A multiconductor model of power line communication in MV lines

Herewith follows the case study and references for the paper published in ESI Africa 3 2018 *on pages 14-20. The paper is intended to introduce a model of PLC over a three-phase medium-voltage alternating current (AC) grid.*

Model of PLC in Trinec Ironworks

Based on the research, it was possible to create models intended for simulating the real communication paths of Trinec ironworks 22kV power lines.

The modeled topology (Figure 10) comprises an active HV/MV transformer at the distance of d_{HV} = 10 m from the crossing point; an MV/MV arc furnace transformer at the distance of $d_{furnance}$ = 2 m from the crossing point; and an MV/LV transformer, whose location from the crossing point is defined as d_{LV} = 2 km. At a distance x (not known exactly but estimated to be 2 km), a backup HV/MV transformer is placed, and the line is interrupted immediately before it. The modems are located at the crossing point and at the end of the line having the length x that leads towards the backup HV/MV transformer; here, the modems are found right before the disconnection. The three phase line consists of 12 AYKCY 1 x 240/25 cables, four per each phase.

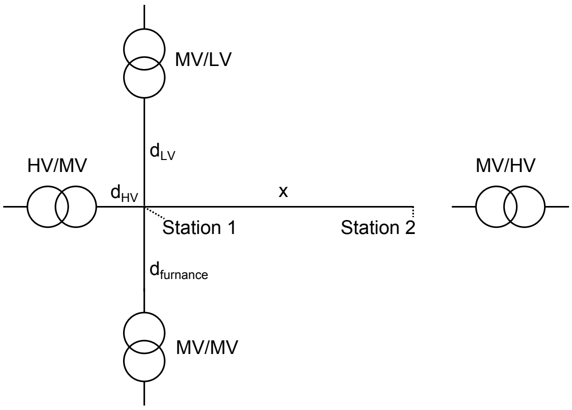

Figure 10. The topology of the medium-voltage distribution network in the Trinec ironworks industrial park.

Considering successful communication, the maximum possible attenuation depends on a broad set of aspects, including the range of frequencies to facilitate the actual communication process, the crest factor, the number of phases into which the signal is transmitted, the bit error ratio (BER)/SNR characteristic, and the current noise level. The most common threshold for satisfactory communication (the 133B frame is received with a 50% success) consists in the attenuation of the transmission channel between —38 dB and —76 dB; the related simulations are shown in Figures 11 and 12 below. As the discussed line is of the MV type and does not comprise many branches, the simulation shows that it could be possible to communicate over distances of up to tens of kilometers.

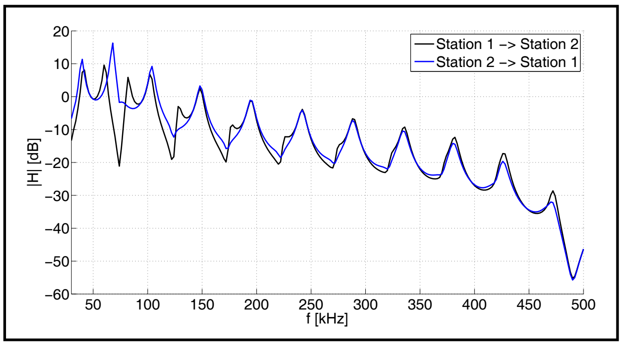

Figure 11. The simulated voltage transmission within Trinec ironworks in relation to the frequency (for the distance of x = 2000 m).

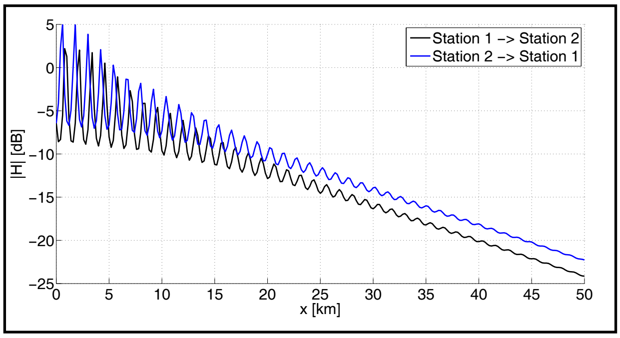

Figure 12. The simulated voltage transmission within Trinec ironworks in relation to the distance (for the frequency of f = 80 kHz).

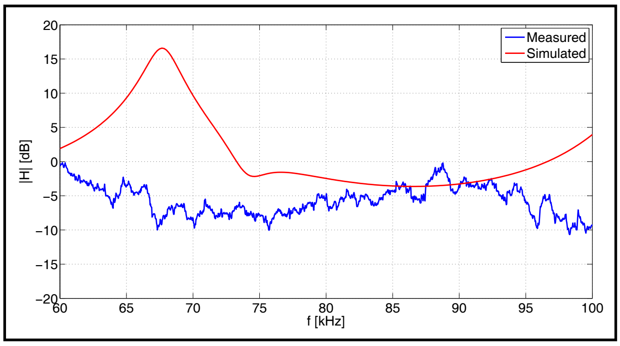

Figure 13. The measured and simulated transmission within Trinec ironworks in relation to the frequency (for the approximate distance of $x \cong$ = 2 km).

The real cable length equaled to approximately 2km, and thus the measured attenuation of the transmission channel in Figure 13 for the frequencies from 60kHz to 100kHz is insignificant and usually does not drop below —10 dB. These observations sufficiently correspond to the simulated transmission at the given frequencies, as shown in Figure 11. In both the measured and the simulated transmission, it is also possible to observe a certain ripple in the frequency domain. **ESI**

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Petr Fiedler, the co-author, provided his theoretical knowledge of modelling, cooperated on developing the model, and supervised the research activities.

The research activities were supported by Grant No. FEKT-S-17-4234—"Industry 4.0 in Automation and Cybernetics"—the Internal Science Fund of Brno University of Technology, Czech Republic.