

# **CD40160BM/CD40160BC** **Decade Counter with Asynchronous Clear** **CD40161BM/CD40161BC** **Binary Counter with Asynchronous Clear** **CD40162BM/CD40162BC** **Decade Counter with Synchronous Clear** **CD40163BM/CD40163BC** **Binary Counter with Synchronous Clear**

## **General Description**

These (synchronous presettable up) counters are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement mode transistors. They feature an internal carry look-ahead for fast counting schemes and for cascading packages without additional gating.

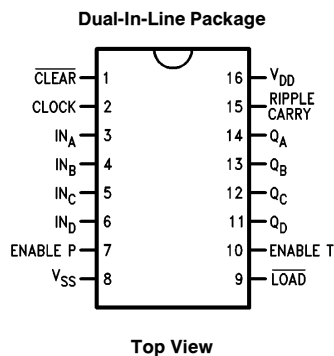
A low level at the load input disables counting and causes the outputs to agree with the data input after the next positive clock edge. The clear function for the CD40162B and CD40163B is synchronous and a low level at the clear input sets all four outputs low after the next positive clock edge. The clear function for the CD40160B and CD40161B is asynchronous and a low level at the clear input sets all four outputs low, regardless of the state of the clock.

Counting is enabled when both count enable inputs are high. Input T is fed forward to also enable the carry out. The carry output is a positive pulse with a duration approximately equal to the positive portion of  $Q_A$  and can be used to enable successive cascaded stages. Logic transitions at the enable P or T inputs can occur when the clock is high or low.

## **Features**

- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45  $V_{DD}$  (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS
- Internal look-ahead for fast counting schemes
- Carry output for N-bit cascading
- Load control line
- Synchronously programmable
- Equivalent to MC14160B, MC14161B, MC14162B, MC14163B
- Equivalent to MM74C160, MM74C161, MM74C162, MM74C163

## **Connection Diagram**



Order Number CD40160B, CD40161B,  
CD40162B or CD40163B

TL/F/5986-1

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

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

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

**Recommended Operating Conditions** (Note 2)

|                                       |                         |
|---------------------------------------|-------------------------|
| DC Supply Voltage ( $V_{DD}$ )        | 3V to 15 $V_{DC}$       |
| Input Voltage ( $V_{IN}$ )            | 0V to $V_{DD}$ $V_{DC}$ |
| Operating Temperature Range ( $T_A$ ) |                         |
| CD40XXXBM                             | −55°C to +125°C         |
| CD40XXXBC                             | −40°C to +85°C          |

**DC Electrical Characteristics** CD40160BM/CD40161BM/CD40162BM/CD40163BM (Note 2)

| Symbol          | Parameter                          | Conditions                                                                                                                                                       | Limits                |                      |                       |                                       |                      |                       |                      | Units          |
|-----------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------|-----------------------|---------------------------------------|----------------------|-----------------------|----------------------|----------------|
|                 |                                    |                                                                                                                                                                  | − 55°C                |                      | + 25°C                |                                       |                      | + 125°C               |                      |                |
|                 |                                    |                                                                                                                                                                  | Min                   | Max                  | Min                   | Typ                                   | Max                  | Min                   | Max                  |                |
| I <sub>DD</sub> | Quiescent Device Current           | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                                           |                       | 5<br>10<br>20        |                       |                                       | 5<br>10<br>20        |                       | 150<br>300<br>600    | μA<br>μA<br>μA |
| V <sub>OL</sub> | Low Level Output Voltage           | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                |                       | 0.05<br>0.05<br>0.05 |                       |                                       | 0.05<br>0.05<br>0.05 |                       | 0.05<br>0.05<br>0.05 | V<br>V<br>V    |
| V <sub>OH</sub> | High Level Output Voltage          | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                | 4.95<br>9.95<br>14.95 |                      | 4.95<br>9.95<br>14.95 | 5<br>10<br>15                         |                      | 4.95<br>9.95<br>14.95 |                      | V<br>V<br>V    |
| V <sub>IL</sub> | Low Level Input Voltage            | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V |                       | 1.5<br>3.0<br>4.0    |                       |                                       | 1.5<br>3.0<br>4.0    |                       | 1.5<br>3.0<br>4.0    | V<br>V<br>V    |
| V <sub>IH</sub> | High Level Input Voltage           | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V | 3.5<br>7.0<br>11.0    |                      | 3.5<br>7.0<br>11.0    |                                       |                      | 3.5<br>7.0<br>11.0    |                      | V<br>V<br>V    |
| I <sub>OL</sub> | Low Level Output Current (Note 3)  | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V                      | 0.64<br>1.6<br>4.2    |                      | 0.51<br>1.3<br>3.4    | 0.88<br>2.25<br>8.8                   |                      | 0.36<br>0.9<br>2.4    |                      | mA<br>mA<br>mA |
| I <sub>OH</sub> | High Level Output Current (Note 3) | V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V                     | −0.64<br>−1.6<br>−4.2 |                      | −0.51<br>−1.3<br>−3.4 | −0.88<br>−2.25<br>−8.8                |                      | −0.36<br>−0.9<br>−2.4 |                      | mA<br>mA<br>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                                                                      |                       | −0.10<br>0.10        |                       | −10 <sup>−5</sup><br>10 <sup>−5</sup> | −0.10<br>0.10        |                       | −1.0<br>1.0          | μA<br>μA       |

