National Semiconductor

March 1988

# CD4002M/CD4002C Dual 4-Input NOR Gate
# CD4012M/CD4012C Dual 4-Input NAND Gate

## General Description

These NOR and NAND gates are monolithic complementary MOS (CMOS) integrated circuits. The N- and P-channel enhancement mode transistors provide a symmetrical circuit with output swings essentially equal to the supply voltage. This results in high noise immunity over a wide supply voltage range. No DC power other than that caused by leakage current is consumed during static conditions. All inputs are protected against static discharge and latching conditions.

## Features

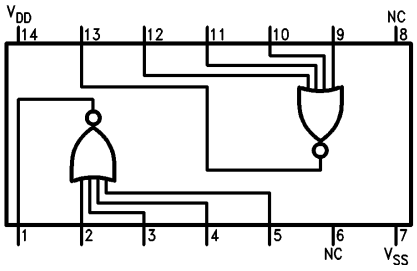
| | |
|---|---|
| ■ Wide supply voltage range | 3.0V to 15V |
| ■ Low power | 10 nW (typ.) |
| ■ High noise immunity | 0.45 $V_{DD}$ (typ.) |

## Applications

- Automotive
- Data terminals
- Instrumentation
- Medical Electronics
- Alarm system
- Industrial controls
- Remote metering
- Computers

## Connection Diagrams

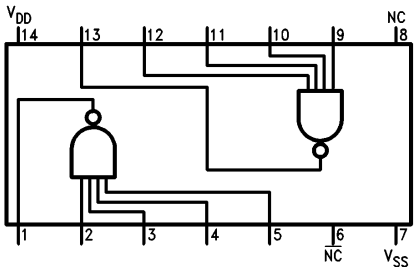
**CD4002**
**Dual-In-Line Package**




TL/F/5940–1

**Top View**

**CD4012**
**Dual-In-Line Package**




TL/F/5940–2

**Top View**

**Order Number CD4002 or CD4012**

RRD-B30M105/Printed in U. S. A.

## Absolute Maximum Ratings (Note 1)

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

Voltage at Any Pin $V_{SS}$ −0.3V to $V_{DD}$ +0.3V

Operating Temperature Range
- CD4002M, CD4012M −55°C to +125°C
- CD4002C, CD4012C −40°C to +85°C

