

# SN54HC4020, SN74HC4020 14-BIT ASYNCHRONOUS BINARY COUNTERS

SCLS158C – DECEMBER 1982 – REVISED FEBRUARY 2000

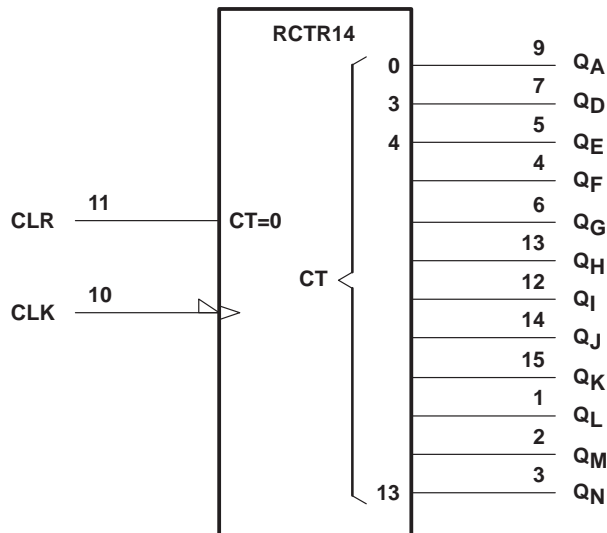
- Package Options Include Plastic Small-Outline (D), Shrink Small-Outline (DB), Thin Shrink Small-Outline (PW), and Ceramic Flat (W) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) DIPs

## description

These devices are 14-stage binary ripple-carry counters that advance on the negative-going edge of the clock pulse. The counters are reset to zero (all outputs low) independently of the clock (CLK) input when the clear (CLR) input goes high.

The SN54HC4020 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74HC4020 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

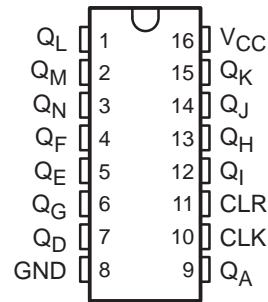
## logic symbol†



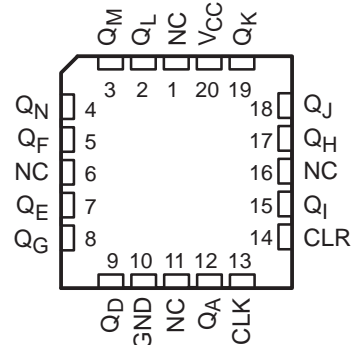
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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

SN54HC4020 . . . J OR W PACKAGE  
SN74HC4020 . . . D, DB, N, OR PW PACKAGE  
(TOP VIEW)



SN54HC4020 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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PRODUCTION DATA information is 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**

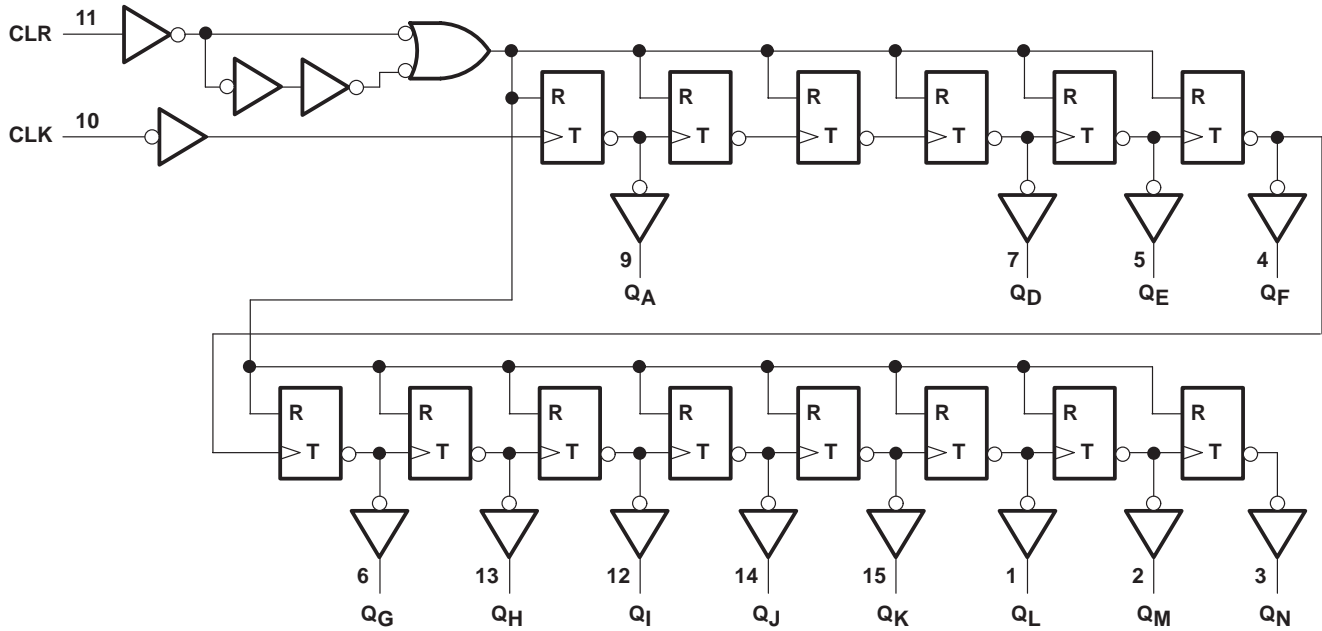
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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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## logic diagram (positive logic)



