

BCD-to-Decimal Decoder

High-Voltage Types (20-Volt Rating)

■ CD4028B types are BCD-to-decimal or binary-to-octal decoders consisting of buffering on all 4 inputs, decoding logic gates, and 10 output buffers. A BCD code applied to the four inputs, A to D, results in a high level at the selected one of 10 decimal decoded outputs. Similarly, a 3-bit binary code applied to inputs A through C is decoded in octal code at output 0 to 7 if D = '0'. High drive capability is provided at all outputs to enhance dc and dynamic performance in high fan-out applications.

The CD4028B-Series types are supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead dual-in-line plastic packages (E suffix), and in chip form (H suffix).

Features:

- BCD-to-decimal decoding or binary-to-octal decoding
- High decoded output drive capability
- "Positive logic" inputs and outputs. decoded outputs go high on selection
- Medium-speed operation.
 $t_{PHL}, t_{PLH} = 80 \text{ ns (typ.) @ } V_{DD} = 10 \text{ V}$
- Standardized, symmetrical output characteristics
- 100% tested for quiescent current at 20 V
- Maximum input current of $1 \mu\text{A}$ at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package-temperature range):
 $1 \text{ V at } V_{DD} = 5 \text{ V}$
 $2 \text{ V at } V_{DD} = 10 \text{ V}$
 $2.5 \text{ V at } V_{DD} = 15 \text{ V}$
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications:

- Code conversion
- Indicator-tube decoder
- Address decoding—memory selection control

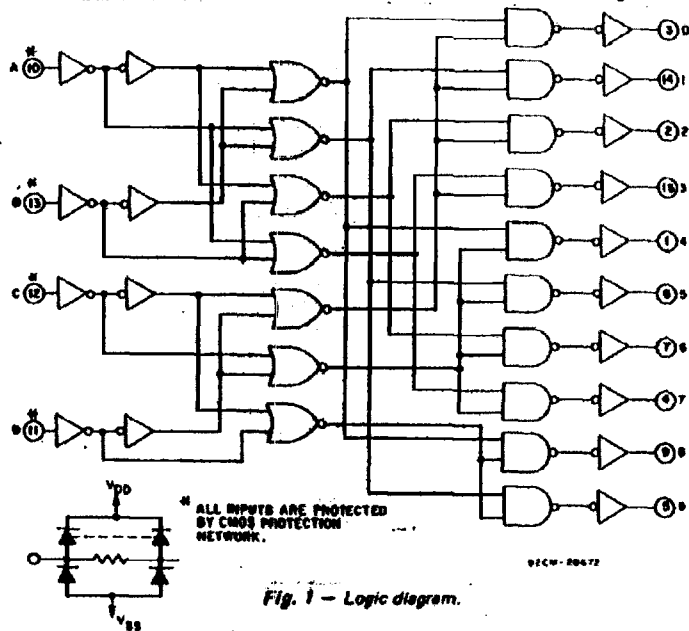
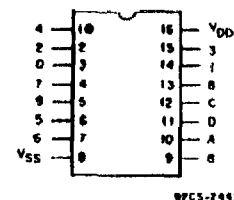
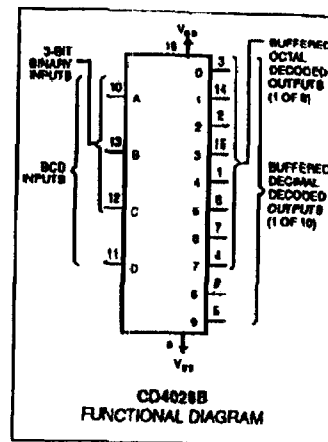


TABLE 1 - TRUTH TABLE

D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	0	0	0	1	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	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
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1
1	0	1	0	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0	0	0

1 = HIGH LEVEL 0 = LOW LEVEL

MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD})

Voltages referenced to V_{SS} Terminal] $-0.5 \text{ V to } +20 \text{ V}$

INPUT VOLTAGE RANGE, ALL INPUTS

..... $-0.5 \text{ V to } V_{DD} + 0.5 \text{ V}$

DC INPUT CURRENT, ANY ONE INPUT

..... $\pm 10 \text{ mA}$

POWER DISSIPATION PER PACKAGE (P_D):

For $T_A = -55^\circ\text{C to } +100^\circ\text{C}$ 500 mW

For $T_A = +100^\circ\text{C to } +125^\circ\text{C}$ Derate Linearly at $12 \text{ mW}/^\circ\text{C}$ to 200 mW

DEVICE DISSIPATION PER OUTPUT TRANSISTOR

For $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$ 100 mW

OPERATING-TEMPERATURE RANGE (T_A)

