

# **CD4020BM/CD4020BC** **14-Stage Ripple Carry Binary Counters** **CD4040BM/CD4040BC** **12-Stage Ripple Carry Binary Counters** **CD4060BM/CD4060BC** **14-Stage Ripple Carry Binary Counters**

## **General Description**

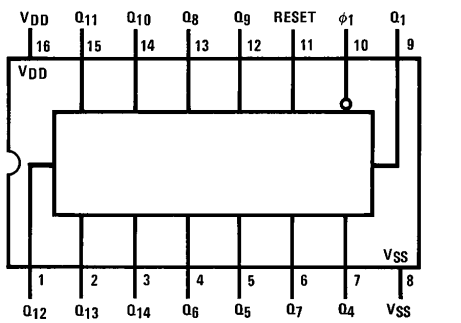
The CD4020BM/CD4020BC, CD4060BM/CD4060BC are 14-stage ripple carry binary counters, and the CD4040BM/CD4040BC is a 12-stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to the zero state by a logical "1" at the reset input independent of clock.

## **Features**

- Wide supply voltage range 1.0V to 15V
- High noise immunity 0.45  $V_{DD}$  (typ.)
- Low power TTL compatibility Fan out of 2 driving 74L or 1 driving 74LS
- Medium speed operation 8 MHz typ. at  $V_{DD} = 10V$
- Schmitt trigger clock input

## **Connection Diagrams**

**Dual-In-Line Package**  
**CD4020BM/CD4020BC**

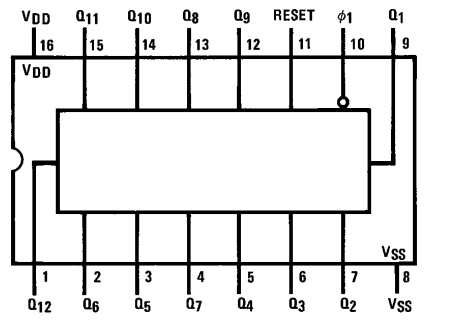


**Top View**

TL/F/5953-1

Order Number CD4020B, CD4040B or CD4060B

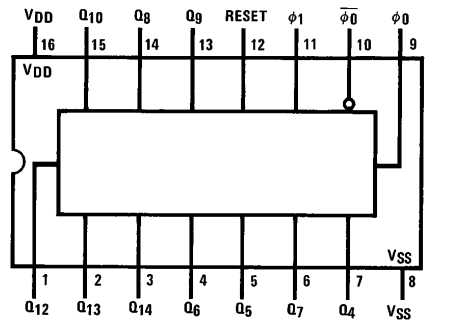
**Dual-In-Line Package**  
**CD4040BM/CD4040BC**



**Top View**

TL/F/5953-2

**Dual-In-Line Package**  
**CD4060BM/CD4060BC**



**Top View**

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**Absolute Maximum Ratings** (Notes 1 and 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                     |                          |
|-------------------------------------|--------------------------|
| Supply Voltage ( $V_{DD}$ )         | −0.5V to +18V            |
| Input Voltage ( $V_{IN}$ )          | −0.5V to $V_{DD}$ + 0.5V |
| Storage Temperature Range ( $T_S$ ) | −65°C to +150°C          |
| Package Dissipation ( $P_D$ )       |                          |
| Dual-In-Line                        | 700 mW                   |
| Small Outline                       | 500 mW                   |
| Lead Temperature ( $T_L$ )          |                          |
| (Soldering, 10 seconds)             | 260°C                    |

**Recommended Operating Conditions**

|                                       |                 |
|---------------------------------------|-----------------|
| Supply Voltage ( $V_{DD}$ )           | +3V to +15V     |
| Input Voltage ( $V_{IN}$ )            | 0V to $V_{DD}$  |
| Operating Temperature Range ( $T_A$ ) |                 |
| CD40XXBM                              | −55°C to +125°C |
| CD40XXBC                              | −40°C to +85°C  |

