BSc (Hons) Computer Science

University of Portsmouth
Third Year

Advanced Networks

M21279
Semester 1

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Contents

Lecture - Introduction

11:00	30/09/24	Asim Ali

Admin

- Lectures given by Dr Asim Ali
- Office - BK 2.20
  - Monday 1300-1400
  - Thursday 1100-1200
- 2 hour lecture every week (PK 2.01)
- 1 hour seminar every week (AG 1.03)

The module information is available at the URL below:
`https://course-module-catalog.port.ac.uk/#/moduleDetail/M21279/2024%2F25`

Assessments

This module is assessed by one exam and one piece of coursework as below

- 60%, 90 minute Exam covering LO1,2,3&4 - TB1 assessment period (January)
- 40%, Group coursework covering LO5 - 2-4 members *or* individual (but not recommended)
  - 5 pages maximum
  - Template provided
  - Previous samples provided

Lecture - Signal Encoding

11:30 30/09/24 Asim Ali

Signals

(In this context) Signals are typically electromagnetic waves that carry information using some method of encoding. This means that the 'shape' of the signal is changed to represent information. There are three main types of signal–

- Analogue Signals, which vary continuously and smoothly over time
- Digital Signals, which have only 2 levels and change near instantly
- Discrete Signals, which have 2 or more levels and change near instantly

When information is transmitted, it is often converted between many different signals before it reaches the destination. For example, if you have ADSL internet, your computer sends the data as a digital signal to the modem, which is then converted to an analogue signal before it is transmitted across a POTS network (Plain Old Telephone System), then the receiver's modem converts it back to a digital signal before it is sent on to the receiver.

Digital Signal Encoding

There are many methods of encoding a digital signal, but some of the most common are–

- Non-return to Zero Level (NRZ-L)
  - 0 – High voltage level
  - 1 – Low voltage level
- Non-return to Zero Inverted (NRZ-I)
  - 0 – No transition (high-low or low-high voltage level) on clock pulse
  - 1 – Transition on clock pulse
- Bipolar-AMI
  - 0 – Zero voltage
  - 1 – Alternating positive or negative voltage level
- MLT-3 (Multi-Level Transmit 3)
  - 0 – Remain at the same voltage level
  - 1 – Transition to the next voltage level
  - Uses 3 voltage levels, named $+1, 0 \& -1$ but can be any arbitrary voltages
- Manchester
  - 0 – Transition from high-low voltage level in the middle of the clock interval
  - 1 – Transition from low-high voltage level
- Differential Manchester

- 0 – Transition (high-low or low-high voltage level) on clock pulse
- 1 – No transition on clock pulse
- Always transitions in the middle of the clock interval

In this context, the high and low voltage levels can be whatever you like, but are typically either a positive and negative voltage of the same magnitude, or are a positive voltage and zero. The most common voltages used for signalling are 3.3, 5 and 12 volts. In the case of Bipolar-AMI, the 3 voltage levels can be arbitrary, and don't have to be, for example $+5$, 0 and -5 volts.

Diagrams

Below is the binary string 01100110 encoded using all of the above encoding schemes. This assumes that the previous state before the transmission starts is always low, and that each vertical dotted line represents a clock pulse.

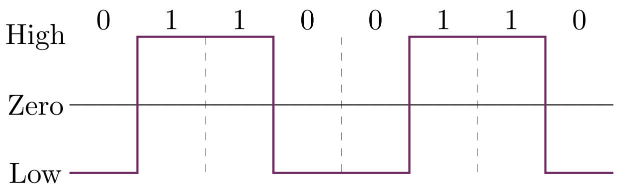

Figure 2.1: Non-return to Zero Level (NRZ-L)

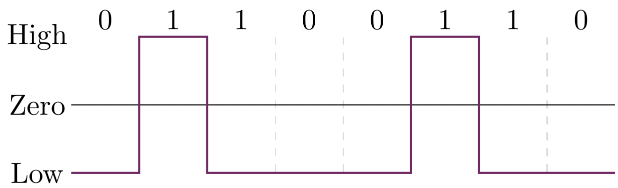

Figure 2.2: Non-return to Zero Inverted (NRZ-I)

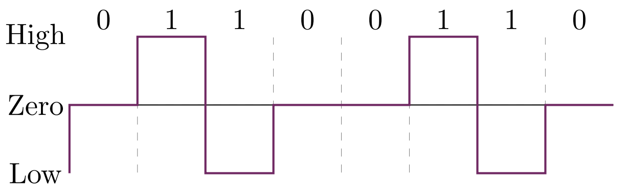

Figure 2.3: Bipolar-AMI

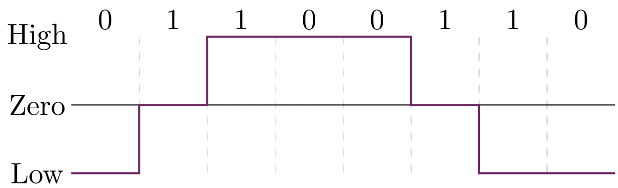

Figure 2.4: Multi-Level Transmit 3 (MLT-3)

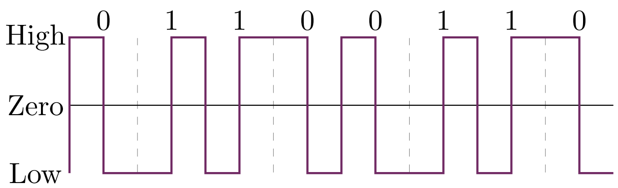

Figure 2.5: Manchester

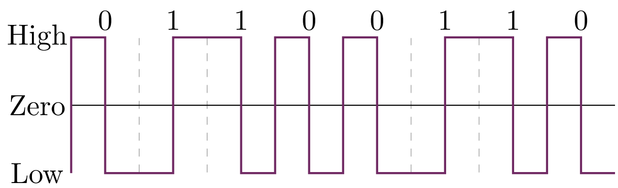

Figure 2.6: Differential Manchester

Carrier Waves and Modulation

A carrier wave is a continuous waveform that, on it's own, carries no information. This carrier wave is then modified by another signal to convey information. This modification can be of it's amplitude, frequency, phase, or a combination of all 3. This is known as modulation, hence the names AM (Amplitude Modulation) and FM (Frequency Modulation) for the two types of analogue radio.

