

Data Communications

* Lab 4 *

* Ch4 Part 1: Data Transmission *

P4.1:

Signal rate ?

data rate = 1Mbps , $c = \frac{1}{2}$.

Figure 4.2 :

$$S = C * N * \frac{1}{r}$$

① $r = 1$

$$S = \frac{1}{2} * 1M * \frac{1}{1} = \boxed{500 \text{ kbaud}}$$

② $r = \frac{1}{2}$

$$S = \frac{1}{2} * 1M * \frac{1}{1/2} = \boxed{1M \text{ baud}}$$

③ $r = 2$

$$S = \frac{1}{2} * 1M * \frac{1}{2} = \boxed{250 \text{ kbaud}}$$

④ $r = \frac{4}{3}$

$$S = \frac{1}{2} * 1M * \frac{1}{4/3} = \boxed{375 \text{ kbaud}}$$

P4.2:

sender clock is 0.2 percent faster than the receiver.

⇒ extra bit/sec if data rate = 1M?

Sol:

$$\frac{0.2}{100} \times 1 \text{ M} = \boxed{2 \text{ K bit}}$$

P4.3:

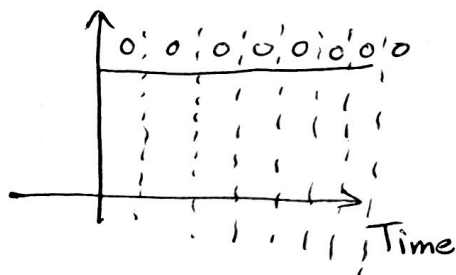
→ Draw the graph of NRZ-L schema.

→ assume last signal level has been positive.

→ BW (Bandwidth) = ?? using avg. number of changes.

Sol:

① 0000 0000



No. of changes = 0.

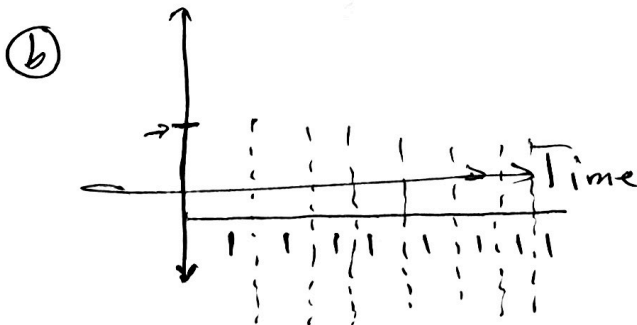
Note:

NRZ-L

(non return to zero - level)

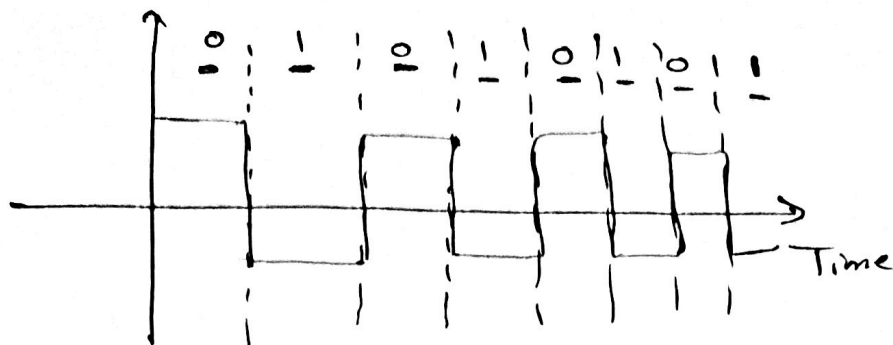
+ve : bit (0)

-ve : bit (1)



