

Utilization of Power Line for Remote Control of Electrical Appliances

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Abstract: - The goal of this work is studying of the possibilities and properties of the data transfer via power lines. The work deals with remote control of the electrical appliances and problems of data transfer via power line 230 V. The designed devices which provide relative communication via power line are used within the frame of the one family house. Designed devices - concretely input-output unit, PC interface and GSM gate work on a bus principle. The bus is constructed by power line 230 V. Designed devices are composed of microcontrollers AVR and modem TDA5051AT provides their relative communication via power line. Communications protocol with which devices work was developed so that corresponds with hardware resolution of particular devices. Particular devices were practically realized and their activity was checked.

Key Words: Power line, interface, GSM gate, remote control, wireless, communication protocol

1 Introduction

The principle of data transmission through power line was described in the first half of the twentieth century. This idea to use power lines to data transfer is relatively old but the first tests were made 20 years ago. The data transfer via power lines can be used in computer areas, building automation or industrial automation. The mentioned technology brings a lot of advantages. The main priority of this technology is using of installed power cable to data transfer, so there isn't necessity to install data cable. On the other side the system for data transfer is very sensitive towards a signal noise. These disadvantages are caused by the fact that power lines are not designed for data transmission, unlike the commonly used means of data communications.

This paper describes design of system for remote control of electrical appliances via power line 230 V. The paper is organized as follows: Section 2 contains principle of physical data transfer via power line; Section 3 presents utilization of power line in data transfer; Section 4 explains basic requests on transmission equipment in power line and Section 5 describes design of bus system for remote control of electrical appliances via power line 230 V. Last section presents results reliability of data transmission via power lines.

2 Principle of Physical Data Transfer Via Power Line

The basic principle of data communication via power lines 230 V can be designed according to the model ISO/OSI. The applied protocols and services of individual layers of the model ISO/OSI are dependent on

data transfer character. The physical data transfer use rules of communication engineering, it means rules of telecommunications and radio-communications. The communication system is the set of devices that realize optimal data transfer via power lines. The principle of the communication devices setting is shown in Fig. 1. The information in power line system are transferred via serial transmission. Outgoing information is decomposed on serial bit sequence. This sequence goes to coder, the coder encodes separate bits to potential pulses (data encoding Manchester). By the help of the modulator the transfer current pulses are modulated in order to safer transfer. The modulator uses analogue type of modulation with discreet modulation signal (ASK, FSK). The coupled circuit is separate part on communication system and is used as a band – elimination filter. It means that this part transmits only frequency band of modulated signal, the rest of frequency spectrum is blocked. This part galvanic separates transceiver and receiver. The data between coupled circuits are transferred via power lines. The data transfer can be designed as full-duplex mode or half-duplex mode.

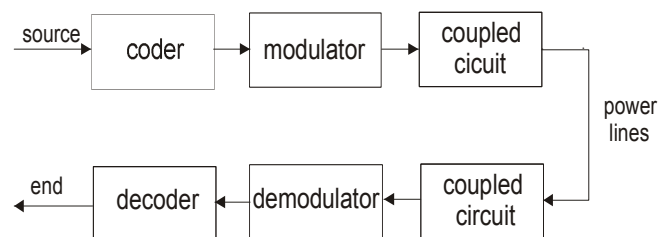


Fig. 1. Setting of communication parts in power line system

3 The Utilization of Data Transfer via Power Line

3.1 Automation

The data transfer via power line is widely used in the areas of building automation and industrial automation. Due to a lower speed data transfer the mentioned principle is suitable for control of slower systems. The means for communication via power lines allow to create an open bus systems. These systems are used for control and monitor heating, lighting, air conditioning or different machines. These bus systems can be equipped with means for remote control via GSM network or the Internet. Everything depends only on the used means of communication via power lines and appropriate software.

Table 1. Frequency bands for data transmission via power lines (CSN EN 50065-1).

Band	Transmission bandwidth [kHz]	Purpose
	3 - 95	for provider of electrical energy
A	9 - 95	for provider of electrical energy and with agreement of customer
B	95- 125	for customer of electrical energy
C	125 - 140	for customer of electrical energy with agreement
D	140 – 148,5	

3.2 Computer Network

In the field of computer networks the power lines can be used for the Internet distribution or for the construction of local area networks. Among the interesting applications of data transmission via the electricity distribution network is the Internet connection. The data transfer rate decreases with increasing distance in power line. The speed of communication in such a network can be about 14 Mbit /s.

4 Basic Requests on Transmission Equipment in Power Line

The system requirements on transmission equipment via power line are as follows [1]:

- maximum speed of data transfer
- to conserve original function of power lines – energy transfer
- electromagnetic compatibility.

4.1 Frequency Band Used for Data Transfer in Power Line

In Europe four frequency band are used for data transfer via power lines [1]. Because of noisy in power lines (noisy of electromotor, noisy of thyristor regulator etc.) the low frequency boundary for data transfer is 100 kHz [3]. In Table 1 are described frequency band for data transfer via power line.

