

Line Coding

CIS748 Class Notes

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1 Introduction

The sent data needs to be somehow coded into an electromagnetic signal to be sent over the wire, and later decoded back. There are many ways of encoding signals, with each scheme having some pros and cons.

Primarily, there are three major categories of line coding: Unipolar, Polar, and Bipolar.

1.1 Unipolar

The most primitive encoding technique is Unipolar. The signal is basically this: high voltage on a '1' bit, and low (zero) voltage on a '0' bit. There is no synchronization information, and the signal has a DC component.

1.2 Polar

There are three categories of Polar line coding: NRZ, RZ, and Biphasic.

1.2.1 NRZ

NRZ is Nonreturn to Zero. This basically means that after each bit is transmitted, the signal doesn't return to zero voltage. There are two major categories of NRZ, the NRZ-L, and NRZ-I.

The NRZ-L is similar to Unipolar, in that the voltage directly depends on the bit it represents. A positive voltage generally represents a '1', and a negative voltage represents a '0' (or vice versa). Unlike the unipolar scheme, NRZ-L alleviates the problem of the DC component.

The NRZ-I does a voltage transition (positive to negative, or negative to positive) on a '1' bit, and no change on a '0' bit. It is the *change* in the voltage that matters, not the actual voltage itself.

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NRZ-I is better than NRZ-L because the destination can use the voltage change to synchronize its clock with the sender—assuming messages don't have long sequences of '0' bits (which don't have a transition).

1.2.2 RZ

A pretty simple scheme. Positive voltage indicates a '1', negative voltage indicates a '0'. The voltage goes down to zero in the middle of every tick.

1.2.3 Biphase

There are two primary Biphase coding schemes: Manchester (Ethernet LANs), and Differential Manchester (Token Ring LANs).

Manchester, like RZ has a transition in the middle of a bit interval. There is a transition for every bit. A low to high transition indicates a '1' bit, and a high to low transition indicates a '0' bit.

Differential Manchester is somewhat similar to NRZ-I. In the beginning of a bit interval, there is a voltage change on a '0' bit, and no voltage switch on a '1' bit. There is always a voltage change in the middle of a bit interval.

1.3 Bipolar

Bipolar scheme is similar to RZ (also has 3 voltage levels). It uses zero voltage to represent a '0' bit, and a '1' bit is represented by either a positive or negative voltage (alternating).