



# **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.

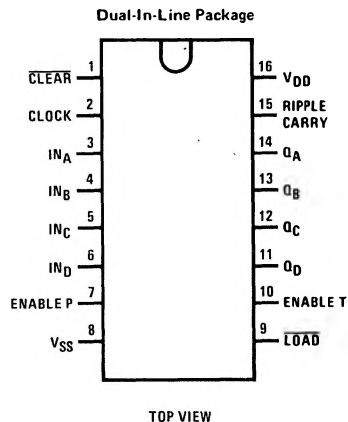
Counting is enabled when both count enable inputs are high. Input T is fed forward to also enable the carry out. The carry output is a positive pulse with a duration approximately equal to the positive portion of  $Q_A$  and can

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



## Absolute Maximum Ratings

(Notes 1 and 2)

|                                                |                           |
|------------------------------------------------|---------------------------|
| $V_{DD}$ dc Supply Voltage                     | -0.5 to +18 VDC           |
| $V_{IN}$ Input Voltage                         | -0.5 to $V_{DD}$ +0.5 VDC |
| $T_S$ Storage Temperature Range                | -65°C to +150°C           |
| $P_D$ Package Dissipation                      | 500 mW                    |
| $T_L$ Lead Temperature (Soldering, 10 seconds) | 300°C                     |

## Recommended Operating Conditions

(Note 2)

|                                   |                   |
|-----------------------------------|-------------------|
| $V_{DD}$ dc Supply Voltage        | 3 to 15 VDC       |
| $V_{IN}$ Input Voltage            | 0 to $V_{DD}$ VDC |
| $T_A$ Operating Temperature Range | -55°C to +125°C   |
| CD40XXXB                          | -40°C to +85°C    |
| CD40XXB                           |                   |

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

| PARAMETER                          | CONDITIONS                          | -55°C |       | 25°C  |            |       | 125°C |      | UNITS   |
|------------------------------------|-------------------------------------|-------|-------|-------|------------|-------|-------|------|---------|
|                                    |                                     | MIN   | MAX   | MIN   | TYP        | MAX   | MIN   | MAX  |         |
| $I_{DD}$ Quiescent Device Current  | $V_{DD} = 5V$                       |       | 5     |       |            | 5     |       | 150  | $\mu A$ |
|                                    | $V_{DD} = 10V$                      |       | 10    |       |            | 10    |       | 300  | $\mu A$ |
|                                    | $V_{DD} = 15V$                      |       | 20    |       |            | 20    |       | 600  | $\mu A$ |
| $V_{OL}$ Low Level Output Voltage  | $ I_O  < 1\mu A$                    |       |       |       |            |       |       |      |         |
|                                    | $V_{DD} = 5V$                       |       | 0.05  |       |            | 0.05  |       | 0.05 | V       |
|                                    | $V_{DD} = 10V$                      |       | 0.05  |       |            | 0.05  |       | 0.05 | V       |
|                                    | $V_{DD} = 15V$                      |       | 0.05  |       |            | 0.05  |       | 0.05 | V       |
| $V_{OH}$ High Level Output Voltage | $ I_O  < 1\mu A$                    |       |       |       |            |       |       |      |         |
|                                    | $V_{DD} = 5V$                       | 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   |       |            | 1.5   |       | 1.5  | V       |
|                                    | $V_{DD} = 10V, V_O = 1V$ or 9V      |       | 3.0   |       |            | 3.0   |       | 3.0  | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V |       | 4.0   |       |            | 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   |            |       | 3.5   |      | V       |
|                                    | $V_{DD} = 10V, V_O = 1V$ or 9V      | 7.0   |       | 7.0   |            |       | 7.0   |      | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V | 11.0  |       | 11.0  |            |       | 11.0  |      | V       |
| $I_{OL}$ Low Level Output Current  | $V_{DD} = 5V, V_O = 0.4V$           | 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 | $V_{DD} = 5V, V_O = 4.6V$           | -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  | $\mu A$ |

