

November 1994

CMOS NOR Gate

## Features

- High-Voltage Types (20V Rating)
- Propagation Delay Time = 60ns (typ.) at  $CL = 50pF$ ,  $VDD = 10V$
- Buffered Inputs and Outputs
- Standard Symmetrical Output Characteristics
- 100% Tested for Maximum Quiescent Current at 20V
- 5V, 10V and 15V Parametric Ratings
- Maximum Input Current of  $1\mu A$  at 18V Over Full Package-Temperature Range;  $100nA$  at 18V and  $+25^{\circ}C$
- Noise Margin (Over Full Package Temperature Range):
  - 1V at  $VDD = 5V$
  - 2V at  $VDD = 10V$
  - 2.5V at  $VDD = 15V$
- Meets All Requirements of JEDEC Tentative Standards No. 13B, "Standard Specifications for Description of "B" Series CMOS Device's

## Description

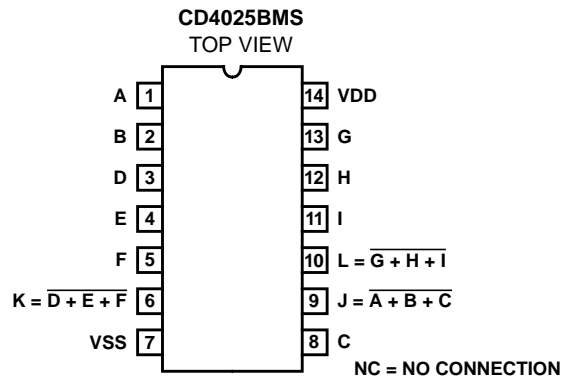
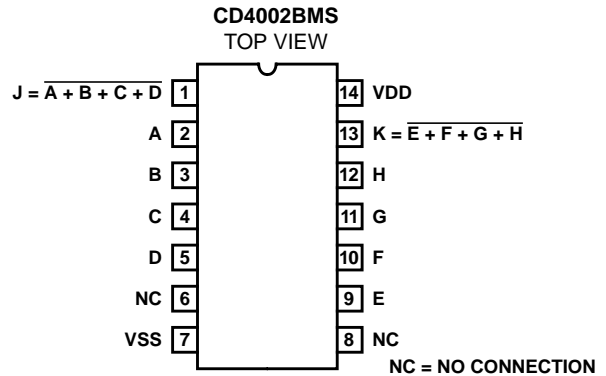
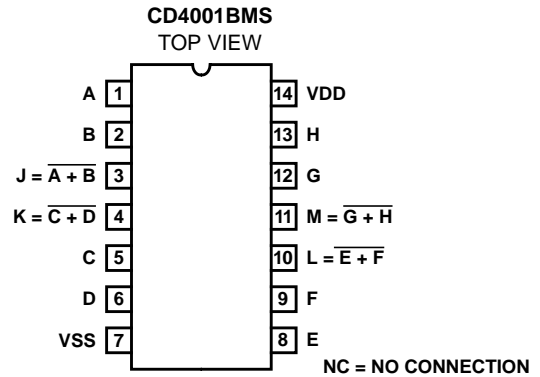
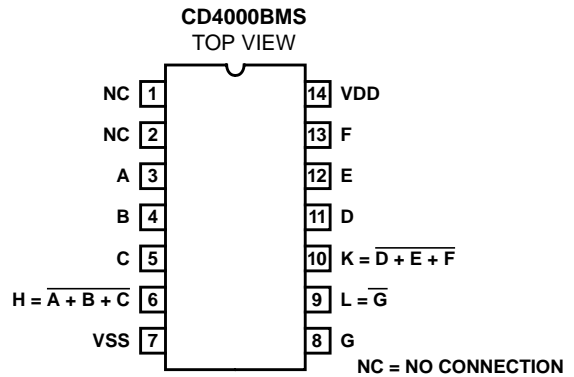
- CD4000BMS - Dual 3 Plus Inverter
- CD4001BMS - Quad 2 Input
- CD4002BMS - Dual 4 Input
- CD4025BMS - Triple 3 Input

CD4000BMS, CD4001BMS, CD4002BMS, and CD4025BMS NOR gates provide the system designer with direct implementation of the NOR function and supplement the existing family of CMOS gates. All inputs and outputs are buffered.