**DC Electrical Characteristics** CD40160BC/CD40161BC/CD40162BC/CD40163BC (Note 2)

| Symbol          | Parameter                 | Conditions                                                                                                                                                       | Limits                |                      |                       |               |                      |                       |                      | Units          |
|-----------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------|-----------------------|---------------|----------------------|-----------------------|----------------------|----------------|
|                 |                           |                                                                                                                                                                  | −40°C                 |                      | +25°C                 |               |                      | +85°C                 |                      |                |
|                 |                           |                                                                                                                                                                  | Min                   | Max                  | Min                   | Typ           | Max                  | Min                   | Max                  |                |
| I <sub>DD</sub> | Quiescent Device Current  | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                                           |                       | 20<br>40<br>80       |                       |               | 20<br>40<br>80       |                       | 150<br>300<br>600    | μA<br>μA<br>μA |
| V <sub>OL</sub> | Low Level Output Voltage  | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                |                       | 0.05<br>0.05<br>0.05 |                       |               | 0.05<br>0.05<br>0.05 |                       | 0.05<br>0.05<br>0.05 | V<br>V<br>V    |
| V <sub>OH</sub> | High Level Output Voltage | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                                                                | 4.95<br>9.95<br>14.95 |                      | 4.95<br>9.95<br>14.95 | 5<br>10<br>15 |                      | 4.95<br>9.95<br>14.95 |                      | V<br>V<br>V    |
| V <sub>IL</sub> | Low Level Input Voltage   | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V |                       | 1.5<br>3.0<br>4.0    |                       |               | 1.5<br>3.0<br>4.0    |                       | 1.5<br>3.0<br>4.0    | V<br>V<br>V    |

## DC Electrical Characteristics CD40160BC/CD40161BC/CD40162BC/CD40163BC (Note 2) (Continued)

| Symbol          | Parameter                          | Conditions                                                                                                                                                       | Limits                |               |                       |                                       |               |                       |             | Units          |
|-----------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|-----------------------|---------------------------------------|---------------|-----------------------|-------------|----------------|
|                 |                                    |                                                                                                                                                                  | −40°C                 |               | +25°C                 |                                       |               | +85°C                 |             |                |
|                 |                                    |                                                                                                                                                                  | Min                   | Max           | Min                   | Typ                                   | Max           | Min                   | Max         |                |
| V <sub>IH</sub> | High Level Input Voltage           | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V | 3.5<br>7.0<br>11.0    |               | 3.5<br>7.0<br>11.0    |                                       |               | 3.5<br>7.0<br>11.0    |             | V<br>V<br>V    |
| I <sub>OL</sub> | Low Level Output Current (Note 3)  | V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V                      | 0.52<br>1.3<br>3.6    |               | 0.44<br>1.1<br>3.0    | 0.88<br>2.25<br>8.8                   |               | 0.36<br>0.9<br>2.4    |             | mA<br>mA<br>mA |
| I <sub>OH</sub> | High Level Output Current (Note 3) | V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V<br>V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V<br>V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V                     | −0.52<br>−1.3<br>−3.6 |               | −0.44<br>−1.1<br>−3.0 | −0.88<br>−2.25<br>−8.8                |               | −0.36<br>−0.9<br>−2.4 |             | mA<br>mA<br>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\* T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, unless otherwise specified.