**DC Electrical Characteristics** CD40XXBM (Note 2)

| Symbol   | Parameter                                 | Conditions                                  | −55°C |       | +25°C |           |       | +125°C |      | Units   |
|----------|-------------------------------------------|---------------------------------------------|-------|-------|-------|-----------|-------|--------|------|---------|
|          |                                           |                                             | Min   | Max   | Min   | Typ       | Max   | Min    | Max  |         |
| $I_{DD}$ | Quiescent Device Current                  | $V_{DD} = 5V, V_{IN} = V_{DD}$ or $V_{SS}$  |       | 5     |       |           | 5     |        | 150  | $\mu A$ |
|          |                                           | $V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$ |       | 10    |       |           | 10    |        | 300  | $\mu A$ |
|          |                                           | $V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$ |       | 20    |       |           | 20    |        | 600  | $\mu A$ |
| $V_{OL}$ | Low Level Output Voltage                  | $V_{DD} = 5V$                               |       | 0.05  |       | 0         | 0.05  |        | 0.05 | V       |
|          |                                           | $V_{DD} = 10V$                              |       | 0.05  |       | 0         | 0.05  |        | 0.05 | V       |
|          |                                           | $V_{DD} = 15V$                              |       | 0.05  |       | 0         | 0.05  |        | 0.05 | V       |
| $V_{OH}$ | High Level Output Voltage                 | $V_{DD} = 5V$                               | 4.95  |       | 4.95  | 5         |       | 4.95   |      | V       |
|          |                                           | $V_{DD} = 10V$                              | 9.95  |       | 9.95  | 10        |       | 9.95   |      | V       |
|          |                                           | $V_{DD} = 15V$                              | 14.95 |       | 14.95 | 15        |       | 14.95  |      | V       |
| $V_{IL}$ | Low Level Input Voltage                   | $V_{DD} = 5V, V_O = 0.5V$ or 4.5V           |       | 1.5   |       | 2         | 1.5   |        | 1.5  | V       |
|          |                                           | $V_{DD} = 10V, V_O = 1.0V$ or 9.0V          |       | 3.0   |       | 4         | 3.0   |        | 3.0  | V       |
|          |                                           | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V         |       | 4.0   |       | 6         | 4.0   |        | 4.0  | V       |
| $V_{IH}$ | High Level Input Voltage                  | $V_{DD} = 5V, V_O = 0.5V$ or 4.5V           | 3.5   |       | 3.5   | 3         |       | 3.5    |      | V       |
|          |                                           | $V_{DD} = 10V, V_O = 1.0V$ or 9.0V          | 7.0   |       | 7.0   | 6         |       | 7.0    |      | V       |
|          |                                           | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V         | 11.0  |       | 11.0  | 9         |       | 11.0   |      | V       |
| $I_{OL}$ | Low Level Output Current<br>(See Note 3)  | $V_{DD} = 5V, V_O = 0.4V$                   | 0.64  |       | 0.51  | 0.88      |       | 0.36   |      | mA      |
|          |                                           | $V_{DD} = 10V, V_O = 0.5V$                  | 1.6   |       | 1.3   | 2.25      |       | 0.9    |      | mA      |
|          |                                           | $V_{DD} = 15V, V_O = 1.5V$                  | 4.2   |       | 3.4   | 8.8       |       | 2.4    |      | mA      |
| $I_{OH}$ | High Level Output Current<br>(See Note 3) | $V_{DD} = 5V, V_O = 4.6V$                   | −0.64 |       | −0.51 | −0.88     |       | −0.36  |      | mA      |
|          |                                           | $V_{DD} = 10V, V_O = 9.5V$                  | −1.6  |       | −1.3  | −2.25     |       | −0.9   |      | mA      |
|          |                                           | $V_{DD} = 15V, V_O = 13.5V$                 | −4.2  |       | −3.4  | −8.8      |       | −2.4   |      | mA      |
| $I_{IN}$ | Input Current                             | $V_{DD} = 15V, V_{IN} = 0V$                 |       | −0.10 |       | $10^{-5}$ | −0.10 |        | −1.0 | $\mu A$ |
|          |                                           | $V_{DD} = 15V, V_{IN} = 15V$                |       | 0.10  |       | $10^{-5}$ | 0.10  |        | 1.0  | $\mu A$ |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and "Electrical Characteristics" provide conditions for actual device operation.