..... $-55^\circ\text{C to } +125^\circ\text{C}$

STORAGE TEMPERATURE RANGE (T_{stg})

..... $-65^\circ\text{C to } +150^\circ\text{C}$

LEAD TEMPERATURE (DURING SOLDERING):

At distance $1/16 \pm 1/32 \text{ inch (1.59 } \pm 0.76 \text{ mm)}$ from case for 10s max $+265^\circ\text{C}$

CD4028B Types

RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply Voltage Range (For T_A = Full Package Temperature Range)	3	18	V

STATIC ELECTRICAL CHARACTERISTICS

CHARACTER- ISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	VO (V)	VIN (V)	VDD (V)					+25			
				-55	-40	+85	+125	Min.	Typ.	Max.	
Quiescent Device Current, IDD Max.	—	0.5	5	5	5	150	150	—	0.04	5	μA
	—	0.10	10	10	10	300	300	—	0.04	10	
	—	0.15	15	20	20	600	600	—	0.04	20	
	—	0.20	20	100	100	3000	3000	—	0.08	100	
Output Low (Sink) Current IOL Min.	0.4	0.5	5	0.64	0.61	0.42	0.36	0.51	1	—	mA
	0.5	0.10	10	1.6	1.5	1.1	0.9	1.3	2.6	—	
	1.5	0.15	15	4.2	4	2.8	2.4	3.4	6.8	—	
Output High (Source) Current, IOH Min.	4.6	0.5	5	-0.64	-0.61	-0.42	-0.36	-0.51	1	—	mA
	2.5	0.5	5	-2	-1.8	-1.3	-1.15	-1.6	-3.2	—	
	9.5	0.10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	—	
	13.5	0.15	15	-4.2	-4	-2.8	-2.4	-3.4	-6.8	—	
Output Voltage: Low-Level, VOL Max.	—	0.5	5	0.05				—	0	0.05	V
	—	0.10	10	0.05				—	0	0.05	
	—	0.15	15	0.05				—	0	0.05	
Output Voltage: High-Level, VOH Min.	—	0.5	5	4.95				4.95	5	—	V
	—	0.10	10	9.95				9.95	10	—	
	—	0.15	15	14.95				14.95	15	—	
Input Low Voltage, VIL Max.	0.5, 4.5	—	5	1.5				—	—	1.5	V
	1, 9	—	10	3				—	—	3	
	1.5, 13.5	—	15	4				—	—	4	
Input High Voltage, VIH Min.	0.5, 4.5	—	5	3.5				3.5	—	—	V
	1, 9	—	10	7				7	—	—	
	1.5, 13.5	—	15	11				11	—	—	
Input Current IIN Max.	—	0.18	18	10.1	10.1	11	11	—	10 ⁻⁵	10.1	μA

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ C$, $C_L = 50$ pF, Input $t_r, t_f = 20$ ns, $R_L = 200$ k Ω

CHARACTERISTIC	TEST CONDITIONS	LIMITS		UNITS
	V_{DD} (V)	Typ.	Max.	
Propagation Delay Time: t_{PHL}, t_{PLH}	5	175	350	ns
	10	80	160	
	15	60	120	
Transition Time t_{THL}, t_{TLH}	5	100	200	ns
	10	50	100	
	15	40	80	
Input Capacitance, C_{IN}	—	5	7.5	pF

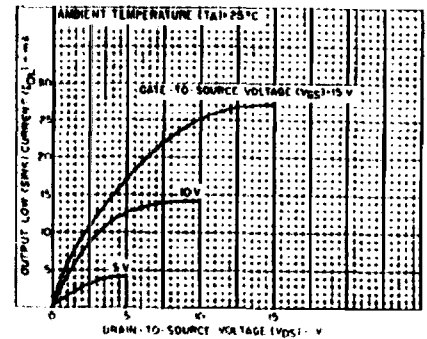


Fig. 2 — Typical output low (sink) current characteristics.

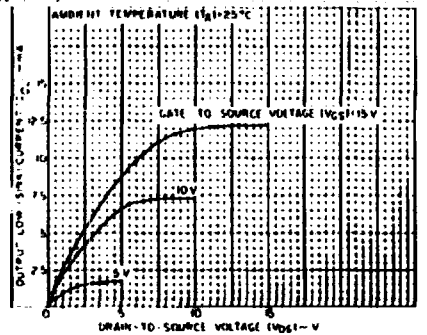


Fig. 3 — Minimum output low (sink) current characteristics.

