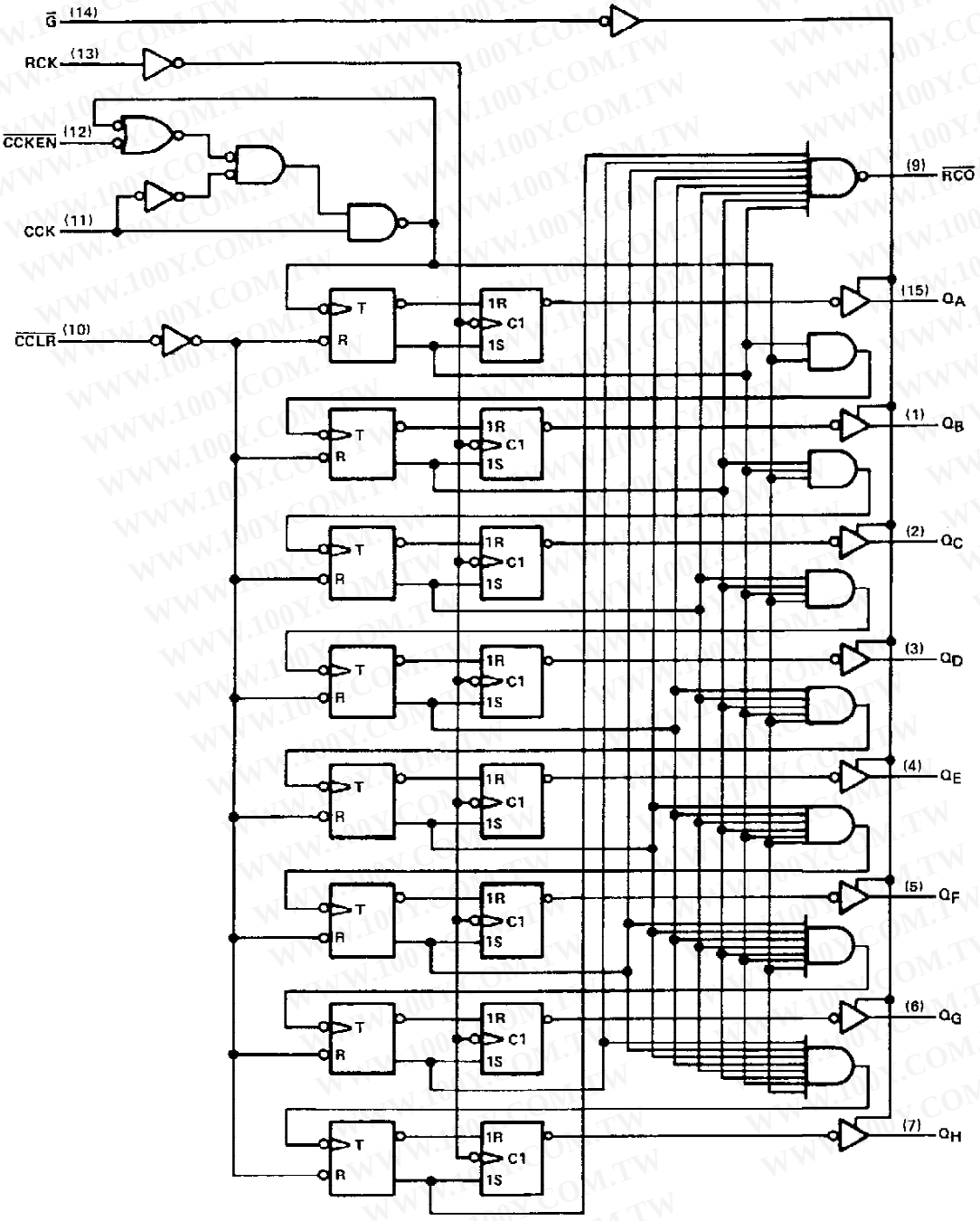

TYPICAL OF Q OUTPUTS ('LS590)




TYPICAL OF Q OUTPUTS ('LS591)