| Symbol                               | Parameter                                                                        | Conditions                                                                            | Min           | Typ               | Max               | Units             |
|--------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------|-------------------|-------------------|-------------------|
| t <sub>PHL</sub> or t <sub>PLH</sub> | Propagation Delay Time from Clock to Q                                           | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 250<br>100<br>80  | 400<br>160<br>130 | ns<br>ns<br>ns    |
| t <sub>PHL</sub> or t <sub>PLH</sub> | Propagation Delay Time from Clock to Carry Out                                   | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 290<br>120<br>100 | 450<br>190<br>160 | ns<br>ns<br>ns    |
| t <sub>PHL</sub> or t <sub>PLH</sub> | Propagation Delay Time from T Enable to Carry Out                                | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 180<br>70<br>60   | 290<br>130<br>110 | ns<br>ns<br>ns    |
| t <sub>PHL</sub>                     | Propagation Time from Clear to Q (CD40160B, CD40161B Only)                       | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 190<br>80<br>70   | 300<br>150<br>120 | ns<br>ns<br>ns    |
| t <sub>SU</sub>                      | Minimum Time Prior to Clock that Data or Load must be Present                    | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 120<br>30<br>25   |                   | ns<br>ns<br>ns    |
| t <sub>SU</sub>                      | Minimum Time Prior to Clock that Enable P or T must be Present                   | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 170<br>70<br>60   | 280<br>120<br>100 | ns<br>ns<br>ns    |
| t <sub>SU</sub>                      | Minimum Time Prior to Clock that Clear must be Present (CD40162B, CD40163B Only) | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 120<br>50<br>40   | 190<br>80<br>70   | ns<br>ns<br>ns    |
| t <sub>WL</sub> or t <sub>WH</sub>   | Maximum Clock Pulse Width                                                        | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               | 125<br>45<br>35   | 250<br>90<br>70   | ns<br>ns<br>ns    |
| t <sub>RCL</sub> or t <sub>FCL</sub> | Maximum Clock Rise or Fall Time                                                  | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                |               |                   | 15<br>5.0<br>5.0  | μs<br>μs<br>μs    |
| f <sub>CL</sub>                      | Maximum Clock Frequency                                                          | V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V                | 2<br>5.5<br>7 | 4<br>11<br>14     |                   | MHz<br>MHz<br>MHz |
| t <sub>THL</sub> or t <sub>TLH</sub> | Transition Time                                                                  | All Outputs<br>V <sub>DD</sub> = 5V<br>V <sub>DD</sub> = 10V<br>V <sub>DD</sub> = 15V |               | 100<br>50<br>40   | 200<br>100<br>80  | ns<br>ns<br>ns    |
| C <sub>IN</sub>                      | Average Input Capacitance                                                        | Any Input                                                                             |               | 5.0               | 7.5               | pF                |
| C <sub>PD</sub>                      | Power Dissipation Capacity                                                       | (Note 4)                                                                              |               | 95                |                   | pF                |

\*AC Parameters are guaranteed by DC correlated testing.

