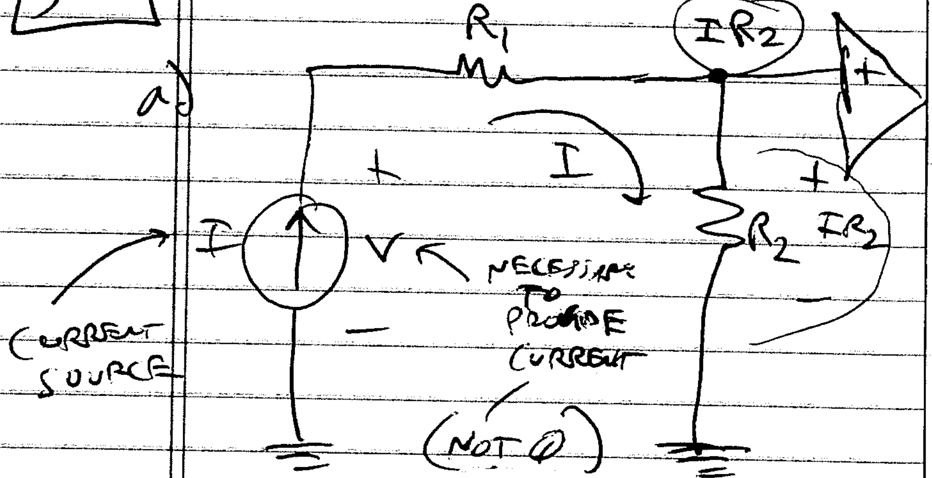
SKIP

SPRING

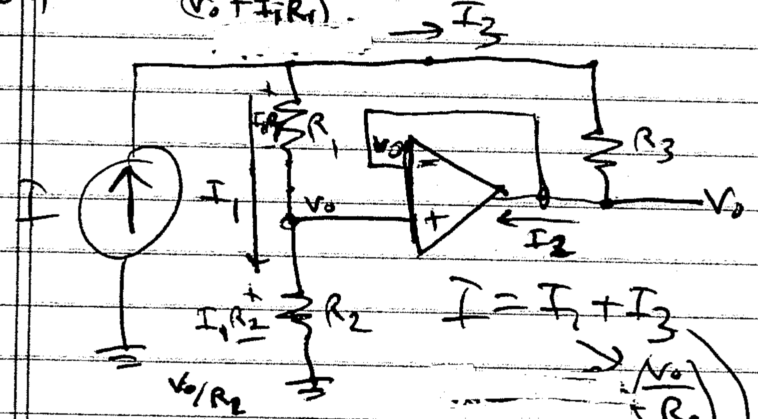
OP AMP HANGER FEEDBACK

5-2

a)



b)



$I = I_1 + I_3$

$= \left(\frac{V_0}{R_2}\right)$

$$\frac{(V_0 + I_1R_1) - V_0}{R_3} = \frac{R_1}{R_3}\left(\frac{V_0}{R_2}\right)$$

AFTER VIDEO #9.13

DIGITAL ENCODER -

TWO TYPES:

(combo of 0's & 1's)

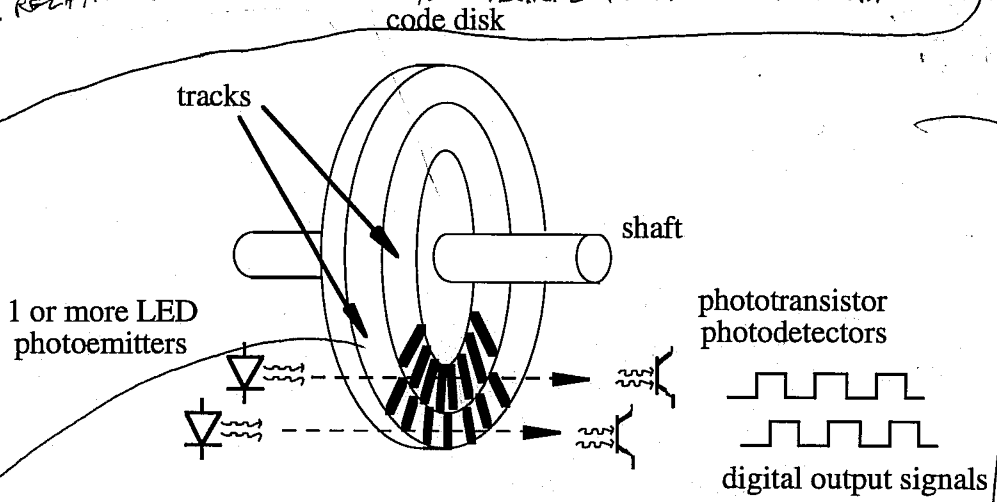
- ABSOLUTE: UNIQUE CODE FOR EACH POSITION
- RELATIVE (INCREMENTAL): COUNT PULSES DURING MOTION TO DETERMINE RELATIVE DISPLACEMENT

