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A Review on Application of Narrowband Power Line Communication In Medium Voltage Smart Distribution Grid

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Abstract-*In this paper we give an overview of the application of narrow band power line communication in medium voltage smart distribution grids over its research, applications, standards and importance. Traditional information transmission techniques have its limitations of cost and availability to reach the maximum number of users. The power line communication is a solution to fulfill demands of today's requirement in the field of information communication. In this paper, a survey on basics of narrow band power line communication (PLC) using KQ330 module, their classification, advantages, issues and applications are presented.*

Key Words: Power line communication, narrow band, KQ330 module

1. INTRODUCTION

Power-line communication (PLC) is a communication method that utilizes existing public and private power line to carry both electric power and data simultaneously [1]. Powerline are usually classified as high (>100kV), medium (1 to 100 kV) and low (<1kV) networks. The advantage of using electric power lines as the data transmission medium is that every building and home is already equipped with the power lines that are connected to the power grid. Utilization of power line for transmission of power and data can also be referred as power-line carrier, powerline communications, power-line digital subscriber line (PDSL), mains communication, power-line telecommunications, or power-line networking (PLN). PLC can be achieved through premises wiring within a single building and or can be between two levels i.e. both the distribution network and premises wiring.

In PLC, power line is transformed into a channel through the superposition of a low energy information signal to the power wave. Figure 1 shows the power line communication system. It shows the basic structure of PLC model.

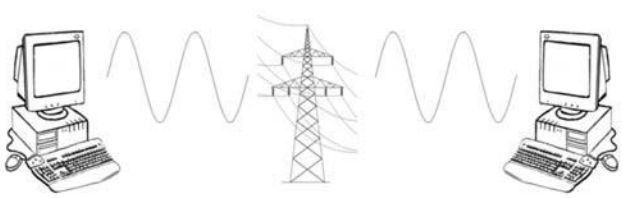

Figure 1 Power line communication system.

Functional blocks of a system are shown in Figure 2.

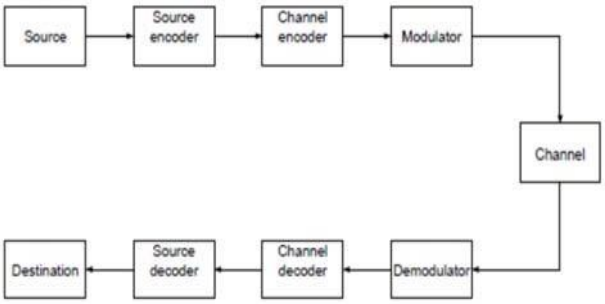

Figure 2. Functional blocks of a PLC system

The frequency range used for PLC narrowband applications is 3 kHz to 148.5 kHz and from 1 MHz to 30 MHz for PLC broadband applications. PLC can be categorized on the basis of their applications as narrowband PLC and broadband PLC. There are four forms of PLC.

- In narrow band, In-house power wiring can be used for low bit rate services like home automation and intercoms.
- Narrowband outdoor applications are mainly used by the utility companiesfor automatic meter reading, remote surveillance and control.
- Broadband In-house networking which utilizes mains power wiring for transmission of data in home networking.
- Broadband over power line (BPL) systems provide high-speed communications capabilities by coupling radio frequency (RF) energy onto the power line and offer broadband internet access.
- The biggest problem for PLC is interference as the power wiring is unshielded and untwisted. The wires act as an antenna which emits large amounts of radio signal. This will cause interference to the existing users of the same frequency band. Noises/disturbances are unwanted signal introduced to PLC at any stages [4]. These signals reduce the performance and reliability of PLC. There are many different sources of noises and disturbances in power line networks. In general, it is very difficult to predict noises present in networks. On high voltage networks, channel noise may be due to

atmospheric or static discharges, lightning, circuit breaker operations or transients within a power station. On medium voltage networks, the on and off switching of capacitor banks used for power factor correction may cause high noise peaks. On low noise voltage networks, some household devices or office equipment contribute the noise [5]. Second issue with PLC is that of security. PLC also suffers from data attenuation problem due to the presence of numerous elements on a power line network. The cost of a power line network modem is high as compared with modem used to connect phone line with network.