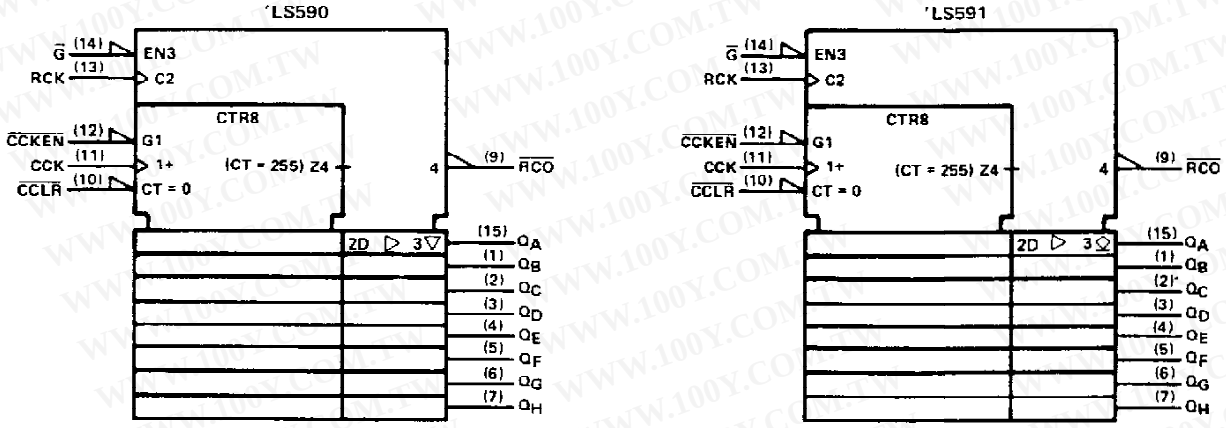


logic diagram (positive logic)




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

## logic symbols†




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

## 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: SN54LS590, SN54LS591 . . . . . −55°C to 125°C
SN74LS590, SN74LS591 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to the 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 |
| $V_{OH}$ | High-level output voltage | Q, 'LS591 only | | | 5.5 | | | 5.5 | V |
| $I_{OH}$ | High-level output current | $\overline{RCO}$ | | | −1 | | | −1 | mA |
| | | Q, 'LS590 only | | | −1 | | | −2.6 | |
| $I_{OL}$ | Low-level output current | $\overline{RCO}$ | | | 8 | | | 16 | mA |
| | | Q | | | 12 | | | 24 | |
| $f_{CCK}$ | Counter clock frequency | | 0 | | 20 | 0 | | 20 | MHz |
| $f_{RCK}$ | Register clock frequency | | 0 | | 25 | 0 | | 25 | MHz |
| $t_{w(CCK)}$ | Duration of counter clock pulse | | 25 | | | 25 | | | ns |
| $t_{w(\overline{CCLR})}$ | Duration of counter clear pulse | | 20 | | | 20 | | | ns |
| $t_{w(RCK)}$ | Duration of register clock pulse | | 20 | | | 20 | | | ns |
| $t_{su}$ | Setup time | $\overline{CCKEN}$ low before CCK↑ | 20 | | | 20 | | | ns |
| | | $\overline{CCLR}$ inactive before CCK↑ | 20 | | | 20 | | | |
| | | CCK before RCK↑ (see Note 2) | 40 | | | 40 | | | |
| $t_h$ | Hold time | $\overline{CCKEN}$ low after CCK↑ | 0 | | | 0 | | | ns |
| $T_A$ | Operating free-air temperature | | −55 | | 125 | 0 | | 70 | °C |

NOTE 2: This setup 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.