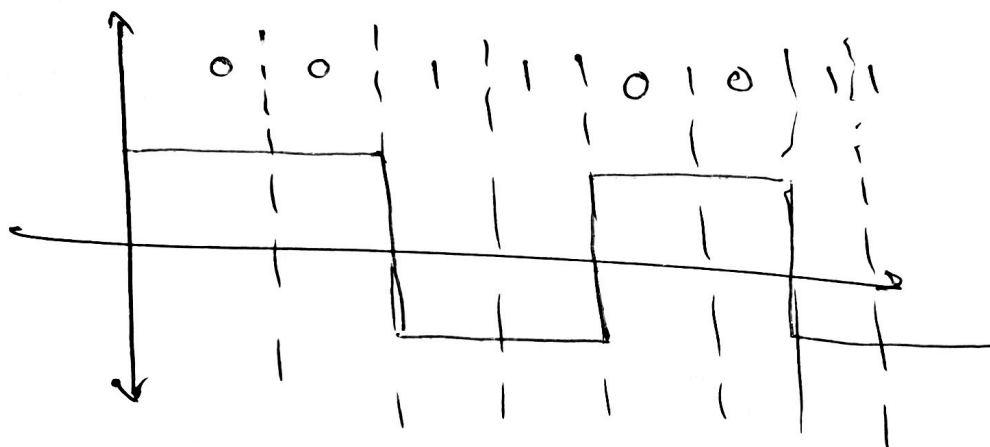
No. of changes = 01.

c) 0 1 0 1 0 1 0 1



No. of changes : $\boxed{7}$

d) 0 0 1 1 0 0 1 1



No. of changes : $\boxed{3}$

$$\Rightarrow \text{average number of changes: } \frac{0+0+7+3}{4} = \boxed{\frac{10}{4}}$$

$$= \boxed{2.75} \quad (N)$$

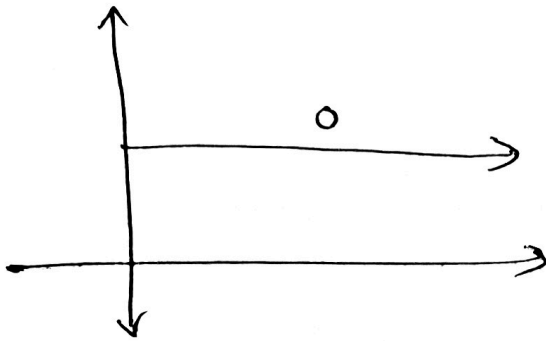
(Data rate is number of data element = $\frac{8}{8}$)

$$\boxed{BW = \left(\frac{2.75}{8}\right) N}$$

P4-4 : Repeat P4-3 for NRZ-1 scheme.

Sol :

(a) 0000 0000



No. change.

NRZ-1 :

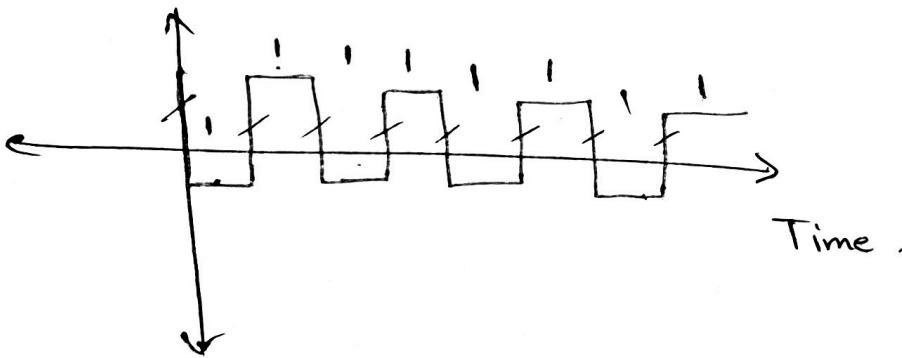
⇒ Next bit is $\boxed{0}$

Then, No inversion.