- GRAY CODE
- BINARY CODE

RELATIVE

SEE ENCODER VIDEO

1st



9.12 (a) schematic

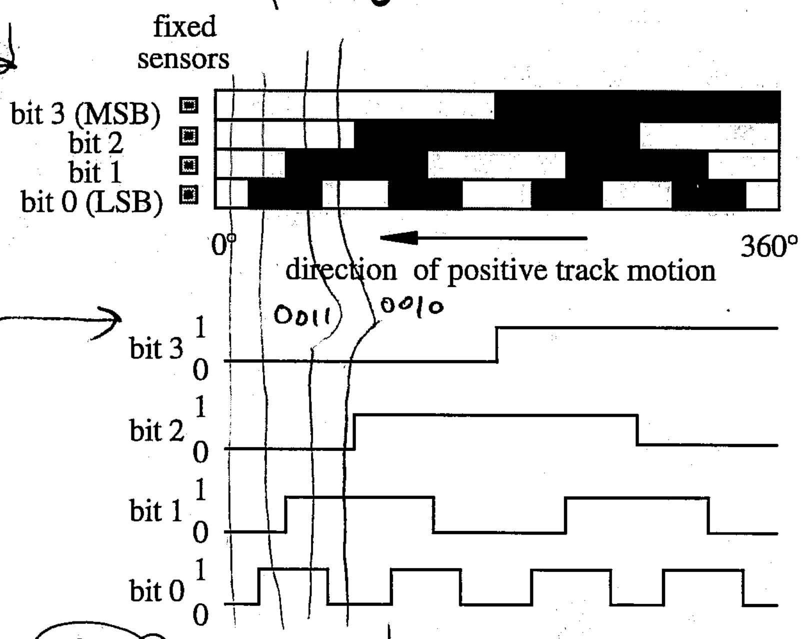
Figure 9.12 Components of an Optical Encoder

(p. 385)

IF CUT & LAYED OUT STRAIGHT

(or linear encoder element)

ex:



9.13 NOT BINARY COUNTING SEQ.

Figure 9.13 4-Bit Gray Code Absolute Encoder Disk Track Patterns

CLASS LOOK @ IT TO CONVINCE YOURSELF

ONLY 1 BIT CHANGES DURING EACH TRANSITION

(see CDI 8.3 for reason)