4.2 Source of Noisy

The most frequent source of noisy in power lines are:

- pulse source – often used in consumer electronics (from 15 kHz to 1 MHz)
- thyristor regulator – used in speed control (from 100 Hz to 120 Hz)
- serial motor – used in household
- communication of distribution company.

5 Design of Bus System for Remote Control of Electrical Appliances via Power Line

Essential features of designed bus system are:

- applicable for remote control (switch on/off mode)
- maximum of working reach – 400 m
- remote control via PC, GSM network, input/output unit
- opened system (maximum of connecting equipment is 254)
- transfer path – power line 230 V (supply system TN-S, TN-C)
- non-standard communication protocol
- system correspond to norm CSN EN 50065-1 [2].

Structure of the bus system is shown in Fig. 2. The system contains three types of modules. There are:

- input – output unit PLM 16 IO
- PC interface PLM 162 PCI
- GSM pager PLM 162 GSM G.

PC interface is unit between PC and designed bus system. By the help of designed program there is possible to monitor data transfer in power line system and to configure individual equipment of the bus system. GSM gate with mobile phone Siemens x35 (or another mobile type) via GSM network is used for remote control of individual equipment of the bus system [4,5]. Input – output unit contains binary inputs and outputs, relay outputs, seven inputs pro temperature sensors, A/D converter. By the help of this unit is possible to control of individual inputs of bus system equipments.

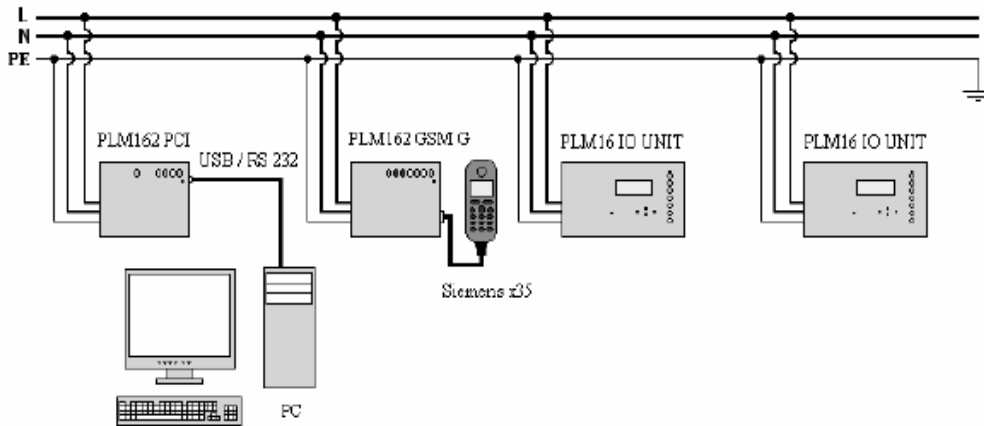
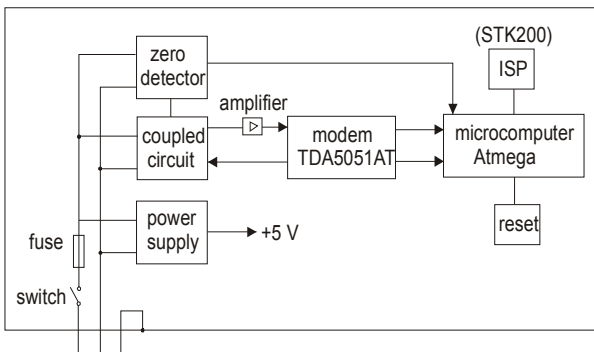


Fig. 2. Structure of design bus system

All designed modules have common features that can be described as follows:

- equipments are handled with microcontrollers AVR (Atmega 162, Atmega 16) [6,7]
- modem TDA 5051 AT is used for data transfer via power line
- equipments are supplied via 230V
- equipments are handled with zero detector.



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Fig. 3. Main elements of individual models

