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NEW WAY OF PASSIVE RFID DEPLOYMENT FOR SMART GRID

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ABSTRACT

This article focuses on RFID technology over Power line for smart grid using exclusively passive tags, that operate in the low frequency bands 125 kHz and high frequency bands 13.56 KHz , passive tags are the most common, least expensive, and they have a virtually unlimited life. This solution for Smart grid is secure; it presents a new way of automatic identification with low voltage, low deployment costs and high reliability. This Smart RFID for Smart Grid helps to monitor and control electricity consumption. It can be used in many applications such as ticketing and Payment and charge energy for electric vehicles in smart home appliances such as the smart refrigerators and residential door keys.

Keywords: *RFID; PLC; Smart Grid; passive tags; Automatic identification.*

1. INTRODUCTION

In order to monitor, manage and control the production, distribution and consumption of electricity, an infrastructure Smart Grid is presently being deployed. Smart grid is a system of systems that integrates information and communication networks technologies with the traditional electrical power grid [1]. Moreover it has the potential to reduce carbon dioxide emissions through the integration of distributed renewable energy resources, energy storage, and plug-in hybrid electric vehicles. Further, it made a prediction before responding to electrical needs of suppliers and consumers.

A typical wired communication method in the Smart Grid is Power Line Communication (PLC), which refers to transmitting high-speed data (2–3 Mb/s) on the same conductor that is used for electric power transmission.

RFID is an automatic identification technology that uses radio-frequency radiation to identify objects bearing tags. It consists of a reader which transmits a signal according to a carrier frequency, to one or more tags within its scan field. There are three types of tags , the first are the passive tags, they are powered by the energy provided by the reader, the antenna captures certain frequencies from the reader who provide enough energy to allow it to issue in turn its unique identifier, the second type are the active tags contain an internal battery used to operate the chip and to broadcast a signal to a reader, the third are the semi passive tags: they act as passive tags in communication, but their battery allows them, for example, to record data during transport.

The technology introduced in this document is Smart RFID for Smart grid based on passive RFID tags connected to Power Line Communication. The development of this latest technology presents a new way of automatic identification with low voltage, low deployment costs and high reliability. The system can be used for various applications such as cashless payment [2], ticketing for public transportation [3], and residential door keys.

The rest of this paper is organized as follows: Section II is interested to related work; Section III describes passive RFID tags connected to Power Line Communication for Smart Grid; Section III describes Smart RFID technology for Smart Grid; followed by conclusion in section III, and finally the acknowledgment.

2. RELATED WORK

After the research we have done, we found several articles that are concerned about RFID over power line among them:

- Chris Diana et al [5] developed an idea to decrease the strain on the power line infrastructure, this idea based on the application of Power Line Data Transmission to Power on

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Demand, PoD systems can be implemented to supply the consumers on the grid with the amount of energy that they need at any time, and this amount can be varied at any moment. they envision a system, where the consumer would go to Meter Man's interface and choose to increase or decrease his power consumption level, and Meter Man would send a signal to the electric company advising them of the change in demand and the system identifies users by RFID.

- Joerg Huettner et al [4] proposed to use low frequency passive RFID communication connected to the Power Line, the technology allows the identification of devices connected to the grid by equipping the tag with additional sensors.

- Takanori Washiro [3] present the advantages of RFID technology over Power Line compared to conventional RFID technology, RFID over Power Line transmits data simply via power line, it does not require an antenna to transmit data, then the author presents the different applications of the technology for Smart Grid.

3. PASSIVE RFID CONNECTED TO POWER LINE

This section is interested in the passive RFID tags that operate in the low frequency bands 125 kHz and high frequency bands 13.56 KHz connected to Power Line.

- RFID over Power Line:

Power Line Communication is used to connect devices with cables that are also used to simultaneously transmit power to consumers in order to send and receive data at high speed and with a minimum of interference by certain modulation techniques.

The system as show in figure1 [6] consists of a reading unit (reader / writer) and RFID tags chip integrated into appliances and connected to the supply line, the Reader / Writer transmitted continuously digitized signals to scan an area of Smart Grid, these signals will be transferred by the power lines that act as a receiving antenna and AM broadcast stations when the connector of appliance is inserted to the electrical outlet which allows the high speed data transmission.

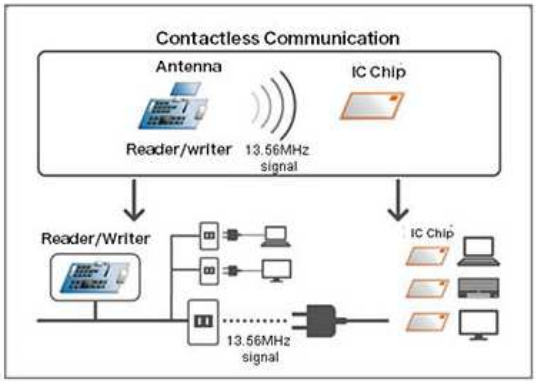

Figure 1: RFID over Power Line principle [6]

The authentication operation between the reader and the tag can be done in a passive manner without the need to provide electricity to cables .Therefore, RFID over Power Line realizes a security gate of the electricity, which supply electricity only after confirming the connected apparatus has the right to use it, and does not supply electricity when it does not.

- Modulation:

The modulation signal is the second step after encoding made by the transmitter in the preparation for RFID communication over Power Line. By symmetry, the phase modulation involves a demodulation phase signal to the reception of the RF response signals. Methods of modulation and demodulation signals are, of course, symmetrical.