Storage Temperature Range ($T_S$) −65°C to +150°C

Power Dissipation ($P_D$)
- Dual-In-Line 700 mW
- Small Outline 500 mW

Operating Range ($V_{DD}$) $V_{SS}$ +3.0V to $V_{SS}$ +15V

Lead Temperature ($T_L$)
(Soldering, 10 seconds) 260°C

## DC Electrical Characteristics CD4002M, CD4012M

| Symbol | Parameter | Conditions | Limits | | | | | | | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | −55°C | | +25°C | | | +125°C | | |
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| $I_{DD}$ | Quiescent Device Current | $V_{DD}$ = 5.0V<br>$V_{DD}$ = 10V | | 0.05<br>0.1 | | 0.001<br>0.001 | 0.05<br>0.1 | | 3.0<br>6 | μA<br>μA |
| $P_D$ | Quiescent Device Dissipation/Package | $V_{DD}$ = 5.0V<br>$V_{DD}$ = 10V | | 0.25<br>1.0 | | 0.005<br>0.01 | 0.25<br>1.0 | | 15<br>60 | μW<br>μW |
| $V_{OL}$ | Output Voltage Low Level | $V_{DD}$ = 5.0V, $V_I$ = $V_{DD}$, $I_O$ = 0A<br>$V_{DD}$ = 10V, $V_I$ = $V_{DD}$, $I_O$ = 0A | | 0.05<br>0.05 | | 0<br>0 | 0.05<br>0.05 | | 0.05<br>0.05 | V<br>V |
| $V_{OH}$ | Output Voltage High Level | $V_{DD}$ = 5.0V, $V_I$ = $V_{SS}$, $I_O$ = 0A<br>$V_{DD}$ = 10V, $V_I$ = $V_{SS}$, $I_O$ = 0A | 4.95<br>9.95 | | 4.95<br>9.95 | 5.0<br>10 | | 4.95<br>9.95 | | V<br>V |
| $V_{NL}$ | Noise Immunity (All Inputs) | $V_{DD}$ = 5.0V, $V_O$ = 3.6V, $I_O$ = 0A<br>$V_{DD}$ = 10V, $V_O$ = 7.2V, $I_O$ = 0A | 1.5<br>3.0 | | 1.5<br>3.0 | 2.25<br>4.5 | | 1.4<br>2.9 | | V<br>V |
| $V_{NH}$ | Noise Immunity (All Inputs) | $V_{DD}$ = 5.0V, $V_O$ = 0.95V, $I_O$ = 0A<br>$V_{DD}$ = 10V, $V_O$ = 2.9V, $I_O$ = 0A | 1.4<br>2.9 | | 1.5<br>3.0 | 2.25<br>4.5 | | 1.5<br>3.0 | | V<br>V |
| $I_DN$ | Output Drive Current N-Channel (4002) (Note 2) | $V_{DD}$ = 5.0V, $V_O$ = 0.4V, $V_I$ = $V_{DD}$<br>$V_{DD}$ = 10V, $V_O$ = 0.5V, $V_I$ = $V_{DD}$ | 0.5<br>1.1 | | 0.40<br>0.9 | 1.0<br>2.5 | | 0.28<br>0.65 | | mA<br>mA |
| $I_DP$ | Output Drive Current P-Channel (4002) (Note 2) | $V_{DD}$ = 5.0V, $V_O$ = 2.5V, $V_I$ = $V_{SS}$<br>$V_{DD}$ = 10V, $V_O$ = 9.5V, $V_I$ = $V_{SS}$ | −0.62<br>−0.62 | | −0.5<br>−0.5 | −2.0<br>−1.0 | | −0.35<br>−0.35 | | mA<br>mA |
| $I_DN$ | Output Drive Current N-Channel (4012) (Note 2) | $V_{DD}$ = 5.0V, $V_O$ = 0.4V, $V_I$ = $V_{DD}$<br>$V_{DD}$ = 10V, $V_O$ = 0.5V, $V_I$ = $V_{DD}$ | 0.31<br>0.63 | | 0.25<br>0.5 | 0.5<br>0.6 | | 0.175<br>0.35 | | mA<br>mA |
| $I_DP$ | Output Drive Current P-Channel (4012) (Note 2) | $V_{DD}$ = 5.0V, $V_O$ = 2.5V, $V_I$ = $V_{SS}$<br>$V_{DD}$ = 10V, $V_O$ = 9.5V, $V_I$ = $V_{SS}$ | −0.31<br>−0.75 | | −0.25<br>−0.6 | −0.5<br>−1.2 | | −0.175<br>−0.4 | | mA<br>mA |
| $I_I$ | Input Current | | | | | 10 | | | | pA |

