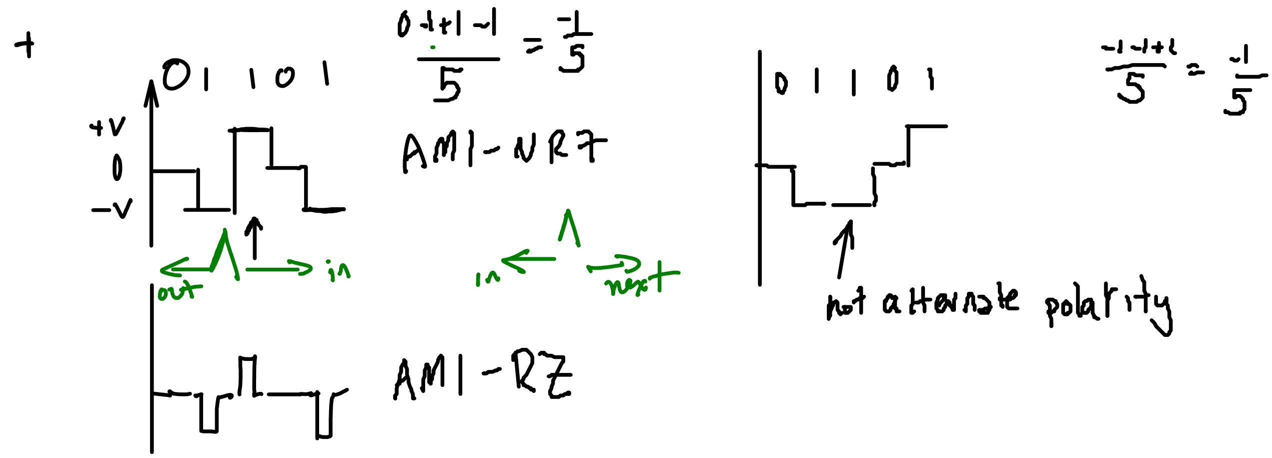
Exercise 1: Draw the waveform for an AMI-NRZ encoded sequence of bits '01101' assuming the previous mark was transmitted as a high. Draw the waveform assuming the second '1' indicates the start of a frame.



Exercise 2: What is the average DC value for the two cases in the previous exercise?

see above (no change, both $-\frac{1}{5}$ V)

Exercise 3: What might be some advantages of using a preamble? What might be some disadvantages?

adv.

- allows multiple protocols to coexist on same medium
- allows backwards compatibility for new signal & framing formats.

< 1 Mb/s
< 6 4 Mb/s.

dis.

- overhead fixed at slowest data rate

Exercise 4: By how much does the use of escape sequences slow down a link if random 8-bit characters are being transmitted? (1) What is the overhead if a continuous stream of escape characters need to be sent over the link? (2)

(2) ALL ESC

$\frac{\text{total sent}}{\text{original}} = \frac{2N}{N} = 2$ new datarate $= \frac{1}{2}$

(1) RANDOM

$P(ESC) = \frac{1}{256}$; $P(\text{any char}) = p$

$\sum p = 1$

$256 \cdot p = 1$

$p = \frac{1}{256}$

method 1 assume N characters are sent

$\frac{N}{256}$ are ESC

total char sent $= N + \frac{N}{256}$ (w/ ESC)

$= N$ (w/o ESC)

ratio of characters sent w/ to sent w/o escaping is $\frac{N + \frac{N}{256}}{N}$

$= 1 + \frac{1}{256}$ $\frac{257}{256}$ data rate $= \frac{256}{257} \cdot$ original rate method (1b)

prob. of having to send an extra character is $\frac{1}{256}$

$$\#\text{ of transmitted on average} = \left(\sum_{\substack{\text{char}=0,1,\ldots \\ \text{but} \neq \text{ESC}}}^{255} \frac{1}{256}\right) 1 + \frac{1}{256} \cdot 2$$

(# characters if not ESC; # characters if ESC)

$$= \overbrace{\left(\frac{1}{256} + \frac{1}{256} + \cdots + \frac{1}{256}\right)}^{255} \times 1 + \frac{1}{256} \times 2$$

$$= \frac{255}{256} \cdot 1 + \frac{1}{256} \cdot 2$$

$$\frac{255}{256} + \frac{2}{256} = \frac{257}{256}$$

w/ dogs 2 hour 10% 2×0.10

w/o dog 1 hour 90% $+ 1 \times 0.9 =$ 0.9

+ 0.2

1.1

0 111 1110

assume: min. bit stuffing is insert a '0' after 5 consecutive.