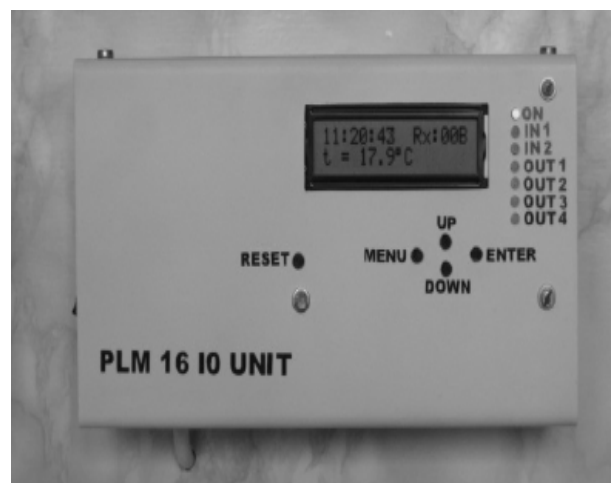


Fig. 5. Input – output unit



Fig. 6. GSM module

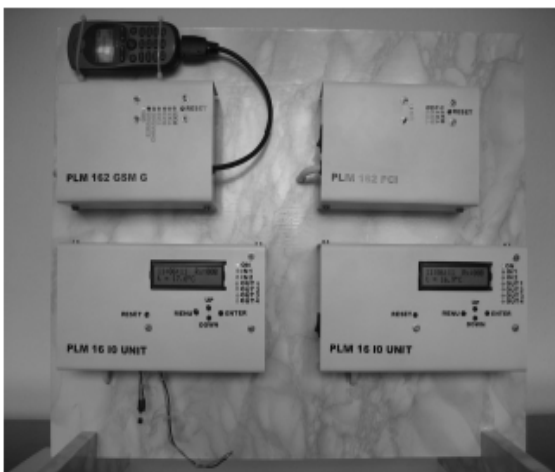


Fig. 4. Designed bus system

6. Modules Testing

For testing of reliability of the designed system the framework with data was used. This framework was sent by the help of testing program and the receiving correct data by a receiver was periodically checked [8].

The sent and received data during testing were reset periodically, the reset period was 60 s.

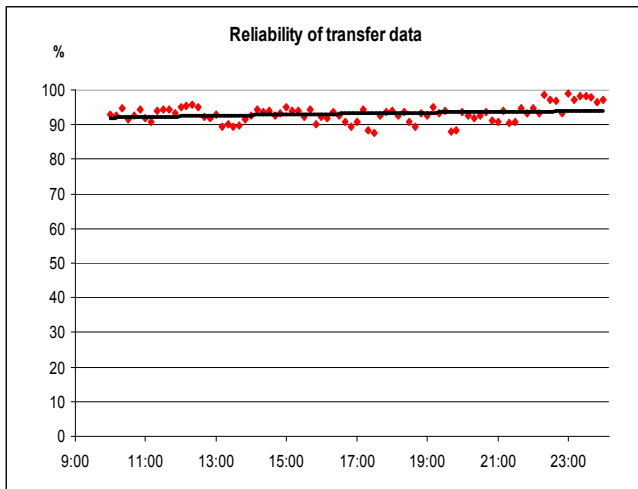


Fig. 7. The reliability of transfer data during a day in flat, the distance between the transceiver and the receiver 25m

The main reason of testing was measuring of transfer reliability depending on distance between of the transmitter and the receiver. The influences of disturbing sources plug in power lines are shown in Fig. 7 and Fig. 8.

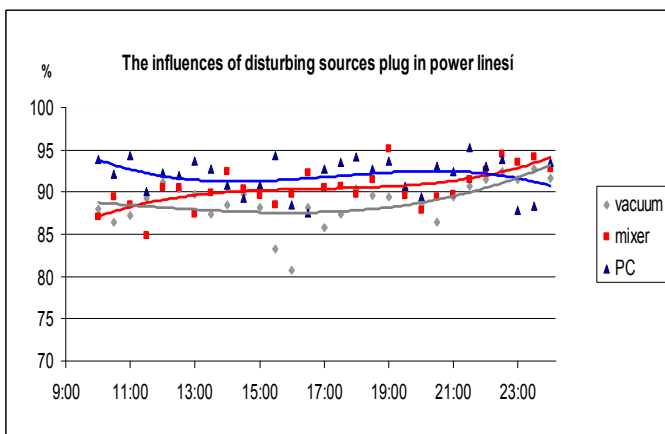


Fig. 8. The influences of disturbing sources plug in power lines, the distance between the transceiver and the receiver 25m

7. CONCLUSIONS

The designed device offers reciprocal communication via power lines within the frame of family house. Application of the proposed system helps to simplify electrical set and to some rates will also increase user experience. The advantage of the proposed system is also the fact that the various inputs and outputs are connected only with the software and electrical become inflexible. Some requests for change can be addressed

only by changing configuration device. As an advantage of the proposed system can be observed and its low price, compared with other similar systems.

The designed equipment is based on a bus principle, the power lines are base of the bus line. The bus system is acceptable for control of electric appliances. The control of electric appliances is practicable by the help of GSM system or personal computer.

Designed system generally could find large use in the area of buildings technology. Especially in the areas where is needed to solve tasks of remote control or remote monitoring. For example, remote control and monitoring of heating, air-conditioning, lighting and etc. Technology transfer data over the electricity distribution network brings many benefits. Particularly significant cost savings for the wiring and its installation, may contribute to simplifying and clarifying the wiring. Furthermore, systems working with data transmission through the electricity network are usually very easy to install. The disadvantages of data communications through the electricity grid in general are prone to all sorts of interference, limited bandwidth, where the higher cost of transmission equipment.

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