Encoder

An encoder is a combinational logic circuit that essentially performs a "reverse" decoder function.

An encoder accepts an active level on one of its inputs representing a digit, such as a decimal or octal digit, and converts it to a coded output, such as BCD or binary.

- encoders can also be devised to encode various symbols and alphabetic characters
- the process of converting from familiar symbols or numbers to a coded format is called encoding

Agenda

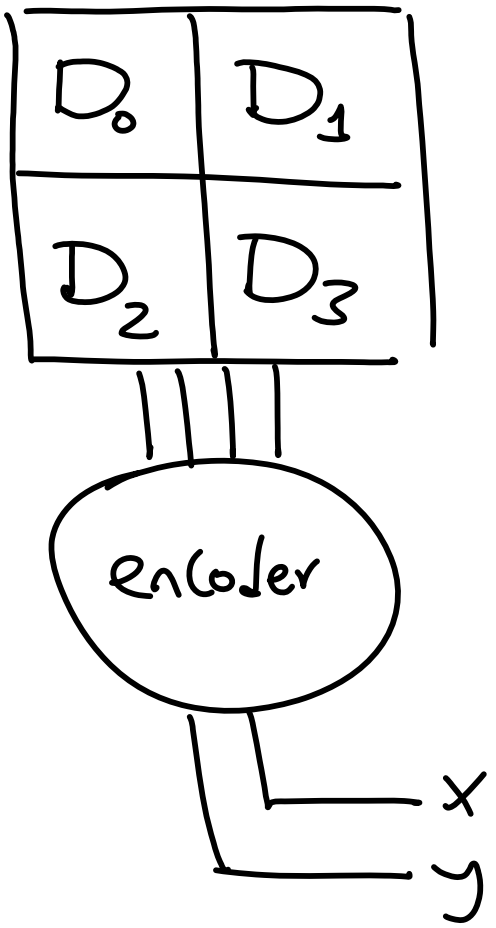
- How to design an encoder
- priority encoder
- 74147 decimal-to-BCD priority encoder
- Applications

Encoder

Input : 2^n lines (keys - buttons)

Output : n bits

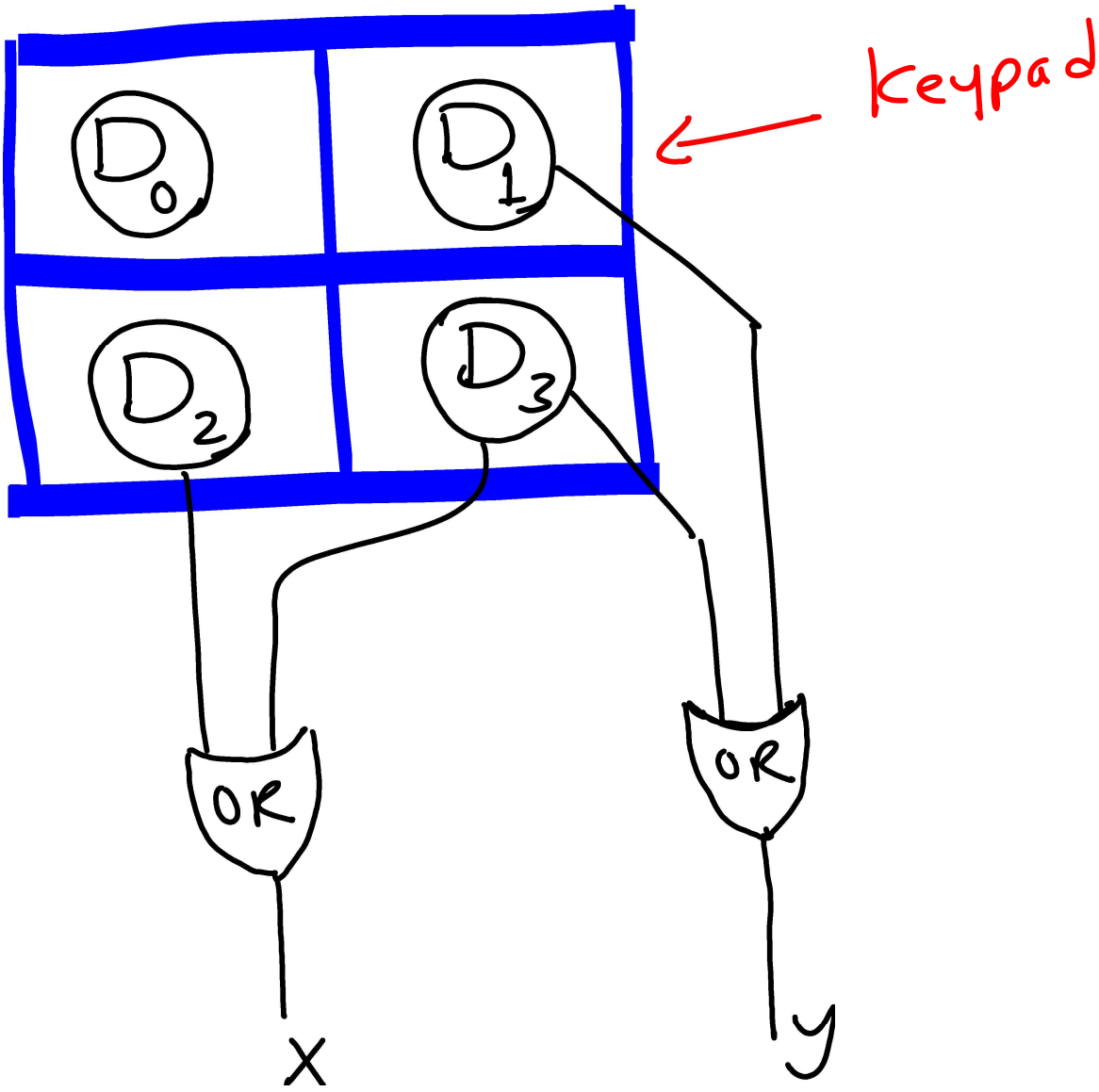
Output is binary coding of input that is being pressed



D_0	D_1	D_2	D_3	x	y
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

$x = D_2 + D_3$ $\Rightarrow$ Make sure by karnaugh

$y = D_1 + D_3$



Note:

- if D_0 is not pressed, what is the output?
- if D_0 is pressed, what is the output?
- where are the other possible combinations of the input

- Here we assume only one input is pressed on a time

Note: to differentiate between the case where no button is pressed and the case where any one is pressed → we need to add one more bit

D_0	D_1	D_2	D_3	V	x	y
0	0	0	0	0	0	0
1	0	0	0	1	0	0
0	1	0	0	1	0	1
0	0	1	0	1	1	0
0	0	1	1	1	1	1

if V = 0, no button is pressed

What should we output if multiple lines are pressed?

⇓ priority encoder

- if multiple lines are pressed, give priority to one of the buttons
- Example: 4-to-1 priority encoder

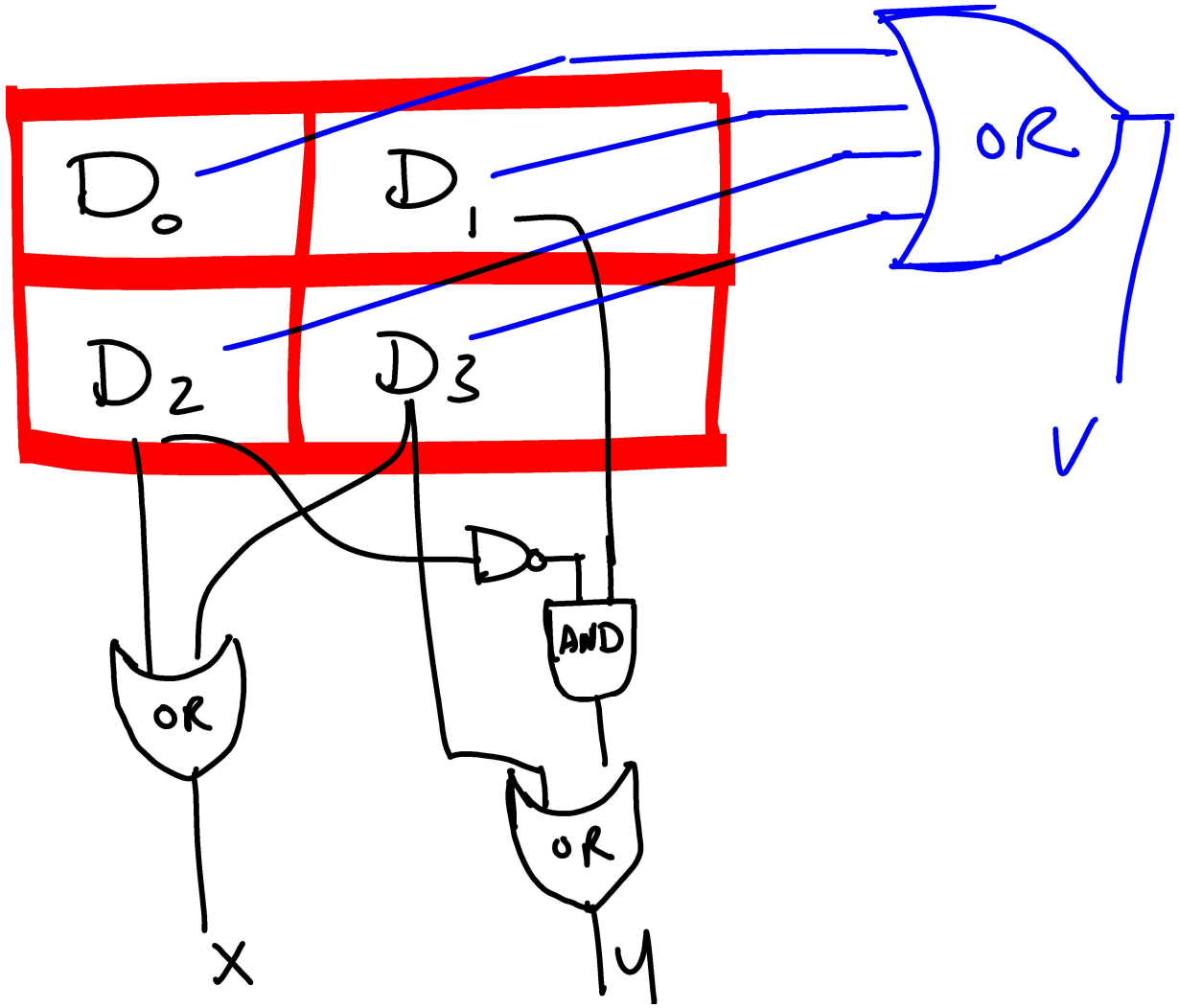
D_0	D_1	D_2	D_3	x	y	V
0	0	0	0	x	x	0
1	0	0	0	0	0	1
x	1	0	0	0	1	1
x	x	1	0	1	0	1
x	x	x	1	1	1	1

↑ highest priority

$X = D_2 + D_3 \Rightarrow$ make sure by Karnaugh

$y = D_3 + D_1\overline{D_2} \Rightarrow$ make sure

$V = D_0 + D_1 + D_2 + D_3$



InfoNote :

An Assembler can be thought of as a software encoder because it interprets the mnemonic instructions with which a program is written and carries out the applicable encoding to Convert each mnemonic to amachine code instruction (series of 1s and 0s) that the processor can understand

Example of mnemonics

ADD — MOV — MuL — XOR —

JMP — Out

Decimal-to-BCD Encoder

D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	A_3	A_2	A_1	A_0
1	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	1
0	0	1	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	0	0	0	1	0	0
0	0	0	0	0	1	0	0	0	0	0	1	0	1
0	0	0	0	0	0	1	0	0	0	0	1	1	0
0	0	0	0	0	0	0	1	0	0	0	1	1	1
0	0	0	0	0	0	0	0	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1	1	0	0	1