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

## absolute maximum ratings over operating free-air temperature†

|   |                |
|---|----------------|
| Supply voltage range, $V_{CC}$ .....  | -0.5 V to 7 V  |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{CC}$ ) (see Note 1) .....  | $\pm 20$ mA    |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ ) (see Note 1) ..... | $\pm 20$ mA    |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ ) .....                  | $\pm 25$ mA    |
| Continuous current through $V_{CC}$ or GND .....                                  | $\pm 50$ mA    |
| Package thermal impedance, $\theta_{JA}$ (see Note 2): D package .....            | 73°C/W         |
| DB package .....  | 82°C/W         |
| N package .....   | 67°C/W         |
| PW package .....  | 108°C/W        |
| Storage temperature range, $T_{stg}$ .....  | -65°C to 150°C |

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.  
2. The package thermal impedance is calculated in accordance with JESD 51.

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## recommended operating conditions (see Note 3)

|                 |                                       | SN54HC4020              |                 |      | SN74HC4020 |                 |     | UNIT |
|-----------------|---------------------------------------|-------------------------|-----------------|------|------------|-----------------|-----|------|
|                 |                                       | MIN                     | NOM             | MAX  | MIN        | NOM             | MAX |      |
| V <sub>CC</sub> | Supply voltage                        | 2                       | 5               | 6    | 2          | 5               | 6   | V    |
| V <sub>IH</sub> | High-level input voltage              | V <sub>CC</sub> = 2 V   | 1.5             |      | 1.5        |                 | V   |      |
|                 |                                       | V <sub>CC</sub> = 4.5 V | 3.15            |      | 3.15       |                 |     |      |
|                 |                                       | V <sub>CC</sub> = 6 V   | 4.2             |      | 4.2        |                 |     |      |
| V <sub>IL</sub> | Low-level input voltage               | V <sub>CC</sub> = 2 V   | 0               | 0.5  | 0          | 0.5             | V   |      |
|                 |                                       | V <sub>CC</sub> = 4.5 V | 0               | 1.35 | 0          | 1.35            |     |      |
|                 |                                       | V <sub>CC</sub> = 6 V   | 0               | 1.8  | 0          | 1.8             |     |      |
| V <sub>I</sub>  | Input voltage                         | 0                       | V <sub>CC</sub> |      | 0          | V <sub>CC</sub> |     | V    |
| V <sub>O</sub>  | Output voltage                        | 0                       | V <sub>CC</sub> |      | 0          | V <sub>CC</sub> |     | V    |
| t <sub>t</sub>  | Input transition (rise and fall) time | V <sub>CC</sub> = 2 V   | 0               | 1000 | 0          | 1000            | ns  |      |
|                 |                                       | V <sub>CC</sub> = 4.5 V | 0               | 500  | 0          | 500             |     |      |
|                 |                                       | V <sub>CC</sub> = 6 V   | 0               | 400  | 0          | 400             |     |      |
| T <sub>A</sub>  | Operating free-air temperature        | -55                     |                 | 125  | -40        |                 | 85  | °C   |

NOTE 3: All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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