## DC Electrical Characteristics CD40160BM/CD40162BM/CD40163BM (Note 2)

| PARAMETER                          | CONDITIONS                          | -40°C |      | 25°C  |     |      | 85°C  |      | UNITS   |
|------------------------------------|-------------------------------------|-------|------|-------|-----|------|-------|------|---------|
|                                    |                                     | MIN   | MAX  | MIN   | TYP | MAX  | MIN   | MAX  |         |
| $I_{DD}$ Quiescent Device Current  | $V_{DD} = 5V$                       |       | 20   |       |     | 20   |       | 150  | $\mu A$ |
|                                    | $V_{DD} = 10V$                      |       | 40   |       |     | 40   |       | 300  | $\mu A$ |
|                                    | $V_{DD} = 15V$                      |       | 80   |       |     | 80   |       | 600  | $\mu A$ |
| $V_{OL}$ Low Level Output Voltage  | $ I_O  < 1\mu A$                    |       |      |       |     |      |       |      |         |
|                                    | $V_{DD} = 5V$                       |       | 0.05 |       |     | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 10V$                      |       | 0.05 |       |     | 0.05 |       | 0.05 | V       |
|                                    | $V_{DD} = 15V$                      |       | 0.05 |       |     | 0.05 |       | 0.05 | V       |
| $V_{OH}$ High Level Output Voltage | $ I_O  < 1\mu A$                    |       |      |       |     |      |       |      |         |
|                                    | $V_{DD} = 5V$                       | 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  |       |     | 1.5  |       | 1.5  | V       |
|                                    | $V_{DD} = 10V, V_O = 1V$ or 9V      |       | 3.0  |       |     | 3.0  |       | 3.0  | V       |
|                                    | $V_{DD} = 15V, V_O = 1.5V$ or 13.5V |       | 4.0  |       |     | 4.0  |       | 4.0  | V       |

CD40160BM/CD40160BC, CD40161BM/CD40161BC,  
CD40162BM/CD40162BC, CD40163BM/CD40163BC

**DC Electrical Characteristics** (Cont'd.) CD40160BC/CD40161BC/CD40162BC/CD40163BC (Note 2)

| PARAMETER                                 | CONDITIONS                                            | -40°C |       | 25°C  |                   |       | 85°C  |      | UNITS |
|-------------------------------------------|-------------------------------------------------------|-------|-------|-------|-------------------|-------|-------|------|-------|
|                                           |                                                       | 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   | 3.5   |       | 3.5   |                   |       | 3.5   |      | V     |
|                                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V      | 7.0   |       | 7.0   |                   |       | 7.0   |      | V     |
|                                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V | 11.0  |       | 11.0  |                   |       | 11.0  |      | V     |
| I <sub>OL</sub> Low Level Output Current  | 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 | 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           |       | -0.30 |       | -10 <sup>-5</sup> | -0.30 |       | -1.0 | μA    |
|                                           | V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V          |       | 0.30  |       | 10 <sup>-5</sup>  | 0.30  |       | 1.0  | μA    |

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.

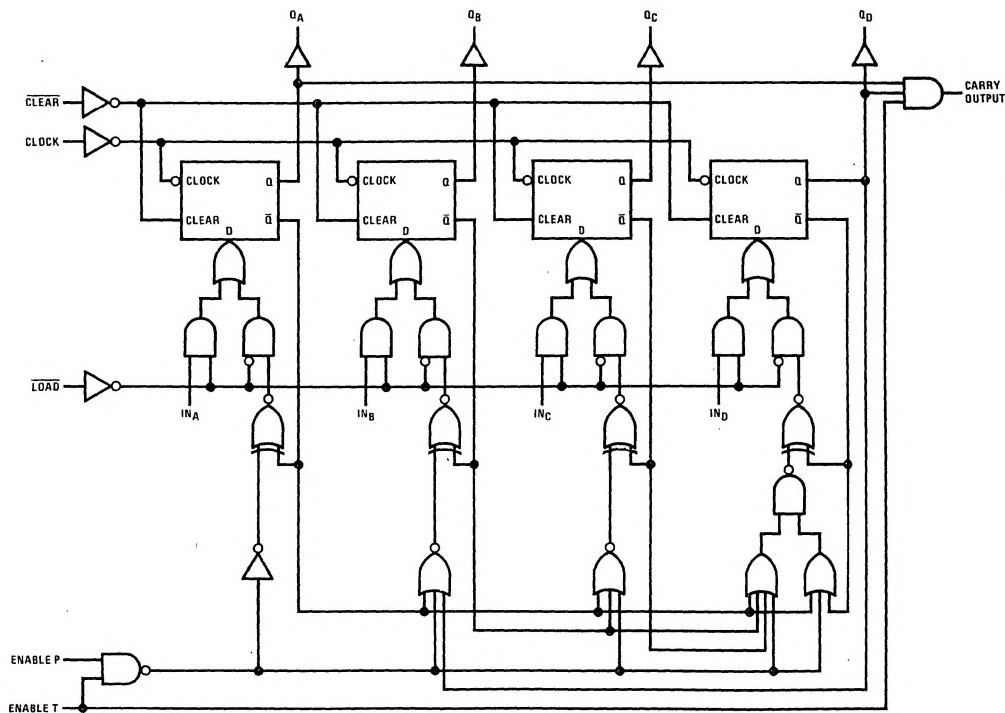
Note 3: C<sub>PD</sub> determines the no load ac power consumption of any CMOS device. For complete explanation see 54C/74C Family Characteristics application note, AN-80.

