

Line Coding Schemes

Line coding is the process of converting binary data, a sequence of bits to a digital signal.

Definitions of the components/Keywords:

1

Binary data can be transmitted using a number of different types of pulses. The choice of a particular pair of pulses to represent the symbols 1 and 0 is called Line Coding.

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The diagram illustrates the relationship between input data and a digital signal. The input data sequence is 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1. The digital signal is a square wave that transitions from low to high at the first rising edge of the input data and remains high for the duration of the input data sequence.

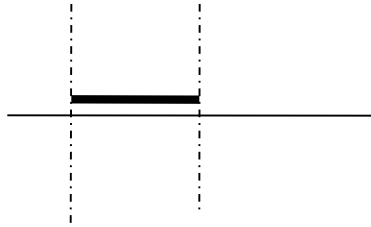
Input Data	Digital Signal
0	Low
1	High
1	High
0	High
1	High
1	High
1	High
0	High
1	High
0	High
1	High

1

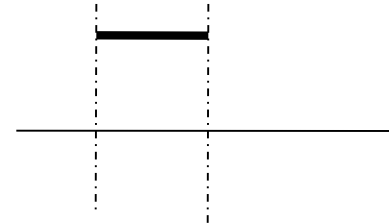
Step 1: unipolar NRZ (Non Return to Zero)

2

Representation of 0



Representation of 1



3

Instruction for the animator

- The first fig should appear then the second fig should appear.
- In parallel to the figures the text should be displayed.

Text to be displayed in the working area (DT)

- *Bit 0* is mapped to amplitude close to zero
- *Bit 1* is mapped to a positive amplitude
- A DC component is present

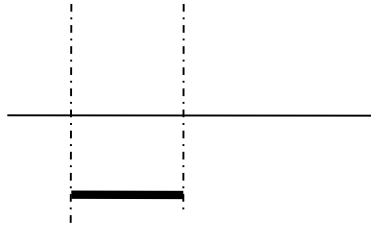
4

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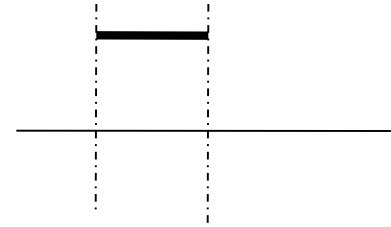
1

Step 2: Polar NRZ (Non Return to Zero)

Representation of 0



Representation of 1



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Instruction for the animator

- The first fig should appear then the second fig should appear.
- In parallel to the figures the text should be displayed.

Text to be displayed in the working area (DT)

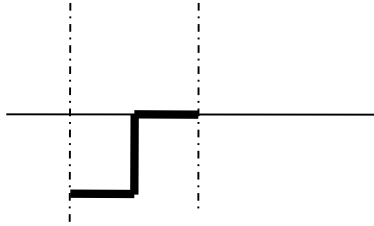
- *Bit 0* is mapped to a negative amplitude
- *Bit 1* is mapped to a positive amplitude
- A DC component is present

1

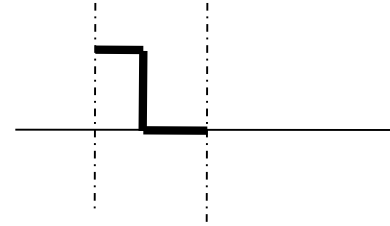
Step 3: Polar RZ (Return to Zero)

2

Representation of 0



Representation of 1



3

Instruction for the animator

- The first fig should appear then the second fig should appear.
- In parallel to the figures the text should be displayed.

Text to be displayed in the working area (DT)

• A bit 0 is mapped to a negative amplitude $-A$ for the first half of the symbol duration followed by a zero amplitude for the second half of the symbol duration.

A bit 1 is mapped to a positive amplitude $+A$ for the first half of the bit duration followed by a zero amplitude for the second half of the bit duration.