2. PLC USING KQ330 MODULE

The advantages of using the KQ 330F Module is that all the components are designed to work with the existing power lines. KQ 330F Modules are widely available, and the range of devices that are available provide a variety of applications that can be achieved using simple plug-in or wire-in modules.

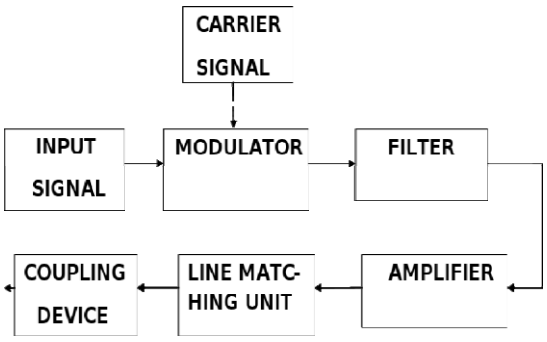

Figure 1. EPLCS TRANSMITTER

The basic block diagram of the transmitter for data communication using power line carrier communication system is shown in Fig. 1 .The existing electrical layout is used to transmit the data or command for the proposed control system from one point towards other without any interference in the electrical signal within the same house. The system can be used to transmit a data signal in the frequency range of 3 KHz to 148.5 KHz

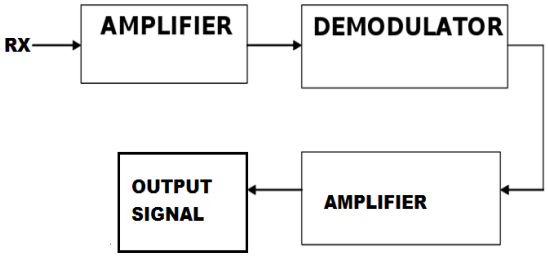

Figure.2. EPLCS Receiver

Since we are using a PLC which is a data communication device. The data code generated is modulated using any of the popular modulation techniques and after that it is fed to the amplifier. Later the signal enters to the power line through the interface circuit that includes a resistor and a capacitor i.e. Line matching unit and coupling device. The coupling capacitor is used so that we can couple the 5V signal to the 230V signal so that the circuit will not get disturbed

The basic block diagram of the receiver for data communication using power line carrier communication system is shown in Fig. 2.

The data that is received is first fed to the amplifier to strengthen the weak signal and then it is given to demodulator then we get the original message signal systems as already stated are classified on the basis of services provided by them i.e. Communication over high voltage grid, access to an internet provider, in-home networking with high data rate and in-home simple control application with low bit rate. These are few key areas where PLC is utilized [6] [7] [8]:

- PLC was first adopted for transmission of electrical signals and information data at a fast rate.
- PLC finds applications in controlling home appliances and automation. The technology can be applied to reduce the resources.
- Multimedia contents can be distributed through PLC throughout the home.
- Data transmission for different types of communications like telephonic communication, audio, video communication can be made with the use of PLC technology.
- In monitoring houses or businesses through surveillance cameras, PLC technology is far useful.
- Automatic Meter reading applications use the PLC technology to send the data from home meters to Host Central Station.

3. ADVANTAGES OF PLC

PLC systems are associated with a number of advantages [9] [10]. Few of them are listed below:

- PLC uses the existing electrical network for communication. So the cost of installation is lower than other communication system.
- Availability of communication service can be everywhere outlets exist.
- For internal communication of electrical utilities, remote measuring and control task high, medium and low voltage supply have been used.
- High data transfer rate (up to hundreds of Mbps) can be achieved through PLC.

4. STANDARDS

Home Plug and CENELEC standards are the most popular standards for high data rate and low data rate PLC system.

Several competing standards are evolving as indicated below:

European Telecommunications Standards Institute (ETSI) power-line telecommunications (PLT): This provides necessary standards for voice and data services over the power line transmission. Interoperability aspects are also discuss [2].

Home-Plug Power-Line Alliance: It is a global organization consisting of some 65 member companies. The main aim of this is to enable and promote rapid availability, adoption and implementation of cost-effective, interoperable and standards- based home power-line networks and products. The resulting standards are expected to offer best performance. The Home Plug Power-Line Alliance has defined some standards like,

(a) Home Plug 1.0 – specification for connecting devices via power-lines in the home,
(b) Home Plug AV – designed for transmitting high definition television (HDTV) and VoIP around the home,
(c) Home Plug BPL – a working group to develop a specification for to-the-home connection and
(d) Home Plug Command and Control (CC) – command and control a specification to enable advanced, whole-house control of lighting, appliances, climate control, security and other devices[3-5]

Institute of Electrical and Electronics Engineers (IEEE): the standards are due to the IEEE BPL Study Group. Some of those standards are:

(a) IEEE P1675 'Standard for Broadband over Power-line Hardware' is a working group working on hardware installation and safety issues.
(b) IEEE P1775 'Power-Line Communication Equipment – Electromagnetic Compatibility. (EMC) Requirements – Testing and Measurement Methods' is a working group focused on PLC equipment, EMC requirements and testing and measurement methods.
(c) IEEE P1901 'IEEE P1901 Draft Standard for Broad-band over Power-Line Networks: Medium Access Control and Physical Layer Specifications' is a working group for delivering BPL. The aim is to define medium access control and physical layer specifications for all classes of BPL devices – from long distance connections to those within subscriber premises [6-8, 9].

5. ISSUES IN PLC

The performance of any PLC system is found to be Dependent upon time, location and wiring topology. Even Communication signaling can only be implemented within the area serviced by one transformer [11] [12].

Design Issues: The power line carrier was not designed for data transmission and provides a harsh environment for it. Variable impedance, noise and high levels of frequency dependent attenuation are the main issues.

- Security Issue- powerline are actually not meant for secure data transfer.
- Lack of global standards: there are several different standards for PLC.
- Varying Channel Model: The channel may be described as random and time varying model.
- Dependency over location of transmitter and receiver: The location of the transmitter or the receiver could also have a serious effect on transmission error rates.
- Reflection, Multi-path Fading and Attenuation: Reflection due to various impedance mismatches, multi-path fading and attenuation/transmission losses are other issues with PLC which affects their performance and implementation

6. MODELING THE POWERLINE CHANNEL

A power line model is considered as a black box described by transfer function and the method to modeling the transfer function the PLC uses the chain parameter matrices describing the relation between input and output voltage and current of two-port network. Actually channel modeling consists of investigating the characteristics of the power network as a communication channel. Bridge taps with different cable lengths and cable types which exists along the transmission line forms a power line network made of sections. For a PLC network with several sections, the transfer function for the whole network will be same equation; however, the transmission matrix for the system differs. PLC channels suffer from a number of technical problems, chief among them are:

- High interference due to noisy loads,
- Time and frequency varying attenuations offered by the medium,
- Dependency on location, network topology and connected loads,
- High non-white background noise and impulsive noise and
- Electromagnetic compatibility (EMC) issues that limit available transmitted power.

Since PLC differs considerably from other well known channels, so special care is required to select a modulation scheme that uses potentially high capacity of these channels optimally and also offers robustness against noise. The selection of modulation mainly depends upon:

noise/ impulse disturbance, frequency selective nature of channel and regulatory constraints.

7. CONCLUSION

The idea of using the power line for exchange of information is not new at all. PLC is a medium that allows the exchange of information by means of the power line that are present in and around us. The use of this medium made it possible to compete against the traditional data service provider. Information can be transmitted through the power line with high bit rates. However, the main purpose of PLC is management, control, and supervision of power plant and distribution facility operation. The issues associated with PLC can be overcome by modern modulation methods and by setting global standard for using it.

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