Practice 2.1: Signal Analysis: ASK simulation in Matlab

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***Abstract*—In this practice we shall implement a CRC error detection with multiple polinomies P(x) in order to detect errors in a telecommunication system based on ARDUINO.**

I. Motivation

It is important to understand and identify the components in each of the layers of the OSI model as it is the model of reference from long ago. Thus, it is really necessary to know the functions and applications of each layers not only theoretically but in real practices, an example of these components is the CRC that is used constantly in telecommunications systems and standards.

II. Objetives

- Implement a CRC (Cyclic Redundancy Check) in the basic 433MHZ ASK RF telecommucation system done in practice 2.3

III. Inroduction

Error detection

Regardless of the design of the transmission system, there will be errors, resulting in the change of one or more bits in a transmitted frame. In what follows, we assume that data are transmitted as one or more contiguous sequences of bits, called frames. the probability that a frame arrives with no bit errors decreases with increasing frame length; the longer the frame, the more bits it has and the higher the probability that one of these is in error. This is the kind of result that motivates the use of error-detecting techniques.All of these techniques operate on the following principle For a given frame of bits, additional bits that constitute an *error-detecting code* are added by the transmitter.

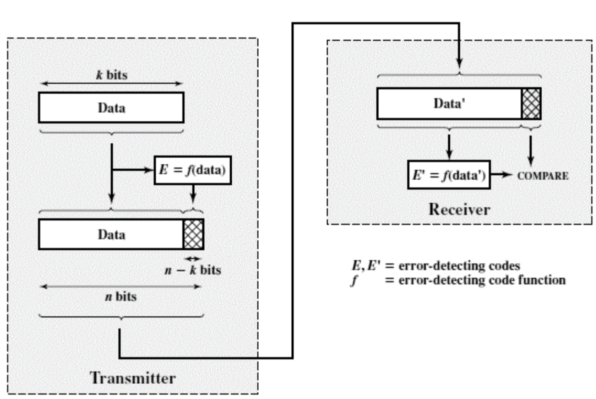

Fig. 1: Error Detection Process

Cyclic Redundancy Check (CRC)

One of the most common, and one of the most powerful, error-detecting codes is the cyclic redundancy check (CRC), which can be described as follows. Given a k-bit block of bits, or message, the transmitter generates an sequence, known as a frame check sequence (FCS), such that the resulting frame, consisting of n bits, is exactly divisible by some predetermined number. The receiver then divides the incoming frame by that number and, if there is no remainder, assumes there was no error.3 To clarify this, we present the procedure in three equivalent ways:

- Modulo 2 arithmetic
- Polynomials
- Digital logic

The methods seen in class where the first two.

Modulo 2 arithmetic

Modulo 2 arithmetic uses binary addition with no carries, which is just the **exclusive-OR (XOR)** operation. Binary subtraction with no carries is also interpreted as the XOR operation.

Now define

$$T = 2n - kD + F$$

Where:
P = pattern of $n - k + 1$ bits; this is the predetermined divisor
$F = (n-k)$-bit FCS, the last $(n-k)$bits of T
$D = k-$bit block of data, or message, the first $k$bits of T
T= n-bit frame to be transmitted

According with Tebauhman:

CRC (Cyclic Redundancy Check is also known as a **polynomial code**. Polynomial codes are based upon treating bit strings as representations of polynomials with coefficients of 0 and 1 only. A k-bit frame is regarded as the coefficient list for a polynomial with $k-$terms, ranging from x^{k-1} to x^0.

For example, 110001 has 6 bits and thus represents a six-term polynomial with coefficients 1, 1, 0, 0, 0, and $1: 1x^5 + 1x^4 + 0x^3 + 0x^2 + 0x^1 + 1x^0$.

When the polynomial code method is employed, the sender and receiver must agree upon a **generator polynomial,** $\mathbf{G(x)}$, in advance. To compute the CRC for some frame with m bits corresponding to the polynomial $\mathbf{M(x)}$, the frame must be longer than the generator polynomial. When the receiver gets the checksummed frame, it tries dividing it by G(x). If there is a remainder, there has been a transmission error.

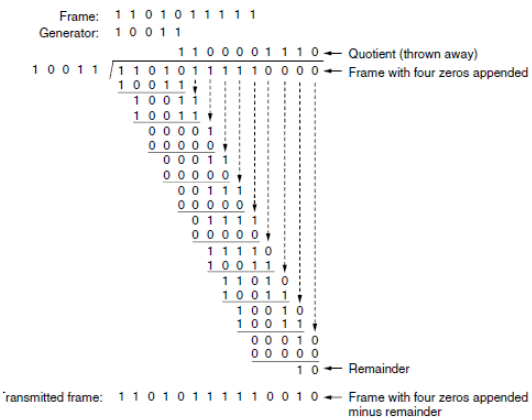

Fig. 2: Error Detection Process