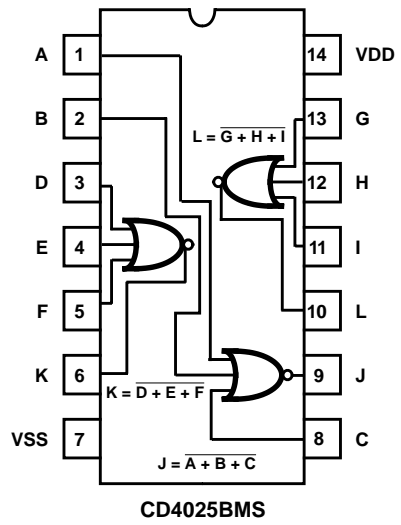
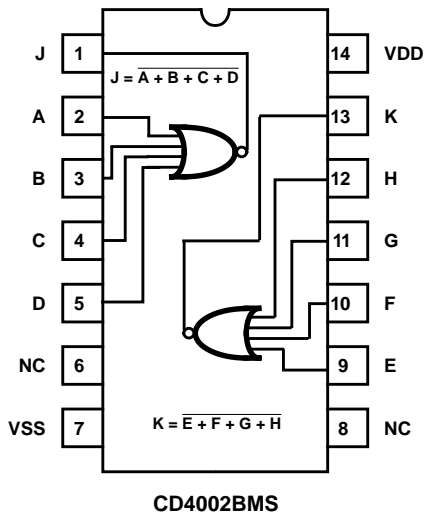
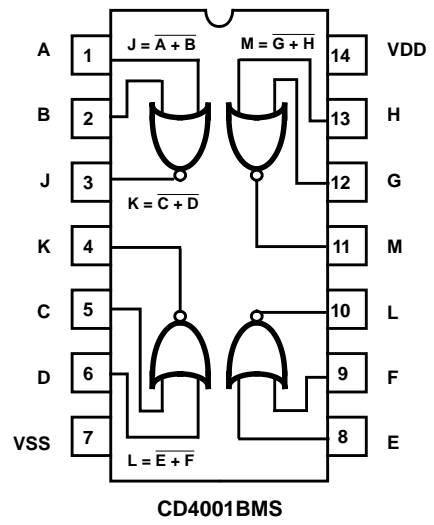
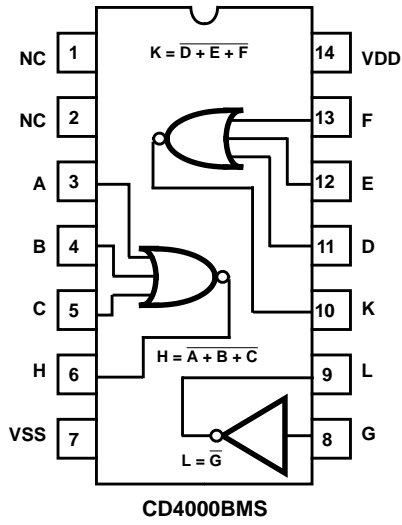
The CD4000BMS, CD4001BMS, CD4002BMS and the CD4025BMS is supplied in these 14 lead outline packages:

	CD4000B	CD4001B	CD4002B	CD4025B
Braze Seal DIP	H4X	H4Q	H4Q	H4Q
Frit Seal DIP	H1B	H1B	H1B	H1B
Ceramic Flatpack	H3W	H3W	H3W	H3W

## Pinouts



Functional Diagrams



# Specifications CD4000BMS, CD4001BMS, CD4002BMS, CD4025BMS

## Absolute Maximum Ratings

DC Supply Voltage Range, (VDD) ..... -0.5V to +20V  
 (Voltage Referenced to VSS Terminals)  
 Input Voltage Range, All Inputs ..... -0.5V to VDD +0.5V  
 DC Input Current, Any One Input ..... ±10mA  
 Operating Temperature Range ..... -55°C to +125°C  
 Package Types D, F, K, H  
 Storage Temperature Range (TSTG) ..... -65°C to +150°C  
 Lead Temperature (During Soldering) ..... +265°C  
 At Distance 1/16 ± 1/32 Inch (1.59mm ± 0.79mm) from case for  
 10s Maximum

## Reliability Information

Thermal Resistance .....  $\theta_{ja}$   $\theta_{jc}$   
 Ceramic DIP and FRIT Package ..... 80°C/W 20°C/W  
 Flatpack Package ..... 70°C/W 20°C/W  
 Maximum Package Power Dissipation (PD) at +125°C  
 For TA = -55°C to +100°C (Package Type D, F, K) ..... 500mW  
 For TA = +100°C to +125°C (Package Type D, F, K) ..... Derate  
 Linearity at 12mW/°C to 200mW  
 Device Dissipation per Output Transistor ..... 100mW  
 For TA = Full Package Temperature Range (All Package Types)  
 Junction Temperature ..... +175°C