⇒ Next bit is $\boxed{1}$

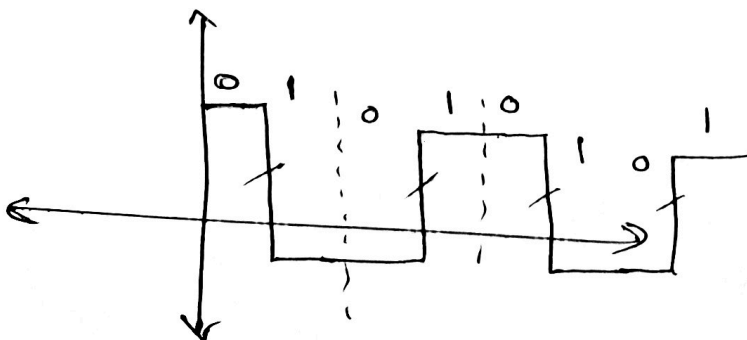
Inversion

(b) 1 1 1 1 1 1 1 1



No. of changes is $\boxed{8}$

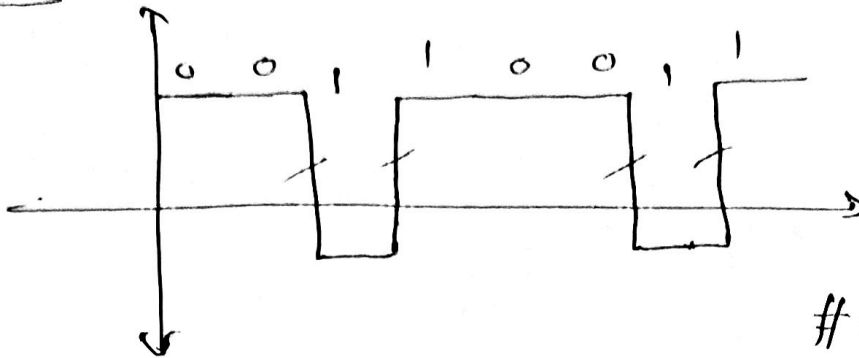
(c) 0 1 0 1 0 1 0 1



No. of changes is $\boxed{4}$

⑥ 00110011

Sol:



changes = 4

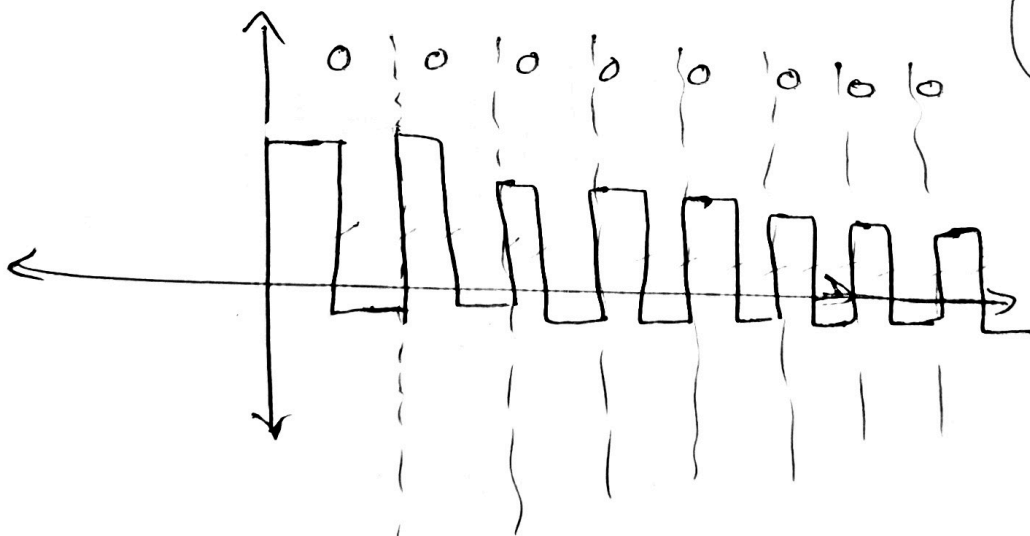
avg. of changes = $\frac{(0+8+4+4)}{4} = 4$, $N=8$

$$BW = \frac{4}{8} = \left[\frac{1}{2} \right] N = \left[N/2 \right]$$

P4-5: Repeat P4-3 for Manchester scheme.