**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 table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

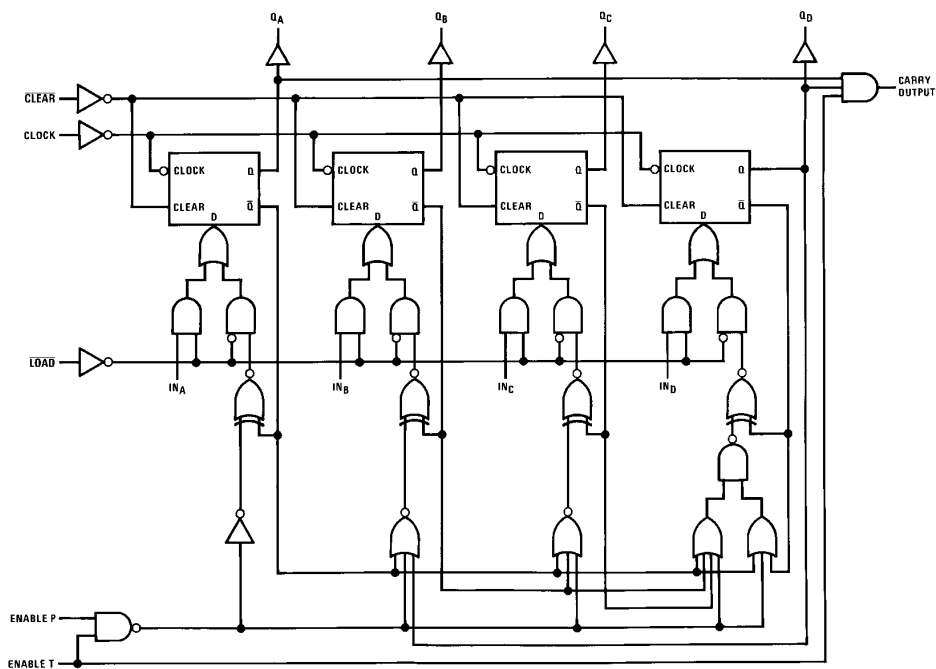
**Note 2:** V<sub>SS</sub> = 0V unless otherwise specified.

**Note 3:** I<sub>OH</sub> and I<sub>OL</sub> are tested one output at a time.

**Note 4:** C<sub>PD</sub> determines the no load AC power consumption of any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-90.