⇓

may be represented simply as

⇓

Decimal Digit	BCD A_3	A_2	A_1	A_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

button pressed

$A_3 = \sum(8,9)$ ⟹ X wrong

↑ it is not midterm

$A_3 = 1$ in case button 8 and Button 9 is pressed

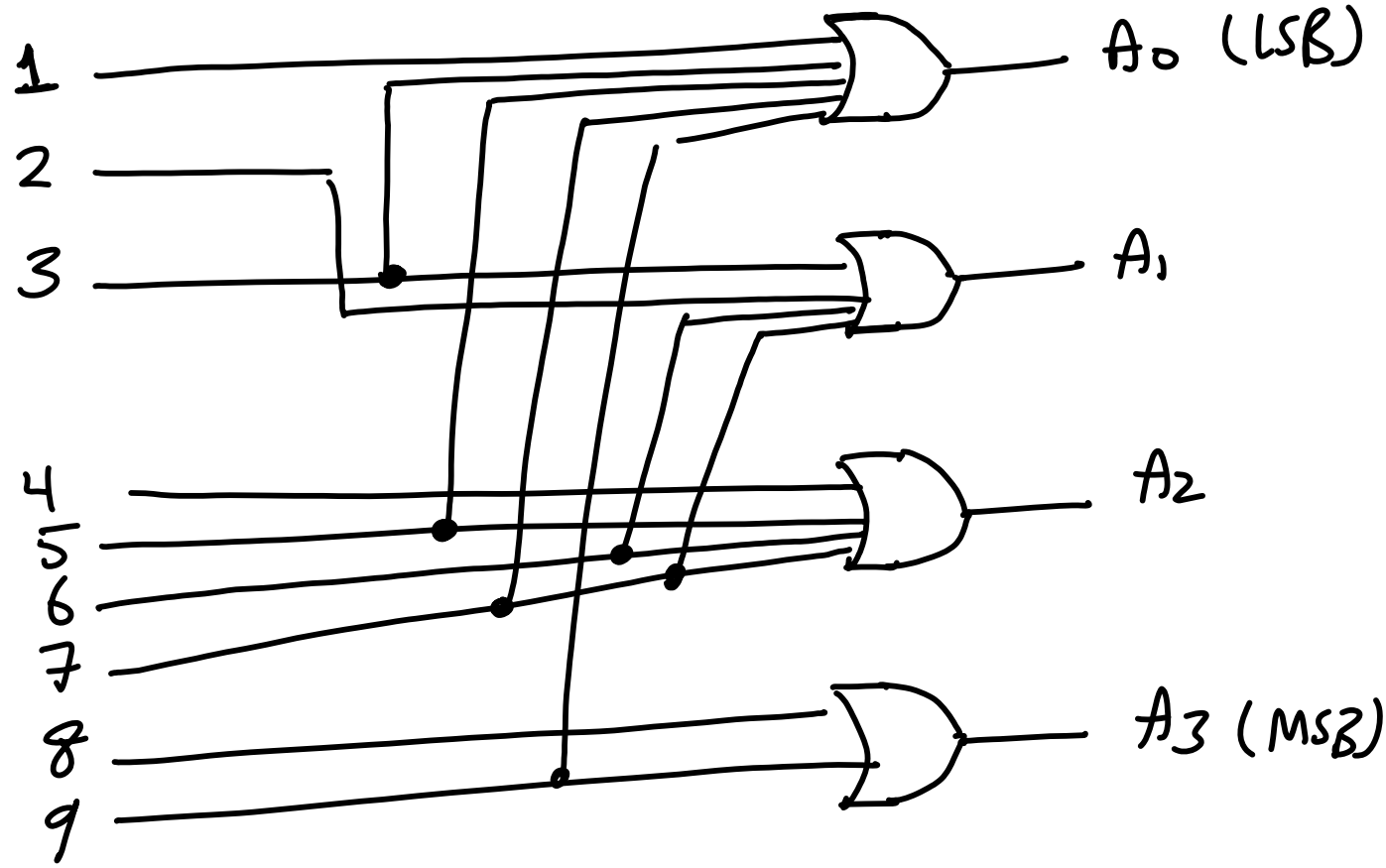
$A_3 = 8 + 9$ button 8 and button 9

↳ check by karnaugh

$A_2 = 4 + 5 + 6 + 7$

$A_1 = 2 + 3 + 6 + 7$

$A_0 = 1 + 3 + 5 + 7 + 9$



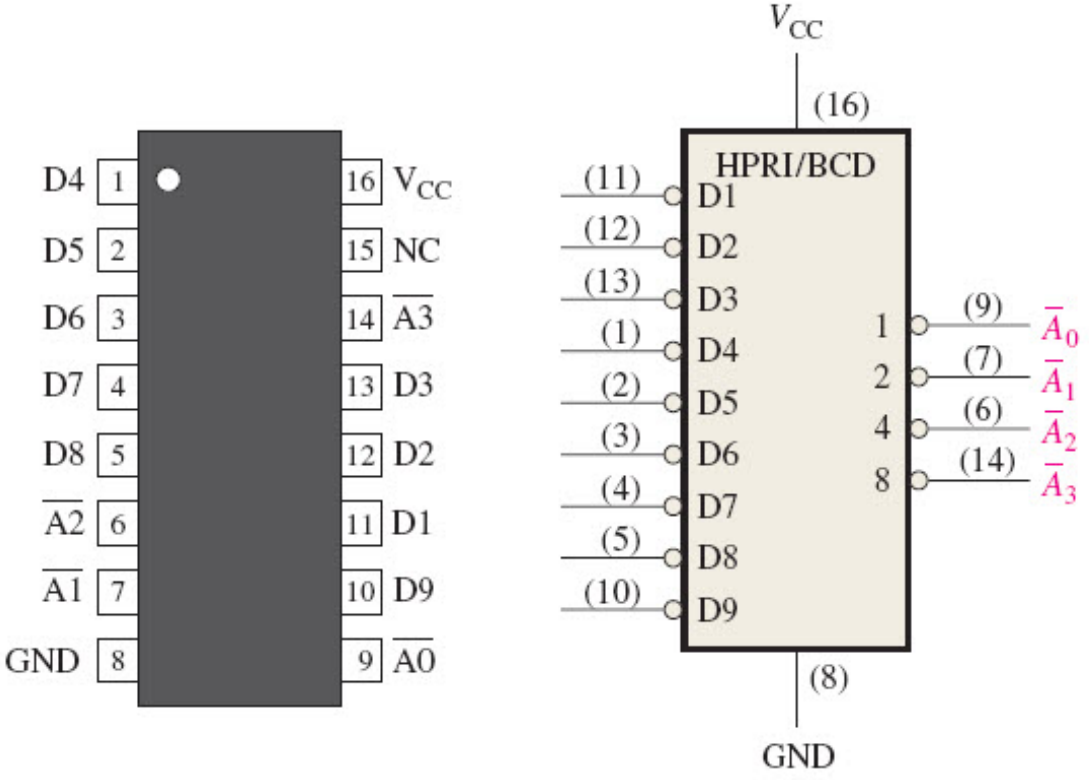
When a high appears on one of the decimal digit input line (button), the appropriate levels occur on the four BCD output line

Decimal_to_BCD priority encoder

- A priority encoder can be used in applications that require priority detection.
- the encoder will produce a BCD output corresponding to the highest_order decimal input that is active and will ignore any other lower-order active inputs

- if the 6 and the 3 inputs are both active (pressed), the BCD output is 0110 (which represent decimal 6)

74147 priority encoder ⇒ active low inputs and active low BCD output



(a) Pin diagram (b) Logic diagram

The 74HC147 decimal-to-BCD encoder (HPRI means highest value input has priority.

- A BCD zero output is represented when none of the inputs is active

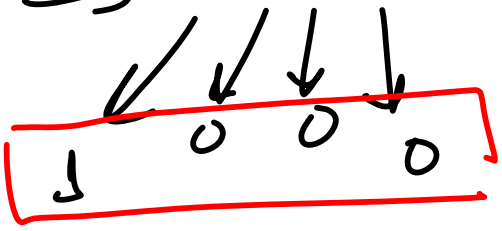
Ex

if low levels appear on pins, 1, 4 and 13 of the 74HC147 — Indicate the state of the four outputs. All other inputs are high

