ABSTRACT

Advancements in smart grid technology have created a need for reliable forms of data transmission to be able to provide the various intelligent features associated with smart grids. One means of data transmission is Power Line Communication (PLC), which transmits data via the power cable with the cable simultaneously performing its normal function of carrying electric power. This is made possible by using suitable coupling interfaces. Attenuation, phase constant and propagation velocity are important characteristics of High Frequency (HF) signal transmission that need to be considered when understanding a power cable's data transmission capability. This research report investigates the extent to which the outer semiconducting layer of an Medium Voltage (MV) power cable affects the HF transmission characteristics by quantifying and comparing HF characteristics. Simulations were performed based on an established HF cable model. The simulations indicated that the outer semiconducting layer has an effect, although marginal, on the HF characteristics. The mean difference of attenuation between 1 to 10 MHz is 2.849×10^4 db/m (3.08%). In the same frequency range the mean difference between the phase constant is 3.82% and the propagation velocity is 4.2%. Physical experimentation was carried out using a Time Domain Reflectometry (TDR) based measurement system. The resultant measurements further confirmed that the outer semiconducting layer has an influence on the HF transmission characteristics of the power cable. Time domain analysis, showed that the outer semiconducting layer has an effect on the velocity factor of the cable with a difference of 5.15%. Frequency domain analysis showed that the mean attenuation difference for the range of 1 to 7 MHz was 0.0054 dB/m (1.14%), which is relatively small when compared to the

simulation value. The outer semiconducting layer has a greater influence on the phase constant and propagation velocity with mean differences of 31.11% and 41.18%, which are significantly larger when compared to the values obtained through simulations. It was also determined that the length of the cable has an effect on the attenuation and usable bandwidth of the power cable with a shift of the peak attenuation from 55 to 45 MHz. In comparing the power cable with a communication (RG-58) cable of the same length it was seen that the RG-58 was better suited for HF transmission within its designated bandwidth and further showed the limitations of PLC. Design of communication channels in MV power cables should take cognisance of the power cable HF transmission limitations caused by components such as the outer semiconducting layer.