SHADES of GRAY 0000 → 1111

black or white

white or black

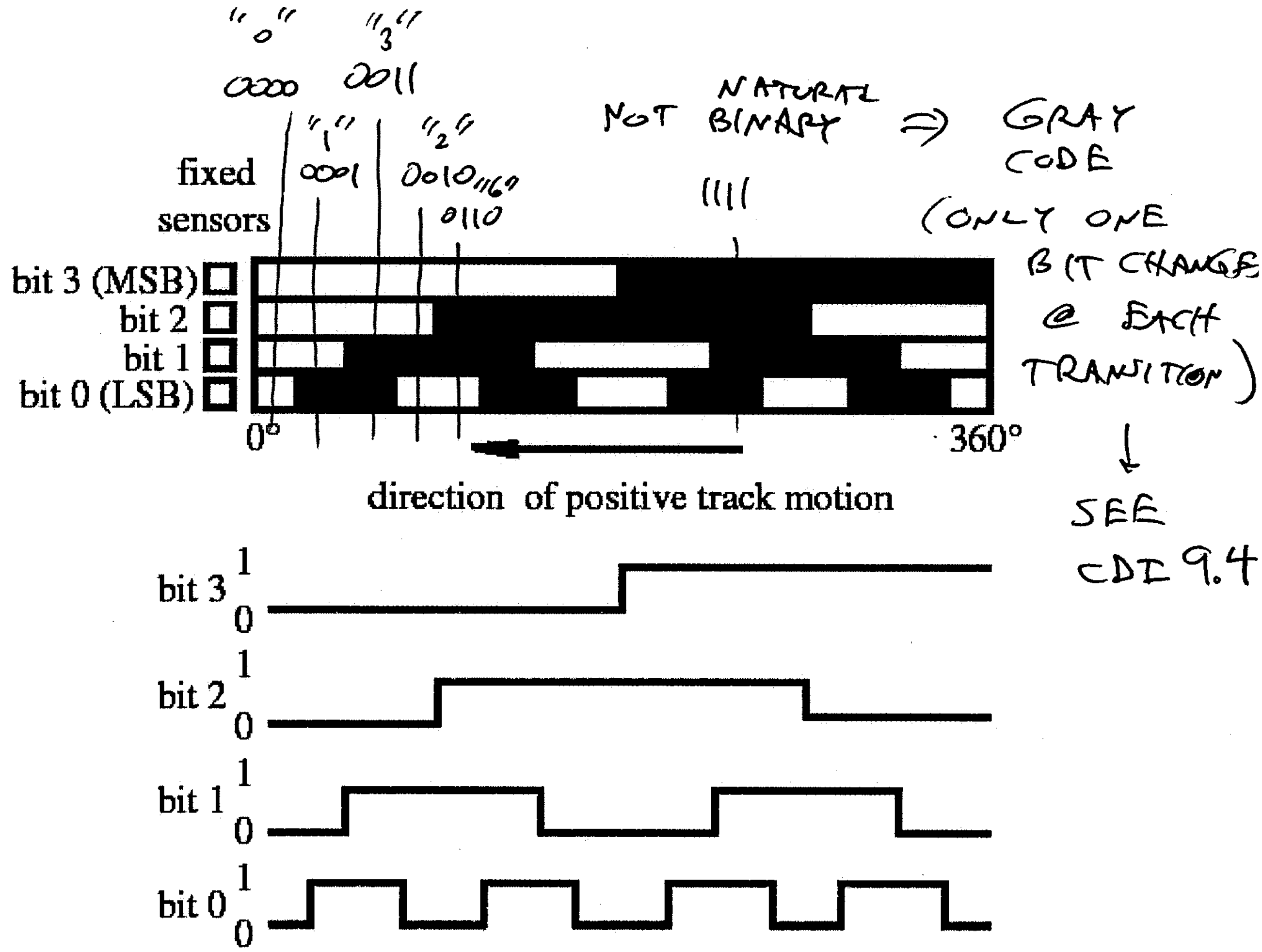
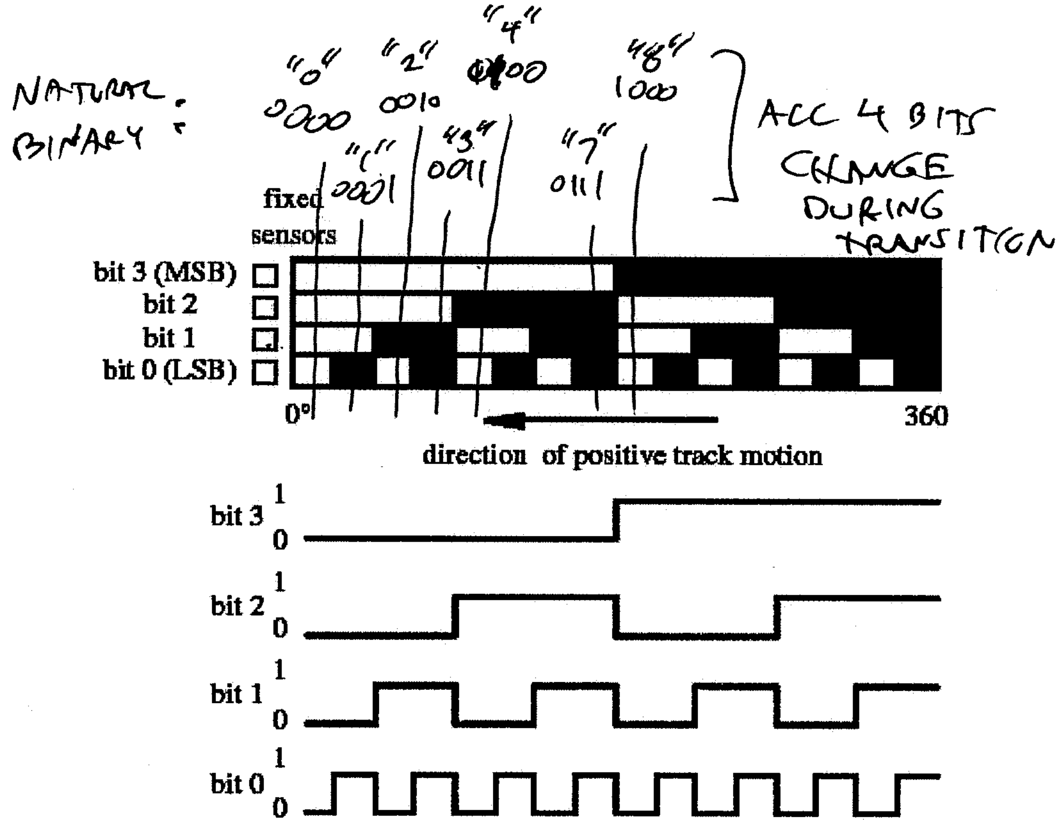
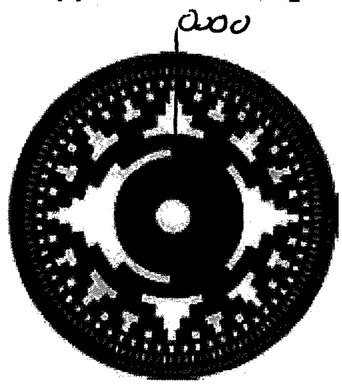


