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Title of Ph.D. thesis: Simulation of Multi-Structured Broadband over Power Lines System

The research work in this thesis is oriented towards the modeling and characterization of low voltage power line distribution networks with different network topologies, and design of the coupling circuits for data transmission. Motivation of these studies is to design and produce more reliable, flexible, efficient and cost effective communication networks using the existing electrical infrastructure. The organization of the thesis is divided into seven chapters.

The first chapter deals with an introductory study on Broadband over power line technology (BPL) in the smart grid implementation plans as one of the key elements. In Chapter 2, an extensive literature survey on PLC and BPL research, design, development and modeling issues is carried out. The focus of this review is to model and characterize the power line channel for data delivery services in indoor environment. In Chapter 3 of the work, a typical BPL system is simulated and its channel characterized based on transmission line theory. The effect of varying topologies on the performance of the BPL system is investigated using different number of branches, load impedances, termination type, method of cascading and line lengths.

Chapter 4 deals with the investigations done on model gain and the phase profiles of the power line channel in multipath environment that provide the information about the suitability of indoor power line network as a medium of data transmission. In Chapter 5, the thrust is to carry out performance analysis of communication model using OFDM for transmission of digital data over power lines and to evolve innovative model for time varying power line communication channel. A comprehensive study based upon MATLAB Simulink models of various modulation techniques is carried out. The modulation techniques investigated for BER performance were

PSK, BPSK, QPSK and QAM. Performance of transmission of digital data over indoor power lines using OFDM with 16-QAM symbol constellation is analyzed for its complete recovery.

In Chapter 6, emphasis is laid on designing coupling circuits for communication of high frequency signals over power lines for residential smart grid applications. A number of filter configurations such as LC, T-type, and capacitor- coupling transformer coupled configurations with simulated results were presented. However, high frequency range, active and passive Chebyshev filters meet coupling circuits' system requirements such as specific signal transmission, appropriate bandwidth, and reduced number of components are finally proposed. Finally, the Chapter 7 provides the conclusion of the thesis with remarks and points towards future scope of research work.

The focus of this research work was to model and characterize the power line channel for data delivery services in indoor environment. A typical BPL system was simulated using bottom-up approach and its channel characterized based on transmission line theory. The effect of varying topologies on the performance of the BPL system was investigated using different number of branches, load impedances, termination type, method of cascading and line lengths. The investigations were also done on model gain and the phase profiles of the power line channel in multipath environment using top-down approach. The information about the suitability of indoor power line network as a medium of data transmission is provided by the results obtained. Performance of transmission of digital data over indoor power lines using OFDM with 16-QAM symbol constellation is analyzed for complete recovery and it was found that symbol error can be reduced significantly by suppressing some weak carriers. Various modulation methods were also investigated for BER comparison. Finally, a number of filter configurations such as *LC*, *T*-type, and capacitor-coupling transformer coupled configurations with simulated results are presented. High frequency, active and passive Chebyshev filters which meet coupling circuits' system requirements such as specific signal transmission, appropriate bandwidth, and reduced number of components are proposed. Thus, the investigations establish that BPL can be considered a viable solution for data communication in a smart grid, for home automation, offices etc.