Digital-to-Analogue Encoding

There are several methods of encoding a digital signal on an analogue transmission medium. In the case of sending digital data over a POTS network, the signal is encoded onto a carrier wave in the range of 300-3400Hz using a MoDem (Modulator-Demodulator). The main methods of encoding are–

- Amplitude-Shift keying (ASK)
- Frequency-Shift keying (FSK)
  - Binary FSK (BFSK)
  - Multiple FSK (MFSK)
- Phase-Shift keying (PSK)
  - Binary PSK – 1 = A sine wave, 0 = The same sine wave shifted by $180°$
  - Differential PSK (DPSK) – 1 = The previous sine wave shifted by $180°$, 0 = The previous sine wave
  - Multiple-level PSK
- Quadratic AM (Combination of ASK and PSK)

The sender and receiver may use different frequencies as to allow full-duplex data transmission on the same physical medium or radio channel. Full-duplex meaning full-speed transmission in both directions simultaneously.

Diagrams

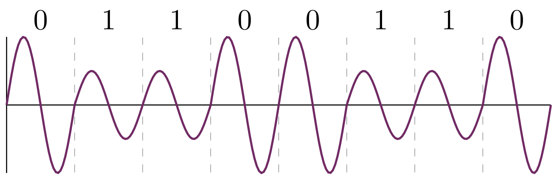

Figure 2.7: Amplitude-Shift Keying

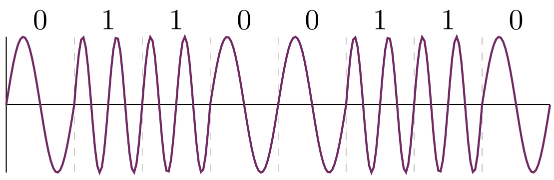

Figure 2.8: Binary Frequency-Shift Keying

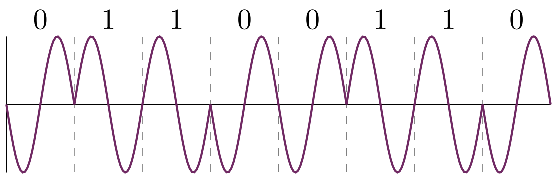

Figure 2.9: Binary Phase-Shift Keying

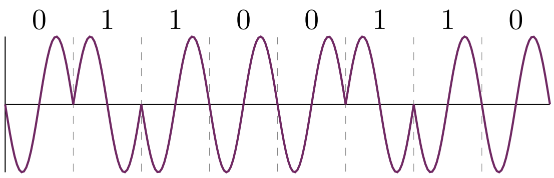

Figure 2.10: Differential Phase-Shift Keying

Seminar - Encoding Exercises

12:00 03/10/24 Asim Ali

Figure 3.1: Encode the binary data 11000011 with the MLT-3 encoding scheme

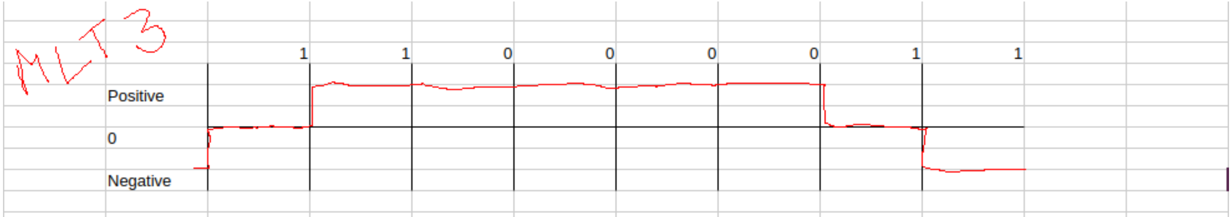

Figure 3.2: Encode the binary data 11000011 with the Non-Differential Manchester encoding scheme

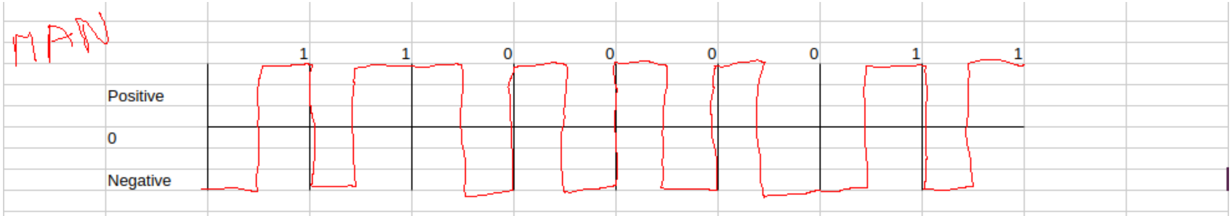

Figure 3.3: Encode the binary data 11000011 with the Differential Manchester encoding scheme