Sol:

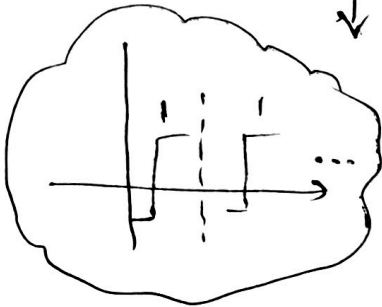
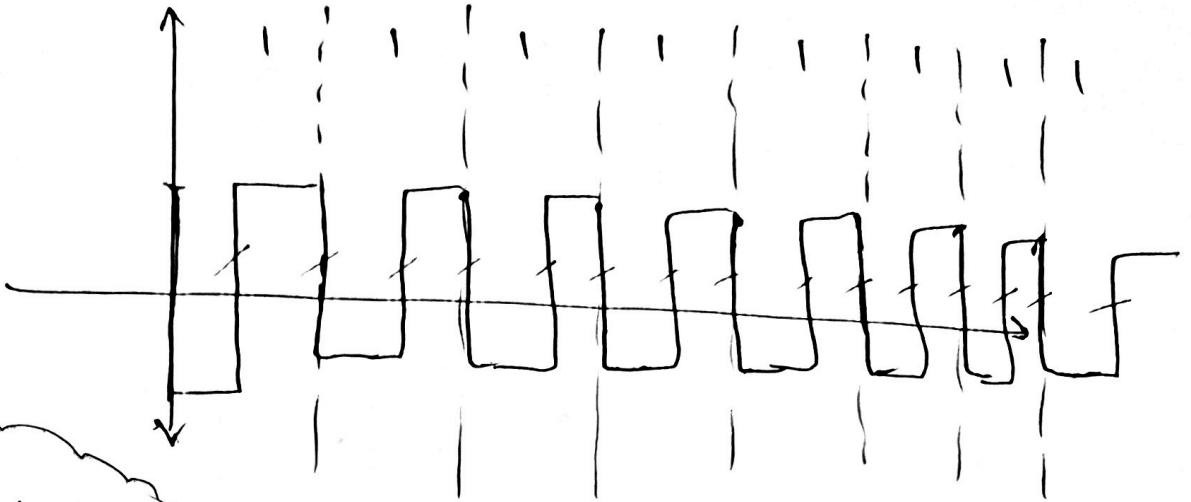
① 00000000



← ... No. changes = 15.

b) 1 1 1 1 1 1 1 1

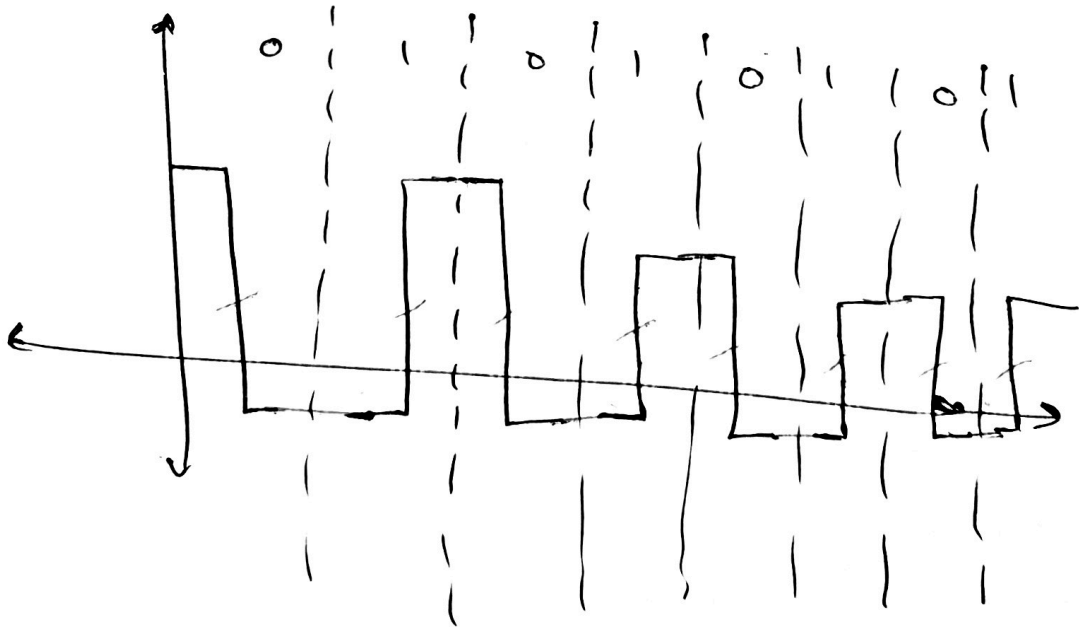
ΣP:



No changes = $\lceil 16 \rceil$

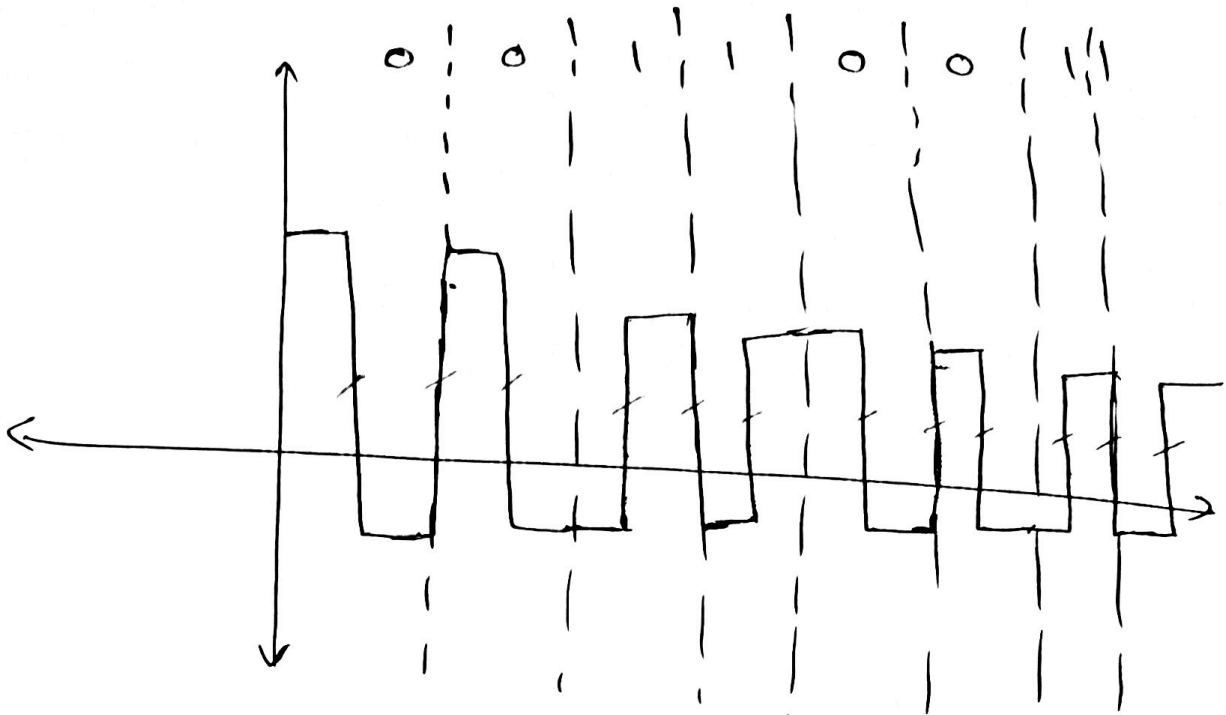
c) 0 1 0 1 0 1 0 1

ΣP:



changes = $\lceil 8 \rceil$

2 0 0 1 1 0 0 1 1



$$\# \text{ changes} = \boxed{12}$$

$$\text{avg.} = \frac{(15 + 15 + 8 + 12)}{4} = \boxed{12.75}$$

$$N = \boxed{8}$$

$$BW = \left(\frac{12.75}{8} N \right) \#$$

P4.6: Repeat P4-3 for differential Manchester.