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITIONS (NOTE 1)		GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
						MIN	MAX	
Supply Current	IDD	VDD = 20V, VIN = VDD or GND		1	+25°C	-	0.5	μA
				2	+125°C	-	50	μA
		VDD = 18V, VIN = VDD or GND		3	-55°C	-	0.5	μA
Input Leakage	IIL	VIN = VDD or GND	VDD = 20	1	+25°C	-100	-	nA
			VDD = 18V	2	+125°C	-1000	-	nA
				3	-55°C	-100	-	nA
Input Leakage	IIH	VIN = VDD or GND	VDD = 20	1	+25°C	-	100	nA
			VDD = 18V	2	+125°C	-	1000	nA
				3	-55°C	-	100	nA
Output Voltage	VOL15	VDD = 15V, No Load		1, 2, 3	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH15	VDD = 15V, No Load (Note 3)		1, 2, 3	+25°C, +125°C, -55°C	14.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V		1	+25°C	0.53	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V		1	+25°C	1.4	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V		1	+25°C	3.5	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V		1	+25°C	-	-0.53	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V		1	+25°C	-	-1.8	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V		1	+25°C	-	-1.4	mA
Output Current (Source)	IOH15	VDD = 15V, VOUT = 13.5V		1	+25°C	-	-3.5	mA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10μA		1	+25°C	-2.8	-0.7	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10μA		1	+25°C	0.7	2.8	V
Functional	F	VDD = 2.8V, VIN = VDD or GND		7	+25°C	VOH > VDD/2	VOL < VDD/2	V
		VDD = 20V, VIN = VDD or GND		7	+25°C			
		VDD = 18V, VIN = VDD or GND		8A	+125°C			
		VDD = 3V, VIN = VDD or GND		8B	-55°C			
Input Voltage Low (Note 2)	VIL	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	+25°C, +125°C, -55°C	-	1.5	V
Input Voltage High (Note 2)	VIH	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	+25°C, +125°C, -55°C	3.5	-	V
Input Voltage Low (Note 2)	VIL	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	+25°C, +125°C, -55°C	-	4	V
Input Voltage High (Note 2)	VIH	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	+25°C, +125°C, -55°C	11	-	V

NOTES: 1. All voltages referenced to device GND, 100% testing being implemented. 2. Go/No Go test with limits applied to inputs 3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.

## Specifications CD4000BMS, CD4001BMS, CD4002BMS, CD4025BMS

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITIONS (NOTE 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay	TPHL TPLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	250	ns
			10, 11	+125°C, -55°C	-	338	ns
Transition Time	TTHL TTLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	200	ns
			10, 11	+125°C, -55°C	-	270	ns

**NOTES:**

1. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
2. -55°C and +125°C limits guaranteed, 100% testing being implemented.

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Supply Current	IDD	VDD = 5V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	0.25	μA
				+125°C	-	7.5	μA
		VDD = 10V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	0.5	μA
				+125°C	-	1.5	μA
		VDD = 15V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	0.5	μA
				+125°C	-	3.0	μA
Output Voltage	VOL	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOL	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	4.95	-	V
Output Voltage	VOH	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	9.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V	1, 2	+125°C	0.36	-	mA
				-55°C	0.64	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V	1, 2	+125°C	0.9	-	mA
				-55°C	1.6	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V	1, 2	+125°C	2.4	-	mA
				-55°C	4.2	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V	1, 2	+125°C	-	-0.36	mA
				-55°C	-	-0.64	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V	1, 2	+125°C	-	-1.15	mA
				-55°C	-	-2.0	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V	1, 2	+125°C	-	-0.9	mA
				-55°C	-	-1.6	mA
Output Current (Source)	IOH15	VDD = 15V, VOUT = 13.5V	1, 2	+125°C	-	-2.4	mA
				-55°C	-	-4.2	mA
Input Voltage Low	VIL	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	-	3	V
Input Voltage High	VIH	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	7	-	V
Propagation Delay	TPHL TPLH	VDD = 10V	1, 2, 3	+25°C	-	120	ns
		VDD = 15V	1, 2, 3	+25°C	-	90	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns

# Specifications CD4000BMS, CD4001BMS, CD4002BMS, CD4025BMS

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Capacitance	CIN	Any Input	1, 2	+25°C	-	7.5	pF

**NOTES:**

1. All voltages referenced to device GND.
2. The parameters listed on Table 3 are controlled via design or process and are not directly tested. These parameters are characterized on initial design release and upon design changes which would affect these characteristics.
3. CL = 50pF, RL = 200K, Input TR, TF < 20ns.

**TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Supply Current	IDD	VDD = 20V, VIN = VDD or GND	1, 4	+25°C	-	2.5	µA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA	1, 4	+25°C	-2.8	-0.2	V
N Threshold Voltage Delta	ΔVNTH	VDD = 10V, ISS = -10µA	1, 4	+25°C	-	±1	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10µA	1, 4	+25°C	0.2	2.8	V
P Threshold Voltage Delta	ΔVPTH	VSS = 0V, IDD = 10µA	1, 4	+25°C	-	±1	V
Functional	F	VDD = 18V, VIN = VDD or GND VDD = 3V, VIN = VDD or GND	1	+25°C	VOH > VDD/2	VOL < VDD/2	V
Propagation Delay Time	TPHL TPLH	VDD = 5V	1, 2, 3, 4	+25°C	-	1.35 x +25°C Limit	ns

- NOTES: 1. All voltages referenced to device GND. 2. CL = 50pF, RL = 200K, Input TR, TF < 20ns. 3. See Table 2 for +25°C limit. 4. Read and Record

**TABLE 5. BURN-IN AND LIFE TEST DELTA PARAMETERS +25°C**

PARAMETER	SYMBOL	DELTA LIMIT
Supply Current - SSI	IDD	±0.1µA
Output Current (Sink)	IOL5	± 20% x Pre-Test Reading
Output Current (Source)	IOH5A	± 20% x Pre-Test Reading

**TABLE 6. APPLICABLE SUBGROUPS**

CONFORMANCE GROUP		MIL-STD-883 METHOD	GROUP A SUBGROUPS	READ AND RECORD
Initial Test (Pre Burn-In)		100% 5004	1, 7, 9	IDD, IOL5
Interim Test 1 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5
Interim Test 2 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Interim Test 3 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Final Test		100% 5004	2, 3, 8A, 8B, 10, 11	
Group A		Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11	
Group B	Subgroup B-5	Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas	Subgroups 1, 2, 3, 9, 10, 11
	Subgroup B-6	Sample 5005	1, 7, 9	
Group D		Sample 5005	1, 2, 3, 8A, 8B, 9	Subgroups 1, 2, 3

NOTE: 1. 5% Parametric, 3% Functional; Cumulative for Static 1 and 2.

# Specifications CD4000BMS, CD4001BMS, CD4002BMS, CD4025BMS

**TABLE 7. TOTAL DOSE IRRADIATION**

CONFORMANCE GROUPS	MIL-STD-883 METHOD	TEST		READ AND RECORD	
		PRE-IRRAD	POST-IRRAD	PRE-IRRAD	POST-IRRAD
Group E Subgroup 2	5005	1, 7, 9	Table 4	1, 9	Table 4

**TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS**

FUNCTION	OPEN	GROUND	VDD	9V ± 0.5V	OSCILLATOR	
					50kHz	25kHz
<b>PART NUMBER CD4000BMS</b>						
Static Burn-In 1 Note 1	1, 2, 6, 9, 10	3 - 5, 7, 8, 11 - 13	14			
Static Burn-In 2 Note 1	1, 2, 6, 9, 10	7	3 - 5, 8, 11 - 14			
Dynamic Burn-In Note 1	1, 2	7	14	6, 9, 10	3 - 5, 8, 11 - 13	
Irradiation Note 2	1, 2, 6, 9, 10	7	3 - 5, 8, 11 - 14			
<b>PART NUMBER CD4001BMS</b>						
Static Burn-In 1 Note 1	3, 4, 10, 11	1, 2, 5 - 9, 12, 13	14			
Static Burn-In 2 Note 1	3, 4, 10, 11	7	1, 2, 5, 6, 8, 9, 12 - 14			
Dynamic Burn-In Note 1	-	7	14	3, 4, 10, 11	1, 2, 5, 6, 8, 9, 12, 13	
Irradiation Note 2	3, 4, 10, 11	7	1, 2, 5, 6, 8, 9, 12 - 14			
<b>PART NUMBER CD4002BMS</b>						
Static Burn-In 1 Note 1	1, 6, 8, 13	2 - 5, 7, 9 - 12	14			
Static Burn-In 2 Note 1	1, 6, 8, 13	7	2 - 5, 9 - 12, 14			
Dynamic Burn-In Note 1	6, 8	7	14	1, 13	2 - 5, 9 - 12	
Irradiation Note 2	1, 6, 8, 13	7	2 - 5, 9 - 12, 14			
<b>PART NUMBER CD4025BMS</b>						
Static Burn-In 1 Note 1	6, 9, 10	1 - 5, 7, 8, 11 - 13	14			
Static Burn-In 2 Note 1	6, 9, 10	7	1 - 5, 8, 11 - 14			
Dynamic Burn-In Note 1	-	7	14	6, 9, 10	1 - 5, 8, 11 - 13	
Irradiation Note 2	6, 9, 10	7	1 - 5, 8, 11 - 14			

