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Research on Low Voltage Power Line Carrier Communication Test Environment

Sun Hongliang
Chong Qing Electric Power Research Institute, Chong Qing, China
gtovictor@163.com

Hou Xingzhe, Zheng ke
Chong Qing Electric Power Research Institute, Chong Qing, China
e-mail:cqhhxz@163.com; cqetzk@sina.com

Li songnong, Ye Jun
Chong Qing Electric Power Research Institute, Chong Qing, China
e-mail:cqepld@163.com; cqepshl@sina.com

Liu Dong, Zhou Quan
Chong Qing Electric Power Research Institute, Chong Qing, China
e-mail:gtovictor@163.com; cqepzq@163.com

***Abstract*—Low voltage power line carrier communication simulation software and simulation test system is analog carrier communication channel environment in different ways, the two systems complement each other, the former design stage for communications equipment, flexible and comprehensive simulation of the channel complex transmission characteristics; the latter stages of a communication device for debugging, you can be more effective and intuitive reflect any change in the characteristics of the load. This paper describes the combination of the two respective characteristics of its ability to effectively simulate the actual channel transmission characteristics.**

Keywords-Power line channel; Data signal coupling; Communication system

I. INTRODUCTION

Research is mainly used to transmit power line 50 / 60Hz electrical energy, which can be used as a communication channel characteristics are very bad, there is a power line channel characteristic is a hot topic in recent years. Comprehensive numerous documents, affect the reliability of the power line communication main factors: the noise level is high, the impedance changes, severe attenuation of the signal level, multipath delay effects.

Meanwhile, due to a high rate of data transfer requires at least IMbPs transmission rate, using a conventional low bandwidth European CENELECEN50065 a 1: 3 a 148.skHz band, US FCC: 100 a 450ld any z band) can not achieve this transmission rate. Attenuation of the power line frequency increases with the increase, the signal frequency bands above 30MHz, excessive attenuation can not be detected at the receiving end. There is now generally agreed that the available frequency bands of the power line for high-speed digital communication Bu 30MHz, and in fact in this frequency band on the power line equipment operation noise level is much lower than the conventional frequency band [2,. The low-voltage power lines as a communication channel, its main interference encountered are:

(1) encounter interference signals within a broad range. If the user of a variety of electrical equipment, especially old and have electrical quality defects, the transmission power line will have catastrophic interference signal. (2) change in the impedance on the electricity network as the load and there will be a significant change, and has a strong time-varying.

(3) Since there is a strong attenuation characteristic, so that each node on the power line exhibiting properties are not the same. In order to achieve reliable communication in low-voltage power lines need to be considered noise, impedance and attenuation in three areas.

This paper analyzes the noise characteristics of low-voltage power lines.

Difficulty powerline communications technology focused on the physical layer and the data link layer. At the physical layer, and how the use of advanced technology and high-frequency spread spectrum modulation technique is the key; at the data link layer, the dielectric characteristics of contention with a power line with the protocol and data frame structure is the key. In addition, variability factors, such as location and multipath effects when determining the low voltage power line high-frequency channel parameters need to be considered.

Grid is a wide range of distributed networks, MV / LV (MV few V) connected in parallel with the transformer secondary has many user load. Varies with time and load, the channel will have a significant change in the impedance value fluctuations. Impedance matching is important, because when impedance matching transmitter, channel and receiver when the receiver receives the signal energy value of the maximum. According to the IBM-supplied housing supply impedance test report Is], through a 30oMHz 20kHz frequency range Wai 25 frequency measurement and analysis, the impedance range of the power line relatively wide, for example, at 100kHz.

II. NOISE ANALYSIS OF LOW VOLTAGE POWER LINE

Noise source is divided into non-human power line noise and artifacts. Artificial noise is a natural phenomenon, such as noise in the power line caused by lightning; artifacts time from a variety of electrical, mechanical and electrical products and power lines themselves, the main power line noise is not additive white Gaussian noise out 17 basic characteristics are very short all changes that may occur within the period. According to the band powerline communication studies at different stages of the power line noise 3OMHz within the classification can be divided into two parts: lookHz below and 100 BU 30MHz. This paper studies

Z girl bands above 100 generally can be divided into five categories [1]: colored background noise (eoloredBaek bad oundNoise), narrowband noise sleepy axrowBandNoise), and asynchronous periodic pulse-frequency noise (periodic ImpulsiveNoise, Async site onoustotheMainsFrequeney), and workers periodic pulse frequency noise PeriodieImpulsiveNoise synchronization, SynehlonoustotheMainsFrequeney) and asynchronous impulse noise (Asyne shy nousImpulsiveNoise). powerline noise distribution is closely related to the time, place and load, etc., independent of each other between the noise [l'l, and therefore in theory, these five superposition of noise can be seen as power line noise. various types of noise characteristics see Figure 2.1 [6].