Figure 9.13 (p. 385)

NATURAL BINARY:



(*a*) schematic and signals



(*b*) actual disk *(Courtesy of Parker Compumotor Division, Rohnert Park, CA)*

Figure 9.14 (p. 385)

ENCODER ≡ A/D CONVERTER
ANALOG DISPLACEMENT

$n = 4$
$N = 2^n = 16$ STATES

Decimal Code	Rotation Range (°)	Natural binary code ($B_3B_2B_1B_0$)	Gray code ($G_3G_2G_1G_0$)	
0	0–22.5	0000	0000	
1	22.5–45	0001	0001	
2	45–67.5	0010	0011	
3	67.5–90	0011	0010	
4	90–112.5	0100	0110	F 9.15
5	112.5–135	0101	0111	
6	135–157.5	0110	0101	
7	157.5–180	0111	0100	CDI
8	180–202.5	1000	1100	9.4
9	202.5–225	1001	1101	
10	225–247.5	1010	1111	
11	24 7.5–270	1011	1110	
12	270–292.5	1100	1010	
13	292.5–315	1101	1011	
14	315–337.5	1110	1001	
15	337.5–360	1111	1000	

Table 9.1 (p. 386)

ADV: DESIRABLE OUTPUT
(POSITIONS #'D IN ORDER)

DISADV: MULTIPLE BITS CHANGE
@ TRANSITIONS
(~~SEE~~ CDI 9.4)

EX.) CODE "4" IN TAB 9.1 :