**Note 2:**  $V_{SS} = 0V$  unless otherwise specified.

**Note 3:** Data does not apply to oscillator points  $\phi_0$  and  $\overline{\phi}_0$  of CD4060BM/CD4060BC.  $I_{OH}$  and  $I_{OL}$  are tested one output at a time.

**DC Electrical Characteristics** 40XXBC (Note 2)

| Symbol   | Parameter                | Conditions                                  | −40°C |      | +25°C |     |      | +85°C |      | Units   |
|----------|--------------------------|---------------------------------------------|-------|------|-------|-----|------|-------|------|---------|
|          |                          |                                             | Min   | Max  | Min   | Typ | Max  | Min   | Max  |         |
| $I_{DD}$ | Quiescent Device Current | $V_{DD} = 5V, V_{IN} = V_{DD}$ or $V_{SS}$  |       | 20   |       |     | 20   |       | 150  | $\mu A$ |
|          |                          | $V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$ |       | 40   |       |     | 40   |       | 300  | $\mu A$ |
|          |                          | $V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$ |       | 80   |       |     | 80   |       | 600  | $\mu A$ |
| $V_{OL}$ | Low Level Output Voltage | $V_{DD} = 5V$                               |       | 0.05 |       | 0   | 0.05 |       | 0.05 | V       |
|          |                          | $V_{DD} = 10V$                              |       | 0.05 |       | 0   | 0.05 |       | 0.05 | V       |
|          |                          | $V_{DD} = 15V$                              |       | 0.05 |       | 0   | 0.05 |       | 0.05 | V       |

## DC Electrical Characteristics 40XXBC (Note 2) (Continued)

| Symbol          | Parameter                                 | Conditions                                                                                  | −40°C |               | +25°C |                                       |               | +85°C |             | Units    |
|-----------------|-------------------------------------------|---------------------------------------------------------------------------------------------|-------|---------------|-------|---------------------------------------|---------------|-------|-------------|----------|
|                 |                                           |                                                                                             | Min   | Max           | Min   | Typ                                   | Max           | Min   | Max         |          |
| V <sub>OH</sub> | High Level Output Voltage                 | V <sub>DD</sub> = 5V                                                                        | 4.95  |               | 4.95  | 5                                     |               | 4.95  |             | V        |
|                 |                                           | V <sub>DD</sub> = 10V                                                                       | 9.95  |               | 9.95  | 10                                    |               | 9.95  |             | V        |
|                 |                                           | V <sub>DD</sub> = 15V                                                                       | 14.95 |               | 14.95 | 15                                    |               | 14.95 |             | V        |
| V <sub>IL</sub> | Low Level Input Voltage                   | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V                                         |       | 1.5           |       | 2                                     | 1.5           |       | 1.5         | V        |
|                 |                                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 1.0V or 9.0V                                        |       | 3.0           |       | 4                                     | 3.0           |       | 3.0         | V        |
|                 |                                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V                                       |       | 4.0           |       | 6                                     | 4.0           |       | 4.0         | V        |
| V <sub>IH</sub> | High Level Input Voltage                  | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V                                         | 3.5   |               | 3.5   | 3                                     |               | 3.5   |             | V        |
|                 |                                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 1.0V or 9.0V                                        | 7.0   |               | 7.0   | 6                                     |               | 7.0   |             | V        |
|                 |                                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V                                       | 11.0  |               | 11.0  | 9                                     |               | 11.0  |             | V        |
| I <sub>OL</sub> | Low Level Output Current<br>(See Note 3)  | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V                                                 | 0.52  |               | 0.44  | 0.88                                  |               | 0.36  |             | mA       |
|                 |                                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V                                                | 1.3   |               | 1.1   | 2.25                                  |               | 0.9   |             | mA       |
|                 |                                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V                                                | 3.6   |               | 3.0   | 8.8                                   |               | 2.4   |             | mA       |
| I <sub>OH</sub> | High Level Output Current<br>(See Note 3) | V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V                                                 | −0.52 |               | −0.44 | −0.88                                 |               | −0.36 |             | mA       |
|                 |                                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V                                                | −1.3  |               | −1.1  | −2.25                                 |               | −0.9  |             | mA       |
|                 |                                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V                                               | −3.6  |               | −3.0  | −8.8                                  |               | −2.4  |             | mA       |
| I <sub>IN</sub> | Input Current                             | V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V<br>V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V |       | −0.30<br>0.30 |       | −10 <sup>−5</sup><br>10 <sup>−5</sup> | −0.30<br>0.30 |       | −1.0<br>1.0 | μA<br>μA |