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

**Note 2:** $I_DN$ and $I_DP$ are tested one output at a time.

## DC Electrical Characteristics CD4002C, CD4012C

| Symbol | Parameter | Conditions | Limits | | | | | | | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | −55°C | | +25°C | | | +85°C | | |
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| $I_{DD}$ | Quiescent Device Current | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 0.5<br>5.0 | | 0.005<br>0.005 | 0.5<br>5.0 | | 15<br>30 | $\mu A$<br>$\mu A$ |
| $P_D$ | Quiescent Device Dissipation/Package | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 2.5<br>50 | | 0.025<br>0.05 | 2.5<br>50 | | 75<br>300 | $\mu W$<br>$\mu W$ |
| $V_{OL}$ | Output Voltage Low Level | $V_{DD} = 5.0V, V_I = V_{DD}, I_O = 0A$<br>$V_{DD} = 10V, V_I = V_{DD}, I_O = 0A$ | | 0.05<br>0.05 | | 0<br>0 | 0.05<br>0.05 | | 0.05<br>0.05 | V<br>V |
| $V_{OH}$ | Output Voltage High Level | $V_{DD} = 5.0V, V_I = V_{SS}, I_O = 0A$<br>$V_{DD} = 10V, V_I = V_{SS}, I_O = 0A$ | 4.95<br>9.95 | | 4.95<br>9.95 | 5.0<br>10 | | 4.95<br>9.95 | | V<br>V |
| $V_{NL}$ | Noise Immunity (All Inputs) | $V_{DD} = 5.0V, V_O \geq 3.6V, I_O = 0A$<br>$V_{DD} = 10V, V_O \geq 7.2V, I_O = 0A$ | 1.5<br>3.0 | | 1.5<br>3.0 | 2.25<br>4.5 | | 1.4<br>2.9 | | V<br>V |
| $V_{NH}$ | Noise Immunity (All Inputs) | $V_{DD} = 5.0V, V_O \leq 0.95V, I_O = 0A$<br>$V_{DD} = 10V, V_O \leq 2.9V, I_O = 0A$ | 1.4<br>2.9 | | 1.5<br>3.0 | 2.25<br>4.5 | | 1.5<br>3.0 | | V<br>V |
| $I_DN$ | Output Drive Current N-Channel (4002) (Note 2) | $V_{DD} = 5.0V, V_O = 0.4V, V_I = V_{DD}$<br>$V_{DD} = 10V, V_O = 0.5V, V_I = V_{DD}$ | 0.35<br>0.72 | | 0.3<br>0.6 | 1.0<br>2.5 | | 0.24<br>0.48 | | mA<br>mA |
| $I_DN$ | Output Drive Current N-Channel (4012) (Note 2) | $V_{DD} = 5.0V, V_O = 0.4V, V_I = V_{DD}$<br>$V_{DD} = 10V, V_O = 0.5V, V_I = V_{DD}$ | 0.145<br>0.3 | | 0.12<br>0.25 | 0.5<br>0.6 | | 0.095<br>0.2 | | mA<br>mA |
| $I_DP$ | Output Drive Current P-Channel (4002) (Note 2) | $V_{DD} = 5.0V, V_O = 2.5V, V_I = V_{SS}$<br>$V_{DD} = 10V, V_O = 9.5V, V_I = V_{SS}$ | −0.35<br>−0.3 | | −0.3<br>−0.25 | −2.0<br>−1.0 | | −0.24<br>−0.2 | | mA<br>mA |
| $I_DP$ | Output Drive Current P-Channel (4012) (Note 2) | $V_{DD} = 5.0V, V_O = 2.5V, V_I = V_{SS}$<br>$V_{DD} = 10V, V_O = 9.5V, V_I = V_{SS}$ | −0.145<br>−0.35 | | −0.12<br>−0.3 | −0.5<br>−1.2 | | −0.095<br>−0.24 | | mA<br>mA |
| $I_I$ | Input Current | | | | | 10 | | | | pA |

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

**Note 2:** $I_DN$ and $I_DP$ are tested one output at a time.

## AC Electrical Characteristics*

$T_A = 25°C$, $C_L = 15$ pF, and input rise and fall times = 20 ns. Typical temperature coefficient for all values of $V_{DD} = 0.3\%/°C$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **CD4002M** | | | | | | |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 35<br>25 | 50<br>40 | ns<br>ns |
| $t_{PLH}$ | Propagation Delay Time<br>Low to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 35<br>25 | 50<br>40 | ns<br>ns |
| $t_{THL}$ | Transition Time High<br>to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 65<br>35 | 175<br>75 | ns<br>ns |
| $t_{TLH}$ | Transition Time Low<br>to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 65<br>35 | 125<br>70 | ns<br>ns |
| $C_{IN}$ | Input Capacitance | Any Input | | 5.0 | | pF |
| **CD4002C** | | | | | | |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 35<br>25 | 120<br>65 | ns<br>ns |
| $T_{PLH}$ | Propagation Delay Time<br>Low to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 35<br>25 | 80<br>55 | ns<br>ns |
| $t_{THL}$ | Transition Time High<br>to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 65<br>35 | 300<br>125 | ns<br>ns |
| $t_{TLH}$ | Transition Time Low<br>to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 65<br>35 | 200<br>115 | ns<br>ns |
| $C_{IN}$ | Input Capacitance | Any Input | | 5.0 | | pF |

*AC Parameters are guaranteed by DC correlated testing.

