CD4028BM/CD4028BC BCD-to-Decimal Decoder

General Description

The CD4028BM/CD4028BC is a BCD-to-decimal or binaryto-octal decoder consisting of 4 inputs, decoding logic gates, and 10 output buffers. A BCD code applied to the 4 inputs, A, B, C, and D, results in a high level at the selected 1-of-10 decimal decoded outputs. Similarly, a 3-bit binary code applied to inputs A, B, and C is decoded in octal at outputs 0-7. A high level signal at the D input inhibits octal decoding and causes outputs 0-7 to go low.

All inputs are protected against static discharge damage by diode clamps to V_{DD} and V_{SS} .

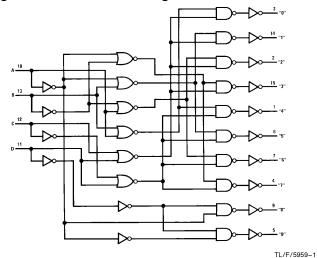
Features

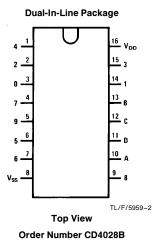
- 3.0V to 15V ■ Wide supply voltage range ■ High noise immunity 0.45 V_{DD} (typ.)
- Low power TTL fan out of 2 driving 74L compatibility or 1 driving 74LS
- Low power
- Glitch free outputs
- "Positive logic" on inputs and outputs

Applications

- Code conversion
- Address decoding
- Indicator-tube decoder

Logic and Connection Diagrams





Truth Table

D	С	В	Α	0	1	2	3	4	5	6	7	8	9	
0	0	0	0	1	0	0	0	0	0	0	0	0	0	ו
0	0	0	1	0	1	0	0	0	0	0	0	0	0	
0	0	1	0	0	0	1	0	0	0	0	0	0	0	
0	0	1	1	0	0	0	1	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	1	0	0	0	0	0	
0	1	0	1	0	0	0	0	0	1	0	0	0	0	
0	1	1	0	0	0	0	0	0	0	1	0	0	0	
0	1	1	1	0	0	0	0	0	0	0	1	0	0	
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1	1	1	0	0	0	0	0	0	0	0	0	1	0	
1	1	1	1	0	0	0	0	0	0	0	0	0	1	ر
	0 0 0 0 0 0 0 0 1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1 0 0 1 1 1 0 0 1 0 0 1 1 0 1 1 0 1 1 0 1 1 0 1 1 0 1 1 1 0	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 1 0 0 0 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 1 1 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 0 1 1 1 0 1 0 0 0 0	0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 1 0 0 0 1 1 0 0 1 0 0 0 0	0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 1 0 0 1 1 0 0 0 0 1 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 0 1 1 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

BCD States

Extraordinary States

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.

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)

 $\begin{array}{ll} \text{Supply Voltage (V}_{\text{DD}}) & 3 \text{ to 15V} \\ \text{Input Voltage (V}_{\text{IN}}) & 0 \text{ to V}_{\text{DD}}\text{V} \end{array}$

Operating Temperature Range (T_A) CD4028BM

DC Electrical Characteristics CD4028BC (Note 2)