In the passive RFID system, reader supplied energy to the tag by performing a modulation of the carrier; Modulation ASK is the most used, it is a good compromise between simplicity of the detection circuits of the transponder side, a good signal to noise ratio and good transmission rate. In the sense transponder to the reader, the transponder that is not an issuer will have to be capable of understanding the reader why he will use the technique of load modulation implemented in most transponder market, ensuring sufficient carrier signal remains for its own power supply.

Load modulation is the process of the activation and deactivation of an additional resistance in the transponder chip by transformation between the reader antenna and the coil of the tag that can generate a pulse frequency by which the data is transmitted to the reader.

The figure 2 shows that a change of the load impedance at the tag is transformed through the communication channel to a change of impedance at the reader.

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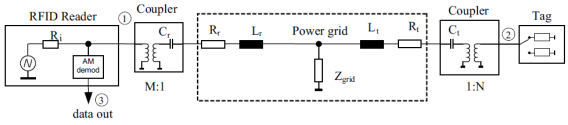

Figure 2: RFID communication over Power Line [4]

The situation changes radically when considering Zgrid an impedance in parallel to the tag's load impedance, the result of ASK modulation would be reduced to as little as 1% and the total voltage at the tag or at the AM demodulator input would be reduced to approx 1/25 th of the generator voltage, which is too low to power the tag. In order to preserve the load modulation, it is necessary to perform impedance and voltage transformations using an up-transformer on the tag side can increase the voltage level at the tag, and it can create a significant load modulation even in parallel to the low grid impedance because it transforms the tag impedance down towards the grid side. Another transformation must be performed between the reader and the grid as known as conventional PLC technology [7]. The load modulation will then be up-transformed to 8/31, resulting in 64% ASK at acceptable voltage levels on the reader side (25% of the carrier voltage). These operations lead to a slight reduction in modulation degree due to impedance matching between the reader and the grid, as to significantly increase the demodulator output [4].

- Coupling circuit :

For low voltage Power Line, the coupling circuit is necessarily used to adapt the Power Line impedance to the modem impedance and also to transmit signals from high voltage RFID cards.

This typical circuit shown in the figure contains a band pass filter and two resonance circuits.

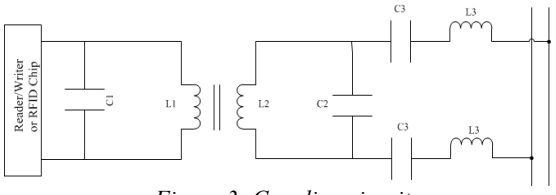

Figure 3: Coupling circuit

The two resonant circuits respond to resonance conditions and give us the following equations.

$$2\pi f = 1/\sqrt{L_1 C_1}$$

$$2\pi f = 1/\sqrt{L_2 C_2}$$

The importance of the filter is to prevent damage to the integrated circuits by high voltage power supplies and it is designed to meet:

$$2\pi f = 1/\sqrt{L_3 C_3}$$

4. SMART RFID FOR SMART GRID

Smart RFID is an evolution of RFID technology connected to Power Line system by using only passive RFID tags as described in the previous paragraph, it consists of an appliance that contains RFID IC chips, and a Smart pack which includes the reader / writer, power meter in real time, equipment for communication and relay switch.

The radio frequency signal runs through the power line; therefore, it is not necessary to "show" or "bring close" the appliance with the IC chip to the reader/writer in Smart pack. Smart pack sends a polling signal to the power line periodically. Once the plug of the appliance is inserted, identification transaction is completed in approximately 0.1 sec [3]. This system can be used for various applications within a Smart grid that require low complexity, low deployment costs and high reliability.

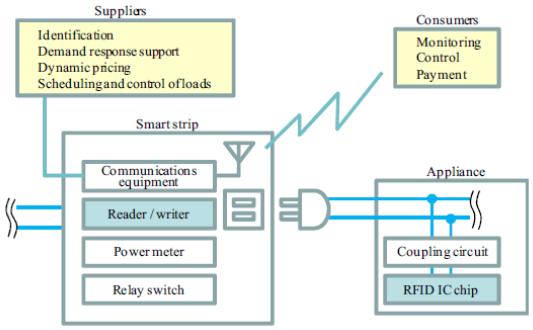

Figure 4: Smart RFID [3]

- Power meter:

The power meter can measure in real time the electric power consumed by the tag and generated by the reader; it can also record the data with ID information of the connected apparatus. Even if the connection status of apparatus changes, Smart Strip recognizes it automatically, and can acquire the data about which device consumed how much power, when, and where for each connected apparatus.

- Communication equipment:

A graphical user interface facilitates users monitoring and control of apparatus, it displays the data of all objects scanned within a designated area for suppliers, the data are in a suppliers server, a

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connection can be established to this server by using PLC, Ethernet, WiFi or Zigbee, so suppliers can manage the reactions of demand, dynamic pricing, and load schedule, according to data collected by the Smart pack.

- Relay Switch:

Relays can be used to allow low power electronic or computer type circuits to switch relatively high currents or voltages both "ON" or "OFF".

5. CONCLUSION

In this article we gave a state of the art in RFID over Power Line using only passive tags, the tags most used in many applications around the world.

The improvements provided by this technology are major, it allows automatic identification with a relatively low price, a saving in wiring and high reliability, to control and monitor the power energy Smart RFID measures in real-time the energy consumed by the tag and generated by the reader. This technology for Smart grid is more secure compared to classic RFID technology using an antenna connected to a chip, it realizes a security gate of the electricity, which supply electricity only after confirming the connected apparatus has the right to use it, and does not supply electricity when it does not.

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