⇓ according to priority

Pin 4 ⇒ D7 is the highest priority

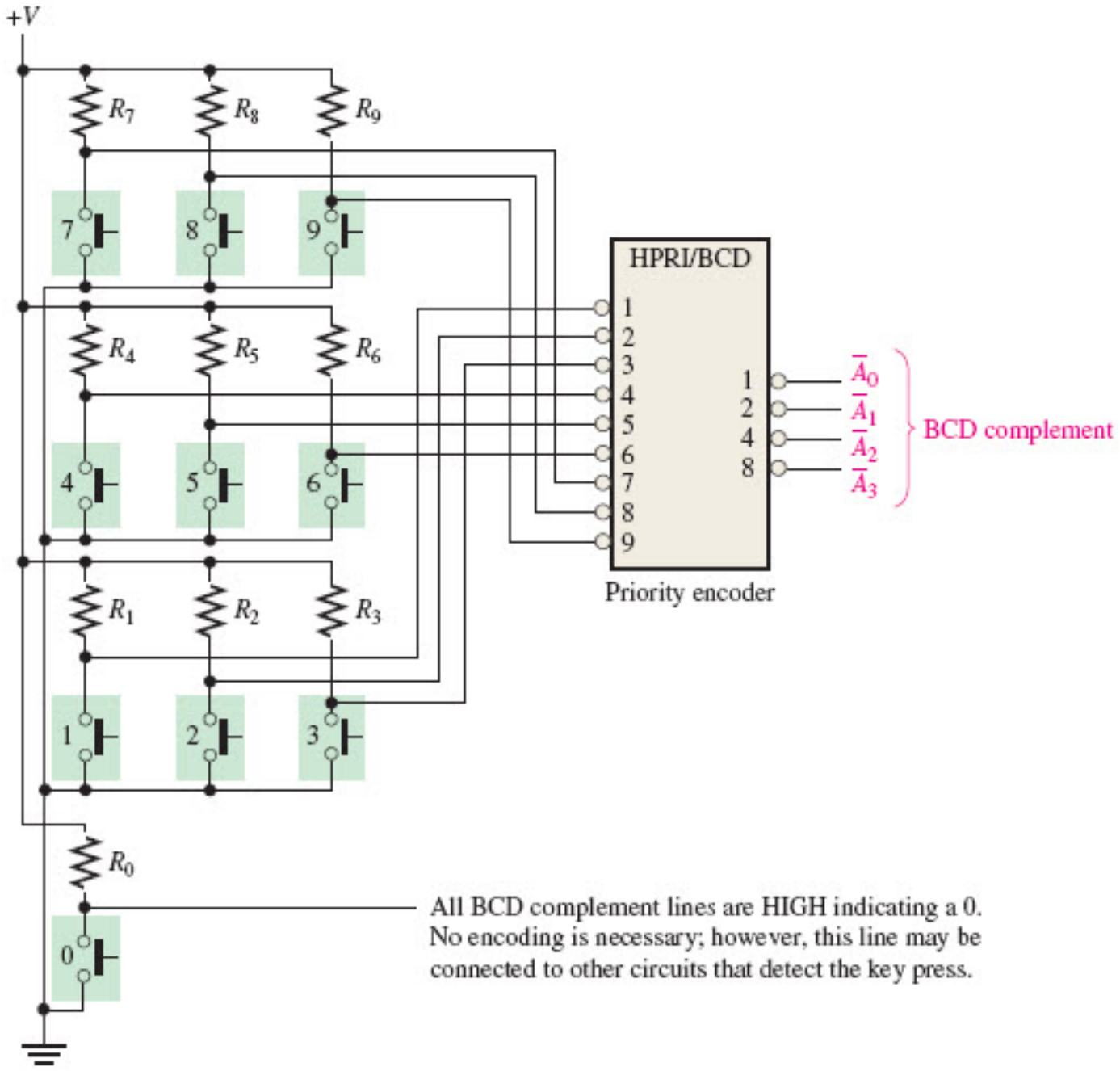
7 ⇒ 0 1 1 1



Ex what are the outputs of the 74HC147 if all its inputs are low? if all its inputs are High?

An application

the ten decimal digits on a numeric keypad must be encoded for processing by the logic circuitry. In this project when one of the keys is pressed, the decimal digit is encoded to the corresponding BCD code



A simplified keyboard encoder.