Sol:

Differential Manchester:

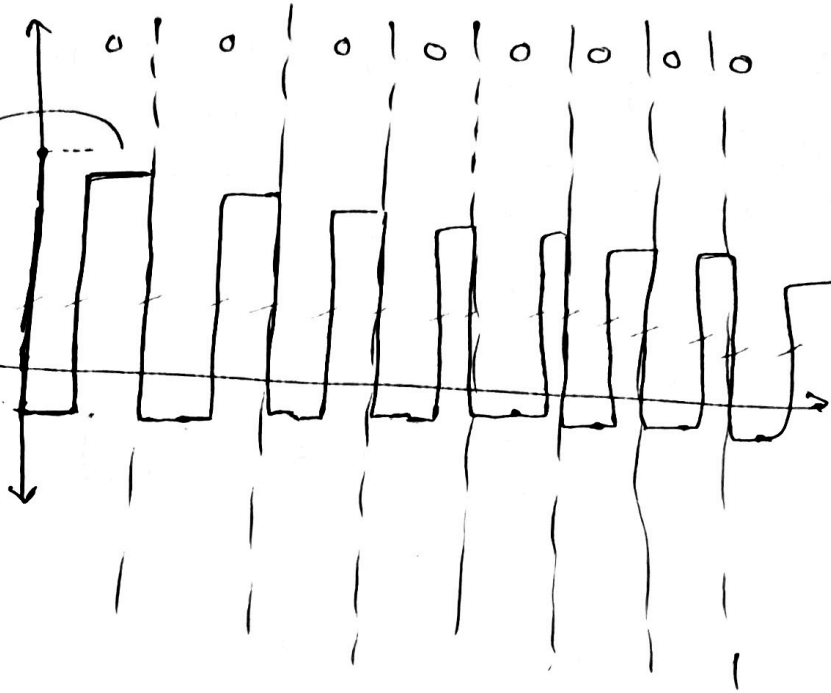
⇒ Next bit is 1
No inversion.

⇒ Next bit is 0 then inversion

⇒ (a) 0 0 0 0 0 0 0 0

sal:

این به 0
فاز signal
منشعب
و کنترل می‌شود.