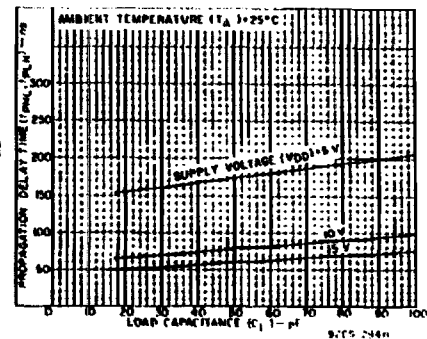


Fig. 4 — Typical propagation delay time as a function of load capacitance.

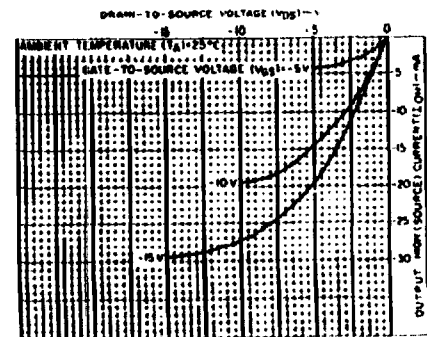


Fig. 5 — Typical output high (source) current characteristics.

TABLE II — CODE CONVERSION CHART

INPUTS				INPUT CODES						OUTPUT NUMBER																			
				Hexa - Decimal		Decimal																							
				4-BIT BINARY	4-BIT GRAY	EXCESS-3	EXCESS-3 GRAY	AIKEN	4-2-1																				
D	C	B	A							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
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	1	1	1				1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0				
0	0	1	0	2	3		0	2	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0				
0	0	1	1	3	2	0	3	3		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0				
0	1	0	0	4	7	1	4	4		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0				
0	1	0	1	5	6	2			3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0				
0	1	1	0	6	4	3	1		4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0				
0	1	1	1	7	5	4	2			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0				
1	0	0	0	8	15	5				0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0				
1	0	0	1	9	14	6			5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0				
1	0	1	0	10	12	7	9		6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0				
1	0	1	1	11	13	8			5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0				
1	1	0	0	12	8	9	5		6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0				
1	1	0	1	13	9		6	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0				
1	1	1	0	14	11		8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0				
1	1	1	1	15	10		7	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1				

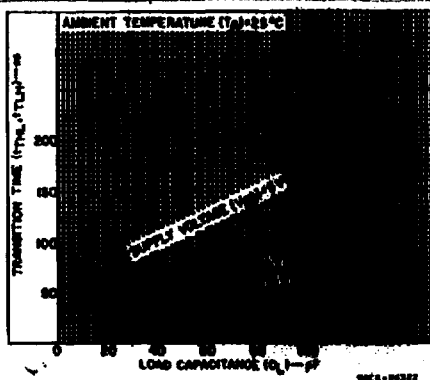


Fig. 8 — Typical transition time as a function of load capacitance.

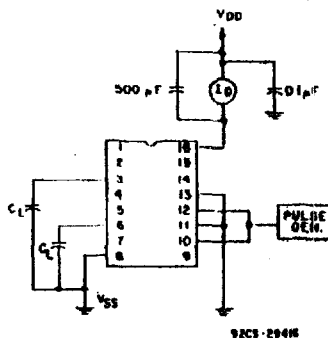


Fig. 10 — Dynamic power dissipation test circuit.

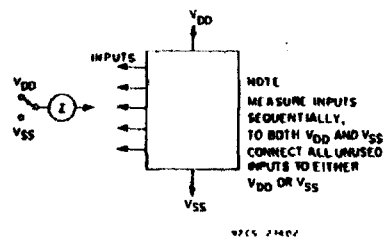


Fig. 9 — Input current test circuit.

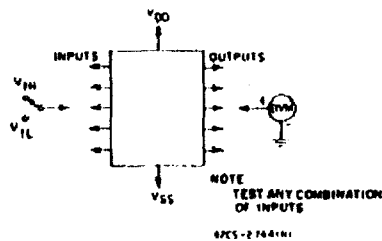


Fig. 11 — Input voltage test circuit.

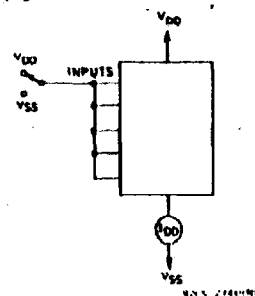


Fig. 12 — Quiescent device current test circuit.

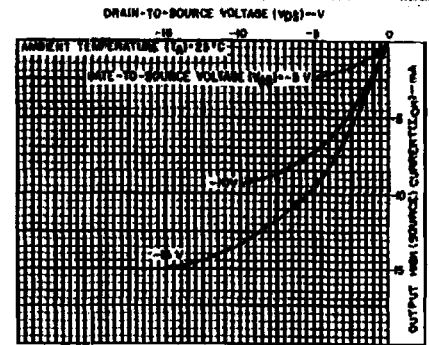


Fig. 6 — Minimum output high (source) current characteristics.

