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Characteristics Evaluation of Data Transmission for Power Line Communication Using the Rail Track

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Abstract. To share train safety information when trains pass through long tunnels, steep curves and single tracks, it is important to develop a real-time two-way auxiliary communications system. The study would examine if characteristics of return circuits in rail tracks can be applied to transmission lines of PLC (Power Line Communication). Moreover, the data transmission characteristics of PLC regarding distance were evaluated. Sustainable channel transmissions were 12 to 20 MHz and 25 to 33 MHz. Furthermore, experimental results showed the possibility of PLC using rail track on 50m distance.

Keywords: PLC(Power Line Communication), Rail track, Return circuit line, PLC Modem, Signal coupler

1 Introduction

When trains pass through long tunnels, steep curves and single tracks, it is difficult to check for railroad maintenance workers and drop blocks, which have often become the cause of accidents. It is important to develop a real-time two-way auxiliary communications system to share train safety information.

Recently, PLC (Power Line Communication) [1-2] has been studied in depth by the Power companies, mainly for the automated measurement system for electrical power distribution to satisfy low and high speed data transmission demands [1-2]. However, PLC technology has been consistently highlighted as a communications media to improve transmission speeds and reliability due to development of digital modulation techniques and rapid development of the internet. The technology has been known to be cost-effective due to existing power facilities and short installation periods. Especially in the fields of railway signaling and communications, new convergence technologies are emerging in the development of CBTC (Communication Base Train Control) and wireless video transmission system. However, in the electric railway field, previous studies applying PLC were limited to use contact wires and messenger wires [3]. Especially, there is almost no research on transmission characteristics or communication network system for lower line communication using rail track. This method is dangerous due to high voltage and difficulty of installation in high locations. In addition, frequent diverging points between messenger wires and contact wires cause degradation of the signal

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transmission rate. As a solution to these shortcomings, this study will examine if the characteristics of return circuit in rail tracks can be applied to PLC transmission lines of PLC.

2 Rail track PLC system

2.1 System concepts

Communication system for safe railway transport system under the current railway operation system uses both wired and wireless communications, but main method to transmit safety information to the running vehicles is voice data transmission based on wireless communication. Thus, if the communication operation system has been added with safety information data, it could play an important role to increase prevention of safety accidents.

Rail track PLC is performed by overlapping from several to tens of MHZ high-frequency modulation signals on return circuit line by using PLC modem and signal coupler. Fig. 1 represents the rail track PLC concept design in electric railway. In this figure, the power supply system at the substation creates a closed circuit with the rail track, the electric car, and the power line. By using this system, electricity flows into the railway substation through the return circuit rail. The system consists of the signal coupler, PLC modem, function generator, and CCTV.

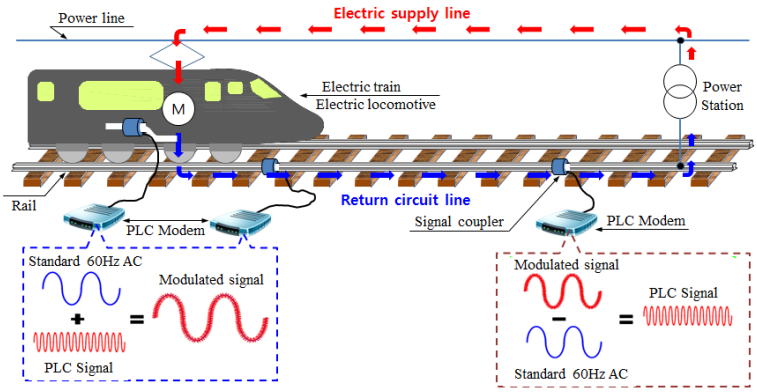

Fig. 1. The schematic diagram of concept on rail track PLC

2.2 Experimental Method

To implement PLC using the rail track, it is necessary to evaluate communication propagation characteristics of that in field. Fig. 2 represents the photos and schematic drawing of a rail track PLC test conducted by KORAIL. The signal coupler was connected to one side of the rail track. Propagation characteristics from an electric

locomotive with an increase of track distance were evaluated. The transmission characteristics according to distance were obtained by measuring a 50 m section 5 times in 10 m spaces.

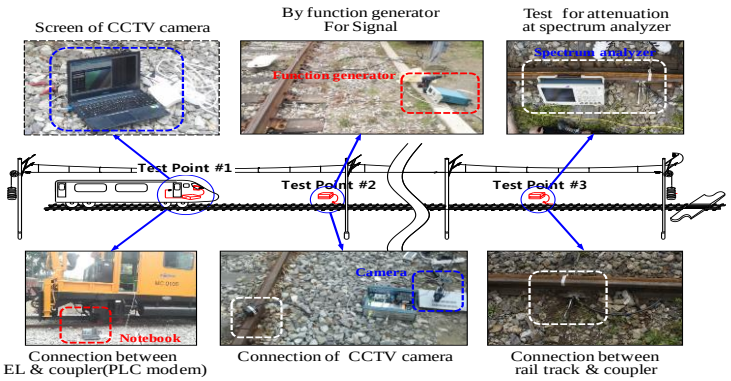

Fig. 2. Actual measurement experiment and schematic drawing of rail track PLC

3 Experimental results

3.1 Propagation characteristics with the distance of track

Fig. 3 represents the maximum attenuation trend in the full range of the 20 MHz frequency at 10 m. As the frequency increase, the signal attenuation rate decreases a minimum of -10 dBm to a maximum of -45 dBm.

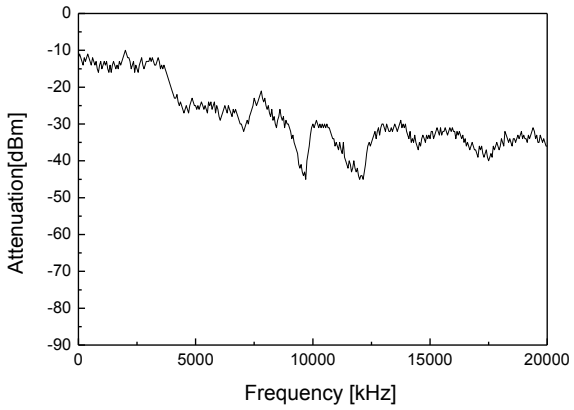

Fig. 3. Attenuation measurement schematic diagram at all bands at 10 m

Fig. 4 represents the changes in signal attenuation in 50 m of rail. The signal attenuation at each frequency of 5, 10, 15, and 20 MHz is approximately constant within 5%. This result shows that rail track is possible to use commercially within the signal attenuation threshold of -70 dBm [3].

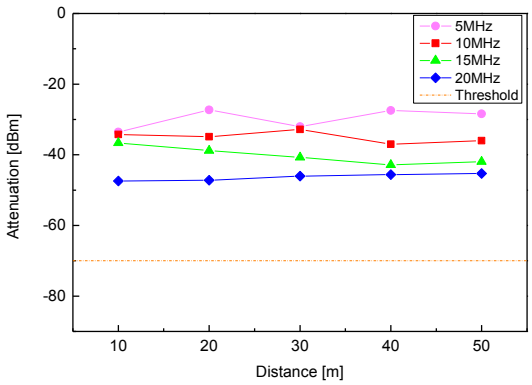

Fig. 4. Attenuation variation with track distance

4. Conclusion

This study examines the PLC channel characteristics of rails. The signal attenuation at each frequency of 5, 10, 15, and 20 MHz is constant within 5%. This result shows that PLC using 50 m of rail track is possible to apply commercially within the signal attenuation threshold of -70 dBm.

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