**NOTE:**

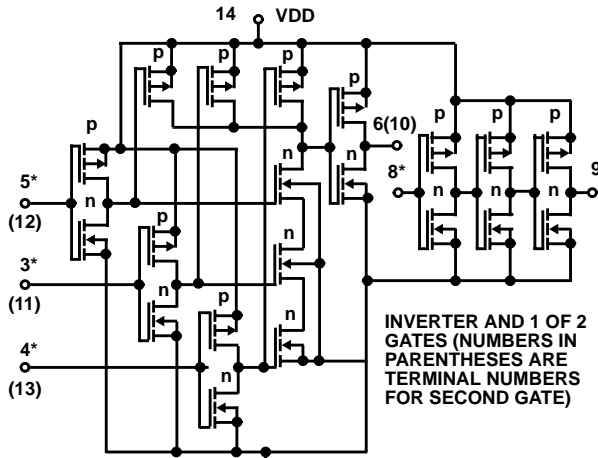
1. Each pin except VDD and GND will have a series resistor of  $10K \pm 5\%$ ,  $VDD = 18V \pm 0.5V$
2. Each pin except VDD and GND will have a series resistor of  $47K \pm 5\%$ ; Group E, Subgroup 2, sample size is 4 dice/wafer, 0 failures,  $VDD = 10V \pm 0.5V$

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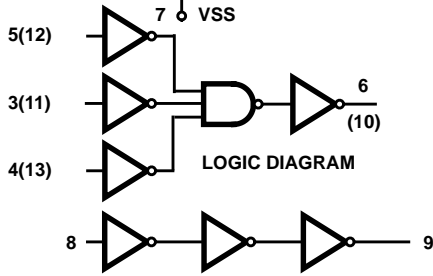
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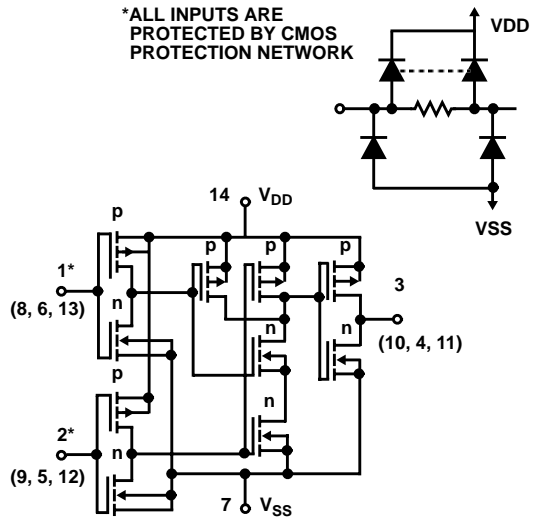
Schematic and Logic Diagrams



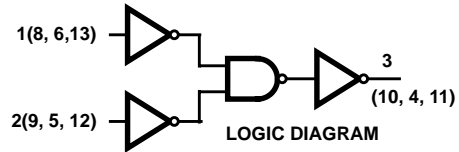
INVERTER AND 1 OF 2 GATES (NUMBERS IN PARENTHESES ARE TERMINAL NUMBERS FOR SECOND GATE)



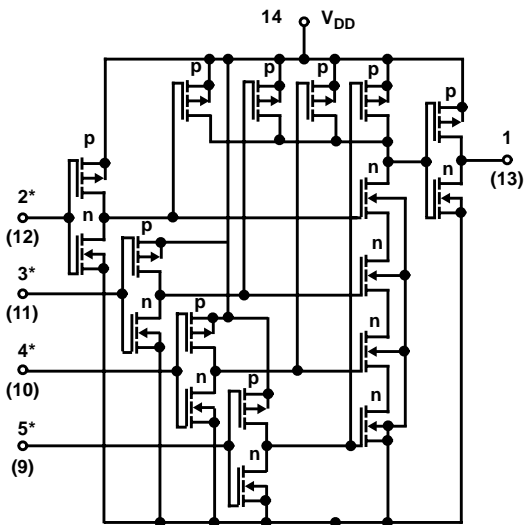
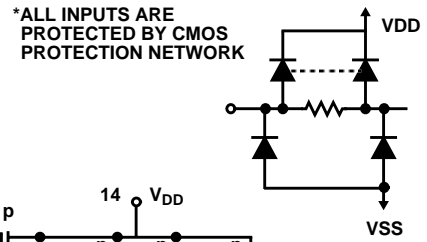
CD4000BMS



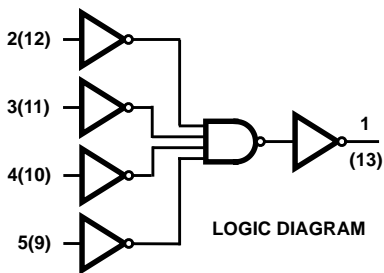
1 OF 4 GATES (NUMBERS IN PARANTHESES ARE TERMINAL NUMBERS FOR OTHER GATES)