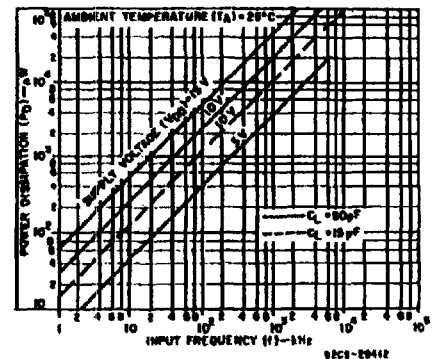


Fig. 7 — Typical dynamic power dissipation as a function of input frequency.

TYPICAL APPLICATIONS

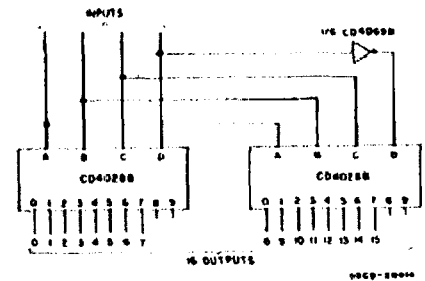
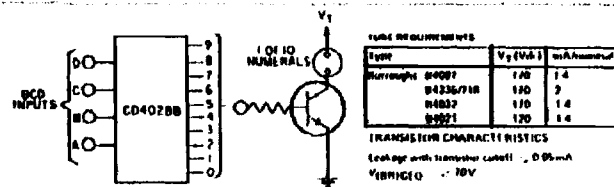


Fig. 13 — Code conversion circuit.

The circuit shown in Fig. 13 converts any 4-bit code to a decimal or hexadecimal code. Table 2 shows a number of codes and the decimal or hexadecimal number in these codes which must be applied to the input terminals of the CD4028B to select a particular output. For example: in order to get a high on output No. 8 the input must be either an 8 expressed in 4-Bit Binary code, a 15 expressed in 4-Bit Gray code, or a 5 expressed in Excess-3 code.

CD4028B Types



[†](Trademark) Burroughs Corp.

92CS-29013

Fig. 14 - Neon readout (Nixie Tube[†]) display application.

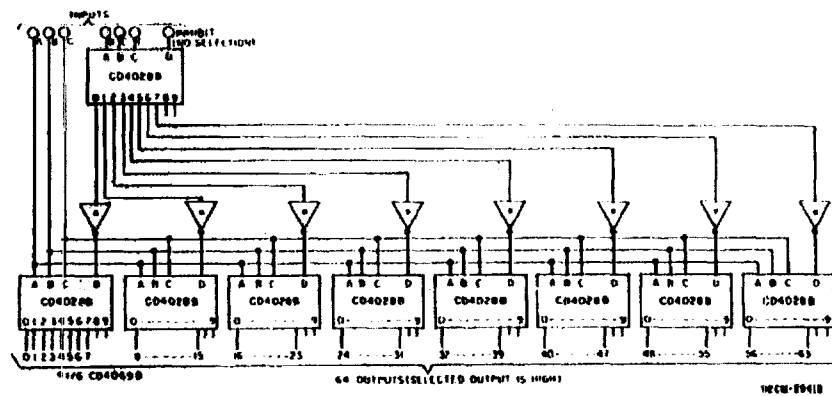
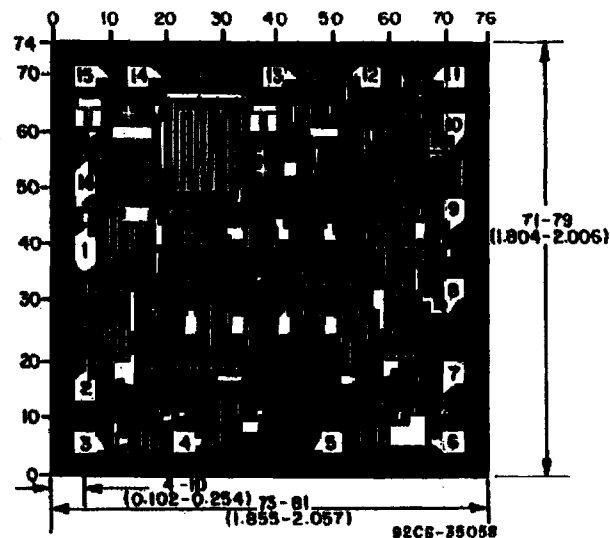


Fig. 15 - 6-bit binary to 1-of-64 address decoder.



CD4028BH DIMENSIONS AND PAD LAYOUT

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