German Jordanian University

Department of Communication Engineering

Digital Communication Systems Lab

CME 313-Lab

Experiment 3

Line Coding

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Experiment3Experiment

Line Coding

Objectives:

The objectives of this experiment are to:

- Get familiar with definitions and properties of commonly used line codes.
- Measure the delay associated with practical digital systems.

Introduction

Digital data can be transmitted by various Line codes. Line codes are waveform patterns of voltage or current used to represent the 1s and 0s. Each line code has its advantages and disadvantages. Among other desirable properties, a line code is preferred to have the following:

- **Bandwidth efficiency**; the possibility of transmitting at a higher rate than other schemes over the same bandwidth.
- **Power efficiency**: For a given bandwidth and quality, the transmitted power should be as small as possible.
- **No DC component**; this allows AC coupling (capacitor or transformer) between stages (as in telephone lines).
- **Spectrum shaping;** this is important in telephone line applications, for example, where the transfer characteristic has heavy attenuation below 300 Hz.
- **Synchronization;** where bit clock recovery can be simplified.
- Error detection capabilities; It should be possible to detect some patterns of errors.

Using a common external clock signal, the SEQUENCE GENERATOR produces twoindependent pseudorandom sequences X and Y. In this experiment we need only one output. The SEQUENCE GENERATOR will be clocked by B.CLK from the LINER ENCODER module. A SYNC output is provided which is coincident with the start of the sequences. The synch out from the SEQUENCE GENERATOR can be used to trigger the oscilloscope. The sequences may be stopped and restarted at any time via front panel controls. Sequences X and Y are available as either standard TTL or analog level output. The SEQUENCE
GENERATOR is a basic module and you can read more about it in TIMS 301 User Manual. The module and its block diagram are shown in the figure below.

LINE ENCODER and LINE DEODER Modules

In a digital transmission system line encoding is the final digital processing performed on the signal before it is connected to the analog channel, although there may be simultaneous bandlimiting and wave shaping. Thus in TIMS the LINE-CODE ENCODER accepts a TTL input, and produce an output that is suitable for transmission via an analog channel. The TIMS LINE-CODE DECODER decodes it back to the binary TTL format. The LINE-CODE ENCODER serves as a source of the system bit clock. It is driven by a master clock (M.CLK) at 8.3 kHz (from the TIMS MASTER SIGNALS module).

The LINE-CODEENCODER module divides M.CLK by a factor of four, in order to derive some necessary internal timing signals at a rate of 2.083 kHz (B.CLK). The latter becomes a convenient for use as the system bit clock. The reason we are using a slower clock (clock/4) is that the encoder requires some cycles to provide the proper output and hence the data should arriveat a slower rate.

Because the LINE-CODE DECODER has some processing to do, it introduces a time delay. To allow for this, it provides a re-timed clock (STROBE) if required by any further digitalprocessing circuits (eg, for decoding, or error counting modules).

For a TTL input signal the following output formats are available from the LINE-CODEENCODER: NRZ-L, NRZ-M, UNI-RZ, BIP-RZ, RZ-AMI, BiØ-L (Manchester), DICODE-NRZ. Rather than defining each of the previous codes, you will find what they mean experimentally.

Lab Work

Modules:

To complete the experiment the following modules are needed:
SEQUENCE GENERATOR,LINE-CODE ENCODER, and LINE-CODE DECODER.
SEQUENCE GENERATOR

1. Construct Construct the TIMS model of line coding system as shown in below **Figure**

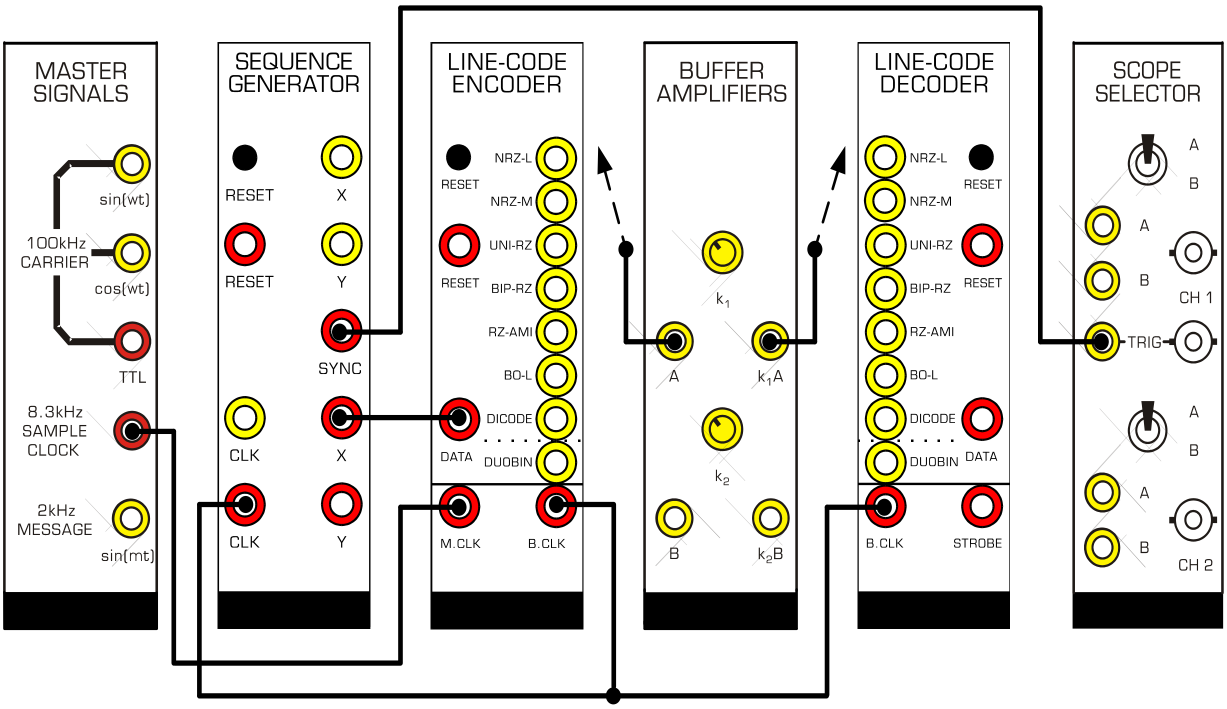

Figure.1`Line Coding TIMS Model

2. Before plugging the SEQUENCE GENERATOR module in locate the on-board switch SW2 and set both toggles UP.
3. Adjust the gain of the BUFFER AMPLIFIERS to 1.

- **Try all the coding schemes and prepare a chart as in Figure 2. Without using any textbook, try to determine the law of transformation for each coding scheme.**

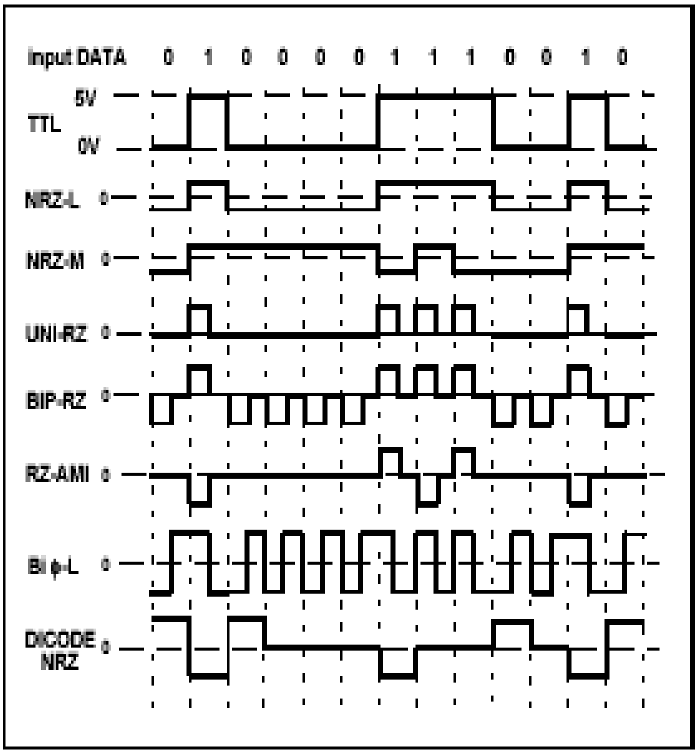

Figure.2 Line Codes

4. Using the PICO SCOPEmonitor the signals at the input of the LINE-CODE ENCODER and at the output of the LINE-CODE ENCODER for the NRZ-L code.

- **Save the obtained signal in step 4 in your lab sheets**.
- **Compare between the original message signal and recovered signal, if there any difference explain the reasons in you lab sheet.**