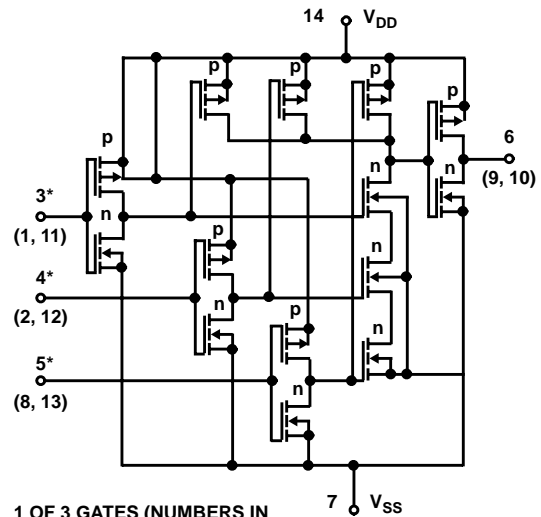
CD4001BMS



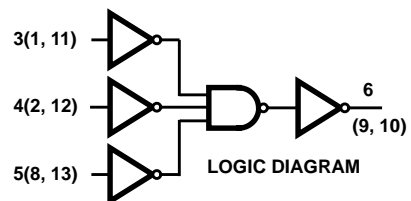
1 OF 2 GATES (NUMBERS IN PARENTHESES ARE TERMINAL NUMBERS FOR SECOND GATE)



