Research on Low Voltage Power Line Carrier Communication Simulation Software

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***Abstract*—The use of semi-physical simulation platform for school laboratory and classroom building scene a lot of field measurements, analysis of power line channel transmission characteristics of the different environments, and features a three-dimensional graphic display of variable power line channel under different scenarios. At the same time in order to improve the efficiency of the data analysis, the use of MATLAB simulation software design based on off-line data analysis software GUI interface. It receiving end signal processing module integrated into the GUI interface, to implement graphical data analysis and processing, and at the same time from multiple dimensions of the channel parameters display.**

Keywords-Adaptive impedance matching; Bit Error rate; Communication equipment; Continuous adaptation

I. INTRODUCTION

With the advent of the information age, low voltage power line carrier communication technology because of its communication lines without additional laying, and widely distributed, so it has broad application prospects in the room automation. However, as a low-voltage power line is mainly used for power transmission lines of the communication environment is very complex, a lot of power line carrier communication technology application development is still in the experimental stage, there are still many difficulties to be resolved.

Low-voltage power line load work status changes, resulting in time-varying characteristics of strong channel transmission characteristics complex, concentrated reaction in the input impedance, signal attenuation and noise three areas. Specific performance input impedance changes, the communication device without having to constantly and line impedance effectively matched, resulting in the carrier signal energy can not achieve the desired output; the same time as the power line complex network structure distribution, so severely attenuated phenomenon signal transmission process occurs, resulting in the signal waveform severe distortion, certain difficulties to the reception carrier signal; and the channel there is a lot of background noise, seriously affect the accuracy of the information-data transfer, resulting in serious errors received data. Impedance characteristic low-voltage power line noise attenuation characteristics and also with the dramatic changes occur in different times and places, has a strong randomness. As in the above three properties in the evening peak period and late trough measured at the same location will be out

Now a huge difference, as the electricity network at the same time to test different cells also showed very different. Because of the complex nature of these low-voltage power line channel, many R & D personnel carrier communication device discovery has been developed in the field of communications equipment running very unstable. Experimental data at different times or in different locations will have a significant difference, and thus to the development and testing of experimental evaluation of communications products brought many difficulties. For this reason, the concept presented here to build a low-voltage power line carrier communication comprehensive experimental test simulation platform, attempts to provide a unified common test environment for R & D personnel and low voltage power line carrier communication, the communication product development as much as possible in a laboratory experiment into, rely solely on the scene to overcome the situation. Establish such a system, but also conducive to communication equipment factory inspection, evaluation of performance, and improved means of communication. At the same time, given the current low-voltage power line channel characteristics analysis and modeling at home and abroad mostly in theoretical research level, so here uses software and hardware combination of methods to establish the analog low-voltage power line carrier communication channel characteristics of the test simulation platform for power line carrier communication technology the research work, but also helpful.

II. CHANNEL CHARACTERISTICS OF LOW VOLTAGE POWER LINE CARRIER COMMUNICATION ANALYSIS

Designed for low-voltage power lines are used to transmit power frequency 50Hz power, does not need to transmit high-frequency communication signals and perform special consideration. So it's topology and physical characteristics there is a huge difference between traditional communication transmission media (twisted pair, coaxial cable, fiber, etc.), resulting in low voltage power line communication channel environment is very bad, the channel characteristics quite complex. Mainly for line input impedance changes, it is difficult to match with the transceiver; high frequency signal attenuation serious and difficult to detect output signal; a large number of low-voltage power grid noise sources exist, communication environment interference large. Through the study of low-voltage power supply system power line channel characteristics, we find the basic characteristics of the channel are as follows [12 - 14]:

(1) The power supply system is in the form of parallel distribution to each user, the system is open, vulnerable to interference from user factors.

(2) power system frequency of 50Hz, all the power supply wires are made of low-frequency, low-cost aluminum or copper production, coupled with the ease of network structure and so will increase the power supply system of distributed capacitance, frequency variation .

(3) power supply system will vary with the number of users and electrical access and random changes occur.

(4) interference system load and the environment by large, access and disconnect the inductive load, thyristor surge devices, switching power supply electrical noise, power failure caused by tripping and fuse so the system have a greater interference.

(5) Since the random network structure of the power supply system, and power supply system and the load characteristics of the line itself random access, resulting in a mismatch of the characteristic impedance. To sum up, the channel transmission characteristics of the power line complex concentrate reaction in the input impedance, signal attenuation and noise three areas. The following detailed analysis will form the original low-voltage power line channel basic characteristics, the input impedance characteristics, transmission attenuation characteristics and channel noise characteristics demonstrated by the changes in the characteristics.

$$y_B^{plc} = h_{AB}^{plc} x_1 + h_{DB}^{plc} x_2 + n_B^{plc} \tag{1}$$

$$y_C^{plc} = h_{AC}^{plc} x_1 + h_{DC}^{plc} x_2 + n_C^{plc} \tag{2}$$

$$\begin{aligned} y_C^{wl} &= h_{BC}^{wl} y_B^{plc} + n_C^{wl} \\ &= h_{BC}^{wl} h_{AB}^{plc} x_1 + h_{BC}^{wl} h_{DB}^{plc} x_2 + h_{BC}^{wl} n_B^{plc} + n_C^{wl} \end{aligned} \tag{3}$$

$$I_{SDF} = \begin{cases} \frac{1}{2}\log_2(1+2\gamma h_0), & h_2 < \gamma_{th} \\ \frac{1}{2}\log_2\left(1+\gamma h_0 + \gamma h_2\right), & h_2 \ge \gamma_{th} \end{cases} \tag{4}$$

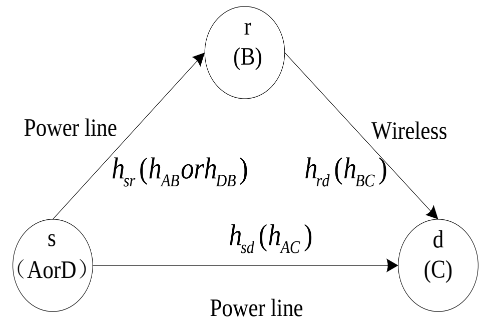

Figure 1. Basic structure of proposed PLC system

III. POWER LINE TRANSMISSION MODEL BASED ON MULTI-PORT

Features summarized as follows:

(1) channel attenuation is mainly due to the coupling attenuation and line attenuation caused in two ways. Coupling attenuation by Output impedance of the signal transmission circuit and the power line input impedance mismatch caused. Attenuation refers to the transmission line Loss of energy input signal lines on the power line, its causes are many, including power lines Network complexity, a number of the access node, and the channel there are many nodes in the impedance mismatches and the like. Low-voltage power line carrier communication channel tend to have the characteristics of the multipath channel, will inevitably lead to more signals Path propagation, resulting in attenuation.

(2) As the frequency increases, the attenuation of the signal will also increase. However, in some special frequency bands, by On the impact of reflection, resonance and transmission line effects such as multipath, attenuation will fluctuate at a specific frequency Change.

(3) The degree of signal attenuation generally speaking, is proportional to the distance of signal transmission. However, due to the power line carrier communication simulation software on the line parameters of the power line, load parameters, noise parameters, and add in the signal parameters power line set by software algorithm simulation to achieve a low-voltage power line communication channel input impedance characteristics, transmission attenuation and interference noise and other characteristics of the power line itself changes, to provide a power line carrier communication with the actual situation close to the channel environment.

Facilitate carrier communication personnel in the preliminary design stage through simulation communication simulation software for analysis to determine the transmission effect of the overall design, but by observing the distortion of the situation to send the signal waveform and the received waveform, to study the line parameters of the power line, load, signal frequency, impact of noise on the power line carrier communication, and try to influence the different communication modulation and demodulation algorithm for data transmission errors, thus providing an operation on a PC, the software platform and simulation environment for power line carrier communications test experiments.

Overall design of power line carrier communication simulation software can be represented by a data flow diagram shown in Fig.3-1. Firstly set the parameters of power line carrier communication by the user, which includes the channel line parameters, namely the length of distribution lines, cable type transmission line resistance, line capacitance, line inductance other items, including signal parameters, noise signal parameters and load setting parameters. Signal parameter setting signal includes a type, amplitude, phase, frequency, the noise signal includes noise intensity parameter settings, the type of coupling point location, the load parameter set includes mainly the form and size of the load.

Choose a variety of topologies channel is also provided by the user parameters to achieve, so the user must select the parameter values before the simulation according to their own circumstances. After completion of the parameter setting parameter data into a unified data store to call during the simulation calculations. When Parameter settings can also be saved in a file, data will be sent to save the parameter settings of the module to save for the next simulation using the same set of parameters, you can call the saved file directly, to avoid duplication of effort.

