Transmission Characteristics Simulation on Power Line Communications

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In Power Line Communication (PLC) systems, medium and low voltage power distribution lines are used as a communication network. However, since no consideration is given to signal transmission characteristics in the high frequency used for PLC systems, reflections caused by impedance mismatches deteriorate transmission characteristics. If channel characteristics of power lines can be estimated by simulation, it will be efficient for the design and the operation of PLC networks. This paper proposes a method to estimate transmission characteristics of a channel model between a transmitter and a receiver installed on a distribution network. Propagation characteristics of PLC signals at each distribution facility is described using two port networks. A channel model is automatically generated from the combination of component models along the topology of distribution network and the locations of a transmitter and a receiver.

For medium-voltage system configurations, systems typically employed are open loop, including loop topologies, which are typically opened in one place by an automatic switch or manual, and tree-like topology systems, which include radial distribution line. Depending on the way the electrical loads are distributed, distribution line types and lengths vary among power systems.

PLC network model generated from the combination of component models is described as a tree model whose root node is a power source as shown in Fig. 1. The input and output terminals of component models are defined correspond to the direction from the root to leaf node. The direction of component models is not the same as the direction of the flow of PLC signal because the flow of PLC signal is depend on the location of a transmitter and receiver. The authors has developed the alogrithm to generate the direction of PLC singal from the location of the transmitter and receiver by tracing the tree from the transmitter and receiver forward the root node along the network topology.

The distribution network model is devided in four sections by the injection/reception branch node, which is the common ancestor node of the transmitter and the receiver. Each sections is reduced into one integrated component model by the matrix calculation of two port matircs. Transmission characteristics and the PHY rate from the transmitter to the receive can be estimated based on the reduced model shown in Figure 2.

Component models were validated using the test distribution network of the low-voltage system inlcuding several kinds of cables and a transformer. The S parameters and PHY rate was measured by a network analyzer and a PLC modems.Figure 3 shows the results of calculated and measured transmission characteristc.The results are almost same, which shows that the proposed method has been proved to be effective.

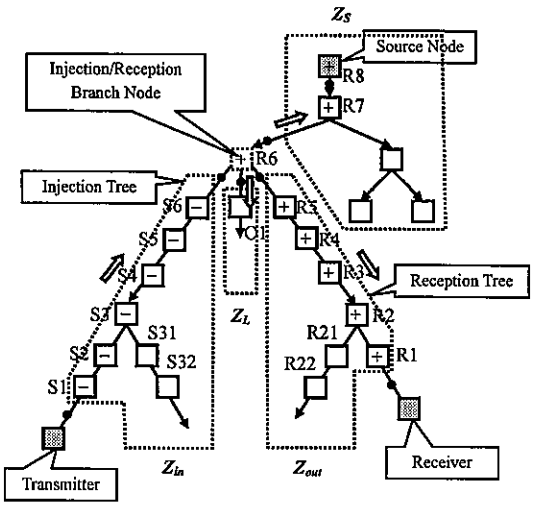

Fig. 1. Distribution network topology model

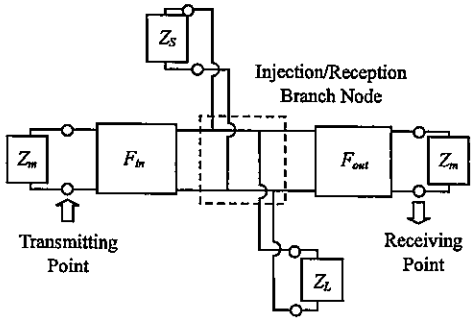

Fig. 2. Reduced network model

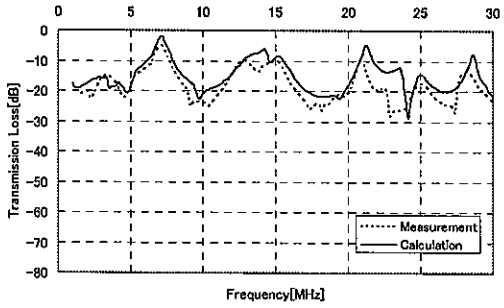

Fig. 3. Transmission Characteristics of calculation and measurement