CD4002BMS



1 OF 3 GATES (NUMBERS IN PARENTHESES ARE TERMINAL NUMBERS FOR OTHER GATES)



CD4025BMS

Typical Performance Characteristics

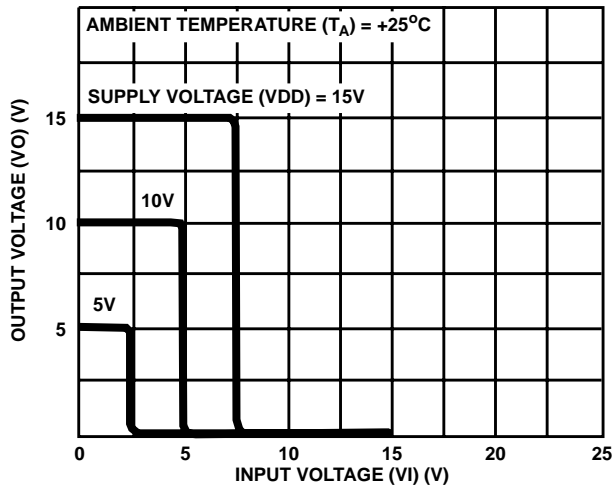


FIGURE 1. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS

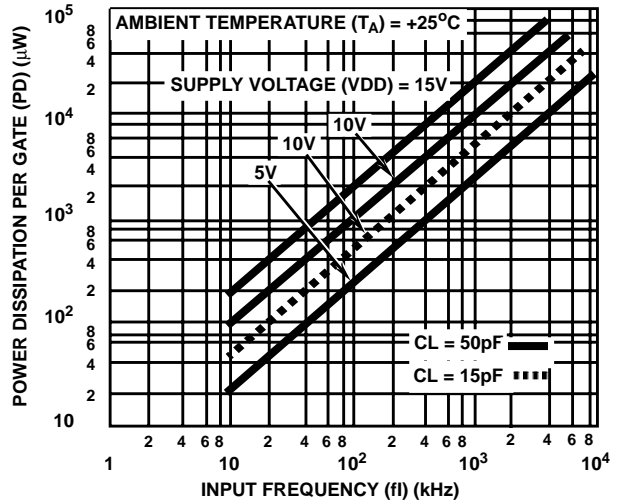


FIGURE 2. TYPICAL POWER DISSIPATION vs FREQUENCY

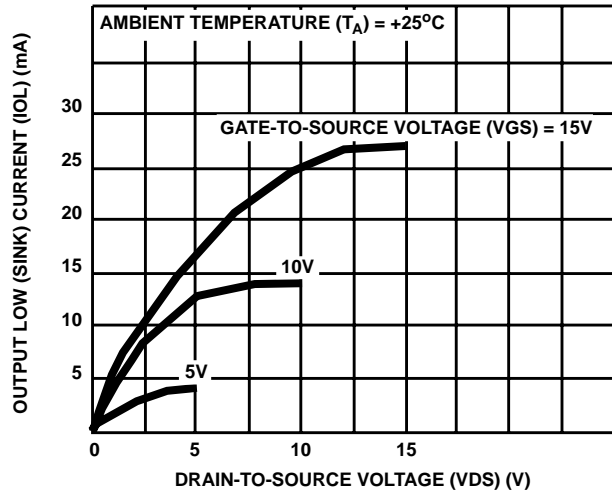


FIGURE 3. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

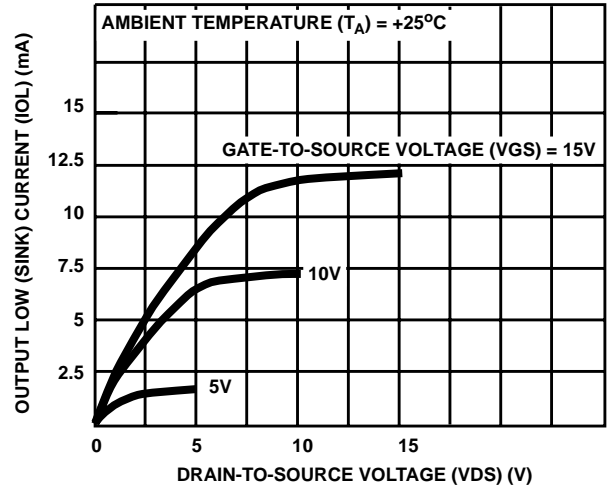


FIGURE 4. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

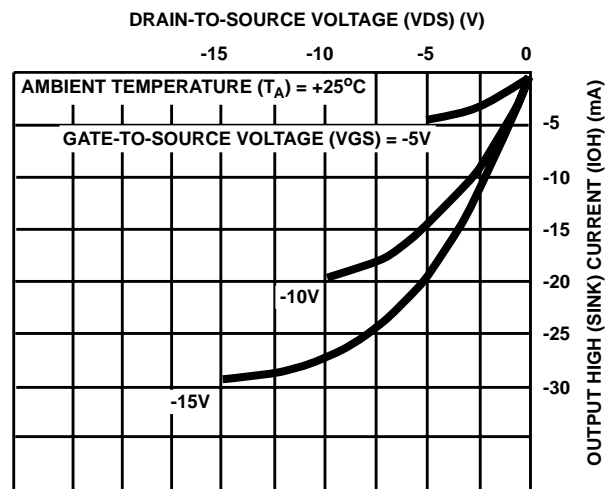


FIGURE 5. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

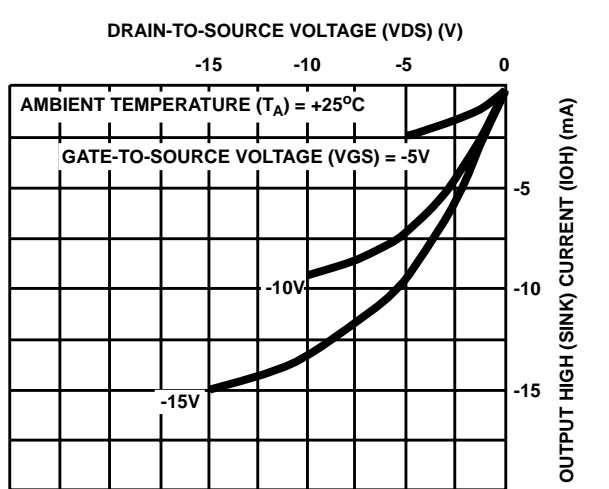


FIGURE 6. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS



Typical Performance Characteristics (Continued)