**AC Electrical Characteristics** T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, unless otherwise specified.

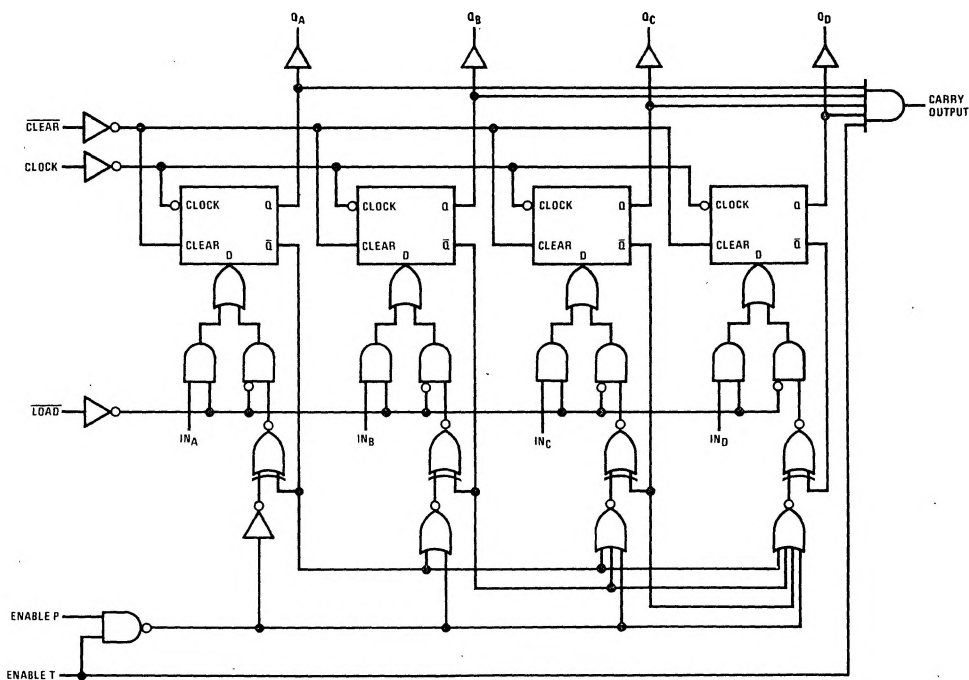
| PARAMETER                                                                                        | CONDITIONS            | MIN | TYP | MAX | UNITS |
|--------------------------------------------------------------------------------------------------|-----------------------|-----|-----|-----|-------|
| t <sub>PHL</sub> or t <sub>PLH</sub> Propagation Delay Time From Clock to Q                      | V <sub>DD</sub> = 5V  |     | 250 | 400 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 100 | 160 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 80  | 130 | ns    |
| t <sub>PHL</sub> or t <sub>PLH</sub> Propagation Delay Time From Clock to Carry Out              | V <sub>DD</sub> = 5V  |     | 290 | 450 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 120 | 190 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 100 | 160 | ns    |
| t <sub>PHL</sub> or t <sub>PLH</sub> Propagation Delay Time From T Enable to Carry Out           | V <sub>DD</sub> = 5V  |     | 180 | 290 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 70  | 130 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 60  | 110 | ns    |
| t <sub>PHL</sub> Propagation Time From Clear to Q (CD40160B, CD40161B Only)                      | V <sub>DD</sub> = 5V  |     | 190 | 300 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 80  | 150 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 70  | 120 | ns    |
| t <sub>SU</sub> Minimum Time Prior to Clock that Data or Load must be Present                    | V <sub>DD</sub> = 5V  |     | 120 |     | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 30  |     | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 25  |     | ns    |
| t <sub>SU</sub> Minimum Time Prior to Clock that Enable P or T must be Present                   | V <sub>DD</sub> = 5V  |     | 170 | 280 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 70  | 120 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 60  | 100 | ns    |
| t <sub>SU</sub> Minimum Time Prior to Clock that Clear must be Present (CD40162B, CD40163B Only) | V <sub>DD</sub> = 5V  |     | 120 | 190 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 50  | 80  | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 40  | 70  | ns    |
| t <sub>WL</sub> or t <sub>WH</sub> Maximum Clock Pulse Width                                     | V <sub>DD</sub> = 5V  |     | 125 | 250 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 45  | 90  | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 35  | 70  | ns    |
| t <sub>RCL</sub> , t <sub>FCL</sub> Maximum Clock Rise or Fall Time                              | V <sub>DD</sub> = 5V  |     |     | 15  | μs    |
|                                                                                                  | V <sub>DD</sub> = 10V |     |     | 5.0 | μs    |
|                                                                                                  | V <sub>DD</sub> = 15V |     |     | 5.0 | μs    |
| f <sub>CL</sub> Maximum Clock Frequency                                                          | V <sub>DD</sub> = 5V  | 2   | 4   |     | MHz   |
|                                                                                                  | V <sub>DD</sub> = 10V | 5.5 | 11  |     | MHz   |
|                                                                                                  | V <sub>DD</sub> = 15V | 7   | 14  |     | MHz   |
| t <sub>THL</sub> or t <sub>TLH</sub> Transition Time                                             | All Outputs           |     |     |     |       |
|                                                                                                  | V <sub>DD</sub> = 5V  |     | 100 | 200 | ns    |
|                                                                                                  | V <sub>DD</sub> = 10V |     | 50  | 100 | ns    |
|                                                                                                  | V <sub>DD</sub> = 15V |     | 40  | 80  | ns    |
| C <sub>IN</sub> Average Input Capacitance                                                        | Any Input             |     | 5.0 | 7.5 | pF    |
| C <sub>PD</sub> Power Dissipation Capacity                                                       | (Note 3)              |     | 95  |     | pF    |

# Logic Diagram

CD40160B, CD40162B Clear is Synchronous for the CD40162B

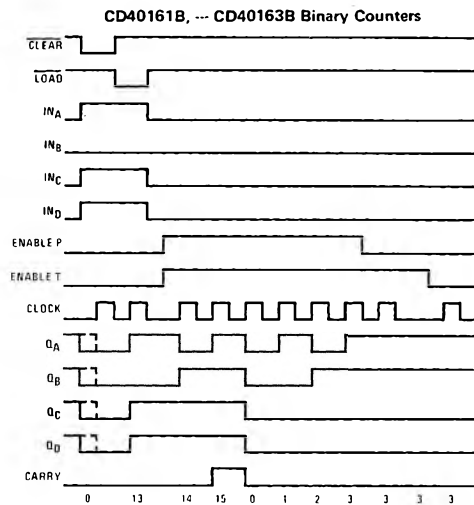
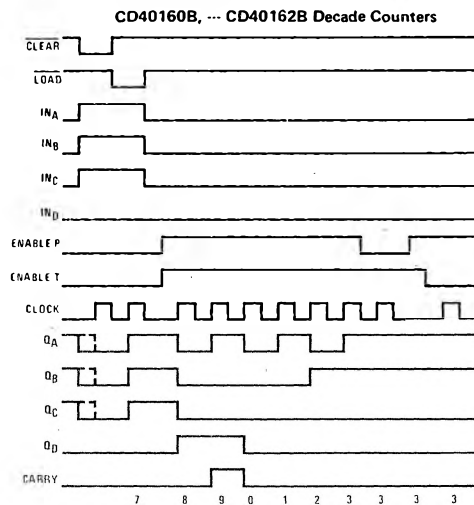


CD40161B, CD40163B Clear is Synchronous for the CD40163B

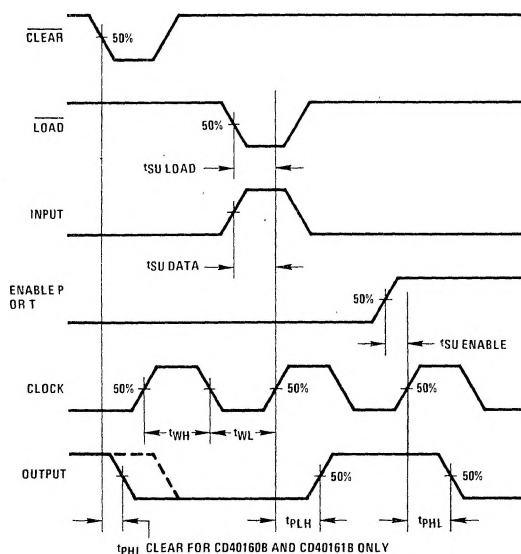


CD40160BM/CD40160BC, CD40161BM/CD40161BC,  
CD40162BM/CD40162BC, CD40163BM/CD40163BC

## Logic Waveforms



## Switching Time Waveforms



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

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

## Cascading Packages