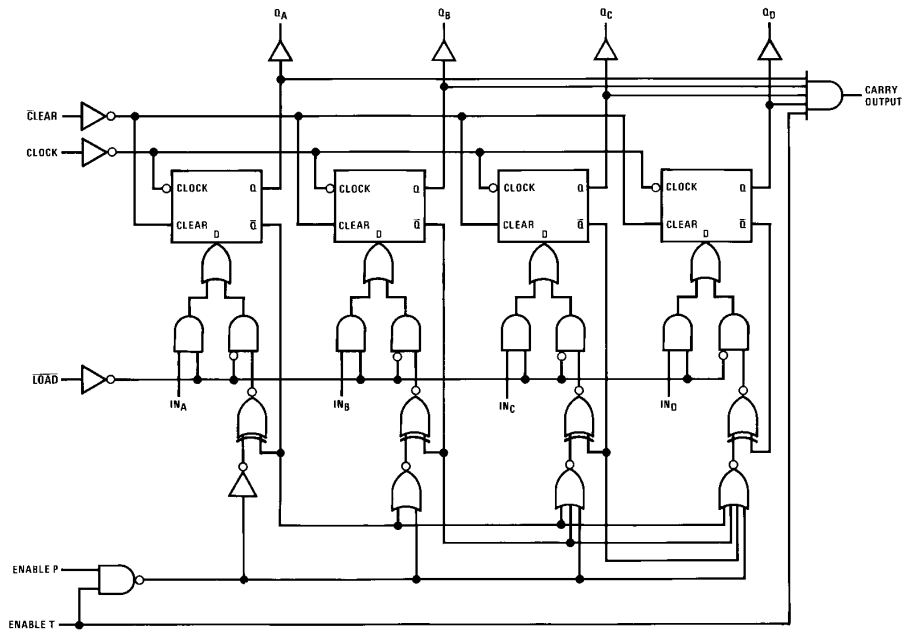
# Logic Diagram

CD40160B, CD40162B Clear is Synchronous for the CD40162B



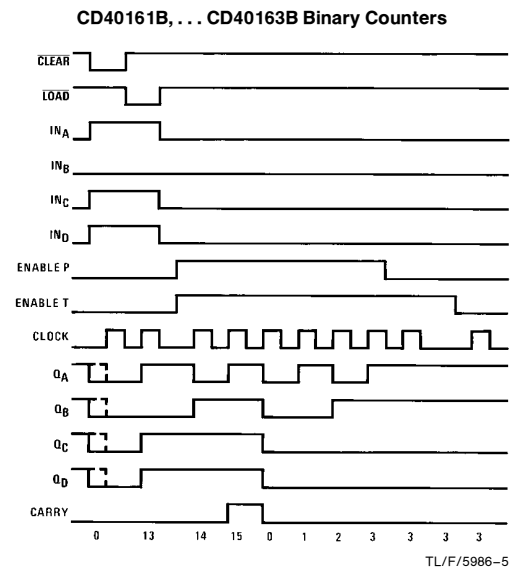
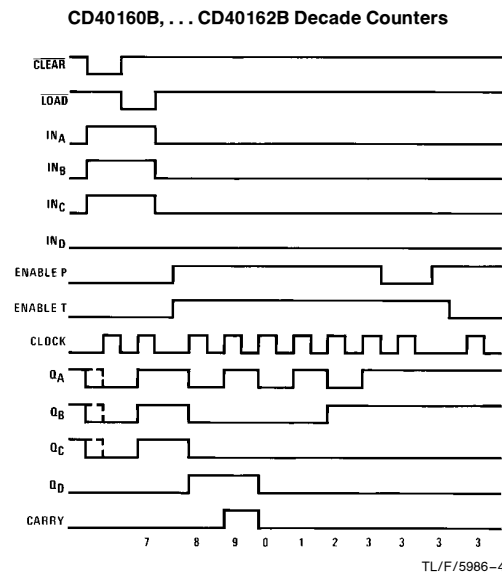
TL/F/5986-2

CD40161B, CD40163B Clear is Synchronous for the CD40163B

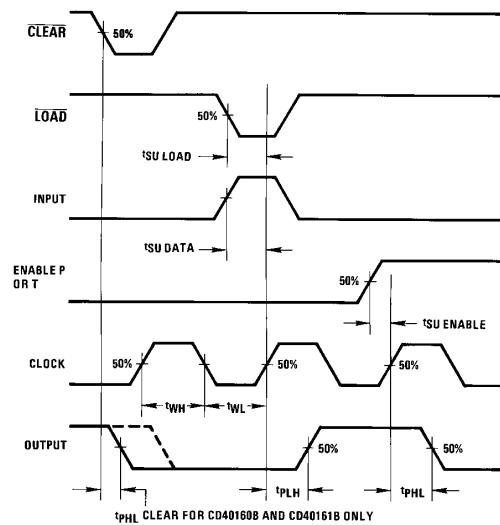


TL/F/5986-3

## Logic Waveforms



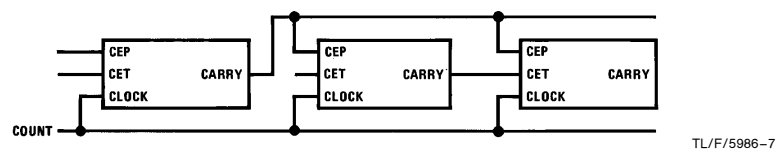
## Switching Time Waveforms



**Note 1:** All input pulses are from generators having the following characteristics:  $t_r = t_f = 20$  ns,  $PRR \leq 1$  MHz, duty cycle  $\leq 50\%$ ,  $Z_{OUT} \approx 50\Omega$ .