## AC Electrical Characteristics\* CD4020BM/CD4020BC, CD4040BM/CD4040BC

T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, t<sub>r</sub> = t<sub>f</sub> = 20 ns, unless otherwise noted

| Symbol                                | Parameter                                                                    | Conditions            | Min | Typ | Max      | Units |
|---------------------------------------|------------------------------------------------------------------------------|-----------------------|-----|-----|----------|-------|
| t <sub>PHL1</sub> , t <sub>PLH1</sub> | Propagation Delay Time to Q <sub>1</sub>                                     | V <sub>DD</sub> = 5V  |     | 250 | 550      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 100 | 210      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 75  | 150      | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub>   | Interstage Propagation Delay Time<br>from Q <sub>n</sub> to Q <sub>n+1</sub> | V <sub>DD</sub> = 5V  |     | 150 | 330      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 60  | 125      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 45  | 90       | ns    |
| t <sub>THL</sub> , t <sub>TLH</sub>   | Transition Time                                                              | V <sub>DD</sub> = 5V  |     | 100 | 200      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 50  | 100      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 40  | 80       | ns    |
| t <sub>WL</sub> , t <sub>WH</sub>     | Minimum Clock Pulse Width                                                    | V <sub>DD</sub> = 5V  |     | 125 | 335      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 50  | 125      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 40  | 100      | ns    |
| t <sub>rCL</sub> , t <sub>fCL</sub>   | Maximum Clock Rise and Fall Time                                             | V <sub>DD</sub> = 5V  |     |     | No Limit | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     |     | No Limit | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     |     | No Limit | ns    |
| f <sub>CL</sub>                       | Maximum Clock Frequency                                                      | V <sub>DD</sub> = 5V  | 1.5 | 4   |          | MHz   |
|                                       |                                                                              | V <sub>DD</sub> = 10V | 4   | 10  |          | MHz   |
|                                       |                                                                              | V <sub>DD</sub> = 15V | 5   | 12  |          | MHz   |
| t <sub>PHL(R)</sub>                   | Reset Propagation Delay                                                      | V <sub>DD</sub> = 5V  |     | 200 | 450      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 100 | 210      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 80  | 170      | ns    |
| t <sub>WH(R)</sub>                    | Minimum Reset Pulse Width                                                    | V <sub>DD</sub> = 5V  |     | 200 | 450      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 10V |     | 100 | 210      | ns    |
|                                       |                                                                              | V <sub>DD</sub> = 15V |     | 80  | 170      | ns    |
| C <sub>in</sub>                       | Average Input Capacitance                                                    | Any Input             |     | 5   | 7.5      | pF    |
| C <sub>pd</sub>                       | Power Dissipation Capacitance                                                |                       |     | 50  |          | pF    |

\*AC Parameters are guaranteed by DC correlated testing.

$T_A = 25^\circ\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ , unless otherwise noted

\*AC Parameters are guaranteed by DC correlated testing.