## AC Electrical Characteristics*

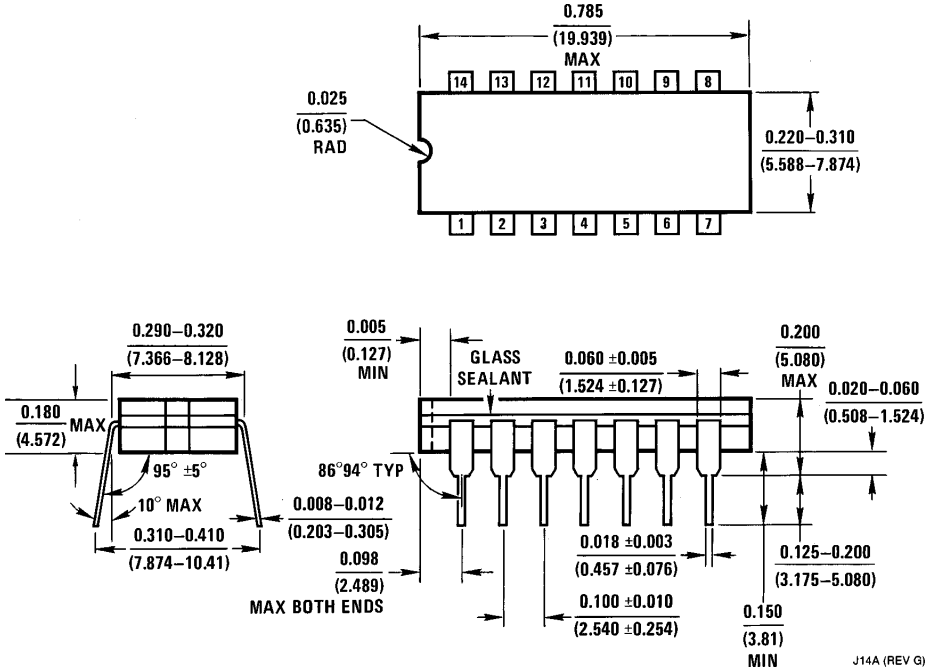
$T_A = 25°C$, $C_L = 15$ pF, and input rise and fall times = 20 ns. Typical temperature coefficient for all values of $V_{DD} = 0.3\%/°C$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **CD4012M** | | | | | | |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 50<br>25 | 75<br>40 | ns<br>ns |
| $t_{PLH}$ | Propagation Delay Time<br>Low to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 50<br>25 | 75<br>40 | ns<br>ns |
| $t_{THL}$ | Transition Time High<br>to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 75<br>50 | 125<br>75 | ns<br>ns |
| $t_{TLH}$ | Transition Time Low<br>to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 75<br>40 | 100<br>60 | ns<br>ns |
| $C_{IN}$ | Input Capacitance | Any Input | | 5.0 | | pF |
| **CD4012C** | | | | | | |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 50<br>25 | 100<br>50 | ns<br>ns |
| $T_{PLH}$ | Propagation Delay Time<br>Low to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 50<br>25 | 100<br>50 | ns<br>ns |
| $t_{THL}$ | Transition Time High<br>to Low Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 75<br>50 | 150<br>100 | ns<br>ns |
| $t_{TLH}$ | Transition Time Low<br>to High Level | $V_{DD} = 5.0V$<br>$V_{DD} = 10V$ | | 75<br>40 | 125<br>75 | ns<br>ns |
| $C_{IN}$ | Input Capacitance | Any Input | | 5.0 | | pF |

*AC Parameters are guaranteed by DC correlated testing.

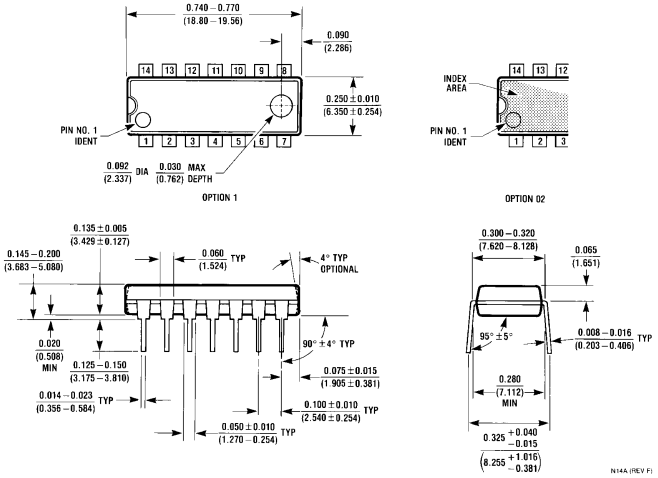
**Note 1:** ''Absolute Maximum Ratings'' are those values beyond which the safety of the device cannot be guaranteed. Except for ''Operating Temperature Range'' they are not meant to imply that the devices should be operated at these limits. The table of ''Electrical Characteristics'' provides conditions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

## Physical Dimensions inches (millimeters)




**Ceramic Dual-In-Line Package (J)**
**Order Number CD4002MJ, CD4002CJ, CD4012MJ or CD4012CJ**
**NS Package Number J14A**

## Physical Dimensions inches (millimeters) (Continued)




**Molded Dual-In-Line Package (N)**
**Order Number CD4002MN, CD4002CN, CD4012MN or CD4012CN**
**NS Package Number N14A**

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