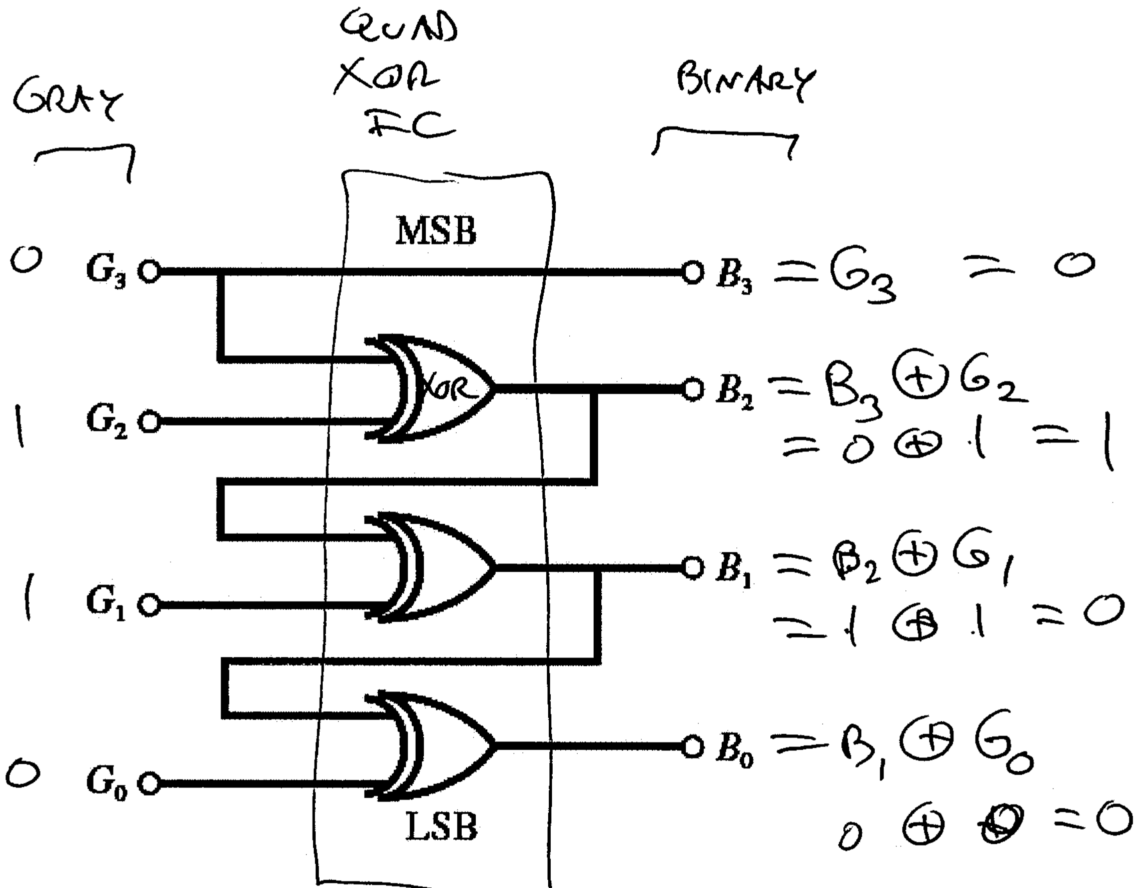


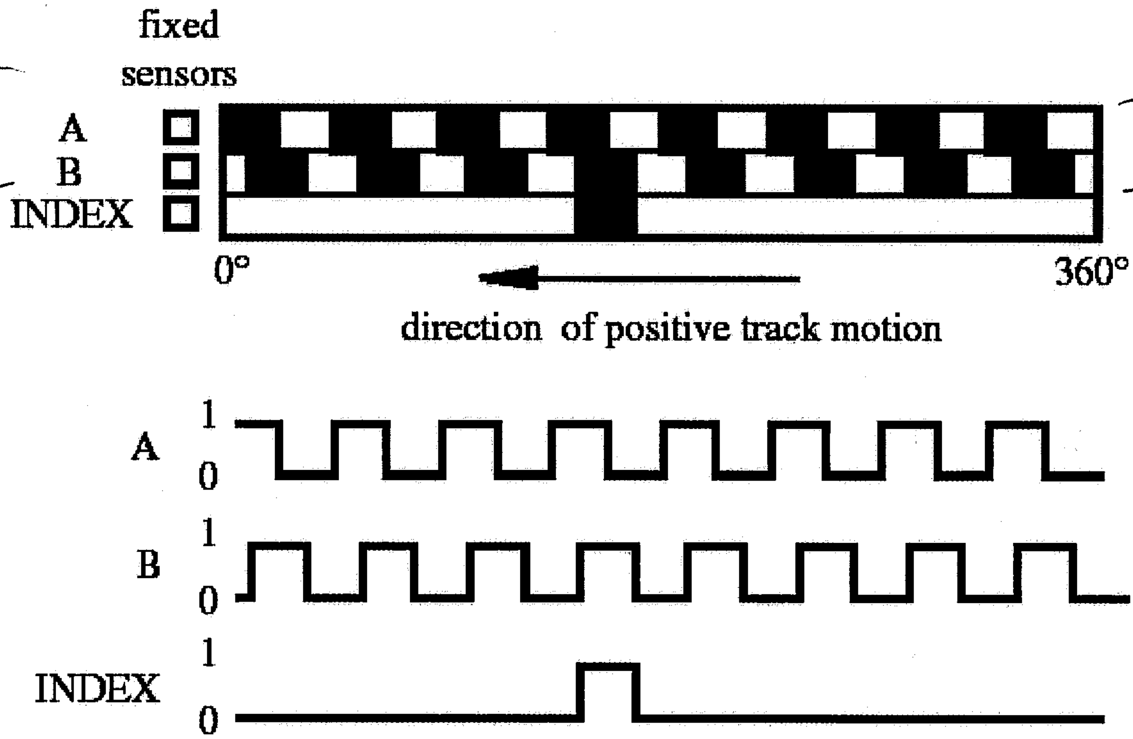
Figure 9.15 (p. 386)