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

| PARAMETER | | | TEST CONDITIONS† | | | SN54LS' | | | SN74LS' | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| $V_{IK}$ | | | $V_{CC}$ = MIN, $I_I$ = −18 mA | | | | | −1.5 | | | −1.5 | V |
| $V_{OH}$ | 'LS590 Q | | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = MAX | | $I_{OH}$ = −1 mA | 2.4 | 3.2 | | | | | V |
| | | | | | $I_{OH}$ = −2.6 mA | | | | 2.4 | 3.1 | | |
| | $\overline{RCO}$ | | | | $I_{OH}$ = −1 mA | 2.4 | 3.2 | | 2.4 | 3.2 | | |
| $I_{OH}$ | 'LS591 Q | | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = MAX | | $V_{OH}$ = 5.5 V | | | 0.1 | | | 0.1 | mA |
| $V_{OL}$ | Q | | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = MAX | | $I_{OL}$ = 12 mA | | 0.25 | 0.4 | | 0.25 | 0.4 | V |
| | | | | | $I_{OL}$ = 24 mA | | | | | 0.35 | 0.5 | |
| | $\overline{RCO}$ | | | | $I_{OL}$ = 8 mA | | 0.25 | 0.4 | | 0.25 | 0.4 | |
| | | | | | $I_{OL}$ = 16 mA | | | | | 0.35 | 0.5 | |
| $I_{OZH}$ | 'LS590 Q | | $V_{CC}$ = MAX, $V_{IH}$ = 2 V, $V_O$ = 2.7 V | | $V_{IL}$ = MAX, | | | 20 | | | 20 | μA |
| $I_{OZL}$ | 'LS590 Q | | $V_{CC}$ = MAX, $V_{IH}$ = 2 V, $V_O$ = 0.4 V | | $V_{IL}$ = MAX, | | | −20 | | | −20 | μA |
| $I_I$ | | | $V_{CC}$ = MAX, $V_I$ = 7 V | | | | | 0.1 | | | 0.1 | mA |
| $I_{IH}$ | | | $V_{CC}$ = MAX, $V_I$ = 2.7 V | | | | | 20 | | | 20 | μA |
| $I_{IL}$ | CCK | | $V_{CC}$ = MAX, $V_I$ = 0.4 V | | | | | −0.8 | | | −0.8 | mA |
| | All others | | | | | | | −0.2 | | | −0.2 | |
| $I_{OS}$§ | 'LS590 Q | | $V_{CC}$ = MAX, $V_O$ = 0 V | | | −30 | | −130 | −30 | | −130 | mA |
| | $\overline{RCO}$ | | | | | −20 | | −100 | −20 | | −100 | |
| $I_{CC}$ | 'LS590 | $I_{CCH}$ | $V_{CC}$ = MAX, All possible inputs grounded, All outputs open | | | | 33 | 55 | | 33 | 55 | mA |
| | | $I_{CCL}$ | | | | | 44 | 65 | | 44 | 65 | |
| | | $I_{CCZ}$ | | | | | 46 | 65 | | 46 | 65 | |
| | 'LS591 | $I_{CCH}$ | | | | | 35 | 55 | | 35 | 55 | |
| | | $I_{CCL}$ | | | | | 42 | 65 | | 42 | 65 | |

† 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 the duration of the short-circuit should not exceed one second.

## switching characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C (see note 3)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | | 'LS590 | | | 'LS591 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $f_{max}$ | RCK | Q | $R_L$ = 667 Ω, | $C_L$ = 45 pF | 20 | 35 | | 20 | 35 | | MHz |
| $t_{PLH}$ | CCK↑ | $\overline{RCO}$ | $R_L$ = 1 kΩ, | $C_L$ = 30 pF | | 14 | 22 | | 16 | 24 | ns |
| $t_{PHL}$ | CCK↑ | $\overline{RCO}$ | | | | 20 | 30 | | 25 | 38 | ns |
| $t_{PLH}$ | $\overline{CCLR}$↓ | $\overline{RCO}$ | | | | 30 | 45 | | 32 | 48 | ns |
| $t_{PLH}$ | RCK↑ | Q | $R_L$ = 667 Ω, | $C_L$ = 45 pF | | 12 | 18 | | 25 | 38 | ns |
| $t_{PHL}$ | RCK↑ | Q | | | | 22 | 33 | | 28 | 42 | ns |
| $t_{PZH}$ | $\overline{G}$↓ | Q | | | | 25 | 38 | | | | ns |
| $t_{PZL}$ | $\overline{G}$↓ | Q | | | | 30 | 45 | | | | ns |
| $t_{PHZ}$ | $\overline{G}$↑ | Q | $R_L$ = 667 Ω, | $C_L$ = 5 pF | | 20 | 30 | | | | ns |
| $t_{PLZ}$ | $\overline{G}$↑ | Q | | | | 25 | 38 | | | | ns |
| $t_{PLH}$ | $\overline{G}$↑ | Q | $R_L$ = 667 Ω, | $C_L$ = 45 pF | | | | | 34 | 50 | ns |
| $t_{PHL}$ | $\overline{G}$↓ | Q | | | | | | | 32 | 48 | ns |

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

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