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Step 4: NRZI (Non Return to Zero Inverted)

Representation of 0

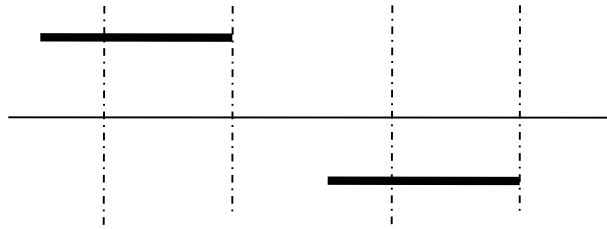


Fig. A

Fig. B

Representation of 1

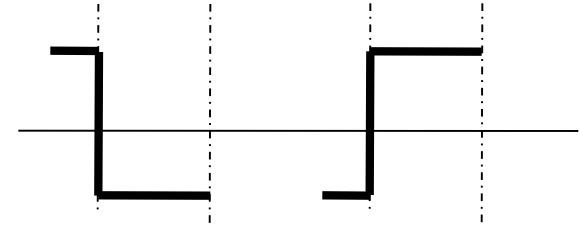


Fig. C

Fig. D

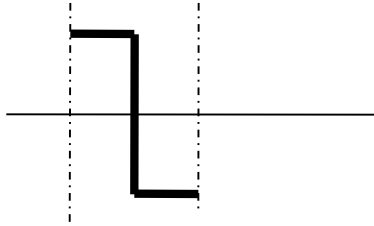
Instruction for the animator	Text to be displayed in the working area (DT)
<ul style="list-style-type: none"> The first fig should appear then the second fig should appear. In parallel to the figures the text should be displayed. 	<ul style="list-style-type: none"> Bit 0 mapped to no signal level transition Bit 1 is mapped to signal level transition at the beginning of the bit interval <p><i>Assumption:</i></p> <ul style="list-style-type: none"> The signal level to the left of the bit is high– Fig. A and Fig. C The signal level to the left of the bit is low – Fig. B and Fig. D

1

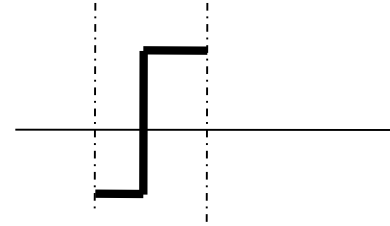
Step 5: Manchester coding

2

Representation of 0



Representation of 1



3

Instruction for the animator

- The first fig should appear then the second fig should appear.
- In parallel to the figures the text should be displayed.

Text to be displayed in the working area (DT)

- Bit 0 is sent by having a mid-bit transition from high to low.
- Bit 1 is sent by having a mid-bit transition from low to high.

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1

Step 6: Differential Manchester coding

2

Representation of 0

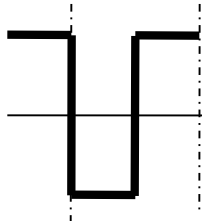


Fig. A

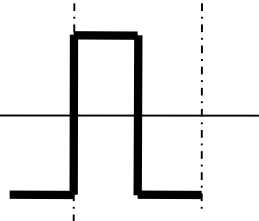


Fig. B

Representation of 1

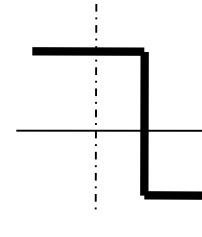


Fig. C

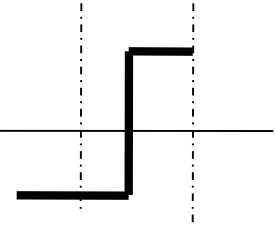


Fig. D

3

Instruction for the animator

- The first fig should appear then the second fig should appear.
- In parallel to the figures the text should be displayed.

Text to be displayed in the working area (DT)

Bit 0 is mapped to signal level transition at the beginning of the bit interval.

Bit 1 is mapped to absence of signal level transition at the beginning of the bit interval.

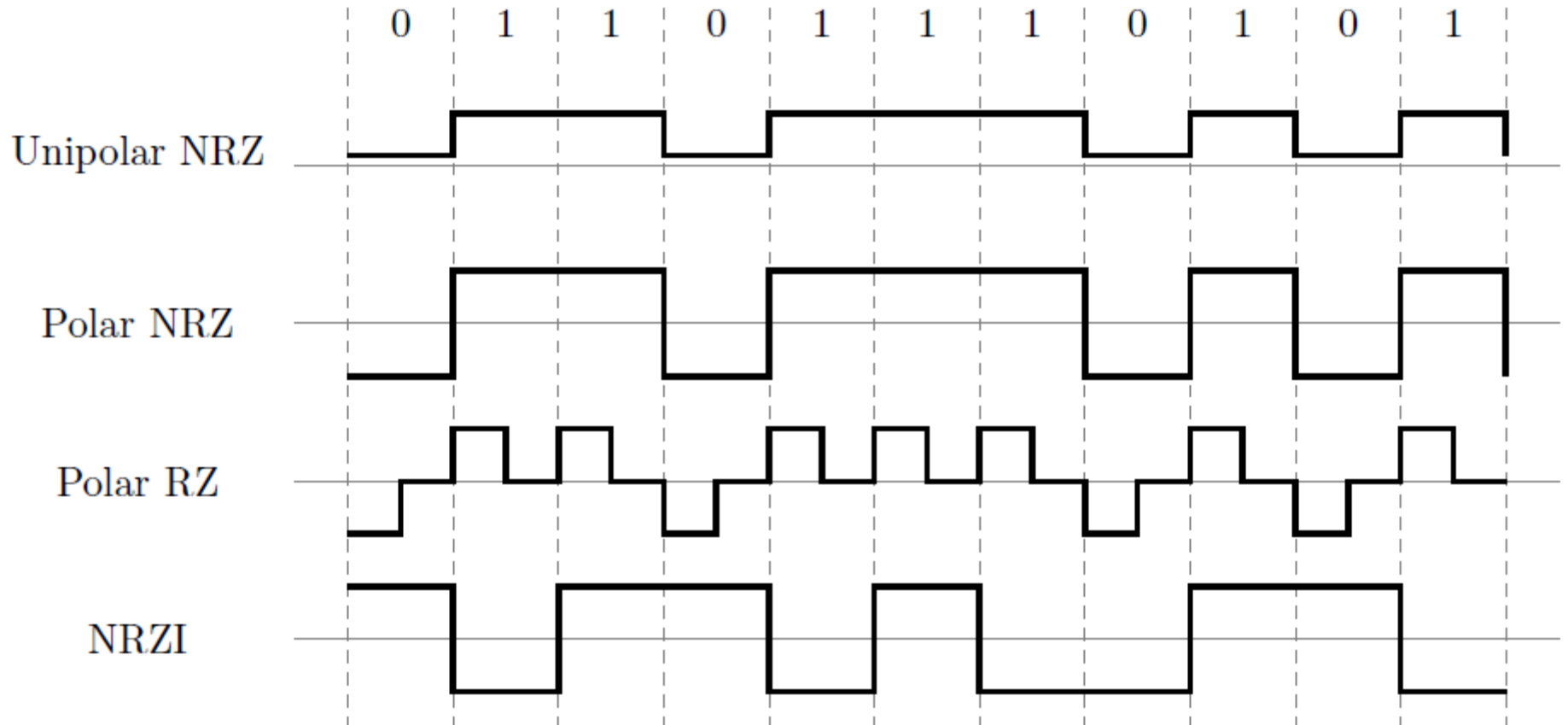
Assumption:

- The signal level to the left of the bit is high – Fig. A and Fig. C
- The signal level to the left of the bit is low – Fig. B and Fig. D

4

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The corresponding waveforms should be shown in the demo part when a particular line code is selected.



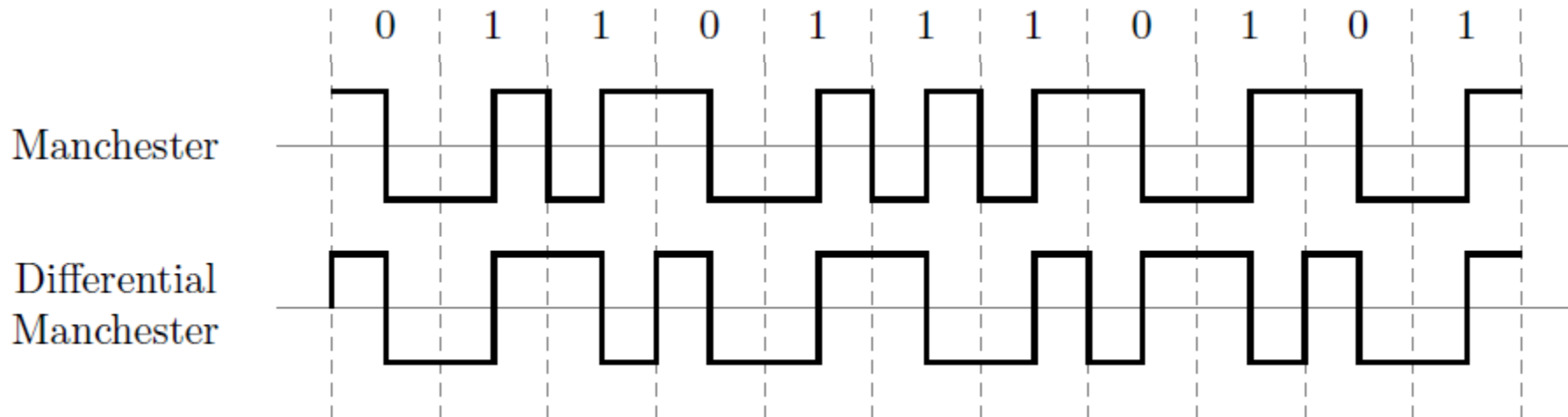

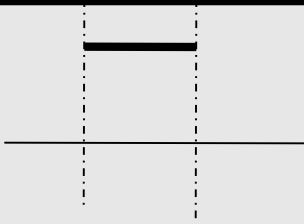
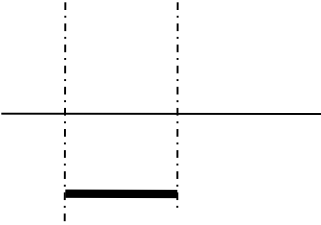
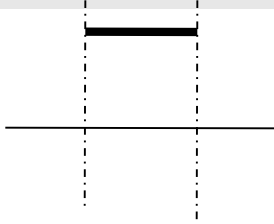
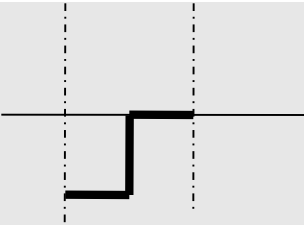
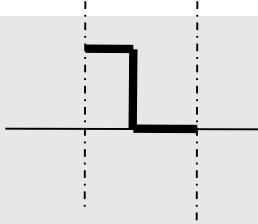
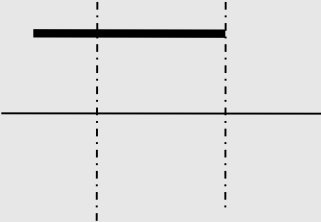
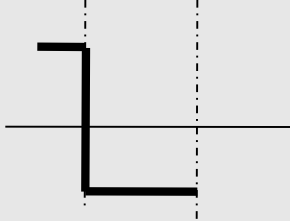
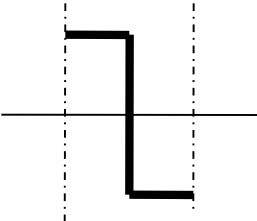
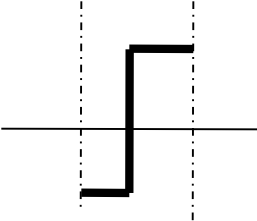
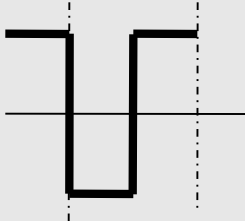
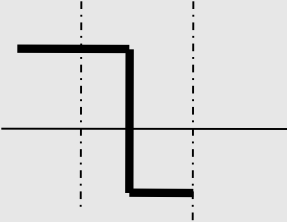


Illustration of different line coding schemes

Assumption: The signal level to the left of the bit is high

Line coding Scheme	Representation of 0	Representation of 1
Unipolar NRZ		
Polar NRZ		
Polar RZ		

Line coding Scheme	Representation of 0	Representation of 1
NRZI		
Manchester		
Differential Manchester		