<u>CDI 9.4</u> WHAT IS MAX COUNT UNCERTAINTY DURING TRANSITIONS IF SENSORS NOT ALIGNED PERFECTLY IN NATURAL BINARY ENCODER?

FIG 9.14 ⇒ DURING 7→8 TRANSITION, ALL SENSOR BITS CHANGE

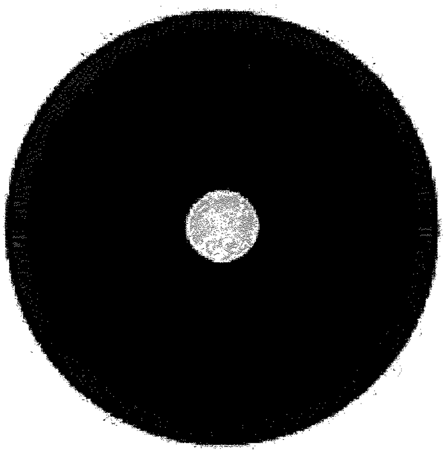
⇒ ANY DIGITAL VALUE CAN RESULT, DEPENDING ON SENSOR ALIGNMENT

OR 2 SENSOR OFFSET ON 1 TRACK
(LIKE VIDEO DEMO)



2 OFFSET TRACKS

(*a*) schematic and signals



(*b*) actual disk *(Courtesy of Parker Compumotor Division, Rohnert Park, CA)*

Figure 9.16 (p. 387)

