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REMOTE CONTROL OF ELECTRICAL APPLIANCES VIA POWER LINE 230V

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Abstract – The presented work deals with problems of data transfer via power line 230 V for the purposes of remote control electrical appliances. The devices providing relative communication via power line for a one-family house were designed and assembled. The designed devices, namely the input-output unit, PC interface and the GSM gate, work on a bus principle. The bus is constructed by power line 230 V. The designed devices are composed of the AVR microcontrollers and their mutual communication via power line is provided by TDA5051AT modem. Communication protocol, with which the devices work, was developed so that it corresponds with hardware resolution of particular devices. The particular devices were practically implemented and their activity was tested.

Keywords: power line, remote control, wireless

1. INTRODUCTION

Nowadays, there is an increasing demand for power monitoring and control through home networks for electric home appliances. The most widespread methods today are RS-232 hardware, IP-based device and radio frequency (RF) or bluetooth technologies [1]. However, the implementation of the named home power management requires new wiring for both networked electric home appliances and home networks. For this reason, new methods have been intensively investigated, one of them being the use of power lines.

The idea to use power lines to data transfer is relatively old. The first tests were made 20 years ago, but the principles were described as early as the first half of the 20th century [2]. 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 advantage of this technology is the use of installed power cable for data transfer, so there is no need to install data cable. On the other hand, the system for data transfer is very sensitive to a signal noise [3].

This paper describes the design of a remote control system for electrical appliances via power line 230 V. The paper is organised as follows: Section 2 contains the principle of physical data transfer via power line; Section 3 presents the basic requests on transmission equipment in the power line and Section 4 describes the design of the bus system for remote control of electrical appliances via power line 230 V.

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 ISO/OSI model are dependent on the data transfer character. The physical data transfer uses the rules of communication engineering, it means the rules of telecommunications and radio-communications. The communication system is the set of devices that realize the optimal data transfer via power lines. The principle of the communication devices setting is shown in Fig. 1.

The information in the power line system is transferred via serial transmission. The outgoing information is decomposed into a serial bit sequence. This sequence goes to the coder; the coder encodes the separate bits to potential pulses. In our case, data encoding Manchester was used which is a widely used code (e.g. in Ethernet). It ensures frequent line voltage transitions directly proportional to the clock rate, which helps clock recovery [4]). With the help of the modulator, the transfer current pulses are modulated in order to provide a safer transfer. The modulator uses the analogue type of modulation with discreet modulation signal (ASK, FSK). The coupled circuit is a separate part of the communication system and is used as a band–elimination filter. It means that this part transmits only the frequency band of the modulated signal, the rest of the frequency spectrum is blocked. This part galvanically separates the transceiver and the receiver. The data between the coupled circuits are transferred via power lines. The data transfer can be designed as a full-duplex mode or a half-duplex mode.

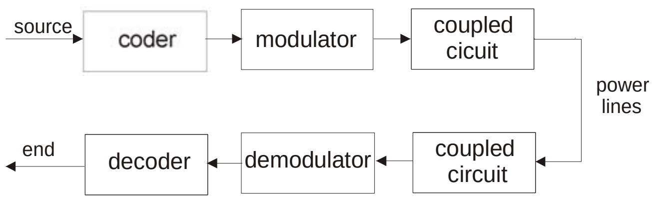

Fig. 1. Setting of the communication parts in the power line system

3. BASIC REQUESTS ON THE TRANSMISSION EQUIPMENT IN POWER LINE

The system requirements on the transmission equipment via power line are as follows [5]:

- maximum speed of data transfer
- preservation of the original function of power lines – energy transfer
- electromagnetic compatibility
- compliance with the norm CSN EN 50065-1 [6].

3.1. Frequency band used for data transfer in power line

In Europe, four frequency bands are used for data transfer via power lines [5]. Because of noise in power lines (noise of electromotor, noisy of thyristor regulator etc.) the lowest frequency limit for data transfer is 100 kHz [2]. The frequency bands for data transfer via power line are described in Table 1.

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

Band	Transmission bandwidth [kHz]	Purpose
	3 - 95	for electric power providers
A	9 - 95	for electric power providers and with customer agreement
B	95- 125	for electric power customers
C	125 - 140	for electric power customers with provider agreement
D	140 – 148,5	

3.2 Sources of noise

The most frequent sources of noise 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.

4. DESIGN OF THE BUS SYSTEM FOR REMOTE CONTROL OF ELECTRICAL APPLIANCES VIA POWER LINE 230V

The essential features of the designed bus system are:

- usability for remote control (switch on/off mode)
- maximum working range – 400 m
- remote control via PC, GSM network, input/output unit
- open system (254 connected equipments at the maximum)
- transfer path – power line 230 V (supply system TN-S, TN-C)
- non-standard communication protocol
- compliance with the norm CSN EN 50065-1 [6].

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

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

The **PC interface** is a unit between the PC and the designed bus system. With the help of the designed program it is possible to monitor data transfer in the power line system and to configure individual equipment of the bus system.

The **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 [7,8].

The **Input – output unit** contains binary inputs and outputs, relay outputs, seven inputs pro temperature sensors, and an A/D converter. With the help of this unit it is possible to control individual inputs of the bus system equipments.

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

- equipments are handled with microcontrollers AVR (Atmega 162, Atmega 16) [9,10]
- modem TDA 5051 AT is used for data transfer via power line
- equipments are supplied via 230V
- equipments are handled with zero detector.