### RC Oscillator

RESET 12

TO COUNTER STAGES

11 R2

10 R1

C

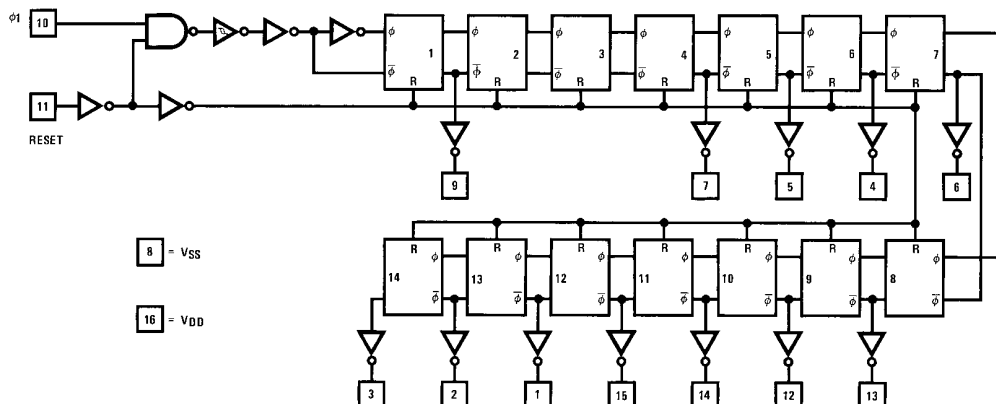
TL/F/5953-4

### Crystal Oscillator

The diagram shows a crystal oscillator circuit. A crystal labeled "32.768 kHz" is connected to a feedback network. The feedback network consists of a 15 MΩ resistor and a 39 pF capacitor. The output of the oscillator is connected to a counter stage. The circuit is powered by a 10 pF capacitor.

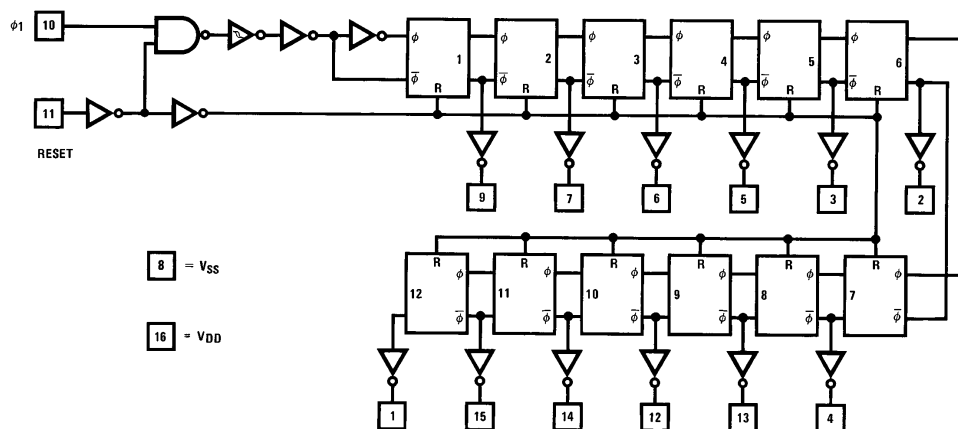
## Schematic Diagrams

CD4020BM/CD4020BC Schematic Diagram



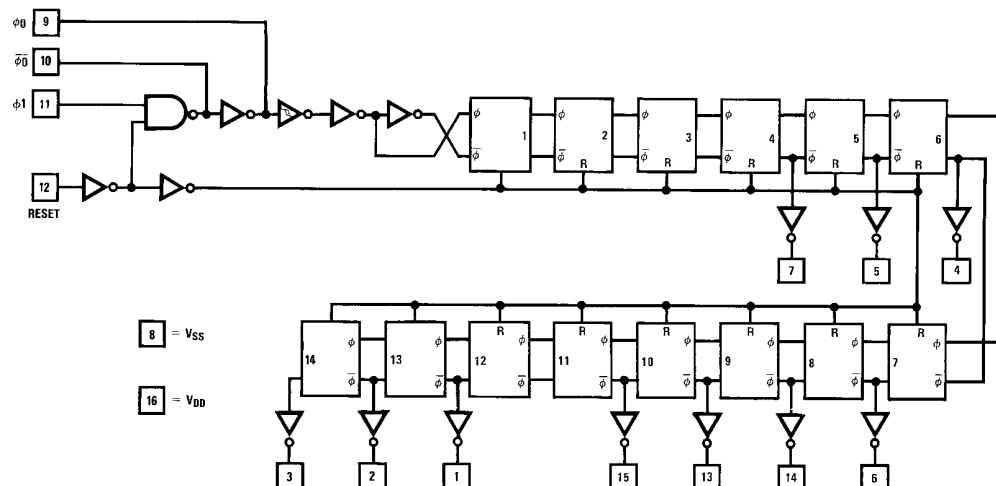
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CD4040BM/CD4040BC Schematic Diagram



TL/F/5953-7

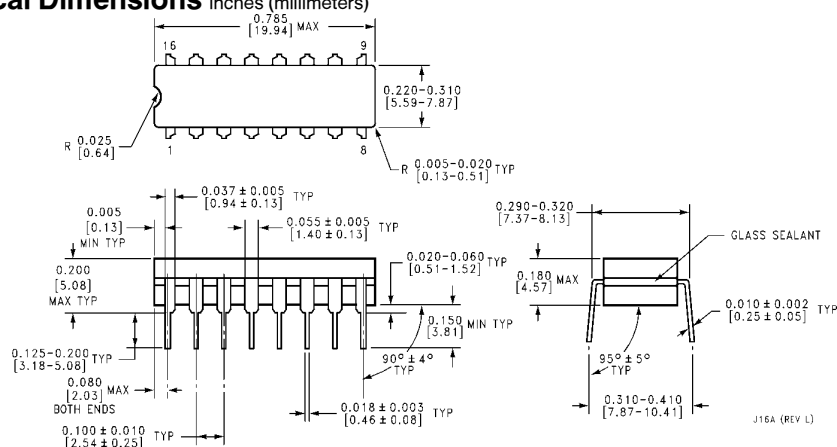
CD4060BM/CD4060BC Schematic Diagram



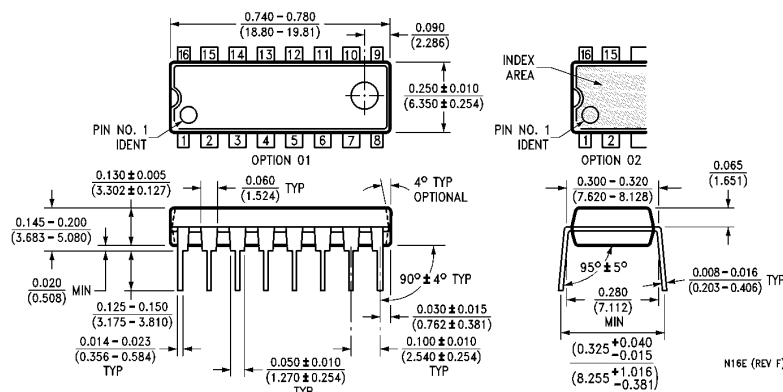
TL/F/5953-8

# CD4020BM/BC 14-Stage Ripple Carry Binary Counters/CD4040BM/BC 12-Stage Ripple Carry Binary Counters CD4060BM/BC 14-Stage Ripple Carry Binary Counters

## Physical Dimensions inches (millimeters)



**Ceramic Dual-In-Line Package (J)**  
**Order Number CD4020BMJ, CD4020BCJ,**  
**CD4040BMJ, CD4040BCJ, CD4060BMJ or CD4060BCJ**  
**NS Package Number J16A**



**Molded Dual-In-Line Package (N)**  
**Order Number CD4020BMN, CD4020BCN,**  
**CD4040BMN, CD4040BCN, CD4060BMN or CD4060BCN**  
**NS Package Number N16E**

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