5 asynchronous impulse noise is mainly to protect the switch instantly switching pulse generated by the corona noise is also classified as such noise. Such as: high voltage switching operation, a large load variations, and other short-circuit fault on the power line caused by a large pulse of energy is often interference or pulse interference groups, short duration, but the energy is concentrated, the spectrum is very wide.

The duration of such noise on a small stage where, large ms level, and the rate reached dB magnitude, therefore, is considered to be the biggest obstacle for power line communication [2]. In addition, the study found that Intellon's node in the building of the power cord has a semiconductor effect, resulting in a non-linear induction noise power frequency half cycle [3]. Part no access devices generate grid power line noise can also enter through the RF coupling. Power line noise with time domain and frequency domain features, Figure 2.2 is the noise amplitude-frequency characteristic diagram shows our power lines maximum at NARI office a second experiment, the average, minimum noise level may indicate a power line letter noise ratio (SNR).

Uniform transmission line is a distributed constant circuit, the most typical transmission line is placed in a homogeneous medium two parallel straight conductor, in the transmission line, the current caused along the voltage drop in the resistance of the wire, and at the same time around the wire produced a magnetic field changes, the magnetic field changes along the line voltage is induced. Therefore, the voltage between the wires is continuously changing along. On the other hand, due to the inter-wire capacitance constituted between the two lines there is displacement current (especially frequently than High, but can not be ignored; if the voltage between two lines also high, the leakage current can not be ignored. In different places along the, current in the wire will be different. In short, in order to account for variations along the current and voltage must be considered for each length of wire has resistance and inductance, and the inter-wire capacitance and conductance is having. This length of the element can be considered to be infinitesimal, that is seen as a limit transmission line consists of a series consisting of lumped elements is distributed circuit model. If the transmission line resistance, inductance, conductance, and capacitance is uniformly distributed along the line, this transmission line is called a uniform transmission line model. Generally, low-voltage distribution network used is a three-phase low voltage power cables multi-conductor transmission line. The method of calculation to determine the length of the cable unit to use the analysis parameters.

$$P(d) = \left|d\right|^{-n} S(d)R(d) \tag{1}$$

$$h(t,\tau) = \sum_{i=1}^{L} \alpha_i(t)\delta(\tau - \tau_i) \tag{2}$$

$$r_{\alpha_i}(\Delta t) @ E\{\alpha_i(t+\Delta t)\alpha_i^*(t)\} = \sigma_i^2 r_t(\Delta t) \tag{3}$$

$$\begin{aligned} & r_H(\Delta t, \Delta f) @ E\{H(t+\Delta t, f+\Delta f)H^*(t,f)\} \\ & @ \sum_{i=1}^{L} r_{\alpha_i}(\Delta t) e^{-j2\pi\Delta f \tau_i} \\ & @ r_t(\Delta t)(\sum_{i=1}^{L} \sigma_i^2 e^{-j2\pi\Delta f \tau_i}) @ \sigma_H^2 r_t(\Delta t) r_f(\Delta f) \end{aligned} \tag{4}$$

$$\sigma_H^2 @ \sum_{i=1}^{L} \sigma_i^2 \tag{5}$$

$$S_{21} = \frac{a(\omega) + b(\omega)Z_L}{c(\omega) + d(\omega)Z_L} \tag{6}$$

In 50 m3 +1 core XLPE insulated PVC sheathed power cable experiment, HP4194 impedance gain phase analyzer, get a set of input impedance measurements (frequency range of 10 kHz ~ 15 MHz). Test seen impedance mismatches, and the peak amplitude of the impedance curves recurring. If we consider a lossless line, the cable is in parallel resonance when the input impedance should be infinite, the input impedance of the series resonance circuit is zero. In the resonant frequency, the input impedance of the power line phase shift is zero. Parallel resonance at lower input signal frequencies greater impedance, decreases with the increase of the peak frequency, mean power line loss increases as the frequency increases, the electromagnetic wave reflected high-frequency signal in the case where the line does not match. For open and short experimental data obtained in accordance with the formula (14) can be calculated R0 frequency within 10 kHz ~ 15 MHz range, L0, C0 and G0. Figure 4 (a) ~ (d) are the result passed Matlab experimental measurement data obtained by the analysis, the pilot test parameters and peak amplitude of the gap occurs, so that the parameters obtained by calculation unit length of cable lines in the resonance point is also be greater peak, and this change in parameter values strong regularity, after fitting the data obtained with the resultant data in Figures 2 and 3 are close, but there are some errors. Description of the physical parameters of the power line is calculated can be applied to more accurately calculate the actual research and analysis, but it needs to be done for the specific circumstances of the appropriate correction and processing.

The input impedance and low voltage power line carrier communication channel refers to the receiving device driver points in the signal transmission device and signal distribution network equivalent impedance directly affect the size of the transmission signal coupling efficiency is an important parameter for low voltage distribution network carrier communication . Overall, the input impedance versus frequency, the signal input low voltage power line network location (ie, the signal input with respect to the location of the network), the timing signal input has a great relationship. Thus, at different times, at different locations, the input impedance of the power line greatly changed, the input impedance of the transmitter power amplifier output impedance matching and a receiver is difficult to maintain, has caused great difficulties to the circuit design. Effects of these properties can be equivalent to the transmission signal on signal attenuation.

