Contribution ID: **40** Type: **Oral**

Analysis, Modeling and Hardware Emulation of Indoor Power Line Channels for Power Line Communication

Saturday 1 November 2025 14:45 (15 minutes)

Abstract: Power Line Communication (PLC) utilizes the available power lines (PLs) for various utilities, such as smart metering, control, Internet of Things (IoT) etc. [1] in places where the implementation of new wires is impossible or costly, and the use of wireless is restricted. However, the cables offer a harsh environment for data transfer characterized by high attenuation, multi-path and non-Additive White Gaussian Noise [2]. Multipath occurring due to impedance mismatches give rise to deep notches and a prime concern of PLC implementation. The primary and foremost requirement for the development of PLC systems is thus, detailed analysis of PL channels [3] and the development of suitable emulated scenarios [4], where the former can be tested and optimized. The latter now is based on complex methodologies [4]. In this paper, an analysis is done for 33 practical indoor PL channels in the frequency range 2-30MHz suitable for broadband PLC (BPLC) in terms of general and notch characteristics by evaluating the S21 parameters. The notch analysis incorporates parameters like occurrences, frequency, depth, bandwidth, quality factor, etc., giving an insight into their performance as a communication channel. An assessment of the channel's capacity and OFDM performance is also carried out. To develop a hardware emulator for PL notches, a multi-notch channel is modelled using series LC circuits and dependencies analyzed. The efficiency of the method for notch and channel emulation is found in terms of correlation of the S21 parameters between observed, modelled, and emulated, as well as the performance of OFDM. Emulation of PL channels using equivalent LC circuits can be achieved using cost-effective hardware, as demonstrated by the work.

References:
[1] S. Ustun Ercan, "Power line Communication: Revolutionizing data transfer over electrical distribution networks,"Engineering Science and Technology, an International Journal, vol. 52, p. 101680, 2024, doi: https://doi.org/10.1016/j.jestch.2024.101680.
[2] E. Biglieri, "Coding and modulation for a horrible channel,"IEEE Communications Magazine, vol. 41, no. 5, pp. 92–98, 2003, doi: 10.1109/MCOM.2003.1200107.
[3] Q. Shang and Y. Zhang, "Research on Channel Modeling and Topology Performance Analysis of PLC Network,"in Proceedings of the 2023 International Conference on Power System Technology (POWERCON), IEEE, 2023.
[4] B. Han, V. Stoica, C. Kaiser, N. Otterbach, and K. Dostert, "Noise Characterization and Emulation for Low-Voltage Power Line Channels between 150 kHz and 10 MHz,"2016. doi: 10.5445/IR/1000056745.

Author: MEDHI, Kangkan (Gauhati University)

Co-authors: Ms DEKA, Bandita (Gauhati University, Pragjyotish College); Prof. TIRU, Banty (Gauhati University); Mr BAISHYA, Kankan (Gauhati University)

Presenter: MEDHI, Kangkan (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics