

# CD4070BM/CD4070BC Quad 2-Input EXCLUSIVE-OR Gate CD4077BM/CD4077BC Quad 2-Input EXCLUSIVE-NOR Gate

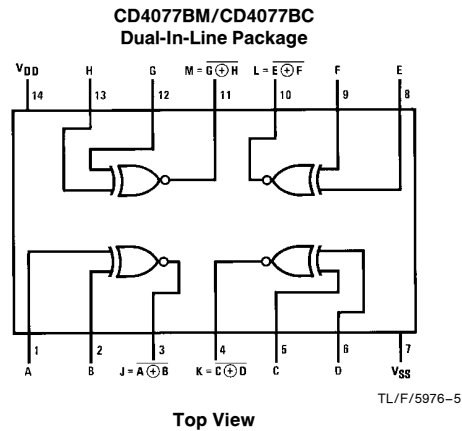
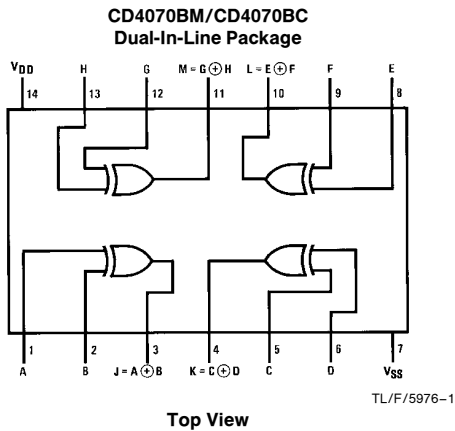
## General Description

Employing complementary MOS (CMOS) transistors to achieve wide power supply operating range, low power consumption, and high noise margin, the CD4070BM/BC and CD4077BM/BC provide basic functions used in the implementation of digital integrated circuit systems. The N- and P-channel enhancement mode transistors provide a symmetrical circuit with output swing essentially equal to the supply voltage. No DC power other than that caused by leakage current is consumed during static condition. All inputs are protected from damage due to static discharge by diode clamps to  $V_{DD}$  and  $V_{SS}$ .

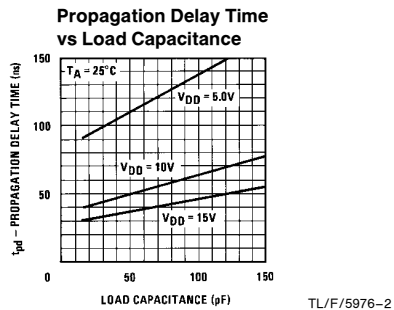
## Features

- 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
- CD4070B—Pin compatible to CD4030A
  - Equivalent to MM54C86/MM74C86 and MC14070B
- CD4077B—Equivalent to MC14077B

## Connection Diagram



## Typical Performance Characteristics



## Truth Tables

| CD4070BM/CD4070BC |         |   |
|-------------------|---------|---|
| Inputs            | Outputs |   |
| A                 | B       | Y |
| L                 | L       | L |
| L                 | H       | H |
| H                 | L       | H |
| H                 | H       | L |

| CD4077BM/CD4077BC |         |   |
|-------------------|---------|---|
| Inputs            | Outputs |   |
| A                 | B       | Y |
| L                 | L       | H |
| L                 | H       | L |
| H                 | L       | L |
| H                 | H       | H |

## 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.

|                                     |                                 |
|-------------------------------------|---------------------------------|
| 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 ( $T_L$ )          |                                 |
| (Soldering, 10 seconds)             | 260°C                           |

## Recommended Operating Conditions (Note 2)

|                                       |                        |
|---------------------------------------|------------------------|
| DC Supply Voltage ( $V_{DD}$ )        | 3V to 15 $V_{DC}$      |
| Input Voltage ( $V_{IN}$ )            | 0 to $V_{DD}$ $V_{DC}$ |
| Operating Temperature Range ( $T_A$ ) |                        |
| CD4070BC/CD4077BC                     | -40°C to +85°C         |
| CD4070BM/CD4077BM                     | -55°C to +125°C        |

