Block Coding

Block coding adds redundancy to line coding so that error detection can be implemented.

Block coding changes a block of *m* bits into a block of *n* bits, where *n* is larger than *m.*

Block coding is referred to as an *mB/nB* encoding technique.

The additional bits added to the original ―m bits‖ are called parity **bits** or **check bits**

m : message bits **Figure : Block Coding Example: 4B/5B encoding** Here a 4 bit code is converted into a 5 bit code **8.4 Analog data to analog signal 8.4.1 Modulation**

The Process of converting analog data to analog signal is called Modulation.

Modulation is used to send an information bearing signal over long distances.

Modulation is the process of varying some characteristic of a periodic wave with an external signal called carrier signal.

These carrier signals are high frequency signals and can be transmitted over the air easily and are capable of traveling long distances.

The characteristics (amplitude, frequency, or phase) of the carrier signal are varied in accordance with the information bearing signal(analog data).

The information bearing signal is also known as the modulating signal.

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The modulating signal is a slowly varying – as opposed to the rapidly varying carrier frequency.

8.4.2 Types of Modulation: Signal modulation can be divided into two broad categories:

- Analog modulation and
- Digital modulation.

Analog or digital refers to how the data is modulated onto a sine wave.

If analog audio data is modulated onto a carrier sine wave, then this is referred to as **analog modulation**.

Digital modulation is used to convert digital data to analog signal. Ex ASK, FSK, PSK.

8.4.2.1 Analog Modulation can be accomplished in three ways:

1. Amplitude modulation (AM)
2. Frequency modulation (FM)
3. Phase modulation (PM).

8.4.2.1.1 Amplitude modulation (AM)

Amplitude modulation is a type of modulation where the amplitude of the carrier signal is varied in accordance with modulating signal.

The envelope, or boundary, of the amplitude modulated signal embeds modulating signal.

Amplitude Modulation is abbreviated *AM*.

Figure : Amplitude modulation (AM)

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8.4.2.1.2 Frequency modulation (FM)

Frequency modulation is a type of modulation where the frequency of the carrier is varied in accordance with the modulating signal. The amplitude of the carrier remains constant.

The information-bearing signal (the modulating signal) changes the instantaneous frequency of the carrier. Since the amplitude is kept constant, FM modulation is a low-noise process and provides a high quality modulation technique which is used for music and speech in hi-fidelity broadcasts.

Frequency Modulation is abbreviated *FM*.

Figure : Frequency modulation (FM) 8.4.2.1.3 Phase modulation (PM).

In phase modulation, the instantaneous phase of a carrier wave is varied from its reference value by an

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amount proportional to the instantaneous amplitude of the modulating signal.

Phase Modulation is abbreviated *PM*.

Figure : Phase modulation (PM). Figure : Comparison of AM, FM & PM

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8.4.2.2 Digital Modulation Types(Digital to Analog signal conversion)

Digital modulation is used to convert digital data to analog signal.

It can be accomplished in the following ways:

1. ASK
2. FSK
3. PSK
4. QAM

8.4.2.2.1 Amplitude Shift Keying (ASK)

In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements.

Both frequency and phase remain constant while the amplitude changes.

Binary ASK (BASK)

ASK is normally implemented using only two levels and is hence called binary amplitude shift keying. Bit 1 is transmitted by a carrier of one particular amplitude. To transmit Bit 0 we change the amplitude keeping the frequency is kept constant **Figure : Amplitude Shift Keying (ASK 8.4.2.2.2 Frequency Shift Keying (FSK)**

In Frequency shift keying, we change the frequency of the carrier wave.

Bit 0 is represented by a specific frequency, and bit 1 is represented by a different frequency.
In the figure below frequency used for bit 1 is higher than frequency used for bit 0
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Figure : Frequency Shift Keying (FSK) 8.4.2.2.3. Phase Shift Keying (PSK)
Phase shift keying (PSK) is a method of transmitting and receiving digital signals in which the phase of a transmitted signal is varied to convey information.
Both amplitude and frequency remain constant as the phase changes.
The simplest from of PSK has only two phases, 0 and 1.
If the phase of the wave does not change, then the signal state stays the same (low or high).
If the phase of the wave changes by 180 degrees, that is, if the phase reverses, then the signal state changes (from low to high or from high to low)
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Figure: Phase Shift Keying (PSK) 8.4.2.2.4 QAM

The concept of Quadrature Amplitude Modulation (QAM) involves use of two carriers, one for phase and the other for quadrature, with different amplitude levels for each carrier.

It is a combination of ASK & PSK.

8.4.2.2 Analog to Digital Conversion using modulation The definition of the term modulation is described in the next section. Here we discuss 3 modulation techniques:

1. PAM
2. PCM
3. PWM

8.4.2.3.1 PAM (Pulse Amplitude Modulation) Pulse Amplitude Modulation refers to a method of carrying information on a train of pulses, the information being encoded in the amplitude of the pulses.

8.4.2.3.2 PCM (Pulse Code Modulation)

PCM is a general scheme for transmitting analog data in a digital and binary way, independent of the complexity of the analog waveform. With PCM all forms of analog data like video, voice, music and telemetry can be transferred.

To obtain PCM from an analog waveform at the source (transmitter), the analog signal amplitude is
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sampled at regular time intervals. The sampling rate (number of samples per second), is several times the maximum frequency of the analog waveform. The amplitude of the analog signal at each sample is rounded off to the nearest binary level (quantization).

The number of levels is always a power of 2 (4, 8, 16, 32, 64, ...). These numbers can be represented by two, three, four, five, six or more binary digits (bits) respectively.

At the destination (receiver), a pulse code demodulator converts the binary numbers back into pulses having the same quantum levels as those in the modulator. These pulses are further processed to restore the original analog waveform.

8.4.2.3.3 PWM (Pulse Width Modulation)

Pulse Width Modulation refers to a method of carrying information on a train of pulses, the information being encoded in the width of the pulses. In applications to motion control, it is not exactly information we are encoding, but a method of controlling power in motors without (significant) loss.

There are several schemes to accomplish this technique. One is to switch voltage on and off, and let the current recirculate through diodes when the transistors have switched off. Another technique is to switch voltage polarity back and forth with a full-bridge switch arrangement, with 4 transistors.

This technique may have better linearity, since it can go right down to an cycles, and may jitter between minimum duty cycles of positive and negative polarity.

In battery systems PWM is the most effective way to achieve a constant voltage for battery charging by switching the system controller's power devices on and off.

The generation of exact working PWM circuitry is complicated, but it is extremely conceptually important since there is good reason to believe that neurons transmit information using PWM spike trains.