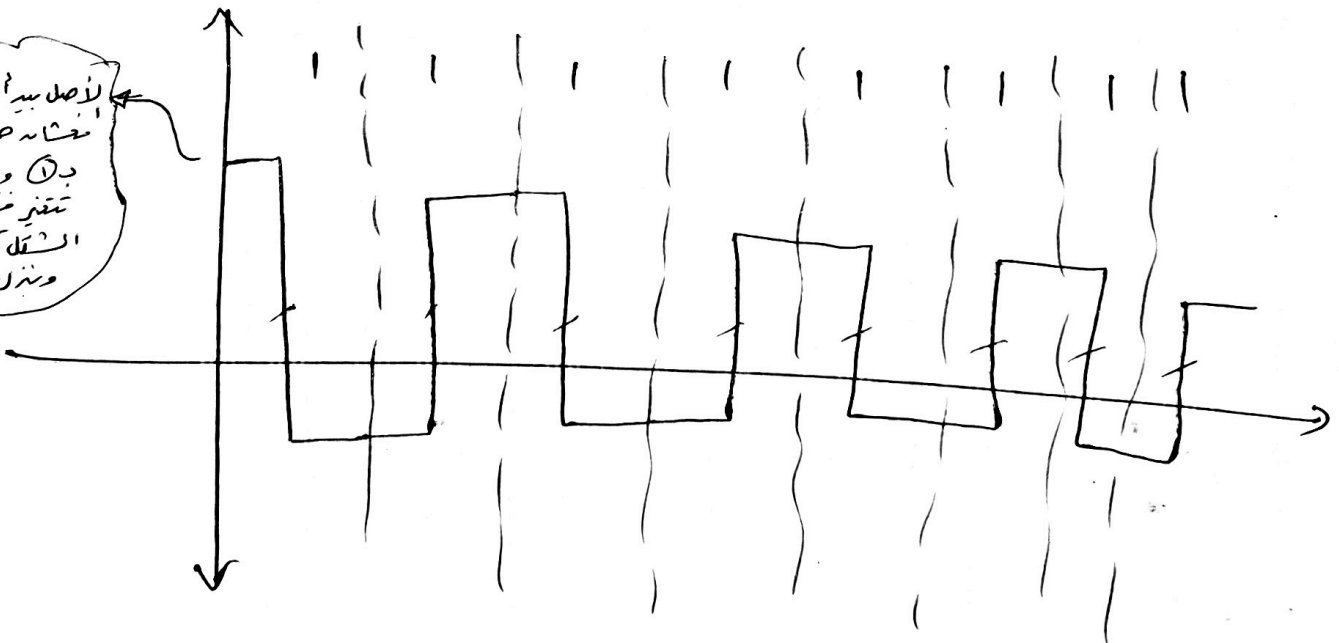
changes = 16

(b)

sal:

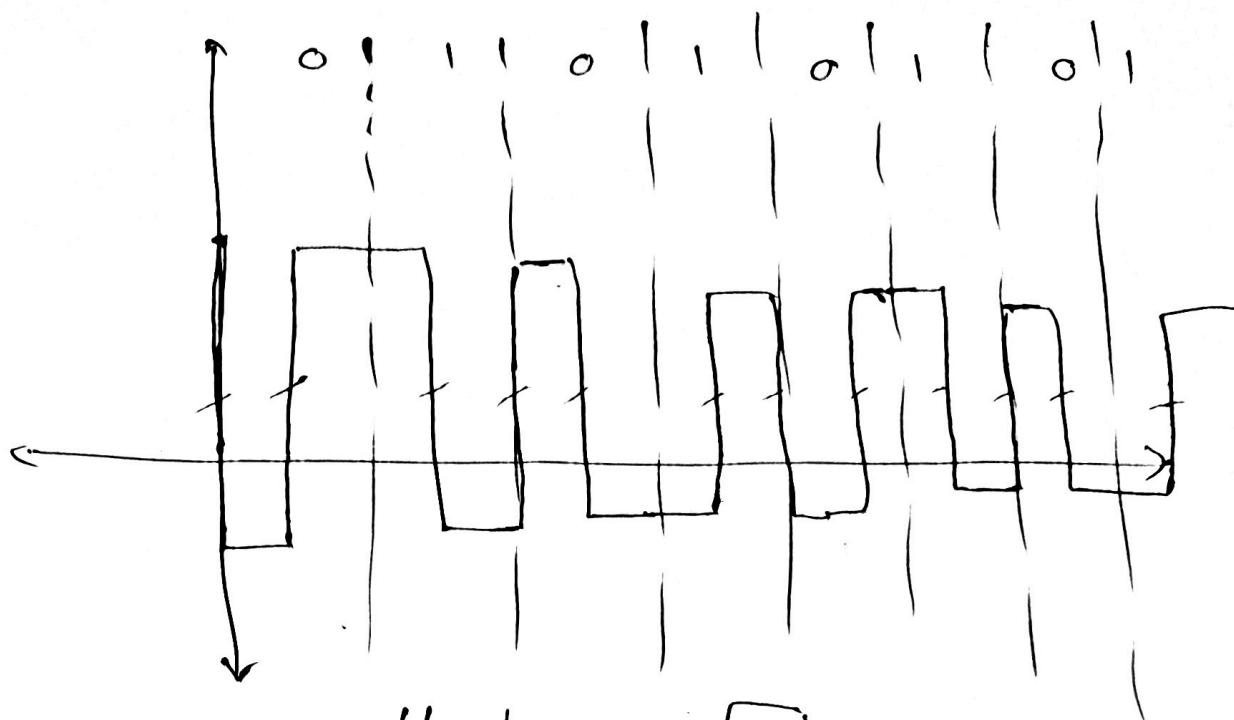
1 1 1 1 1 1 1 1

این به 1
فاز signal
منشعب
و کنترل می‌شود.