Slide
1

Slide
3

Slide
14,15

Slide
17

Slide
16

Introduction

Definitions

Analogy

Test your understanding
(questionnaire)

Lets Sum up (summary)

Want to know more...
(Further Reading)

Input
Data

Digital
Signal

Interactivity:

Try it yourself

- Select the coding scheme
 - Uni polar NRZ
 - Polar NRZ
 - Polar RZ
 - NRZI
 - Manchester
 - Differential Manchester
- Enter 11 bit input data

Questionnaire

1

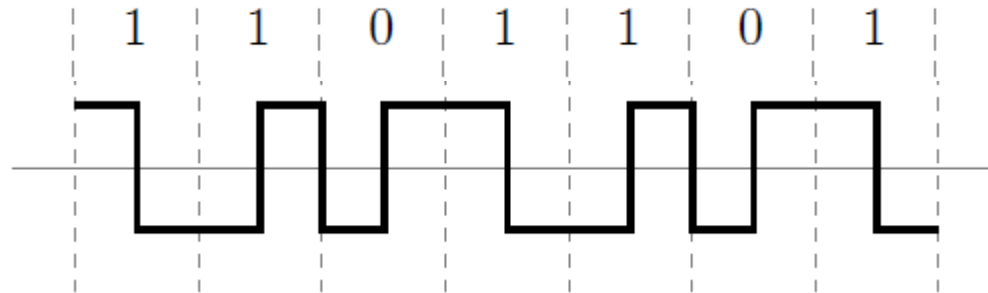
1. What is the Differential Manchester waveform corresponding to the bit string 1101101

Note: The signal level before the first bit is assumed to be high

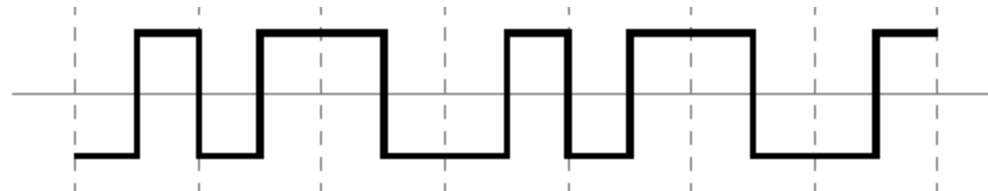
2

Answers:

a)



b)



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Questionnaire

1

2

3

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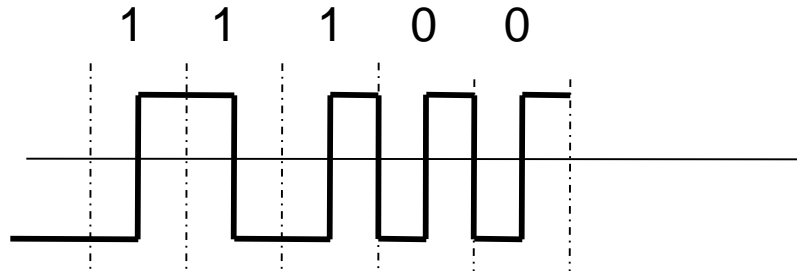
5

2. What is the Differential Manchester waveform for the bit string 11100

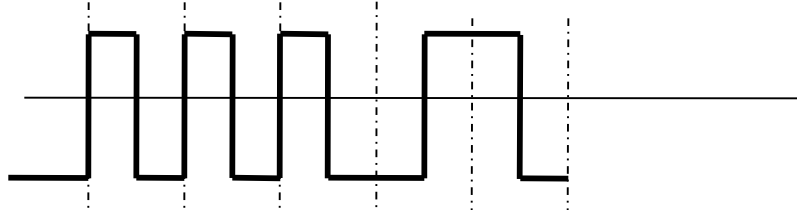
Note: The signal level to the left of the first bit in the string is low

Answers:

a)



b)



Links for further reading

Reference websites:

Books: “Communication Systems” by Simon Haykin, fourth Edition

“Data and Computer Communications” by William Stallings, eighth Edition

Research papers:

Summary

- Binary data can be transmitted using a number of different types of pulses. The choice of a particular pair of pulses to represent the symbols 1 and 0 is called Line Coding.
- *Line coding* is the process of converting binary data, a sequence of bits to a digital signal.