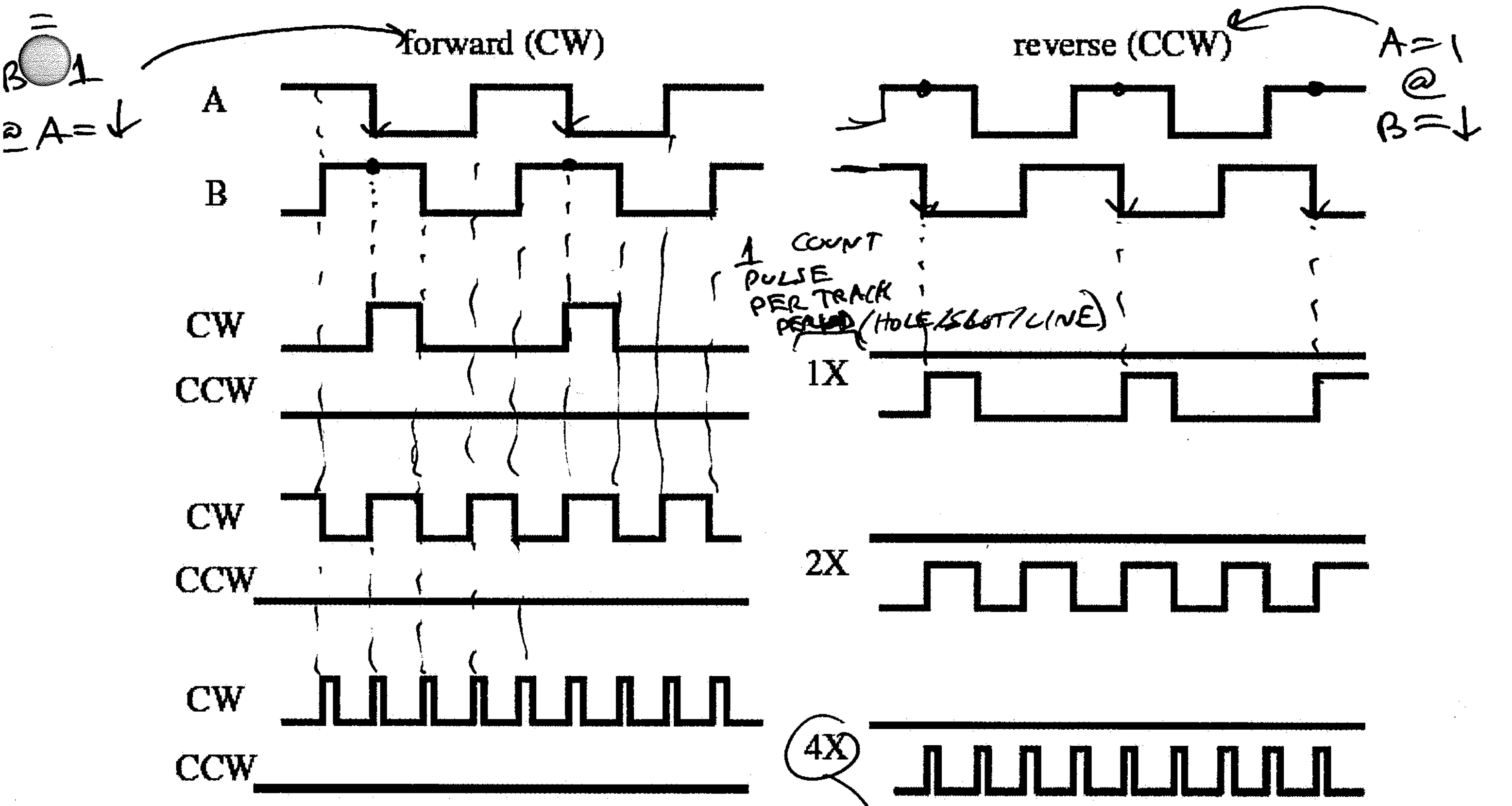
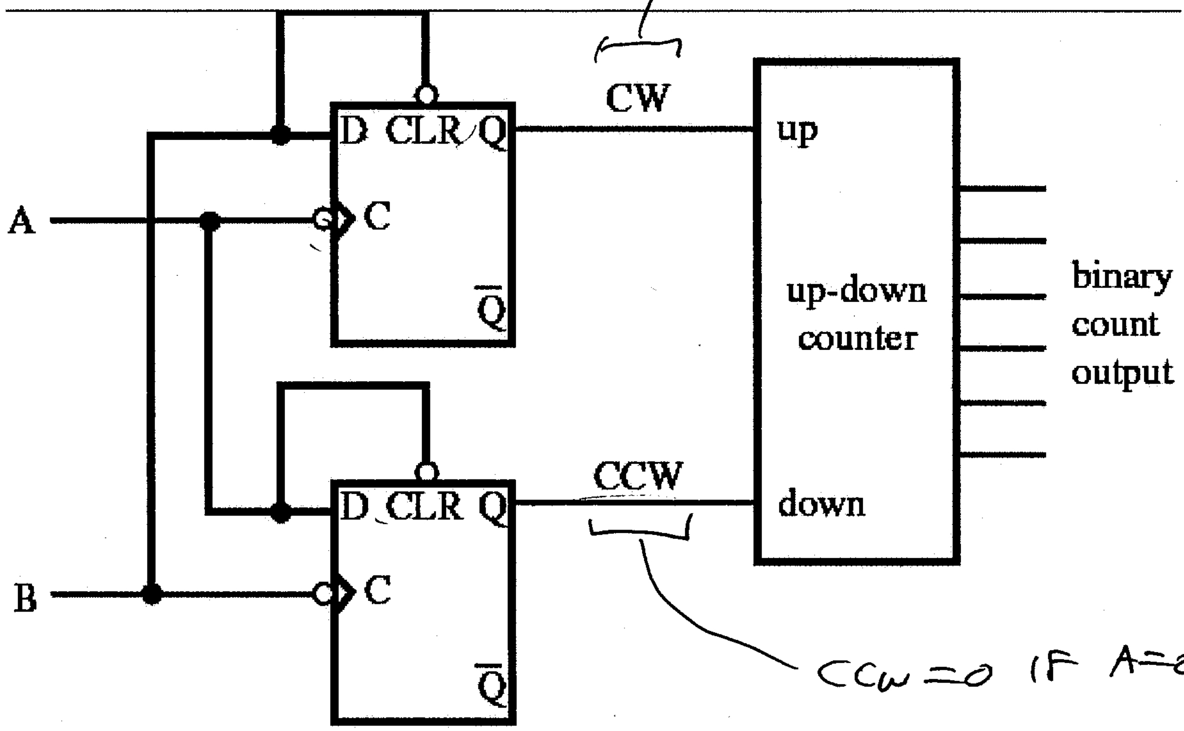