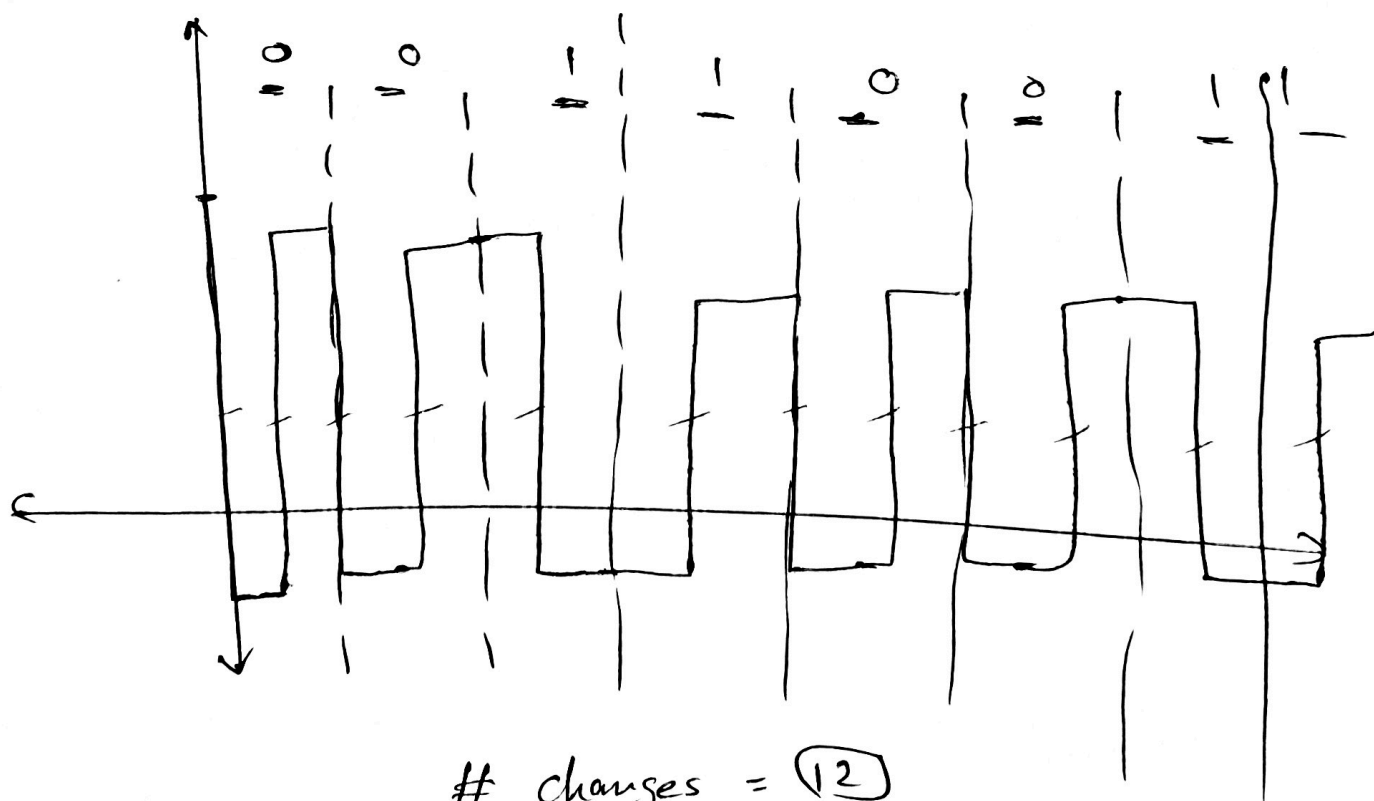
changes = 8

⇒ f = ③ 0 1 0 1 0 1 0 1



changes = 12

④ 0 0 1 1 0 0 1 1



changes = 12

$$\text{avg. of changes} = \frac{16 + 8 + 12 + 12}{4} = 12, N = 8$$

$$BW = 12/8 = (1.5) N \#$$

⑨