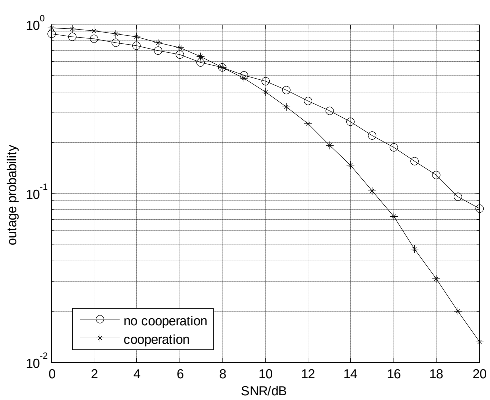

Figure 2. utage probability of cooperation system and no cooperation system with the SDF cooperation model

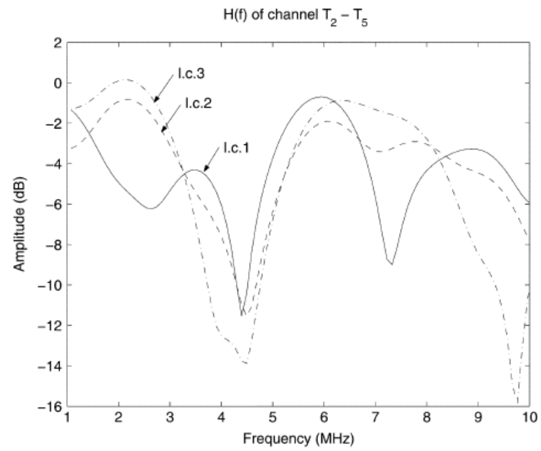

Figure 3. frequency response of the channel in the 1-10MHz band

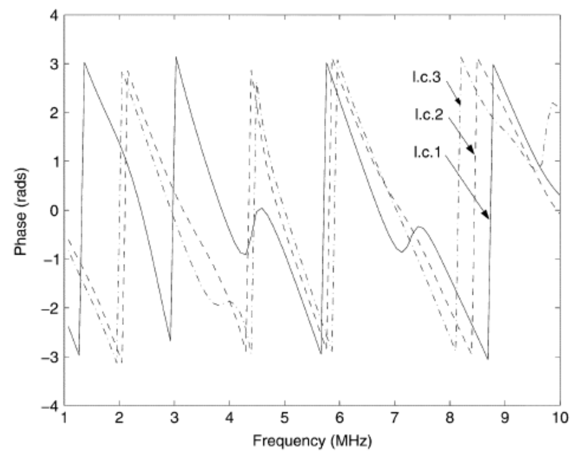

Figure 4. RMS delay spread for channel T2-T5

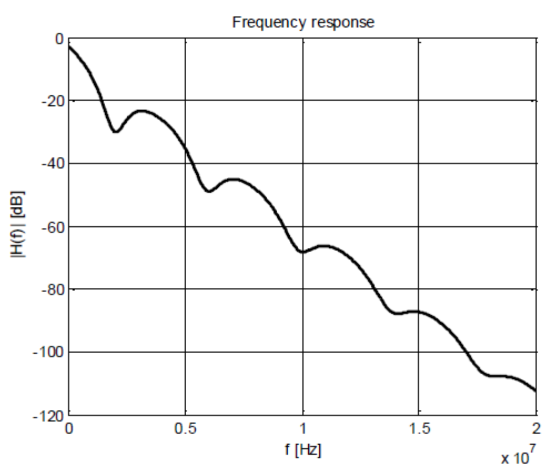

Figure 5. simulation of the sample network

IV. CONCLUSION

Setup procedure under the data flow good parameter level is as follows: First, the user set up the channel model of the channel characteristics of the test analysis, including input impedance characteristics, the transmission attenuation and channel noise characteristics, so that the test results observable meets expectations channel performance requirements, if greater access should return to the previous channel reset line and load parameters, until satisfied. Then set the data good noise parameters and signal parameters added to the channel model, communication simulation. Finally, on the one hand by the output waveform module can display waveform signal after transmission through the channel distortion situation; on the other hand can be observed through the error rate of the entire power line carrier communication after the data transfer process, to verify the feasibility of communication algorithms.

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