Symbol	Parameter	Conditions	−55°C		+ 25°C			+ 125°C		Units
Syllibol	Farameter	Conditions	Min	Max	Min	Тур	Max	Min	Max	Ullits
I _{DD}	Quiescent Device Current	$V_{DD} = 5V, V_{IN} = V_{DD} \text{ or } V_{SS}$ $V_{DD} = 10V, V_{IN} = V_{DD} \text{ or } V_{SS}$ $V_{DD} = 15V, V_{IN} = V_{DD} \text{ or } V_{SS}$		5 10 20		0.01 0.01 0.02	5 10 20		150 300 600	μΑ μΑ μΑ
V _{OL}	Low Level Output Voltage	$\begin{array}{l} I_{O} < 1~\mu A, V_{IL} = 0 V, V_{IH} = V_{DD} \\ V_{DD} = 5 V \\ V_{DD} = 10 V \\ V_{DD} = 15 V \end{array}$		0.05 0.05 0.05		0 0	0.05 0.05 0.05		0.05 0.05 0.05	V V V
V _{OH}	High Level Output Voltage	$\begin{aligned} & I_O < 1 \; \mu A, V_{IL} = 0 V, V_{IH} = V_{DD} \\ &V_{DD} = 5 V \\ &V_{DD} = 10 V \\ &V_{DD} = 15 V \end{aligned}$	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V V V
V _{IL}	Low Level Input Voltage	$\begin{array}{l} I_O < 1 \; \mu A \\ V_{DD} = \; 5V, V_O = 0.5V \; or \; \; 4.5V \\ V_{DD} = \; 10V, V_O = \; 1V \; or \; 9V \\ V_{DD} = \; 15V, V_O = \; 1.5V \; or \; 13.5V \end{array}$		1.5 3.0 4.0		2.25 4.5 6.75	1.5 3.0 4.0		1.5 3.0 4.0	V V
V _{IH}	High Level Input Voltage	$\begin{array}{l} I_O < 1 \; \mu A \\ V_{DD} = \; 5V, V_O = 0.5V \; or \; \; 4.5V \\ V_{DD} = \; 10V, V_O = \; 1V \; or \; 9V \\ V_{DD} = \; 15V, V_O = \; 1.5V \; or \; 13.5V \end{array}$	3.5 7.0 11.0		3.5 7.0 11.0	2.75 5.5 8.25		3.5 7.0 11.0		V V
loL	Low Level Output Current (Note 3)	$ \begin{aligned} &V_{IL} = & 0V, V_{IH} = V_{DD} \\ &V_{DD} = & 5V, & V_{O} = & 0.4V \\ &V_{DD} = & 10V, & V_{O} = & 0.5V \\ &V_{DD} = & 15V, & V_{O} = & 1.5V \end{aligned} $	0.64 1.6 4.2		0.51 1.3 3.4	1.0 2.6 6.8		0.36 0.9 2.4		mA mA mA
Гон	High Level Output Current (Note 3)	$\begin{array}{llll} V_{IL} & & \text{OV, } V_{IH} = V_{DD} \\ V_{DD} & & \text{5V, } V_{O} = 4.6V \\ V_{DD} & & \text{10V, } V_{O} = 9.5V \\ V_{DD} & & \text{15V, } V_{O} = 13.5V \\ \end{array}$	-0.25 -0.62 -1.8		-0.2 -0.5 -1.5	-0.4 -1.0 -3.0		-0.14 -0.35 -1.1		mA mA mA
I _{IN}	Input Current	$V_{DD} = 15V, V_{IN} = 0V$ $V_{DD} = 15V, V_{IN} = 15V$		-0.1 0.1		-10 ⁻⁵	-0.1 0.1		-1.0 1.0	μA μA

DC Electrical Characteristics CD4028BC (Note 2)

Symbol	Parameter	Conditions		−40°C		+ 25°C			+ 85°C	
Symbol	raidilletei			Max	Min	Тур	Max	Min	Max	Units
I _{DD}	Quiescent Device Current	$V_{DD} = 5V$, $V_{IN} = V_{DD}$ or V_{SS}		20		0.01	20		150	μΑ
		$V_{DD} = 10V$, $V_{IN} = V_{DD}$ or V_{SS}		40		0.01	40		300	μΑ
		$V_{DD} = 15V$, $V_{IN} = V_{DD}$ or V_{SS}		80		0.02	80		600	μΑ
V_{OL}	Low Level Output Voltage	$ I_{O} < 1 \mu A$, $V_{IL} = 0V$, $V_{IH} = V_{DD}$								
		$V_{DD} = 5V$		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

DC Electrical Characteristics CD4028BC (Note 2) (Continued)