III. PLC NETWORK STRUCTURE INSIDE THE CHAMBER

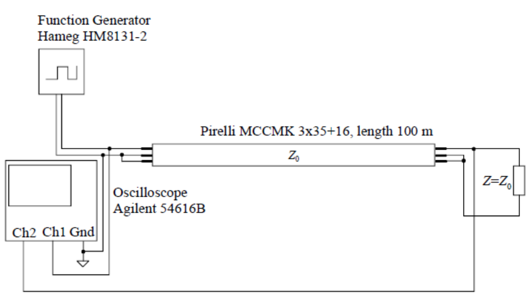

Figure 1. Test arrangement for the measurement of signal propagation velocity in a low voltage power cable with a surge wave test

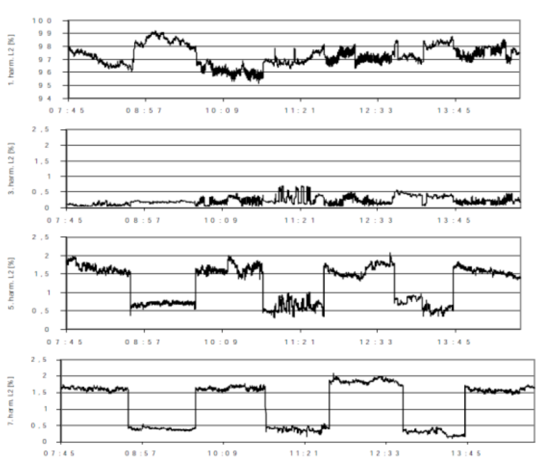

Figure 2. The measured fundamental voltage and the odd harmonics

The reason for this phenomenon is that a variety of grid load. Therefore, the noise low voltage power line channel is not common Gaussian white noise: Also, different grid noise intensity varies with time and variability, is difficult to directly define its size. But the noise also has a certain regularity, such as the size of noise with increasing frequency, and a downward trend, and no matter what kind of noise is superimposed by the specific nature of various noise sources from. Power line noise is usually divided into five categories.1).With a smooth spectrum colored background noise. Mainly produced by a variety of electrical loads, such as hair dryers, computers, power spectral density is relatively low and generally decreases with increasing frequency; 2) the system is independent of frequency narrowband noise. Mainly by the various wireless transmitter signal is coupled to the power line caused: 3) and asynchronous periodic pulse-frequency noise. Mainly produced by the power line switching power supply; 4) _ [periodic impulse noise frequency synchronization. Mainly for the high-power thyristor devices caused when small: 5) and the system frequency independent random impulse noise. Mainly by electrical switching operation, each of the impulse noise will affect a wide frequency band. Usually the first three noise changes slowly with time, often attributed to background noise: After two kinds of noise strong variability, which occurs when noise, power spectral density of certain frequencies will suddenly rise, can cause data transmission bit or sudden string error, causing large errors for data transmission.

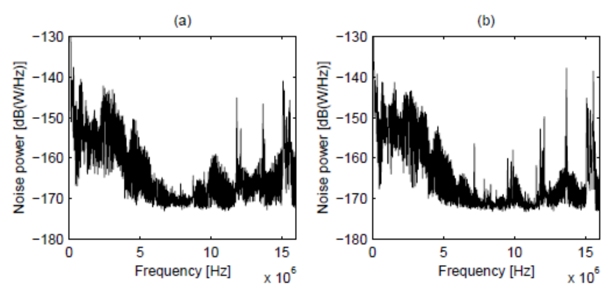

FIGURE 4-4 The power spectrum of the noise in cable-box 443 at phase 1 (a) and 3 (b).

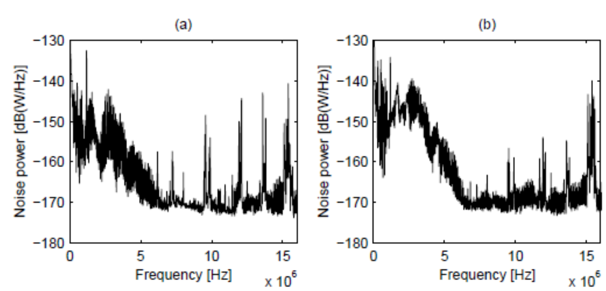

Figure 3. The power spectrum of the noise

IV. CONCLUSION

The results show that 443 and 444 can be considered as having relatively high-quality channels, on the contrary 447 is considered a low-quality channel. The PLC-P system, which is the system observed in that chapter, uses frequencies in the CENELEC A band (9-95 kHz), which is within the frequency band considered here. An objective with these measurements has also been to try to point out which parameters reduce the quality of some channels in the PLC-P system. Note that we do not evaluate PLC-P, but the quality of the channels that is used in the system.

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