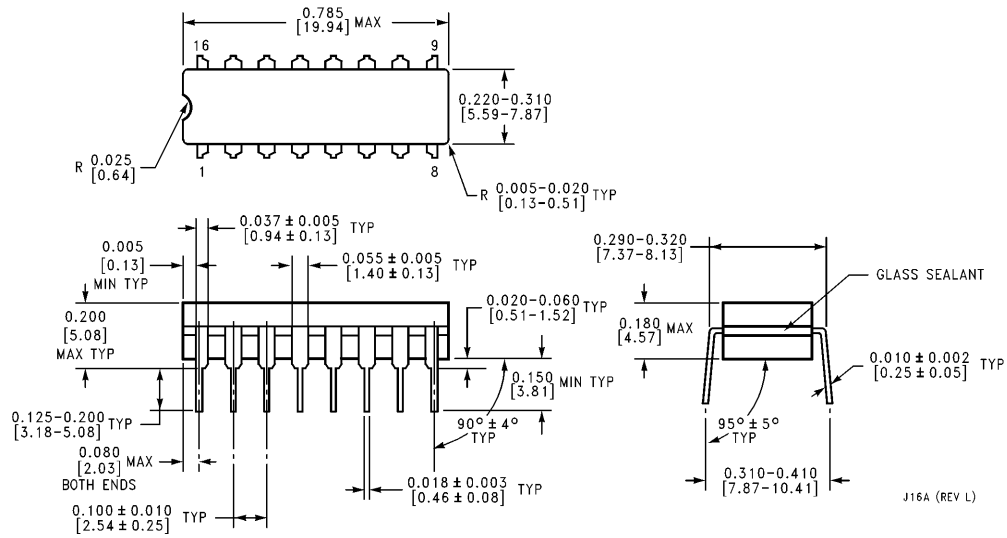
**Note 2:** All times are measured from 50% to 50%.

## Cascading Packages



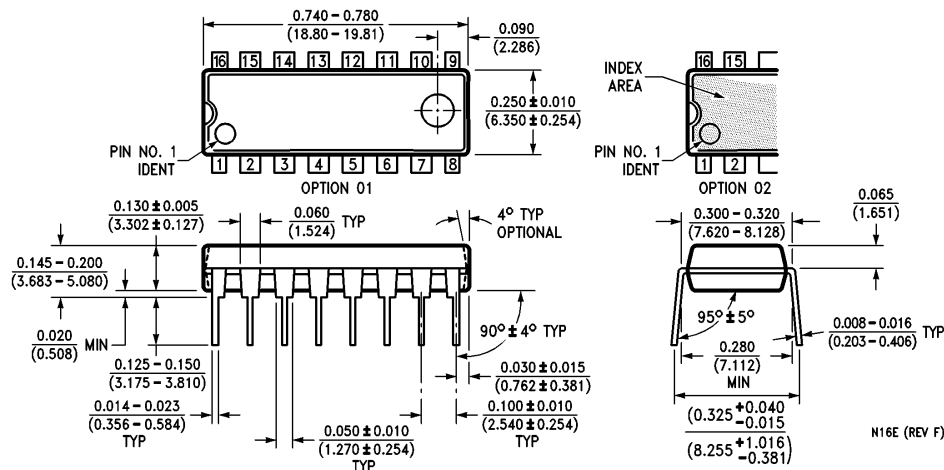


## Physical Dimensions inches (millimeters)



**Ceramic Dual-In-Line Package (J)**  
**Order Number CD40160BMJ, CD40160BCJ, CD40161BMJ,**  
**CD40161BCJ, CD40162BMJ, CD40162BCJ, CD40163BMJ or CD40163BCJ**  
**NS Package Number J16A**

## Physical Dimensions inches (millimeters) (Continued)



### Molded Dual-In-Line Package (N)

Order Number CD40160BMN, CD40160BCN, CD40161BMN,  
CD40161BCN, CD40162BMN, CD40162BCN, CD41063BMN or CD40163BCN  
NS Package Number N16E

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
1111 West Bardin Road  
Arlington, TX 76017  
Tel: (800) 272-9959  
Fax: 1(800) 737-7018

**National Semiconductor Europe**  
Fax: (+49) 0-180-530 85 86  
Email: onjwge@tevm2.nsc.com  
Deutsch Tel: (+49) 0-180-530 85 85  
English Tel: (+49) 0-180-532 78 32  
Français Tel: (+49) 0-180-532 93 58  
Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
13th Floor, Straight Block,  
Ocean Centre, 5 Canton Rd.  
Tsimshatsui, Kowloon  
Hong Kong  
Tel: (852) 2737-1600  
Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
Tel: 81-043-299-2309  
Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.