Exercise 5: Write out the complete sequence of 1's and 0's required to transmit the 12 bits 0110 1111 1100. Include the start and end flag sequences and any necessary bit stuffing.

count of 1's →

0 1 1 1 1 1 1 0   0 1 1 0   1 1 1 1 1 0 1   0 0   0 1 1 1 1 1 1 0

↑ "stuffed" 0 bit

HDLC →
SDLC
DATA LINK CONTROL

Exercise 6: An HDLC receiver sees the sequence 1000 0111 1110 1111 1001 0111 1110 0110. What data bits were contained within the frame?

1 0 0 0   0 1 1 1   1 1 1 0   1 1 1 1   1 0 0 1   0 1 1 1

1 1 1 0   0 1 1 0

1 1 1 1 1 0 1

data in frame

Exercise 7: A physical layer transmits 3-bits per symbol. A frame of 128 bytes is being transmitted. How many padding bits will have to be added to the frame?

$128 \text{ bytes} \times 8 \text{ bits/byte} = 2^7 \cdot 2^3 = 2^{10} = 1024 \text{ bits.}$

$$\frac{1024}{3 \text{ bits/symbol}} = 341.\dot{3} \text{ symbols}$$

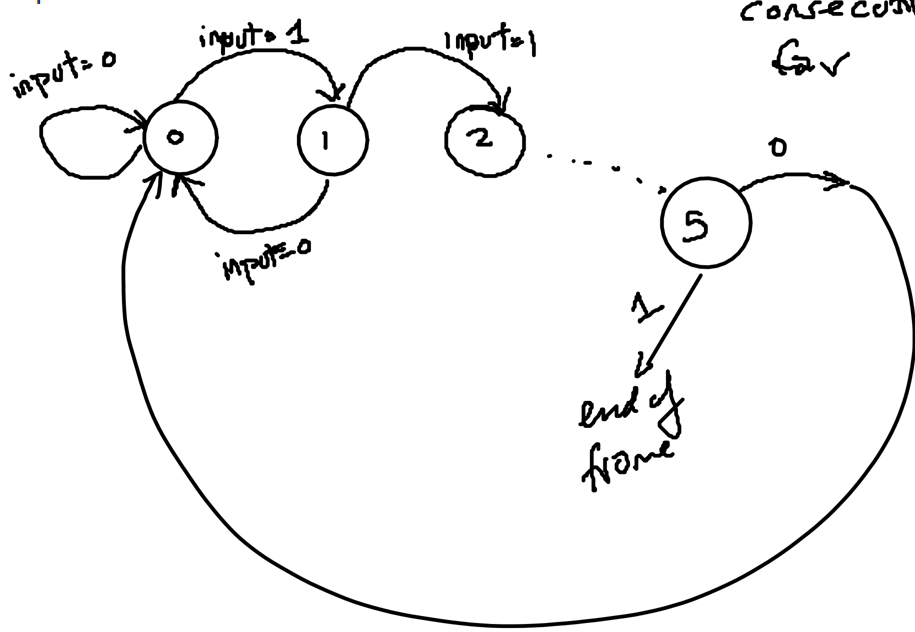
round <u>up</u> to 342 symbols transmitted.

total bits transmitted (including padding) $= 342 \times 3 = 1026$

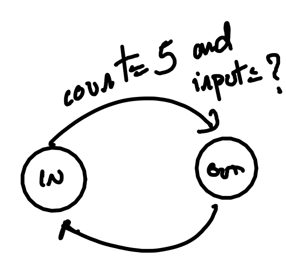
padding bits $= 1026 - 1024 = 2$

Exercise 8: How many states are required to implement a circuit that detects stuffed bits in an HDLC frame? How many bits of state are required?

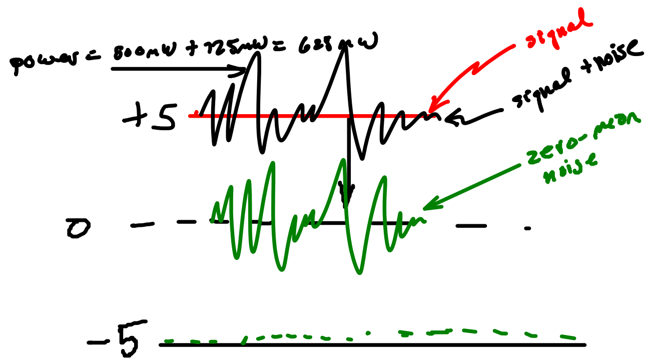
state number represents consecutive 1's seen thus far



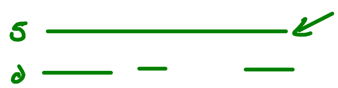
FSM



Mid-Term Questions



$$P(s(t) + n(t)) < 0$$



$$P(n(t)) < -5$$

power → $\overline{x}^2 = c$

RMS $\overline{x} = \sqrt{c}$

$$(\overline{5})^2 = 25\ V^2$$

5 is rms value

mean square value