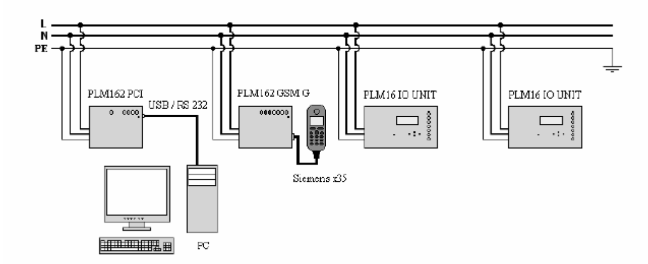

Fig. 2. Structure of the bus system

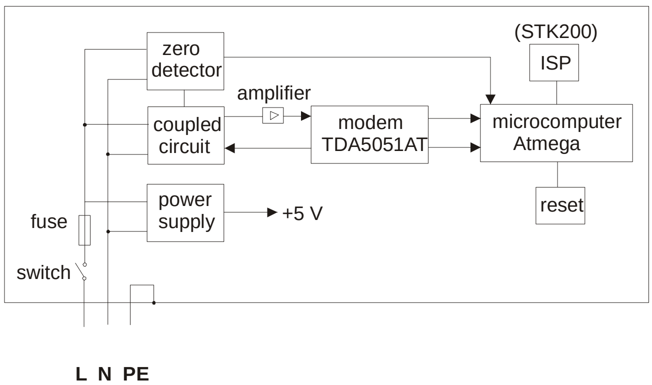

Fig. 3. Main elements of the individual models

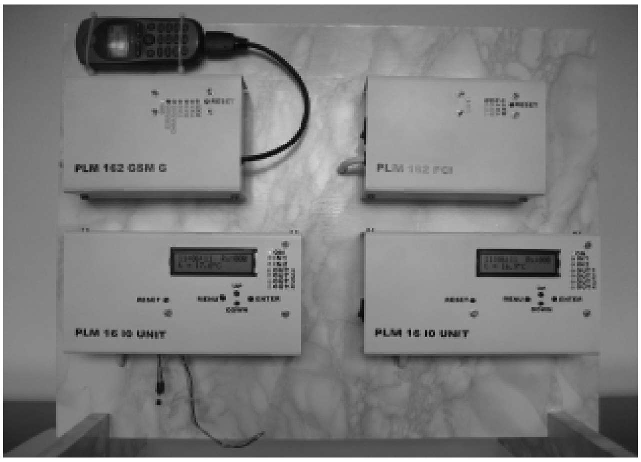

Fig. 4. Designed bus system

Fig. 5. Input – output unit

5. MODULES TESTING

A data framework was used for testing of the reliability of the designed system. This framework was sent by the testing program and the receiving of correct data by a receiver was periodically checked [11, 12].

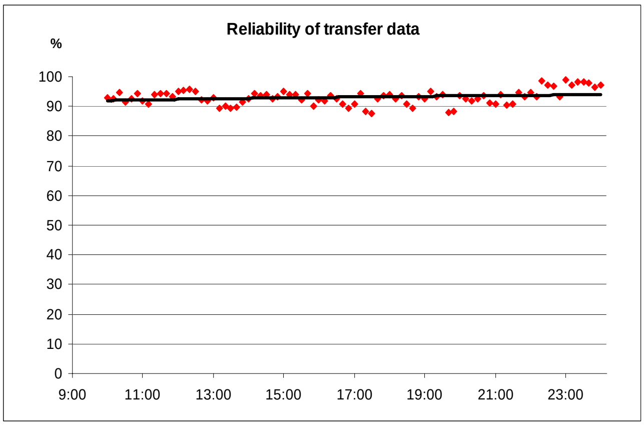

Fig. 6. The reliability of transfer data during a day in a flat, the distance between the transceiver and the receiver 25m

The sent and received data during the testing were reset periodically; the reset period was 60 s. The main reason of testing was the measurement of transfer reliability in dependence on the distance between the transmitter and the receiver. The influences of disturbing sources in power lines are shown in Figures 6 and 7.

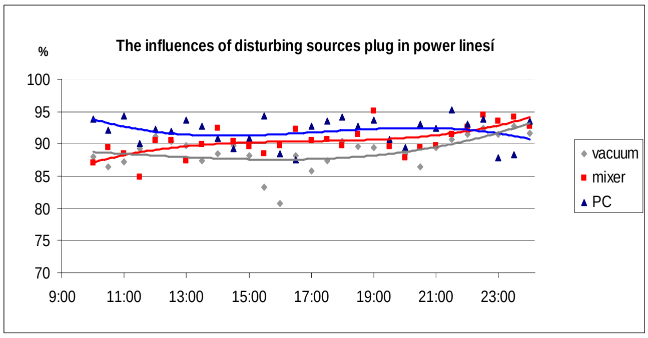

Fig. 7. The influences of disturbing sources in power lines, the distance between the transceiver and the receiver 25m

4. CONCLUSIONS

A device was designed and assembled, which offers reciprocal communication via power lines within a family house. The device is based on a bus principle. The bus system is designated particularly for remote control of electric appliances by a GSM system, a personal computer or directly from an input-output unit. Application of the systems will facilitate the electro-installation and increases the users' comfort. In practice, the developed system is suitable for controlling and monitoring of heating, air–conditioning or lighting in a family house.

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