| PARAMETER       | TEST CONDITIONS   |                           | V <sub>CC</sub> | T <sub>A</sub> = 25°C |       |      | SN54HC4020 |       | SN74HC4020 |       | UNIT |
|-----------------|---|---------------------------|-----------------|-----------------------|-------|------|------------|-------|------------|-------|------|
|                 |   |                           |                 | MIN                   | TYP   | MAX  | MIN        | MAX   | MIN        | MAX   |      |
| V <sub>OH</sub> | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>       | I <sub>OH</sub> = -20 μA  | 2 V             | 1.9                   | 1.998 |      | 1.9        |       | 1.9        | V     |      |
|                 |   |                           | 4.5 V           | 4.4                   | 4.499 |      | 4.4        |       | 4.4        |       |      |
|                 |   |                           | 6 V             | 5.9                   | 5.999 |      | 5.9        |       | 5.9        |       |      |
|                 |   | I <sub>OH</sub> = -4 mA   | 4.5 V           | 3.98                  | 4.3   |      | 3.7        |       | 3.84       |       |      |
|                 |   | I <sub>OH</sub> = -5.2 mA | 6 V             | 5.48                  | 5.8   |      | 5.2        |       | 5.34       |       |      |
| V <sub>OL</sub> | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>       | I <sub>OL</sub> = 20 μA   | 2 V             |                       | 0.002 | 0.1  |            | 0.1   |            | V     |      |
|                 |   |                           | 4.5 V           |                       | 0.001 | 0.1  |            | 0.1   |            |       | 0.1  |
|                 |   |                           | 6 V             |                       | 0.001 | 0.1  |            | 0.1   |            |       | 0.1  |
|                 |   | I <sub>OL</sub> = 4 mA    | 4.5 V           |                       | 0.17  | 0.26 |            | 0.4   |            |       | 0.33 |
|                 |   | I <sub>OL</sub> = 5.2 mA  | 6 V             |                       | 0.15  | 0.26 |            | 0.4   |            |       | 0.33 |
| I <sub>I</sub>  | V <sub>I</sub> = V <sub>CC</sub> or 0                     |                           | 6 V             |                       | ±0.1  | ±100 |            | ±1000 |            | ±1000 | nA   |
| I <sub>CC</sub> | V <sub>I</sub> = V <sub>CC</sub> or 0, I <sub>O</sub> = 0 |                           | 6 V             |                       |       | 8    |            | 160   |            | 80    | μA   |
| C <sub>i</sub>  |   |                           | 2 V to 6 V      |                       | 3     | 10   |            | 10    |            | 10    | pF   |



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timing requirements over recommended operating free-air temperature range (unless otherwise noted)

|                    |                                      | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     | SN54HC4020 |     | SN74HC4020 |     | UNIT |
|--------------------|--------------------------------------|-----------------|-----------------------|-----|------------|-----|------------|-----|------|
|                    |                                      |                 | MIN                   | MAX | MIN        | MAX | MIN        | MAX |      |
| f <sub>clock</sub> | Clock frequency                      | 2 V             | 0                     | 5.5 | 0          | 3.7 | 0          | 4.3 | MHz  |
|                    |                                      | 4.5 V           | 0                     | 28  | 0          | 19  | 0          | 22  |      |
|                    |                                      | 6 V             | 0                     | 33  | 0          | 22  | 0          | 25  |      |
| t <sub>w</sub>     | CLK high or low                      | 2 V             | 90                    |     | 135        |     | 115        |     | ns   |
|                    |                                      | 4.5 V           | 18                    |     | 27         |     | 23         |     |      |
|                    |                                      | 6 V             | 15                    |     | 23         |     | 20         |     |      |
|                    | CLR high                             | 2 V             | 70                    |     | 105        |     | 90         |     |      |
|                    |                                      | 4.5 V           | 14                    |     | 21         |     | 18         |     |      |
|                    |                                      | 6 V             | 12                    |     | 18         |     | 25         |     |      |
| t <sub>su</sub>    | Setup time, CLR inactive before CLK↓ | 2 V             | 60                    |     | 90         |     | 75         |     | ns   |
|                    |                                      | 4.5 V           | 12                    |     | 18         |     | 15         |     |      |
|                    |                                      | 6 V             | 10                    |     | 15         |     | 13         |     |      |

switching characteristics over recommended operating free-air temperature range, C<sub>L</sub> = 50 pF (unless otherwise noted) (see Figure 1)

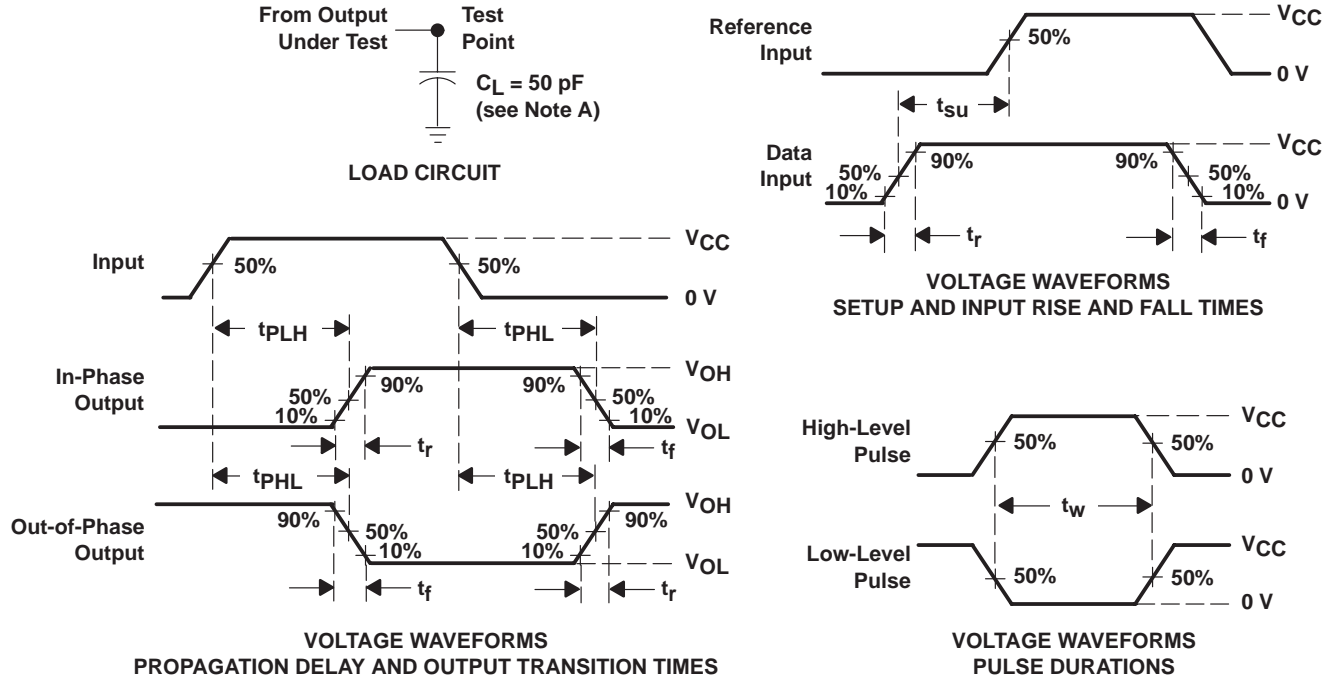
| PARAMETER        | FROM (INPUT) | TO (OUTPUT)    | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     |     | SN54HC4020 |     | SN74HC4020 |     | UNIT |
|------------------|--------------|----------------|-----------------|-----------------------|-----|-----|------------|-----|------------|-----|------|
|                  |              |                |                 | MIN                   | TYP | MAX | MIN        | MAX | MIN        | MAX |      |
| f <sub>max</sub> |              |                | 2 V             | 5.5                   | 10  |     | 3.7        |     | 4.3        |     | MHz  |
|                  |              |                | 4.5 V           | 28                    | 45  |     | 19         |     | 22         |     |      |
|                  |              |                | 6 V             | 33                    | 53  |     | 22         |     | 25         |     |      |
| t <sub>pd</sub>  | CLK          | Q <sub>A</sub> | 2 V             |                       | 62  | 150 |            | 225 |            | 190 | ns   |
|                  |              |                | 4.5 V           |                       | 16  | 30  |            | 45  |            | 38  |      |
|                  |              |                | 6 V             |                       | 12  | 26  |            | 38  |            | 32  |      |
| t <sub>PHL</sub> | CLR          | Any            | 2 V             |                       | 63  | 140 |            | 210 |            | 175 | ns   |
|                  |              |                | 4.5 V           |                       | 17  | 28  |            | 42  |            | 35  |      |
|                  |              |                | 6 V             |                       | 13  | 24  |            | 36  |            | 30  |      |
| t <sub>t</sub>   |              | Any            | 2 V             |                       | 28  | 75  |            | 110 |            | 95  | ns   |
|                  |              |                | 4.5 V           |                       | 8   | 15  |            | 22  |            | 19  |      |
|                  |              |                | 6 V             |                       | 6   | 13  |            | 19  |            | 16  |      |

operating characteristics, T<sub>A</sub> = 25°C

| PARAMETER                                     | TEST CONDITIONS | TYP | UNIT |
|---|-----------------|-----|------|
| C <sub>pd</sub> Power dissipation capacitance | No load         | 88  | pF   |



PARAMETER MEASUREMENT INFORMATION



- NOTES: A.  $C_L$  includes probe and test-fixture capacitance.  
 B. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 6 \text{ ns}$ ,  $t_f = 6 \text{ ns}$ .  
 C. For clock inputs,  $f_{max}$  is measured when the input duty cycle is 50%.  
 D. The outputs are measured one at a time with one input transition per measurement.  
 E.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 1. Load Circuit and Voltage Waveforms

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