Figure 9.17 (p. 388)

⇒ 4X THE TRACK RESOLUTION IF WE COUNT PULSES @ EVERY EDGE OF BOTH SENSOR OUTPU

CW = 0 IF B = 0 [OR B=0 @ A=↓]
CW = 1 IF B = 1 @ A = ↓



CCW = 0 IF A = 0 [OR A=0 @ B=↓]
CCW = 1 IF A = 1 @ B = ↓

Figure 9.18 (p. 389)

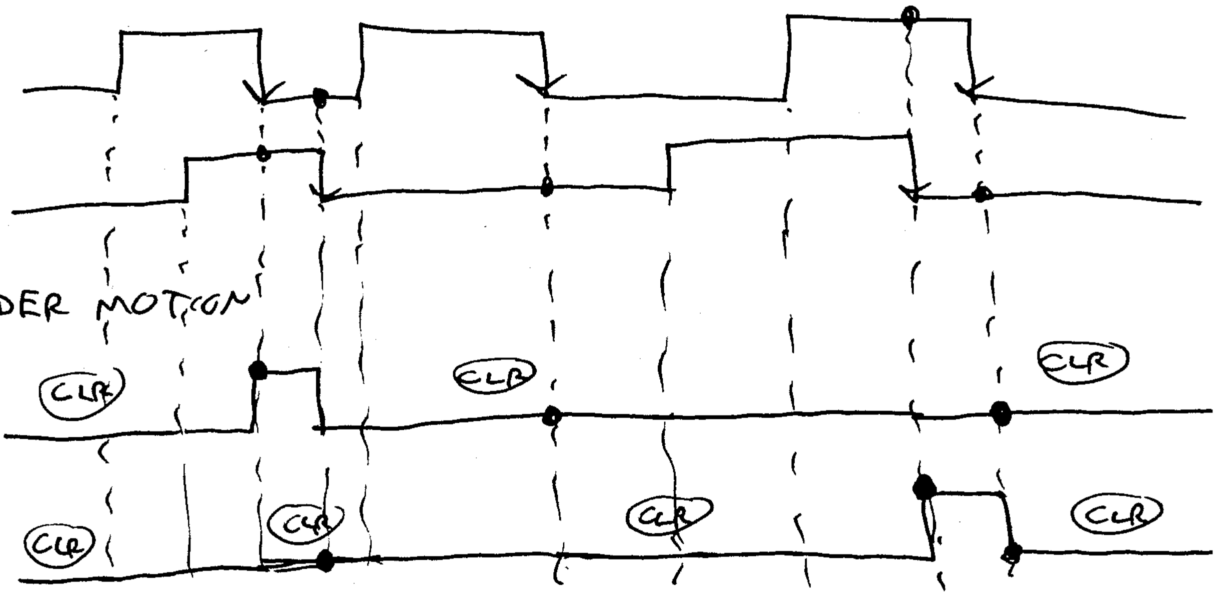
Ex.) F9.18

GIVEN: A, B

FIND: ENCODER MOTION

CW

CCW



⟹ ENCODER MOVED FORWARD 1 ANG INCREMENT & THEN BACK

Q 9.6 4X QUADRATURE INCREMENTAL ENCODER w/ CODE DISK CONTAINING 2500 SLOTS

FIND: ANGULAR RESOLUTION $\dfrac{360°}{2500\text{ SLOTS}} \cdot \dfrac{1\text{ SLOT}}{4\text{ PULSES}} = 0.036°/\text{PULSE}$