Symbol	Parameter	Conditions	-40°C			+ 25°C		+ 85	Units	
Symbol	Farameter	Conditions	Min	Max	Min	Тур	Max	Min	Max	- Cilito
V _{OH}	High Level Output Voltage	$ I_{O} < 1 \mu A, V_{IL} = 0 V, V_{IH} = V_{DD}$								
		$V_{DD} = 5V$	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 μA								
		$V_{DD} = 5V, V_{O} = 0.5V \text{ or } 4.5V$		1.5		2.25	1.5		1.5	V
		$V_{DD} = 10V, V_{O} = 1V \text{ or } 9V$		3.0		4.5	3.0		3.0	V
		$V_{DD} = 15V, V_{O} = 1.5V \text{ or } 13.5V$		4.0		6.75	4.0		4.0	V
V _{IH}	High Level Input Voltage	I _O < 1 μA								
		$V_{DD} = 5V$, $V_{O} = 0.5V$ or 4.5V	3.5		3.5			3.5		V
		$V_{DD} = 10V, V_{O} = 1V \text{ or } 9V$	7.0		7.0			7.0		V
		$V_{DD} = 15V, V_{O} = 1.5V \text{ or } 13.5V$	11.0		11.0			11.0		V
loL	Low Level Output Current	$V_{IH} = V_{DD}, V_{IL} = 0V$								
	(Note 3)	$V_{DD} = 5V, V_{O} = 0.4V$	0.52		0.44	0.88		0.36		mA
		$V_{DD} = 10V, V_{O} = 0.5V$	1.3		1.1	2.2		0.9		mA
		$V_{DD} = 15V, V_{O} = 1.5V$	3.6		3.0	6.0		2.4		mA
I _{OH}	High Level Output Current	$V_{IH} = V_{DD}, V_{II} = 0V$								
0	(Note 3)	$V_{DD} = 5V, V_{O} = 4.6V$	-0.2		-0.16	-0.32		-0.12		mA
		$V_{DD} = 10V, V_{O} = 9.5V$	-0.5		-0.4	-0.8		-0.3		mA
		$V_{DD} = 15V, V_{O} = 13.5V$	-1.4		-1.2	-3.5		-1.0		mA
I _{IN}	Input Current	$V_{DD} = 15V$, $V_{IN} = 0V$		-0.3			-0.3		-1.0	μΑ
	,	$V_{DD} = 15V, V_{IN} = 15V$		0.3			0.3		1.0	μA

AC Electrical Characteristics*

 $\rm T_A$ = 25°C, $\rm C_L$ = 50 pF, $\rm R_L$ = 200k, Input $\rm t_r$ = $\rm t_f$ = 20 ns, unless otherwise specified

Symbol	Parameter	Conditions	Min	Тур	Max	Units
t _{PHL} or t _{PLH}	Propagation Delay Time	$V_{CC} = 5V$		240	480	ns
		$V_{CC} = 10V$		100	200	ns
		$V_{CC} = 15V$		70	140	ns
t _{THL} or t _{TLH}	Transition Time	$V_{CC} = 5V$		175	350	ns
		$V_{CC} = 10V$		75	150	ns
		$V_{CC} = 15V$		60	110	ns
C _{IN}	Input Capacitance	Any Input		5	7.5	pF

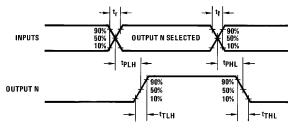
^{*} AC Parameters are guaranteed by DC correlated testing.

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.

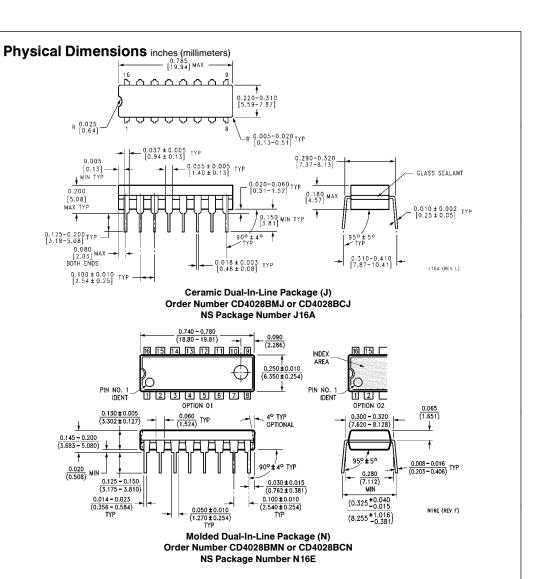
Note 2: $V_{SS} = 0V$ unless otherwise specified.

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

Switching Time Waveforms



TL/F/5959-3



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

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