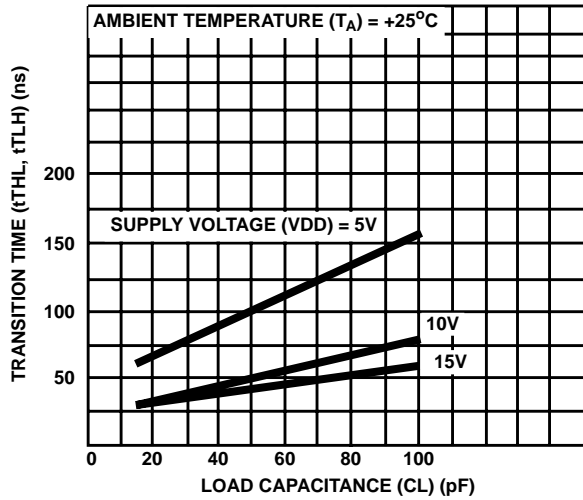


FIGURE 7. TYPICAL TRANSITION TIME vs LOAD CAPACITANCE

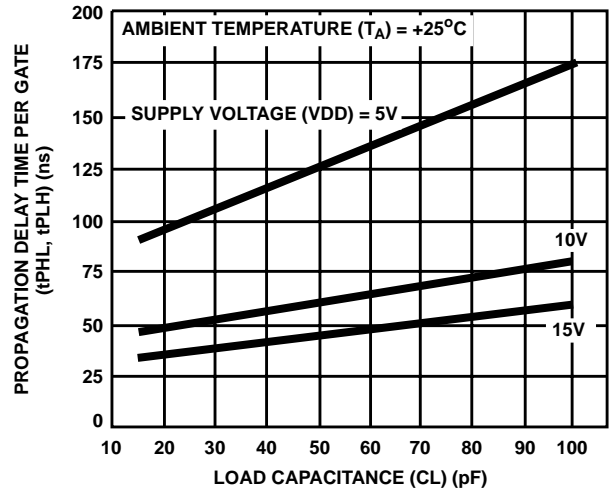
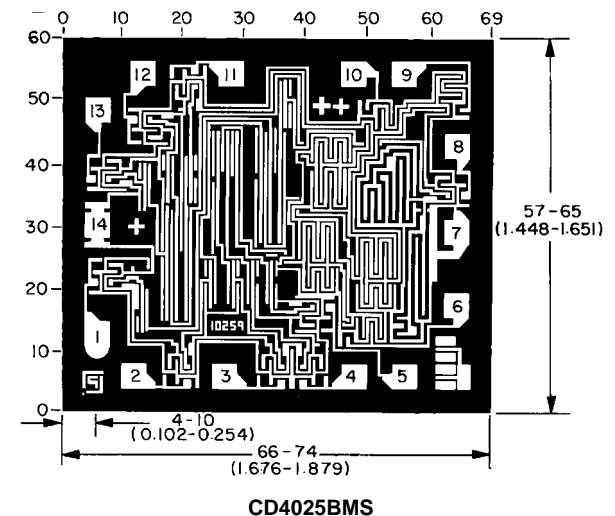
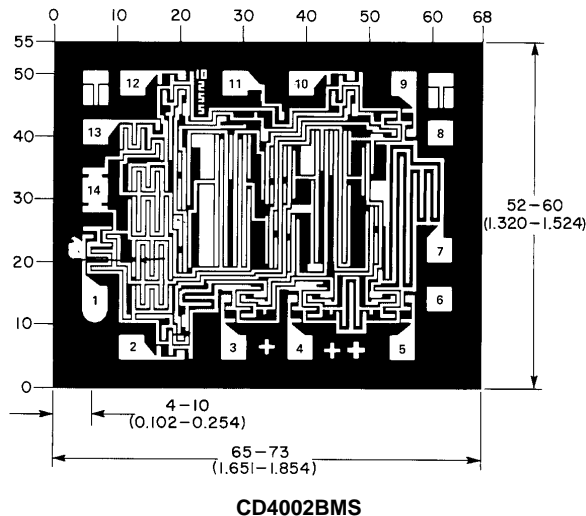
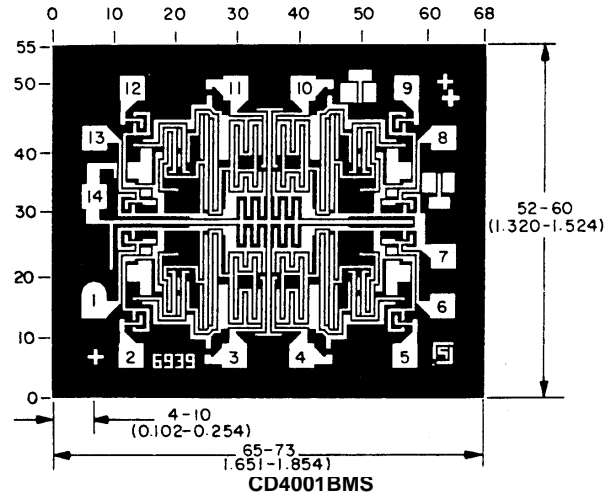
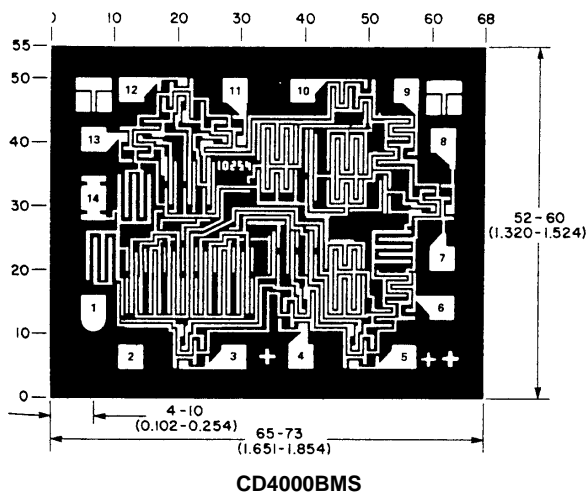


FIGURE 8. TYPICAL PROPAGATION DELAY TIME vs LOAD CAPACITANCE

Chip Dimensions and Pad Layouts



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch)