IJETST- Vol.||03||Issue||12||Pages 4801-4810||December||ISSN 2348-9480 2016

Open access Journal International Journal of Emerging Trends in Science and Technology
IC Value: 76.89 (Index Copernicus) Impact Factor: 2.838 DOI: https://dx.doi.org/10.18535/ijetst/v3i12.02

Bit Error Rate of Twisted Pair Cable for Different Noise Environments a Novel Approach

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Abstract
The channel for Bit Error Rate simulation using Matlab is shielded twisted-pair cable, its characteristics have been implemented in the simulation model. Furthermore, different noise sources have been implemented in order to run the simulation under realistic conditions for different twisted pair cable say AWG26, AWG24. This work is concerned with the physical layer of the Open System Inter connection (OSI) Model. The physical layer treats the transmission of a raw bit stream over a cable and defines different techniques to do so. For this purpose, the Manchester code is explained in this report and implemented.
Keywords—*Bit Error Rate, Twisted Pair Cable, Matlab, OSI Physical Layer, Manchester Code.*

I. Introduction

A. Introduction to thesis

A proper communication is required to connect different entities in a network. The communication should happen uninterruptedly. It is interesting to analyze BER Performance of a Twisted Pair Cable with Manchester baseband modulation.

The goal of this thesis is to develop a model of a communication system with twisted pair cable in Matlab. It shall validate the functionality of a transmission of Manchester signals in the base band and implemented in the Matlab. In order to design a realistic model, the gain and phase characteristics of a twisted pair cable has to be measured and implemented. In addition, models of various noise sources shall be developed to simulate data transmission in different noise environments.

B. Motivation for Thesis

Communication systems need to perform the critical activities in different environmental conditions. A proper communication is required in order to synchronize the different entities so all will be connected in a network. The communication should happen uninterruptedly since they may participate in a critical application. Hence it is essential to investigate the root cause for that communication failure if exist, and analyze the cable performance in different noise environment which will leads to analysis.

II. Study of transmission line characteristics with respect to twisted pair cable

A. Balanced Transmission and Differential Mode

Twisted pair wires provide a balanced signal transmission. One of the wires in a pair in an unbalanced circuit is grounded at both ends. An example is RS-232 protocol of the physical layer. These signals are represented by voltage levels with respect to the ground. One of the main problems with this is that any noise produced from an external source is added to the signal and will be seen as data. This is because any noise on the ground wire will be dropped to earth and any noise appearing on the signal wire will be added or subtracted to the signal. Therefore, the signals may be distorted strongly which means that the cable length and data rate of these kinds of cables are strongly limited.

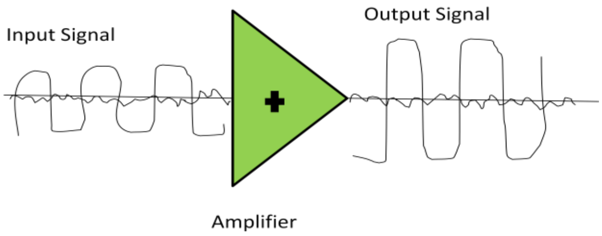

Figure 3.1 Unbalanced transmission circuit

A better way to resolve this issue is to use a balanced circuit. This only requires a twisted pair cable. In comparison to an unbalanced circuit which has one of the wire pair grounded at both ends, in a balanced circuit both wire pairs are used to transmit data. A balun transformer isolates the wires from the circuitry.

Consider that one of the twisted pair wires is designated as **A** and the other one is designated as **B**. Then, we transmit a logical one of Manchester code when line **A** transmits a positive transition in the middle of a cell and line **B** transmits a negative transition in the middle of a cell. Thus, each wire passes the opposite signal of the other wire's signal, meaning only the difference between wires **A** and **B** matters. For a balanced transmission system which is also designated as a transmission in differential mode, we need drivers with differential inputs/outputs. Thus, the costs of a balanced transmission system are much higher than those of an unbalanced transmission system. One of the major advantages of the differential mode is the rejection of common mode noise. Noises are introduced into the cable which means that the same amount of noise is picked up by both wires, meaning the voltage difference of this noise between **A** and **B** is almost zero. The receiver does the calculation **A-B** in order to obtain the signal which will be demodulated. Therefore, the noise is also subtracted and thus eliminated and we obtain a proper signal.

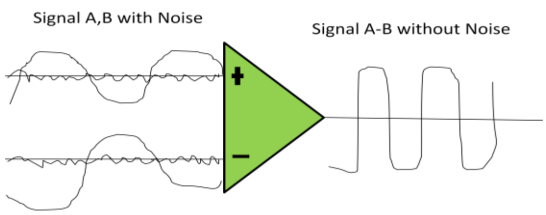

Figure 3.2 balanced transmission circuit

B. Transmission Line Analysis

In order to determine the Gain/attenuation and phase characteristics of the twisted pair cable, the cable. In order to obtain precise results for the gain and phase characteristics we measure the input impedance of the cable. In the ideal case, the termination impedance Z is equal to the characteristic impedance Z_C. In this case the reflection coefficient is zero which means that there are no reflections of the wave from the sending end to the load, meaning the whole power of this wave is absorbed by the termination impedance.

$$Z_C = \sqrt{R + J\omega L / G + J\omega C} \quad (3.1)$$

Where

$$R = \frac{dR}{dx} \quad L = \frac{dL}{dx} \quad C = \frac{dC}{dx} \quad G = \frac{dG}{dx}$$

are the longitudinal derivatives of resistance, inductance, capacitance and admittance along the line. Each of these parameters depends on the frequency. For example, R and the termination impedance Z_R will change in dependence on the frequency due to the skin effect as well as G due to frequency dependent dielectric losses .Thus, Z_C measured at a certain frequency will not necessarily be the same as Z_C measured at another frequency. For this reason the line is not adapted for every frequency which implies reflections.

$$\rho = \frac{Z_R - Z_C}{Z_R + Z_C} \quad (3.2)$$

In this case there is a wave from the sending end to the load and its reflection from the load to the sending end. These two waves are overlapped which leads in some cases to positive and in other cases to negative interferences. The input impedance of the cable which is determined by the relation Z = U /I depends consequently on the reflections and therefore on the frequency of the voltage and current waves. The aim of analysis is to determine the characteristic impedances and the propagation constant as a function of the frequency.

$$\gamma = \alpha + J\beta = \sqrt{(J\omega L + R).(J\omega C + G)} \quad (3.3)$$

Where α is designated as the attenuation constant and β is designated as the phase constan*t*. In order to obtain accurate values for the input impedance and the characteristic impedance which take into account their dependence on the frequency, some equations should be derived. Input impedance of the cable measured with an opened end and then with a shortened end in the desired frequency band up from 100Hz to 100 Mhz. The two impedances will lead to values of the characteristic impedance and to values of the propagation constant dependent on the frequency. Furthermore, It was derived a relation between the input and output voltage and current independence on the characteristic impedance, the propagation constant and the input impedance. This relation represents the transfer function of the cable.

Determination of Transmission Line Parameters

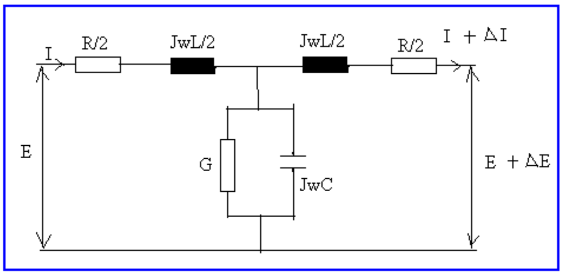

Figure 3.3 T section of a short length of transmission line

$$\frac{E}{E_S} = Cosh(\gamma x) - \frac{Z_C}{Z_S} Sinh(\gamma x) \quad (3.4)$$

$$\frac{I}{I_S} = Cosh(\gamma x) - \frac{Z_S}{Z_C} Sinh(\gamma x) \quad (3.5)$$

These equations are used to determine the voltage and current at a certain distance of length x away from the sending end of the cable, meaning that these equations represent a transfer function which is the relation of the output signal to the input signal. In order to apply above equation it is required to determine the relation between the characteristic impedance and the input impedance at the sending end Z_C/Z_S and the values of γ. Due to the fact that the impedances Z_R and Z_C also change slightly in dependence on the frequency, hence determine a general expression of the input impedance Z_S of the cable at the sending end as a function of the termination impedance Z_R and the characteristic impedance Z_C.

$$Z_S = Z_C \cdot \frac{Z_R + Z_C.Tanh(\gamma r)}{Z_C + Z_R.Tanh(\gamma r)} \quad (3.6)$$

This is a general equation of the input impedance in dependence on the termination resistance, the characteristic impedance and the propagation constant which is also valid for the ideal case, when the line is adapted ($Z_R = Z_C$). In this case the fraction disappears and the input impedance at the sending end is equal to the characteristic impedance ($Z_S = Z_C$). But in order to obtain accurate values apply the general case because Z_C and Z_R vary in frequency. To do so measurement of the input impedances at the sending end x = 0 with two different termination impedances at the load. In the first case the cable is shortened ($Z_R = 0$) and in the second case it is opened ($Z_R = 1$). Considering the first case the voltage at the load of the cable is equal to zero because it is shortened meaning $E_R = 0$.

$$E_{shortened} = I_R Z_C.Sinh(\gamma r) \quad (3.7)$$

$$I_{shortened} = I_R Cosh(\gamma r) \quad (3.8)$$

$$Z_{shortened} = \frac{E_{shortened}}{I_{shortened}} = Z_C Tanh(\gamma r) \quad (3.9)$$

Considering the second case when the cable is opened the load is infinite and therefore the current in the load equal to zero meaning $I_R = 0$. Thus

$$E_{opened} = E_R.Cosh(\gamma r) \quad (3.10)$$

$$I_{opened} = \frac{E_R}{Z_C}.Sinh(\gamma r) \quad (3.11)$$

$$Z_{opened} = \frac{E_{opened}}{I_{opened}} = \frac{Z_C}{Tanh(\gamma r)} = Z_C.Coth(\gamma r) \quad (3.12)$$

In order to determine the characteristic impedance Z_C in dependence on the two input impedances ($Z_{shortened}$, Z_{opened})

$$Z_C = \sqrt{Z_{opened}.Z_{shortened}} \quad (3.13)$$

This expression will be used in order to determine the input impedance Z_S at the sending end of the cable in the case when it is adapted with a certain ending impedance Z_R.

$$\frac{Z_{shortened}}{Z_{opened}} = Tanh^2(\gamma r) \quad (3.14)$$

Thus, for γ

$$\gamma = \frac{1}{r}.\arctan h\left(\sqrt{\frac{Z_{shotened}}{Z_{opened}}}\right) \quad (3.15)$$

Now the values for and Z_C in dependence on the measured input impedance Z_{opened} and $Z_{shortened}$. Finally the transfer function will be

$$\frac{E}{E_s} = Cosh(\gamma x) - \frac{Z_C + Z_R.Tanh(\gamma r)}{Z_R + Z_C.Tanh(\gamma r)}.Sinh(\gamma x) \quad (3.16)$$

where Z_R is the termination resistance of 120Ω, r is equal to the length of the cable measured.

$$Z_C = \sqrt{Z_{opened}.Z_{shortened}} \quad (3.17)$$

$$\gamma = \frac{1}{r}.\arctan h\left(\sqrt{\frac{Z_{shotened}}{Z_{opened}}}\right) \quad (3.18)$$

This equation gives the gain and phase characteristics of any cable length x.

Direct Transfer function

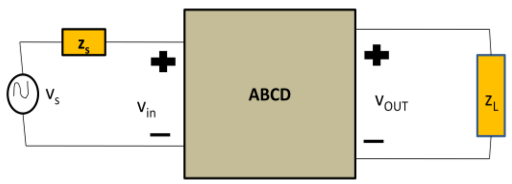

Figure 3.4 Transmission Line Characterized By ABCD Transmission Matrix

The block diagram above is used to characterize a transmission line using ABCD parameters. Based on this model, the following equations for the direct transfer function, H_{direct} can be extracted.

$$H_{direct}(f) = \frac{V_{out}}{V_{in}} = \frac{Z_s + Z_L}{AZ_L + B + (CZ_L + D)Z_S} \quad (3.19)$$

In order to apply the above results to model twisted pair cables it is necessary to determine the correct ABCD parameters. These parameter values can vary based on various wire types and sizes.

The ABCD parameters for a transmission line are shown below.

$$A = D = \cosh(\gamma d) \quad (3.20)$$

$$B = Z_o \sinh(\gamma d) \quad (3.21)$$

$$C = \frac{\sinh(\gamma d)}{Z_O} \quad (3.22)$$

Where d- in km

$$Z_C = \sqrt{(R(f) + J\omega L(f))/(G(f) + J\omega C(f))}\,\frac{\Omega}{km} \quad (3.33)$$

$$\gamma = \alpha + J\beta = \sqrt{(J\omega L(f) + R(f)).(J\omega C(f) + G(f))}\,\frac{1}{km} \quad (3.34)$$

$$R(f) = \frac{1}{\frac{1}{\sqrt[4]{r_{oc}{}^4 + a_c f^2}} + \frac{1}{\sqrt[4]{r_{os}{}^4 + a_s f^2}}}\left[\frac{\Omega}{km}\right] \quad (3.35)$$

$$L(f) = \frac{L_o + L_\infty\left[\frac{f}{f_m}\right]^b}{1 + \left[\frac{f}{f_m}\right]^b}\left[\frac{H}{km}\right] \quad (3.36)$$

$$C(f) = c_\infty + c_o f^{-c_e}\left[\frac{F}{km}\right] \quad (3.37)$$

$$G(f) = g_o f^{g_e}\left[\frac{S}{km}\right] \quad (3.38)$$

The above constants (modeling parameters) used vary based on the type of cable used. Summarized below are the modeling parameters for twisted-pair 24-American wire gauge (AWG) and 26-AWG

Table 3.1 24-AWG Twisted Pair RLCG Modeling Parameters

Resistance	$r_{oc} = 174.559$ Ω / km	$r_{os} = \infty$ Ω / km	$a_c = 0.05307$ $\Omega^4/(km^4 Hz^2)$	$a_s = 0$ $\Omega^4/(km^4 Hz^2)$
Inductance	$L_o = 617.295\mu$ H / km	$L_\infty = 478.971\mu$ H / km	$b = 1.15298$	$f_m = 553.76K$ Hz
Capacitance	$C_\infty = 50n$ F / km	$C_o = 0$ F / km	$C_e = 0$	
Conductance	$g_o = 234.875f$ S / km	$g_e = 1.38$		

Table 3.2 26-AWG Twisted Pair RLCG Modeling Parameters

Resistance	$r_{oc} = 286.176$ Ω / km	$r_{os} = \infty$ Ω / km	$a_c = 0.14769620$ $\Omega^4/(km^4 Hz^2)$	$a_s = 0$ $\Omega^4/(km^4 Hz^2)$
Inductance	$L_o = 675.369\mu$ H / km	$L_\infty = 488.952\mu$ H / km	$b = 0.929$	$f_m = 806.34K$ Hz
Capacitance	$C_\infty = 49n$ F / km	$C_o = 0$ F / km	$C_e = 0$	
Conductanc e	$g_o = 43n$ S / km	$g_e = 0.7$		

E. Implementation of different noises like white, color noise in Matlab

An equation is obtained in order to calculate the gain and phase of the cable in dependence on the cable length. Due to the fact that the phase of this cable is linear over the entire frequency band, the signals are not corrupted by ISI. Hence, only noise sources may distort the shape of the signals. Here it is described about different noise sources which may corrupt the signals in the transmission channel like white and colored background noise.

F. White and Colored Noise

Stochastic processes are used in order to describe white and colored noise. A random Process is characterized in the frequency domain by its power spectral density or psd $S_x(f)$ and in the time domain by its autocorrelation function R_x (T). The fourier transformation of the autocorrelation function is the power spectral density and the inverse fourier transformation of the psd leads to the autocorrelation function. In electronic devices, which are used in the implementation of communication systems, thermal noise is generated. This noise is assumed as a white random process n(t) which has a flat and constant power spectral density $S_x(f)$ for all frequencies f. If the stochastic process is normal distributed its talk of *gaussian white noise*

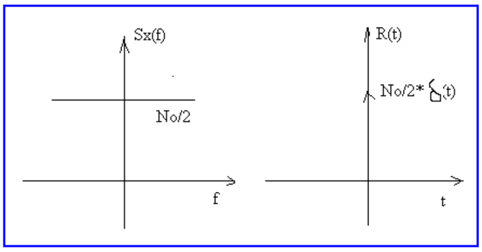

Figure 4.1 Power spectral density and autocorrelation function of white noise

The psd is defined as $S_x(f) = N_{o/}\ 2$ for all f and the unit of the psd is W/Hz . The inverse fourier transform of power spectra density Rx(T) which is

$$R_x(\tau) = \int_{-\infty}^{+\infty} S_x(f) e^{j2\pi f\tau} df = \frac{N_o}{2} \int_{-\infty}^{+\infty} e^{j2\pi f\tau} df = \frac{N_o}{2}\delta(\tau) \quad (4.1)$$

As shown above figure, the autocorrelation function is equal to N_o /2 at T = 0 and 0 everywhere else. This means that adjacent signal values of the stochastic process n(t) are always uncorrelated, so that the signal should variate with an infinite velocity. But this is physically not possible. Another way to show this can also be derived from the power of the noise signal n(t), Since $S_x(f) = N_o/2$ = const for all frequencies and the power of the noise signal is the integral over the whole frequency band of $S_x(f)$, will obtain an infinite power which obviously does not exist.

$$R_x(\tau) = \int_{-\infty}^{+\infty} S_x(f) df = \int_{-\infty}^{+\infty} \frac{N_o}{2} df = \infty \quad (4.2)$$

However, in modeling thermal noise which is generated in electronic devices it is assumed that such noise is a white random process. In order to obtain colored noise, get rid of the high frequencies by using a low pass filter. At the output of this low pass filter the colored noise time signal will be obtained which is band limited white noise with a smaller variance. the higher the bandwidth of the system the greater the power and consequently the influence of the white noise. The obtained noise power by multiplying the bandwidth B of a transmission system with the average power density spectrum N_o /2.

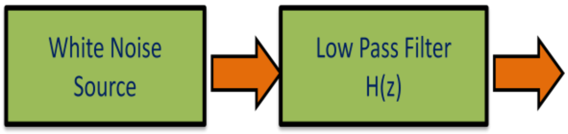

Figure 4.2 Model for the generation of colored noise

The colored noise is obtained by using a digital Finite Impulse Response (FIR) or Infinite Impulse Response (IIR) filter of the form.

$$H(z) = \frac{B(z)}{A(z)} = \frac{1 + \sum_{i=1}^{m} b_i . z^{-i}}{1 + \sum_{i=1}^{n} a_i . z^{-i}} \quad (4.3)$$

In this work, Butterworth (FIR) filter of order 10 to obtain the colored noise time signal is used. The cut-off frequency of this filter was chosen to 4MHz because the frequency band of band limited white noise up to 4MHz. This frequency has to be put in the MATLAB function butter(), meaning the real cut off frequency has to be divided by $f_s/2$. Considering a sample frequency of f_s = 96MHz, the relative cut off frequency f_c is

$$\frac{f_C}{\frac{f_S}{2}} = \frac{4Mhz}{\frac{96Mhz}{2}} = \frac{1}{12} = 0.083 \quad (4.4)$$

From below it is observed that the high frequencies of the white noise signal are eliminated by the IIR filter. In addition to that the amplitude respectively the variance of the colored noise is decreased due to the filtering process

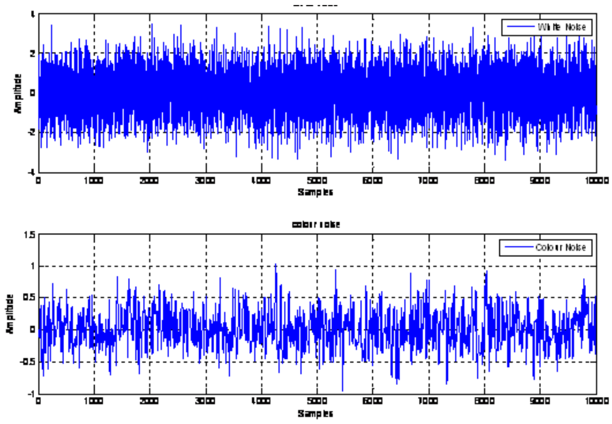

Figure 4.3 Time signals of white and colored noise

G. MATLAB Model of the White and Colored Noise

The model of white and colored noise can easily be created in MATLAB by applying the random function randn (n,1), where n is the length of the vector of random values between -1 and 1. This function provides random values which respect the standard normal distribution of white noise, meaning that the mean value of the output vector is equal to zero and the variance is equal to one. The function [b a]=butter(10,1/12) provides the filter coefficient of the denominator and numerator of a Butterworth low pass filter and the function y=filter (b,a,x) convolutes the signal x with the low pass filter in order to obtain the colored noise.

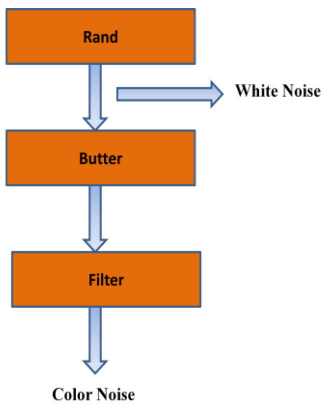

Figure 4.4 Flow chart of generation of white and color noise

H. Discussion and Analysis of Simulated Results

The parameters R, L, C, G are the primary constants, namely resistance, inductance, capacitance and conductance, respectively, of the transmission line which are expressed in per unit length. These parameters also depend on frequency, and are found for twisted pairs through measurement. Practical measurements, however, are subject to error; that is why the measured R, L, C, G values may not follow smooth curves with frequency. Therefore, parameterized smooth fitting models are used to represent.

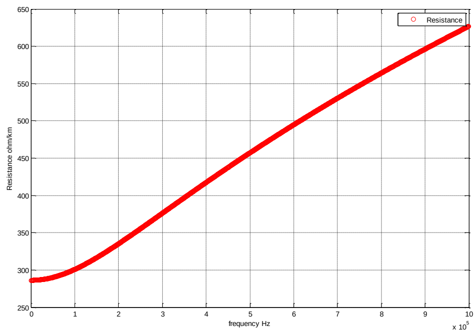

Figure 6.2 Resistance vs frequency for a 26 gauge cable

The parameterized model for resistance with the frequency dependency is

$$R(f) = \frac{1}{\frac{1}{\sqrt[4]{r_{oc}^{4} + a_c f^2}} + \frac{1}{\sqrt[4]{r_{os}^{4} + a_s f^2}}} \left[\frac{\Omega}{km}\right] \qquad (6.1)$$

where r_{oc} and r_{os} are the copper and steel *DC* resistances, respectively. Furthermore, a_C and a_S are the constants indicating the rise of resistance with frequency in the skin effect. The frequency dependency of resistance are shown in above plot. From the above plot it is evident that resistance is an increasing function of frequency, and at low frequencies (typically from 0 to 10 KHz) its value is almost constant.

The parameterized model for inductance showing the frequency dependency is:

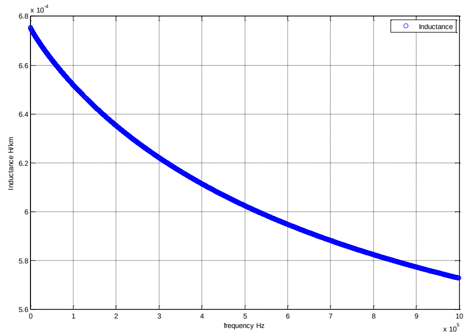

Figure 6.3 Inductance vs frequency for a 26 gauge cable.

$$L(f) = \frac{L_o + L_\infty \left[\frac{f}{f_m}\right]^b}{1 + \left[\frac{f}{f_m}\right]^b} \left[\frac{H}{km}\right] \quad (6.2)$$

where l_0 and $l\infty$ are the low-frequency and high-frequency inductance, respectively, and b is a parameter chosen to characterize the transition between low and high frequencies in the measured inductance values. The frequency dependency of inductance can be clearly visualized from below plot. The plot shows that inductance is a decreasing function of frequency, and at low frequencies its value is also almost constant.

The parameterized model for capacitance is:

$$C(f) = c_\infty + c_o f^{-c_e} \left[\frac{F}{km}\right] \quad (6.3)$$

where $c\infty$ is the contact capacitance, and c_0, c_e are constants used to fit the measurement

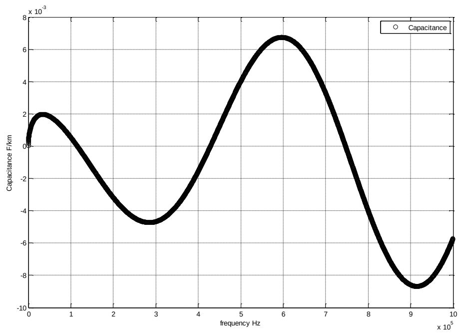

Figure 6.4 Capacitance vs frequency for a 26 gauge cable.

As shown above the capacitance to frequency curve increasing and decreasing function which shows over the frequency range the capacitance value is oscillatory.

The parameterized model for conductance is:

$$G(f) = g_o f^{g_e} \left[\frac{S}{km}\right] \quad (6.4)$$

Where the constants g_0 and g_e are used to fit the measurement.

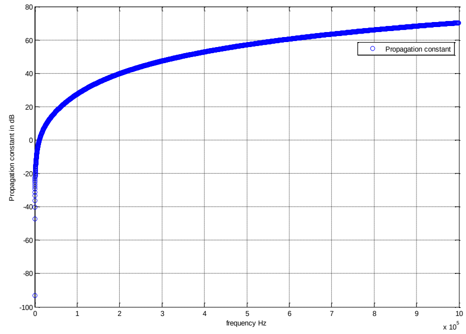

Figure 6.5: Conductance vs frequency for a 26 gauge cable.

As shown above the plot between frequency and conductance is a increasing function.

The parameterized model for characteristic impedance:

$$Z_C = \sqrt{(R(f) + J\omega L(f))/(G(f) + J\omega C(f))} \frac{\Omega}{km} \quad (6.5)$$

As shown the characteristic impedance of the cable is a function of Resistance, Inductance, Capacitance, Conductance which are functions of frequency. The magnitude of the plot shows impedence over the entire given frequency range.

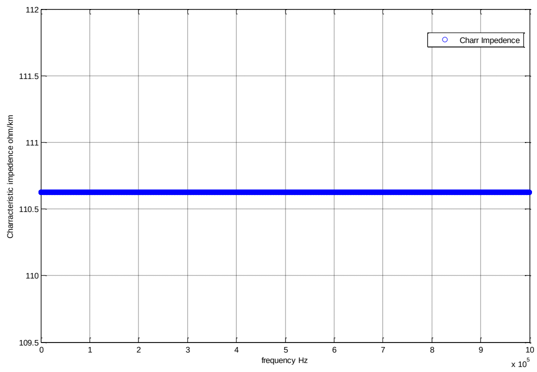

Figure 6.6 Characteristic impedance vs frequency for a 26 gauge cable. The parameterized model for propagation constant:

$$\gamma = \alpha + J\beta = \sqrt{(J\omega L(f) + R(f)).(J\omega C(f) + G(f))} \frac{1}{km} \quad (6.6)$$

As shown above the terms alpha, beta are the attenuation constant, phase constant respectively, which is the function of frequency for unit length.

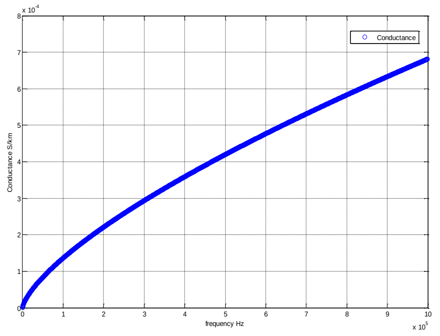

Figure 6.7 Propagation constant vs frequency for a 26 gauge cable.

As shown in above plot the propagation constant is a increasing function of frequency, it is almost starts from -20dB and constant at higher frequency.

The model for transfer function of cable:

$$H_{direct}(f) = \frac{V_{out}}{V_{in}} = \frac{Z_s + Z_L}{AZ_L + B + (CZ_L + D)Z_S} \quad (6.7)$$

Where

$$A = D = \cosh(\gamma d) \quad (6.8)$$

$$B = Z_o \sinh(\gamma d) \quad (6.9)$$

$$C = \frac{\sinh(\gamma d)}{Z_O} \quad (6.10)$$

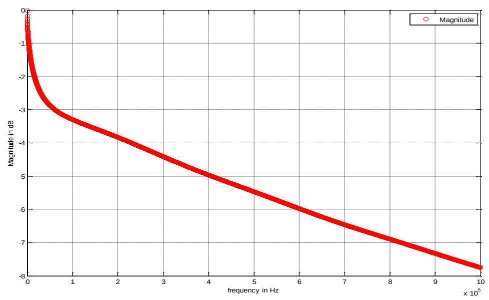

Figure 6.8 Magnitude of transfer function of cable in dB vs frequency for AWG26 cable.

As shown in above plot which is the plot between frequency and magnitude of transfer function in dB, the response starts from 0 dB (1 neper) and is almost constant over the entire frequency range

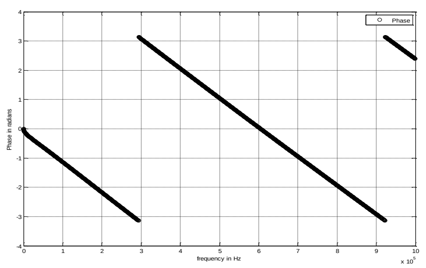

Figure 6.9 Phase of transfer function of cable in radians vs frequency for AWG26 cable.

As shown above plot the phase response of AWG26 cable is linear, which starts at 0 radians and the ramp goes for negative and positive values.

We observe that the gain is almost constant. Furthermore, the phase of the cable is linear over the whole frequency band. Hence, the group delay is constant, meaning every frequency of a signal is delayed by the same time.

I Model of white and color noise:

From below we observe that the high frequencies of the white noise signal are eliminated by the IIR filter. In addition to that the amplitude respectively the variance of the colored noise is decreased due to the filtering process.

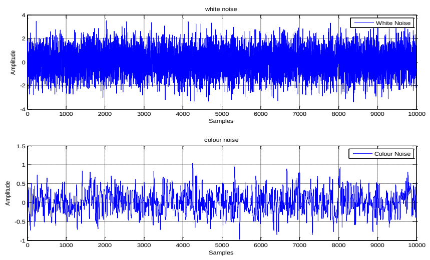

Figure 6.10 The generated color and white noise.

J. Transmitted and Received Manchester signals:

As observed in below plot of received and transmitted Manchester signals, the envelope of transmitted signal deserves good shape but In case of received Manchester signal the envelope has degraded due to white and color noise effect, it will also influenced by attenuation of the cable. The degradation in the received Manchester signal will cause for incorrect decoded message. This will influence the Bit Error Rate (BER) performance.

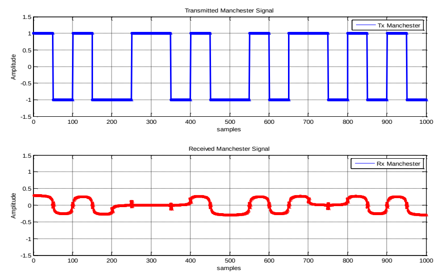

Figure 6.11 Transmitted and received Manchester signals.

K. Transmitted and Received Message signals:

As observed in below plot of received and transmitted Message signals, the envelope of transmitted signal deserves good shape but In case of received signal the envelope has degraded due to white and color noise effect, it will also influenced by attenuation of the cable.

The degradation in the signal will cause for incorrect decoded message. As shown in the plot of received and transmitted message signals this will influence the Bit Error Rate (BER) performance.

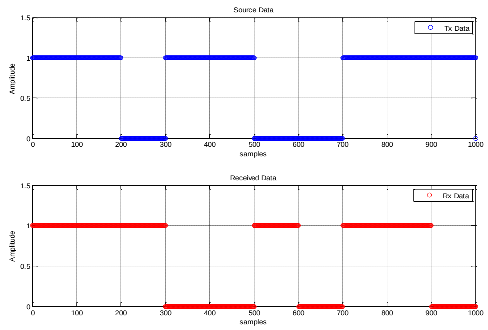

Figure 6.12 Transmitted and received message signals.

BER performance for different lengths of AWG26 cable for white, color, combination of both Noises:

As shown in below plot for BER performance for different lengths of AWG26 cable for white, color, combination of both Noises. The degradation in the signal will cause for incorrect decoded message, which leads to lost of some bits and there by some packets. It will result for a particular BER to exist. But as per the result it can be concluded that the BER is more for any length of cable for white noise and Combination of white and color noise case. If observed in terms of lengths it shows interesting results, like shown in plot the BER is more for 300ft cable and the next position is the 200 ft, 1000ft respectively. From this one can conclude that the BER performance is different for different lengths of cable, this is mainly due to transmission line characteristics. The transmission line primary parameters RLGC will change according to the length and these parameters will be added or subtracted of individual sub sections, if the entire cable assumed to be divided into logical parts.

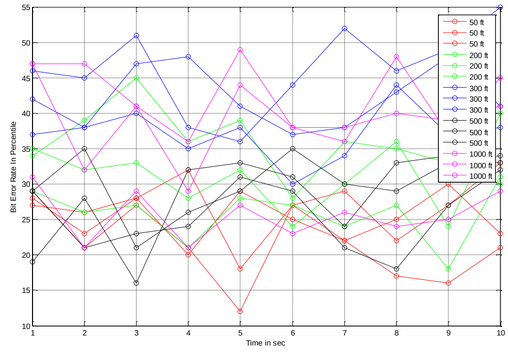

Figure 6.13 BER performance for different lengths of AWG26 cable for white, color, combination of both Noises:

In above plot the X-axis is time in sec and Y-axis is BER in terms of percentile. This plot was plotted to logically analyze the BER performance for different cable lengths and in different noise environments like white, color, and combination of white and color noises.

BER performance for different lengths of AWG24 cable for white, color, combination of both Noises:

The degradation in the signal will cause for incorrect decoded message, which leads to lost of some bits and there by some packets. It will result for a particular BER to exist. But as per the result it can be concluded that the BER is more for any length of cable for white noise and Combination of white and color noise case. If observed in terms of lengths it shows interesting results, like shown in plot the BER is more for 300ft cable and the next position is the 1000 ft, 200ft respectively. From this one can conclude that the BER performance is different for different lengths of cable, this is mainly due to transmission line characteristics. The transmission line primary parameters RLGC will change according to the length and these parameters will be added or subtracted of individual sub sections, if the entire cable assumed to be divided into logical parts.

III. Conclusions

The transmission line parameters were derived and discussed which will be used in simulation, like RLGC, propagation constant, characteristic impedance, transfer function of twisted pair cable by using the model of ABCD parameters. Simulated all the primary and secondary parameters.The theory about white and color noise was discussed in terms of power spectral density and auto correlation function a technique was developed to generate white noise, color noise, by using signal processing techniques in MATLAB.

A communication model was designed and analyzed based on Manchester baseband modulation, the decoding or demodulation technique was explained and simulated.

The parametric model of RLGC for twisted pair cable were plotted to observe behavior of cable in terms of its primary parameters. The cable performance in terms of its magnitude and phase response analyzed to find the amount of attenuation on the signal and to assess the performance of group delay. The transmission line secondary parameters like propagation constant, characteristic impedance were simulated. The transmitted and received Manchester, message signals were analyzed and plotted. Finally the BER performance of the AWG26, AWG24 twisted pair cables were plotted and analyzed. The degradation in the signal will cause for incorrect decoded message, which leads to lost of some bits and there by some packets. It will result for a particular BER to exist. But as per the result it can be concluded that the BER is more for any length of cable for white noise and Combination of white and color noise case. If observed in terms of lengths it shows interesting results, like shown in plot, the BER for AWG26 is more for 300ft cable and the next position is the 200 ft, 1000ft respectively. From this one can conclude that the BER performance is different for different lengths of cable, this is mainly due to transmission line characteristics. The transmission line primary parameters RLGC will change according to the length and these parameters will be added or subtracted of individual sub sections, if the entire cable assumed to be divided into logical parts.

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