## DC Electrical Characteristics CD4070BM/CD4077BM (Note 2)

| Symbol   | Parameter                          | Conditions  | -55°C |      | +25°C |            |      | +125°C |         | Units   |
|----------|------------------------------------|---|-------|------|-------|------------|------|--------|---------|---------|
|          |                                    |   | Min   | Max  | Min   | Typ        | Max  | Min    | Max     |         |
| $I_{DD}$ | Quiescent Device Current           | $V_{DD} = 5V$ ,<br>$V_{IN} = V_{DD}$ or $V_{SS}$            |       | 0.25 |       |            | 0.25 |        | 7.5     | $\mu A$ |
|          |                                    | $V_{DD} = 10V$ ,<br>$V_{IN} = V_{DD}$ or $V_{SS}$           |       | 0.5  |       | 0.5        |      | 15     | $\mu A$ |         |
|          |                                    | $V_{DD} = 15V$ ,<br>$V_{IN} = V_{DD}$ or $V_{SS}$           |       | 1.0  |       | 1.0        |      | 30     | $\mu A$ |         |
| $V_{OL}$ | Low Level Output Voltage           | $ I_O  < 1 \mu A$<br>$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          | $ I_O  < 1 \mu A$<br>$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            | $ I_O  < 1 \mu A$<br>$V_{DD} = 5V$ , $V_O = 4.5V$ or $0.5V$ |       | 1.5  |       |            | 1.5  |        | 1.5     | V       |
|          |                                    | $V_{DD} = 10V$ , $V_O = 9V$ or $1.0V$                       |       | 3.0  |       |            | 3.0  |        | 3.0     | V       |
|          |                                    | $V_{DD} = 15V$ , $V_O = 13.5V$ or $1.5V$                    |       | 4.0  |       |            | 4.0  |        | 4.0     | V       |
| $V_{IH}$ | High Level Input Voltage           | $ I_O  < 1 \mu A$<br>$V_{DD} = 5V$ , $V_O = 0.5V$ or $4.5V$ | 3.5   |      | 3.5   |            |      | 3.5    |         | V       |
|          |                                    | $V_{DD} = 10V$ , $V_O = 1.0V$ or $9.0V$                     | 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 (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 (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                      | $V_{DD} = 15V$ , $V_{IN} = 0V$                              |       | -0.1 |       | $-10^{-5}$ | -0.1 |        | -1.0    | $\mu A$ |
|          |                                    | $V_{DD} = 15V$ , $V_{IN} = 15V$                             |       | 0.1  |       | $10^{-5}$  | 0.1  |        | 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 table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

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

**Note 3:**  $I_{OL}$  and  $I_{OH}$  are tested one output at a time.

## DC Electrical Characteristics CD4070BC/CD4077BC (Note 2)

| Symbol          | Parameter                 | Conditions   | - 40°C |      | + 25°C |                   |      | + 85°C |      | Units |
|-----------------|---------------------------|--|--------|------|--------|-------------------|------|--------|------|-------|
|                 |                           |  | Min    | Max  | Min    | Typ               | Max  | Min    | Max  |       |
| I <sub>DD</sub> | Quiescent Device Current  | V <sub>DD</sub> = 5V,<br>V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub>  |        | 1.0  |        |                   | 1.0  |        | 7.5  | μA    |
|                 |                           | V <sub>DD</sub> = 10V,<br>V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub> |        | 2.0  |        | 2.0               |      | 15     | μA   |       |
|                 |                           | V <sub>DD</sub> = 15V,<br>V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub> |        | 4.0  |        | 4.0               |      | 30     | μA   |       |
| V <sub>OL</sub> | Low Level Output Voltage  | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V                                |        | 0.05 |        | 0                 | 0.05 |        | 0.05 | V     |
|                 |                           | V <sub>DD</sub> = 10V  |        | 0.05 |        | 0                 | 0.05 |        | 0.05 | V     |
|                 |                           | V <sub>DD</sub> = 15V  |        | 0.05 |        | 0                 | 0.05 |        | 0.05 | V     |
| V <sub>OH</sub> | High Level Output Voltage | I <sub>O</sub>   < 1 μA<br>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   | I <sub>O</sub>   < 1 μA<br>V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.5V or 0.5V |        | 1.5  |        |                   | 1.5  |        | 1.5  | V     |
|                 |                           | V <sub>DD</sub> = 10V, V <sub>O</sub> = 9V or 1.0V                             |        | 3.0  |        |                   | 3.0  |        | 3.0  | V     |
|                 |                           | V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V or 1.5V                          |        | 4.0  |        |                   | 4.0  |        | 4.0  | V     |
| V <sub>IH</sub> | High Level Input Voltage  | I <sub>O</sub>   < 1 μA<br>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 9.0V                             | 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                                    |        | -0.3 |        | -10 <sup>-5</sup> | -0.3 |        | -1.0 | μA    |
|                 |                           | V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V                                   |        | 0.3  |        | 10 <sup>-5</sup>  | 0.3  |        | 1.0  | μA    |

## AC Electrical Characteristics\*

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

| Symbol                                  | Parameter                                      | Conditions            | Min | Typ | Max | Units |
|---|--|-----------------------|-----|-----|-----|-------|
| t <sub>PHL</sub> or<br>t <sub>PLH</sub> | Propagation Delay Time<br>from Input to Output | V <sub>DD</sub> = 5V  |     | 110 | 185 | ns    |
|   |  | V <sub>DD</sub> = 10V |     | 50  | 90  | ns    |
|   |  | V <sub>DD</sub> = 15V |     | 40  | 75  | ns    |
| t <sub>THL</sub> or<br>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    |
| C <sub>IN</sub>                         | Average Input Capacitance                      | Any Input             |     | 5   | 7.5 | pF    |
| C <sub>PD</sub>                         | Power Dissipation Capacitance                  | Any Input (Note 4)    |     | 20  |     | pF    |

\*AC Parameters are guaranteed by DC correlated testing.

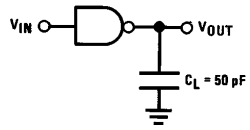
**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for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

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

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

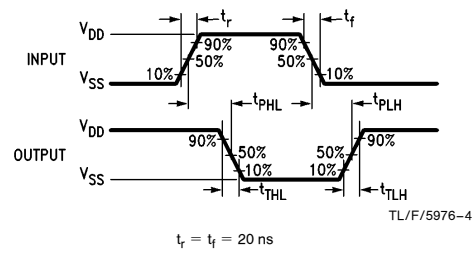
**Note 4:** C<sub>PD</sub> determines the no load AC power consumption of any CMOS device. For complete explanation, see 54C/74C Family Characteristics Application Note—AN-90.

## AC Test Circuit and Switching Time Waveforms

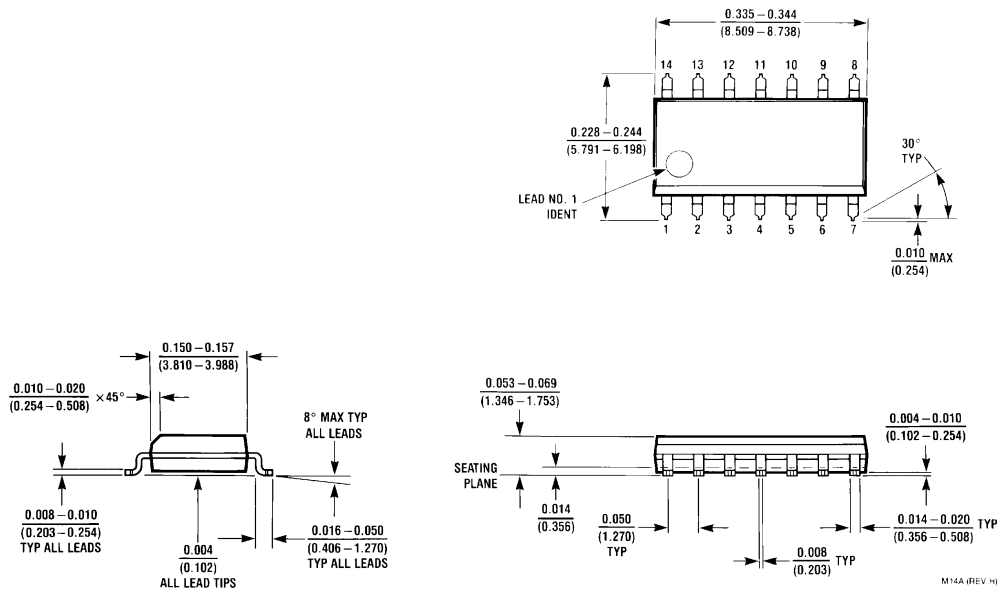


TL/F/5976-3

Note: Delays measured with input  $t_r, t_f = 20 \text{ ns}$ .



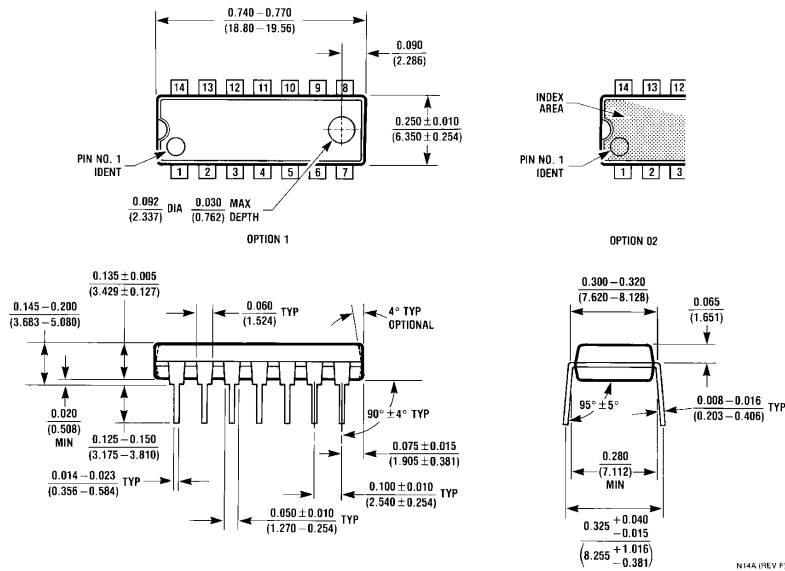
**Physical Dimensions** inches (millimeters)



**Molded Small Outline Package (M)**  
**Order Number CD4070BCM or CD4077BCM**  
**NS Package Number M14A**

M14A (REV HI)

**Physical Dimensions** inches (millimeters) (Continued)



**Molded Dual-In-Line Package (N)**  
**Order Number CD4070BCN or CD4077BCN**  
**NS Package Number N14A**

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